

10th Annual Systems Engineering Conference
"Focusing on Improving Performance of Defense Systems Programs"

San Diego, CA
22-25 October 2007

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Agenda

Tuesday, 23 October 2007

Keynote Addresses:

- *Hon James Finley*, Deputy Under Secretary of Defense, Acquisition and Technology
- *Hon Charles McQueary*, Director, Operational Test and Evaluation

Plenary Session: Executive Panel:

- *Mr. Mark Schaeffer*, Director, Office of Under Secretary of Defense of Acquisition, Technology and Logistics; Director, Systems and Software Engineering

Panelists:

- *Mr. Terry Jaggers*, SAF/AQR – Science, Technology, and Engineering
- *Mr. Carl Siel*, Chief Engineer, Office of the Assistant Secretary of the Navy Research, Development and Acquisition
- *Mr. Doug Wiltsie*, HQDA, OASA (ALT)

Track 1

- "Update: OSD Systems Engineering Revitalization Efforts," Col Richard Hoeferkamp, USAF
- "The Effectiveness of Systems Engineering: On Federal (DoD) System Development Programs", Mr. Al Mink, SRA International
- "Tools and Resources to Enable Systems Engineering Improvement," Mr. Michael Kutch, SPAWAR Systems Center Charleston
- "Sound Systems Engineering Assures Proper/Early Producibility", Dr. Thomas Christian, Aeronautical Systems Center
- "Realization of Systems Engineering For the Future", Ms. Karen Bausman, AF Center for Systems Engineering

Track 2

- "Developmental Test & Evaluation Policy Vectors", Ms. Darlene Mosser-Kerner OUSD (AT&L)
- "Test Strategy Done Early Drives Test Planning and Successful Testing", Mr. William Lyders,ASSETT, Inc.
- "Applying Design of Experiments Methodology to Sortie Generation Rate Evaluation", Mr. Joseph Tribble,_AVW_"Implementing a Systems Engineering Risk Program in a Sustainment Environment", Mr. James Miller, USAF
- "Joint Safety Review Process Study", Ms. Paige Ripini, Booz Allen Hamilton

Track 3

- "DoD Systemic Root Cause Analysis", Mr. Dave Castellano, OUSD (AT&L)
- "Applying Systems Engineering During Pre-Acquisition Activities", Lt Col Mark Wilson, USAF
- "Reforming the DoD Acquisition Process—A Systems Engineering Approach", Mr. Stephan Ward, U.S. Air Force
- "The Effectiveness of Systems Engineering: On Federal System Development Programs", Mr. Alan Mink, SRA International

Track 4

- "Environment, Safety, and Occupational Health (ESOH)—Design Considerations to Support Sustainability and Readiness", Ms. Patricia Huheey, ODUSD (I&E)
- "Real-Time Diagnostics for High Availability Systems", Mr. Edward Beck, Computer Sciences Corporation
- "Sparing Satellites Comparative Strategies of On-orbit & In-factory Storage", Mr. James Mazzei, The Aerospace Corporation

Track 5

- "Acquisition M&S Master Plan Implementation Status", Mr. Michael Truelove, SAIC
- "Establish M&S-Related Guidelines for Solicitations, Source Selections, and Contracting", Mr. Michael Truelove, SAIC
- "Modeling and Simulation Resource Reuse Business Model", Mr. Dennis Shea, Center for Naval Analyses

- "Modeling and Simulation Support Plan", Mr. David Henry, Lockheed Martin
- "Modeling and Simulation Education for the Acquisition/T&E Workforce: Requirements Analysis", Mr. David Olwell, NPS

Track 6

- "The Use of Enterprise Architecture to Support the Development of the Next Generation Air Transportation System (NextGen)", Mr. David Synder, The MITRE Corp.
- "Complex Systems of Systems: The Dual Challenge", Mr. Phillip Boxer, Software Engineering Institute
- "Systems Engineering in the Cognitive and Social Domains of Net Centric Operations", Dr. Abe Meilich, Lockheed Martin
-

Track 7

- "Simplifying & Scaling Engineering Processes: Unifying Business Units and Engineering Disciplines", Mr. Raymond Jorgensen, Rockwell Collins
- "NAVAIR Systems Engineering Revitalization", Mr. Michael Gaydar, Department of Navy, NAVAIR
- "Integrating Engineering Project Management and Product Development Processes", Mr. Raymond Jorgensen, Rockwell Collins
- "Engineering for System Assurance—Legacy, Life Cycle, Leadership", Mr. Paul Croll, Computer Sciences Corporation

Track 8

- "DoD Software Engineering and System Assurance", Ms. Kristen Baldwin, ODUSD (A&T) Systems and Software Engineering
- "The Integrated Software and Systems Engineering Curriculum Project: Creating a Reference Curriculum for Graduate Software Engineering Education", Ms. Kristen Baldwin, ODUSD (A&T) Systems and Software
- "Requirements for a Chief Software Engineer in a DoD Acquisition Agency", Mr. Al Florence, The MITRE Corporation
- "Developing an Integrated Process Methodology for Interim Software Releases", Mr. Tim Woods, Southern Methodist University

Wednesday, 24 October 2007

Track 1

- "Change Management of UML-Based Systems Engineering Artefacts", Mr. David Price, Eurostep
- "A Day in the Life of a Verification Requirement", Mr. Stephen Scukanec, Northrop Grumman Corporation
- "How to Measurably Improve Your Requirements", Mr. Timothy Olson, Lean, Solutions Institute, Inc.
- "Case Studies: A Common Language Between Engineers and Managers", Capt DeWitt Latimer, USAF
- "A Strategy for Improved System Assurance", Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA
- "Discussion of the U.S. Army RDECOM APS Objective Trade Study", Mr. Frank Salvatore, High Performance Technologies, Inc.
- "Program Support Review Deep Dive", Mr. Peter Nolte, OUSD/SSE

Track 2

- "An Update on the DT&E Committee's Recommended Policy Changes to DoD 5000", Col Richard Stuckey,USAF,OUSD (AT&L)/SSE/ DT&E
- "System Test and Evaluation in the DARPA Immune Building Demonstration Program", Mr. Mark Saxon,Battelle
- " Modeling and Simulation in the Navy Warfare Systems Test & Evaluation Enterprise", Ms. Shala Malone,Navy Program Executive Office Integrated Warfare
- "Joint Mission Environment Test Capability (JMETC)", Mr. Richard Lockhart, Test Resource Management Center
- "Testing Concept of Operations in DoD's Net Centric Environment", Mr. Steve Reeder, South Carolina
- Research Authority (SCRA
- "Do it right, do it early; Do it early, do it right"—Considerations for the Early Stages of Concept, System, and Systems of-Systems Definition", Mr. Jeff Loren, MTC Technologies, Inc. (SAF/AQRE)
- "Applications of Systems Engineering to Pre-Milestone A Projects", Ms. Lori Zipes,Naval Surface Warfare Center PC
- "Systems Engineering in a Systems of Systems Environment - Defense Update", Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA
- "ASW System-of-Systems Engineering Analysis Applied in an LCS ASW Integration Pilot Project", Mr. G. Richard Thompson, JHU/APL

Track 3

- "Systems Engineering Plan Preparation Guide Update", Mr. Chester Bracuto, OSD/AT&L/A&T/SSE/ED
- " Toward a Unified Systems Engineering Plan", Mr. Robert Scheurer, Boeing Integrated Defense Systems
- "Integrating Risk & Knowledge Management", Mr. David Lengyel, NASA
- "Systems Engineering and Program Management—How Different are They?", Ms. Lori Zipes, Naval Surface Warfare Center PC
- "Systems Engineering Analysis to Improve Concept Development of Complex Defense Systems", Mr. Michael Harper, SPAWAR Systems Center Charleston
- " The Joint Partnership Between Program Management and Systems Engineering", Mr. Samuel Son, The Boeing Company
- "Lockheed Martin Aeronautics Company Approach to Solving Systemic Development Program Issues", Mr. John Weaver, Lockheed Martin Aeronautics Company
- "Airborne Signals Intelligence Payload (ASIP) Program Integrated Risk Management", Mr. Danial Bolek, USAF
- "Improvements to the Risk Management Process", Mr. Doug Atkinson, USAF
- "Integrated Risk and Earned Value Management", Mr. Paul Davis, Northrop Grumman
- "Application of Risk Management Practices to NNSA Tritium Readiness Subprogram",Mr. Sham Shete, Washington Savannah River Co.

Track 4

- "Defining Lean Service and Maintenance Processes", Mr. Timothy Olson, Lean Solutions Institute, Inc.
- "Modeling Integrated Logistics Systems to Support Transformation in the U.S. Coast Guard", Mr. Patrick Cumby, VectorCSP, L

"Asset-Based PBL for Navy Warships – A Case Study for LCS Class Ships", Mr. Michael Mahon, Lockheed Martin

- "Integrated Diagnostics Closed Loop Data System (At the Point of Use) (Support Systems Knowledge Engineering Enhances Traditional Support Equipment Systems Engineering)," Mr. Steven Head, Boeing
- "Aging Aircraft Sustainment with Non-Standard Engineering", Ms. Kendal Hinton, Georgia Tech Research Institute
- "Maintaining System Viability for the Long Term", Mr. Peter Henry, BAE Systems Land and Armament
- "C-17 Program Applies Systems Engineering to a Large Improvement Project", Mr. Brent Theodore,The Boeing Company

Track 5

- "*Advancing the FEDEP for Simulation Based Acquisition*", Dr. Katherine Morse, SAIC
- "Acquisition M&S Community Sponsored M&S Project: Standardized Documentation for Verification, Validation, and Accreditation", Mr. Kevin Charlow, *(paper) (slides)* Space and Naval Warfare Systems Center Charleston
- "A Methodology for Assessing & Prioritizing the Risks Associated with the Level of Verification, Validation and Accreditation (VV&A) of Models and Simulations", Dr. James Elele, U.S. Navy
- "Experiences in Applying SysML to Develop Interoperable Torpedo Modeling and Simulation Components", Mr. Thomas Haley, Naval Undersea Warfare Center
- "Unifying Systems Engineering Simulations", Mr. Ryan O'Grady, Cybernet Systems Corporation
- "Information Modeling for Systems Integration", Ms. Claudia Rose,BBII
- "Simulation Supported Decision Making", (slides1) (slides 2) *Mr. Gene Allen*, MSC Software Corporation

Track 6

- "Achieving Agility in Cyberspace", Mr. Phillip Boxer, Software Engineering Institute
- "Application of Autonomic Agents for Global Information Grid", Mr. David Cox, University of Arizona
- "Architecture-Based Concept Evaluation in Support of JCIDS", Dr. David Jacques,Air Force Institute of Technology
- "System of Systems Implications for Operational Test", Dr. John Colombi, Air Force Institute of Technology
- "Case Study: Net Centric Mission Thread Modeling and Analysis", Dr. Prem Jain, MITRE
- "Quantitative Comparison of Alternative Designs for a JC3M System", Mr. Gregory Miller, Naval Postgraduate School
- "Advanced Net Centric Simulation for Aerospace Command and Control", Ms. Kimberly Kendall, 753d ELSG/NEM, ESC, USAF

Track 7

- "CMMI—Next Steps", Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA
- "CMMI Instructional Challenges to Systems Engineers in Small Settings", Dr. Mary Anne Herndon, Transdyne Corporation
  "FISMA Operational Controls and Their Relationship to Process Maturity", Ms. Rhonda Henning, Harris Corporation
- "Executing a Successful CMMI Maturity Level 3 SCAMPI For SPAWAR Systems Center Charleston", Mr. Michael Kutch, SPAWAR Systems Center Charleston
- "CMMI for Services: Re-Introducing the CMMI for Services Constellation", Mr. Craig Hollenbach, Northrop Grumman Corporation
- "How to Paint a Room: The Role of Specs & Standards in SE", Mr. Robert Kuhnen, USAF
- "Continuous Improvement at the Organization, Team, and Individual Levels —Lessons Learned Integrating CMM,TSP, and PSP and Why All Three are Needed", Mr. Girish Seshagiri,Advanced Information Services, Inc
- "Addressing Environment, Safety and Occupational Health Issues for the Mine Resistant Ambush Protected (MRAP) Vehicle Program", Ms. Jennifer Malone, EG&G
- "Anatomy of an Award Winning Safety Program: A Case Study of the SSGN OHIO Class Conversion Safety Program", Mr. Ricky Milnarik, Electric Boat Corporation
- "The Safety of Unmanned Systems: The Process Used to Develop Safety Precepts for Unmanned Systems", Mr. Mike Demmick, NOSSA

Track 8

- "Defining Software Component Specifications: An Open Approach", Mr. Kenneth Klein,Computer Sciences Corporation
- "System Engineering and Software Exception Handling (SEH)", Mr. Herbert Hecht, SoHaR Incorporated
- "A Convergence of Technologies for Better Software NOW!", Ms. Dorothy Acton, Lockheed Martin IS&GS
- "Identifying Acquisition Patterns of Failure Using System Archetypes", Mr. William Novak, Software Engineering Institute
- *"Revitalizing Education and Training in Systems Engineering", Dr. Don Gelosh*, Department of Defense, OSD(AT&L)/SSE/ED
- "Customer-Driven, Partnership-Based Systems Engineering Education and Training", Mr. Jerrell Stracener, Southern Methodist University
- "Application of Systems Engineering Principles in the Design of Acquisition Workforce Curricula", (paper) (slide) *Dr. David Olwell*, Naval Postgraduate School

Thursday, 25 October 2007

Track 1

- "USAF Type Certification of Commercial Derivative Aircraft", Mr. Thomas Morgan, USAF
- "Global Positioning System Case Study", Mr. Randall Bullard, Air Force Center for Systems Engineering

Track 2

- "Implementing the Technology Maturity Vector", Mr. Joseph Terlizzese, Systems Engineering Support Office
- "Technology Readiness Assessments; Milestone B Certification Requirement for Technologies to be Demonstrated in a Relevant Environment", Dr. Jay Mandelbaum, Institute for Defense Analyses
- "Meeting Enterprise System Engineering Challenges for the U.S. Next Generation Air Transportation System (NextGen)", Mr. Jerry Friedman,

The MITRE Corporation
- "Sensor Resource Allocation as a Driver in System Concept Development", Mr. Ravi Moorthy, Lockheed Martin MS2

Track 3

- "Managing Requirements to Manage Scope in the Case of MUOS", Ms. Christy Howard, Maxim Systems, Inc.
- "Organizational Leadership and Management Dynamics for Technical Execution in Acquisition Programs", Mr. Francis Sisti, Aerospace Corporation
- "C-17 Systems Engineering Process to Prioritize Material Improvement Program (MIP) Projects", Mr. Thomas Condron, USAF (516 AESG/ASC)
- "How to Talk to a Program Manager", Dr. John Mishler, Software Engineering Institute
- "U.S. Department of Defense (DoD) Approach to Best Practices: Building Evidence for Practice Selection Based on Real Experiences", Dr. Forrest Shull, Fraunhofer Center Maryland

Track 4

- "Strategic Focus: Reduction of Total Ownership Costs (R-TOC) and Value Engineering (VE)", Dr. Danny Reed, Institute for Defense Analyses
- "Progress Toward an Empirical Relationships Between Reliability Investments and Life-Cycle Support Cost", Dr. James Forbes, LMI
- "Innovation Strategies for Affordable Readiness", Mr. Tom Choinski, Naval Undersea Warfare Center
- "Implementing a Systems Engineering Risk Program in a Sustainment Environment", Mr. James Miller, USAF
- "Asset-Based PBL for Navy Warships – A case study for LCA Class Ships", Mike Mahon
- "The Deployment Readiness Service: The Challenges of Implementing a Service Oriented Architecture in a Legacy System Environment", Mr. George Dalton, USAF

Track 5

- "Aircraft Flight Simulator Acceptance Criteria", Mr. Dean Carico, NAWCAD PAX
- "Computer Modeling to Solve Problems with the T-38 Propulsion Modernization Program", Mr. Randall Wimer, USAF – FVB
- "Efficacy of Modeling & Simulation in Defense Life Cycle Engineering", Mr. Donald Cox, Raytheon Missile Systems
- "Modeling Integrated Logistics Systems to Support Transformation in the U.S. Coast Guard", Mr. Patrick Cumby, Vector CSP, LLC
- "Generic Sensor Model", Dr. Stanley Hack, Lockheed Martin MS-2
- "Event Timeline Analysis in Multi Mission Scenarios with System Simulation Models", Mr. Ravi Moorthy, Lockheed Martin MS2

Track 6

- "Testing Concept of Operations in DoD's Net Centric Environment", Mr. Steve Reeder, South Carolina Research Authority (SCRA)
- "Agile Governance for SOA-Based Military Systems of Systems", Mr. Robert Beck, Villanova University
- "Reducing Acquisition Costs Through Incremental Upgrades by Migrating to SOA", Mr. Tim Greer, Lockheed Martin Corporation

Track 7

- "The DoD's Proactive Approach to Emerging Contaminants: Managing Risks Today for Tomorrow's Warfighter and Mission Readiness", Dr. Carole LeBlanc, Office of the Deputy Under Secretary of Defense
- *"Safe-Escape Analysis System Safety Engineering Study"*, (paper) (slide) *Mr. David Hall,* SURVICE Engineering Company

Track 8

- "Development of Systems Engineers in the Sensors & SONAR Systems Department", Mr. Lawrence Lazar,Naval Undersea Warfare Center
- "Systems Engineering and the Art of Seeing", Dr. Robert Monson, Lockheed Martin Corporation
- "Understanding Social Networks-A Key Requirement for System Engineers", Mr. Karl Selke, Systems Engineering Analyst, Evidence Based Research, Inc.

NDIA
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10th ANNUAL SYSTEMS ENGINEERING CONFERENCE









HYATT REGENCY MISSION BAY ~ SAN DIEGO, CA

OCT. 22 - 25, 2007

WWW.NDIA.ORG/MEETINGS/8870

Event # 8870

Conference Agenda {At A Glance}

Sunday, October 21, 2007

5:00 pm - 7:00 pm	Registration for Tutorials and General Conference *(Tutorials are an additional $225.00 registration fee)*

Monday, October 22, 2007

7:00 am - 6:00 pm	Registration
7:00 am - 8:00 am	Continental Breakfast for Tutorial Attendees ONLY *(Tutorials are an additional $225.00 registration fee)*
8:00 am - 11:45 am	Tutorial Tracks *(Please refer to pages 4-5 for Tutorial schedule)*
12:00 pm - 1:00 pm	Lunch for Tutorial Attendees ONLY
1:00 pm - 5:00 pm	Tutorial Tracks Continued
5:00 pm - 6:00 pm	Reception in the Regatta Pavilion (Open to All Participants)

Tuesday, October 23, 2007

7:15 am - 6:30 pm	Registration
7:15 am - 8:15 am	Continental Breakfast
8:15 am - 8:30 am	Introductions & Opening Remarks: *Mr. Sam Campagna, Director, Operations, NDIA* *Mr. Bob Rassa, Director, Systems Supportability, Raytheon,* *Chair, Systems Engineering Division, NDIA*
8:30 am - 9:45 am	Keynote Addresses: *HON James Finley, Deputy Under Secretary of Defense, Acquisiton & Technology* *HON Charles McQueary, Director, Operational Test & Evaluation*
9:45 am - 10:00 am	Break



10:00 am - 12:00 pm	Plenary Session: Executive Panel Moderator: *Mr. Mark Schaeffer, Director, Office of Under Secretary of Defense for Acquisition, Technology and Logistics; Director, Systems and Software Engineering* Panelists: *Mr. Terry Jaggers, SAF/AQR - Science, Technology, and Engineering* *Mr. Carl Siel, Chief Engineer, Office of the Assistant Secretary of the Navy Research, Development and Acquisition* *Mr. Doug Wiltsie, HQDA, OASA (ALT)*
12:00 pm - 1:30 pm	Luncheon with Speaker in the Regatta Pavilion *Mr. Mike Kern, Senior Systems Engineer, OASD (NII)*
1:30 pm - 5:00 pm	Concurrent Sessions *(Please refer to pages 6-10 for session schedule)*
5:00 pm - 6:30 pm	Reception in the Regatta Pavilion

Wednesday, October 24, 2007

7:00 am - 5:00 pm	Registration
7:00 am - 8:00 am	Continental Breakfast
8:00 am - 12:00 pm	Concurrent Sessions *(Please refer to pages 6-10 for session schedule)*
12:00 pm - 1:30 pm	Awards Luncheon in the Regatta Pavilion
1:30 pm - 5:00 pm	Concurrent Sessions *(Please refer to pages 6-10 for session schedule)*

Thursday, October 25, 2007

7:00 am - 3:00 pm	Registration
7:00 am - 8:00 am	Continental Breakfast
8:00 am - 12:00 pm	Concurrent Sessions *(Please refer to pages 6-10 for session schedule)*
12:00 pm - 1:00 pm	Luncheon in the Regatta Pavilion
1:00 pm - 3:00 pm	Concurrent Sessions *(Please refer to pages 6-10 for session schedule)*
3:00 pm	Conference Adjourns

Tutorial Sessions - Monday, October 22, 2007

7:00 am Registration & Continental Breakfast

	8:00 am - 9:45 am		Break	10:15 am - 11:45 am	
Bayview A	Track 1 Tutorial Session 1A1	5305 - Are we Ready for CMMI®? If not, Let's Fix Ourselves *Mr. Al Florence, The MITRE Corporation*		Track 1 Tutorial Session 1B1	5305 - Are we Ready for CMMI®? If not, Let's Fix Ourselves (Cont'd) *Mr. Al Florence, The MITRE Corporation*
Bayview B	Track 2 Tutorial Session 1A2	5454 - Cost As an Independent Variable and Trade Studies *Mr. Ed Casy, Raytheon Missile Systems*		Track 2 Tutorial Session 1B2	5454 - Cost As an Independent Variable and Trade Studies (Cont'd) *Mr. Ed Casy, Raytheon Missile Systems*
Bayview C	Track 3 Tutorial Session 1A3	5404 - How to Reduce Schedule Uncertainty by Integrating Sound Management Methods with Systems Engineering Best Practices *Mr. Gary Langford, The Naval Postgraduate School*		Track 3 Tutorial Session 1B3	5404 - How to Reduce Schedule Uncertainty by Integrating Sound Management Methods with Systems Engineering Best Practices (Cont'd) *Mr. Gary Langford, The Naval Postgraduate School*
Mission I	Track 4 Tutorial Session 1A4	5498 - System Verification Organization *Mr. Jeffrey Grady, JOG System Engineering, Inc.*		Track 4 Tutorial Session 1B4	5498 - System Verification Organization (Cont'd) *Mr. Jeffrey Grady, JOG System Engineering, Inc.*
Mission II	Track 5 Tutorial Session 1A5			Track 5 Tutorial Session 1B5	
Mission III	Track 6 Tutorial Session 1A6	5542 - Best-In-Class Early Defect Detection and Defect Prevention *Mr. Timothy Olson, Lean Solutions Institute, Inc.*		Track 6 Tutorial Session 1B6	5542 - Best-In-Class Early Defect Detection and Defect Prevention (Cont'd) *Mr. Timothy Olson, Lean Solutions Institute, Inc.*
Palm I	Track 7 Tutorial Session 1A7	5784 - Operational Concepts: Using Cases & Scenarios to Understand User's Needs *Mr. Raymond Jorgensen, Rockwell Collins*		Track 7 Tutorial Session 1B7	5784 - Operational Concepts: Using Cases & Scenarios to Understand User's Needs (Cont'd) *Mr. Raymond Jorgensen, Rockwell Collins*
Palm II	Track 8 Tutorial Session 1A8	5577 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) *Mr. Abe Meilich, Lockheed Martin*		Track 8 Tutorial Session 1B8	5577 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) (Cont'd) *Mr. Abe Meilich, Lockheed Martin*

Buffet Lunch

1:00 pm - 2:45 pm

Track 1 Tutorial Session 1C1	5307 - Requirements Development and Management *Mr. Al Florence, The MITRE Corporation*
Track 2 Tutorial Session 1C2	5326 - Integrating Systems Engineering with Earned Value Management *Mr. Paul Solomon, Performance-Based Earned Value®*
Track 3 Tutorial Session 1C3	5404 - How to Reduce Schedule Uncertainty by Integrating Sound Management Methods with Systems Engineering Best Practices (Cont'd) *Mr. Gary Langford, The Naval Postgraduate School*
Track 4 Tutorial Session 1C4	5511 - Modeling Sustainment and Risk Mitigation for Net-Enabled Realities *Mr. Philip Boxer, Software Engineering Institute/CMU*
Track 5 Tutorial Session 1C5	5540 - Introduction to Reliability Analysis *Dr. Meng-Lai Yin, Raytheon Company*
Track 6 Tutorial Session 1C6	5544 - How to Define Practical Systems Engineering Metrics *Mr. Timothy Olson, Lean Solutions Institute, Inc.*
Track 7 Tutorial Session 1C7	5582 - Leading Effective System of Systems (SoS) Technical Reviews *Mr. David Walden, Sysnovation, LLC*
Track 8 Tutorial Session 1C8	5577 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) *Dr. Abe Meilich, Lockheed Martin*

Break

3:15 pm - 5:00 pm

Track 1 Tutorial Session 1D1	5307 - Requirements Development and Management (Cont'd) *Mr. Al Florence, The MITRE Corporation*
Track 2 Tutorial Session 1D2	5326 - Integrating Systems Engineering with Earned Value Management (Cont'd) *Mr. Paul Solomon, Performance-Based Earned Value®*
Track 3 Tutorial Session 1D3	5404 - How to Reduce Schedule Uncertainty by Integrating Sound Management Methods with Systems Engineering Best Practices (Cont'd) *Mr. Gary Langford, The Naval Postgraduate School*
Track 4 Tutorial Session 1D4	5511 - Modeling Sustainment and Risk Mitigation for Net-Enabled Realities (Cont'd) *Mr. Philip Boxer, Software Engineering Institute/CMU*
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Track 7 Tutorial Session 1D7	5582 - Leading Effective System of Systems (SoS) Technical Reviews (Cont'd) *Mr. David Walden, Sysnovation, LLC*
Track 8 Tutorial Session 1D8	5577 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) (Cont'd) *Dr. Abe Meilich, Lockheed Martin*

5:00 pm - 6:00 pm Reception in Regatta Pavilion

Tuesday, October 23, 2007

	concurrent sessions	1:30 pm - 3:00 pm			concurrent sessions	3:30 pm - 5:00 pm		
Bayview A	TRACK 1 *Systems Engineering Effectiveness* Session 2C1	5378 - DoD's Systems Engineering Revitalization Efforts—An Update *Col Richard Hoeferkamp, USAF*	5399 - The Effectiveness of Systems Engineering: on Federal (DoD) System Development Programs *Mr. Al Mink, SRA International*		TRACK 1 *Systems Engineering Effectiveness* Session 2D1	5484 - Tools and Resources to Enable Systems Engineering Improvement *Mr. Michael Kutch, SPAWAR Systems Center Charleston*	5626 - Good Systems Engineering Insures Good Producibility *Dr. Thomas Christian, Aeronautical Systems Center*	5405 - Systems Engineering Realization for the Future *Ms. Karen Bausman, AF Center for Systems Engineering*
Bayview B	TRACK 2 *Test & Evaluation in Systems Engineering* Session 2C2	5503 - A Vector Check—Revitalizing DT&E *Mr. Chris DiPetto, OUSD (AT&L)*	5402 - A Test Strategy Done Early Drives Test Planning and Successful Testing *Mr. William Lyders, ASSETT, Inc.*		TRACK 2 *Test & Evaluation in Systems Engineering* Session 2D2	5489 - Applying Design of Experiments Methodology to Sortie Generation Rate Evaluation *Mr. Joseph Tribble, AVW Technologies*	5774 - Implementing and Measuring Test Program in a Sustainment Environment *Mr. James Miller, USAF*	*Joint Safety Review Process Study* *Ms. Paige Ripini, Booz Allen Hamilton*
Bayview C	TRACK 3 *Program Management* Session 2C3	5522 - Systemic Root Cause Analysis of Acquisition Program Issues *Mr. Dave Castellano, OUSD (AT&L)*	Systemic Root Cause Analysis - Emerging Recommendations Industry Panel Discussion *Mr. Dave Castellano, OUSD (AT&L)*		TRACK 3 *Program Management* Session 2D3	5779 - Applying Systems Engineering Dring Pre- Acquisition Activities *Lt Col Mark Wilson, USAF*	5435 - Reforming the DoD Acquisition Process—A Systems Engineering Approach *Mr. Stephan Ward, U.S. Air Force*	5365 - P Value of Systems Engineering: Analysis & Results from Previous and Current Studies of Over 100 System Development Projects *Mr. Alan Mink, SRA International*
Mission I	TRACK 4 *Integrated Diagnostics* Session 2C4	5797 - Environment, Safety, and Occupational Health (ESOH)—Design Considerations to Support Sustainability and Readiness *Ms. Patricia Huheey, ODUSD (I&E)*	5508 - Integrated Structural Health Monitoring System Using Lamb Waves *Maj Joerg Walter, USAF, Air Force Institute of Technology*		TRACK 4 *Integrated Diagnostics* Session 2D4	5368 - Real-Time Diagnostics for High Availability Systems *Mr. Edward Beck, Computer Sciences Corporation*	5271 - Leveraging EMS for Condition Based Maintenance *Mr. Bob Heilman, O'Neil & Associates, Inc.*	5287 - Sparing Satellites- Comparitive Strategies of In-orbit & In-factory Storage *Mr. James Mazzei, The Aerospace Corporation*
Mission II	TRACK 5 *Modeling & Simulation* Session 2C5	5446 - Implementing the Acquisition M&S Master Plan *Mr. Michael Truelove, SAIC*	5421 - M&S-Related Guidelines for Contracting *Mr. Michael Truelove, SAIC*	5606 - M&S Planning and Employment Best Practices *Mr. James Hollenbach. Simulation Strategies, Inc.*	TRACK 5 *Modeling & Simulation* Session 2D5	5427 - Modeling and Simulation Resource Reuse Business Model *Mr. Dennis Shea, Center for Naval Analyses*	5603 - Modeling and Simulation Support Plan *Mr. David Henry, Lockheed Martin*	6099 - Modeling and Simulation Education for the Acquistion Workforce: Requirements Analysis *Mr. David Olwell, NPS*
Mission II	TRACK 6 *Net Centric Operations* Session 2C6	5430 - The Use of Enterprise Architecture to Support the Development of the Next Generation Air Transportation System (NextGen) *Mr. David Synder, The MITRE Corp.*	5500 - Complex Systems of Systems: The Dual Challenge *Mr. Phillip Boxer, Software Engineering Institute*		TRACK 6 *Net Centric Operations* Session 2D6	5576 - Systems Engineering in the Cognitive and Social Domains of Net Centric Operations *Dr. Abe Meilich, Lockheed Martin*	Global Information Grid (GIG) Technical Foundation (GTF) and GIG Compliance Assessment (GICA) *Mr. Brendan Goode, Booz Allen Hamilton*	Global Information Grid (GIG) Performance Assessment Framework *Mr. Tony Modelfino, Stratogis*
Palm I	TRACK 7 *Best Practices & Standardization* Session 2C7	5780 - Simplifying & Scaling Engineering Processes: Unifying Business Units and Engineering Disciplines *Mr. Raymond Jorgensen, Rockwell Collins*	5491 - Systems Engineering Process Improvements at NAVAIR *Mr. Michael Gaydar, Department of Navy, NAVAIR*		TRACK 7 *Best Practices & Standardization* Session 2D7	5781 - Integrating Engineering Project Management and Product Development Processes *Mr. Raymond Jorgensen, Rockwell Collins*	5831 - Engineering for System Assurance—Legacy, Life Cycle, Leadership *Mr. Paul Croll, Computer Sciences Corporation*	
Palm II	TRACK 8 *Software* Session 2C8	6163 - DoD Software Engineering and System Assurance *Ms. Kristen Baldwin, ODUSD (A&T) Systems and Software Engineering*	6164 - A Reference Curriculum for Software Engineering Graduate Education *Ms. Kristen Baldwin, ODUSD (A&T) Systems and Software Engineering*		TRACK 8 *Software* Session 2D8	5315 - Requirements for a Chief Software Engineering in a DoD Acquisition Agency *Mr. Al Florence, The MITRE Corporation*	5481 - Developing an Integrated Process Methodology for Interim Software Releases *Mr. Tim Woods, Southern Methodist University*	

Break in the Regatta Pavilion

5:00 pm - 6:00 pm Reception in the Regatta Pavilion

Wednesday, October 24, 2007

concurrent sessions — 8:00 am - 9:45 am

Bayview A	TRACK 1 *Systems Engineering Effectiveness* Session 3A1	5824 - Change Management of UML-Based Systems Engineering Artefacts *Mr. David Price, Eurostep*	5806 - Investigating the Use of SysML on the FBX-T Radar Program *Mr. Chad Schuyler, Raytheon*	5536 - A Day in the Life of a Verification Requirement *Mr. Stephen Scukanec, Northrop Grumman Corporation*
Bayview B	TRACK 2 *Test & Evaluation in Systems Engineering* Session 3A2	5812 - An Update on the DT&E Committee's Recommended Policy Changes to DoD 5000 *Col Richard Stuckey, USAF, OUSD (AT&L)/SSE/DT&E*	5520 - System Test and Evaluation in the DARPA Immune Building Demonstration Program *Mr. Mark Saxon, Battelle*	5553 - Modeling and Simulation in the Navy Warfare Systems Test & Evaluation Enterprise *Ms. Shala Malone, Navy Program Executive Office Integrated Warfare*
Bayview C	TRACK 3 *Program Management* Session 3A3	5523 - Systems Engineering Plan Preparation Guide Update *Mr. Chester Bracuto, OSD/AT&L/A&T/SSE/ED*	5525 - Toward a Unified Systems Engineering Plan *Mr. Robert Scheurer, Boeing Integrated Defense Systems*	5587 - Integrating Risk & Knowledge Management *Mr. David Lengyel, NASA*
Mission I	TRACK 4 *Integrated Diagnostics* Session 3A4	5546 - Defining Lean Service and Maintenance Processes *Mr. Timothy Olson, Lean Solutions Institute, Inc.*	5355 - Modeling Integrated Logistics Systems to Support Transformation in the U.S. Coast Guard *Mr. Patrick Cumby, VectorCSP, LLC*	
Mission II	TRACK 5 *Modeling & Simulation* Session 3A5	5614 - Live Virtual Constructive (LVC) Architecture Interoperability Assessment *Mr. Warren Bizub, USJFCOM*	5538 - Advancing the FEDEP for Simulation Based Acquisition *Dr. Katherine Morse, SAIC*	
Mission III	TRACK 6 *Net Centric Operations* Session 3A6	5497 - Achieving Agility in Cyberspace *Mr. Phillip Boxer, Software Engineering Institute*	5815 - Distributed Firewalls *Mr. Alejandro Gastelum, Northrop Grumman*	
Palm I	TRACK 7 *Best Practices & Standardization* Session 3A7	5592 - CMMI—Next Steps *Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA*	5743 - CMMI Instructional Challenges to Systems Engineers in Small Settings *Dr. Mary Anne Herndon, Transdyne Corporation*	
Palm II	TRACK 8 *Software* Session 3A8	5526 - Defining Software Component Specifications: An Open Approach *Mr. Kenneth Klein, Computer Sciences Corporation*	5676 - System Engineering and Software Exception Handling (SEH) *Mr. Herbert Hecht, SoHaR Incorporated*	

Break in the Regatta Pavilion

concurrent sessions — 10:15 am - 12:00 pm

TRACK 1 *Systems Engineering Effectiveness* Session 3B1	5557 - How to Measurably Improve Your Requirements *Mr. Timothy Olson, Lean Solutions Institute, Inc.*	5670 - Review of the Roles of a System Architect *Dr. Dinesh Verma, Stevens Institute of Technology*	5865 - Case Studies: A Common Language Between Engineers and Managers *Capt DeWitt Latimer, USAF*
TRACK 2 *Test & Evaluation in Systems Engineering* Session 3B2	5473 - Joint Mission Environment Test Capability (JMETC) *Mr. Richard Lockhart, Test Resource Management Center*	5585 - Testing Concept of Operations in DoD's Net Centric Environment *Mr. Steve Reeder, South Carolina Research Authority (SCRA)*	
TRACK 3 *Program Management* Session 3B3	5381 - Systems Engineering and Program Management—How Different are They? *Ms. Lori Zipes, Naval Surface Warfare Center PC*	5799 - Systems Engineering Analysis to Improve Concept Development of Complex Defense Systems *Mr. Michael Harper, SPAWAR Systems Center Charleston*	5531 - The Joint Partnership Between Program Management and Systems Engineering *Mr. Samuel Son, The Boeing Company*
TRACK 4 *Logistics, Supportability, and Readiness* Session 3B4	5903 - Asset-Based PBL for Navy Warships – A Case Study for LCS Class Ships *Mr. Michael Mahon, Lockheed Martin*	5530 - Considerations & Propose Approach for Integrating New Hardware & Software into the Legacy Military Aircraft Avionics Systems—A Systems Engineering Lesson-Learned Perspective on the C-17 Program *Mr. Phat Vu, The Boeing Company*	5954 - Integrated Diagnostics Closed Loop Data System (At the Point of Use) (Support Systems Knowledge Engineering Enhances Traditional Support Equipment Systems Engineering) Mr. Steven Head, Boeing
TRACK 5 *Modeling & Simulation* Session 3B5	5431 - Acquisition M&S Community Sponsored M&S Project: Standardized Documentation for Verification, Validation, and Accreditation *Mr. Kevin Charlow, Space and Naval Warfare Systems Center Charleston*	5426 - A Methodology for Assessing & Prioritizing the Risks Associated with the Level of Verification, Validation and Accreditation (VV&A) of Models and Simulations *Dr. James Elele, U.S. Navy*	
TRACK 6 *Net Centric Operations* Session 3B6	5386 - Application of Autonomic Agents for Global Information Grid *Mr. David Cox, University of Arizona*	5847 - Architecture-Based Concept Evaluation in Support of JCIDS *Dr. David Jacques, Air Force Institute of Technology*	
TRACK 7 *Best Practices & Standardization* Session 3B7	5808 - FISMA Operational Controls and Their Relationship to Process Maturity *Ms. Rhonda Henning, Harris Corporation*	5485 - Executing a Successful CMMI Maturity Level 3 SCAMPI For SPAWAR Systems Center Charleston *Mr. Michael Kutch, SPAWAR Systems Center Charleston*	CMMI for Services: Re-Introducing the CMMI for Services Constellation *Mr. Craig Hollenbach, Northrop Grumman Corporation*
TRACK 8 *Software* Session 3B8	5764 - A Convergence of Technologies for Better Software NOW! *Ms. Dorothy Acton, Lockheed Martin IS&GS*	5803 - Identifying Acquisition Patterns of Failure Using System Archetypes *Mr. William Novak, Software Engineering Institute*	

12:00 pm Lunch in the Regatta Pavilion

Wednesday, October 24, 2007

	concurrent sessions	1:30 pm - 3:00 pm			concurrent sessions	3:30 pm - 5:15 pm		
Bayview A	TRACK 1 *Systems Engineering Effectiveness* Session 3C1	5594 - Handbook on Engineering for System Assurance *Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA*	5805 - A Pragmatic Approach for Defining and Utilizing System States and Modes *Mr. Mark Minnucci, Raytheon*		TRACK 1 *Systems Engineering Effectiveness* Session 3D1	5433 - A Practical Application of Structured System Engineering and Failure Mode Effects Analysis to New Technologies *Mr. Paul Deniston, Ford Motor Company*	5505 - Discussion of the U.S. Army RDECOM APS Objective Trade Study *Mr. Frank Salvatore, High Performance Technologies, Inc.*	A Deep Dive into Program Review Findings *Mr. Peter Nolte, OUSD/SSE*
Bayview B	TRACK 2 *Systems Engineering Effectiveness* Session 3C2	5464 -"Do it right, do it early; Do it early, do it right"—Considerations for the Early Stages of Concept, System, and Systems-of-Systems Definition *Mr. Jeff Loren, MTC Technologies, Inc. (SAF/AQRE)*	5380 - Applications of Systems Engineering to Pre-Milestone A Projects *Ms. Lori Zipes, Naval Surface Warfare Center PC*		TRACK 2 *Systems Engineering Effectiveness* Session 3D2	5593 - Systems Engineering in a Systems of Systems Environment - Defense Update *Ms. Kristen Baldwin, ODUSD (A&T) SSE/SSA*	5602 - ASW System-of-Systems Engineering Analysis Applied in an LCS ASW Integration Pilot Project *Mr. G. Richard Thompson, JHU/APL*	5832 - A Brigade Capability Approach to the Evolution of Current Ground Combat Systems *Ms. Roberta Desmond, U.S. Army*
Bayview C	TRACK 3 *Program Management* Session 3C3	5795 - Lockheed Martin Aeronautics Company Approach to Solving Systemic Development Program Issues *Mr. John Weaver, Lockheed Martin Aeronautics Company*	5450 - Airborne Signals Intelligence Payload (ASIP) Program Integrated Risk Management *Mr. Danial Bolek, USAF*		TRACK 3 *Program Management* Session 3D3	5434 - Improvements to the Risk Management Process *Mr. Doug Atkinson, USAF*	5388 - Integrated Risk and Earned Value Management *Mr. Paul Davis, Northrop Grumman*	5800 - Application of Risk Management Practices to NNSA Tritium Readiness Subprogram *Mr. Sham Shete, Washington Savannah River Co.*
Mission I	TRACK 4 *Logistics, Supportability, and Readiness* Session 3C4	5843 - Aging Aircraft Sustainment with Non-Standard Engineering *Ms. Kendal Hinton, Georgia Tech Research Institute*	5477 - M109 Howitzer Sustainment *Mr. Peter Henry, BAE Systems Land and Armaments*		TRACK 4 *Logistics, Supportability, and Readiness* Session 3D4	5528 - C-17 Program Applies Systems Engineering to a Large Improvement Project *Mr. Brent Theodore, The Boeing Company*	5854 - Effective Time on Station (ETOS): The Persistent Performance Metric for Aircraft Systems *Mr. Christopher Marchefsky, NAVAIR*	
Mission II	TRACK 5 *Modeling & Simulation* Session 3C5	5740 - Leveraging the Integrated Engineering Model (IEM) Process as a Lead Systems Integrator *Mr. Anthony Montano, Raytheon Company*	5376 - Experiences in Applying SysML to Develop Interoperable Torpedo Modeling and Simulation Components *Mr. Thomas Haley, Naval Undersea Warfare Center*		TRACK 5 *Modeling & Simulation* Session 3D5	5835 - Unifying Systems Engineering Simulations *Mr. Ryan O'Grady, Cybernet Systems Corporation*	5409 - Information Modeling for Systems Integration *Ms. Claudia Rose, BBII*	5575 - Simulation Supported Decision Making *Mr. Gene Allen, MSC Software Corporatiton*
Mission III	TRACK 6 *Net Centric Operations* Session 3C6	5848 - System of Systems Implications for Operational Test *Dr. John Colombi, Air Force Institute of Technology*	5519 - Case Study: Net Centric Mission Thread Modeling and Analysis *Dr. Prem Jain, MITRE*		TRACK 6 *Net Centric Operations* Session 3D6	5407 - Quantitative Comparison of Alternative Designs for a JC3M System *Mr. Gregory Miller, Naval Postgraduate School*	5445 - Advanced Net Centric Simulation for Aerospace Command and Control *Ms. Kimberly Kendall, 753d ELSG/NEM, ESC, USAF*	
Palm I	TRACK 7 *Best Practices & Standardization* Session 3C7	5760 - How to Paint a Room: The Role of Specs & Standards in SE *Mr. Robert Kuhnen, USAF*	5837 - Continuous Improvement at the Organization, Team, and Individual Levels —Lessons Learned Integrating CMM, TSP, and PSP and Why All Three are Needed *Mr. Girish Seshagiri, Advanced Information Services, Inc.*		TRACK 7 *System Safety* Session 3D7	Addressing Environment, Safety and Occupational Health Issues for the Mine Resistant Ambush Protected (MRAP) Vehicle Program *Ms. Jennifer Malone, EG&G*	Anatomy of an Award Winning Safety Program: A Case Study of the SSGN OHIO Class Conversion Safety Program *Mr. Ricky Milnarik, Electric Boat Corporation*	The Safety of Unmanned Systems: The Process Used to Develop Safety Precepts for Unmanned Systems *Mr. Mike Demmick, NOSSA*
Palm II	TRACK 8 *Education & Training* Session 3C8	5350 - Revitalizing Education and Training in Systems Engineering *Dr. Don Gelosh, Department of Defense, OSD(AT&L)/SSE/ED*	5501 - Customer-Driven, Partnership-Based Systems Engineering Education and Training *Mr. Jerrell Stracener, Southern Methodist University*		TRACK 8 *Education & Training* Session 3D8	5873 - Reference Curriculum for a Graduate Program in Systems Engineering *Dr. Rashmi Jain, Stevens Institute of Technology*	5522 - Application of Systems Engineering Principles in the Design of Acquisition Workforce Curricula *Dr. David Olwell, Naval Postgraduate School*	5438 - Autopsy of A Good Systems Engineer – An Endangered Species *Mr. Jimmy Thai, SAIC*

Break in the Regatta Pavilion

Thursday, October 25, 2007

	concurrent sessions	8:00 am - 9:45 am			concurrent sessions	10:15 am - 12:00 pm	
Bayview A	TRACK 1 *Systems Engineering Effectiveness* Session 4A1	5499 - A Robust Process for Resolving Interface Design Issues in the Complex Concurrent LCS System Engineering Environment *Mr. William Traganza, NAVSEA PMS 485*	5785 - UAI Increasing Flexibility Through Data Driven Interfaces *Mr. Jonathon Miller, USAF —Aeronautical Systems Center*	5785 - Describing Flexibility as an Operational Capability *Mr. Oren Edwards, USAF —Aeronautical Systems Center*	TRACK 1 *Systems Engineering Effectiveness* Session 4B1	5490 - USAF Type Certification of Commercial Derivative Aircraft *Mr. Thomas Morgan, USAF*	6135 - Global Positioning System Case Study *Mr. Randall Bullard, Air Force Center for Systems Engineering*
Bayview B	TRACK 2 *Systems Engineering Effectiveness* Session 4A2	5675 - Implementing the Technology Maturity Vector *Mr. Joseph Terlizzese, Systems Engineering Support Office*	5443 - Technology Readiness Assessments; Milestone B Certification Requirement for Technologies to be Demonstrated in a Relevant Environment *Dr. Jay Mandelbaum, Institute for Defense Analyses*	5453 - Meeting Enterprise System Engineering Challenges for the U.S. Next Generation Air Transportation System (NextGen) *Mr. Jerry Friedman, The MITRE Corporation*	TRACK 2 *Systems Engineering Effectiveness* Session 4B2	5759 - Sensor Resource Allocation as a Driver in Ballistic Missile Defense System Concept Development *Mr. Ravi Moorthy, Lockheed Martin MS2*	5369 - Benchmarking Operational Configuration in a Spiral Development Process: Ballistic Missile Defense System *Mr. Hannibal Wright, Barca Strategy and Technology Consulting, LLC*
Bayview C	TRACK 3 *Program Management* Session 4A3	5849 - Managing Requirements to Manage Scope in the Case of MUOS *Ms. Christy Howard, Maxim Systems, Inc.*	5867 - Organizational Leadership and Management Dynamics for Technical Execution in Acquisition Programs *Mr. Francis Sisti, Aerospace Corporation*	5532 - Systems Engineering Approach to Prioritize Projects *Mr. Thomas Condron, USAF (516 AESG/ASC)*	TRACK 3 *Program Management* Session 4B3	5850 - How to Talk to a Program Manager *Dr. John Mishler, Software Engineering Institute*	U.S. Department of Defense (DoD) Approach to Best Practices: Building Evidence for Practice Selection Based on Real Experiences *Dr. Forrest Shull, Fraunhofer Center Maryland*
Mission I	TRACK 4 *Logistics, Supportability, and Readiness* Session 4A4	5419 - DoD/OSD Sustainment/ Readiness Initiatives: Reduction of Total Ownership Costs (R-TOC) and Value Engineering (VE) *Dr. Danny Reed, Institute for Defense Analyses*	5629 - Relating Investment in Reliability Engineering to Reliability Improvement and Reduction of Total Ownership Cost *Dr. James Forbes, LMI*	5493 - Innovation Strategies for Affordable Readiness *Mr. Tom Choinski, Naval Undersea Warfare Center*	TRACK 4 *Logistics, Supportability, and Readiness* Session 4B4	5773 - Implementing a Systems Engineering Risk Program in a Sustainment Environment *Mr. James Miller, USAF*	5826 - Risk Management and Software Life Cycle Selection *Mr. Thomas McDermott, Georgia Tech Research Institute*
Mission II	TRACK 5 *Modeling & Simulation* Session 4A5	5444 - Aircraft Flight Simulator Acceptance Criteria *Mr. Dean Carico, NAWCAD PAX*	5829 - Computer Modeling to Solve Problems with the T-38 Propulsion Modernization Program *Mr. Randall Wimer, USAF - FVB*		TRACK 5 *Modeling & Simulation* Session 4B5	5397 - Efficacy of Modeling & Simulation in Defense Life Cycle Engineering *Mr. Donald Cox, Raytheon Missile Systems*	5355 - Modeling Integrated Logistics Systems to Support Transformation in the U.S. Coast Guard *Mr. Patrick Cumby, VectorCSP, LLC*
Mission III	TRACK 6 *Net Centric Operations* Session 4A6	5585 - Testing Concept of Operations in DoD's Net Centric Environment *Mr. Steve Reeder, South Carolina Research Authority (SCRA)*	5798 - Agile Governance for SOA-Based Military Systems of Systems *Mr. Robert Beck, Villanova University*		TRACK 6 *Net Centric Operations* Session 4B6	5820 - Reducing Acquisition Costs Through Incremental Upgrades by Migrating to SOA *Mr. Tim Greer, Lockheed Martin Corporation*	5320 - Toward an Intelligent Military Enterprise: An Introduction to an Approach to Joint Forces Based on Meta-Systems Theory *Dr. Kent Palmer, UniSA SEEC*
Palm I	TRACK 7 *System Safety* Session 4A7	5460 - The DoD's Proactive Approach to Emerging Contaminants: Managing Risks Today for Tomorrow's Warfighter and Mission Readiness *Dr. Carole LeBlanc, Office of the Deputy Under Secretary of Defense*	5439 - Safe-Escape Analysis System Safety Engineering Study *Mr. David Hall, SURVICE Engineering Company*	5377 - Risk and System Safety in Aerospace Systems Engineering *Dr. Daniel Schrage, Georgia Tech*	TRACK 7 *System Safety* Session 4B7	Overview of DoD Environment, Safety and Occupational Health Requirements, Terminology, System Safety Methodology and Risk Assessment *Mr. Sherman Forbes, USAF SAF/AQRE*	Overview of Environment, Safety and Occupational Health Activities within Systems Engineering *Mr. Sherman Forbes, USAF SAF/AQRE*
Palm II	TRACK 8 *Education & Training* Session 4A8	5494 - Development of Systems Engineers in the Sensors & SONAR Systems Department *Mr. Lawrence Lazar, Naval Undersea Warfare Center*	5617 - Systems Engineering and the Art of Seeing *Dr. Robert Monson, Lockheed Martin Corporation*	5792 - Understanding Social Networks—A Key Requirement for System Engineers *Mr. Karl Selke, Evidence Based Research, Inc.*			

Break in the Regatta Pavilion

12:00 pm Lunch in the Regatta Pavilion

Thursday, October 25, 2007

concurrent sessions **1:30 pm - 3:00 pm**

Bayview A	TRACK 2 *Systems Engineering Effectiveness* Session 4C2	5814 - Defense System and Large-Scale Systems Based on Terminal Control *Mr. Xiang-Wen Xiong, Zhongheng High-Tech Institute, Inc.*		
Bayview B	TRACK 4 *Logistics, Supportability, and Readiness* Session 4C4	5416 - The Deployment Readiness Service: The Challenges of Implementing a Service Oriented Architecture in a Legacy System Environment *Mr. George Dalton, USAF*		
Bayview C	TRACK 5 *Modeling & Simulation* Session 4C5	5838 - Generic Sensor Model *Dr. Stanley Hack, Lockheed Martin MS-2*	5852 - Event Timeline Analysis in Multi Mission Scenarios with System Simulation Models *Mr. Ravi Moorthy, Lockheed Martin MS2*	5428 - A Prototype Tool for Concept Design Modeling and Optimization of Combat Systems *Mr. Vikram Ganesan, General Dynamics Land Systems*

Conference Adjourns

Track Chairs

Systems Engineering Effectiveness:
- Mr. Al Brown
- Ms. Sharon Vannucci
- Mr. Bob Lyons

Logistics Supportability & Readiness:
- Mr. Chuck Silva
- Mr. Joel Moorvich

Test & Evaluation in Systems Engineering:
- Col Rich Stuckey, USAF
- Mr. Tom Wissink

Program Management:
- Mr. Hal Wilson

Modeling & Simulation:
- Mr. Jim Hollenbach
- Mr. Gary Belie

Net Centric Operations:
- Mr. Jack Zavin
- Dr. Rich Eilers
- Dr. Tom Wickstrom

Best Practices & Standardization:
- Mr. Paul Croll

Software:
- Dr. Tom Christian

Education & Training:
- Mr. George Mooney

Integrated Diognostics:
- Mr. Howard Savage
- Mr. Dennis Hecht

Additional Authors

Track	Abstract	Paper Title	Authors
1A1	5305	Are We Ready for CMMI®? If Not, Let's Fix Ourselves	Mr. Al Florence
1A2	5454	Cost As an Independent Variable and Trade Studies	Mr. Ed Casey
1A3	5404	How to Reduce Schedule Uncertainty by Integrating Sound Management Methods with Systems Engineering Best Practices	Mr. Gary Langford
1A4	5498	System Verification Organization Tutorial	Mr. Jeffrey Grady
1A6	5542	Best-In-Class Early Defect Detection and Defect Prevention	Mr. Timothy Olson
1A7	5784	Operational Concepts: Using Cases & Scenarios to Understand User's Needs	Mr. Raymond Jorgensen
1A8	5577	Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM)	Mr. Abe Meilich
1C1	5307	Requirements Development and Management	Mr. Al Florence
1C2	5326	Integrating Systems Engineering with Earned Value Management	Mr. Paul Solomon
1C4	5511	Modeling Sustainment and Risk Mitigation for Net-Enabled Realities	Mr. Philip Boxer Ms. Lisa Brownsword Mr. Bill Anderson Mr. Jim Smith
1C5	5540	Introduction to Reliability Analysis	Dr. Meng-Lai Yin
1C6	5544	How to Define Practical Systems Engineering Metrics	Mr. Timothy Olson
1C7	5582	Leading Effective System of Systems (SoS) Technical Reviews	Mr. David Walden
2C1	5378	DoD's Systems Engineering Revitalization Efforts—An Update	Mr. Robert Skalamera Col Richard Hoeferkamp
2C1	5399	The Effectiveness of Systems Engineering: On Federal (DoD) System Development Programs	Mr. Al Mink Mr. Dennis Goldenson Mr. Geoff Draper Mr. Al Brown Mr. Ken Ptack
2C2	5402	A Test Strategy Done Early Drives Test Planning and Successful Testing	Mr. William Lyders
2C2	5503	A Vector Check - Revitalizing DT&E	Mr. Chris DiPetto
2C3	5531	The Joint Partnership Between Program Management and Systems Engineering	Mr. Samuel Son
2C4	5508	Integrated Structural Health Monitoring System Using Lamb Waves	Maj Joerg Walter, USAF Dr. Som Soni
2C4	5797	Environment, Safety, and Occupational Health (ESOH) - Design Considerations to Support Sustainability and Readiness	Ms. Patricia Huheey Ms. Karen Gill
2C5	5421	M&S-Related Guidelines for Contracting	Mr. Michael Truelove
2C5	5446	Implementing the Acquisition M&S Master Plan	Mr. Michael Truelove Mr. Jim Hollenbach
2C5	5606	M&S Planning and Employment Best Practices	Mr. Jim Hollenbach
2C6	5430	The Use of Enterprise Architecture to Support the Development of the Next Generation Air Transportation System (NextGen)	Mr. Jerry Friedman Mr. David Snyder
2C6	5500	Complex Systems of Systems: The Dual Challenge	Mr. Philip Boxer Ms. Lisa Brownsword Mr. Ed Morris
2C7	5491	Systems Engineering Process Improvements at NAVAIR	Mr. Michael Gaydar
2C7	5780	Simplifying & Scaling Engineering Processes: Unifying Business Units and Engineering Disciplines	Mr. Raymond Jorgensen
2D1	5405	Systems Engineering Realization for the Future	Ms. Karen Bausman
2D1	5484	Tools and Resources to Enable Systems Engineering Improvement	Mr. Michael Kutch, Jr. Mr. Michael Knox

2D1	5626	Good Systems Engineering Insures Good Producibility	Dr. Thomas Christian, Jr. Mr. Rich Stepler Mr. Hamid Akhbar
2D2	5489	Applying Design of Experiments Methodology to Sortie Generation Rate Evaluation	Mr. Joseph Tribble Mr. Matthew Rodakis
2D2	5774	Implementing and Measuring Test Program in a Sustainment Environment	Mr. James Miller
2D3	5365	PValue of Systems Engineering: Analysis & Results from Previous and Current Studies of Over 100 System Development Projects	Mr. Allan Mink, II
2D3	5435	Reforming the DoD Acquisition Process - A Systems Engineering Approach	Mr. Stephen Ward Mr. Christopher Perkins
2D3	5779	Applying Systems Engineering During Pre-Acquisition Activities	Lt Col Mark Wilson, USAF Mr. Jeff Loren
2D4	5271	Leveraging EMS for Condition Based Maintenance	Mr. Thomas Hawley
2D4	5287	Sparing Satellites--Comparitive Strategies of In-Orbit & In-Factory Storage	Mr. James Mazzei Mr James Ayers Ms. Camille Keeley Mr. Jon Westergaard
2D4	5368	Real-Time Diagnostics for High Availability Systems	Mr. Edward Beck
2D5	5427	Modeling and Simulation Resource Reuse Business Model	Mr. Dennis Shea Dr. John Hampson
2D5	5603	Modeling and Simulation Support Plan	Mr. David Henry
2D5	6099	Modeling and Simulation Education for the Acquisition Workforce: Requirements Analysis	Mr. David Olwell Ms. Jean Johnson
2D6	5576	Systems Engineering in the Cognitive and Social Domains of Net Centric Operations	Dr. Abe Meilich
2D6		Global Information Grid (GIG), Technical Foundation (GTF) and GIG Compliance Assessment (GICA)	Mr. Brendan Goode
2D6		Global Information Grid (GIG) Performance Assessment Framework	Mr. Tony Modelfino
2D7	5781	Integrating Engineering Project Management and Product Development Processes	Mr. Raymond Jorgensen
2D7	5831	Engineering for System Assurance – Legacy, Life Cycle, Leadership	Mr. Paul Croll
2D8	5315	Requirements for a Chief Software Engineering in a DoD Acquisition Agency	Mr. Al Florence
2D8	5481	Developing An Integrated Process Methodology For Interim Software Releases	Mr. Tim Woods Mr. Jerrell Stracener
3A1	5536	A Day in the Life of a Verification Requirement	Mr. Stephen Scukanec Mr. James van Gaasbeek
3A1	5806	Investigating the Use of SysML on the FBX-T Radar Program	Mr. Chad Schuyler Mr. Mark Minnucci Ms. Caroline Elias
3A1	5824	Change Management of UML-Based Systems Engineering Artefacts	Mr. David Price
3A2	5520	System Test and Evaluation in the DARPA Immune Building Demonstration Program	Mr. Mark Saxon Mr. James Risser
3A2	5553	Modeling and Simulation in the Navy Warfare Systems Test & Evaluation Enterprise	Ms. Shala Malone Mr. Richard Reading
3A3	5523	Systems Engineering Plan Preparation Guide Update	Mr. Chester Bracuto
3A3	5525	Toward a Unified Systems Engineering Plan	Mr. Robert Scheurer
3A3	5587	Integrating Risk & Knowledge Management	Mr. David Lengyel
3A4	5546	Defining Lean Service and Maintenance Processes	Mr. Timothy Olson
3A5	5538	Advancing the FEDEP for Simulation Based Acquisition	Dr. Katherine Morse Mr. Paul Lowe
3A5	5614	Live Virtual Constructive (LVC) Architecture Interoperability Assessment	Mr. Warren Bizub Mr. Ken Goad

3A6	5497	Achieving Agility in Cyberspace	Mr. Philip Boxer Mr. Edwin Morris
3A6	5815	Distributed Firewalls	Mr. Alejandro Gastelum
3A7	5592	CMMI—Next Steps	Ms. Kristen Baldwin Mr. Lawrence Osiecki Dr. Karen Richter
3A7	5743	CMMI Instructional Challenges to Systems Engineers in Small Settings	Dr. Mary Anne Herndon
3A8	5526	Defining Software Component Specifications: An Open Approach	Mr. Kenneth Klein
3A8	5676	System Engineering and Software Exception Handling (SEH)	Mr. Herbert Hecht
3B1	5557	How to Measurably Improve Your Requirements	Mr. Timothy Olson
3B1	5670	Review of the Roles of a System Architect	Mr. Tomasz Lomecki Dr. Dinesh Verma Mr. Eirik Hole
3B1	5865	Case Studies: A Common Language Between Engineers and Managers	Capt DeWitt Latimer IV, USAF
3B2	5473	Joint Mission Environment Test Capability (JMETC)	Mr. Richard Lockhart
3B2	5585	Testing Concept of Operations in DoD's Net Centric Environment	Mr. John Eleazer Mr. Charles Reeder
3B3	5381	Systems Engineering and Program Management – How Different are They?	Ms. Lori Zipes
3B3	5799	Systems Engineering Analysis to Improve Concept Development of Complex Defense Systems	Mr. Michael Harper Mr. Philip Butler Dr. Jerrell Stracener
3B4	5530	Considerations & Propose Approach for Integrating New Hardware and Software into the Legacy Military Aircraft Avionics Systems – a Systems Engineering Lesson-Learned Perspective on the C-17 Program	Mr. Phat Vu
3B4	5903	Asset-Based PBL for Navy Warships – A Case Study for LCS Class Ship	Mr. Michael Mahon
3B4	5954	Integrated Diagnostics Closed Loop Data System (At the Point of Use) (Support Systems Knowledge Engineering Enhances Traditional Support Equipment Systems Engineering)	Mr. Steven Head Mr. John Bauer
3B5	5426	A Methodology for Assessing and Prioritizing the Risks Associated with the Level of Verification, Validation and Accreditation (VV&A) of Models and Simulations	Dr. James Elele
3B5	5431	Standardized Documentation for Verification, Validation, and Accreditation - A Status Report to the Systems Engineering Community	Mr. Kevin Charlow Mr. Curtis Blais Mr. David Broyles Ms. Marcy Stutzman
3B6	5386	Application of Autonomic Agents for Global Information Grid	Mr. David Cox Mr. Youssif Al-Nashif Dr. Salim Hariri
3B6	5847	Architecture-Based Concept Evaluation in Support of JCIDS	Dr. David Jacques Dr. John Colombi
3B7	5485	Executing a Successful CMMI Maturity Level 3 SCAMPI For SPAWAR Systems Center Charleston	Mr. Michael Kutch Ms. Sandra Guidry
3B7	5808	FISMA Operational Controls and Their Relationship to Process Maturity	Mr. Ronda Henning
3B8	5764	A Convergence of Technologies for Better Software NOW!	Mr. Dorothy Acton
3B8	5803	Identifying Acquisition Patterns of Failure Using System Archetypes	Mr. William Novak Dr. Linda Levine
3B8	5883	Acoustic Rapid COTS Insertion (ARCI) Advanced Processor Build (APB) Systems	Mr. Gary Tissandier
3C1	5594	Handbook on Engineering for System Assurance	Ms. Kristen Baldwin Ms. Christine Hines
3C1	5805	A Pragmatic Approach for Defining and Utilizing System States and Modes	Mr. Mark Minnucci Mr. Chad Schuyler Ms. Caroline Elias

3C2	5380	Applications of Systems Engineering to Pre-Milestone A Projects	Ms. Lori Zipes
3C2	5464	"Do it right, do it early; Do it early, Do it right" -- Considerations for the Early Stages of Concept, System, and Systems-of-Systems Definition	Mr. Jeff Loren Lt Col Mark Wilson
3C3	5450	Airborne Signals Intelligence Payload (ASIP) Program Integrated Risk Management	Mr. Daniel Bolek
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3C7	5760	How to Paint a Room: The Role of Specs & Standards in SE	Mr. Robert Kuhnen
3C7	5837	Continuous Improvement at the Organization, Team, and Individual Levels - Lessons Learned Integrating CMM, TSP, and PSP and Why All Three are Needed	Mr. Girish Seshagiri
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Notes



Transforming USCG Logistics

A systems engineering approach to transforming the USCG Enterprise Logistics Systems

Patrick W. Cumby
Director Performance Systems
VectorCSP

www.vectorcsp.com

Agenda

- USCG Logistics Transformation Background
- Enterprise Transformation Basics
- USCG Logistics Transformation
- Demos of Logistics Models and Transition Dashboards

Logistics Transformation Background

- USCG has several “stovepiped” logistics business models (surface, air, shore, IT)
- Models have evolved over time and are not integrated or strategically aligned
- Some of the various models utilize modern logistics concepts, others do not
- Limited visibility into systems performance
- Limited ability to manage costs and effectiveness
- ***Then along comes the Deepwater program, the CFO Act, and Katrina…***

Logistics Transformation Drivers

- Deepwater program – recapitalization of USCG assets and capabilities
  - Deepwater program has experienced several issues that have led to a major restructuring of the program.
- CFO Act – Mandate to institute total asset visibility and financial controls
- Success of Katrina disaster response – demonstrated strengths of USCG Aviation logistics model

Logistics Transformation Objectives/Scope



- **Admiral Allen issues CIAO #4**
- Bi-level maintenance w/more standardized procedures.
- Centralized supply chain management w/spending driven by maintenance requirements.
- *Disciplined/standard Coast Guard-wide engineering and logistics business processes, modeled after our internal best practices currently in use in aviation.*
- Strong configuration management processes, w/associated compliance inspections, to ensure all configurations are safe, effective, and supportable when installed.
- Reduce the number of financial and information systems.

Transformation Support Team

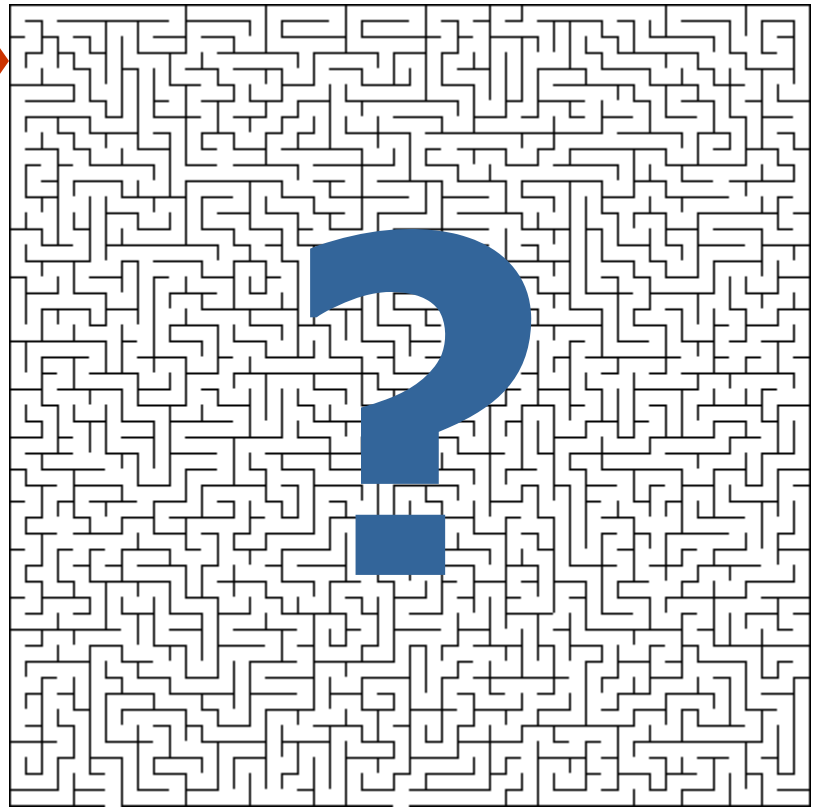
- Logistics Transformation Program Integration Office (LTPIO) established
- General Dynamics contracted to provide program management
- VectorCSP contracted to support organizational and logistics transformation

Transformation Management Approach

- LTPIO chose VectorCSP's Pathfinder approach to develop the logistics business model
- Pathfinder is a systems-oriented, tools-based transformation management methodology
- Pathfinder incorporates a complete business systems performance model, with an emphasis on behavioral engineering

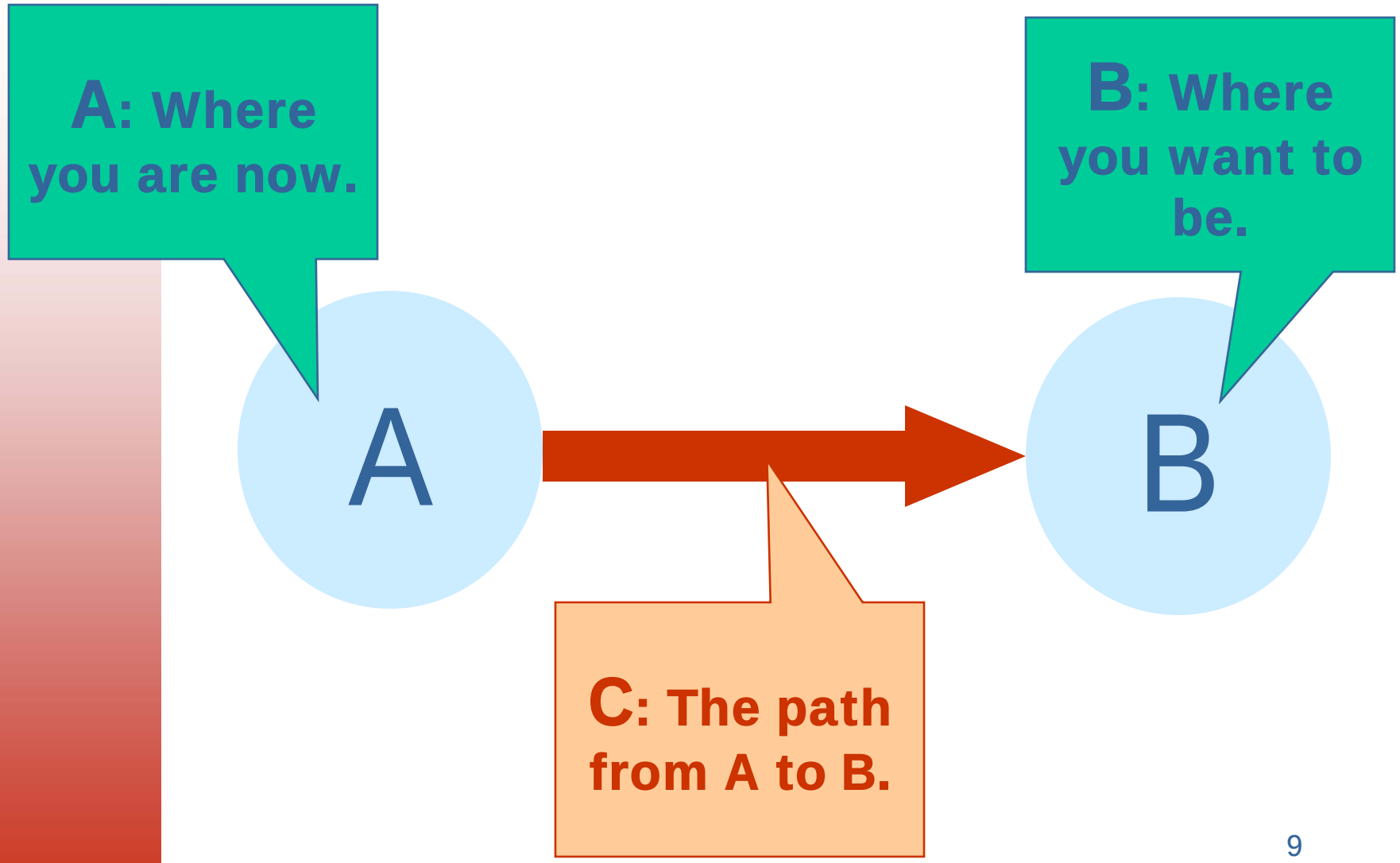
Let's go back to Org Transformation Basics!

Start Here



Finish!

Enterprise Transformation ABCs

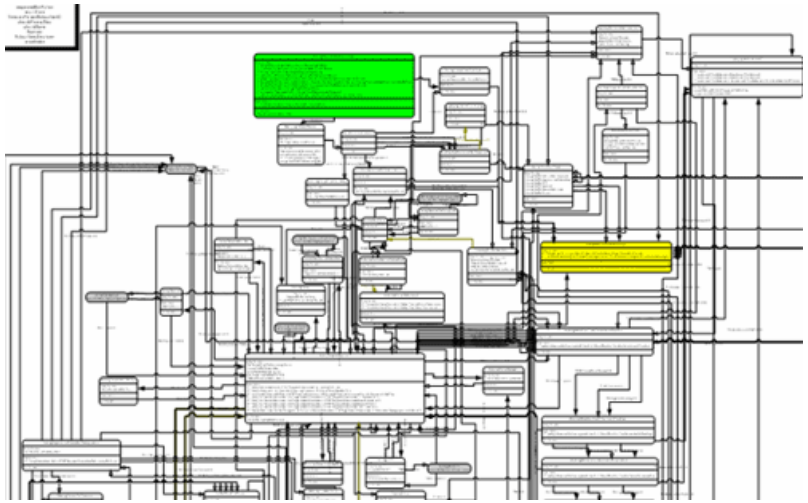


A: Where you are now.

A

- In order to get from **A** to **B**, you have to understand **A**.
- **A** is your "As-Is" organizational and business model
- **A** is usually very, very complex...

Usually the important cultural and political aspects of a business model are not well documented.



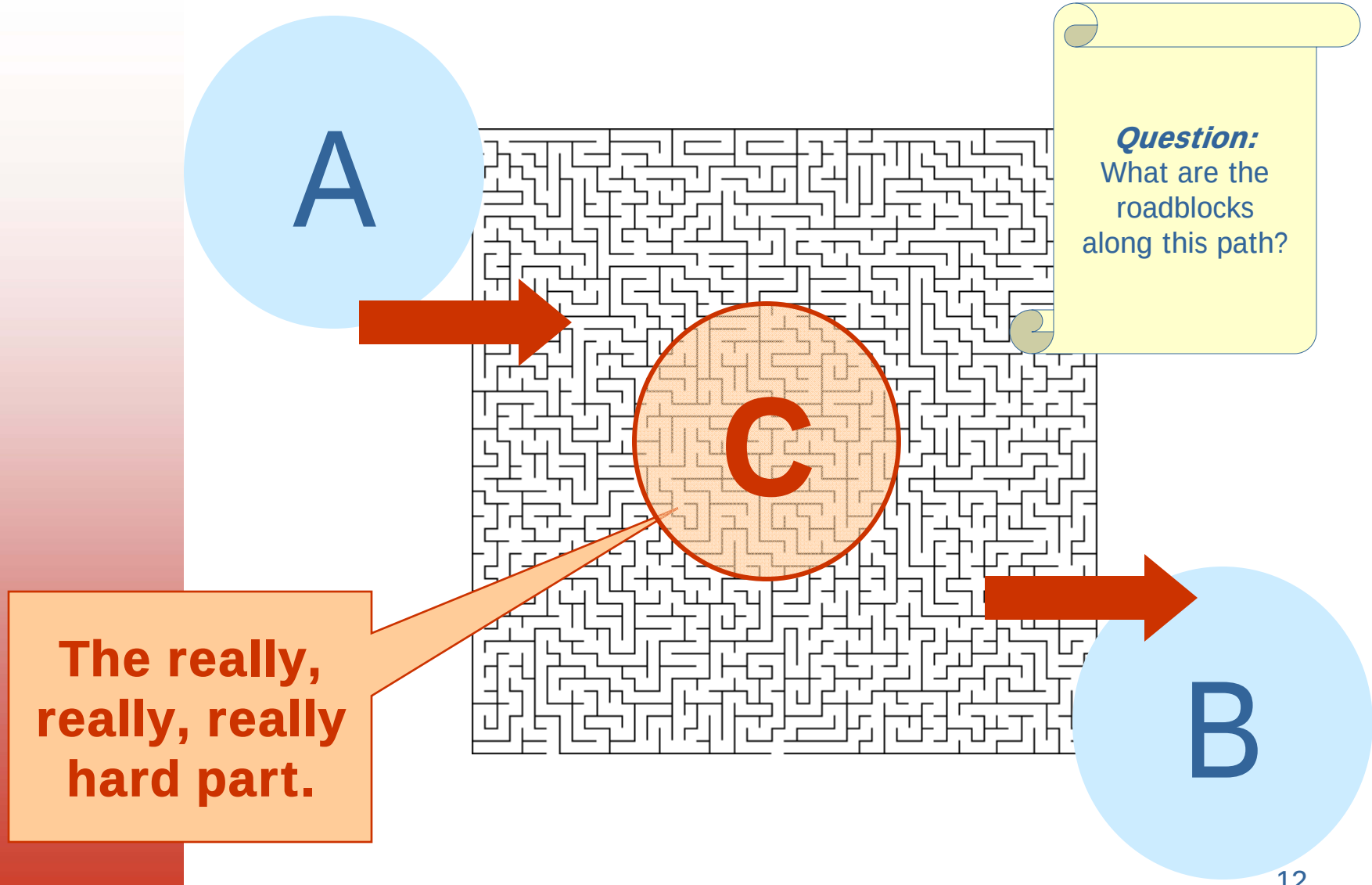
B: Where you want to be.

B

- In order to get from **A** to **B**, you also have to understand **B**.
- **B** is your “To-Be” organizational and business model
- **B** is usually not well defined...



C: The Path from A to B



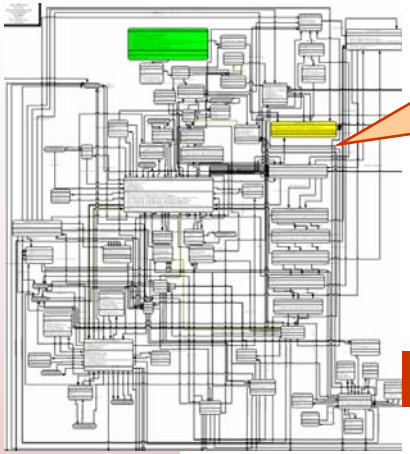
Speedbumps on the Path

- Strategic Alignment
- Technology
- Process
- Organizational Design
- Culture
- Politics

Question:
Of these roadblocks, which is most difficult to overcome?

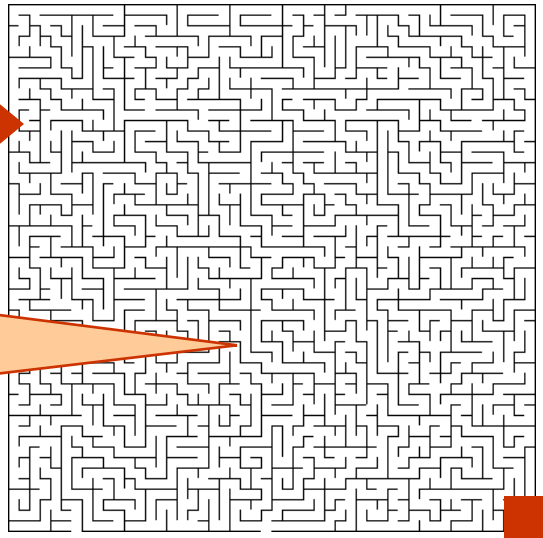
Path from A to B

To sum it up…

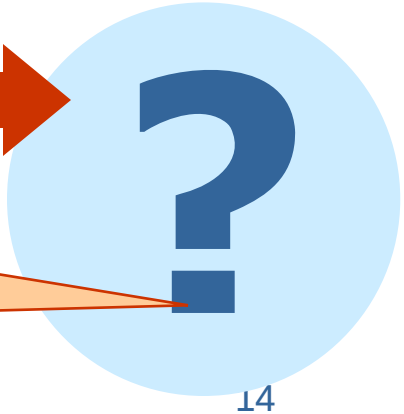


You move from a highly complex (and usually broken) system…

Question:
What percentage of enterprise transformations succeed?



…through a complex transformation process fraught with cultural, technical, and political barriers…



…to get to what is usually a poorly understood end state.

It's no wonder that

85%

of all enterprise transformations

Do not fully succeed!

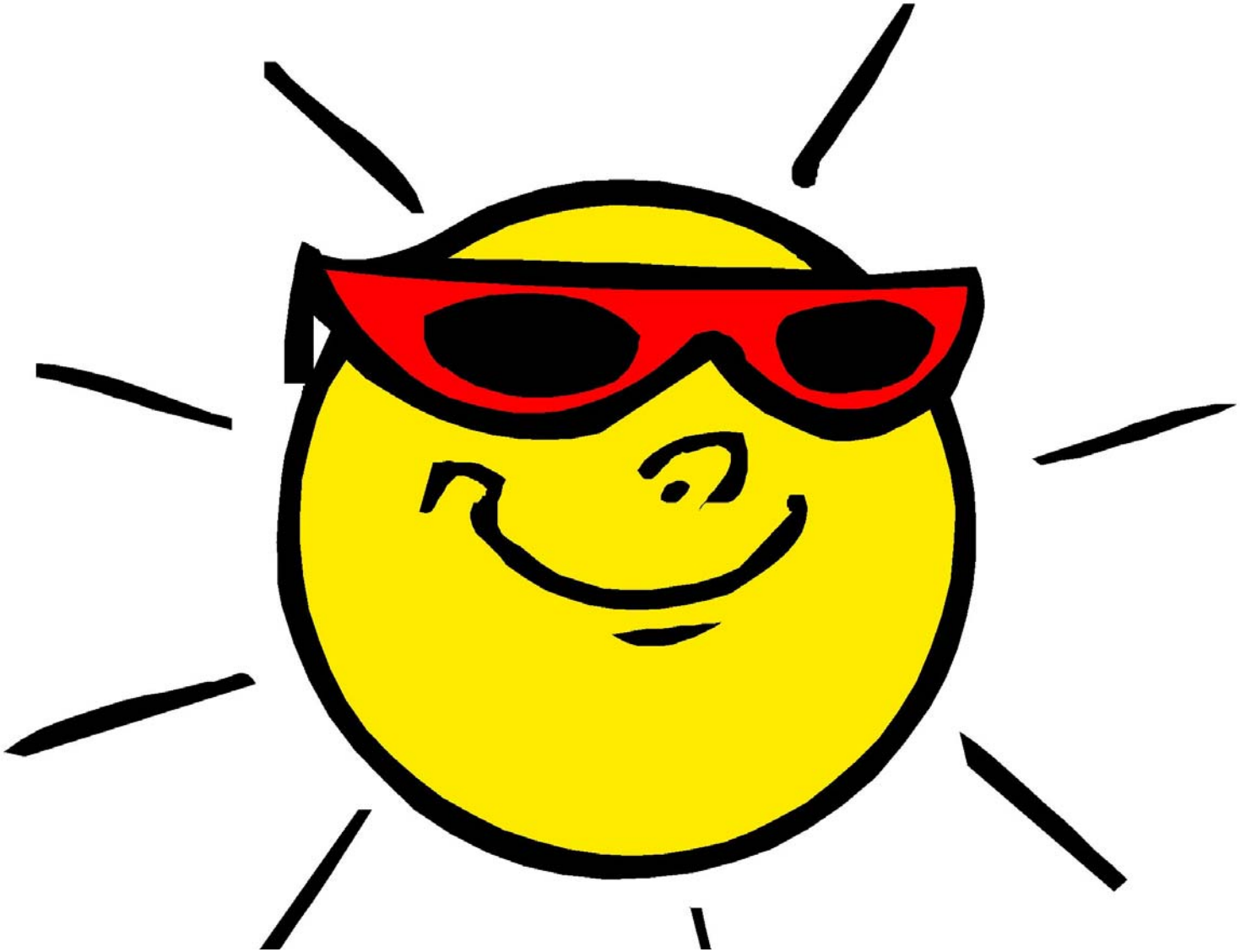


What you need to succeed

1. Clearly defined transformation **objectives**
2. A way to identify **A** and **B**
3. A roadmap to transform the **structures**, **processes**, **technology**, **culture** and **politics** of the organization
4. A way to manage the **astounding complexity** and **mountains of data** of such a large-scale endeavor
5. A way to **communicate** with all stakeholders
6. A way to **measure success** of the transformation
7. A **fully-dedicated** transformation management team

In other words…

…you need a systems engineering approach!



The Coast Guard Logistics Transformation

Start Here



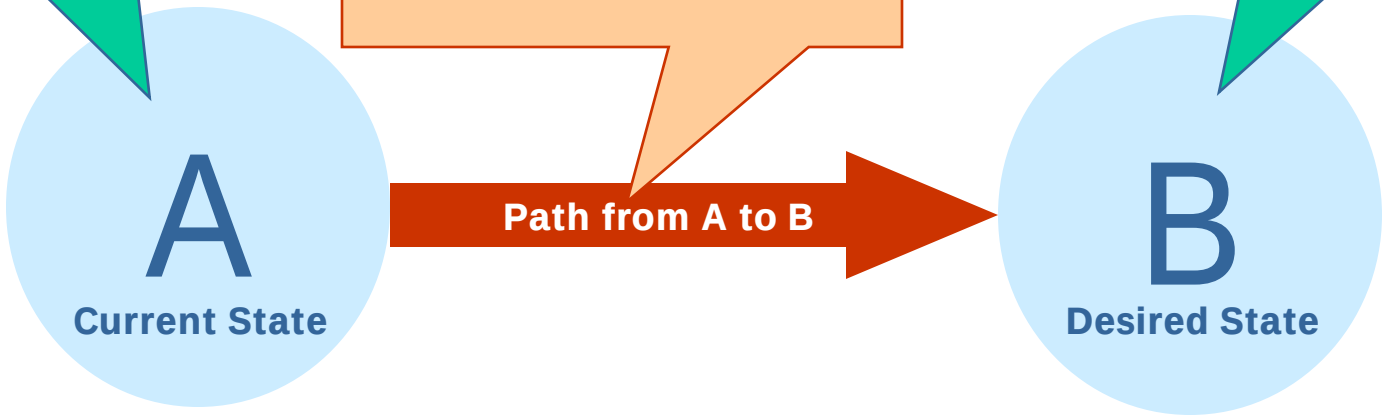
Finish!

Coast Guard Transformation

A: Separate logistics models for surface and aviation.

B: Standard logistics model based on aviation model.

C: Logistics Transformation.



A: The "As-Is" State of CG Logistics

A

- Multiple logistics models (naval, aviation, shore, C4ISR)
- Problematic logistics systems for naval, shore, and technology systems
  - Non-standard fleet assets and inventories
  - Antiquated logistics processes and technology
  - Sub-optimal acquisition model
  - Poor financial controls
- Not compliant with CFO Act
- Problems with Deepwater program
- Getting the mission accomplished despite sub-optimal logistics systems due to dedication and "can-do" attitude

B: The "To-Be" State of CG Logistics

B

- Adopt CG Aviation Integrated Logistics Systems (ILS) model
- Standard fleet assets and Total Asset Visibility
- Integrated technology infrastructure (based on modified ALMIS)
- Transparent and tightly controlled financials
- CFO Act Compliance
- Systems measures of effectiveness (MOEs)

C: The Path to Transition

C

- Commandant's CIAO establishes transformation objectives
- LTPIO established as the **fully-dedicated transition team**
- **Pathfinder Performance Modeling** approach chosen by LTPIO as a key transformation management tool.

About Pathfinder

- Pathfinder is a dedicated **transformation modeling** and support system
- Designed for **large-scale** organizational transformations
- Pathfinder is based upon a **systems engineering** approach to org transformation

Performance System Engineering

- Pathfinder breaks organizational performance into discrete systems elements



- It incorporates **process engineering**, **organizational design**, **enterprise architecture**, and most importantly **behavioral engineering**
- It enables modeling of all elements that **influence** organizational performance
- It makes it possible to manage the complexity of a large transformation

Performance Systems Components

- **Key building blocks of a Performance Model**

 System

 System Outcome

 Job Role or Team (People)

 Strategic Objective

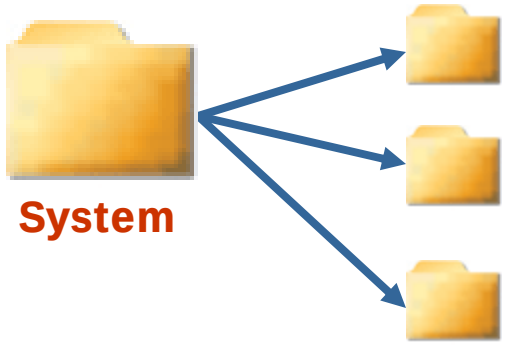
 Policy

 Technology

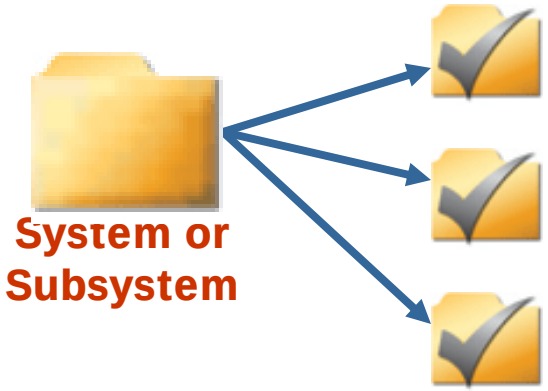
 Organization

Question:
Which of these elements is most critical to performance, yet most often overlooked?

Performance Model Basics



A performance system can have multiple subsystems



A performance system is defined by its System Outcomes



The Outcome is the central element of a performance model

Examples of Systems and Outcomes

- The Coast Guard logistics performance model is based on the standard ILS (Integrated Logistics System)
- *Excerpt from the CG model:*



Coast Guard ILS System Hierarchy

Design Interface	Maintenance	Manpower	Supply	Support Equip.
Ops	Ops	Ops	Ops	Ops
Manpower	Manpower	Manpower	Manpower	Manpower
Facilities	Facilities	Facilities	Facilities	Facilities
Training	Training	Training	Training	Training
Tools/Equipment	Tools/Equipment	Tools/Equipment	Tools/Equipment	Tools/Equipment
Info Management	Info Management	Info Management	Info Management	Info Management
Tech data	Tech data	Tech data	Tech data	Tech data
Environment/Hazmat	Environment/Hazmat	Environment/Hazmat	Environment/Hazmat	Environment/Hazmat
CM/Standardization	CM/Standardization	CM/Standardization	CM/Standardization	CM/Standardization
Safety	Safety	Safety	Safety	Safety
Comms/Feedback	Comms/Feedback	Comms/Feedback	Comms/Feedback	Comms/Feedback
Finance	Finance	Finance	Finance	Finance
Vendor/OGA Contracts	Vendor/OGA Contracts	Vendor/OGA Contracts	Vendor/OGA Contracts	Vendor/OGA Contracts

Tech Data	Training	IT	PHS&T	Facilities
Ops	Ops	Ops	Ops	Ops
Manpower	Manpower	Manpower	Manpower	Manpower
Facilities	Facilities	Facilities	Facilities	Facilities
Training	Training	Training	Training	Training
Tools/Equipment	Tools/Equipment	Tools/Equipment	Tools/Equipment	Tools/Equipment
Info Management	Info Management	Info Management	Info Management	Info Management
Tech data	Tech data	Tech data	Tech data	Tech data
Environment/Hazmat	Environment/Hazmat	Environment/Hazmat	Environment/Hazmat	Environment/Hazmat
CM/Standardization	CM/Standardization	CM/Standardization	CM/Standardization	CM/Standardization
Safety	Safety	Safety	Safety	Safety
Comms/Feedback	Comms/Feedback	Comms/Feedback	Comms/Feedback	Comms/Feedback
Finance	Finance	Finance	Finance	Finance
Vendor/OGA Contracts	Vendor/OGA Contracts	Vendor/OGA Contracts	Vendor/OGA Contracts	Vendor/OGA Contracts

Performance Model Relationships

All components of the model are related to Outcomes



System Outcome



What job roles are involved in producing the outcome?



What policies are related to the outcome?



What strategic objectives does the outcome support?



What organizations are involved in producing the outcome?



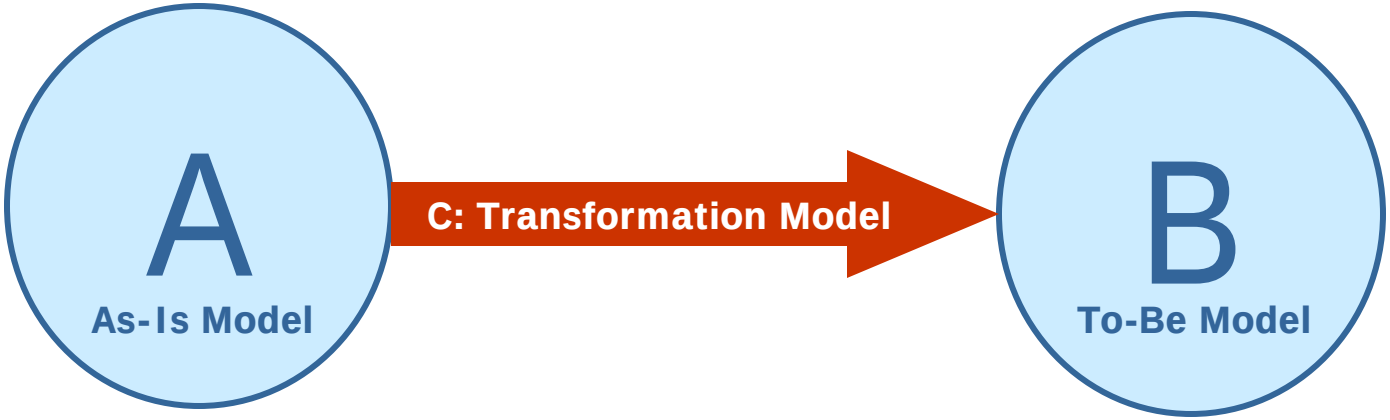
What technology is involved in producing the outcome?



What systems are related to the outcome?

Modeling A and B for CG Logistics

- This “performance modeling” approach is used to create as-is (**A**) and to-be (**B**) models of CG logistics



- *The next step is to develop the Logistics Transformation Model (**C**)*

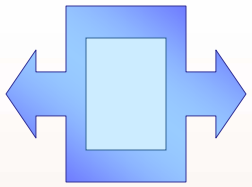
Outcomes as Key Transformation Drivers



"To-Be" System Outcome

- In the Pathfinder transformation model, system outcomes are the **key transformation drivers**.
- *In other words, **if the "to-be" outcome can be achieved**, then the transformation to that part of the system is considered a **success***

Eliminating Outcome Performance Gaps

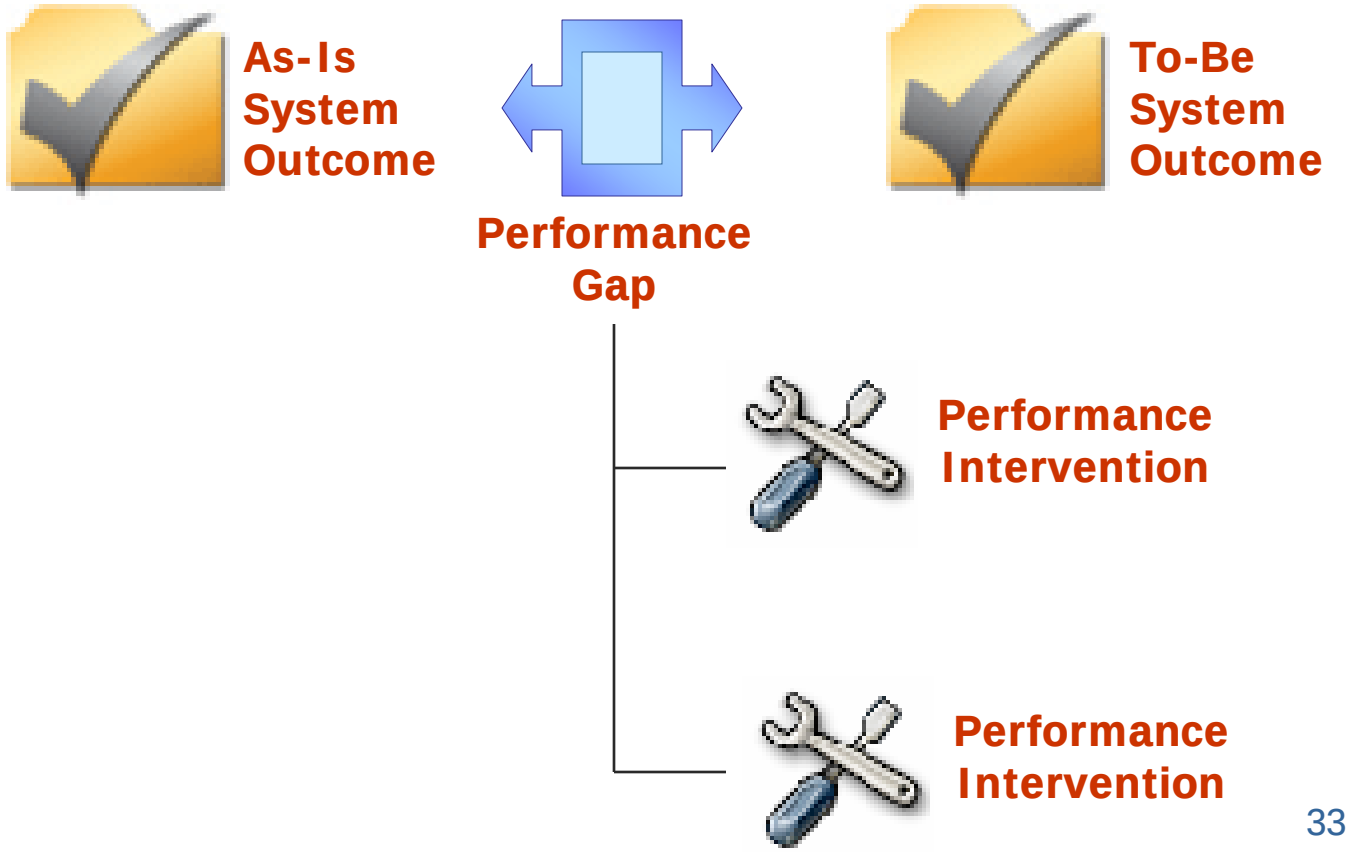


Performance Gap

- There are typically **gaps** between an **as-is** outcome and the **to-be** outcome
- These gaps are recognized in our model as a **performance gap** element
- Some gaps are simply differences in processes or personnel
- Other gaps may require technology, infrastructure, or organizational changes to eliminate
- These gaps must be eliminated by actions called **performance interventions**

Elements of the Transformation Framework

- Pathfinder includes **gaps** and **interventions** as discrete elements of the transformation model



Coast Guard Intervention Examples

- **Outcome: Approved Maintenance Procedure Card produced IAW COMDINST xxx.x**
  - **Gap: Maintenance Requirements List (MRL) not defined for surface assets**
    - Intervention: Perform MSG-3 logic analysis
    - Intervention: Enroll asset in ACMS
    - Intervention: Modify MPC process guide
    - Intervention: Identify and train MPC production staff

About Interventions



Performance Intervention

- Each intervention:
  - Is an actionable item
  - Has an accountable owner
  - Has schedule constraints
  - Has associated resources
  - Can be used to build a transition project plan
  - And most importantly, **has measurable success criteria**

Putting the elements together…

- **Strategies**
- **Systems**
- **Subsystems**
- **Outcomes**
- **Influencers** (policies, organizations, people, technology, etc.)
- **Gaps**
- **Interventions**
- *How does it all fit together?*

Transformation Model Framework



Strategic Framework



Systems Framework



Org Framework



Technology Framework

Vision/Mission

Strategic Goal

Statute

Policy

Best Practice

Documentation

System

Sub-System

Outcome

Requirement

Org Unit

Performer:

- Job Role
- Team
- Automated System

IT System

IT Feature

Facility/Equipment

Facility

Tool/Equipment



Transition Framework

Transformation Goal

Performance Gap

Transformation Objective

Intervention

Transition
Success Criteria

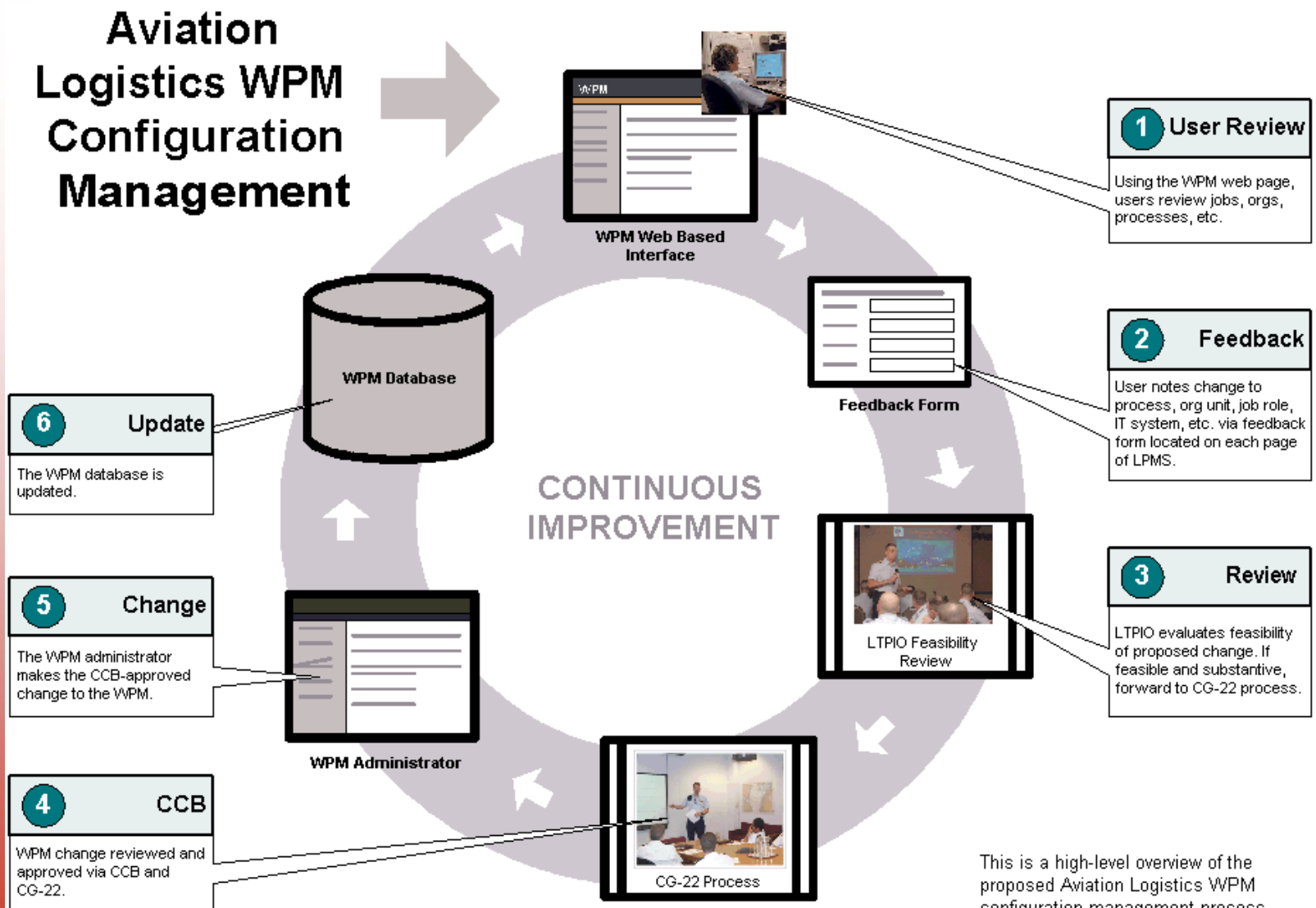
The USCG Transition Process

- LTPIO alignment conducted, **transformation objectives identified**
- Docs and resources reviewed
- SMEs identified
- **ILS systems outcome-based framework developed**
- Best practices identified by SMEs (42)
- Preliminary outcomes identified by SMEs (800)
- Org and strategic models defined
- **Key outcomes identified (250)**
- Framework relationships to key outcomes identified by SMEs (docs, job roles, policies, best practices, etc.)
- Skilled Performers (SPs) identified by USCG
- SP outcome review worksheets prepared
- SP outcomes reviews and validation conducted
- All data collected in Pathfinder Performance Modeler
- All data reviewed
- Analysis reports prepared
- PVs and PIs developed using facilitated meetings with LTPIO working groups
- Activity crosswalks prepared
- **Project plans and transition dashboards developed**
- **Transition training prepared and delivered**

Aviation Logistics Framework Scale

- 800 aviation logistics model outcomes were identified in all 10 ILS elements (and a cross-cutting set of subelements)
- 250 Key Outcomes (transformation drivers) identified
- Key Outcomes mapped to
  - 41 Systems
  - 698 Job roles, teams, or org units
  - 80 Documents (Policy/Directives/Statutes, etc)
  - 122 IT systems and features
  - 84 Strategic elements (goals and objectives)
  - Over 600 functional and business requirements
  - Over 7,000 performance factors and influencers
- Nearly 22,000 performance relationships

Model Configuration Management



This is a high-level overview of the proposed Aviation Logistics WPM configuration management process which can be used both to validate and enhance WPM content and also to manage its configuration over time.

People are Key



- **Changing the behavior of your people is the most difficult task of all…**

- Culture and politics are the most difficult roadblocks to logistics transformation
- You've got to convince people at all levels to change the way they operate.





Promoting cultural and political change

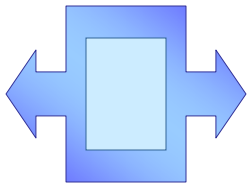
- Each outcome identifies human factors influencers (technological, environmental, social, and process)
- Relationships in model indicate cultural and political power bases
- Model enables stakeholders to “see” vision
- The **Transformation Dashboard** is key to producing measurable changes in organization, infrastructure, processes, systems, and behavior.
- Manages and measures progress in **making the changes required to achieve “to-be” outcomes**

Transition Success Criteria

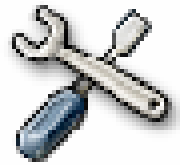
Each level includes a summary scorecard that shows transition progress.



To-Be System Outcome



Performance Gap



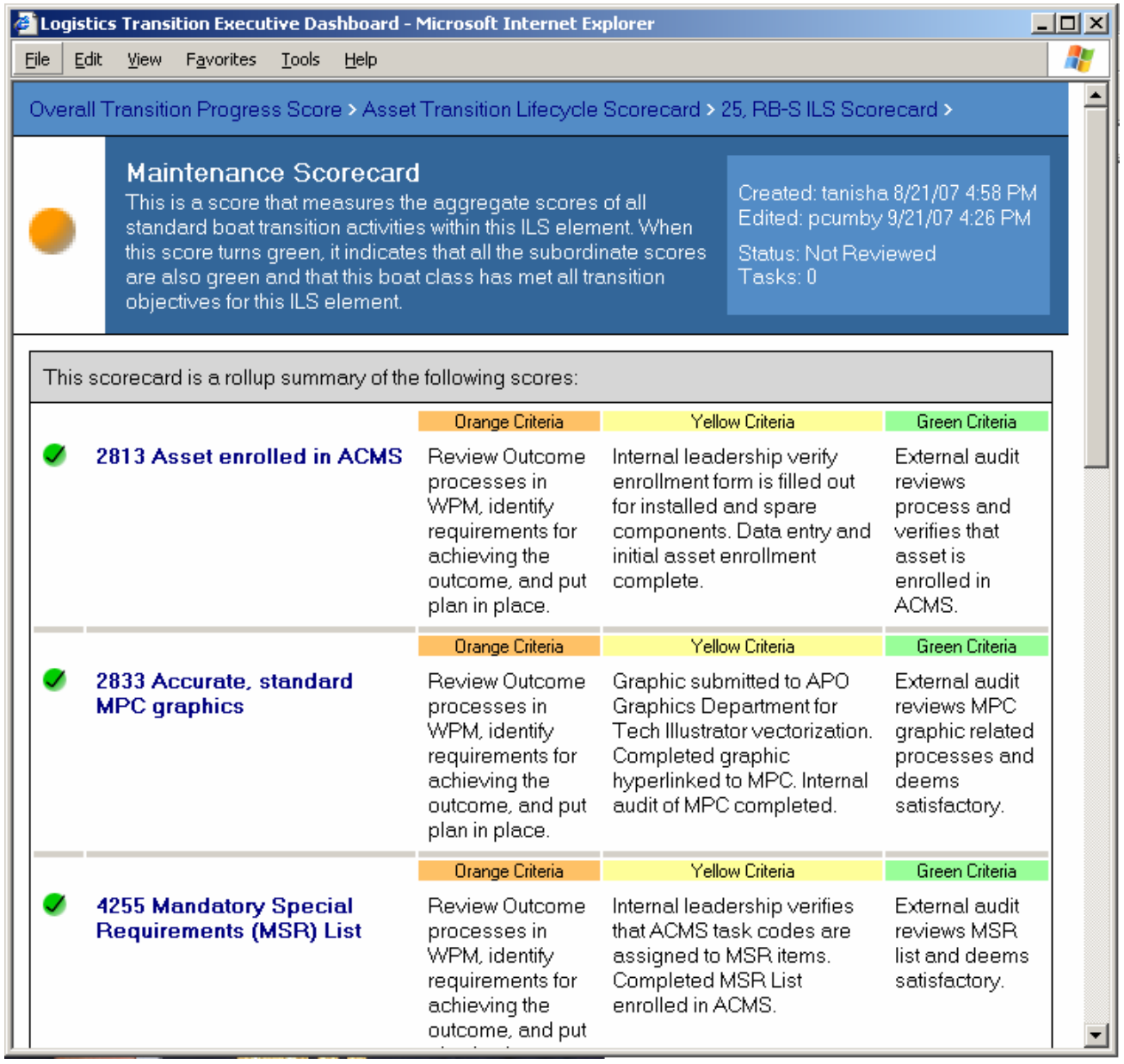
Performance Intervention

- External audit conducted - Final Operating Capability (FOC) achieved
- Internal audit conducted - Initial Operating Capability (IOC) achieved
- Process requirements identified and plan of action in place
- No Progress

Example Success Criteria

- **Outcome: Authorized Chemical List**
  - **Intervention: Chemical Locker Storage Established**
  - **Criteria:**
    - **Red:** No Progress
    - **Orange**: Location for chemical storage locker identified.
    - **Yellow**: Authorized Chemical List established and utilization instruction developed and signed by Sector Engineering Officer.
    - **Green:** Personnel trained in proper storage procedures and usage of the Chemical locker IAW Hazmat plan.
    - ***Owner, schedule criteria, compliance inspection process, etc. defined for intervention in model***

Sample USCG Scorecard



Summary

- Performance Model Framework identifies all elements of logistics system performance
- All relationships between systems elements are defined
- Performance outcomes are central to model
- Each outcome has transition plan that identifies gaps and interventions
- Each intervention has measurable success criteria
- Success criteria form the basis for the Transition Dashboard
- Transition Dashboard drives systems, organizational, technological, and behavioral change

Demos and Questions

- USCG Logistics Performance Management System (LPMS)
- Logistics Transition Dashboard
- Transformation support materials



Efficacy of Modeling & Simulation in Defense Life Cycle Engineering

October 22-25, 2007

Don P. Cox, MS
Salim Hariri, Ph.D.

University of Arizona
Electrical and Computer Engineering
Tucson, AZ
dpcox@email.arizona.edu

Topics

- Introduction
- DoD M&S View
- DoD Acquisition
- Military Logistics
- M&S Tool Example
- Conclusions

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Thank you !



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HPDC

High Performance Distributed Computing Laboratory



Salim Hariri, Ph.D (HPDC, CAC Director).



Don Cox, MS

NEW!

National Science Foundation

WHERE DISCOVERIES BEGIN

Center for Autonomic Computing

www.ece.arizona.edu

Introduction

- US DoD is world's largest single consumer
- Simulation Based Acquisition
- Logistics M&S lags engineering
- Increasingly important – selection discriminator

DoDD 5000.1 DoDI 5000.2
Defense Acquisition Guidebook



Definition of Simulation Based Acquisition (SBA)/(SMART)



The Army's vision for SMART is a process in which we capitalize on Modeling and Simulation (M&S) technology to address the issue of system development and life-cycle costs through the combined efforts of the requirements, training and acquisition communities.

Importance of M&S

Lessons Learned Through Acquired Experience

Apache
(Legacy system upgrades using M&S)

Crusader
(Relied heavily on M&S to support systems engineering)

Comanche
(Down select based on M&S)

Grizzly
(Revitalized the program with M&S)

Aerial Common Sensor
(Using virtual prototypes for source selection)

Future Scout and Cavalry System
(Collected Data)

Army Model & Simulation Office

Characterized Levels of DoD M&S

1. "Live" (Man vs Man)



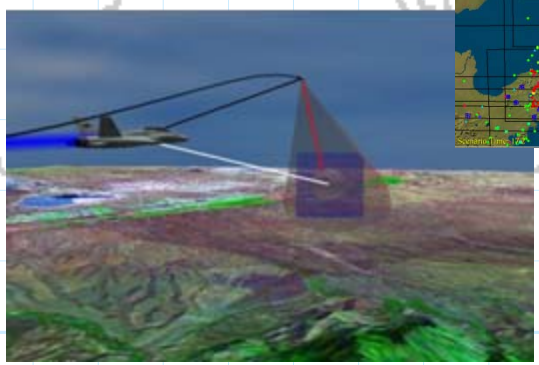
- Training
- Development
- Test & Evaluation
- Operations

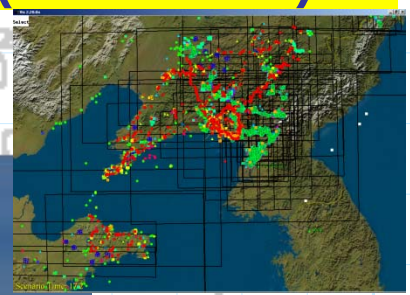
2. "Virtual" (Man vs Simulation)



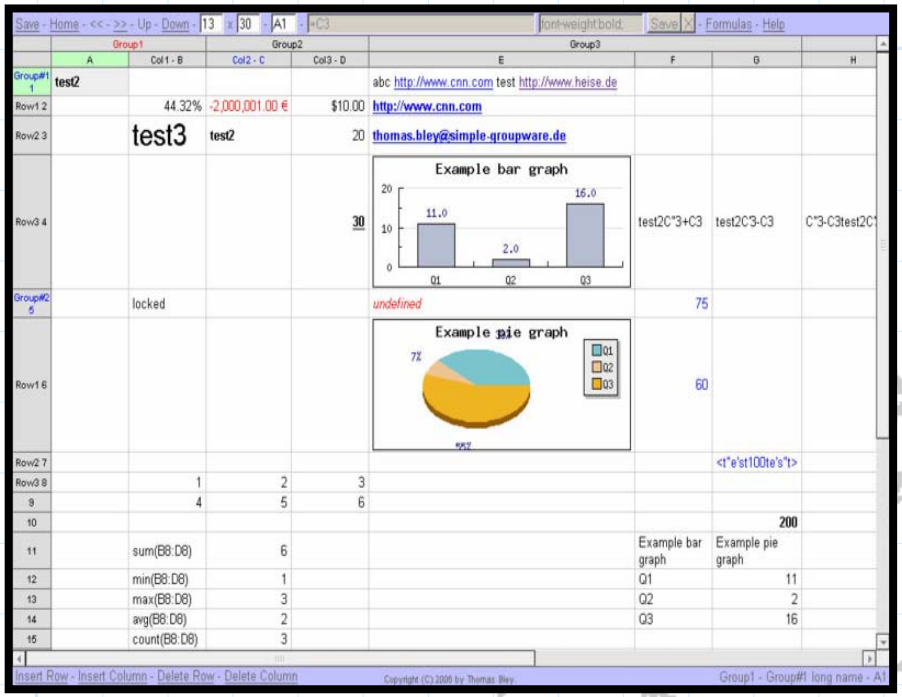


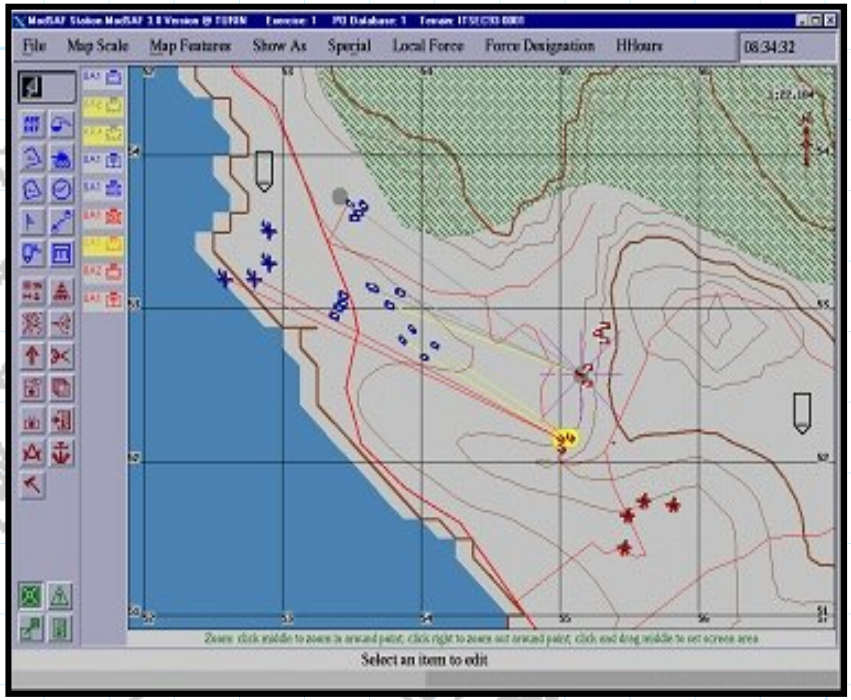
3. "Constructive" (Sim vs Sim)





Static (Steady State) & Dynamic





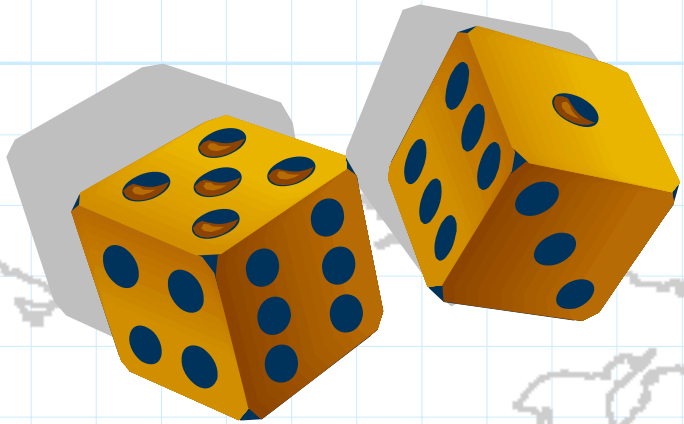
- Relationships mathematically defined
- Dependant/Predefined (1:1)
- Equilibrium seeking
- No dynamic temporal effects

- Relationships defined many ways
- Independent & Dependent (1:n)
- Equilibrium no factor
- Dynamic temporal effects

Deterministic & Stochastic



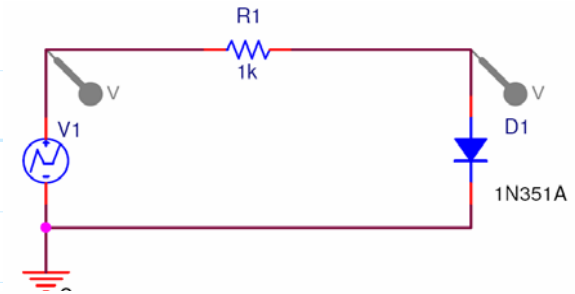
- Totally causal events & decisions
- No random events
- No “degrees of freedom”

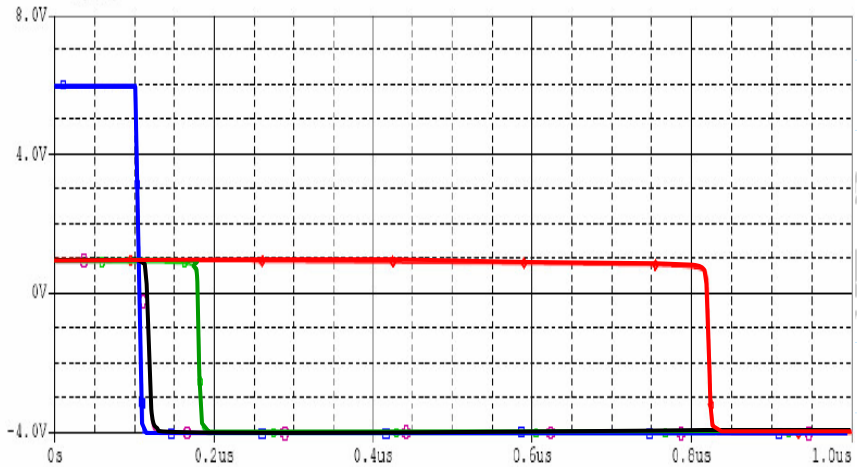


Monte Carlo

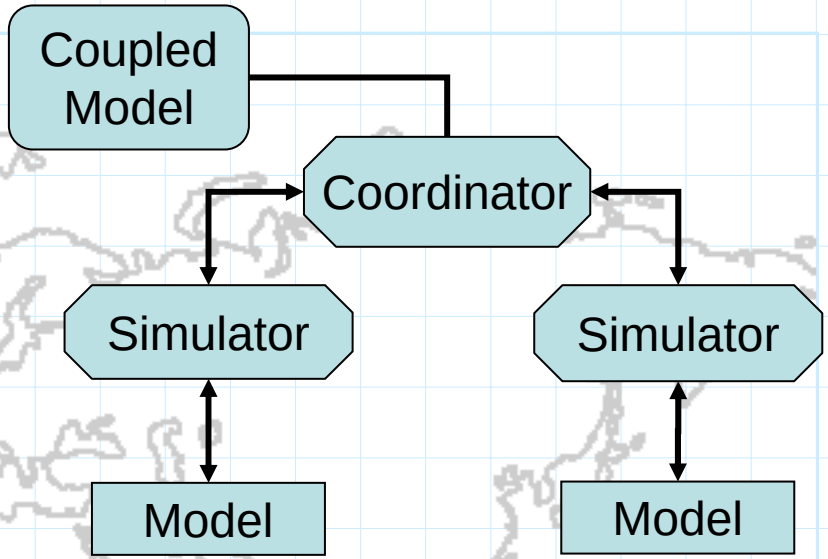
- Indexed collection of variables
- Random number generators
- Multiple degrees of freedom

Continuous & Discrete Event





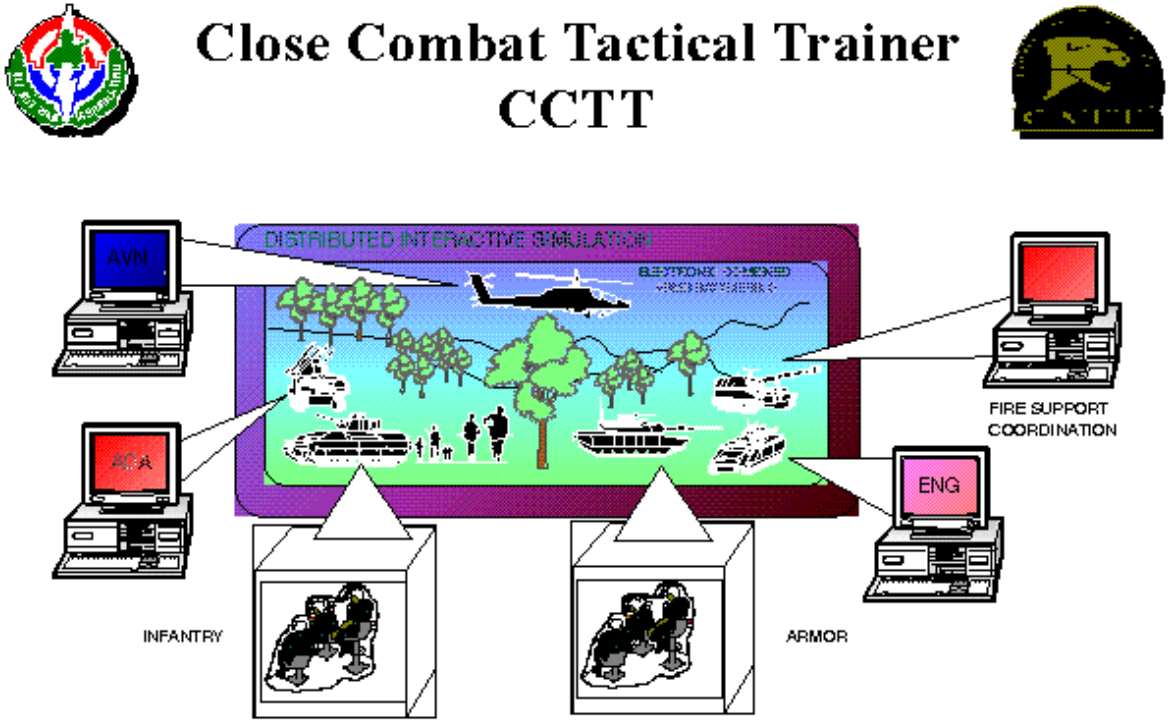
- **Analog computing**
- **Differential Equation (partial/ordinary)**
- **Continuous between *f(x)* limits**
- **Approximated by digital computers**



- **Time referenced events**
- **Models independent of simulators**
- **Models respond to events**
- **DEVS: Formalization = less errors**

Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim,
"Theory of Modeling and Simulation", 2nd Edition, Academic Press, 2000

Unitary vs Distributed Simulation



- High Level Architecture (HLA).
- Test and Training Enabling Architecture (TENA)
- Aggregate Level Simulation Protocol (ALSP)
- Distributed Interactive Simulation (DIS)

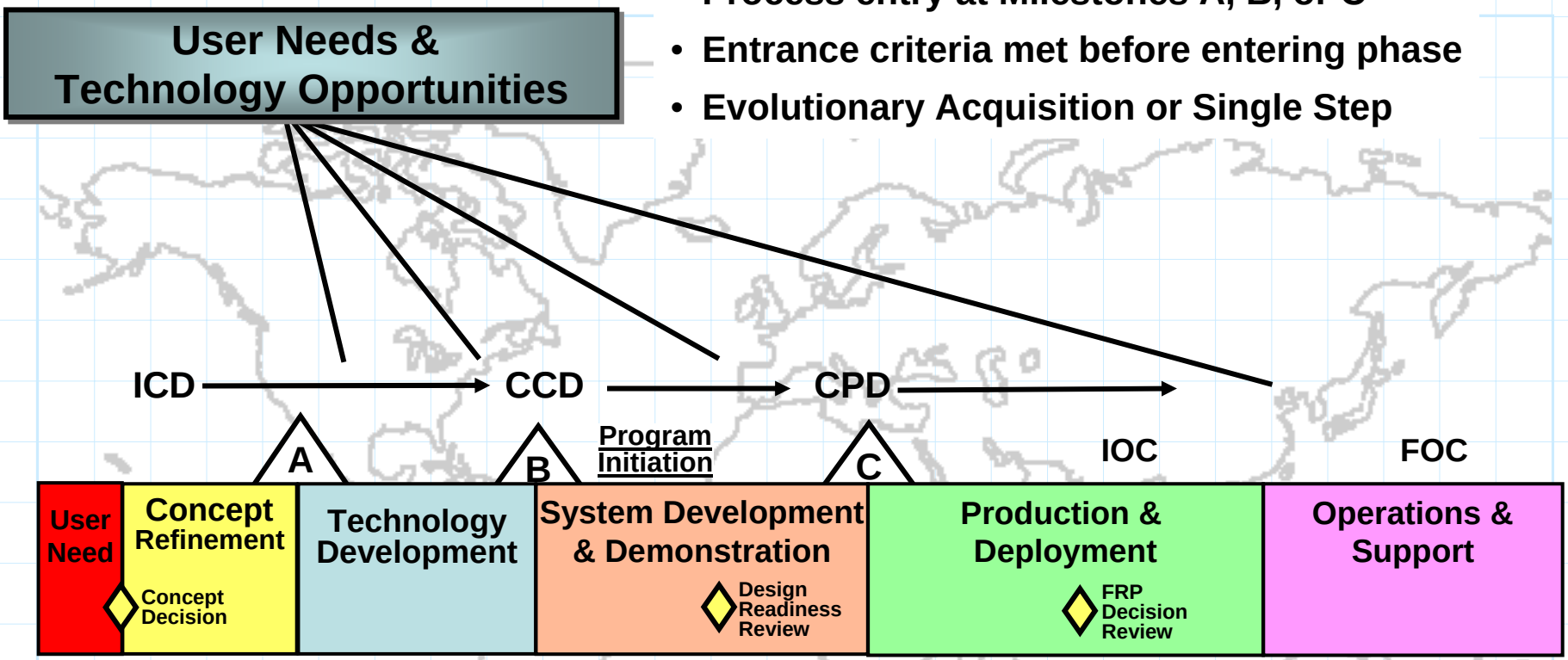
Military Logistics

- Military logistics is the science of planning and carrying out the movement and maintenance of armed forces. In its most comprehensive sense, those aspects of military operations that deal with:
  - a. design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel;
  - b. movement, evacuation, and hospitalization of personnel; acquisition or construction, maintenance, operation and disposition of facilities; and acquisition or furnishing of services.

Defense Technical Information Center

DoD Acquisition Framework

- Process entry at Milestones A, B, or C
- Entrance criteria met before entering phase
- Evolutionary Acquisition or Single Step



Graphics Sourced from the Defense Acquisition University

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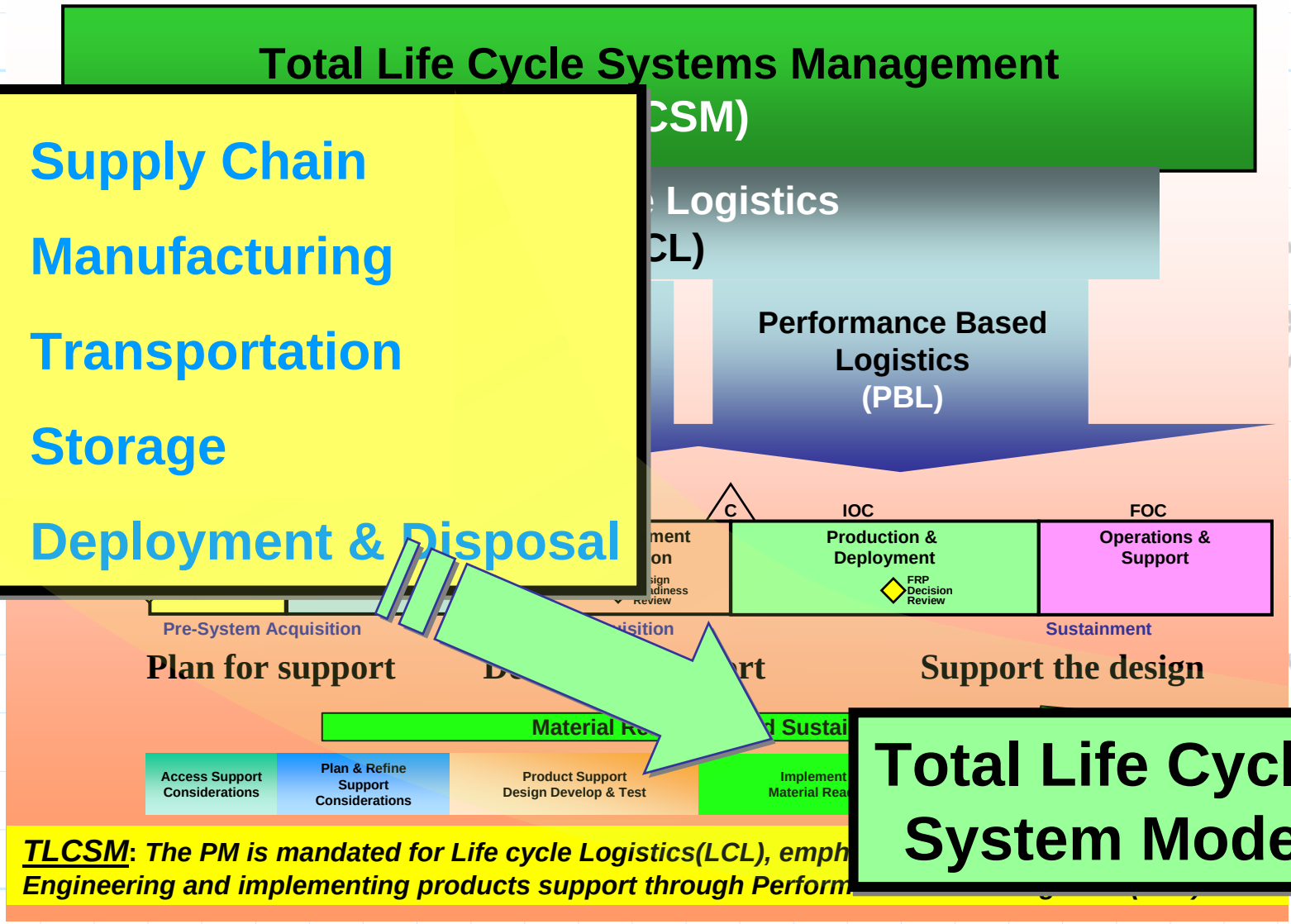
New Cargo Jet Specification



Military Logistics

Defense Acquisition Guidebook (Chap. 5.0)

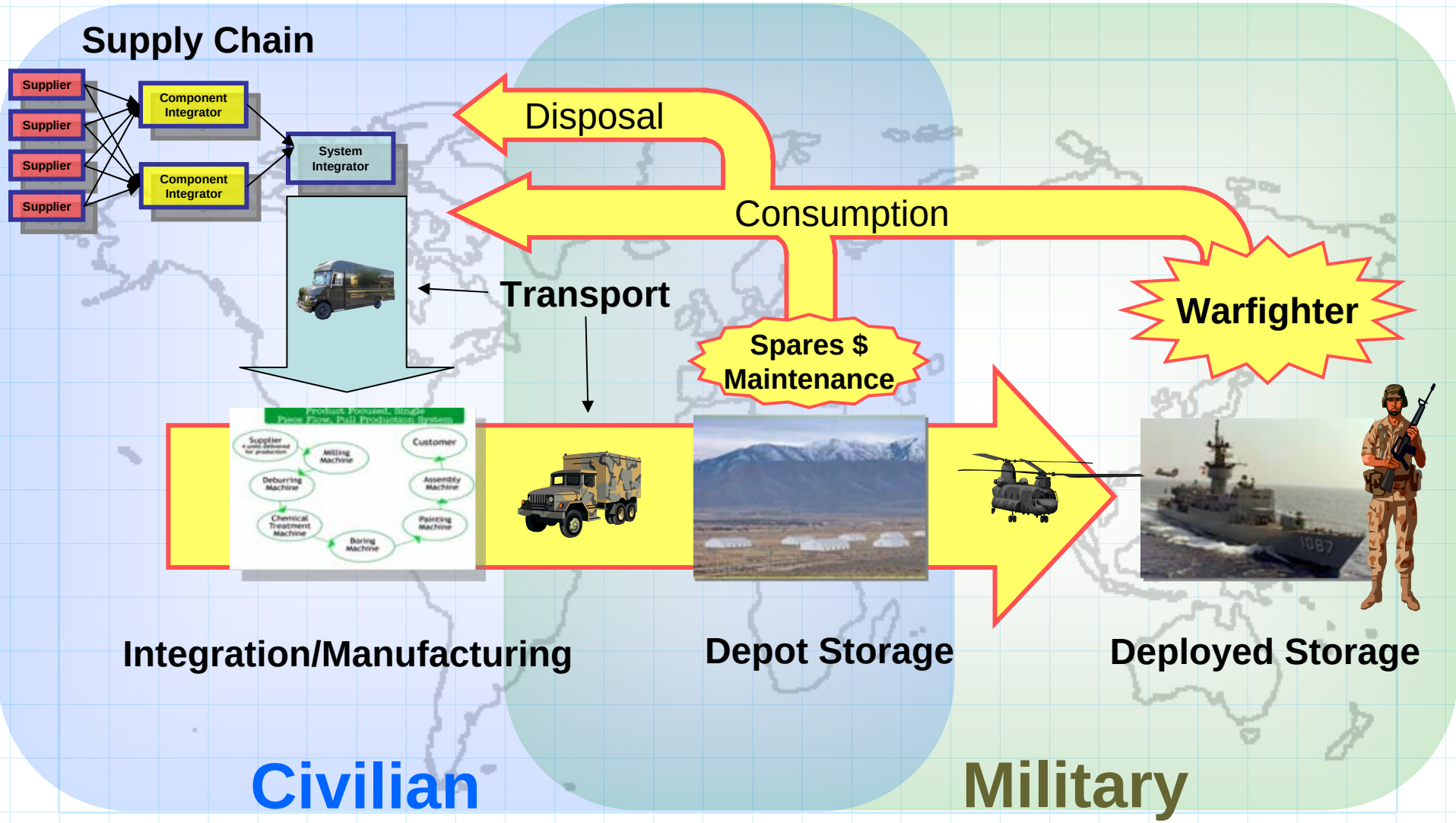
1. Supply Chain
2. Manufacturing
3. Transportation
4. Storage
5. Deployment & Disposal



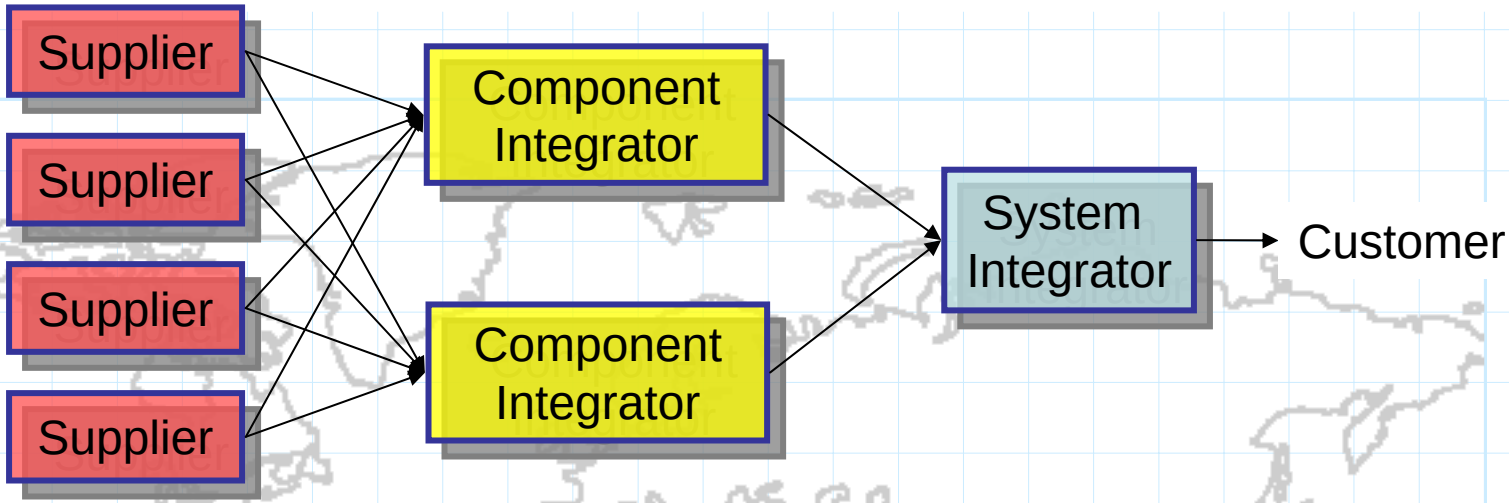
***TLCSM**: The PM is mandated for Life cycle Logistics(LCL), emph*
Engineering and implementing products support through Perform

Total Life Cycle System Model

Life Cycle System Model

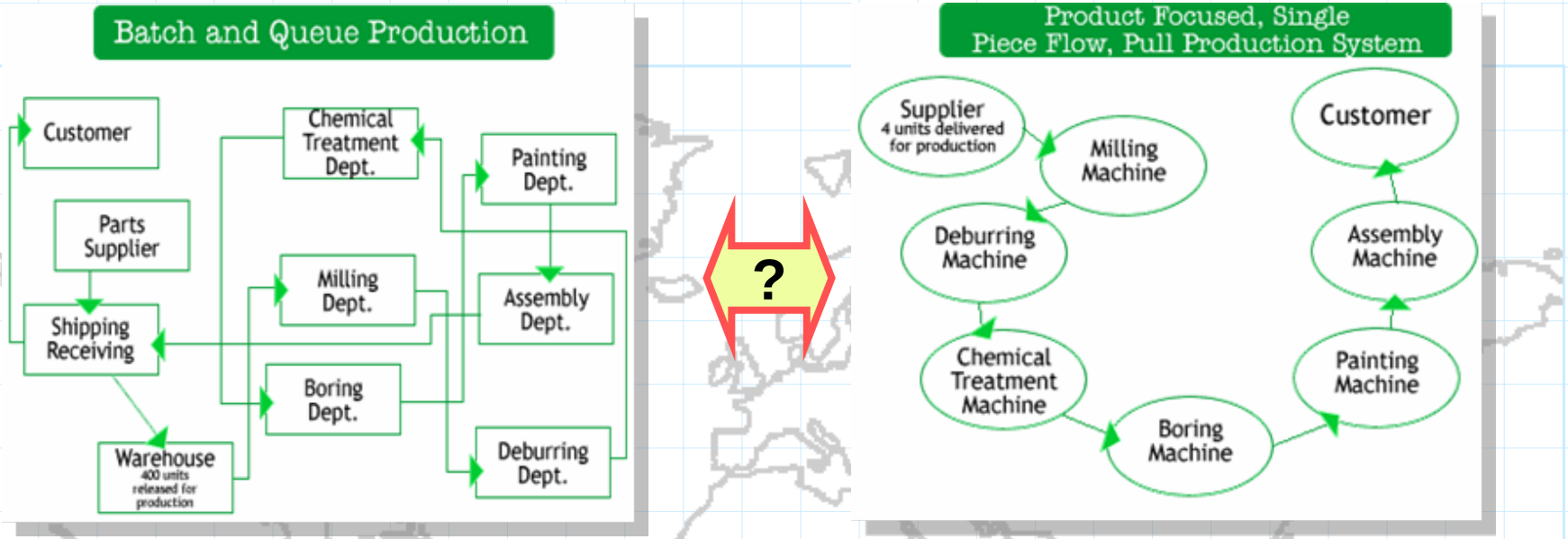


Supply Chain



- **Manufacturing Process**
- **Low fidelity models - parameterize assumptions**
- **Obsolescence management**
- **Socio-political & economic effects**
- **KPPs:**
  - **Consumption driven – model demand drivers**
  - **Cost, capacity, lead-time, etc**

Manufacturing (Integration)



- **Optimize processes & material flow**
- **Cost (risk) reduction**
  - **Dynamic – Discrete Event Simulation**
  - **Supply Chain model integration**
- **KPPs**
  - **Cost, Process, Flow**
  - **Resource Allocation, etc.**

Transportation

- Military & Civilian
- Touch Labor
- Damage
- KPPs
  - Reliability, Availability
  - Lead Time (customs, etc.)
  - Cost, Choke Points
  - Sustainment, Surge







Storage

- **Location**
  - **Depots (Strategic)**
  - **Theater (tactical)**
- **KPPs**
  - **Inventory (operations, spares)**
  - **Cost, availability, reliability**
  - **Assembly**







Deploy & Dispose

- Inventory levels
- Asset visibility
- Surplus or Destroy ?
- Life Extension
  - Training
  - Recycle

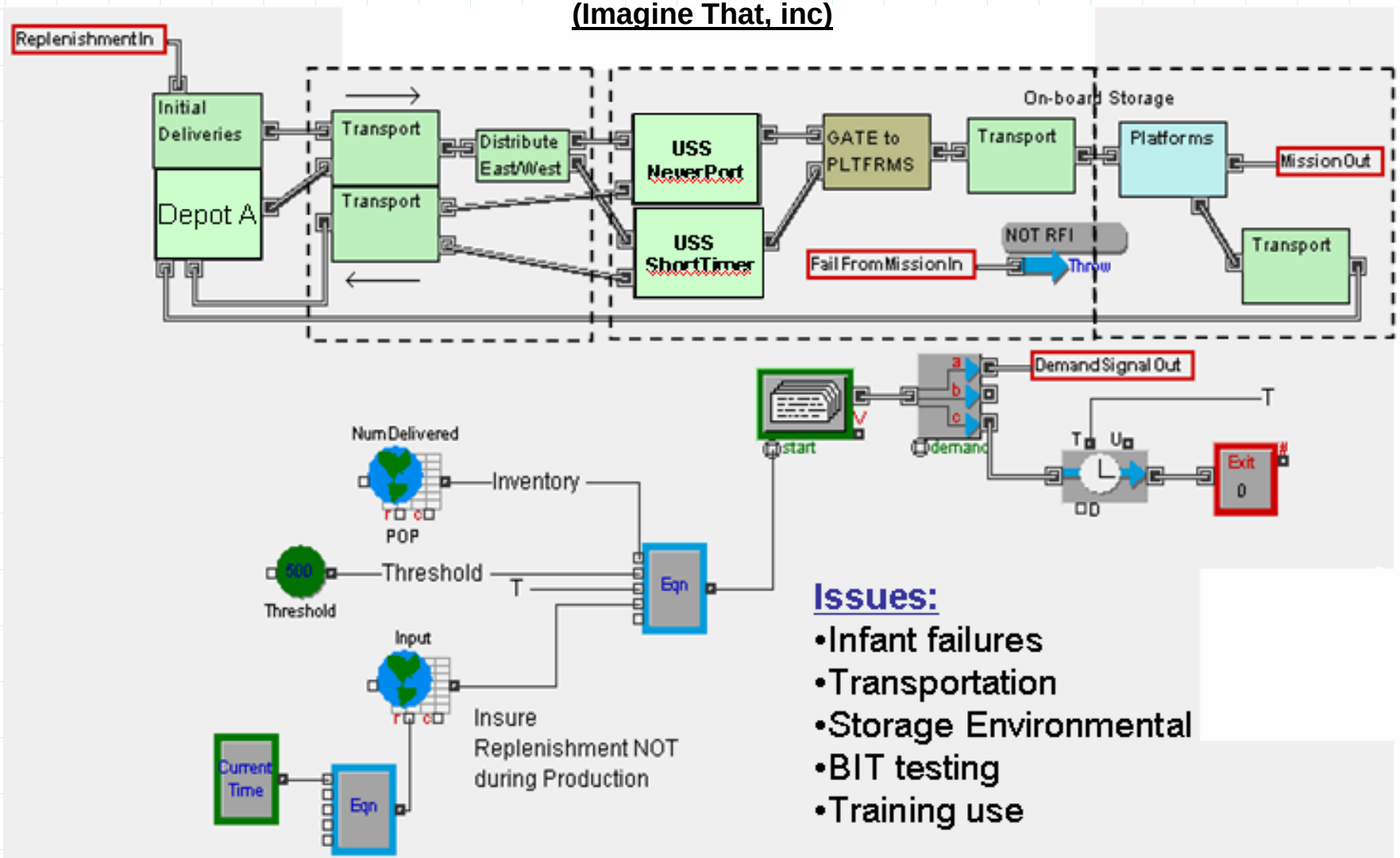




M&S Tool Example

Extend®

(Imagine That, inc)



Issues:

- Infant failures
- Transportation
- Storage Environmental
- BIT testing
- Training use

M&S Resources

- **Military**
  - Defense Modeling & Simulation Office (DMSO)
  - Modeling and Simulation Information Analysis Center (MSIAC)
  - Advanced Air Force Modeling & Simulation (AFAMS)
  - Navy Modeling & Simulation Office (NMSO)
  - Army Modeling & Simulation Office (AMSO)
  - Army Simulation, Training & Instrumentation (PEO STRI)
  - National Security Council (NSC)
- **Industry**
  - Simulation Interoperability Standards Organization (SISO)
  - Association of Computing Machinery (ACM)
  - Society for Modeling and Simulation International (SCS)
- **Academia**

University of Arizona
Georgia Institute of Technology
University of Pennsylvania
INFORMS College on Simulation
Old Dominion University
California State University
University of Magdeburg
University of Central Florida

Conclusion

- M&S is increasingly important in Military Logistics
  - Contractually required by many DoD programs
- Beneficial in all phases of life cycle
- Highly useful in logistic modeling & management
  - Highly granular (high fidelity)
  - Dynamic inventories & environments
  - Interoperable with engineering & operational models
- Source selection discriminator
  - Total Lifetime Cost analysis (TLC)
  - Logistic support capability




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Questions?
Thank You for Your Attention!



The Deployment Readiness Service: A Case Study of the Challenges of Implementing a Service Oriented Architecture in a Legacy System Environment

George C. Dalton II, USAF

Air Force Institute of Technology



Overview

- What Problem is being solved by DRS?
- What is a Service Oriented Architecture?
- What are the Challenges?
- How can these Challenges be overcome?

The views expressed in this presentation are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

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What Problem is being solved by DRS?

- **Unit Deployment Managers**
  - **Must pull information from many sources**
    - **Personnel Information**
    - **Immunization and medical records**
    - **Training**
    - **Etc….**
- **Commanders (at all levels)**
  - **Need a snapshot of Unit readiness**
  - **Need ability to Identify problem areas and trends**

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"As Is" Readiness Data Challenge

Example: Training Completion Data Origination Process (Generic)

Student Completes Course









Authoritative Source (Instructor) Creates Completion Record



Course certificate



Attendance list / Graduation roster



Form

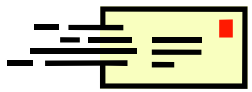


Specialized System

UDM / UTM Obtains Copy of record



Fax/Copier



Email



Distribution



Specialized System



In-Person



UDM / UTM Manages Record Copy

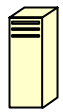
Files Copy in Mobility Folder



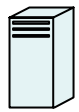
AND (May)

Manually enter some data elements from record into one or more of the following systems:





ACES-PR



SFMIS



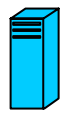
CAMS



LOGMOD



G081



ARMS



Other Functional Systems (MRDSS, LSA, etc.)



Local Solutions (Excel, Access, Custom Apps)

Time Flow

Integrity - Service - Excellence

Deployment Readiness Service

- What is DRS?
  - AF personnel deployment readiness solution
  - Automates a manually intensive process
  - Subscribes to data from multiple sources
  - *Pathfinder to integrate data on GCSS-AF*



- Initial Users:
  - Commanders
  - Installation Deployment Officers
  - Unit Deployment Managers
  - Unit Training Managers

- Why DRS?
  - Creates standard service to across AF
  - Integrates diverse readiness indicators (med, trng, etc.)
  - Automates review, forecasting (by AEF), and scheduling
  - Eliminates dual data entry (same data; multiple systems)
  - Eliminates record re-creation (PCS/PCA)

Identify Information Needs

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INDIVIDUAL DEPLOYMENT REQUIREMENTS		DATE PLACED ON DEPLOYMENT STATUS		DATE ALL ACTIONS COMPLETED	
NAME (Last, First, Middle Initial)	GRADE	AFSC	UNIT/SHOP	PRIMARY	
STUFF, LEVEL N.	CPT	3221		DEPLOYMENT AVAILABILITY CODE (DAV)	

REQUIREMENTS	DATE INITIALLY ACCOMPLISHED/ COMPLETED	INDIVIDUALDS INITIALS	INSPECTION RECORD				
DOCUMENTATION							
ID CARD, DD FORM 2AFACT (United States Uniformed Services ID Card)(Accountable Form)	16-Apr-98		®	√	X	NR	
DOG TAGS (ID Tags and Chains)	04-Apr-04		√	√	NR	X	
EMERGENCY DATA CARD, DD FORM 93 (Record of Emergency Data Card)	15-Aug-93		X	X	X	NR	
SHOT RECORD, PHS 73 1 (International Certificate of Vaccination)	07-May-00		√	√	√	NR	
LOCATOR CARD, AF FORM 245 (Deployment Locator and Processing Checklist)	02-Dec-99		√	NR	X	®	
HAND RECEIPT, AF FORM 1297 (Temporary Issue Receipt) (For issue of mini C-1 bags and weapons to cargo couriers)	24-Jan-94		NR	√	@	√	

Individual Readiness Summary (IRS) Wireframe

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Logged in as: Airforce, Uiz D.
Rank: TSgt (E6)
Login Role: UDM
Login Unit: 20 SVS, 20 FW, Shaw AFB

Displayed individual: Flien, Keepe, M.
Rank: TSgt (E6)
Assigned Unit: 20 SVS, 20 FW
Assigned Base: Shaw AFB

Members AEF
color = forecast

Medical | Equipment | Training | Administrative | Legal

"Requirement" displays solutions corresponding to the requirements, e.g. the courses completed to satisfy a training requirement; except the requirement itself should be listed in cases where nothing has been completed.

Requirement	STATUS
PHA	
LAB	
SHOTS	
EQUIP	
DLC	

Requirement	STATUS
GAS_MASK	
GLASSES	
HEARING_AID	
PERSONAL_CLOTHES	
PROF_EQUIP	
DOG_TAG	

Requirement	STATUS
CARGO_PREP	
CHEM_WARFARE	
EOR	
FORCE	
FOREIGN_CLEARANCE	
HAZ_CERT	
LOAC	
RELIGIOUS_SENSITIVITY	
SELF_AID	
SMALL_ARMS	

Requirement	STATUS
GENEVA_CARD	
GOV_DL	
LES	
LINE_BADGE	
PRP	
BAG_TAG	
HAND_RECEIP	
ID_CARD	
LOCATOR	

Requirement	STATUS
DEPENDENT	
POWER_ATT	
WILL	

Next Requirement Expires 20 May 2007

DAV Status Expires 11 Nov 2007

Click on box to initiate DAV Code query for currently displayed person (waivers can be applied from query results screen)

Click here to create AF 4005 with displayed data

Box Color Reflects Category Readiness

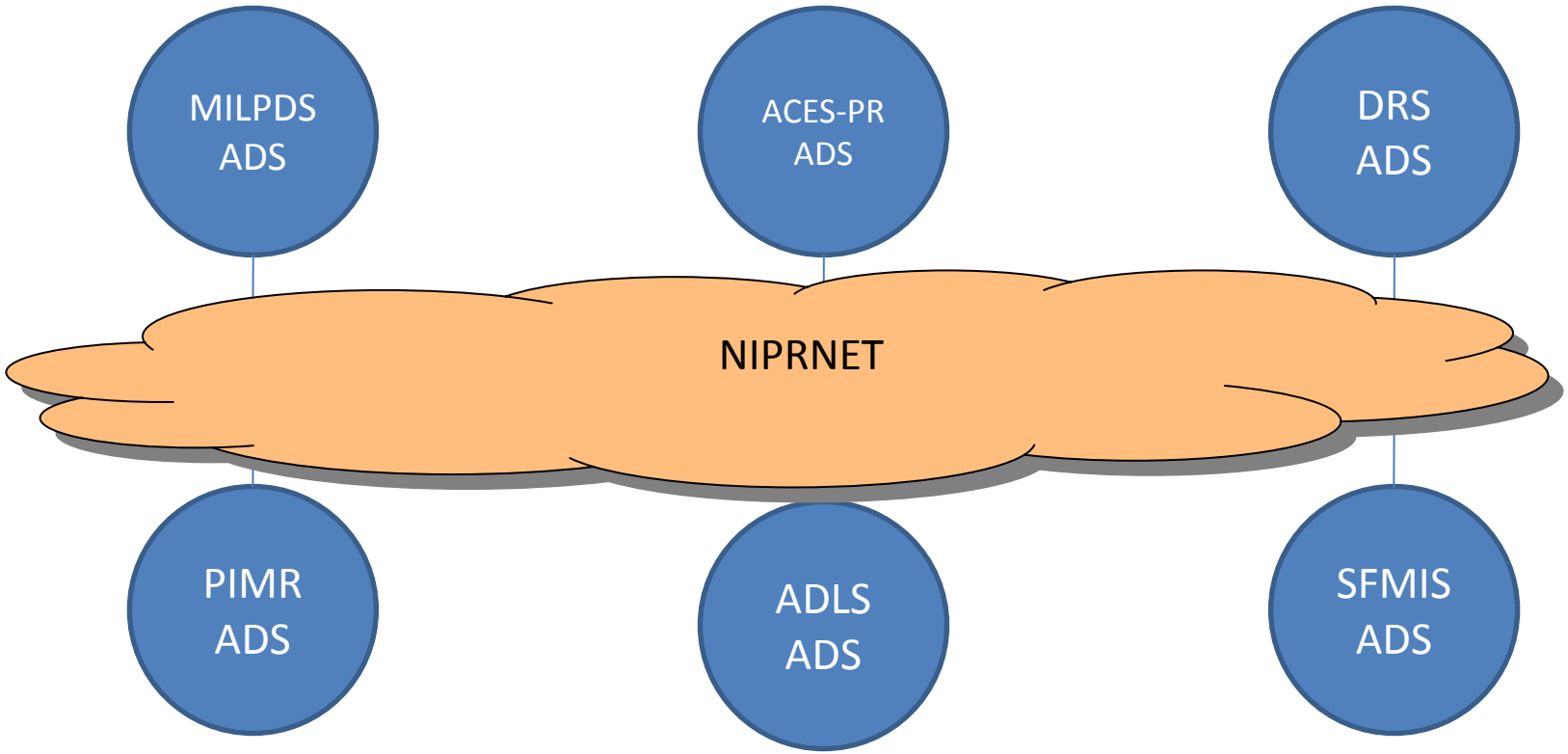
Click here for other display formats

BLACK Unwaived DAV Code | RED Fixable/Expired | YELLOW Expiring in 15 Days | GREEN Complete

Integrity - Service - Excellence

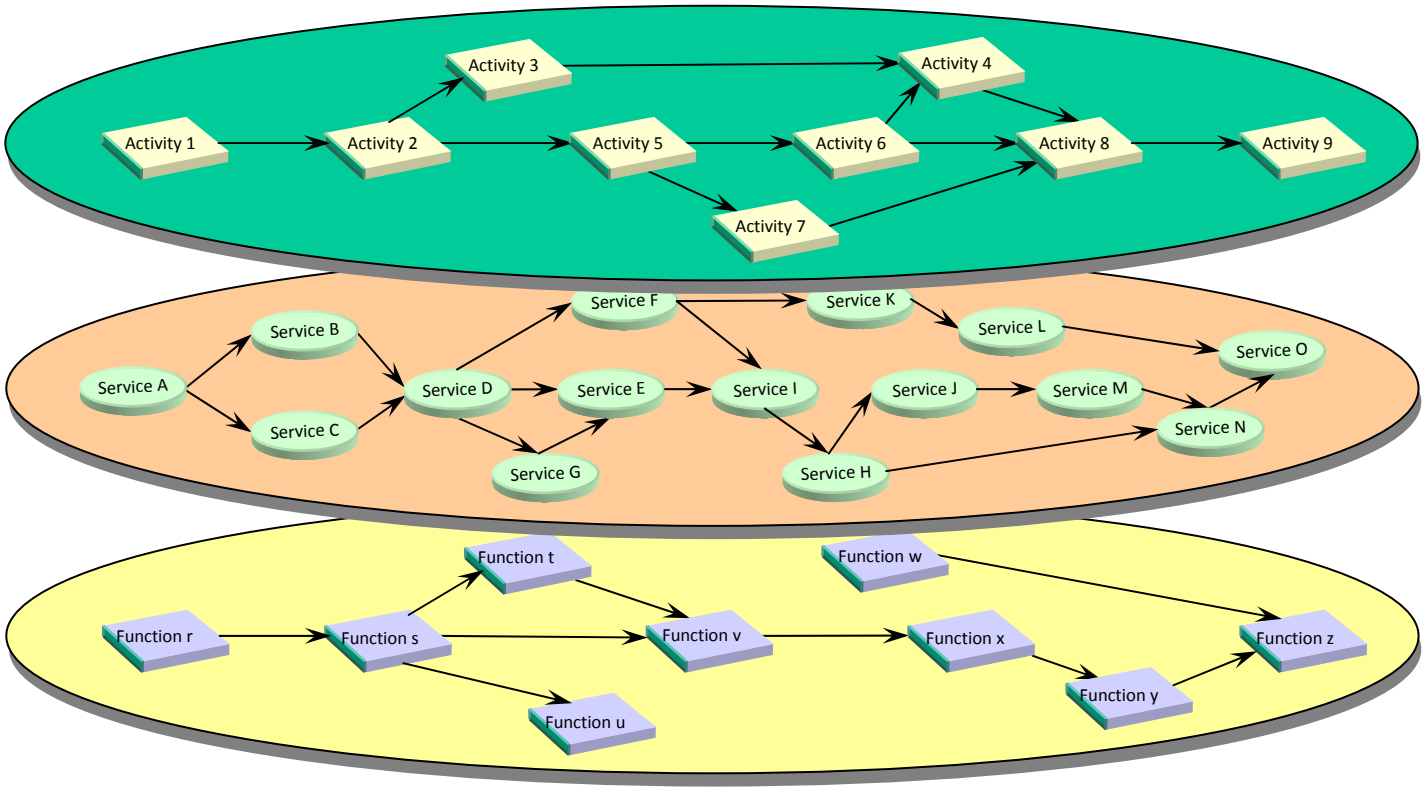
Version 0.91 9 Apr 07

Current State



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Service-Oriented Viewpoint



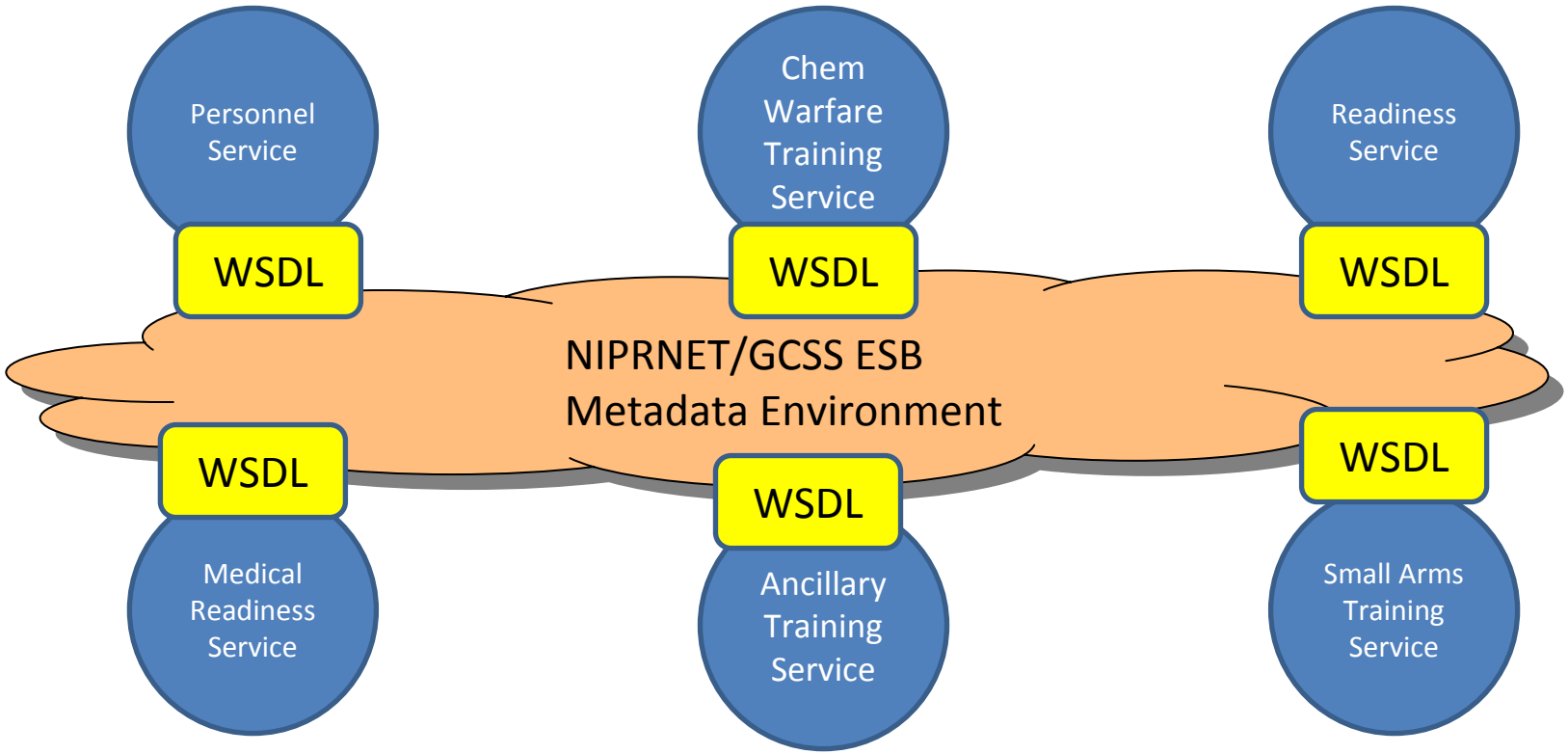
Operational View

Enterprise Services View

Systems View

In a Service-Oriented Viewpoint Operations drive Services and Services drive Systems – effectively decoupling Operations from Systems

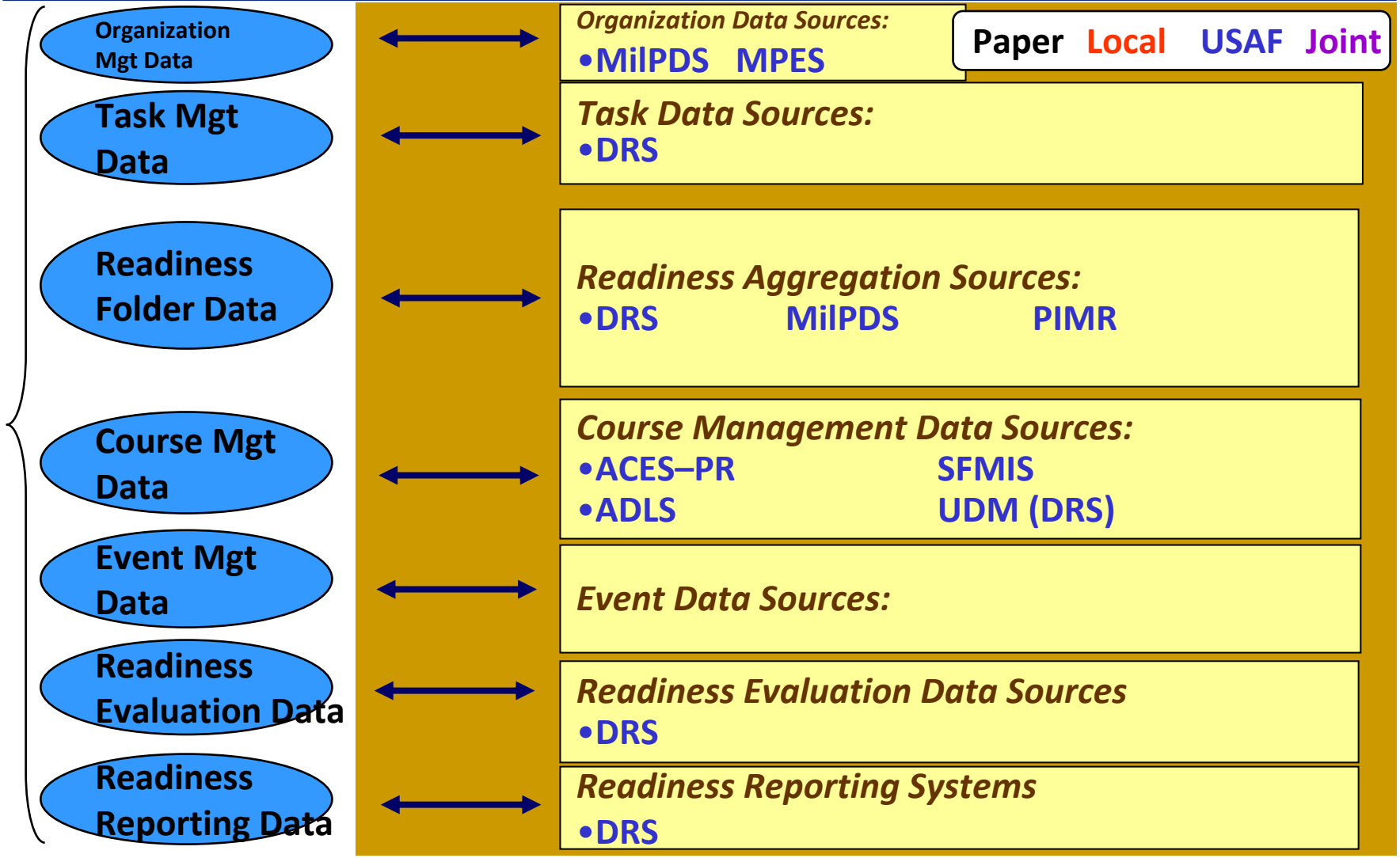
Future State



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Deployment Readiness Service (DRS)

SV-4 Pathfinder Authoritative Data Sources Summary



No "as is source" for enterprise Coordination & Orchestration data

Readiness COI
Preliminary Authoritative Data Sources*

- **ACES-PR**
  - Chemical Warfare Training
- **SFMIS**
  - Arming Group
  - Small Arms Training
- **MPES**
  - Position Number
- **PIMR**
  - Deployment Limiting Condition
  - Equipment
  - Immunizations
  - Individual Medical Readiness Overall
  - LAB
  - Physical Health Assessment
- **ADLS**
  - Explosive Ordnance Recognition (EOR) Training
  - Information Assurance
  - Language and Cultural Training
  - Law of Armed Conflict (LOAC) Self-Aid/Buddy Care
  - Trafficking in persons Awareness
- **MilPDS**
  - Air Expeditionary Force Indicator
  - Assigned Flight (office symbol if flight unavailable)
  - Assigned Group
  - Assigned Installation
  - Assigned Squadron or Unit
  - Assigned Wing
  - Control Air Force Specialty Code
  - Duty Air Force Specialty Code
  - Deployment Availability Codes
  - Duty Status Code
  - First Name
  - Gender
  - Grade
  - Grade Description
  - Last Name
  - Middle Name
  - Office Symbol
  - Primary Air Force Specialty Code
  - Parent Personnel Accounting Symbol Code
  - Personnel Accounting Symbol Code
  - Social Security Number
  - Special Experience Identifier Code
  - Special Experience Indicator Type
  - Suffix (Name)
- **UDM**
  - BAGGAGE TAGS (2 Sets)
  - Date Placed on Deployment Status
  - Dependent Care Certification, AF Fm 357
  - Dog Tags (ID Tags and Chains)
  - Emergency Data Card DD Form 93
  - Expeditionary Combat Skills Training
  - Force Protection Familiarization
  - Foreign Clearance Guide Briefing
  - Gas Mask Spectacle Inserts
  - Geneva Convention Card, DD Form 1934
  - Hand Receipt, AF Form 1297
  - Hazardous Cargo Certification (If Req'd)
  - Hearing Aids
  - ID Card
  - Leave & Earnings Statement, DFAS Fm 700
  - Line Badge, USAF Restricted Area Badge
  - Locator Card, AF Form 245 (Employment Locator and Processing Checklist)
  - Pallet Build-Up/Cargo Preparation (If Req'd)
  - Personal Clothing Requirements
  - Personnel Reliability Pgm (PRP), AF Fm 286
  - Power of Attorney
  - Prescription Glasses
  - Professional Equipment
  - Religious Sensitivity Briefing
  - Shot Record, PHS 73 1
  - U.S. Government Driver's License
  - Will

* Initial set based on Spiral 0

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Example Use Cases: Log-in For All Use Cases and Users

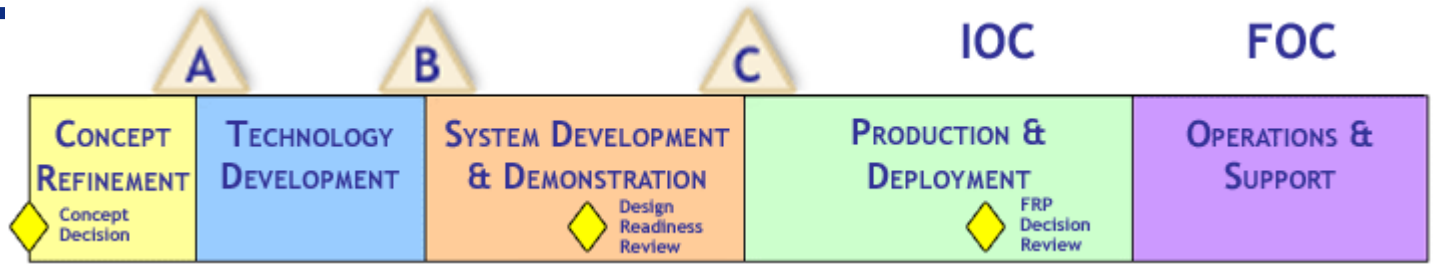
- User logs-in to AF Portal
- User clicks on DRS
- DRS comes up with specific role for current user based on Portal log-in
- Screen shows
  - User summary: % of unit (or wing) ready, # overdue, # expiring
    - Print/export to Powerpoint option
  - User name, rank, date, unit name, base, etc.
  - Selectable options
    - Reports, Query, Create (Requirements, Notifications, Thresholds), Mass Actions (Updates, Printing), My Account, etc.

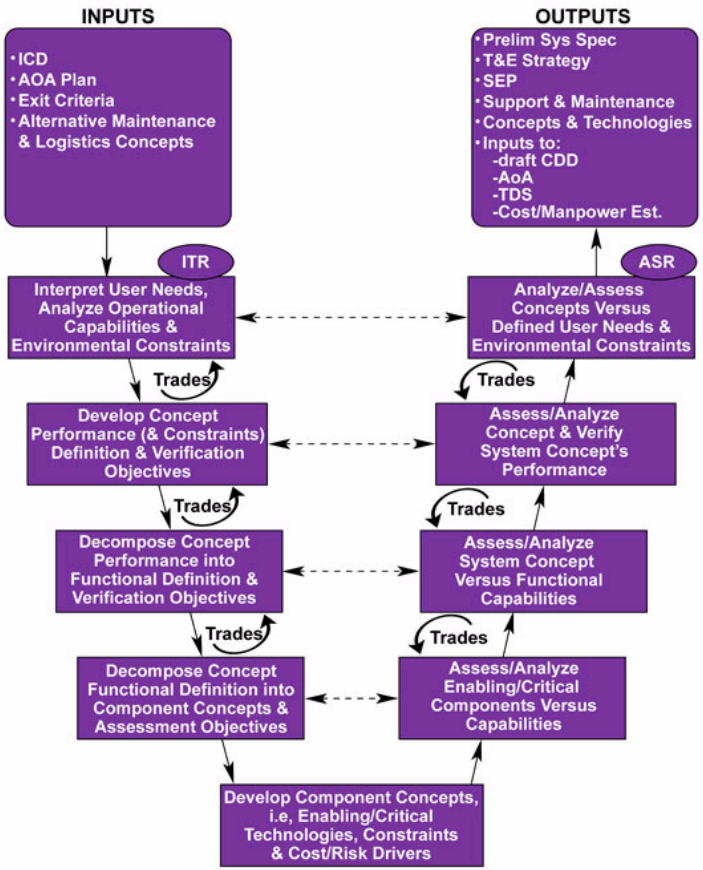
Example Survey based off of Use Cases

Readiness Reporting	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree	Avg
i. DRS provided easy to interpret readiness indicators	0	1	2	11	9	**4.2**
ii. DRS accurately produced AF Forms 4005	1	3	4	10	6	**3.7**
iii. DRS accurately printed AF Forms 4005	0	3	6	8	6	**3.7**
iv. DRS enabled me to conduct readiness reporting	0	2	7	8	4	**3.7**
v. It was easy to notice when there were problems with unit personnel readiness	0	2	1	13	7	**4.1**
vi. DRS enhanced my unit readiness briefings	0	2	7	9	3	**3.6**

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Concept Refinement

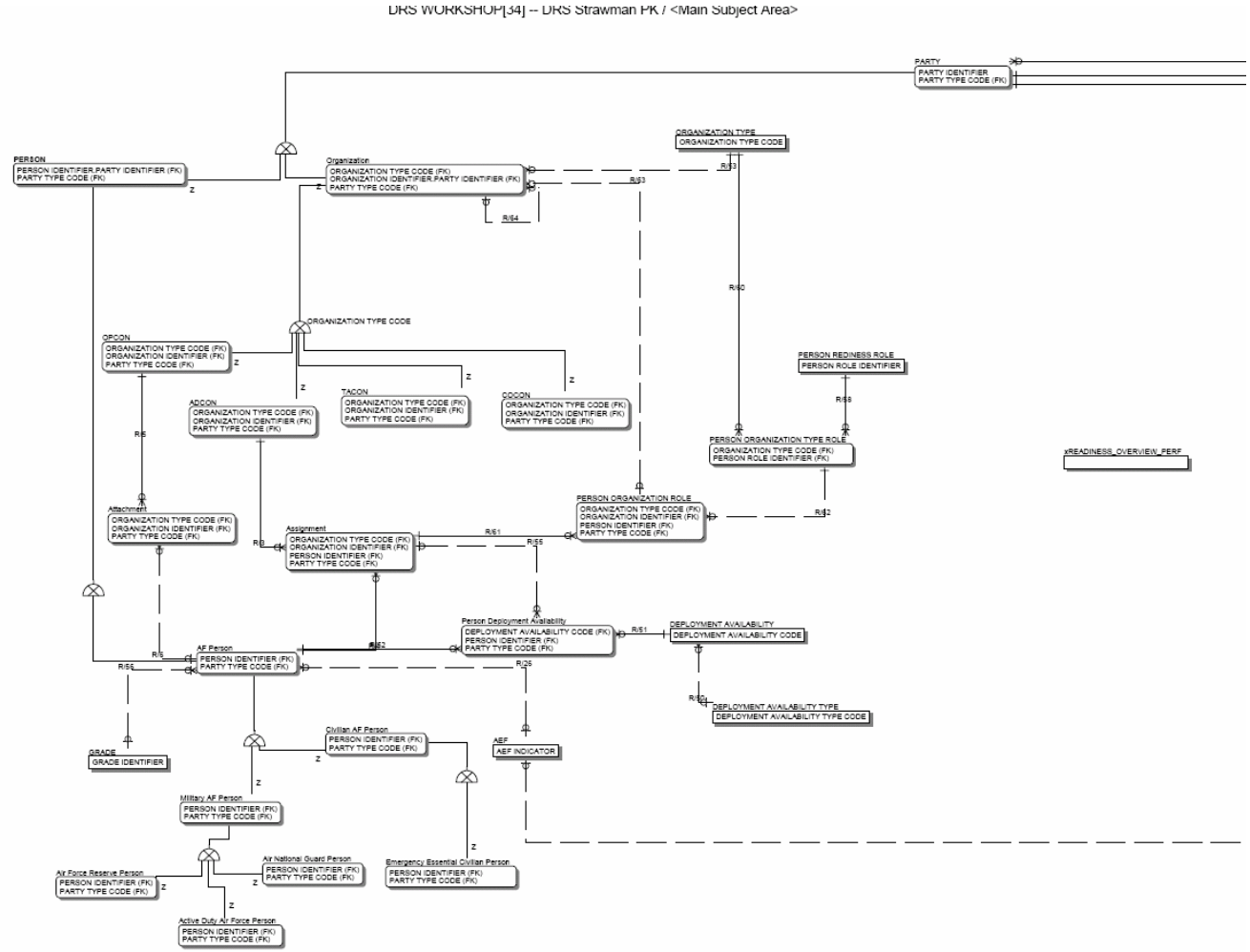




- Challenges
  - Short Schedule
    - < 5Months
  - Limited Funding
    - NTE $1M
    - No additional Funding for ADS
  - Prescribe Performance
    - No Data Warehouse
    - No Pub/Sub
      - Must use Request/Reply
    - Must Follow COI Vocabulary
      - Not yet Developed
  - Limited Experience Building Services
    - Hard to map services in DoDAF

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Example Original Product From Readiness Community of Interest



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Current Process

PREPARED 19-SEP-2005 1520 Personnel Deployment Checklist PCN SA200U504

INDIVIDUAL DEPLOYMENT REQUIREMENTS | STATUS | DATE ALL ACTIONS COMPLETED

NAME (Last, First Middle Initial)	GRADE	DAFSC	DUTY SECTION	PRIMARY DEPLOYMENT AVAILABILITY CODE (DAV)
MARQUEZ, RONALD ANT	1LT	021M3	MXMW	00

REQUIREMENTS	COMPLETED DATE	INDIVIDUAL'S INITIALS	INSPECTION RECORD
CHECKLIST ITEMS			
ID CARD (DD FORM 2AF)	19SEP05	RAM	✓
LINE BADGE (AF FORM 1199)	19SEP05	RAM	✓
DOG TAGS (2 ID TAGS AND 1 LRG, 1 SM CHAINS)	19SEP05	RAM	✓
EMERGENCY DATA CARD (DD FORM 93)	19SEP05	RAM	✓
IMMUNIZATION RECORD (DMHS FORM PHS 731)	19 SEP 05	RAM	✓
CURRENT LEAVE AND EARNINGS STATEMENT (DFAS FORM 702)	19 SEP 05	RAM	✓
US GOVERNMENT DRIVER'S LICENSE (AF FORM 2293)	19 SEP 05	RAM	✓
WILL	19 SEP 05	RAM	✓
POWER OF ATTORNEY	19 SEP 05	RAM	✓
DEPENDENT CARE CERTIFICATION (AF FORM 357)	N/R	N/R	N/R
LOCATOR CARD (AF FORM 245)	19 SEP05	RAM	✓
PRESCRIPTION GLASSES (2 PAIR)	19 SEP05	RAM	✓
GAS MASK SPECTACLE INSERTS	19 SEP05	RAM	✓
HEARING AID AND 2 SETS OF BATTERIES	N/R	N/R	N/R
PRESCRIPTION MEDICATION (180-DAY SUPPLY)	19 SEP05	RAM	✓
PERSONAL CLOTHING/HYGIENE ITEMS	19 SEP05	RAM	✓
BAGGAGE TAGS	19 SEP05	RAM	✓
ON-THE-JOB TRAINING RECORD (AF FORM 623)	N/R	N/R	N/R
PROFESSIONAL EQUIPMENT	19 SEP 05	RAM	✓
USAF FIREARMS QUALIFICATION	19 SEP 05	RAM	✓
GAS MASK FIT CHECK	19 SEP 05	RAM	✓
FAMILY READINESS BRIEFING	19 SEP05	RAM	✓
POST/PRE HEALTH ASSESSMENT FORMS	19 SEP05	RAM	✓
TRAINING REQUIREMENTS			
LAW OF ARMED CONFLICT (LOAC)		RAM	✓
SELF-AID BUDDY CARE (SABC)		RAM	✓
FORCE PROTECTION FAMILIARIZATION		RAM	✓
SMALL ARMS TRAINING		RAM	✓
NUCLEAR-BIOLOGICAL-CHEMICAL DEFENSE (NBCDT) AND EXPLOSIVE ORDINANCE RECOGNITION (EOR) TRAINING		RAM	✓
IMMUNIZATIONS			
ORAL POLIO (ONE DOSE FOR LIFE)	27-AUG-2002	RAM	✓
MMR (MUMPS/MEASLES/RUBELLA)	27-AUG-2002	RAM	✓
TD (TETANUS/DIPTHERIA)	27-AUG-2002	RAM	✓
IPPD (TB SKIN TEST POST DEPLOYMENT)	29-AUG-2002	RAM	✓
INFLUENZA (ANNUALLY)	07-FEB-2005	RAM	✓
MENOMUNE (MENINGITIS) (HIGH-RISK)	27-AUG-2002	RAM	✓
HEPATITIS A (1ST SERIES)	27-AUG-2002	RAM	✓
HEPATITIS A (2ND SERIES) (DUE 6-12 MONTHS LATER)	27-FEB-2003	RAM	✓
YELLOW FEVER (TO HIGH-RISK AREA)	25-NOV-2002	RAM	✓
TYPHOID (TYPHIM VI) (2YR) (TO HIGH-RISK AREA)	25-NOV-2002	RAM	✓
ANTHRAX #1 (INITIAL) (HIGH-RISH)	06-NOV-2003	RAM	✓

AF FORM 4005, JUN 97 (EF-V1) REPLACES ACC FORM 160, MAR 96, WHICH IS OBSOLETE.

LOGMOD 4005

TQA Page 1 of 1

PERSONAL DATA - PRIVACY ACT OF 1974
INDIVIDUAL TRAINING REQUIREMENT NOTICE AS OF 17 OCT 05

NAME	EMP #	GRADE	W/C	ORG	TDY RETURN DATE
MARQUEZ RONALD A	00663	014/		OUT BOUND	/

COURSE CODE	TITLE	DURATION TYP	INTV	STATUS	STATUS DATE	DUE DATE	EVI
002986	CERTF15 IMPOUND AUTHORITY	001	Y	QUAL	12 NOV 04		
006066	PADMINITIAL EVAL	001	Y	COMPL	17 JAN 03		
006096	PADMMISSION ORIENTATION	004	Y	COMPL	18 FEB 03		
006170	PADMW/C CONTROLLED AREA TNG	001	A	COMPL		22 AUG 06	
010033	PMILORM AWARENESS	002	Y	COMPL	09 JAN 03		
013024	PSECOPSEC	001	A	COMPL		12 OCT 06	
013045	PSECSECURITY TNG PHASE 1	002	Y	COMPL	23 NOV 03		
013046	PSECSECURITY TNG PHASE 2	002	A	COMPL		30 JAN 06	
018024	QANCLAW OF ARMED CONFLICT	001	H	QUAL		30 APR 06	
018036	QANCPROT FROM TERROR LVL I	003	A	QUAL		08 FEB 06	
018049	QANCSELF AID & BUDDY CARE	001	T	QUAL		25 NOV 06	
018054	QANCSUICIDE AWARE/VIOLENCE	001	H	QUAL		08 AUG 06	
018055	QANCSUPERVISOR SAFETY TNG	003	Y	QUAL	16 JAN 03		
018071	QANCHOMOSEXUAL POLICY TNG	001	Y	QUAL	04 JUN 03		
019111	QDEPFSTR CBRNE DEFENSE LTA	006	H	*AWACT		07 JAN 06	
019114	QDEPFSTR CBRNE TQT STD LTA	002	H	QUAL		17 JUN 06	
019242	QDEPSMALL ARMS 9MM CAT C	008	K	QUAL		01 OCT 07	
024013	QMEDCPR 2 YEAR RECERT	001	T	QUAL		25 NOV 06	
027049	QMUNMUNS EXPLOSIVE SAFETY	002	A	*AWACT		16 NOV 05	

A9F 05290 08:34:53 PROCESSED. VERSION DATE: 040105

CAMS Report

INDIVIDUAL DEPLOYMENT REQUIREMENTS | DATE PLACED ON DEPLOYMT STATUS | DATE ALL ACTIONS COMPLETED

NAME (Last, First, Middle Initial) | GRADE | AFSC | UNIT/SHOP | PRIMARY DEPLOYMENT AVAILABILITY CODE (DAV)

REQUIREMENTS	DATE INITIALLY ACCOMPLISHED/ COMPLETED	INDIVIDUAL'S INITIALS	INSPECTION RECORD
DOCUMENTATION			
ID CARD, DD FORM 2AFACT (United States Uniformed Services ID Card)(Accountable Form)			
DOG TAGS *(ID Tags and Chains)*			
EMERGENCY DATA CARD, DD FORM 93 *(Record of Emergency Data Card)*			
SHOT RECORD, PHS 731 *(International Certificate of Vaccination)*			
LOCATOR CARD, AF FORM 245 *(Employment Locator and Processing Checklist)*			
HAND RECEIPT, AF FORM 1297 (Temporary Issue Receipt) (For issue of mini C-1 bags and weapons to cargo couriers)			
BAGGAGE TAGS *(2 Sets)*			
OTHER *(If Required)*			
GENEVA CONVENTIONS CARD, DD FORM 1934 (Geneva Conventions Identity Card) FOR MEDICAL AND RELIGIOUS PERSONNEL WHO SERVE IN OR ACCOMPANY THE ARMED FORCES			
PRP, AF FORM 286 *(Personnel Reliability Program)*			
DEPENDENT CARE CERTIFICATION, AF FORM 357			
U.S. GOVERNMENT DRIVER'S LICENSE *(Special Purpose Vehicles)*			
PRESCRIPTION GLASSES *(2 Pairs) (1 pair for ARC)*			
GAS MASK SPECTACLE INSERTS			
HEARING AIDS			
PERSONAL CLOTHING REQUIREMENTS			
PROFESSIONAL EQUIPMENT			
LINE BADGE, USAF RESTRICTED AREA BADGE (Accountable Form)			
OPTIONAL			
LES, DFAS FORM 700 *(Leave and Earning Statement)*			
WILL			
POWER OF ATTORNEY			

	DATE				
	INDIVIDUAL'S INITIALS				
	UDM/SUPERVISOR INITIALS				
TRAINING	INIT. TRAINING	DUE DATE	DUE DATE	DUE DATE	DUE DATE
SMALL ARMS					
SELF-AID/BUDDY CARE					
CHEMICAL WARFARE					
PALLET BUILD-UP/CARGO PREPARATION *(If Required)*					
HAZARDOUS CARGO CERTIFICATION *(If Required)*					
RELIGIOUS SENSITIVITY BRIEFING					
FOREIGN CLEARANCE GUIDE BRIEFING					
EXPLOSIVE ORDNANCE RECOGNITION *(EOR)* TRAINING					
LAW OF ARMED CONFLICT *(LOAC)* BRIEFING					
FORCE PROTECTION FAMILIARIZATION					

INDIVIDUAL'S SIGNATURE | UDM/SUPERVOR'S SIGNATURE

AF FORM 4005,19970601 *(EF-V2)* REPLACES ACC FORM 160, MAR 96, WHICH IS OBSOLETE.

Blank 4005

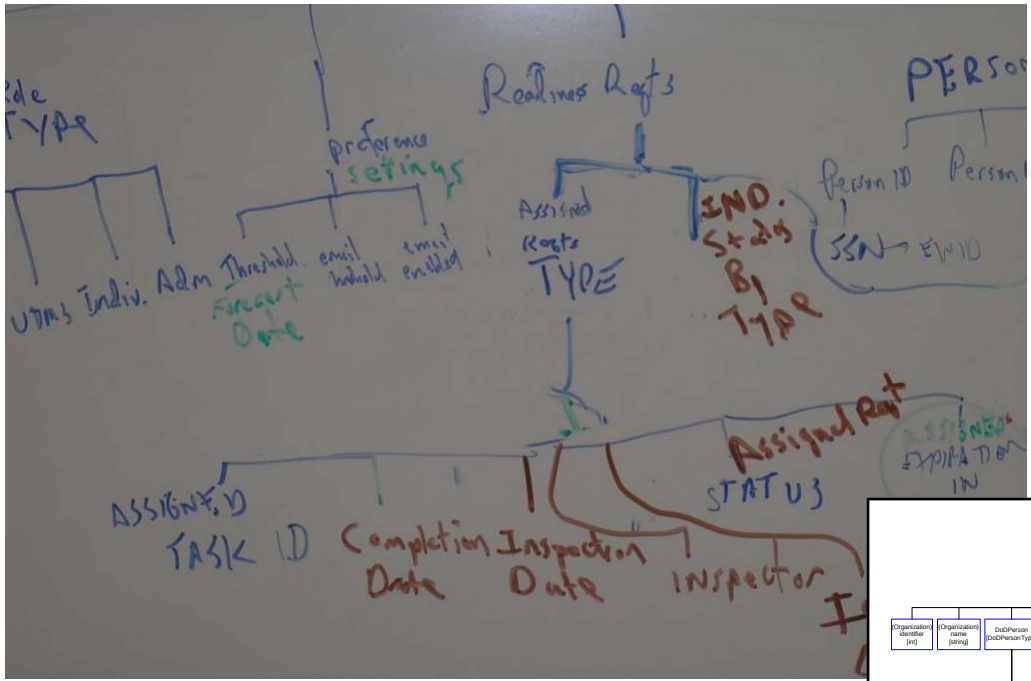
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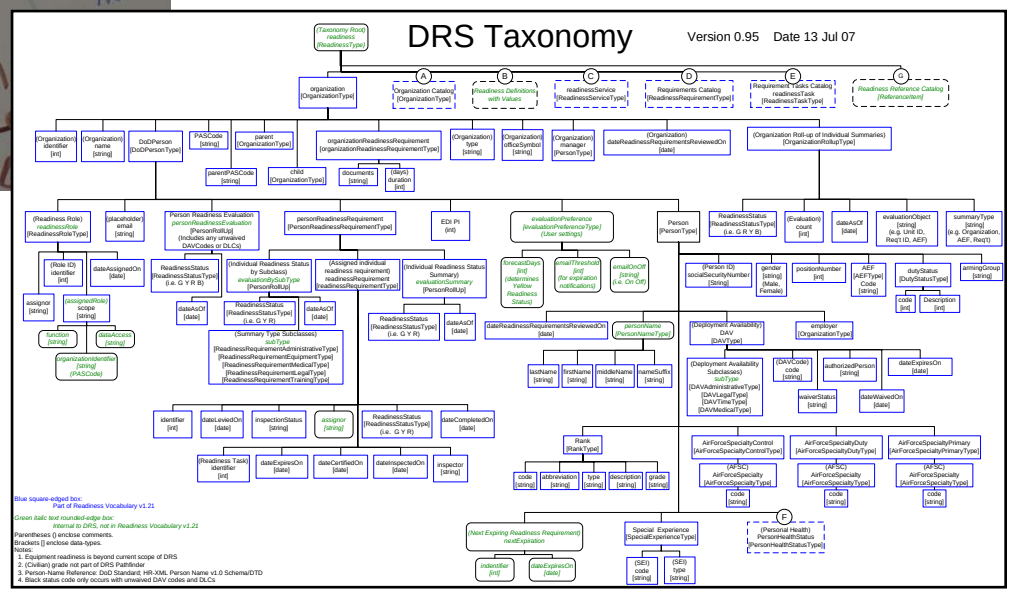
Form 4005 Source Matrix

Data Field	Data Provider	Method Of Entry
Top Portion		
• Date Placed on Deployment Status	UDM**	Manual Entry in DRS
• Date All Actions Completed	UDM**	Manual Entry in DRS
• Name	MilPDS	Automated Feed
• Grade	MilPDS	Automated Feed
Documentation		
• ID Card, DD Form 2AFACT	UDM**	Manual Entry in DRS
• Dog Tags	UDM**	Manual Entry in DRS
• Emergency Data Card, DD Form 93	UDM**	Manual Entry in DRS
• Shot Record, PHS 731	UDM**	Manual Entry in DRS
• Locator Card, AF Form 245	UDM**	Manual Entry in DRS
• Hand Receipt, AF Form 1297	UDM**	Manual Entry in DRS
• Baggage Tags	UDM	Manual Entry in DRS
Other (if Required)		
• Geneva Conventions Card, DD Form 1934	UDM	Manual Entry in DRS
• PRP, AF Form 286	UDM	Manual Entry in DRS
• Dependent Care Certification, AF Form 357	UDM	Manual Entry in DRS
• U.S. Government Driver's License	UDM	Manual Entry in DRS
• Prescription Glasses	UDM	Manual Entry in DRS
• Gas Mask Spectacle Inserts	UDM	Manual Entry in DRS
• Hearing Aids	UDM	Manual Entry in DRS
• Personal Clothing Requirements	UDM	Manual Entry in DRS
• Professional Equipment	UDM	Manual Entry in DRS
• Line Badge, USAF Restricted Area Badge	UDM	Manual Entry in DRS
Optional		
• LES, DFAS Form 700	UDM	Manual Entry in DRS
• Will	UDM	Manual Entry in DRS
• Power of Attorney	UDM	Manual Entry in DRS
• Blank Fields	UDM	Manual Entry in DRS
Training		
• Small Arms	SFMIS	Automated Feed
• Self-Aid/Buddy Care	*ADLS*	Automated Feed
• Chemical Warfare	*ACES*	Automated Feed
• Pallet Build-Up/Cargo Preparation (If Required)	UDM	Manual Entry in DRS
• Hazardous Cargo Certification (If Required)	UDM	Manual Entry in DRS
• Religious Sensitivity Briefing	UDM	Manual Entry in DRS
• Foreign Clearance Guide Briefing	UDM	Manual Entry in DRS
• Explosive Ordnance Recognition (EOR) Training	ADLS	Manual Entry in DRS
• Law of Armed Conflict (LOAC) Briefing	*ADLS*	Automated Feed
• Force Protection Familiarization	*ADLS*	Automated Feed

Cross-check Model for Completeness & Consistency

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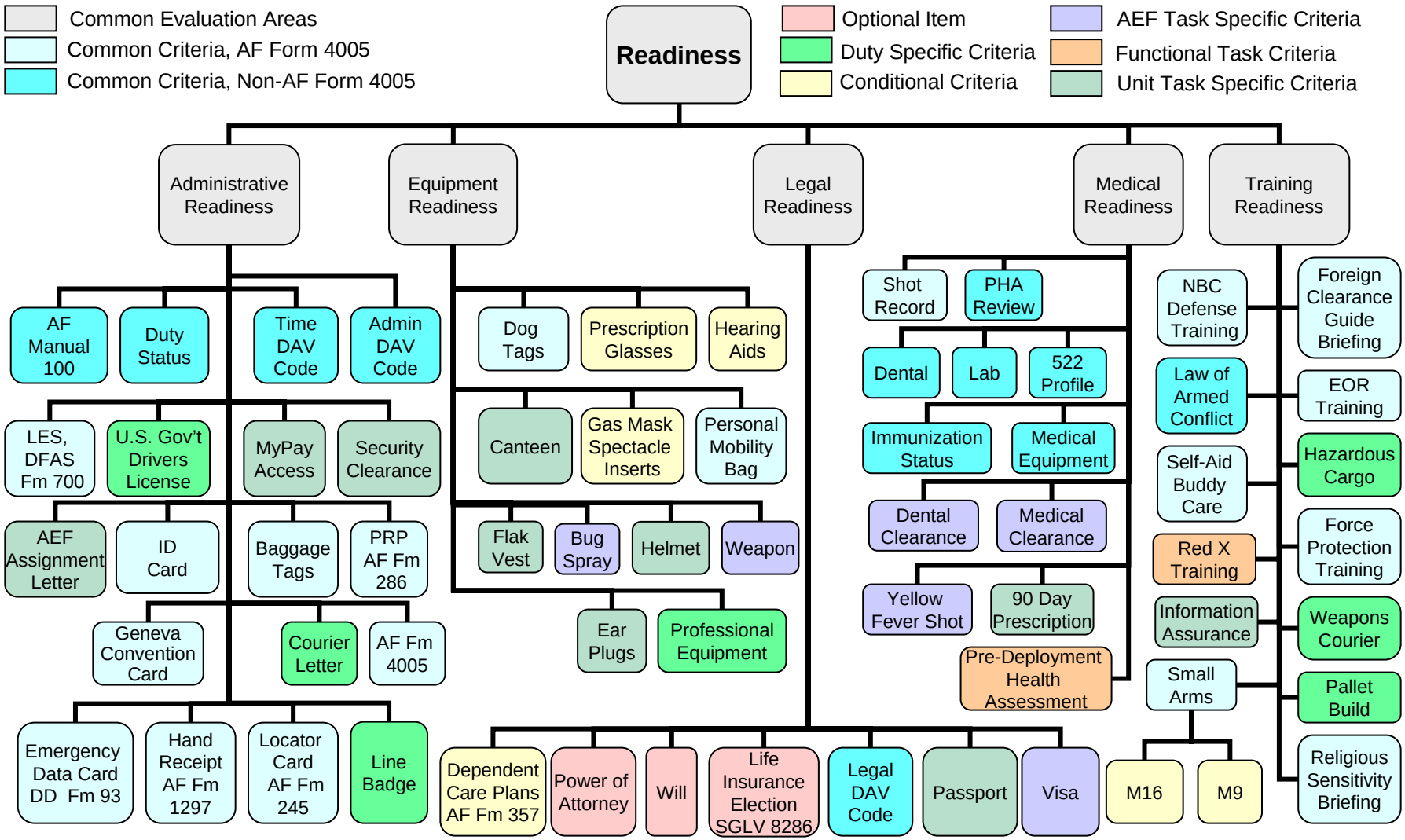




Deployment Readiness Service

Readiness Items Grouped by Type

Example



Note: This is by no means a complete set but provides insight to the types of factors involved

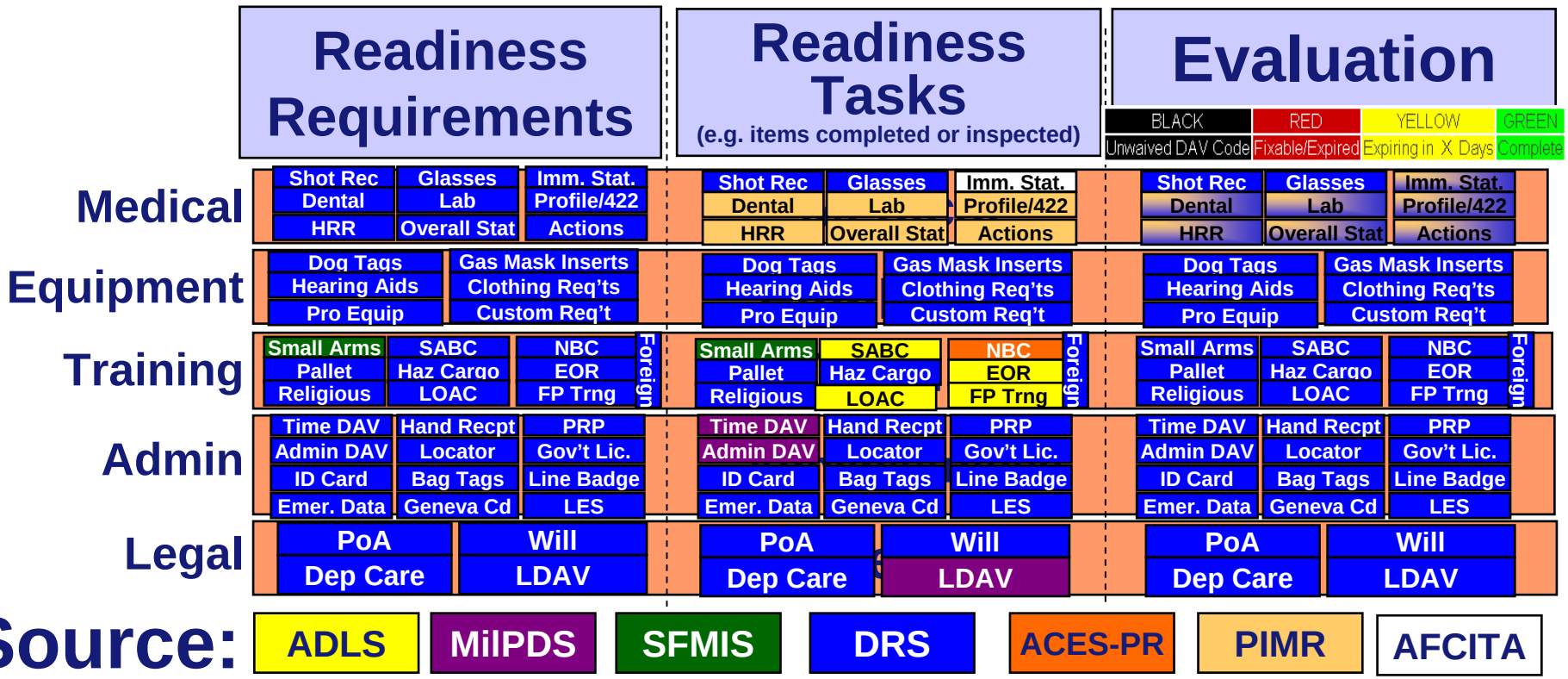
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Other Checks

Organization

Person

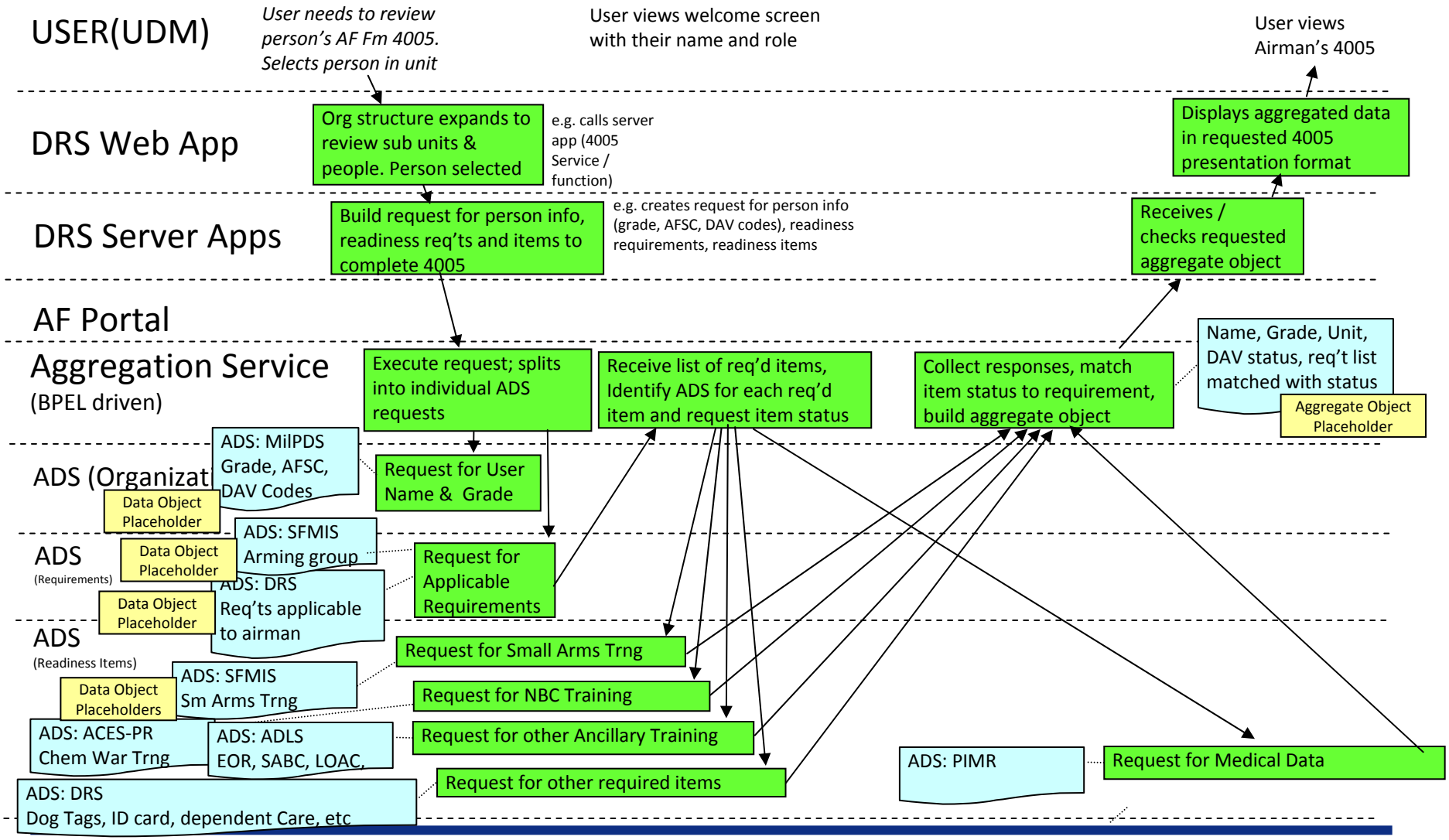
Reporting



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UDM Selects Airman & Requests Indiv Readiness (4005 + Medical Data)

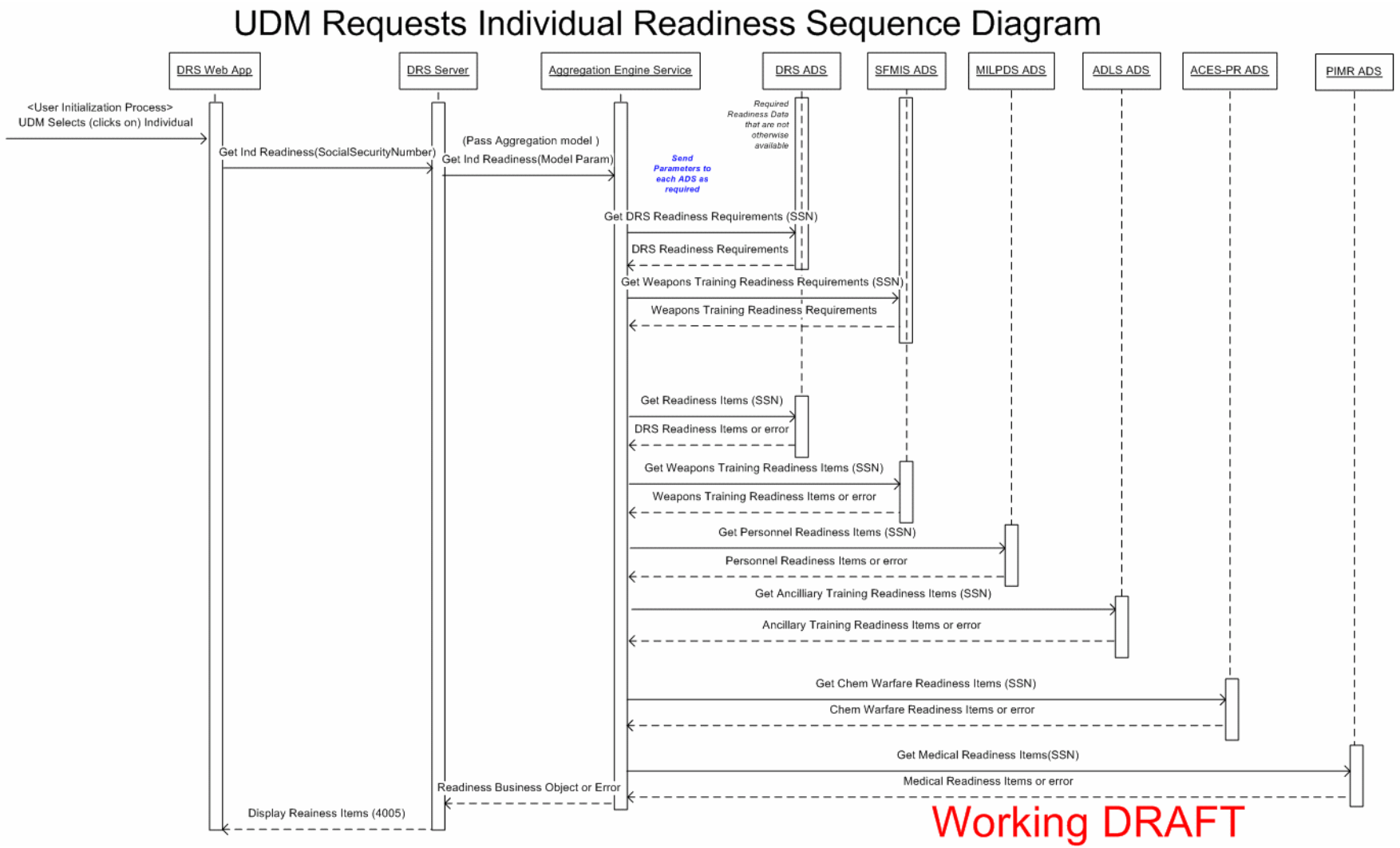
Use Case references X-025



MDE Used to discover at design/development time

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Example Sequence Diagram



DRS develop/deploy/use Timeline

UC 11: Use Mission Services (Web App)



Aggregation service pulls data from multiple services, processes it, and re-packages as single business object



Readiness Request

W

M

M

M

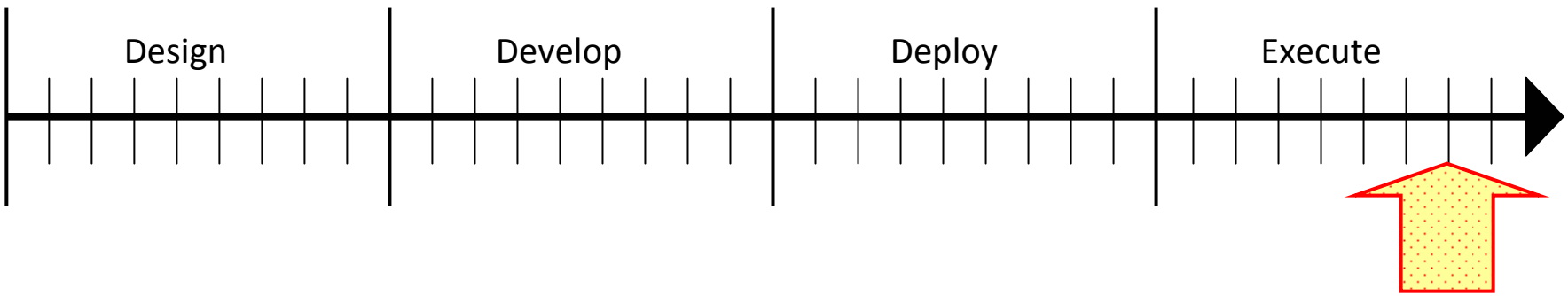
M

Complete business Object replied

MDE

User invokes web application, which uses aggregation service to call the wrappers, and then converts the resulting business object into human readable representation on the AF Portal

Note: Aggregation service does not use MDE to determine which Mission Services (Wrappers) to call at runtime



DRS Pathfinder SV-1 (DRAFT)

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= Mission Service
= Enterprise Service
CDS = Core Data Service
VDE = Vocabulary Defined Elements



Commanders, IDOs, UDMs and UTMs

GCSS-AF Security Boundary

AF Portal
COP (Pres Svc)

Service Registry (MDE)
DRS Agg Svc 1 WSDL
DRS Agg Svc 2 WSDL
DRS Agg Svc 3 WSDL
DRS Agg Svc n WSDL
DRS CDS WSDL
MilPDS CDS WSDL
ADLS CDS WSDL
SFMIS CDS WSDL
ACES CDS WSDL
PIMR CDS WSDL

SOAP msgs

Application Server
DRS Web App
DRS Agg Svc
DRS CDS
DRS DB

Data Warehouse

Regional Cache
ADS CDS
ADS DB

Method 1 – ADS Keeps Local Cache
Method 2 – ADS Uses Regional Cache
Method 3 – ADS Direct Service

Secured SOAP messages

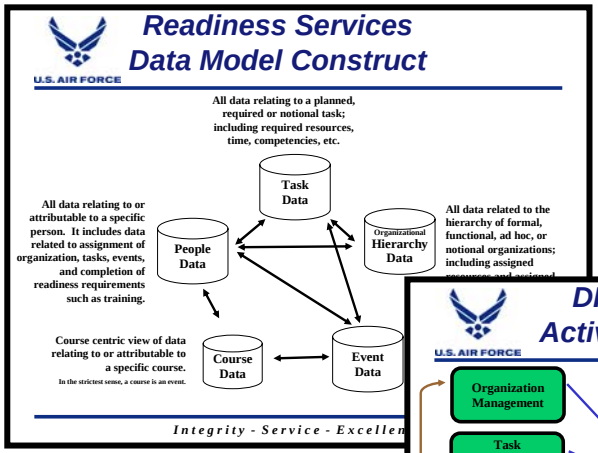
Method1
Source Cache (VDE)
ADS CDS
Filte r
ADS DB
ADS Transactional Processes

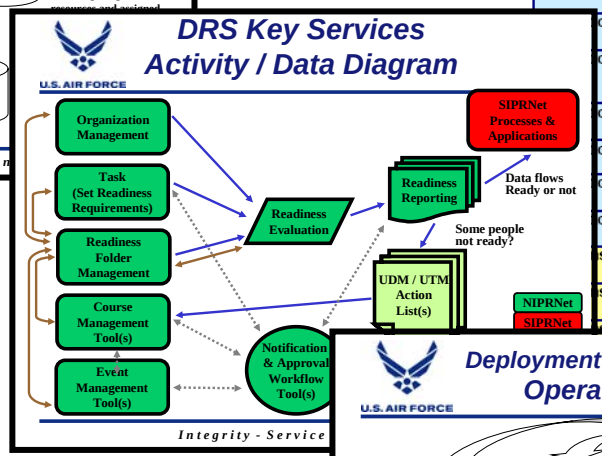
Method 2
Filte r
ADS DB
ADS Transactional Processes

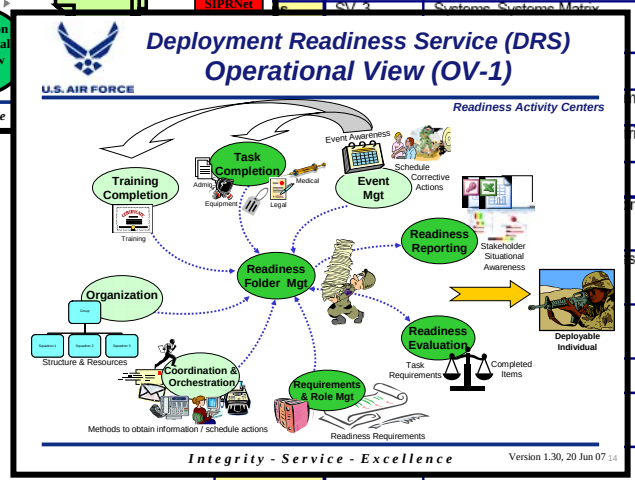
Method 3 (Preferred)
ADS DB
ADS CDS

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Refine the Model







Update DoD Architecture Framework (DoDAF) artifacts

Applicable View	Framework Product	Framework Product Name	General Description
All Views	AV-1	Overview and Summary Information	Scope, purpose, intended users, environment depicted, analytical findings
All Views	AV-2	Integrated Dictionary	Architecture data repository with definitions of all terms used in all products
Operational	OV-1	High-Level Operational Concept Graphic	High-level graphical/textual description of operational concept
Operational	OV-2	Operational Node Connectivity Description	Operational nodes, connectivity, and information exchange needlines between nodes
Operational	OV-3	Operational Information Exchange Matrix	Information exchanged between nodes and the relevant attributes of that exchange
		onal OV-4	Organizational, role, or other relationships among organizations
		onal OV-5	Capabilities, operational activities, relationships among activities, inputs, and outputs; overlays can show cost, performing nodes, or other pertinent information
		onal OV-6a	One of three products used to describe operational activity—identifies business rules that constrain operation
		onal OV-6b	One of three products used to describe operational activity—identifies business process responses to events
		onal OV-6c	One of three products used to describe operational activity—traces actions in a scenario or sequence of events
		onal OV-7	Logical Data Model
		s SV-1	Systems Interface Description
		s SV-2	Systems Communications Description
			Relationships among systems in a given architecture; can be designed to show relationships of interest, e.g., system-type interfaces, planned vs. existing interfaces, etc.
			Functions performed by systems and the system data flows among system functions
		ns	Mapping of systems back to capabilities or of system functions back to operational activities
		nix	Provides details of system data elements being exchanged between systems and the attributes of that exchange
			Performance characteristics of Systems View elements for the appropriate time frame(s)
		n	Planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation
		st	Emerging technologies and software/hardware products that are expected to be available in a given set of time frames and that will affect future development of the architecture
			One of three products used to describe system functionality—identifies constraints that are imposed on systems functionality due to some aspect of systems design or implementation
			One of three products used to describe system functionality—identifies responses of a system to events
			One of three products used to describe system functionality—identifies system-specific refinements of critical sequences of events described in the Operational View
			Physical implementation of the Logical Data Model entities, e.g., message formats, file structures, physical schema

Identify Information Assets

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Readiness Services

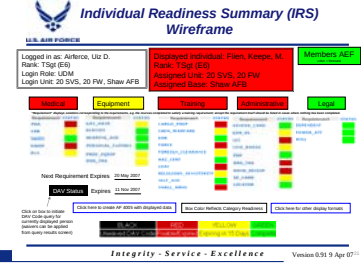
- **Organization Mgt Data** ⟷ *Organization Data Sources:* • MilPDS DCPDS Local Da — Paper Local USAF Joint
- **Requirements Mgt Data** ⟷ *Task Data Sources (automation incomplete):* • AFIs UDM spreadsheets TPFDD libraries • Emails Web pages Phone Local policy DRS
- **Readiness Task Data** ⟷ *Readiness Data Sources:*
  - • LOGMOD CAMS/IMDS GO81 Paper
  - • ARMS SFMIS MRDSS Artifacts
  - • ACES–PR DRS ADLS UDM Spreadsheets
  - *Personnel:* • MILPDS DEERS DCPDS DIMHRS
  - *Medical:* • PIMR AFCITA DMHRSi
- **Course Mgt Data** ⟷ *Course Management Data Sources:* • Training spreadsheets Paper rosters • Local Tools Dozens of MAJCOM systems *Emerging tools*: DIMHRS, ADLS, SRRS, DRS, etc.*
- **Event Mgt Data** ⟷ *Event Data Sources:* • Staff meeting charts Outlook calendar Local Tools
- **Readiness Evaluation Data** ⟷ *Readiness Evaluation Systems* DRS • Mobility folder reviews UDM Spreadsheets • AF Form 4005 Modified AF Form 4005
- **Readiness Reporting Data** ⟷ *Readiness Reporting Systems (Group or higher)* DRS • Manual aggregation and manipulation of local data

No “as is source” for enterprise Coordination & Orchestration data

Map Data Flow

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Use Case #X-022
(Use Case X-010 is prerequisite)



USER

Activated by selecting an individual from an actionable link from other users cases--including but not limited to X-020, X-030, X-032, X-035, X-036, X-040)

Display Fields:
- See IRS wireframe

Screen Data Object

Actions:
- Sort by display fields
- Export to AF 4005
- Launch DAV code query for user
- Other formats
- *Req't drill down (future)*

User views selected Airman's IRS can change viewing format or generate 4005

DRS Web App

Calls IRS service/function with selected user's ID

e.g. calls server app (IRS)

Displays aggregated data in IRS presentation format

DRS Server Apps

Build request for person info, readiness req'ts, eval criteria, and items necessary to build IRS

e.g. creates request for person info (grade, AFSC, DAV codes), readiness requirements, readiness tasks (completion data)

Receives / checks requested aggregate object

Aggregation Service

Use session data, identify and obtain any missing pieces through individual ADS requests

Receive list of req'd items, definitions & task sources, and request task status

Collect responses, match item status to requirement, eval, build aggregate object

Name, Grade, Unit, DAV status, req't list matched with status

Aggregate Object Placeholder

ADS (Definitions & Catalogs)
(Man
- DRS: Get_DAV_Code_Definitions
- DRS: Get_AEF_Definitions
- DRS: Get_Requirement_Definitions
- DRS: Get_Readiness_Status_Definitions
- DRS: Get_ADS(Null)

Request for DAV codes, titles, ADSs, requirements, tasks

ADS (Organization)
- MILPDS: Get_Detailed_Individual_Data

Request for person info

ADS (Requirements)
- DRS: Get_Assigned_Requirements
- SFMIS: Get_Arming_Group

Request for Applicable Requirements

ADS (Readiness Evaluation)
- DRS: Get_Readiness_Eval_Thresholds
- DRS: Get_DAV_Code_Waiver

Request for evaluation thresholds

DRS: Store_Readiness_Evaluation_Status

Evaluation results stored as last eval record

ADS (Readiness Tasks)
- SFMIS: Get_Completed_Training
- ACES-PR: Get_Completed_Training
- ADLS: Get_Completed_Training
- PIMR: Get_Medical_Readiness_Individual
- DRS: Get_Readiness_Item

Request for Small Arms Trng

Request for CBRNE Training

Request for other Ancillary Training

Request for Medical Eval Status

Request for other required items

U.S. AIR FORCE

DoDAF Service View

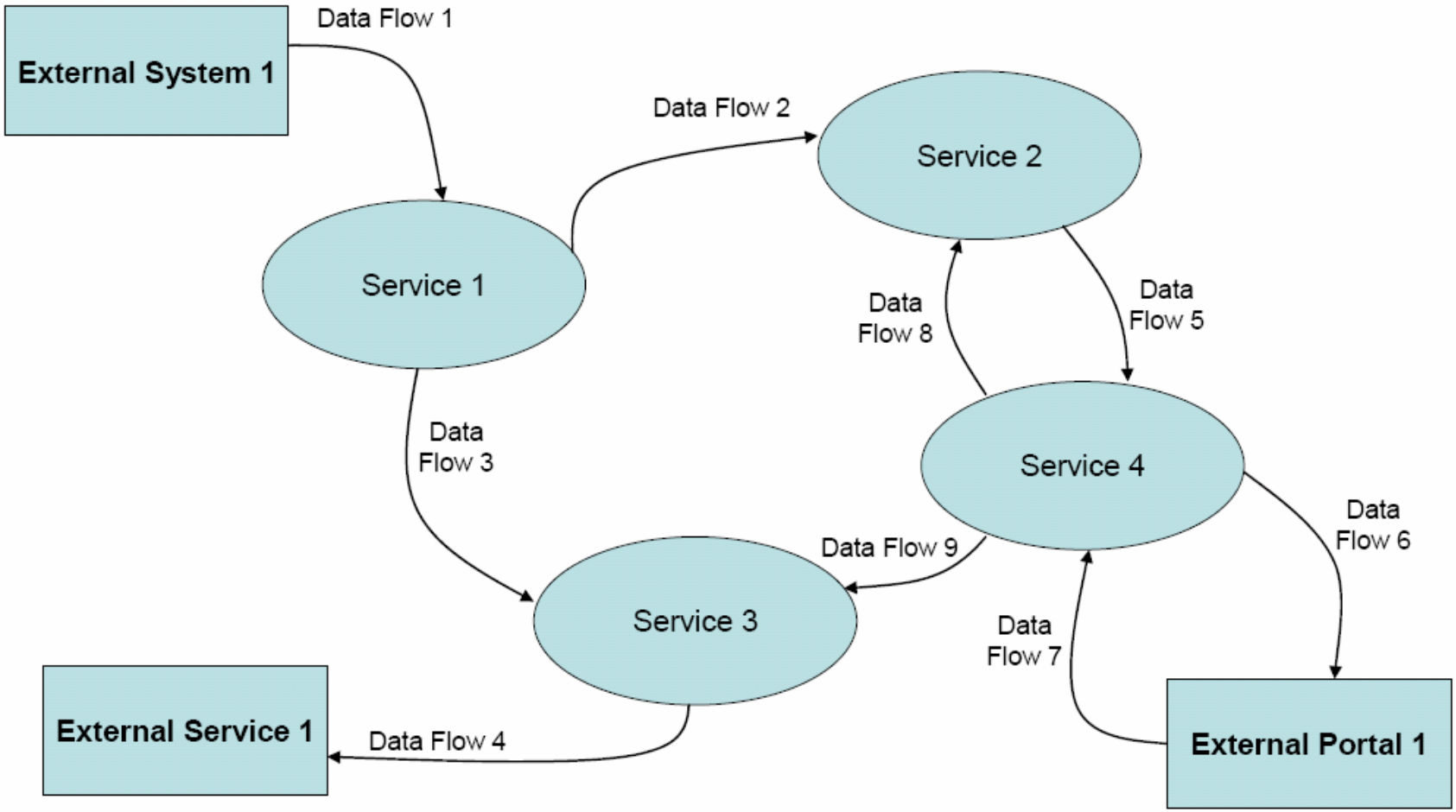


Figure 5-24: Notional Example: SV-4b: Data Flow Diagram

U.S. AIR FORCE

Overcoming Challenges

- Realistic Schedule
- Realistic Funding
- Rethinking Performance Constraints
  - “Regional Cache”
- Up Front Engineering
  - Created Technical Package
- Iterative Vocabulary Development



Summary

- What Problem is being solved by DRS?
- What is a Service Oriented Architecture?
- What are the Challenges?
- How can these Challenges be overcome?



U.S. AIR FORCE

Questions?

10th Annual Systems Engineering Conference

Strategic Focus: Reduction of Total Ownership Costs (R-TOC) and Value Engineering (VE)

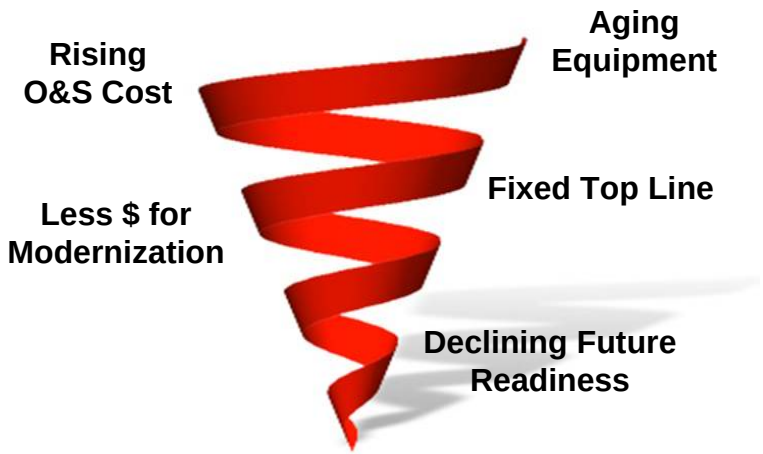
Mr. David Erickson
Office of the Secretary of Defense
Acquisition, Technology & Logistics
Systems and Software Engineering

Dr. Danny Reed
Institute for Defense Analyses

October 25, 2007

R-TOC Genesis

- Initiated in 1999 by the USD(AT&L) to address:
  - O&S cost growth at expense of force modernization and readiness
  - O&S budget constraints limit programs to near-term, critical solutions only
  - R-TOC program seeks to seed O&S cost avoidance solutions that have broader impact
  - Thirty Pilot Programs



DEATH SPIRAL

USD(AT&L) FY 2005 R-TOC Goal

- USD(AT&L) Goal: "…reduce the O&S cost of fielded systems (excluding manpower and fuel) by 20% (compared to current FY 1998 levels) by the year 2005."
- "Overall, each Service's O&S reduction plans will be based on tradeoffs among these three areas for savings:
  1. Reduced demand from weapon systems via reliability and maintainability improvements
  2. Reduced supply chain response times, leading to reduced spares, system support footprint, and depot needs
  3. Competitive sourcing of product support, leading to streamlining and overhead reductions"

FY 2005 O&S Savings

- FY 2005 cost avoidances exceeded $2.1B
- Projected life cycle cost avoidances will exceed $76B, for the R-TOC Pilot Programs

O&S Costs Can Be Reduced!!

Life Cycle Savings Provides a Focus on Long Term Benefits

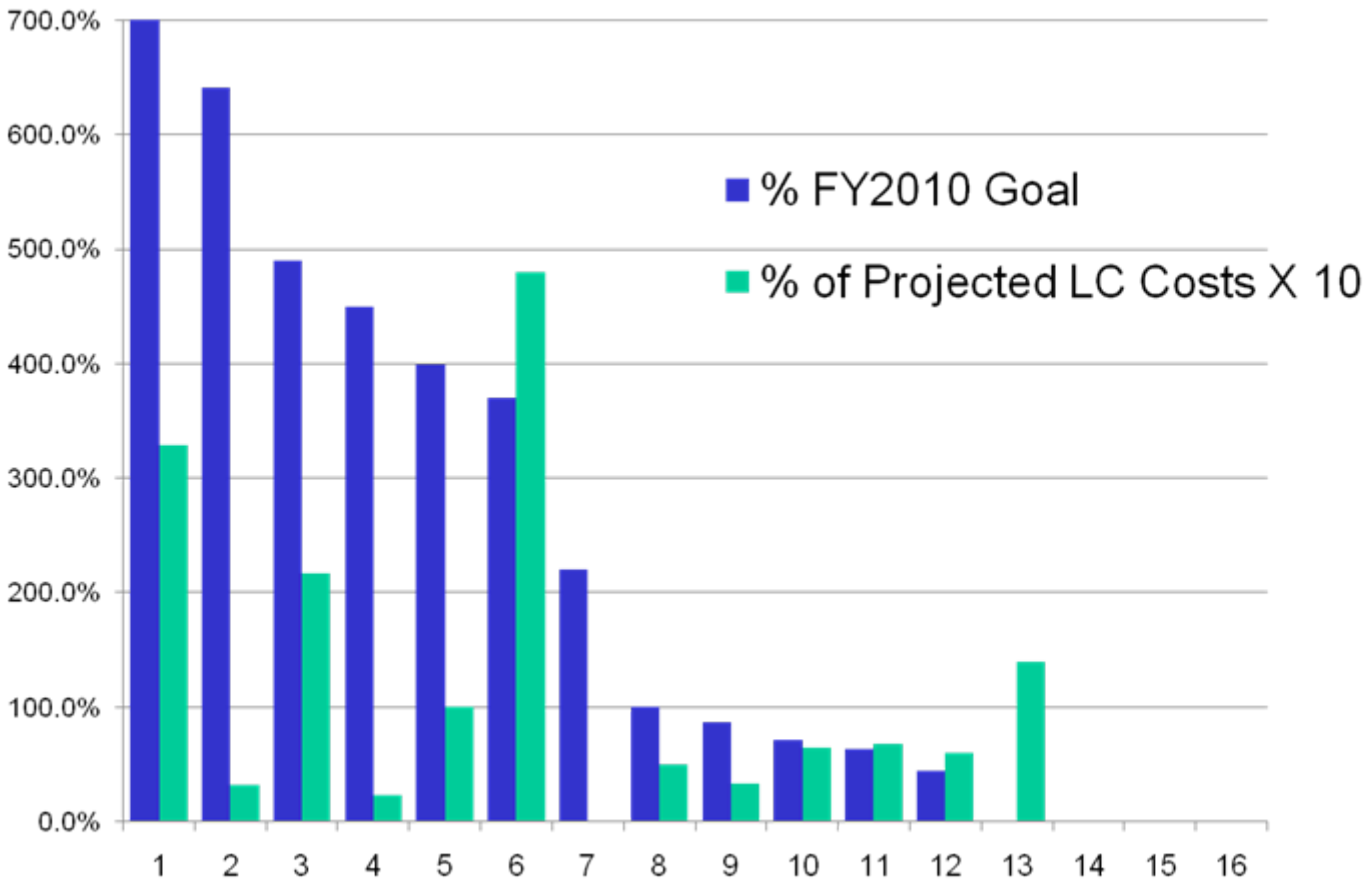
New Strategic Direction

- With the successful completion of the Pilot Programs FY 2005 goal, a new direction was needed
- Strategic Directions:
  - New goal for FY 2010
  - Focus on life cycle O&S cost reductions
  - Direct funding for long-term savings projects
  - Adoption of quantitative method for evaluating near-term vs. long-term projects

USD(AT&L) FY 2010 R-TOC Goal

- USD(AT&L) Goal: "Maximize cost avoidance on total defense systems FY 2010 O&S costs from an FY 2004 baseline, by offsetting 30% of predicted inflation."
  - Goal extends to all defense systems on program-by-program basis
  - 15 Special Interest Programs (SIPs) designated lead programs to "show the way" towards achieving the goal
  - SIPs are monitored through semi-annual reports and quarterly R-TOC Forums
  - Services will include this goal in their reviews
- Ultimately expand to all defense systems
- $25M/year R-TOC PE created

Status of R-TOC SIP Program Savings

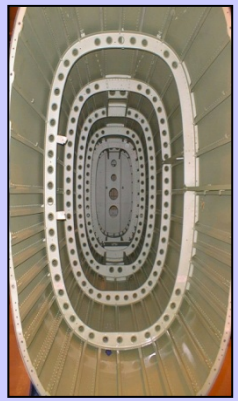


UH-60M Composite Tailcone

Program Description

Problem: The currently proposed metal tailcone for the UH-60M's, MH-60S's and MH-60R's are labor intensive to manufacture and require thousands of parts and fasteners.

Solution: Incorporate a composite tailcone into the UH-60M, MH-60S and MH-60R fleets.





Benefits

- Cost savings of $60,000.00 per new production aircraft.
- Fewer parts and fasteners
- No corrosion or fatigue maintenance
- Weight Reduction (50 pounds)

Investment/ROI

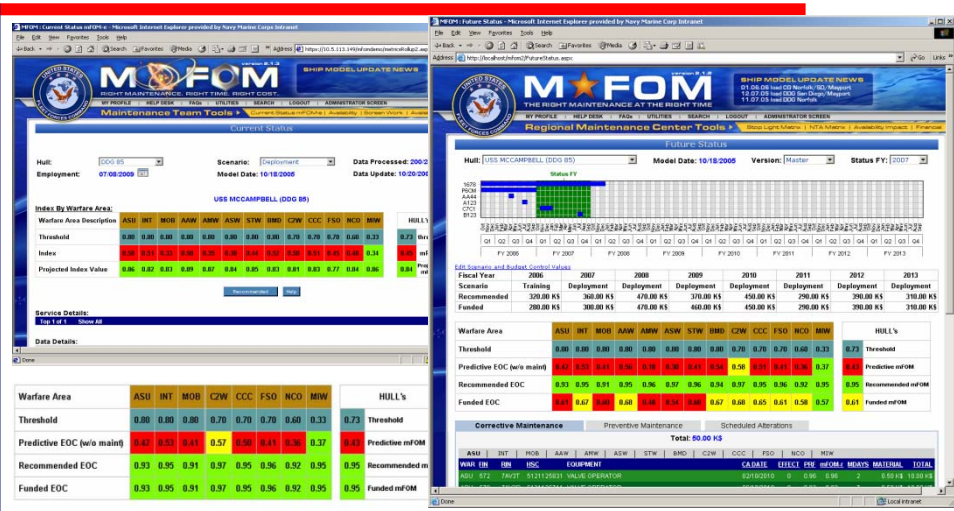
Investment: $2.35M

Life Cycle ROI: 33:1

Ship's Material Condition Model

Overview/Problem

- USN does not have a consistent objective method to determine material condition and its impact on mission / warfare area
- USN has multiple antiquated software tools and systems to validate, screen and broker work candidates depending on platform type and coast
- USN has no objective method to determine future material condition readiness when routine maintenance is not performed



Solution

- Model each ship using a hierarchical structure that will show the impact of each shipboard equipment on material condition readiness
- Provide a single validation, screening and brokering tool for use across all ship platforms
- Allow for a near term predictive nature in modeling accounting for failure to perform routine maintenance

Investment/ROI

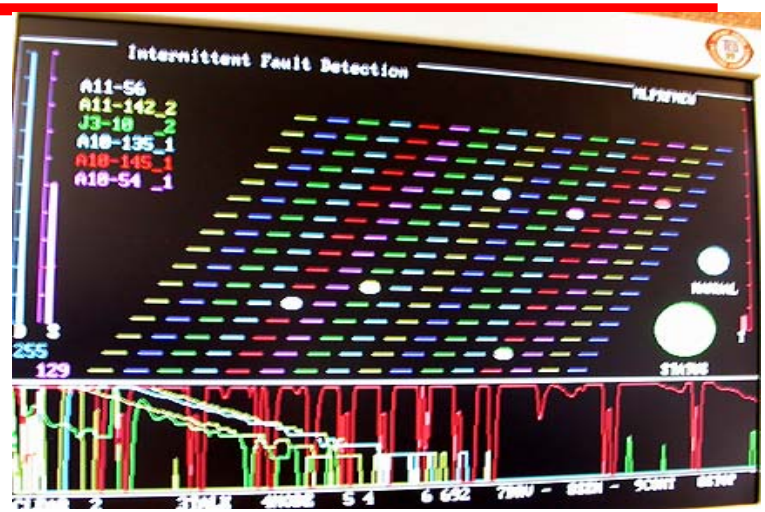
Investment: $0.5M

Life Cycle ROI: 34:1

Intermittent Fault Detection & Isolation System (IFDIS)

Overview/Issue

- Unable to duplicate discrepancy on No Fault Found (NFF) LRU's
- Bad Actor LRU's continued to be recycled through the repair cycle process



Solution

- Develop maintenance tool to augment traditional testing methods
- Will identify and isolate intermittent faults on end items
- Repeats Vigorous Test scenario

Investment/ROI

Investment: $2.20M

Life Cycle ROI: 22:1

R-TOC Project Funding vs. Savings

FY06-FY09 ($M)

	Funding	Reliability Life Cycle Savings	Maintainability Life Cycle Savings	Supportability Life Cycle Savings	Total Life Cycle Savings	Return On Investment
FY06	23.077	1,618	943	1,472	4,032	174:1
FY07	23.281	12	23	208	243	10:1
FY08	25.598	34	519	746	1,298	51:1
FY09	23.802	725	466	998	2,190	92:1
DoD Total	95.758	2,389	1,951	3,423	7,763	81:1

Initiatives Contributing to R-TOC

- Lean Enterprise Value
- Six Sigma
- Supply Chain Management
- DoD Manufacturing Technology (ManTech)
- Value Engineering
  - FAR provisions offer contractual incentives
  - Methodology offers approach to partner with industry

Definition

- **<u>Value Engineering</u> -** ***An organized effort directed at analyzing the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life cycle cost consistent with required performance, reliability, quality, and safety*****. OMB Circular A-131**

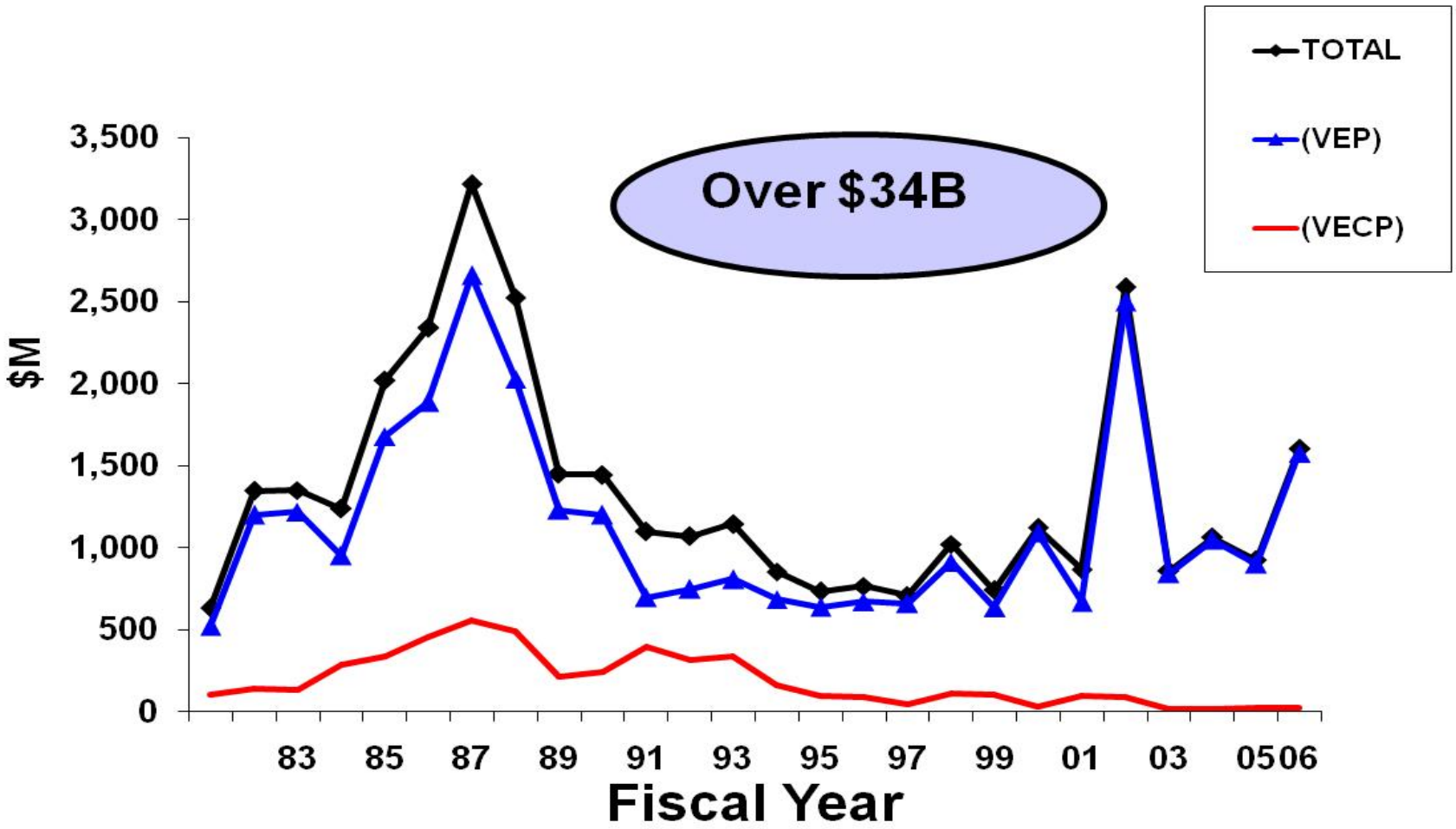
- **Bottom Line: Identify and Eliminate Unnecessary Cost**

Value Engineering is an R-TOC Best Practice

- VE provides:
  - Cost reduction (VEPs and VECPs)
  - Product or process improvement
    - Higher quality
    - Reduced cycle time
  - Better means and materials for maintenance
    - Increased reliability
    - Greater safety
    - Less environmental impact

VE Goal: Lower the government's costs for goods and services & provide cost effective solutions to problems in design, development, fielding, support, & disposal

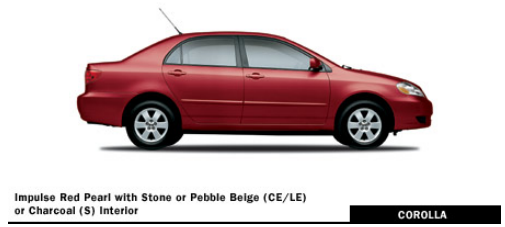
DoD VE Savings & Cost Avoidance



VE – An Industry Example

1998 Toyota Corolla - VE Project

- **Problems: Increased material costs, production time issues**
- **Objective: Correct problems using VE**
  - **Lighter by 10%**
  - **25% Fewer engine parts**
  - **Faster production**
  - **Better fuel economy**
  - **Decreased emissions**
  - **15% Horsepower increase**
  - **Costs $1,000 less to make than in 1997**



VE in Systems Engineering

- **VE methodology is an effective tool for making systems engineering decisions**
  - Reduce cost
  - Increase productivity
  - Improve quality related features

  While…meeting or exceeding functional performance capabilities
- **VE is applicable at any point in the life cycle**

  How…making SE trades

VE and R-TOC in Systems Engineering

- **VE and R-TOC Early in the Life Cycle – Concept Refinement**
  - Analysis of Alternatives – evaluate functions vs. requirements
  - Challenge needs/ensure requirements are valid
  - SE trades
    - Develop cost of alternatives
  - Consider life cycle cost implications – (R-TOC)

Savings For All Production Units

VE and R-TOC in Systems Engineering

- **VE and R-TOC During Technology Development**
  - Analyze value of requirements/specifications
    - Can these be tailored?
  - Cost as an independent variable
  - Compare function, cost and worth of technologies
  - Consider life cycle cost implications of new technologies – R-TOC

VE and R-TOC in Systems Engineering

- **VE and R-TOC During Systems Development and Demonstration**
  - Identify technical approaches
  - Eliminate unnecessary design restrictions
  - Estimate cost of functions
  - Identify alternatives
  - Evaluate design concepts – O&S life cycle concepts (R-TOC)
  - Search for new technologies
  - Simplify designs

VE and R-TOC in Systems Engineering

- **VE and R-TOC During Production and Deployment**
  - Evaluate and improve manufacturing processes, methods and materials
- **VE and R-TOC During Operations and Support**
  - Analyze advances in technologies
  - Evaluate modifications
  - Reduce repair costs
  - Analyze packaging requirements
  - Improve RM&S – R-TOC
  - Analyze/Improve supply chain/logistics footprint – R-TOC
  - Implement CBM – R-TOC
  - Reduce manpower – R-TOC

SUMMARY

- R-TOC and VE provide savings/cost avoidances for DoD
- VE is a tool for Systems Engineering
- R-TOC provides a focus on life cycle design considerations
- VE supports SE trades
- Three new VE documents: 1) VE Contractor's Guide, 2) VECP Contracting Guide, and 3) VE Handbook
- VE revitalization effort in-work – USD(AT) memo on OMB Circular A-131
- R-TOC is driving towards institutionalization of O&S cost reductions across all programs
- R-TOC/VE websites: http://rtoc.ida.org or http://ve.ida.org

- R-TOC / VE Points of Contact: David Erickson: David.Erickson@osd.mil - Danny Reed: dreed@ida.org

BACKUP

History

- **VE emerged from the industrial community.**
- **The VE concept is a by-product of material shortages during WW II where alternative approaches often worked as well or better and cost less.**
- **DoD established its VE Program in 1963.**
- **VE has proven to be a successful cost reduction/product improvement tool for over 40 years!**

VE Application Areas

Examples: How VE can be used:

- **Improve/streamline operations**
- **Improve quality**
- **Increase the use of environmentally-sound and energy-efficient practices and materials**
- **Simplify logistics**
- **Reduce maintenance**
- **Increase availability**
- **Improve durability**
- **Reduce cost**

VE Authority

- **Office of Federal Procurement Policy Act 41 USC 432 – Each executive agency shall establish & maintain cost-effective VE procedures & processes**
- **Public Law Implemented by OMB Circular A-131**
- **All Agencies Will:**
  - **Establish and maintain a VE Program**
  - **Develop annual plans**
  - **Budget for VE**
  - **Encourage VECPs**
  - **Encourage VEPs**
  - **Identify and report**
  - **Train in VE**
- **OMB Circular A-131 implemented by the DoD VE Strategic Plan, December 2003**

Definition of Terms

- **<u>Value Engineering Change Proposal (VECP)</u>:**

  A proposal submitted by a contractor that changes the contract and saves the government money

- **<u>Value Engineering Proposal (VEP)</u>:**

  A government generated change that adds value

VE – A Systematic Approach

1. Information - frame the problem
2. Function Analysis
3. Speculation - generate ideas based on function
4. Evaluation of ideas
5. Development of ideas
6. Verification
7. Reporting - present business case
8. Implementation - Use Champions & follow-up

Provides planned systematic approach that is more productive than undisciplined or opportunistic approach

Why Optimization May Not Have Been Achieved

- Shortage of time
- Requirements are technically beyond capability
- Lack of insight into costs
- Change in technology (hardware & processes)
- Lack of knowledge of actual requirements
- Fixation with previous designs
- Presence of bad information/failure to fully communicate
- Habits and attitudes
- Temporary circumstances
- Honest but wrong beliefs

VE Savings Proposals
In-house (VEP) Example

Value Engineering Proposals (VEP) –
In house proposals generate the majority of savings & cost avoidances



PA125 Ammo Container

Before



Sold as scrap

Govt Savings totaled $7.155 M over 3 years

After



Saved for refurbishment and reuse

DoD VE Strategic Plan

- DoD VE Strategic Plan signed by USD(AT&L)
  - Improve value for defense systems
  - Align industry and government value
  - Increase VE expertise
- Strategic Plan
  - Establishes a goal of VE cost savings and avoidances of 1.5% of TOA by FY06 for all the Services and other DoD Agencies – Difficult Stretch Goal
  - At least 500 people will have completed VE continuous learning module by FY06 – Currently over 1100
  - 90% of VECPs should be fully processed within 180 days by FY06 - Accomplished
  - VECP Community of Practice (CoP) - Accomplished

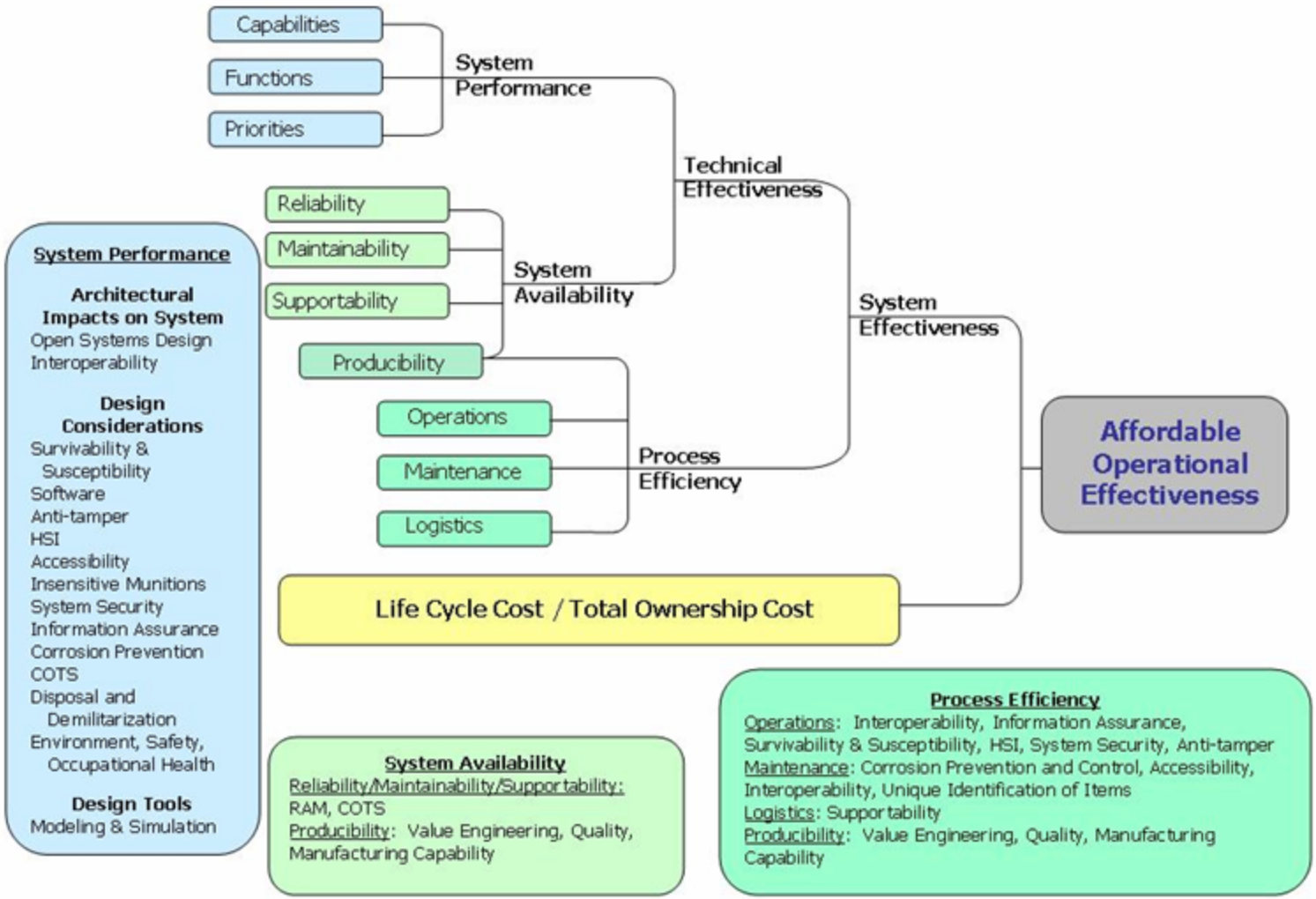
Quantitative Method for Project Evaluation

- Projects submitted for R-TOC funding are selected based on 11 criteria, five objective and six subjective
- Highest values are placed on Return on Investment (ROI) over the FYDP and over the Life Cycle of the system (using OMB discount values) and on a subjective evaluation of improvements in Operational Readiness
- ROI calculations are performed automatically by use of a calculation template

Lessons Learned

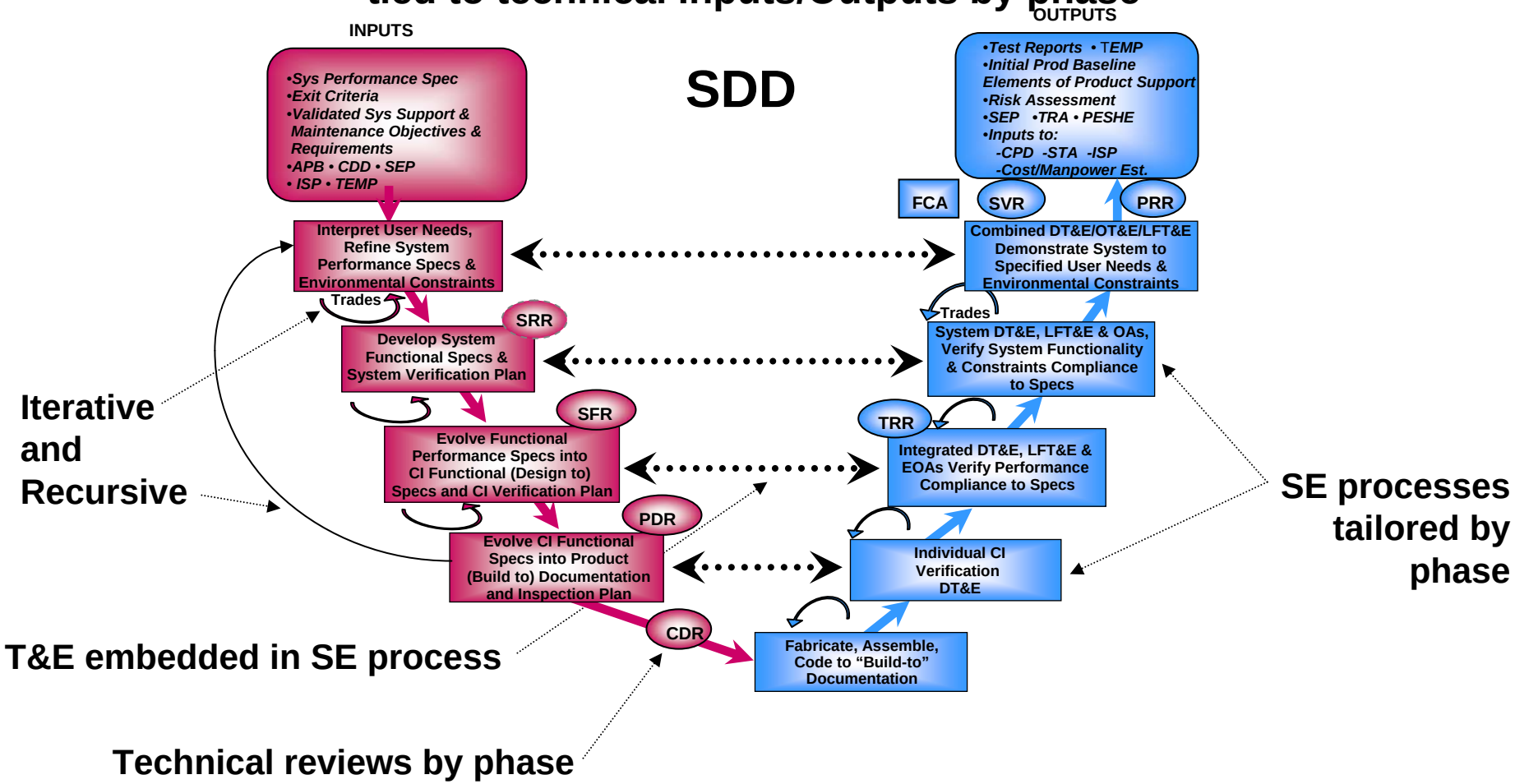
- Most Pilot Programs focused on “reduced demand” via Reliability, Maintainability and Supportability (RM&S)
- A few programs were able to sign long-term contracts for product support (“competitive sourcing”), which produced O&S savings while at the same time increasing readiness and availability
- Both approaches provided savings in the second listed area for savings – reduced response times

Important Design Considerations

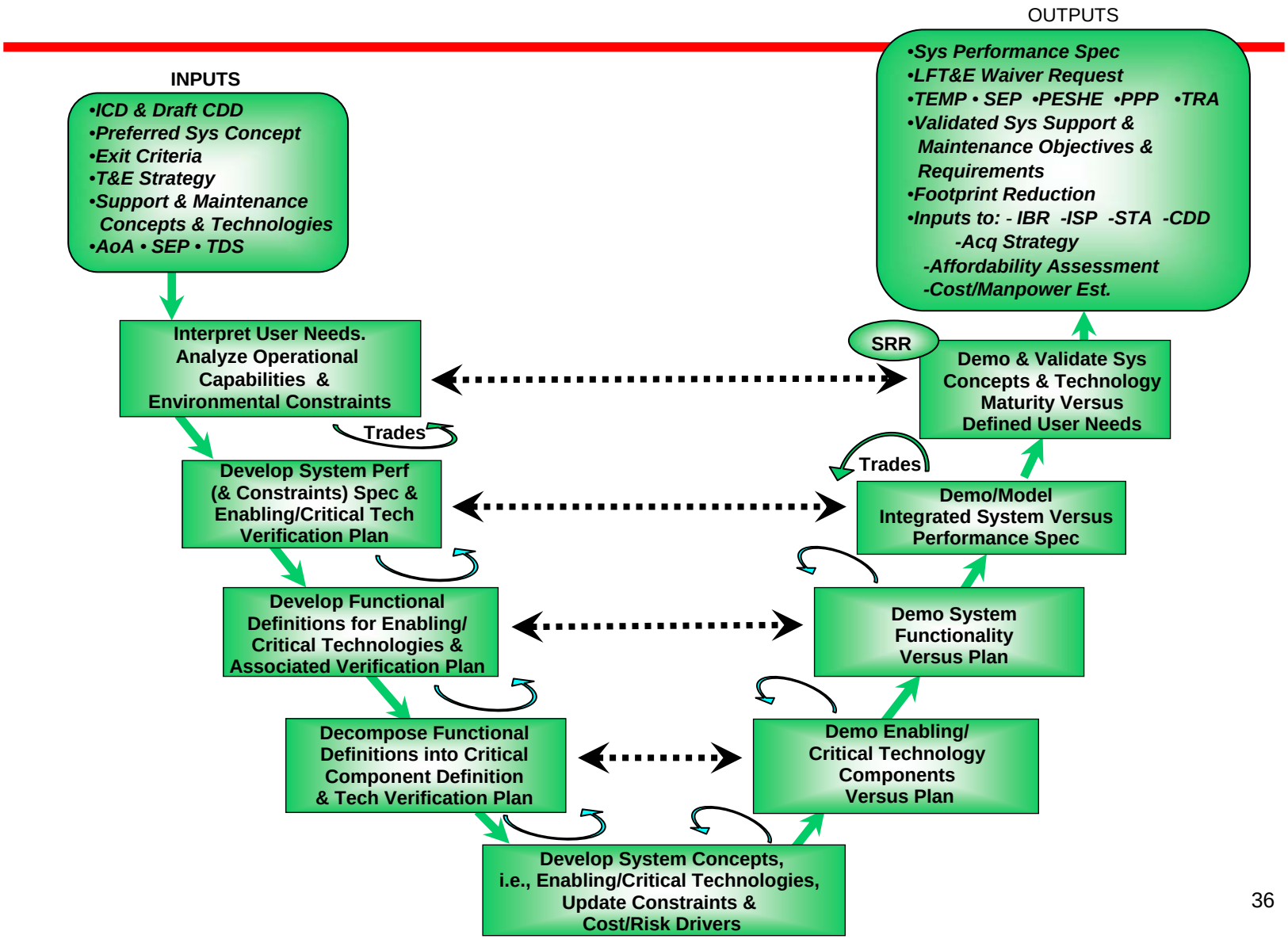


Understanding Systems Engineering by Phase

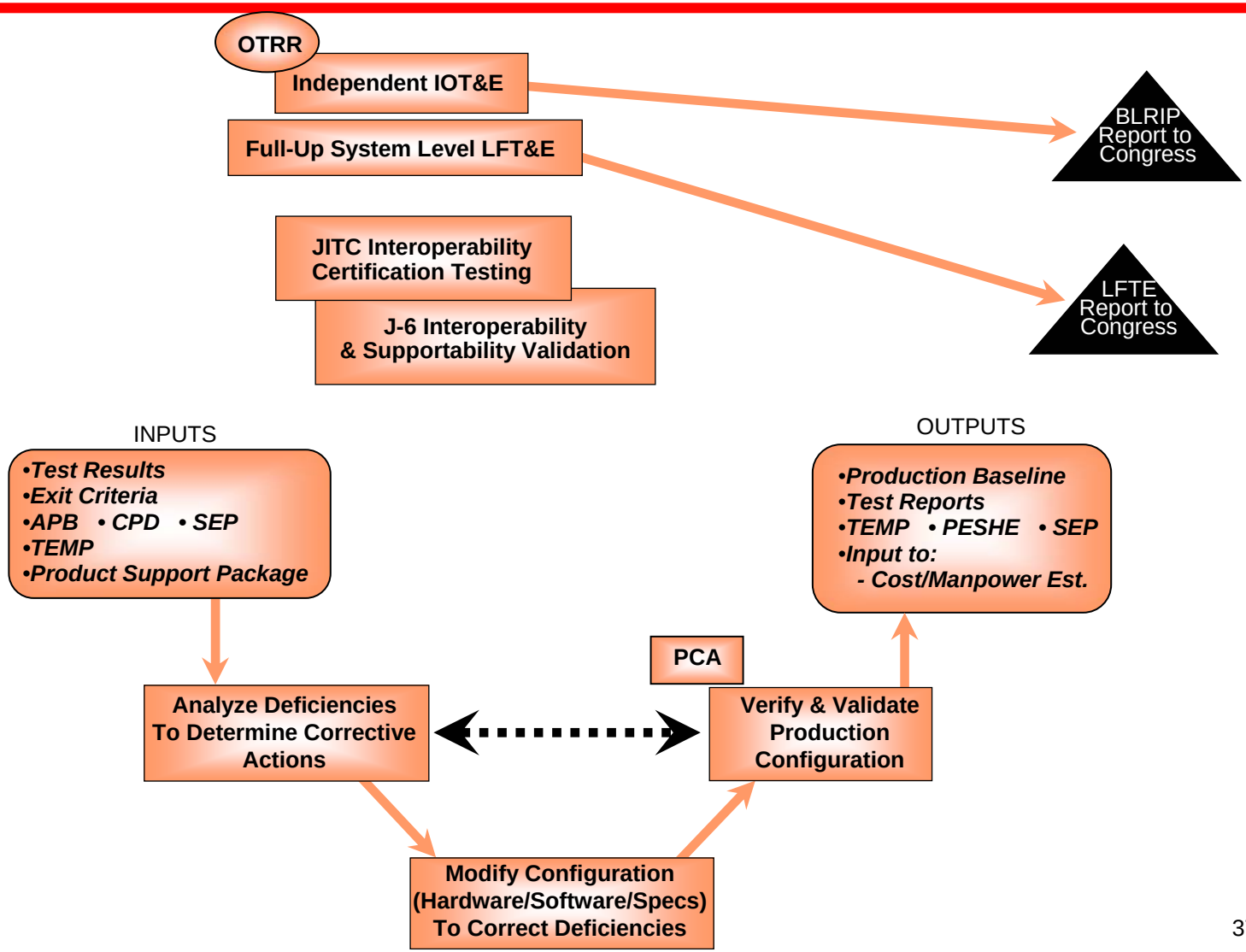
SE Processes (Engineering, Supportability, TA&E) directly tied to technical Inputs/Outputs by phase



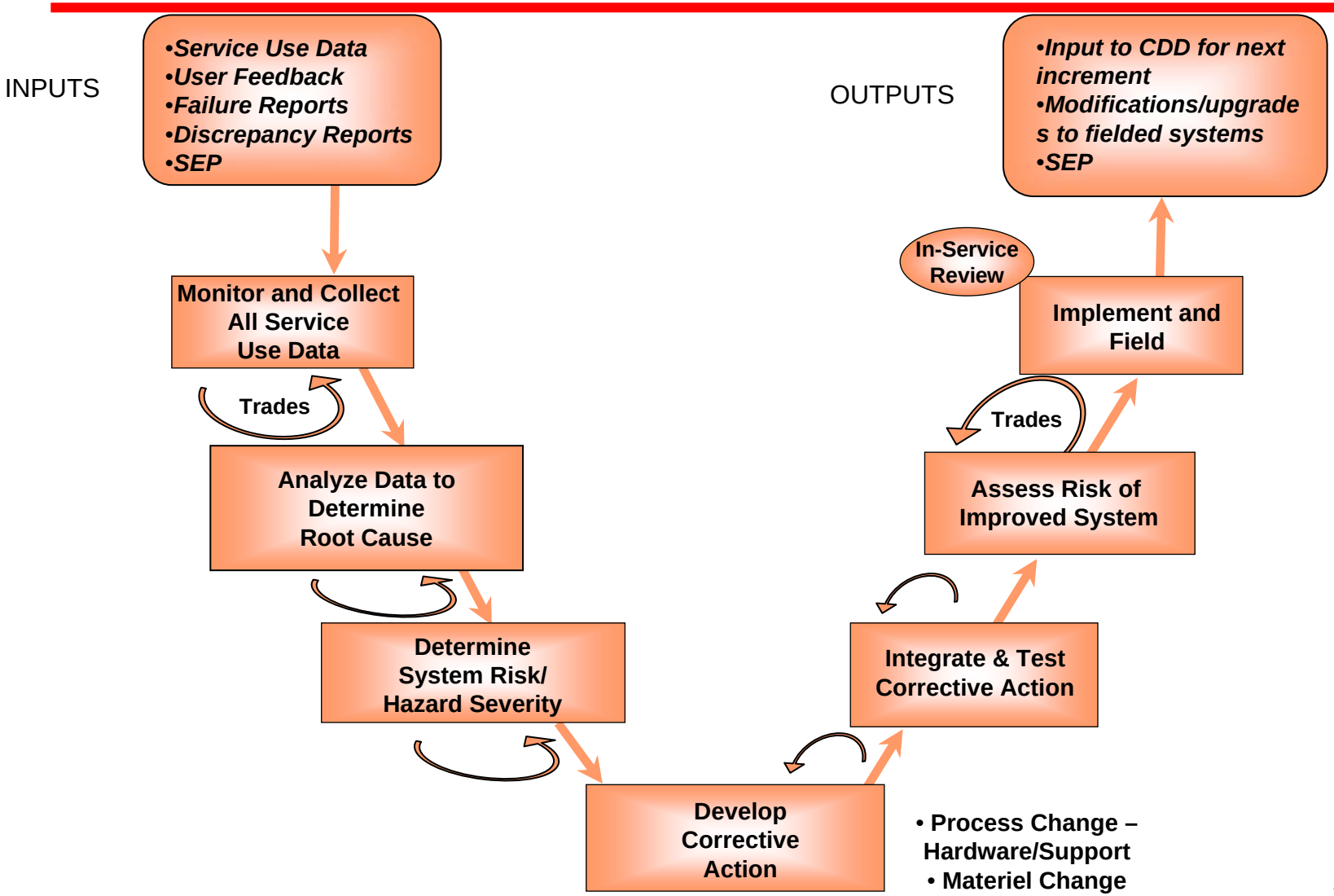
Technology Development Phase



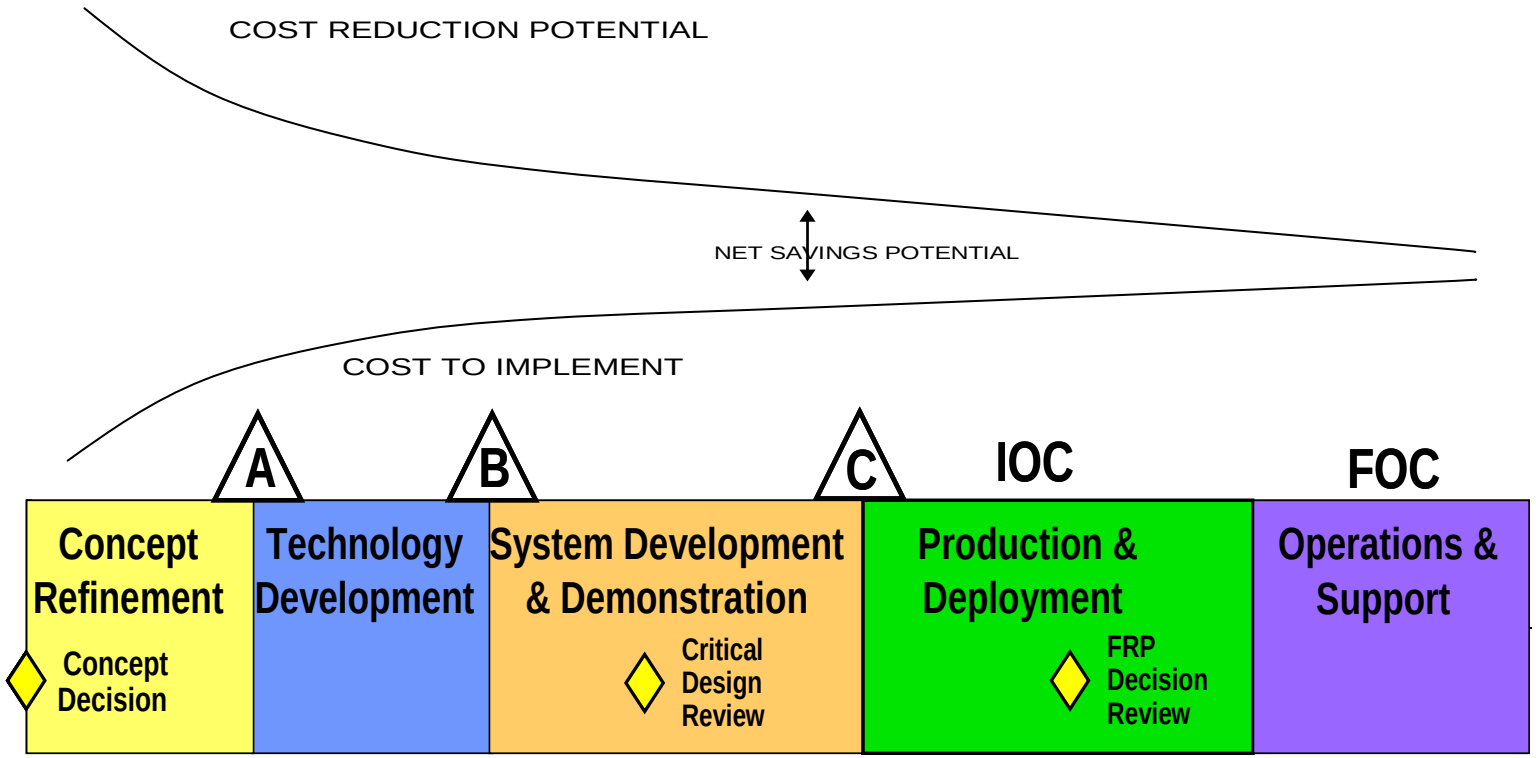
Production and Deployment Phase



Operations and Support Phase



LifeCycle Cost Reduction Potential



USD(A&T) FY 2005 R-TOC Goal

- USD(AT&L) Goal: "…reduce the O&S cost of fielded systems (excluding manpower and fuel) by 20% (compared to current FY 1998 levels) by the year 2005."
- "Each Military Department recently proposed ten major 'pilot program' activities to test Program Manager performance…I intend to use the pilot programs to demonstrate the type of cost savings depicted in the Defense Planning Guidance."

  (Under Secretary of Defense Jacques Gansler)

OSD Funding for Selected R-TOC Projects

- R-TOC Program Element (PE) was created using funds ($25M per year) provided by the Services in PBD 707
- PBD 707: USD(AT&L) and the Services agreed to move 1/3 each from the Services O&M accounts to an OSD account to fund the R-TOC PE
- Competitive funding of projects submitted by Services to reduce long-term O&S costs

SAFE-SEPARATION ANALYSIS
SYSTEM SAFETY ENGINEERING STUDY

Ken Chirkis, Jason Cushing, Steve Bussell
NAWCWD China Lake

Dave Hall, Ray Terry
SURVICE Engineering

Cleared for Public Release

SURVICE ENGINEERING COMPANY

Background

- **Tasking from PMA-201 to review safe escape – safe separation analysis methodologies across the Services**
  - **NAWCWD China Lake: Ken Chirkis, Jason Cushing, Steve Bussell**
  - **SURVICE Engineering: Dave Hall, Ray Terry, Mike Ray**

- **Presented results to the DoD Fuze Engineering Standardization Working Group (FESWG), 28 – 30 November 2006**
  - **FESWG recommended we brief the DOD Fuze IPT**
  - **Study recommends changes to Joint definitions, establishing Joint guidance for analysis assumptions and methodologies**

- **Presented results to DOD Fuze IPT, 28 February 2007**
  - **IPT supported recommendations for changes to standards and process documents**
  - **Recommended FESWG as the technical standards group**

- **Presented results to Fuze Safety Summit, March 2007**

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Statement of Work

- **Review Safe Separation/Safe Escape Analysis Approaches**
  - **Analyses to determine minimum arm time/distance, safe escape release conditions, risk assessments for air launched weapons systems**
  - **Examine requirements, approaches, assumptions, methodologies**
  - **Account for post-release aircraft maneuvering**
- **Compare service approaches**
- **Consider additional sources of information**
  - **Survivability analyses (aircraft vulnerability models)**
  - **Other known risks to aircraft (enemy weapons, etc.)**
- **Provide independent recommendations for improvement**
- **Prepare briefing on results to PMA-201 Fuze IPT System Safety Working Group (SSWG)**

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Technical Approach

- **Develop Consistent Evaluation Questionnaire**
  - **Assumptions (post-launch aircraft maneuvers, weapon variations, environmental variations, launch modes, S/A device variations)**
  - **Requirements (risk probability, hit and/or kill, analysis objectives, post-launch maneuver requirement)**
  - **Definitions (safe separation, safe escape, safe arming, definition source)**
  - **Aircraft Modeling (flight path, physical description, vulnerability, maneuvers, air target maneuvers)**
  - **Weapon Modeling (trajectory, debris model fidelity, variations, S/A device modeling)**
  - **M&S and Credibility (what M&S, capability, accuracy, usability)**
- **Interview Service Safe-Separation/Safe-Arming Analysts**
- **Analyze Interview Results (and any additional data collected)**
- **Formulate Recommendations**
- **Document Results**

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Data Collection Results

- **Interviewed NAWCWD and AMRDEC analysts**
  - **NAWCWD Warfare Analysis Division at China Lake**
  - **Aviation Engineering Directorate at Redstone Arsenal**
- **Seek Eagle and NAWCAD analysts declined to be interviewed**
  - **Referred us to JSF JSEAS effort**
    - Joint Safe Escape Analysis Solution
  - **JSF provided document "JSF Common Safe Escape Criteria"**
    - Agreement on 23 joint requirements for safe escape analysis
    - Covers air-to-ground weapons
    - Participants included NAWCAD, Seek Eagle, UK analysts
    - Covered most of our interest in requirements, very little in other categories of information (assumptions, M&S, etc.)
- **We filled in some information from other sources**
  - **NAWCWD and Seek Eagle have close working relationship**
  - **Air Force, Army briefings from April 06 Seek Eagle conference**

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Results: Assumptions

Assumption	NAWCWD	NAWCAD	SEEK EAGLE	AMRDEC
Launch aircraft maneuvers	Assume straight and level is worst case; fixed “g” maneuvers; altitudes & speeds from tactics guides		Assume straight and level is worst case; fixed “g” maneuvers; altitudes & speeds from tactics guides	Hover, Bank,Dive, attack run, break turn toward masking terrain after launch, or vertical or lateral unmask & egress
Weapon Variations	Hot/cold motor when data available; no roll variations; variable launch modes		Hot/cold motor when data available; no roll variations; variable launch modes	Hot/cold motor when data available and IFS of sufficient fidelity
S/A Device Variations	Spec value plus and minus tolerance	Spec value minus tolerance	Spec value minus tolerance + delay	UNK

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Results: Requirements

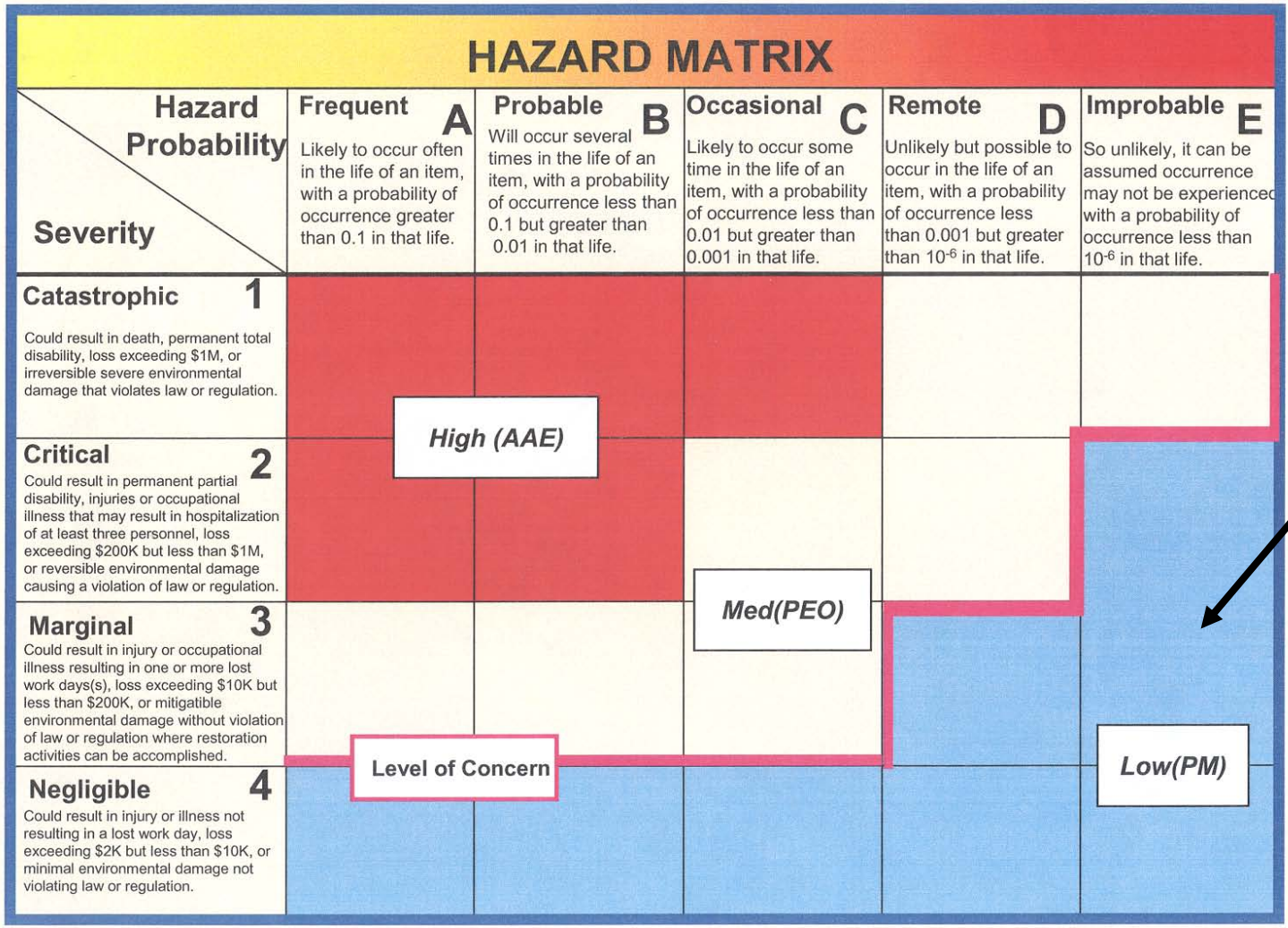
Requirement	NAWCWD	NAWCAD	SEEK EAGLE	AMRDEC
Launcher vulnerability metric	Hit & Kill	Hit Only	Hit Only	Hit (frag KE>5 ft-lbs or V>V_{50}) & Kill
Probability requirement	.0001 or .01* or outside hazards analysis	.0001	.0001 or .01* or outside hazards analysis	Zero, or 10^{-6} In some cases may use .0001**
Maneuver after launch required if probability not met?	Yes (in one or two cases)			No
Analysis Objectives	Safety of flight clearance; safe escape maneuver determination		Safety of flight clearance; safe escape maneuver determination	Minimum low-altitude safe release range; risk assessment

* Modified by Pdet

** AMRDEC System Simulation and Development Directorate

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Army Hazard Matrix



Drive S/A Results to Blue Area

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From: Fuze Management Board Joint Agreement (1978)

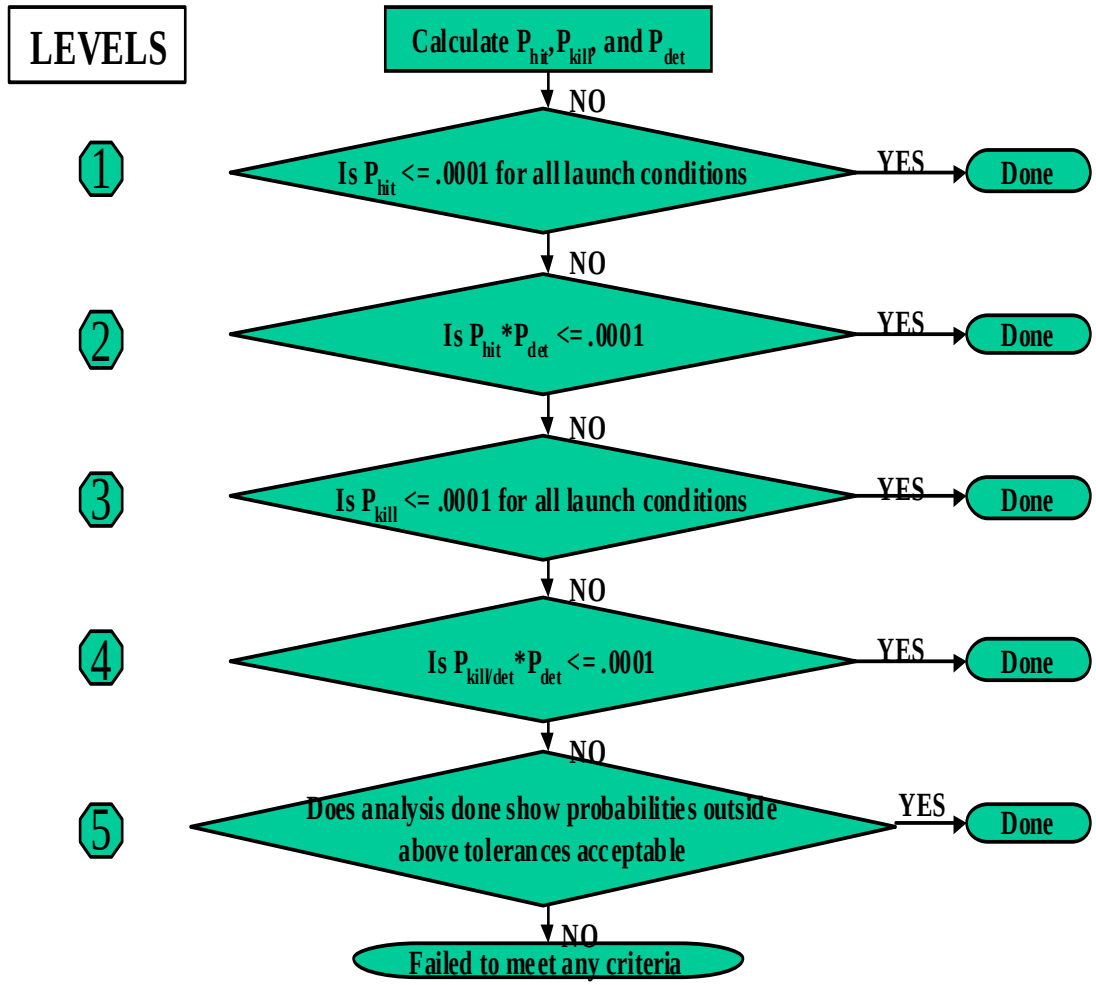
- **Pkill:** **"If the minimum safe-separation distance *(resulting from the Phit<.0001 requirement)* restricts tactical delivery conditions, the probability of a fragment hit may be further qualified by considering only the presented area of critical systems or components rather than the area of the complete launching system."**
  - **Interpreted by NAWCWD (and AMRDEC) as Pkill**
  - **UK uses "self damage" metric**
- **Risk Analysis:** **"If the above procedures *(Phit or Pkill <.0001)* still result in restricting tactical delivery conditions, then selected fuze arming conditions which are such that a safe-separation distance is not achieved must be justified by a thorough analysis."**
  - **"This analysis should consider probability of a specific type of damage, decreased risk from enemy ordnance, and tactical advantage gained by use of the recommended fuze arming characteristics"**
- **Fragment Hit:** **"A fragment which contains sufficient kinetic energy to penetrate the launch aircraft skin which is exposed to the hazard."**
  - **Army uses KE>5 ft-lbs, or V_{50} analysis**
  - **Not clear what, if anything, anyone else uses as hit criteria**

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Safe Escape Analysis Requirements

(From NAWCWD Briefing)

Note: Pdet cannot be less than .01



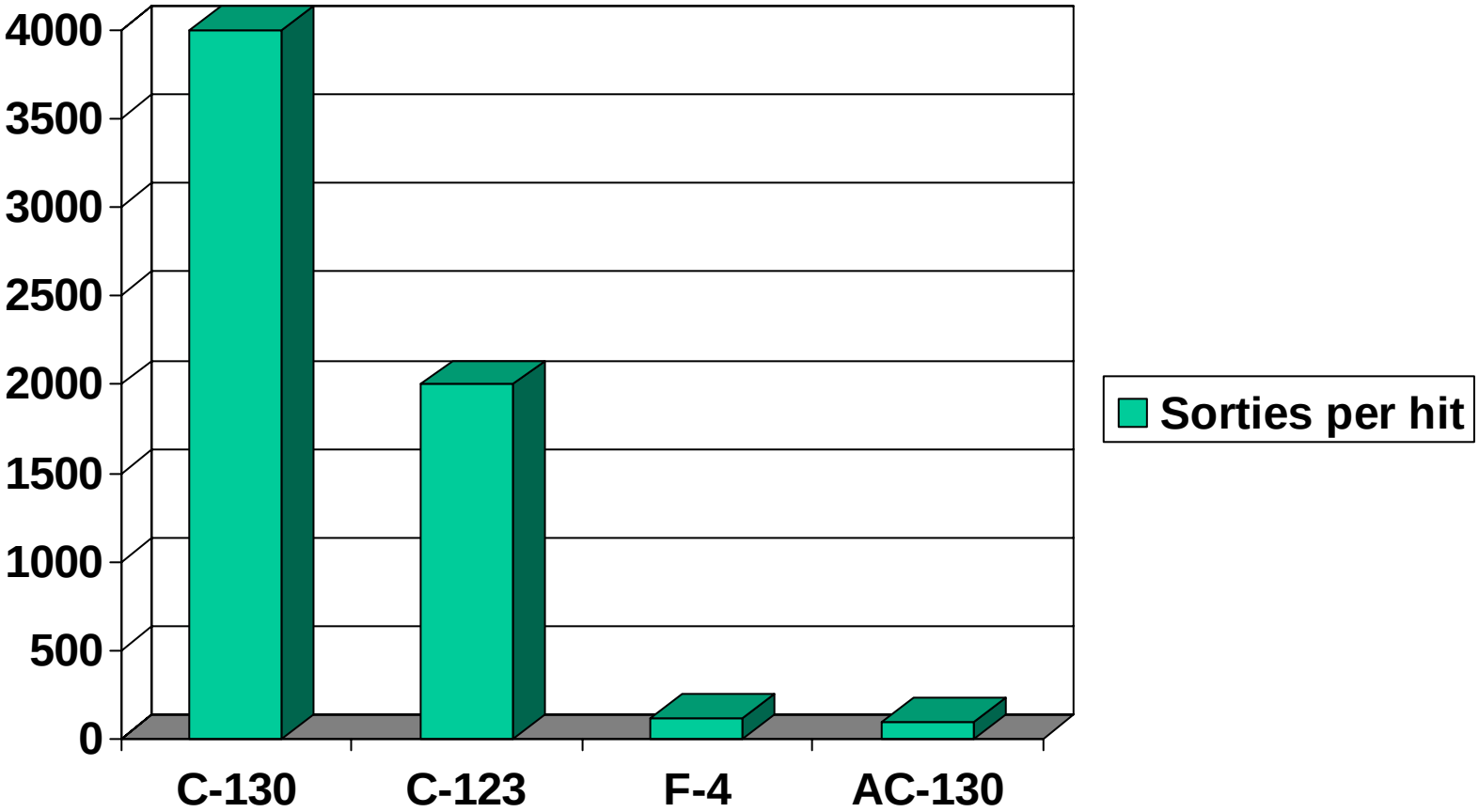
Fuze Management Board Joint Agreement on Safe Separation Analysis for Air-Launched Munitions (Signed by the Army, Navy and Air Force on 23 February 1978)

4

P_{hit} Requirement and Historical Data

- 10^{-4} requirement purported to be based on historical data
- No documentation available from original decision (1978)
- Analyzed available hit rate data from SEA and Desert Storm
- Obtained mishap rate data for F-16 and UAV systems
- Compared to Phit requirement

SEA Hit Rate Experience
Air Force Aircraft



P_{hit} per sortie ~ 10^{-3} for transports, 10^{-2} for attack a/c

Source: ASD/XRM Analysis
SURVIAC Data

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SEA Hit & Kill Rates
USN & USMC Fixed Wing Aircraft, (Apr 1965 – Mar 1973)

Service	Hit Rate (per 1000 sorties)	Kill Rate (per 1000 sorties)
USN	5.23	1.05
USMC	6.32	0.54

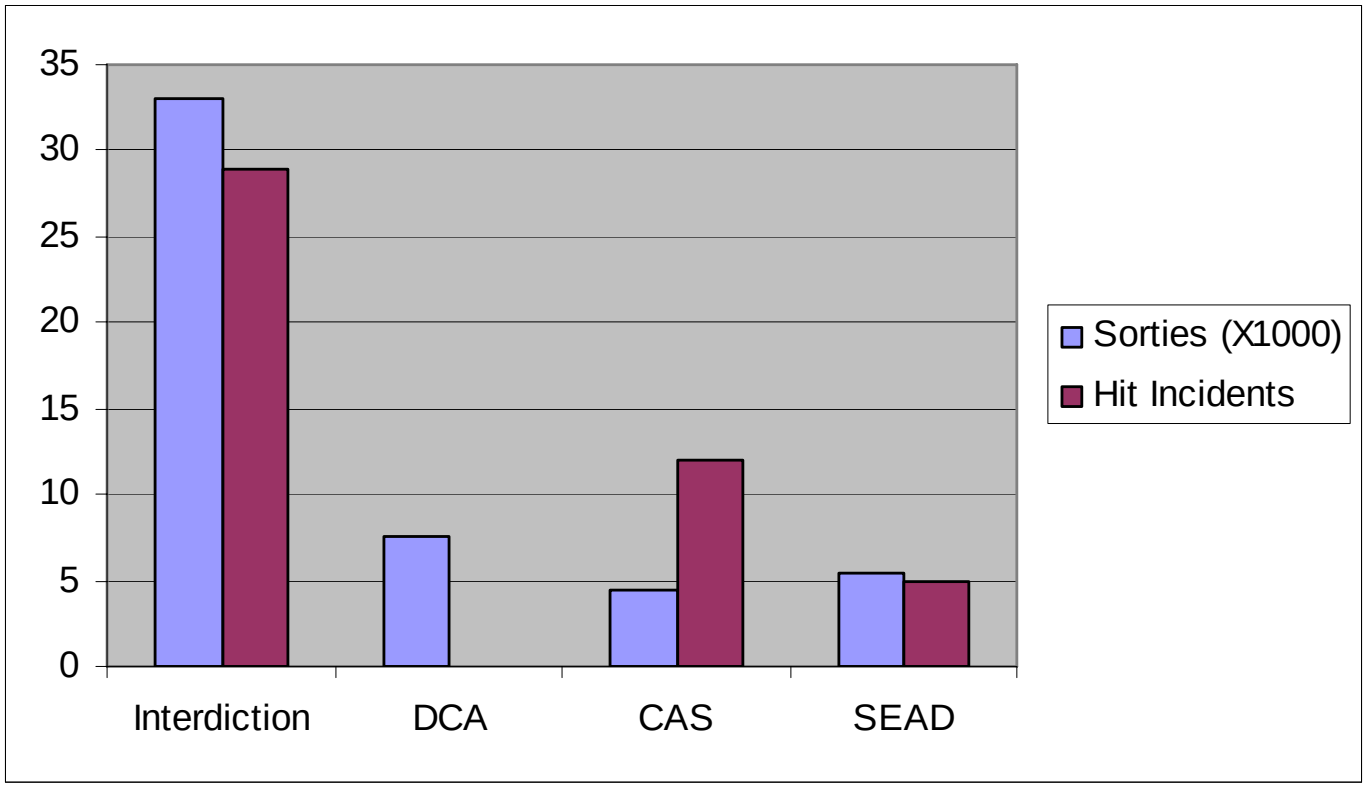
P_{hit} per sortie ~ 10^{-2}

P_{kill} per sortie ~ 10^{-3}

Source: ***U.S. Navy, Marine Corps and Air Force Fixed Wing Aircraft Losses and Damage in Southeast Asia (1962-1973),*** **Center for Naval Analyses, Aug 1976**

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Desert Storm
Hits by Mission Type



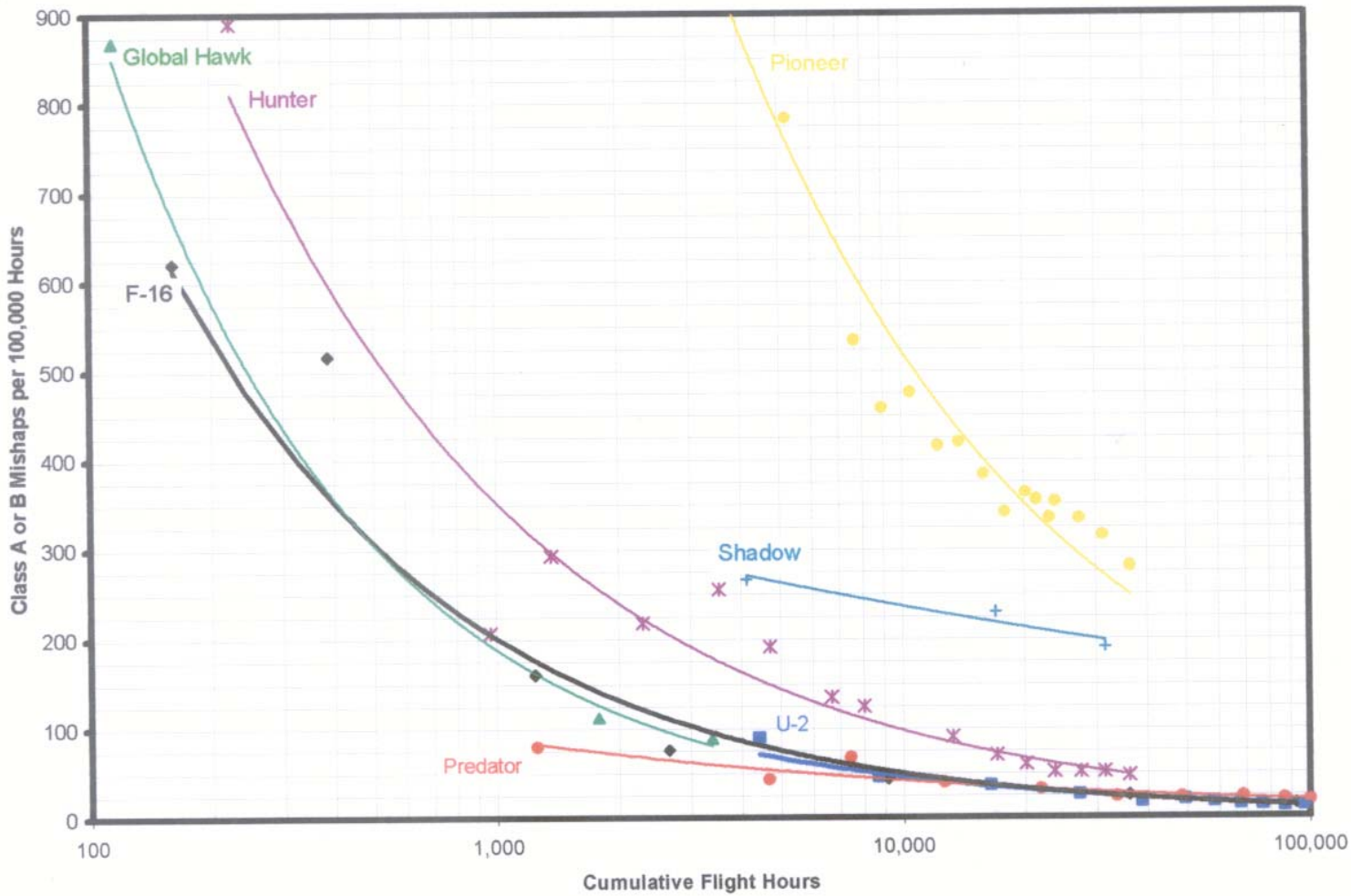
P_{hit} per sortie ~ 10^{-3}

(or zero, for DCA – no threat a/c)

Source: SURVIAC

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Mishap Rate Comparison



Mishap Rate Approaches 10^{-4} as cumulative flight hours approach 100,000

Source: UAS Roadmap 2005

P_{hit} Requirement and Historical Data

- **Historical Data Summary**
  - SEA and Desert Storm Combat hit rates per sortie vary from 10^{-2} to 10^{-3}, depending on aircraft type and mission
  - Aircraft combined Class A and B mishap rates per flight hour converge to around 10^{-4}

- **Apples and Oranges:**
  - Mishap rate per flight hour
  - Combat hit rate per sortie
  - Weapon fragment hit probability per weapon release

- **However, a 10^{-4} requirement is not inconsistent with overall historical rates**
  - Not exactly supported by history, but not completely out of line
  - Combat hit rates support "additional analysis of other risks" to justify not meeting probability requirement

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MIL-HDBK-1763 Definitions

3.1.27 Safe escape/safe arming

Safe escape is the minimum release altitude which will provide the delivery aircraft acceptable protection from weapon fragmentation for detonation at the preplanned point. Safe arming separation is the selection of a minimum safe fuze arm time setting which will provide the delivery aircraft acceptable protection from weapon fragmentation if early detonation should occur.

3.1.28 Separation

The terminating of all physical contact between a store, or portions thereof, and an aircraft; or between a store, or portions thereof; and suspensions equipment.

3.1.28.1 Safe separation

The parting of a store(s) from an aircraft without exceeding the design limits of the store or the aircraft or anything carried thereon, and without damage to, contact with, or unacceptable adverse effects on the aircraft, suspension equipment, or other store(s) both released and unreleased.

3.1.28.2 Acceptable separation

Acceptable store separations are those which meet not only the "safe" separation criteria, but also meet pertinent operational criteria. For instance, guided weapons as a minimum must remain within control limitations consistent with mission effectiveness. Conventional weapons, bombs, should not experience excessive angular excursion which induce ballistic dispersions that adversely affect weapons effectiveness, or bomb-to-bomb collisions.

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Other Documents' Definitions

MIL-STD-1316E:

Safe Separation Distance: The minimum distance between the delivery system (or launcher) and the launched munition beyond which the hazards to the delivery system and its personnel resulting from the functioning of the munition are acceptable.

1978 Joint Agreement:

Safe-Separation Distance: the minimum distance between the launching system (AIRCRAFT & PILOT) and its launched munitions at which hazards associated with munitions functioning are acceptable. This distance may be achieved by providing arming delays(s) (time or distance).

Analysis Definitions

- All analysts in all Services call what they do “safe escape analysis” vice “safe separation analysis”
  - Consequently, should consider changing the MIL-STD and Joint Agreement definitions to make “safe separation” mean safe release of the weapon from the launch mechanism
  - Change “safe separation distance” to “safe arming distance” or “safe escape distance”
- However, not all safe escape analyses involve determining minimum release altitude (MRA) or minimum safe release altitude for fragment avoidance (MinAlt) per the MIL-HDBK definition
  - Air to air analyses do not in general determine safe release altitudes
- So there is still some difference in definition of safe escape analysis that needs to be resolved

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Results: Aircraft Modeling

Aircraft Modeling Issue	NAWCWD	NAWCAD	SEEK EAGLE	AMRDEC
Physical Description	6-view presented area		6-view presented area	6-sided box enclosing aircraft + CAD model
Vulnerability Description	6-view vulnerable area (from survivability analysis)	NA	NA	AJEM model
Target Maneuvers (air-to-air)	Straight and level (assumed worst case); occasionally consider target maneuvers		UNK	NA
Aircraft Flight Path Model	JAAM		JAAM, AWDS	RCAS or FlightLab
Target Debris Model	Not modeled		Not Modeled	Not Modeled

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Results: Weapon Modeling

Weapon Modeling Issue	NAWCWD	NAWCAD	SEEK EAGLE	AMRDEC
Weapon trajectory	Program office 6-dof		Program office 6-dof	Program Office 6-dof
Motor Temperature	Hot/Cold variations if data available		Hot/Cold variations if data available	Hot/Cold variations if data available
Debris source	Arena Test Data		Arena Test Data	Arena Test Data
Debris frag zones	5-10 deg polar zones; uniform distribution		10 deg polar zones; 24 roll zones	5 deg polar zones; unif. dist.
Debris Frags	Large frags & warhead frags modeled separately; no min frag size or velocity; no data available for statistical variations		Large frags & warhead frags modeled separately; no data for statistical variations; unk min frag size or velocity	UNK treatment of large & warhead frags; small frags KE<5 ft-lbs removed; Monte Carlo frag flyout simulation
S/A Device	Arm time plus & minus spec tolerance	Spec value minus tolerance	Spec value minus tolerance + delay	UNK

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Results: M&S & Credibility

M&S Issue	NAWCWD	NAWCAD	SEEK EAGLE	AMRDEC
M&S Used	ASEP	Path 4	CASES	ASEAT
Capability	Adds asymmetric roll zones to Path 3D	3D dynamic frag zones	Pre-generated warhead data files; adds GUI to ASEP	Monte-Carlo, two passes (hit box, then CAD model)
Accuracy	No formal V&V; comparison runs between ASEP & CASES; no data V&V documented; no formal validation; accreditation package done by SEEK EAGLE		No formal V&V; comparison runs between ASEP & CASES; no data V&V documented; no formal validation; accreditation package done by SEEK EAGLE	AJEM V&V; no V&V or documentation available on ASEAT and associated M&S
Usability	User Manual & Analyst Manual; SEEK EAGLE provides limited user support		UNK Documentation; SEEK EAGLE provides user support	

Recommendations

- **Assumptions: Should be Joint guidance for assumptions used in safe-escape analyses**
  - **Launch aircraft maneuvers, weapon variations (angle of attack, motor temperature, roll orientation, etc.), environmental factors, safe-arm device variations, and other factors that potentially drive the analysis results**
- **Requirements: JSEAS requirements should serve as the starting point for expansion to include Army requirements and air-to-air weapon system requirements**
  - **Include provision for application of the process outlined in the original Joint Agreement between all the Services, particularly:**
    - Inclusion of P_{kill} as a metric
    - Provision for additional analyses to support operational use of weapons that do not meet the 0.0001 probability requirement

Recommendations (Continued)

- **Recommend changing MIL-HDBK-1763 Definitions:**
  - **Safe escape: Safe escape is the required release conditions and post-launch maneuvers that will provide the delivery aircraft acceptable protection from weapon fragmentation for detonation at the preplanned point or at or after arming; this may result in a minimum safe release altitude.**
  - **Safe arming: Safe arming is the selection of a minimum safe fuze arm setting that will provide the delivery aircraft acceptable protection from weapon fragmentation if detonation should occur at or after the fuze arm time/distance.**
- **Also change MIL-STD-1316E and Fuze Management Board Joint Agreement definitions of "safe separation distance" to be "safe arming distance" (or "safe escape distance")**
- **Would require fairly extensive changes to MIL-HDBK-504 processes and definitions**

Recommendations (Continued)

- **Aircraft Modeling: Should be guidance for launch aircraft post-launch maneuvers to consider for safety reasons.**
  - **Conduct Sensitivity Analyses to determine whether there is a need for more detailed aircraft representations than 6-view presented areas (as in AMRDEC approach)**
- **Weapon Modeling: Should be guidance for:**
  - **Fidelity of weapon debris modeling (polar zones, etc.).**
  - **When to segregate "unusual" fragments for separate analysis**
    - **Such as bomb lugs, warhead fragments that are likely to have much higher velocities than debris fragments, etc.**
  - **What fragments to include in the weapon debris model**
    - **Capable of penetrating the skin of the aircraft**
      - **Per the Joint Agreement definition of "fragment hit"**
    - **Consistent with the Army's KE>5 ft-lbs requirement for fragment inclusion in the debris model (or V_{50} analysis)**
  - **Conduct sensitivity analyses to determine requirement for variations in weapon orientation (roll, pitch,yaw) and effect on results**

Recommendations (Continued)

- **M&S and Credibility:**
  - **USN representatives should consider migrating to the latest version of the Seek Eagle methodology (CASES)**
  - **When available, the JSEAS methodology should be assessed for adoption as the standard Joint Service methodology**
  - **Documented verification and validation evidence should be developed for all M&S tools used in safe escape/safe arming analyses**
  - **Documentation of all methodologies used by the Services should be developed, maintained and distributed to users**
  - **An Accreditation Support Package (ASP) should be developed for the M&S tools that are continuing in use**

Status

- **Prepared a draft revision of the 1978 Joint Fuze Management Board Agreement on safe-escape analyses**
  - **Will present draft to the FESWG for review and action**

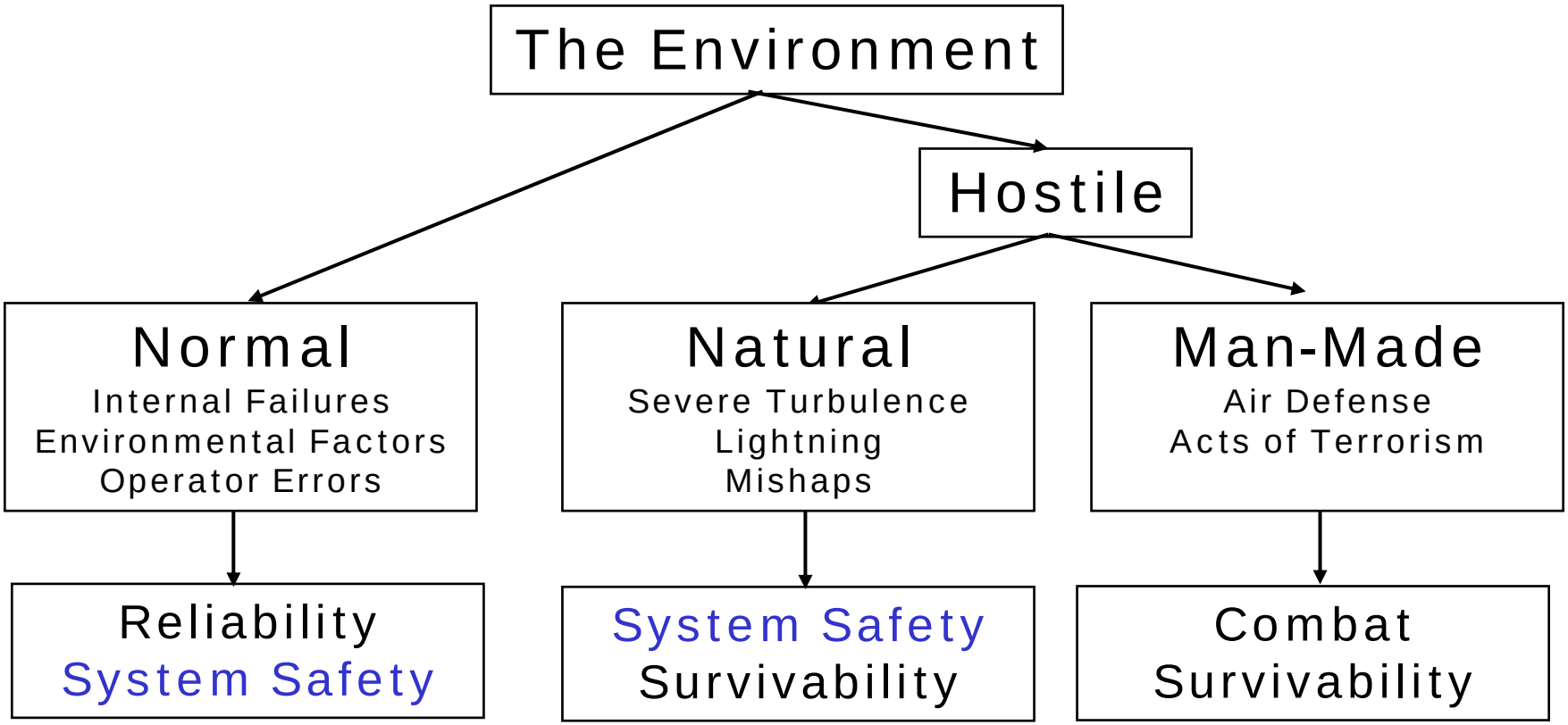
- **Developed draft revisions of definitions and methodology descriptions in:**
  - **MIL HDBK 1763, *Aircraft/Stores Compatibility: Systems Engineering Data Requirements And Test Procedures***
  - **MIL STD 1316E & F, *Department of Defense Safety Criteria For Design Criteria Standard, Fuze Design***
  - **MIL HDBK 504, *Guidance On Safety Criteria For Initiation Systems***
  - **STANAG 4187E4, *Fuzing Systems Safety Design Requirements***
  - **MIL STD 1911A, *Department Of Defense Design Criteria Standard, Safety Criteria For Hand-emplaced Ordnance Design***

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BACKUPS

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Combat Survivability, Reliability and System Safety



SURVICE-TR-06-033



SAFE-SEPARATION ANALYSIS
SYSTEM SAFETY ENGINEERING STUDY

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SURVICE ENGINEERING COMPANY

July 2006
Updated August 2007

Approved for Public Release

ABSTRACT

The Naval Air Systems Command (NAVAIR) contracted with SURVICE Engineering Company to review current technical requirements, approaches, assumptions and methodologies associated with the determination of safe-separation (minimum arm-time or arm distance) and safe-escape (weapons target impact) calculations and corresponding release conditions for air launched weapons systems. This document reports the results of that study, comparing two Navy approaches: one at the Naval Air Warfare Center, Weapons Division (NAWCWD), China Lake, CA, and the other at the Naval Air Warfare Center Aircraft Division (NAWCAD), Patuxent River, MD; the Air Force Seek Eagle Office approach at Eglin AFB, FL; and the Army approaches at the Aviation Engineering Directorate at Redstone Arsenal, AL. The study team conducted interviews with available service experts; reviewed briefings and papers presented in various venues; and analyzed available modeling and simulation (M&S) documentation. The study also drew on the results of the ongoing Joint Strike Fighter (JSF) effort to develop a Joint Safe Escape Analysis Solution (JSEAS). The comparison criteria included assumptions, requirements, definitions, aircraft modeling, weapon modeling, and the safe escape/safe arming modeling and simulation suites used by the various service commands. The study concluded with recommendations for improvement in each of those areas.

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PREFACE

This work was conducted for the Naval Air Warfare Center Weapons Division at China Lake, CA, Systems Safety Division. The technical monitor was Mr. Ken Chirkis. The SURVICE Engineering Lead Analyst for the project was David Hall, working from the Ridgecrest Area Operation, 900E N. Heritage Drive Suite 1, Ridgecrest, CA, 93555, (760) 446-2424, dave.hall@survice.com.

INTRODUCTION

Safe Separation analyses (also called Safe Arm analyses and Safe Escape Analyses) are conducted as part of the system safety program for air weapons systems. These analyses are conducted for a variety of related purposes: to develop safe-arming times (or distances) to be designed into the weapon's safety and arming device; for a risk assessment as part of a safety of flight analysis; to determine safe escape maneuvers that may be required of the launch aircraft in order to meet safety requirements; and to support safety of flight clearance for the weapon.

Currently, the Services use somewhat different approaches to determine safe-escape requirements and weapons release conditions. These analyses are conducted at the Naval Air Warfare Center Aircraft Division (NAWCAD), Naval Air Warfare Center Weapons Division (NAWCWD), the Seek Eagle office at Eglin Air Force Base, the Aviation Engineering Directorate of the Aviation & Missile Research, Development & Engineering Center (AMRDEC) at Redstone Arsenal, and the AMRDEC System Simulation and Development Directorate, Endgame Analysis Branch. Past comparisons between the results of these analyses for Joint weapons systems have shown that in some cases the results from one Service activity derive release conditions that are restrictive or result in specific weapons capabilities not being authorized for use, whereas analysis by another Service activity may obtain a different result.

While NAWCAD and NAWCWD, for example, have specific commodities for which they are each responsible (powered weapons at NAWCWD and gravity weapons at NAWCAD), it is reasonable to expect approaches to be relatively consistent between the two organizations. In the past, attempts have been made to understand the similarities and differences, but this effort has not been pursued to conclusion. With more Joint weapons entering service, it is imperative that release conditions be consistent among the services and that they provide effective employment tactics while maintaining adequate safety margins.

As a result of this issue, the Naval Air Systems Command (NAVAIR) contracted with SURVICE Engineering Company to review current technical requirements, approaches, assumptions and methodologies associated with the determination of safe-separation (minimum arm-time or arm distance) and safe-escape (weapons target impact) calculations and corresponding release conditions and to provide independent recommendations for improvement of this capability. This task was coordinated with the Weapon System Explosives Safety Review Board (WSESRB) and its associated sub-panels such as the Fuze and Initiation System Technical Review Panel (FISTRP) and Software System Safety Technical Review Panel (SSSTRP). SURVICE personnel attended the PMA-201 Fuze Integrated Product Team (IPT) System Safety Working Group (SSWG), as part of the system safety engineering support to program activities relating to requirements of the WSESRB. The results of this project were briefed to the Fuze Explosives Safety Working Group (FESWG) and the DOD Fuze IPT.

APPROACH

SURVICE developed a study plan that was approved by the Technical Monitor. The elements of that study plan were as follows:

1. **Develop Consistent Comparison Criteria:** SURVICE developed a matrix of comparison criteria to use for conducting a detailed survey of the various approaches used at NAWCWD, China Lake (for Navy and Marine Corps air launched powered weapons systems), NAWCAD, Patuxent River (for Navy and Marine Corps air-launched gravity weapons), at the Seek Eagle office at Eglin AFB for Air Force weapons, and at the Aviation Engineering Directorate of AMRDEC at Redstone Arsenal for Army air launched weapons. These criteria include methodology, data, and process issues (Appendix A).

2. **Interview Service Safe-Separation/Safe-Arming Analysts:** SURVICE planned to meet with personnel involved in safe-separation and safe-escape analyses at each of the organizations to review all aspects of their methodology for performing safe-escape and safe-separation calculations against the comparison criteria. Of particular interest was whether any of the models used are formally accredited. This approach had to be modified when Air Force and NAWCAD personnel were not available to be interviewed. Where service personnel were not available for interview, SURVICE attempted to fill in their information by interviewing other available experts in the field and reviewing previous briefings and reports. In addition, NAWCAD and Air Force personnel directed SURVICE to an ongoing project for the Joint Strike Fighter (JSF) program to develop a "Joint Safe Escape Analysis Solution (JSEAS)" for JSF.

3. **Analysis of Interview Results:** SURVICE compared the various Service methodologies using the comparison criteria. This analysis used the results of task 2 plus all additional available information. The outcome of this task was a draft of the main body of this final report, highlighting differences in each of the methodologies.

4. **Recommendations:** SURVICE developed some recommendations regarding best practices for safe separation/safe arming analyses. These recommendations take into account the ongoing JSF JSEAS development, and include methodologies, data, processes, acceptable levels of risk, and standardized terminology.

5. **Documentation:** The study results were documented in this final report, as well as in a briefing prepared for the PMA-201 Fuze IPT System Safety Working Group, the Fuze Explosives Safety Working Group (FESWG) and the DOD Fuze IPT.

DISCUSSION

The first task in this project was to develop a set of consistent criteria against which to compare the various approaches taken by the service facilities to conducting safe-separation/safe-arming analyses. These criteria were expressed in the form of interview questions. Appendix A lists the set of questions that were asked of each of the service experts; these questions had to do with:

1. **Assumptions:** assumptions made regarding launch aircraft maneuvers, both before and after weapon release; variations in weapon trajectory; environmental variations; launch modes; variations in safety and arming device functioning
2. **Requirements:** requirements used to evaluate weapon system safety (probability of hit, probability of kill, what values); whether post-launch maneuvers may be required to meet safety requirements; objectives of the analyses (risk assessment only, determining safe-arm time/distance, safe escape maneuver, safety of flight clearance)
3. **Definitions:** terms used to describe the analyses, such as safe-separation analysis, safe escape analysis, safe arming analysis, etc.; what source documents describe those terms
4. **Aircraft Modeling:** how the launch aircraft is physically described (presented area, vulnerable area); what maneuvers are assumed before, during and after weapon release; how the launch aircraft flight path is determined; how the target flight path is determined (for air-to-air weapons)
5. **Weapon Modeling:** how the weapon's trajectory is modeled after release; how the warhead fragments and weapon debris are modeled, and how those data are obtained; how the safety and arming device is modeled; and whether debris from the target is included in the analysis
6. **M&S and Credibility:** safe-separation/safe-escape/safe-arming M&S used in conducting these analyses; what (if any) significant differences in capability exist between the various codes; what software accuracy (verification) documentation is available; what data accuracy documentation is available; what output accuracy (validation) documentation is available; whether the code has been accredited by any users; and what usability support (user groups or documentation) is available

In addition to these comparison criteria, the JSF JSEAS effort has resulted in a document that describes 23 criteria for a common safety analysis methodology for all air-to-ground weapons authorized for release by JSF. Those criteria were developed jointly between NAWCAD, the Air Force Seek Eagle Office, and the United Kingdom's Ministry of Defense (MOD). The JSEAS document compares some current approaches (Seek Eagle, NAWCAD, UK) for those 23 criteria, and documents the proposed JSF approach in each case. Since the JSEAS study as reported only applies to air-to-ground weapons (primarily gravity weapons), the criteria have a slightly different focus than originally envisioned for the study reported here, which includes air-to-air weapons as well. Also, the JSEAS criteria are not focused on M&S issues, but rather on joint safety criteria. As a result, the JSEAS criteria are more comprehensive than the questions in Appendix A when describing air-to-ground weapon safety criteria, but they do not mention M&S

criteria, or address air-to-air or powered weapons specifically. They also do not address assumptions about target maneuvers, or risks from enemy weapons.

Table 1 shows the results obtained from interviews with NAWCWD and AMRDEC personnel. NAWCWD personnel have worked closely with the Seek Eagle Office for powered weapon analyses, so the entries in the Seek Eagle column are based on the NAWCWD interviews, with some minor modification based on briefings from an April 2006 Seek Eagle conference at Eglin AFB. Consequently, the entries in the table may not reflect what Seek Eagle personnel responses would have been. The entries for AMRDEC are based on an Army briefing given at the Seek Eagle conference and another given earlier to the FESWG, as well as interviews with AMRDEC analysts. In addition, comments were received from the Aviation Engineering Directorate of AMRDEC and incorporated into this report.

Assumptions

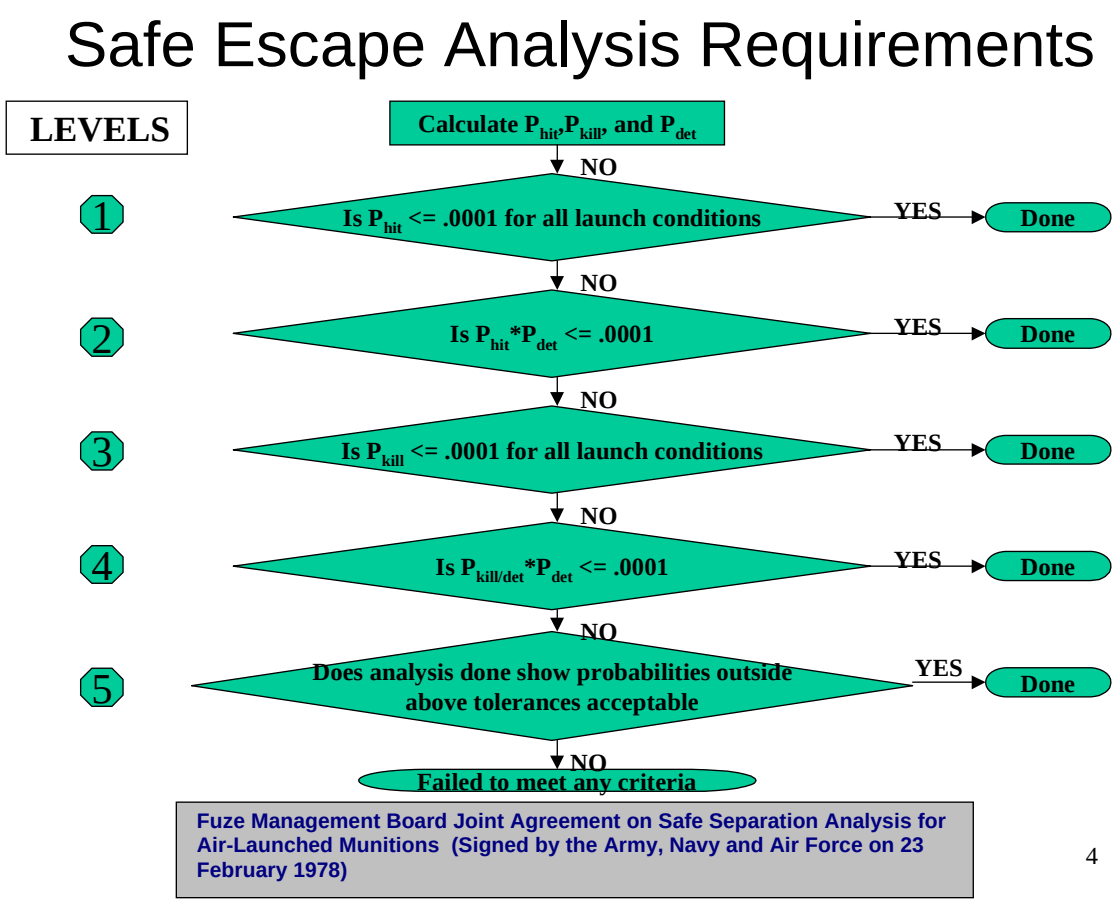
The assumptions made about aircraft maneuvers, variations in weapon characteristics, safety and arming device function, and any parameters that are unknown quantities can often be significant drivers of the results of this type of analysis. We were unable to obtain much information about the general assumptions made by NAWCAD, but it appears that the Seek Eagle Office and the NAWCWD analysts generally make similar assumptions in these areas, and have come to some agreement on general approaches for powered air weapons systems. They generally assume that straight and level flight of the launch aircraft is the "worst case" scenario from a safety standpoint, since in that case the aircraft is following behind the weapon. That assumption may not hold, of course, for air-to-air weapons where the target is maneuvering, or for off-boresight launch. For air-to-air weapons, varying after-launch fixed-g maneuvers are evaluated. Launch altitudes and speeds are chosen from tactics manuals, which is likely to be the case with analyses conducted by all the Service agencies. Variations in weapon trajectory are handled by varying launch modes, weapon angle of attack and motor temperature (where data are available). And the assumed arming time/distance takes into account the tolerances on fuze design.

The Army approach seems to be focused on specific low-altitude launch tactics for helicopters against ground targets: hover, bank, dive, break turns toward masking terrain after launch, or vertical and/or horizontal unmask, then re-mask and egress after launch. For the Army, the minimum safe range is a combination of altitude and down range from the helicopter to its ground target. Army's helicopters normally fire weapons from 30ft to 150ft altitude and airspeed between hover and 90 knots. For running cases (level flight or diving), the common practice after releasing the weapon is either veer to the left or veer to the right and get away from target.

Requirements

There are some known differences between the requirements used by the various service agencies that conduct these analyses. One significant difference between the Seek Eagle Office and NAWCWD is that the Navy analysts consider probability of kill (P_{kill}) of the launch aircraft as a fallback metric to probability of hit (P_{hit}). It appears that the UK also uses a similar metric to P_{kill} in their "self-damage" probability, and the Army allows for calculation of P_{kill} as part of their risk assessment process. While P_{kill} (or self damage) as a metric is less conservative from a safety standpoint than P_{hit}, it follows the guidelines of the original Joint Fuze Management Board Agreement on safe separation analysis requirements[1]. This approach is best described by a graphic from a NAWCWD viewgraph presentation[2], shown in Figure 1.

Figure 1. Safe Escape Analysis Requirements



[1] *Fuze Management Board Joint Agreement on Safe Separation Analysis for Air Launched Munitions*, 23 Feb 1978

[2] *Safe Escape Analysis Overview*, Naval Air Systems Command (NAVAIR) Warfare Analysis Department, Systems Division, AIR 4.10.2, 18 August 2003

The process is a series of questions: if the probability of hit is below the one-in-ten-thousand threshold, then the system meets the basic requirement. If that is not the case, if the probability of hit (given detonation at or after arming) multiplied by the probability of detonation at arming is less than .0001, then it meets the threshold. In Figure 1, P_{det} is defined as the probability of detonation at arming and cannot be less than .01 for this calculation.

If neither of those conditions is met, then probability of kill is substituted for P_{hit}. The following language in the Joint Fuze Management Board Agreement justifies this approach:

> "If the minimum safe-separation distance resulting from the above procedure restricts tactical delivery conditions, the probability of a fragment hit may be further qualified by considering only the presented area of critical systems or components rather than the area of the complete launching system."[3]

The NAWCWD approach interprets "probability of hit on presented area of critical systems or components" to be represented by P_{kill}. If the system still does not meet the criterion using P_{kill}, then the Joint Agreement allows for an analysis of other risks and hazards; for example, with an air-to-air weapon, if the arm time is too long, there is some risk that the enemy aircraft may be able to launch a weapon inside our weapon's minimum range. Thus the hazard from enemy weapons may exceed the hazard from our own weapon, and justify a shorter arm time. The actual wording in the Joint Agreement on this subject is as follows:

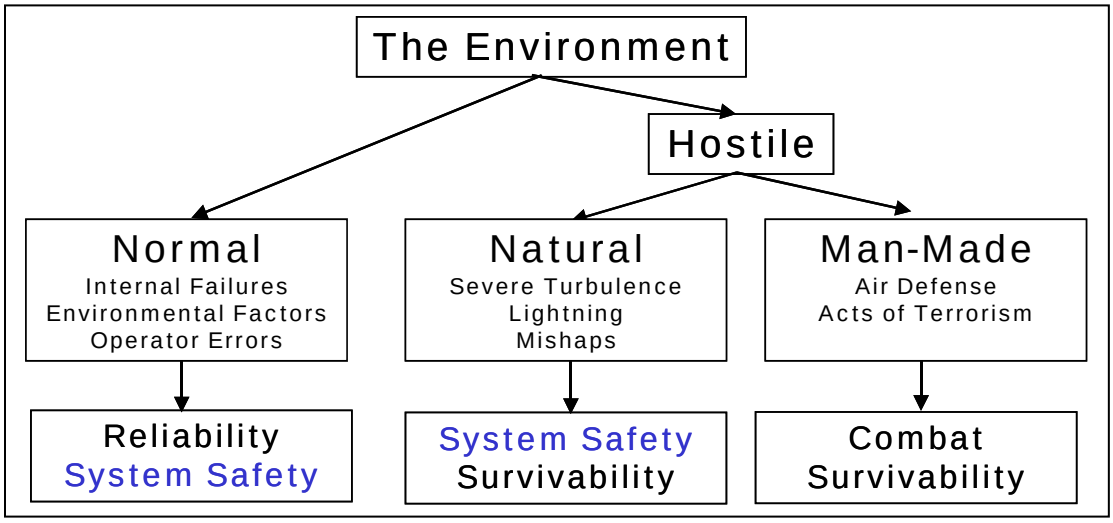
> "If the above procedures still result in restricting tactical delivery conditions, then selected fuze arming conditions which are such that a safe-separation distance is not achieved must be justified by a thorough analysis. This analysis should consider probability of a specific type of damage, decreased risk from enemy ordnance, and tactical advantage gained by use of the recommended fuze arming characteristics…The results of this analysis will be included in the final safe-separation analysis report and the tactical manuals will identify those fuze arming conditions which, for given delivery conditions result in specified hazards to the launching system."[4]

There is a natural complementary relationship between the system safety, reliability, and survivability disciplines, illustrated in Figure 2. The reliability discipline evaluates the likelihood and the effects of natural operating failures, environmental factors and operator-induced events. The survivability discipline assesses man-made hostile events and their influence on the system's ability to perform its mission. And the system safety discipline assesses the effects of both hostile and normal environmental events on the system. In particular, the survivability discipline evaluates the vulnerability of the launch/release aircraft to damage by weapon debris fragments. Safe escape analyses can

[3] *Fuze Management Board Joint Agreement on Safe Separation Analysis for Air Launched Munitions*, 23 Feb 1978, Page 3, paragraph 4b
[4] Ibid, Page 4, paragraph 4d

make use of the vulnerability assessments that are a natural byproduct of survivability analyses, and in fact that is what NAWCWD and AMRDEC analysts use as input to their probability of kill assessments. As a result, the P_{kill} assessments that support safe escape analyses are based on high-fidelity models of the launch aircraft.

Figure 2. Relationships Between Safety, Survivability and Reliability



The Seek Eagle office does not follow this approach; their analysts use only P_{hit} as a metric. From anecdotal evidence it appears that the same is true of NAWCAD analysts.

It should be noted that a "fragment hit" is defined in the Joint Agreement as:

> "A fragment which contains sufficient kinetic energy to penetrate the launch aircraft skin which is exposed to the hazard. Caution must be exercised not to eliminate from the calculations those low relative velocity fragments which may cause serious damage if ingested by the engine(s)."[5]

Other than the Army, it is not clear whether the service agencies that conduct these analyses restrict fragment sizes and velocities to those conditions when calculating probability of hit. Anecdotal evidence seems to indicate that very small fragment sizes are included in most of these analyses, which could result in overly conservative risk assessments. The Army, on the other hand, restricts the hit analysis to only include fragments with kinetic energy of 5 ft-lbs or more relative to the aircraft, or for which the striking velocity is above V_{50} (velocity at which half of the fragments penetrate the aircraft skin) – the two different criteria are used by the two different directorates at AMRDEC that conduct these analyses.

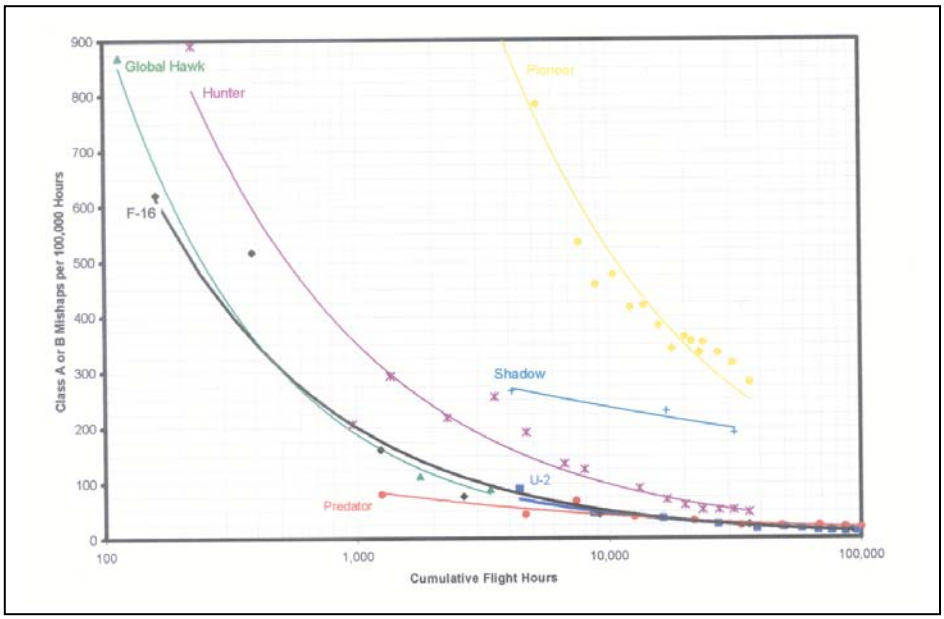
Based on the results of safe escape/safe arming analyses conducted by NAWCWD, there have occasionally been post-launch maneuver requirements placed on the launch aircraft in order to meet the safety criterion. This is only true for air-to-ground weapons, as

[5] Ibid, Page 1, paragraph 2c

opposed to air-to-air weapons. There is some evidence that this is also the case for Seek Eagle, UK and NAWCAD analysis results. It is unknown whether the Army places similar restrictions on their weapons delivery helicopters. A briefing to the FESWG by AMRDEC analysts from the System Simulation and Development Directorate seems to indicate that they do not place such restrictions[6]. That briefing also confirms that the AMRDEC analysts from that directorate use the one in ten thousand probability requirement.

The requirement for probability of hit (or kill) being less than one in ten thousand seems to have been based on historical loss rates and/or mishap rates from the era of the Vietnam conflict. The initial analysis of that data appears to have been reported in a letter dated in 1973, which led to the eventual signing of the Joint Fuze Management Board Agreement in 1978. We were unable to retrieve a copy of the 1973 letter; however, a more recent analysis of mishap rates for both tactical aircraft and unmanned aircraft was reported in the UAS Roadmap 2005[7]. Figure 3, reproduced from that document, shows mishap rates for F-16, Global Hawk, Predator and other unmanned aircraft systems (UAS) as a function of cumulative flight hours. For the F-16 and the Predator, which both have over 100,000 flight hours logged, the mishap rate appears to be on the order of ten mishaps per 100,000 flight hours; most of the other systems seem to be converging on a similar mishap rate as their cumulative flight hours increase.

Figure 3. Mishap Rate Comparison

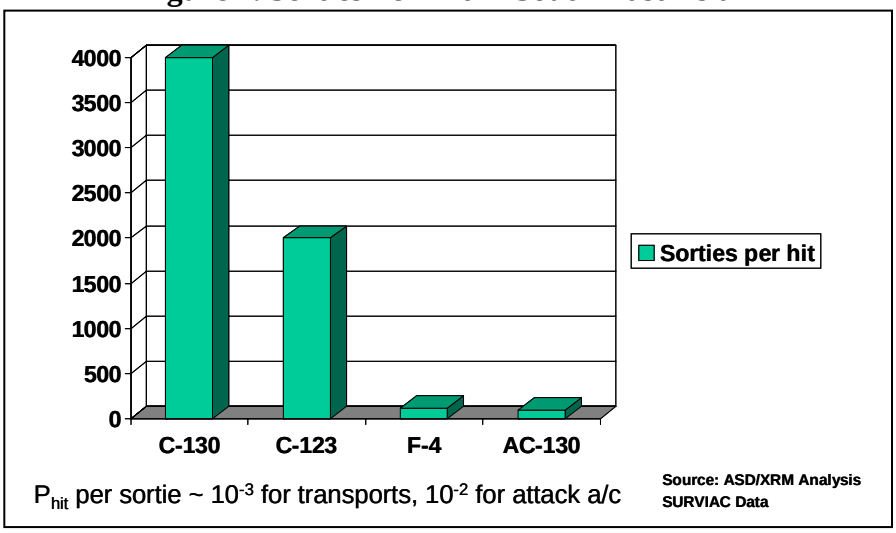


It is difficult to reconstruct data on probability of hit by threat action for the Vietnam era (or for more recent conflicts, for that matter). One analysis done by the Air Force using data from the Survivability/Vulnerability Information Analysis Center (SURVIAC) shows that USAF aircraft hit rates per sortie in Vietnam ranged from one in 100 (for F-4

[6] *Safe Separation Analysis*, Kim Williams, Shane Strickland, Brent Deerman, 30 Nov 2005
[7] *Unmanned Aircraft Systems Roadmap 2005-2030, Office of the Secretary of Defense, 4 Aug 2005*

and AC-130 aircraft) to one in 4,000 (for the C-130): see Figure 4. The wide range in probability of hit is explained by the fact that the relative exposure of the aircraft to threat systems varied considerably by mission in that conflict. Gunships and fighters were far more likely to be directed to areas where they encountered threat systems than were transport aircraft. For none of the aircraft of that era was the probability of hit per sortie less than two in 10,000: they tended more toward one in 100 or one in 1,000[8].

Figure 4. Sorties Per Hit in South-East Asia



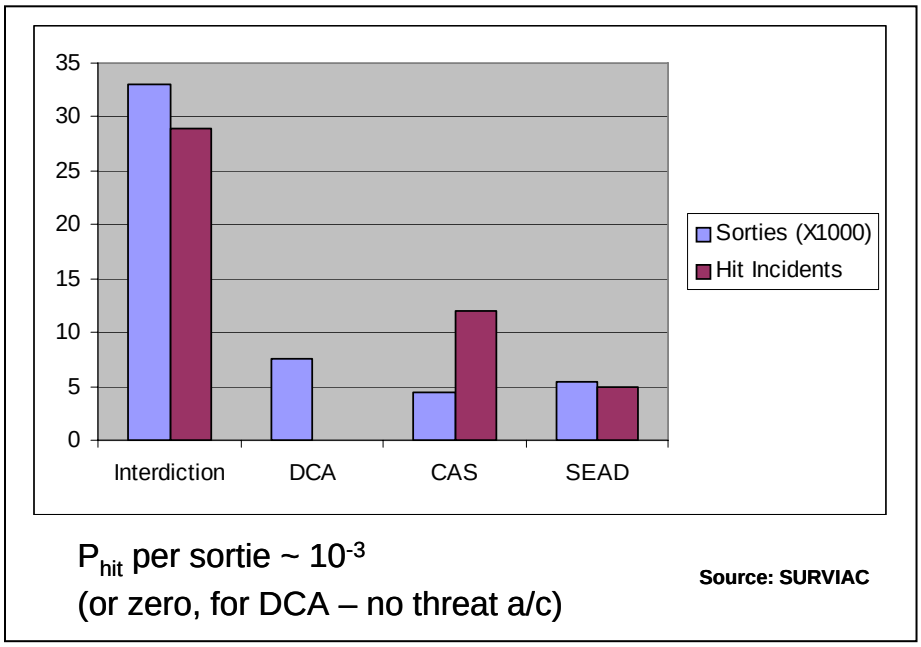
We obtained a report by the Center for Naval Analyses that reported Vietnam combat damage incidents and aircraft kill rates for USN and USMC fixed wing aircraft[9]. In that report, the damage incident and kill rates for USN aircraft were 2,147 damage incidents and 538 loss incidents per 512,757 sorties, or a hit rate of 5.23 per 1000 sorties and a kill rate of 1.05 per 1000 sorties. For USMC aircraft, there were 1,871 damage incidents and 173 kills in 323,542 sorties, or hit rate of 6.32 per 1000 sorties and a kill rate of 0.54 per 1000 sorties (note that damage incidents plus kills add up to hit incidents). These data were for the period from April 1965 through March 1973. Thus, the overall average hit rates were on the order of one hit per 100 sorties, and the kill rates on the order of one loss per 1000 sorties.

Another analysis by SURVIAC of aircraft hits during Desert Storm[10] (see Figure 5) indicates that hit rates in that conflict also varied by mission type: for interdiction missions, there were about 30 hits in 33,000 sorties (about one in 1,000); for close-air-support (CAS) missions, there were 12 hits in fewer than 5,000 sorties (about one in 400). Suppression of Enemy Air Defense (SEAD) missions resulted in 5 hits for approximately 5,000 sorties (one in 1,000), whereas Defensive Counter Air (DCA) missions resulted in

[8] *Historical Combat Data*, briefing given by Kevin Crosthwaite, Director, Survivability-Vulnerability Information Analysis Center (SURVIAC), Aircraft Survivability Short Course, 11-13 July 2006
[9] *U.S. Navy, Marine Corps and Air Force Fixed Wing Aircraft Losses and Damage in Southeast Asia (1962-1973)*, Michael M. McCrea, Center for Naval Analyses, CRC 305, August 1976
[10] *Mission & Campaign Analysis*, briefing given by Kevin Crosthwaite, Director, Survivability-Vulnerability Information Analysis Center (SURVIAC), Aircraft Survivability Short Course, 11-13 July 2006

no hits for 7,500 sorties (because there were virtually no air-to-air threats that would fly in that conflict). This analysis seems to imply that the hit rate due to hostile action during Desert Storm was on the order of one hit in 1,000 sorties.

Figure 5. Hits During Desert Storm by Mission Type



Comparing either mishap rates (per flight hour) or probability of hit during historical conflicts (per sortie) to probability of being hit by your own weapon given launch is really comparing apples and oranges. We have mishaps per flight hour; threat hits per sortie; and in the safe escape case, fragment hits per weapon launch. However, in a system safety sense, both mishap rate and combat hit rate provide some measure of how "safe" each of these activities are: in the one case, what are historical "acceptable" mishaps during flight operations, and in the other what are the historical hit rates that have been tolerated each time an aircraft is sent on a mission. As such, they provide at least a qualitative measure of accepted safety levels.

Using probability of hit less than 0.0001 as a safety criterion seems to be a reasonable fit with historical mishap rate data and with more recent data as reported for both manned and unmanned systems. It is less consistent with combat hit rates per sortie, which are on the average at least an order of magnitude higher (one in 1,000 for Desert Storm, and for USN and USMC fixed wing aircraft in Vietnam, closer to one in 100). Those higher combat hit rates do, however, provide justification for considering an analysis of "…probability of a specific type of damage, decreased risk from enemy ordnance, and tactical advantage gained by use of the recommended fuze arming characteristics…" in the system safety assessment, as allowed by the Joint Fuze Management Board Agreement. If the hit (or kill) probability does not meet the one in 10,000 requirement, then an analysis of other risks to the system should be conducted to determine if they out-

weigh the risk of damage from launching our own weapon. Historically, those hit rates from threat weapons have been much higher.

Definitions

Much confusion has resulted from multiple definitions of terms in this area over the last 30 years and more. "Safe Separation" in particular has been used for more than one purpose. "Safe separation" has been taken to mean both safe release of the weapon from its launcher, and that the weapon is a safe distance away from the launcher at the time the fuze arms the warhead. Those are two completely different concepts, but have both been called the same thing in the past. Official documentation doesn't seem to help the problem, as can be seen from the published definitions below:

Definition from MIL-HDBK-1763[11]:

> **Safe Separation:** The parting of a store(s) from an aircraft without exceeding the design limits of the store or the aircraft or anything carried thereon, and without damage to, contact with, or unacceptable adverse effects on the aircraft, suspension equipment, or other store(s) both released and unreleased.

Definition from MIL-STD-1316E[12]:

> **Safe Separation Distance:** The minimum distance between the delivery system (or launcher) and the launched munition beyond which the hazards to the delivery system and its personnel resulting from the functioning of the munition are acceptable.

Definition from the Joint Agreement[13]:

> **Safe-Separation Distance:** the minimum distance between the launching system (AIRCRAFT & PILOT) and its launched munitions at which hazards associated with munitions functioning are acceptable. This distance may be achieved by providing arming delays(s) (time or distance).

It could be argued that the MIL-HDBK definition of "safe separation" is distinct from the two (similar) definitions of "safe separation distance". However, the use of the words "safe separation" in all three definitions is the cause of the confusion, especially when assessments of the two have been called "safe separation analysis" in the past.

With regard to definitions, all of the service experts now seem to use "Safe Escape Analysis" to describe the work they do in arriving at risk assessments for air-launched

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[11] *Aircraft/Stores Compatibility: Systems Engineering Data Requirements And Test Procedures*, MIL-HDBK-1763

[12] *Department of Defense Design Criteria Standard, Fuze Design, Safety Criteria Fo*r, 10 July 1998, MIL-STD-1316E

[13] *Fuze Management Board Joint Agreement on Safe Separation Analysis for Air Launched Munitions*, 23 Feb 1978, Page 1, paragraph 2a

weapon systems. The details of that analysis differ, however. Seek Eagle and NAWCAD analysts appear to define safe escape analysis as producing a Minimum Release Altitude (MRA) consistent with a maximum probability of hit threshold; MRA is termed Minimum Safe Release Altitude for Fragment Avoidance, or MinAlt by NAWCWD. NAWCWD, on the other hand, uses the term "safe escape analysis" to refer to an assessment of the risk of launching an air weapon, and does not refer to a minimum safe release altitude, probably since NAWCWD only analyzes powered weapons. The AMRDEC analysts define it as "determining the minimum safe range for helicopters to release weapons." They also feel that any definition of "Safe Escape" should include both altitude and down range, since to them the minimum safe range is a combination of altitude and down range from the helicopter to its ground target.

MIL-HDBK-1763 provides a definition for safe escape that may be part of the solution, but that still concatenates the two terms "safe escape" and "safe separation":

> **Safe Escape/Safe Arming:** Safe escape is the minimum release altitude that will provide the delivery aircraft acceptable protection from weapon fragmentation for detonation at the preplanned point. Safe arming separation is the selection of a minimum safe fuze arm time setting that will provide the delivery aircraft acceptable protection from weapon fragmentation if early detonation should occur.

Aircraft Modeling

Probability of hit on the aircraft by weapon debris fragments is calculated using a simple six-view "box" representation of the presented area of the aircraft. This is true of all the approaches used by the services, except that the AMRDEC process provides for a second pass with a detailed CAD model of the aircraft: their first pass with the "shoe-box model" is intended to compute "potentially-hit-fragments". Since their approach is a set of one million Monte-Carlo iterations of the warhead detonation, the initial screening pass is needed to reduce the computations required for the detailed CAD model of the aircraft to only those fragments with some probability of actually hitting it. The second pass actually calculates the probability of hit on the aircraft.

For the NAWCWD approach to determining probability of kill, the presented areas are replaced by six-view vulnerable areas obtained from vulnerability analyses conducted by the NAWCWD Survivability Division for the launch aircraft in question. Vulnerable area is defined as probability of kill given a hit multiplied by presented area; consequently, it is an "expected value" approach to describing system vulnerability. In a way, it represents the presented area of critical components and systems. Vulnerable area is a function of fragment size and striking velocity.

In the case of air-to-air weapons, NAWCWD analysts assume that straight and level flight for the target aircraft is the worst case, since in that case the launch aircraft is most likely to follow directly behind the weapon. NAWCWD and Seek Eagle analysts use the JTCG/ME Joint Air-to-Air Model (JAAM) to develop flight paths for both launch

aircraft and target aircraft (for air-to-air weapons). In addition, for the Air Force the Aircraft/Weapon Delivery Software (AWDS) library can be used with CASES to develop aircraft flight paths. No information was available on NAWCAD aircraft trajectory modeling. For AMRDEC analyses, flight data (aircraft velocity components and orientation) are generated with RCAS or FlightLab, both of which are high fidelity helicopter simulation software..

Weapon Modeling

For the NAWCWD and Seek Eagle analyses, the trajectory of the weapon is almost always provided by the weapon systems program office, either directly or via delivery of their weapon flight simulation; for powered weapons the simulation is almost always a six degree-of-freedom simulation, providing position, yaw, pitch and roll as a function of time after launch. The Seek Eagle approach also allows for weapon trajectories to be developed by the AWDS dynamically linked library as part of CASES. For the Army, weapon trajectories are provided by program office 6-dof simulations and input into the ADAMS software.

Generally speaking, the weapon trajectory simulations provided by the program office responsible for the weapon's development are considered to be "ground truth" and are usually rigorously validated, even if those validation data are not always documented or retrievable.

Weapon system debris fragments and warhead fragments are modeled using polar (and in some cases azimuth) zones, usually with constant fragment ejection velocity over the zone and an average number of fragments per zone. The size of the fragment zones depends on the quality of the arena test data for the specific weapon in question; generally 10-degree polar zones are used, and occasionally the data will allow for 5-degree polar zones. CASES allows a maximum of 18 polar zones and exactly 24 roll zones (of 15 degrees). For most systems, the fragment zones are symmetric around the body of the weapon. It is possible to conduct separate analyses for fragments of unusual size and/or velocity (warhead fragments, for example, or bomb lugs), and combine the results of that analysis with the main body of fragments into an aggregate result. Gamma zones are the mechanism that accounts for fragment size and shape, where gamma is the ratio of a fragment's average presented area to its mass.

Without discussing this in person with the individual service experts, we were not able to determine with what fidelity all service weapons debris patterns are modeled. However, we did obtain a briefing and paper that were presented at an April 2006 Seek Eagle conference that describes the approach used for Seek Eagle fragmentation test data collection and analysis[14]. That paper described the use of a computer-driven Fragment Digitizer System that greatly facilitates development of fragment shape factors, presented

[14] *Common Advanced Safe Escape System (CASES): A Look Behind the Scene*, Tommy Collins, James Burton, Shane Sartalamacchia, Tama Leach

areas, and gamma values. The weapon debris model is a principal driver of the results of the safe escape/safe arming analysis.

The Army briefing from the Seek Eagle conference[15] shows example polar zones for a 2.75 inch rocket (M151 Warhead and rocket debris); the data in the briefing show 5-degree polar zones, and those are assumed to be representative of the fidelity of Army system debris models.

M&S and Credibility

NAWCAD, NAWCWD and Seek Eagle all use safe escape models and simulations that have common heritage. NAWCAD uses Path 4, NAWCWD uses the Advanced Safe Escape Program (ASEP), and Seek Eagle uses the Common Advanced Safe Escape System (CASES), all of which have their origins in the development of Path 2 by the Navy at Dahlgren, VA. Path 4 is an evolution from Path 2, Path 3D was an evolution from Path 2, ASEP is an evolution from Path 3D, and CASES is an evolution from ASEP.

All of those methodologies use similar (if not the same) representations of missile debris and warhead fragments, fragment flight paths, calculations of probability of hit (and kill), and launch aircraft representations. There are some capabilities that have been added with each evolution of the code: for example, CASES appears to be ASEP with a better Graphical User Interface (GUI) and some pre-generated warhead data files for certain weapons. It also allows for calculation of "deconfliction", meaning that it will determine whether fragments can hit another aircraft in the same flight as the launch aircraft. ASEP added asymmetric fragment roll zones to PATH-3D along with some other improvements.

There has been no organized effort to conduct and document verification and validation on any of the codes. There have been comparison runs made between CASES and ASEP, with some minor errors corrected as a result of those runs; however, there is no documentation available of those comparisons or the changes that were made as a result. There is anecdotal evidence that the Seek Eagle office has accredited both CASES and ASEP for individual weapons systems analyses, but no documentation of those accreditation decisions was available.

The Seek Eagle office provides limited support to users of both ASEP and CASES. A User Manual[16] and Analyst Manual[17] are available for ASEP. It is unknown what documentation is available for CASES or for Path 4.

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[15] *Safe Escape for the Army Helicopters*, Tuan Pham, Aviation & Missile Research, Development & Engineering Center, Aviation Engineering Directorate, Weapons & Sensors Branch, April 2006

[16] *Advanced Safe Escape Program (ASEP) Users Manual*, ASEP-UM-002, December 1996, Tybrin Corporation

[17] *Advanced Safe Escape Program (ASEP) Analysts Manual*, ASEP-AM-002, December 1996, Tybrin Corporation

The Army analysts at AMRDEC use a set of simulations that were developed independently from the Seek Eagle set of models. They use the Army Safe Escape Analysis Tool (ASEAT), which includes several additional software packages: ADAMS, EASY5, FlightLab, 3D-CAD and weapon fly-out models. ADAMS is the 6-dof simulation used for aircraft flight paths and fragment trajectories. EASY5 is a system-level modeling tool used for describing the physical components of the aircraft system, such as hydraulics, controls and electrical subsystems. The 3D-CAD simulation provides a detailed physical description of the aircraft that is used in the final P_{hit} calculation. ADAMS, EASY5, and FlightLab are commercial software. RCAS and weapons 6-dof are the Army's software.

If there is a need to fire the munition at a target at a range closer than the minimum safe range, then P_{kill} can be calculated as a safety metric with a simulation such as the Advanced Joint Effectiveness Model (AJEM). P_{kill} is an important piece of information used in conducting risk assessments for the Army Airworthiness Qualification and Release processes.

The primary differences between the AMRDEC and Seek Eagle simulations is that the AMRDEC approach uses a one-million iteration Monte Carlo simulation of weapon debris fragmentation, and a two-pass calculation of probability of hit (to reduce run-time). The Seek Eagle models, on the other hand, use an expected value approach, computing an expected number of fragments in each polar-azimuth zone. The Army P_{hit} calculation also uses a detailed CAD model of the aircraft, whereas the other methodologies use a simple six-sided representation of the aircraft's presented area. It is not clear whether the fidelity of the weapon debris data obtained from arena testing is consistent with the detail available in CAD models of the aircraft. It may be that the shorter range weapons employed by the Army result in close enough detonations to justify the need for the additional fidelity in the aircraft model.

There is no documented verification, validation or accreditation of the ASEAT set of simulations, nor is there documentation available for ASEAT.

CONCLUSIONS

Assumptions: There was very little information available about assumptions made by analysts other than those at NAWCWD. Since these assumptions can drive the answers, it is important that they be consistent across the service agencies that conduct these analyses.

Requirements: The requirement for probability of less than one in ten thousand appears to be consistent with historical mishap rates (per flight hour), but it is not as consistent with combat hit rates (per sortie), which are an order of magnitude higher. The principal difference between the service agencies in requirements is the use of P_{kill} as a fallback metric to P_{hit}. Analysts at NAWCWD use probability of kill (and the UK analysts use something similar), and AMRDEC uses P_{kill} as part of their risk assessment process, but it appears that Seek Eagle and NAWCAD strictly use P_{hit}. The JSEAS project has put considerable effort into examining requirements across the services and coming up with common requirements for the JSF program. That project has not involved the Army, however, since there is no Army variant of JSF. Consequently, the requirements developed by JSF only apply (so far at least) to the Navy (and by extension the Marine Corps) and the Air Force. Also, the JSEAS requirements document states that they only apply to air-to-ground weapons (with an apparent emphasis on gravity weapons).

Definitions: The use of the term "safe separation analysis" to mean more than one thing causes considerable confusion, especially for weapons system program offices who may think they've met a requirement only to find that they only addressed another issue entirely. All of the current practitioners of the discipline seem to refer to their work as "safe escape analysis", which may offer a solution to that issue.

Aircraft Modeling: Aircraft presented area seems to be modeled in the same way by all of the services, using a six-view total presented area (the Army adds a detailed CAD model of the aircraft for their final P_{hit} calculation). NAWCWD analysts also use six-view vulnerable area to represent "the presented area of critical components and systems". AMRDEC allows for using a model like AJEM for a detailed P_{kill} calculation. Aircraft flight paths for NAWCWD and Seek Eagle are based on the JTCG/ME JAAM methodology; AMRDEC uses RCAS or FlightLab. It is unknown what methodology NAWCAD uses.

Weapon Modeling: Weapon trajectories are usually generated using program office 6-dof flight simulations for powered weapons systems. We were unable to obtain information about NAWCAD approaches to gravity weapons modeling or with what fidelity weapon fragmentation is usually modeled at NAWCAD.

M&S and Credibility: NAWCWD, NAWCAD and Seek Eagle all use M&S which evolved from the same original source, Path-2, which was developed originally by the Navy at Dahlgren, VA. Based on anecdotal evidence, the differences between these

codes seem to be minor compared to the similarities. There is no available documentation of past verification and validation activities. We were only able to obtain documentation of the ASEP model used at NAWCWD. Seek Eagle has apparently accredited ASEP and CASES for some applications, but documentation of those accreditation decisions was not available. The Army uses an independently developed methodology called ASEAT, which is a Monte Carlo simulation, and uses detailed representations of the launch aircraft's geometry. There is no documentation of any past VV&A results for ASEAT.

RECOMMENDATIONS

Assumptions: There should be Joint Service guidelines for the assumptions made in conducting safe escape/safe arming analyses. In particular, guidance should be provided regarding launch aircraft maneuvers, weapon variations (angle of attack, motor temperature, roll orientation, etc.), environmental factors, safe-arm device variations, and other factors that potentially drive the analysis results.

Requirements: The JSEAS document provides a comprehensive set of requirements for air-to-ground weapons safety analyses that have been accepted by the participants in JSF. Those requirements should serve as the starting point for expansion to include Army requirements and air-to-air weapon system requirements, and to ensure that powered air-to-ground weapon requirements are adequately treated. Provision should be considered in future Joint requirements for application of the process outlined in the original Joint Agreement between all the services, particularly the inclusion of P_{kill} as a metric and the provision for additional analyses to support operational use of weapons that do not meet the 0.0001 probability requirement. Historical combat hit rates offer justification for those additional analyses. Historical mishap rates seem to be consistent with the basic safety requirement of P_{hit} given weapon release of less than one in 10,000: there does not appear to be a rationale for changing that requirement.

Definitions: A possible solution to the definitions problem is to divide the definition of "Safe Escape/Safe Arming" that is offered in MIL-HDBK-1763 into separate definitions for the two terms. Since all of the current participants in this type of analysis use the term "safe escape analysis" vice "safe separation analysis", this would seem to be in line with current practice. However, using these definitions, the analyses conducted for air-to-air weapons are better characterized as "safe arming analyses", since they do not generally involve determining a minimum release altitude. We offer an alternative below that should satisfy both air-to-air and air-to-ground weapons systems. This change also would mean that the definitions of "safe separation distance" in both MIL-STD-1316E and in the original Joint Fuze Management Board agreement should be changed to "safe arming distance". Draft definitions are as follows:

> **Safe escape:** Safe escape is the required release conditions and post-launch maneuvers that will provide the delivery aircraft acceptable protection from weapon fragmentation for detonation at the preplanned point, or at or after arming; this may result in a minimum safe release altitude or safe release altitude and down range from the target.
>
> **Safe arming:** Safe arming is the selection of a minimum safe fuze arm setting that will provide the delivery aircraft acceptable protection from weapon fragmentation if detonation should occur at or after the fuze arm time/distance.

Separation: The termination of all physical contact between a store, or portions thereof, and an aircraft; or between a store, or portions thereof, and suspension equipment.

Safe separation: The parting of a store(s) from an aircraft without exceeding the design limits of the store or the aircraft or anything carried thereon, and without damage to, contact with, or unacceptable adverse effects on the aircraft, suspension equipment, or other store(s) both released and unreleased.

Aircraft Modeling: There should be agreed-upon guidelines for launch aircraft post-launch maneuvers to consider for safety reasons. Sensitivity analyses should be conducted to determine whether there is a need for more detailed aircraft representations than 6-view presented areas (as in the AMRDEC approach).

Weapon Modeling: There should be agreed-upon guidelines for the fidelity of weapon debris modeling (polar zones, etc.). Guidelines should be established for when to segregate "unusual" fragments for separate analysis (such as bomb lugs, warhead fragments that are likely to have much higher velocities than debris fragments, etc.). Fragments should only be included in the weapon debris model if they are capable of penetrating the skin of the aircraft (per the Joint Agreement definition of "fragment hit", and consistent with the Army's KE>5 ft-lbs or striking velocity>V_{50} requirement for fragment inclusion in the debris model).

M&S and Credibility: Navy representatives should consider migrating to the latest version of the Seek Eagle methodology (CASES). When available, the JSEAS methodology should be assessed for adoption as the standard Joint Service methodology. Documented verification and validation evidence should be developed for any M&S tools used in safe escape/safe arming analyses. Documentation of all methodologies used by the services should be developed, maintained and distributed to users. An Accreditation Support Package (ASP) should be developed for any M&S tools that are continuing in use.

Table 1. Interview Results

Category	Issue	NAWCWD	NAWCAD	Seek Eagle	AMRDEC
Requirements	Launcher Vulnerability Metric	Hit & Kill	Hit Only	Hit Only	Hit (KE>5 ft-lbs or $V>V_{50}$) & Kill
	Probability Requirement	0.0001 or 0.01 Or outside hazards analysis	0.0001	0.0001 or 0.01 Or outside hazards analysis	0.0001
	Maneuver after launch required if Prob. not met?	Yes (in one or two cases)			No
	Analysis Objectives	Safety of flight clearance; Safe escape maneuver determination		Safety of flight clearance; safe escape maneuver determination	Minimum low-altitude safe release range; risk assessment
Assumptions	Launch aircraft maneuvers	Assume straight and level is worst case; fixed "g" maneuvers; altitudes & speeds from tactics guides		Assume straight and level is worst case; fixed "g" maneuvers; altitudes & speeds from tactics guides	Use Hover, Bank, Dive, break turn toward masking terrain after launch, or vertical or lateral unmask & egress
	Weapon variations	Hot/cold motor when data available; no roll variations; variable launch modes		Hot/cold motor when data available; no roll variations; variable launch modes	Hot/cold motor when data are available and IFS fidelity supports
	S/A variations	Spec value plus and minus tolerance	Spec value minus tolerance	Spec value minus tolerance + delay	UNK

Category	Issue	NAWCWD	NAWCAD	Seek Eagle	AMRDEC
Definitions		"Safe Escape Analysis"	"Safe Escape Analysis"	"Safe Escape Analysis"	"Safe Escape Analysis"
Aircraft Modeling	Physical Description	6 view presented area		6 view presented area	6-sided box enclosing aircraft + CAD model
	Vulnerability Description	6 view vulnerable area	NA	NA	AJEM model
	Target Maneuvers (air-to-air)	Straight and level (assumed worst case); occasionally consider target maneuvers	NA	UNK	NA
	Aircraft Flight Path Model	JAAM		JAAM, AWDS	RCAS, FlightLab
	Target Debris Model	Not modeled		Not modeled	Not Modeled
Weapon Modeling	Weapon Trajectory	Program Office 6-dof		Program Office 6-dof	Program Office 6-dof
	Motor Temp	Use hot/cold variations if data available		Use hot/cold variations if data available	Use hot/cold variations if data available
	Debris Pattern Source	Arena Test Data		Arena Test Data	Arena Test Data
	Debris Frag Zones	5-10 deg polar zones, uniform distribution		10 deg polar zones; 24 azimuth zones	5 deg polar zones, uniform distribution
	Debris Frags	Large frags modeled separately		Large frags modeled separately	UNK
		Warhead frags can be modeled separately		Warhead frags can be modeled separately	UNK
		No min frag size		UNK	KE>5 ft-lbs
		No min frag velocity		UNK	$V>V_{50}$

Category	Issue	NAWCWD	NAWCAD	Seek Eagle	AMRDEC
Weapon Modeling	Debris Frags	No data for statistical variations		No data for statistical variations	Monte Carlo frag fly-out simulation
	SA Device	Modeled as arm time plus and minus spec tolerance	Spec value minus tolerance	Spec value minus tolerance + delay	UNK
M&S	SA M&S Used	ASEP	Path 4	CASES	ASEAT
	Capability	Adds asymmetric roll zones to Path 3-D	3-D dynamic frag zones; calculates Ph or Pk	Pre-generated warhead data files available; adds GUI to ASEP	Monte-Carlo, two passes (hit box, then detailed CAD model)
	Accuracy	No formal V&V available	No formal V&V available	No Formal V&V available	Some V&V on AJEM
		Comparison runs between ASEP and CASES		Comparison runs between ASEP and CASES	No V&V documented on ASEAT
		No data V&V documentation		No data V&V documentation	No data V&V documentation
		No formal validation		No formal validation	No formal validation
		Accreditation Package done by Seek Eagle		Accreditation Package done by Seek Eagle	
	Usability	User Manual and Analyst Manual (Dec 1996)		UNK documentation	No documentation on ASEAT
		Seek Eagle provides limited user support		Seek Eagle provides limited user support	

APPENDIX A: SURVEY QUESTIONS & INFORMATION CATEGORIES

Assumptions and Requirements

Requirements
- Phit only
- Pk and/or Phit
- Probability Requirement & rationale
  - 0.01
  - 0.0001
  - Consider other outside hazards (from threat weapons, etc)
    - If analysis is required to justify S/A times that do not meet the probability requirements, what analysis process is used?

- Require maneuver after launch if probability threshold not met in all cases?

- What is required in order to pass the flight clearance "safe escape box"?

- What is the objective of the analysis?
  - Safe arm time/distance determination?
  - Risk Assessment?
  - Safe Escape maneuver determination?
  - Safety of flight clearance?

Assumptions
- Launch aircraft maneuvers
  - Straight and level flight
  - Fixed "g" maneuvers (horizontal, vertical)
  - Find safe-escape maneuvers
  - Launch/release altitudes, speeds

- Assume only one weapon trajectory per release condition, or include variations?
  - Hot/Cold motor
  - Roll variations/statistics
  - Environmental variations (wind, etc.)

- Variations in S/A functioning?
  - Fixed time/distance?
  - Statistical Distribution?

Definitions
- How do you define "safe separation analysis"?

How do you define "Safe escape analysis"?
How do you define "safe arming analysis"?

MIL HDBK 1763 definitions?
MIL-STD 1316E?
Fuze Management Board Joint Agreement?

Aircraft Modeling

Physical description
- 6 view Presented Area
- 26 View Presented Area
- Detailed model

Vulnerability description
- 6 view vulnerable area
- 26 view vulnerable area
- Detailed model of components/subsystems
  - Source?

Maneuvers
- Straight and level
- Fixed-g turns
- Complex flight paths
- Safe escape maneuvers

Flight Path modeling
- Linear
- 3-dof
- 5-dof
- 6-dof

Target Debris model (after weapon impact)?

Weapon Modeling

Trajectory
- Simple equations
- 3-dof
- 5-dof
- 6-dof

Motor temperature

Debris Pattern
- Sources

- Arena test data (static, dynamic)
- Simulation
- Surrogate system

Fragment zones
- Fragment zone sizes
- Fragment distribution within zone
  - Average # frags per zone?
  - Distribution over zone?
  - Fragment size distribution within zone?
- Fragment velocity
  - Equal over zone?
  - Fixed at zone interfaces<
  - Distribution over zone?
  - Varies with fragment size?

Individual fragments modeled (bomb lugs, etc) separately?
Warhead fragments separate from debris fragments?
Minimum fragment size included (lethal fragments)
Minimum fragment velocity included
Statistical variations?

Safety and Arming device
- Arm time only
- Arm distance only
- Distance integrator model
- Error distribution

M&S, Assumptions

Source of weapon trajectory simulation
- Weapon Developer
- Government development or independent analysis shop
- Safe separation M&S

S/A M&S Utilized
- Path 3-D
- ASEP
- CASES
- Other

Significant Differences between S/A M&S

Capability
- What are the significant differences in capability between the codes?
- Are there differing levels of fidelity?
  - If so, are authoritative data available to support the higher levels of fidelity?

Are functions modeled in one code that are not available in another?

Accuracy

Software Accuracy

What verification activities have been conducted and documented?
Is there a software design specification?
Have CASE tools been applied to the code?

Data Accuracy

What data V&V activities have been conducted and documented?
Have embedded data been V&V'd?

Output Accuracy

What validation activities have been conducted and documented?
Have there been expert reviews of code input/output?

Has the code been benchmarked against other authoritative codes?

Usability

Is there an active user group?
What documentation is available? Is it up to date?
Is there support for user questions, problems?

Material Presented Herein Is Not Official Until Captured in TRA Deskbook

Technology Readiness Assessments: Milestone B Requirement for Technologies to be Demonstrated in a Relevant Environment

NDIA 10th Annual Systems Engineering Conference
October 22-25, 2007

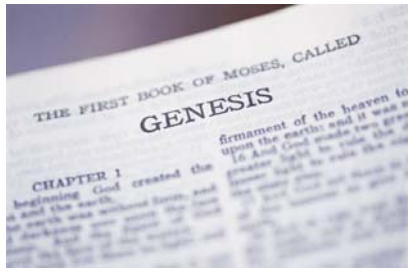
Dr. Jay Mandelbaum
Institute for Defense Analyses
4850 Mark Center Drive • Alexandria, Virginia 22311-1882

Outline

- **Introduction**
  - **What is a TRA**
  - **Why it is important**
- **Impact of 10 USC 2366a on TRA processes and practices**
  - **Technology maturation policy**
  - **Best practices for**
    - **Increasing TRA rigor**
    - **Focusing on technology maturity in source selection**
    - **Using the ADM to pursue technology maturation and insertion after Milestone B**
- **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***

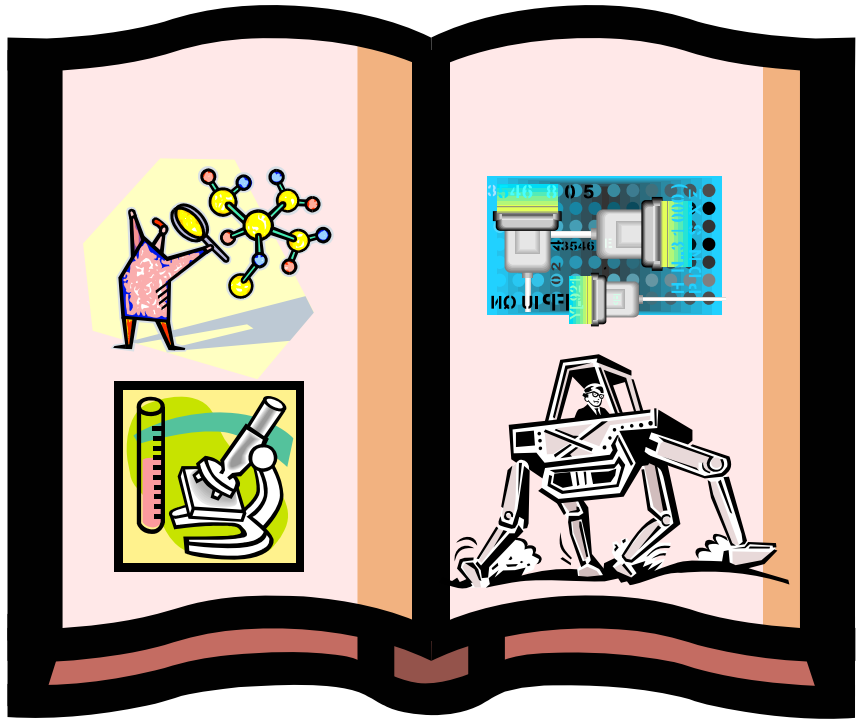


- **"Identify each case in which a major defense acquisition program entered system development and demonstration … into which key technology has been incorporated that does not meet the technology maturity requirement … and provide a justification for why such key technology was incorporated and identify 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

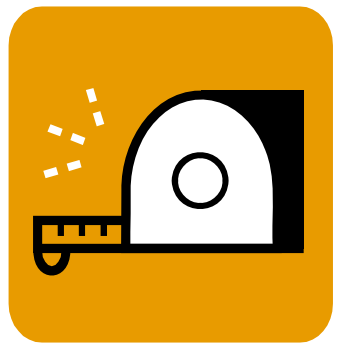
A technology element is "critical" if the system being acquired depends on this technology element to meet operational requirements with acceptable development cost and schedule and with acceptable production and operation costs *and* if the technology element or its application is either new or novel.

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, manufacturing, or life cycle related 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**

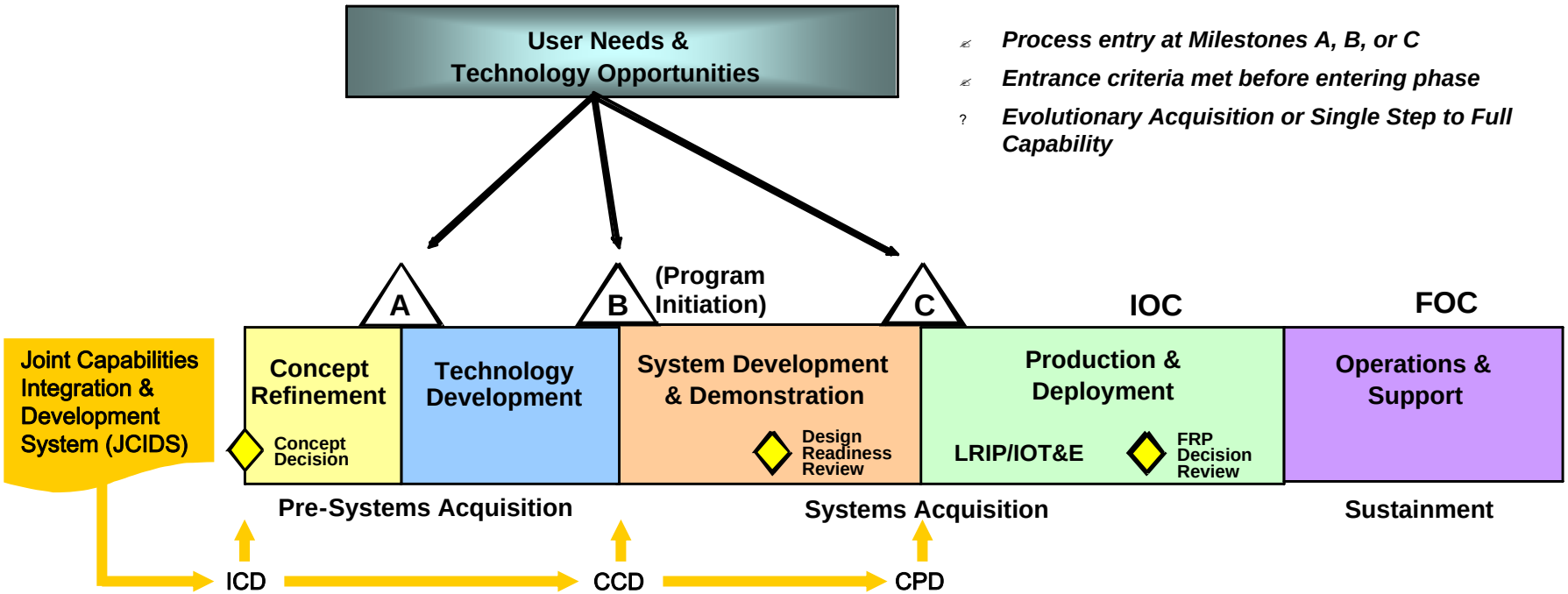
Hardware and Manufacturing TRLs

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



Overview of Technology Considerations During Systems Acquisition

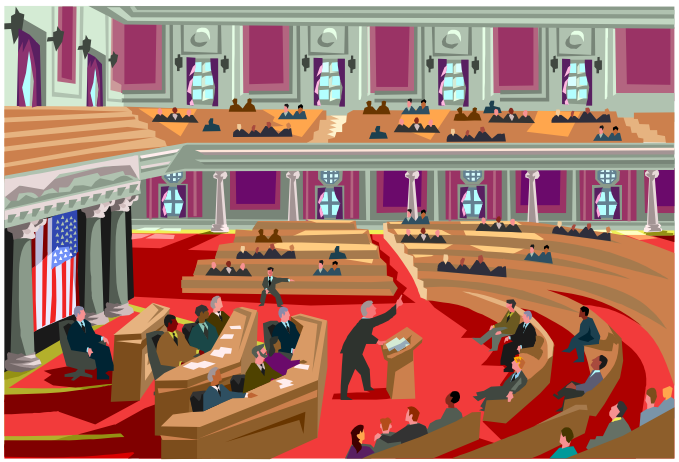


TRAs required at MS B, MS C, and program initiation for ships (usually MS A).

Why is a TRA Important? (1 of 2)

- **The Milestone Decision Authority (MDA) 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**





- **Congressional interest**
  - **MDA must certify to Congress that the technology in programs has been demonstrated in a relevant environment at program initiation**
  - **MDA must justify any waivers for national security to Congress**

Quantifying the Effects of Immature Technologies (1 of 2)



According to a *2006* GAO review of 52 DoD programs:

- **Only 10% of programs began SDD with mature technology (TRL 7)**
  - **Programs that started with mature technologies averaged 4.8% development cost growth and a 1% acquisition unit cost growth**
  - **Programs that did not have mature technologies averaged 34.9% development cost growth and a 27% acquisition unit cost growth**
- **Only 23% of programs began SDD with DoD's standard for mature technology (TRL 6)**
  - **Programs that started with mature technologies averaged 18.8% development cost growth**
  - **Programs that started with mature technologies averaged 34.6% development cost growth**

Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-06-391, March 2006

Quantifying the Effects of Immature Technologies (2 of 2)



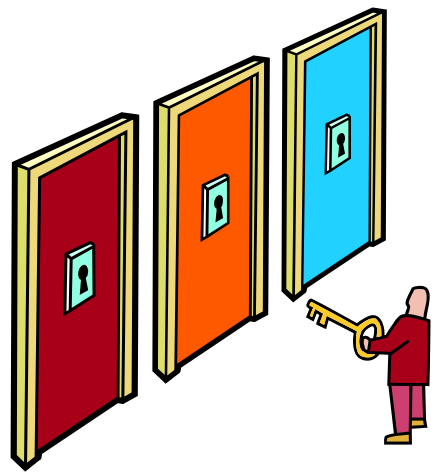
According to a *2007* GAO review of 33 DoD programs:

- **Only 16% of programs began SDD with mature technology (TRL 7)**
  - **Programs that started with mature technologies averaged 2.6% development cost growth, a 1% acquisition unit cost growth, and a 1 month schedule slippage**
  - **Programs that did not have mature technologies averaged 32.3% development cost growth, a 30% acquisition unit cost growth, and a 20 month schedule slippage**
- **Only 32% of programs began SDD with DoD's standard for mature technology (TRL 6)**
  - **Programs that started with mature technologies averaged 8.4% development cost growth**

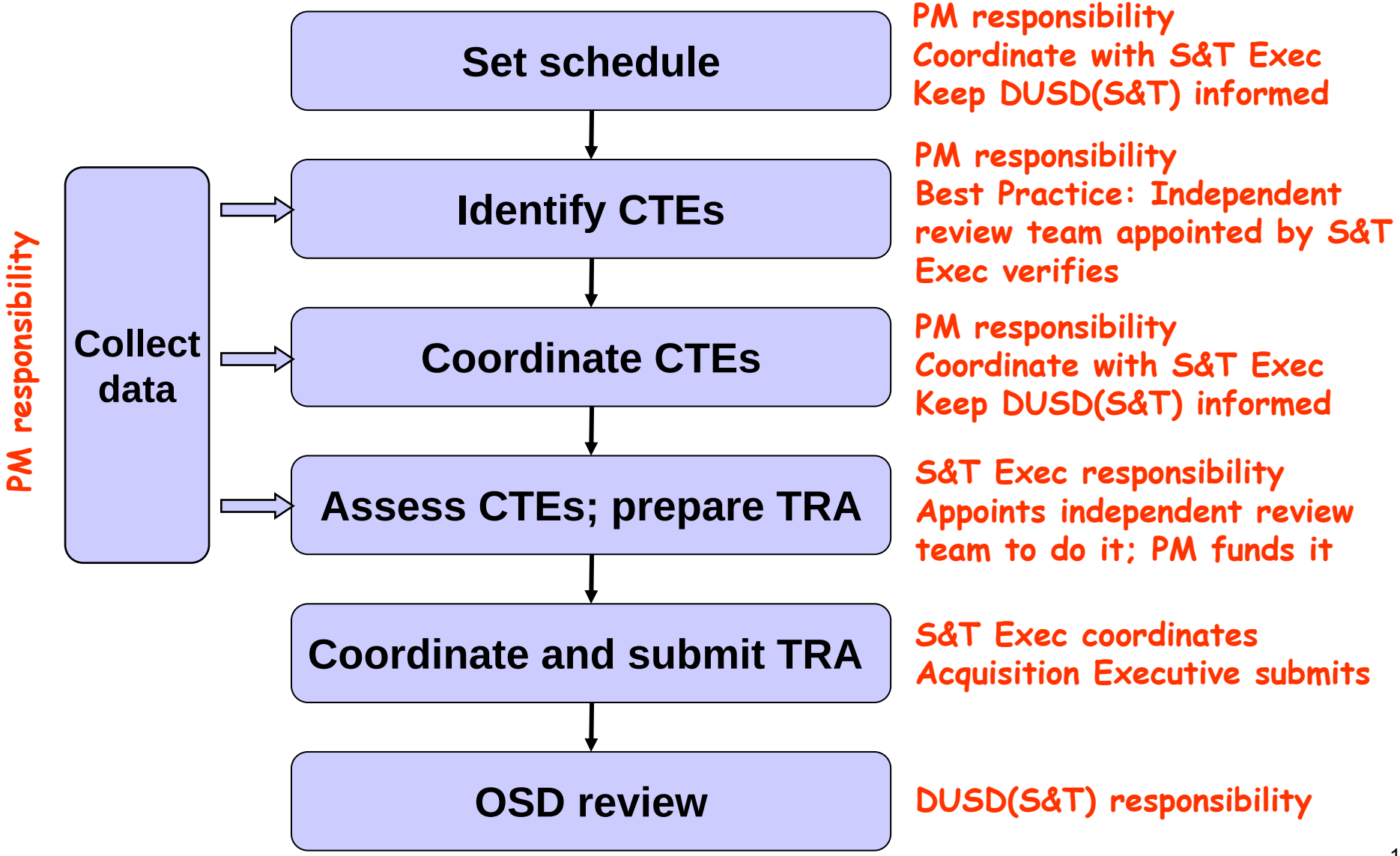
Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-07-406SP, March 2007

Why is a TRA Important? (2 of 2)

- **The PM uses the expertise of the assessment team and the rigor and discipline of the process to allow for:**
  - **Early, in depth review of the conceptual product baseline**
  - **Periodic in-depth reviews of maturation events documented as verification criteria in an associated CTE maturation plan**
  - **Highlighting *(and in some cases discovering)* critical technologies and other potential technology risk areas that require management attention (and possibly additional resources)**
- **The PM, PEO, and CAE use the results of the assessment to:**
  - **Optimize the acquisition strategy and thereby increase the probability of a successful outcome**
  - **Determine capabilities to be developed in the next increment**
  - **Focus technology investment**



Process Overview

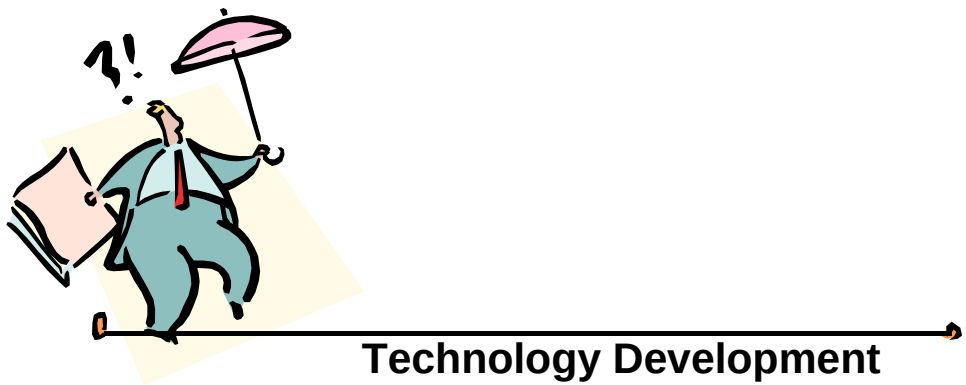


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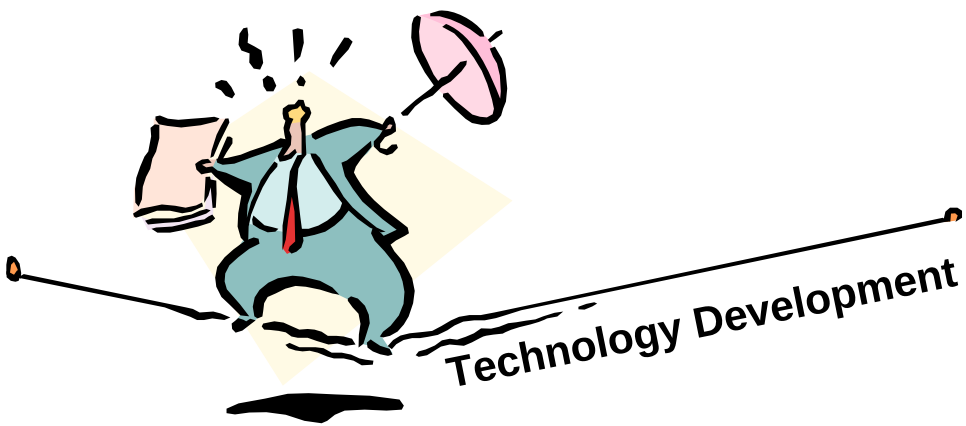
Technology Maturation Policy Leading to Milestone B is Unambiguous

"The project shall exit Technology Development 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 than five years); or when the MDA decides to terminate the effort. …. A Milestone B decision follows the completion of Technology Development." (DoDI 5000.2, paragraph 3.6.7)



Technology Maturation Policy Leading to Milestone B is Unambiguous (cont'd)

"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. Technology developed in S&T or procured from industry or other sources shall have been demonstrated in a relevant environment or, preferably, in an operational environment to be considered mature enough to use for product development in systems integration. Technology readiness assessments, and where necessary, independent assessments, shall be conducted.

If technology is not mature, the DoD Component shall use alternative technology that is mature and that can meet the user's needs." (DoDI 5000.2, paragraph 3.7.2.2)

and • • •

• • • The Policy is Reflected as a Title 10 Requirement for Certification

10 USC §2366a states

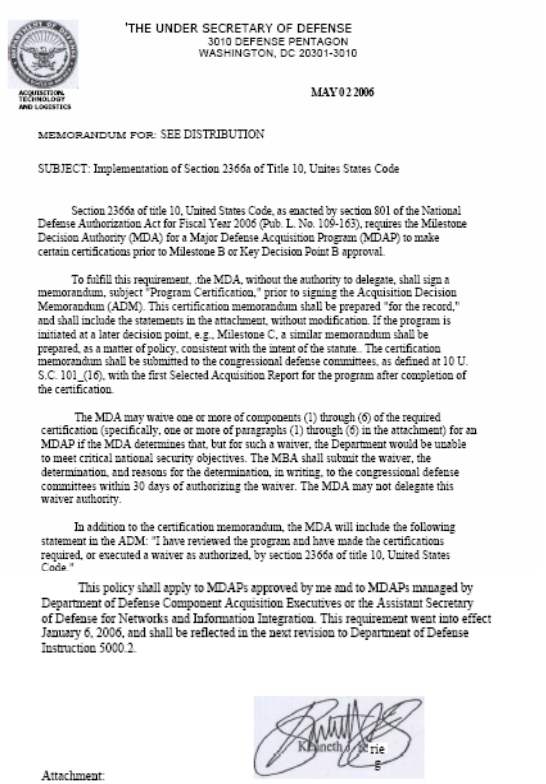
Major defense acquisition programs: certification required before Milestone B or Key Decision Point B approval:

(a) CERTIFICATION. A major defense acquisition program may not receive Milestone B approval, or Key Decision Point B approval in the case of a space program, until the milestone decision authority certifies that –

(2) the technology in the program has been demonstrated in a relevant environment;

. . .

(10) the program complies with all relevant policies, regulations and directives of the Department of Defense



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

ACQUISITION, TECHNOLOGY AND LOGISTICS

MAY 02 2006

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Implementation of Section 2366a of Title 10, Unites States Code

Section 2366a of title 10, United States Code, as enacted by section 801 of the National Defense Authorization Act for Fiscal Year 2006 (Pub. L. No. 109-163), requires the Milestone Decision Authority (MDA) for a Major Defense Acquisition Program (MDAP) to make certain certifications prior to Milestone B or Key Decision Point B approval.

To fulfill this requirement, the MDA, without the authority to delegate, shall sign a memorandum, subject "Program Certification," prior to signing the Acquisition Decision Memorandum (ADM). This certification memorandum shall be prepared "for the record," and shall include the statements in the attachment, without modification. If the program is initiated at a later decision point, e.g., Milestone C, a similar memorandum shall be prepared, as a matter of policy, consistent with the intent of the statute. The certification memorandum shall be submitted to the congressional defense committees, as defined at 10 U. S.C. 101_(16), with the first Selected Acquisition Report for the program after completion of the certification.

The MDA may waive one or more of components (1) through (6) of the required certification (specifically, one or more of paragraphs (1) through (6) in the attachment) for an MDAP if the MDA determines that, but for such a waiver, the Department would be unable to meet critical national security objectives. The MBA shall submit the waiver, the determination, and reasons for the determination, in writing, to the congressional defense committees within 30 days of authorizing the waiver. The MDA may not delegate this waiver authority.

In addition to the certification memorandum, the MDA will include the following statement in the ADM: "I have reviewed the program and have made the certifications required, or executed a waiver as authorized, by section 2366a of title 10, United States Code."

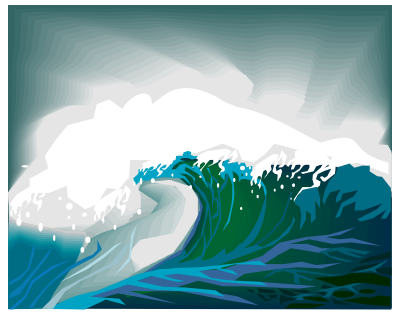
This policy shall apply to MDAPs approved by me and to MDAPs managed by Department of Defense Component Acquisition Executives or the Assistant Secretary of Defense for Networks and Information Integration. This requirement went into effect January 6, 2006, and shall be reflected in the next revision to Department of Defense Instruction 5000.2.

Attachment:
As stated

Certification Submitted with the First Selected Acquisition Report for the Program

• • • But Waivers Are Allowed

(c) WAIVER FOR NATIONAL SECURITY. The milestone decision authority may waive the applicability to a major defense acquisition program of one or more components (as specified in paragraph (1), (2), (3), (4), (5), (6), (7), (8), or (9) of subsection (a)) of the certification requirement if the milestone decision authority determines that, but for such a waiver, the Department would be unable to meet critical national security objectives. Whenever the milestone decision authority makes such a determination and authorizes such a waiver, the waiver, the determination, and the reasons for the determination shall be submitted in writing to the congressional defense committees within 30 days after the waiver is authorized.



Changes Made to Meet the Statutory Requirements



- **USD(AT&L) practice**
  - **Programs will no longer be initiated with immature technologies**
  - **The same standards apply to all acquisition programs**
- **DDR&E will provide technical advice to the MDA in support of certification**
  - **For MDAPs, MAIS, and space systems**
  - **Approved TRA process and report will be the basis of that advice**

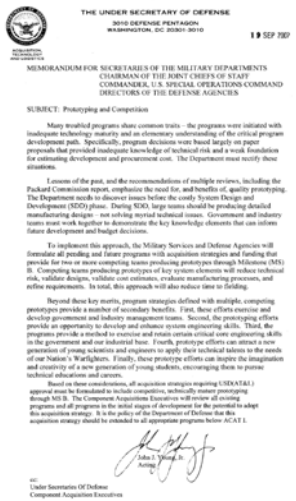
Draft New 5000.2 Language
September 13, 2007

- **For the SDD Phase:**

3.6.7.1 "Final Requests for Proposals (RFPs) for the SDD phase shall not be released, nor shall any action be taken that would commit the program to a particular contracting strategy for SDD, until the MDA has approved the Acquisition Strategy. The PM shall include language in the RFP advising offerors that (1) the government will not award a contract to an offeror whose proposal is based on technologies that have not been demonstrated in a relevant environment, and (2) that offerors will be required to specify the technology readiness level of the key technologies on which their proposal is based and to provide reports documenting how those technologies have been demonstrated in a relevant environment."



Prototyping and Competition Policy Promotes Technology Maturity



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

19 SEP 1997

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
COMMANDER, U.S. SPECIAL OPERATIONS COMMAND
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Prototyping and Competition

Many troubled programs share common traits – the programs were initiated with inadequate technology maturity and an elementary understanding of the critical program development path. Specifically, program decisions were based largely on paper proposals that provided inadequate knowledge of technical risk and a weak foundation for estimating development and procurement cost. The Department must rectify these situations.

Lessons of the past, and the recommendations of multiple reviews, including the Packard Commission report, emphasize the need for, and benefits of, quality prototyping. The Department needs to discover issues before the costly System Design and Development (SDD) phase. During SDD, large teams should be producing detailed manufacturing designs – not solving myriad technical issues. Government and industry teams must work together to demonstrate the key knowledge elements that can inform future development and budget decisions.

To implement this approach, the Military Services and Defense Agencies will formulate all pending and future programs with acquisition strategies and funding that provide for two or more competing teams producing prototypes through Milestone (MS) B. Competing teams producing prototypes of key system elements will reduce technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. In total, this approach will also reduce time to fielding.

Beyond these key merits, program strategies defined with multiple, competing prototypes provide a number of secondary benefits. First, these efforts exercise and develop government and industry management teams. Second, the prototyping efforts provide an opportunity to develop and enhance system engineering skills. Third, the programs provide a method to exercise and retain certain critical core engineering skills in the government and our industrial base. Fourth, prototype efforts can attract a new generation of young scientists and engineers to apply their technical talents to the needs of our Nation's Warfighters. Finally, these prototype efforts can inspire the imagination and creativity of a new generation of young students, encouraging them to pursue technical educations and careers.

Based on these considerations, all acquisition strategies requiring USD(A&T&L) approval must be formulated to include competitive, technically mature prototyping through MS B. The Component Acquisitions Executives will review all existing programs and all programs in the initial stages of development for the potential to adopt this acquisition strategy. It is the policy of the Department of Defense that this acquisition strategy should be extended to all appropriate programs below ACAT I.

John J. Young, Jr.
Acting

cc:
Under Secretaries Of Defense
Component Acquisition Executives

- **Policy**
  - **During SDD, large teams should be producing detailed manufacturing designs – not solving myriad technical issues**
  - **All pending and future programs formulate acquisition strategies and provide funding for two or more competing teams to produce prototypes of key system elements through Milestone B**
- **Promotes maturity via**
  - **More rigorous relevant environment demonstrations**
  - **More comprehensive evidence of maturity**
  - **Fewer technical problems in the final design**
  - **Using prototypes for accelerated life-cycle tests**
  - **Providing insight into production issues**

Desired Outcomes from Process Changes in Support of the New Situation

- **Safeguards in place to provide the DDR&E with the confidence necessary to assure the MDA that certification can be made**
  - **To make the TRA support the certification, it must draw upon the best technical information available *prior to source selection***
- **Assurance that technologies have been demonstrated in a relevant environment by the winning SDD Phase contractor**
  - **To initiate programs with mature technologies, the source selection process should include a focus on technical maturity**
- **ADM language establishing conditions for CTE insertion after Milestone B**
  - **To initiate programs with mature technologies, immature CTEs may be pursued in a parallel development effort, if approved maturation plans submitted with the TRA— *on ramp vice off ramp for preferred approaches with undemonstrated technologies***

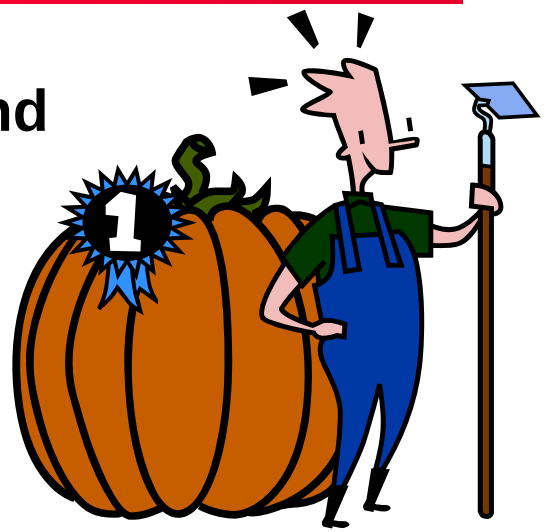


Processes and Best Practices Must Change to Achieve These Outcomes (1 of 2)

- **10 USC 2366a is new, so technically what follows are to some extent *best ideas* vice *best practices***
  - **Nevertheless, many of the changes to increase rigor in the process are indeed best practices**
  - **The new practices and processes are subject to change as more experience is gained**
- **All practices and processes presented herein are not official until captured in the TRA Deskbook**



Processes and Best Practices Must Change to Achieve These Outcomes (2 of 2)



- Increasing the rigor of the TRA process and report to assure a quality product
  - Initiating the TRA process
  - Identifying CTEs
  - Assessing CTE maturity
  - Preparing the TRA report
- Including a focus on technical maturity in source selection to assure mature technologies in programs
  - Preparing the RFP
  - Assessing CTE maturity during source selection
- Using the ADM to pursue technology maturation and insertion after Milestone B
  - Preparing maturation plans for CTEs the PM would like to insert
  - Drafting ADM language

Best Practices for Initiating the TRA Process (1 of 2)

No change to current Deskbook

- ***Keep the Component S&T Executive and the DUSD(S&T) informed throughout the entire TRA process***

No change to current Deskbook

- **Begin the TRA process 12-14 months prior to the anticipated Milestone/KDP B for an ACAT ID or IAM program**
  - **Component should immediately prepare a schedule**
  - **Align with the Acquisition Strategy**
  - **Incorporate into IMS**
  - **DUSD(S&T) should provide comments on the schedule and indicate conditions for agreement**



Best Practices for Initiating the TRA Process (2 of 2)

Adds rigor to current Deskbook

- **Establish an Independent Panel of subject matter experts to identify candidate CTEs and assess CTE maturity**
  - ***Must be genuine subject matter experts in relevant disciplines***
  - ***Must be independent of program to be credible***
  - **Coordinate with DUSD (S&T) who should provide comments and indicate conditions for agreement**



Best Practices for Identifying CTEs

Change to current Deskbook; shifts responsibility from the PM to the Panel

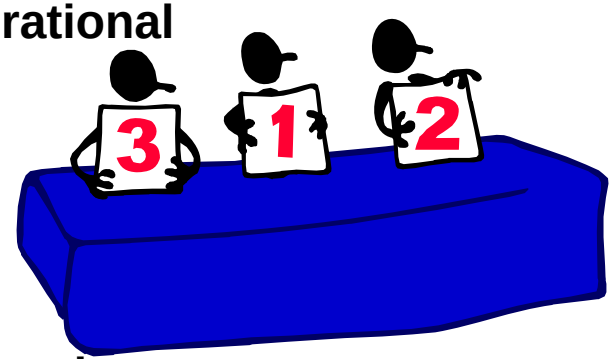


- **Use the Independent Panel of subject matter experts to identify CTE candidates in conjunction with the program; final list should reflect DUSD(S&T) recommended changes**
  - **Most current system design should be the starting point for**
  - **Any system/component may be a CTE until proven otherwise**
  - **Determination is based on system design, WBS, or architecture provided by the program**
  - **PM should prepare an initial list of CTE candidates**
    - **Based on information from BAAs, RFIs, and literature searches along with actual results from program-funded efforts in government laboratories or industry when there will be a full and open competition with a formal source selection process**
    - **Based on planned technical approaches (e.g., actual design when available otherwise use government's reference architecture) when sole source or competitive down select**
  - **Final CTE list established during coordination; DUSD(S&T) may recommend changes**
    - **Additions may include any technologies that warrant the rigor of the formal TRA process**

Best Practices for Assessing CTE Maturity

Adds rigor to current Deskbook

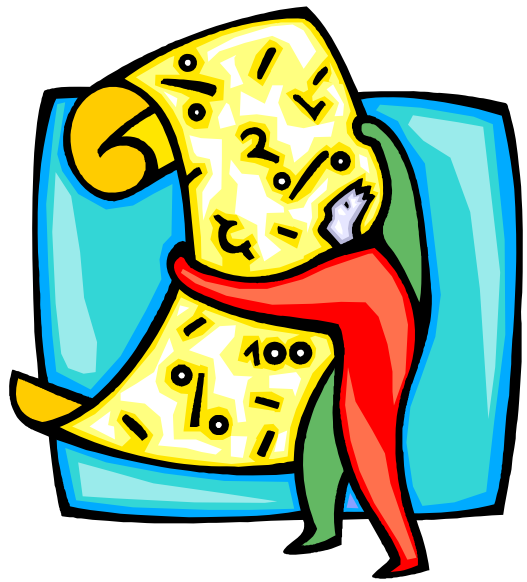
- **Use the Independent Panel to assess CTE maturity; base all conclusions on objective evidence and the technical expertise of the Panel**
  - **Use the requirements, identified capabilities, system architecture, and the concept of operations and/or the concept of employment to define relevant and operational environments**
  - **Form subteams (on the basis of subject matter expertise) to deliberate on the appropriate TRL and then defend their position to the entire Panel**
  - **Do not constrain the assessment process to be a response to a "program-developed" position on the TRL**



Best Practices for Preparing the TRA Report

Adds rigor to current Deskbook

- **The TRA report should consist of (1) a short description of the program (2) the Independent Panel credentials (3) Independent Panel findings and supporting evidence (4) other technical information deemed pertinent by the Component S&T Executive and (5) a cover letter signed by the Component S&T Executive**
  - **The Independent Panel (Chair) should prepare the following:**
    - **Panel deliberations, findings, and conclusions**
    - **Evidence and rationale for the final assessment in a way that the chain of logic is clear**
      - **Reference specific sources using actual pages in reports for the evidence presented**
  - **A PM's self assessment of TRLs may be included in the cover letter**
  - **The Component S&T Executive should indicate agreements or disagreements with the findings of the Independent Panel in the cover letter**



Best Practices for Preparing the RFP

Change to current Deskbook

- **Include language in the RFP to convey DoD's desire to have technologies demonstrated in a relevant environment by the winning SDD Phase contractor**
  - **A description of the relevant environment and the candidate CTEs**
  - **Based upon the definitions and guidance provided in the TRA Deskbook, offerors must identify all CTEs in their proposal, provide the rationale for classifying them and as CTEs, assess their TRL, and include sufficient technical evidence to support the TRL assessment**
  - **A description of how the CTEs and the associated evidence of maturity will be evaluated**



Other

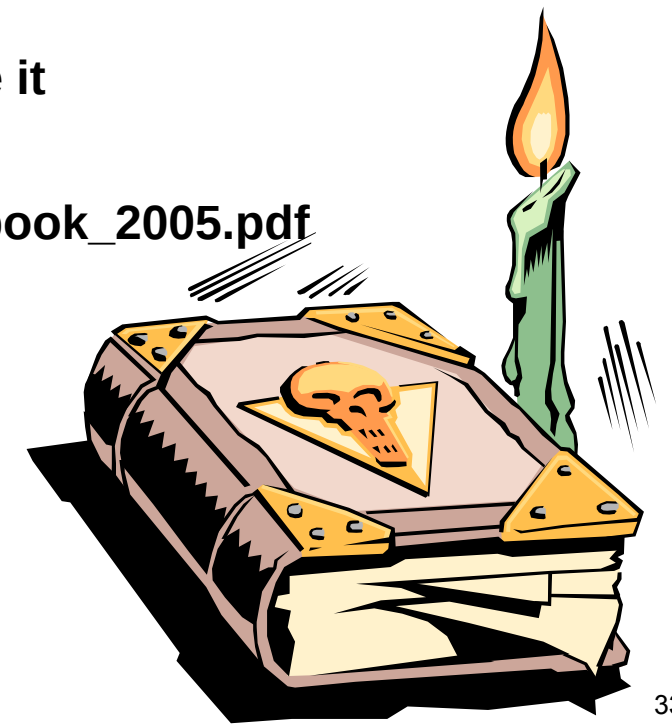


Outline

- Introduction
  - What is a TRA
  - Why it is important
- Impact of 10 USC 2366a on TRA processes and practices
  - Technology maturation policy
  - Best practices for
    - Increasing TRA rigor
    - Focusing on technology maturity in source selection
    - Using the ADM to pursue technology maturation and insertion after Milestone B
- References and Resources

References and Resources

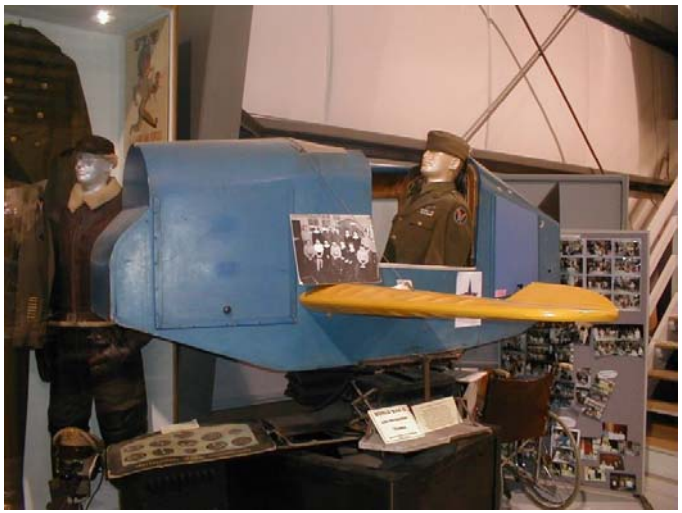
- **Defense Acquisition Resource Center http://akss.dau.mil/darc/darc.html**
  - **DoD Directive 5000.1 (DoDD 5000.1), *The Defense Acquisition System*, dated May 12, 2003**
  - **DoD Instruction 5000.2 (DoDI 5000.2), *Operation of the Defense Acquisition System*, dated May 12, 2003**
  - ***Defense Acquisition Guidebook***
- ***DAU Continuous Learning Module CLE021***
  - **https://learn.dau.mil/html/clc/Clc.jsp to browse it**
- ***TRA Deskbook***
  - **http://www.defenselink.mil/ddre/doc/tra_deskbook_2005.pdf**
- **DDR&E**
  - **Mr. Jack Taylor jack.taylor@osd.mil**
- **Institute for Defense Analyses**
  - **Dr. Dave Sparrow dsparrow@ida.org**
  - **Dr. Jay Mandelbaum jmandelb@ida.org**
  - **Dr. Michael May mmay@ida.org**





Revisiting Aircraft Flight Simulator Acceptance Criteria

?



??



???

1930

2000

Dean Carico
Rotary Wing Ship Suitability
Naval Air Warfare Center Aircraft Division
Patuxent River, MD., USA

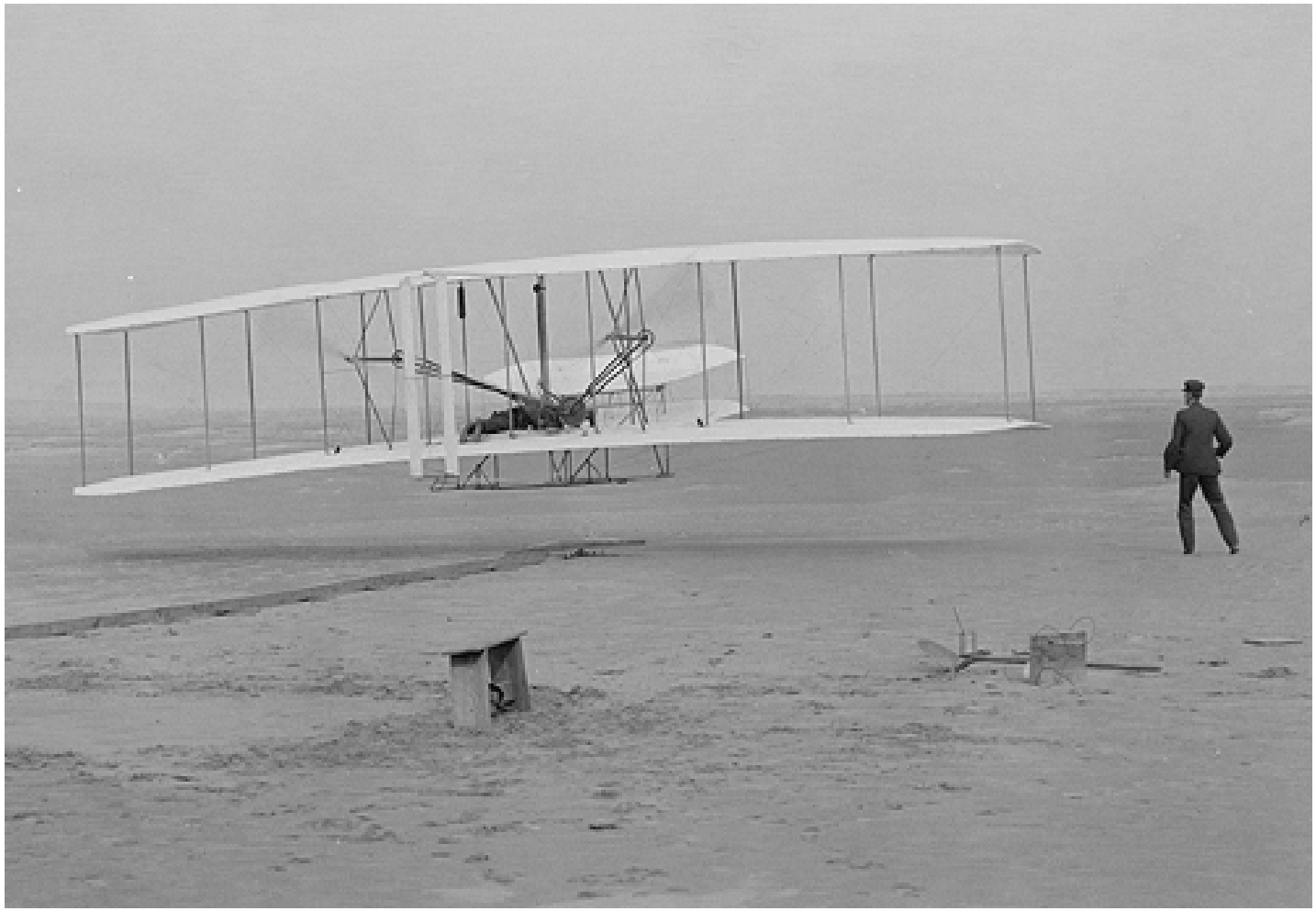
Presentation Outline

- Flight Training Background
- Early Simulation Fidelity Studies
- Existing Simulator Criteria
- US Navy Simulation Initiative
- Modeling Mission Applications
- MFOQA
- Summary

Lilienthal Glider ~ 1894



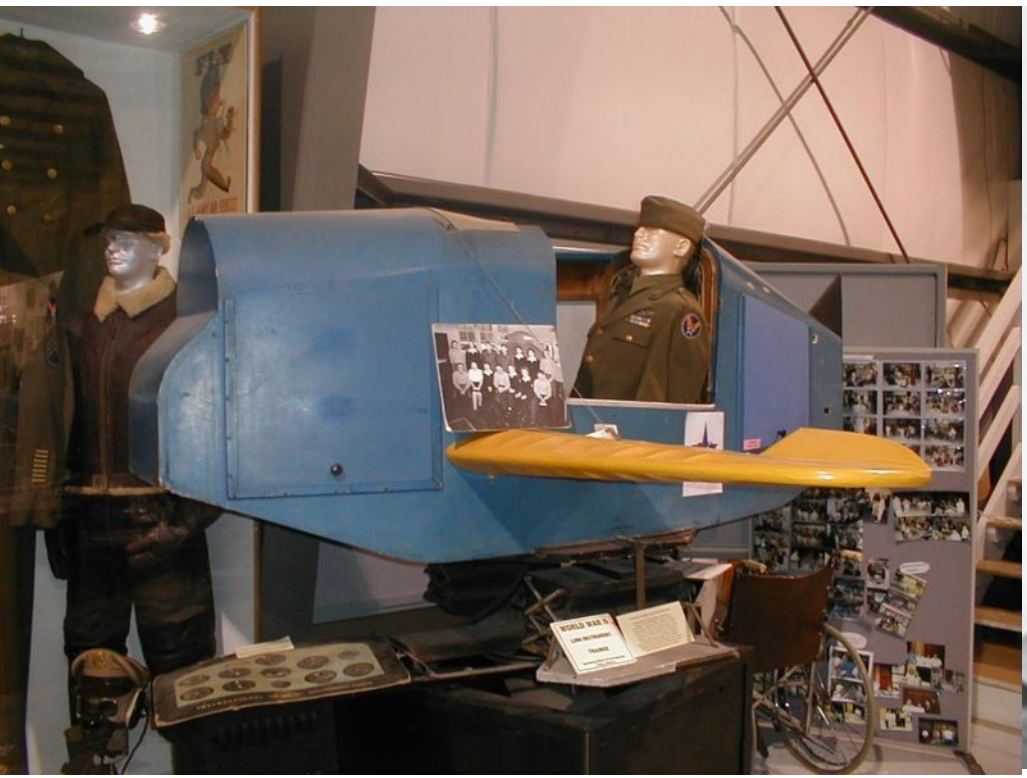
Wright Brothers First Flight 1903

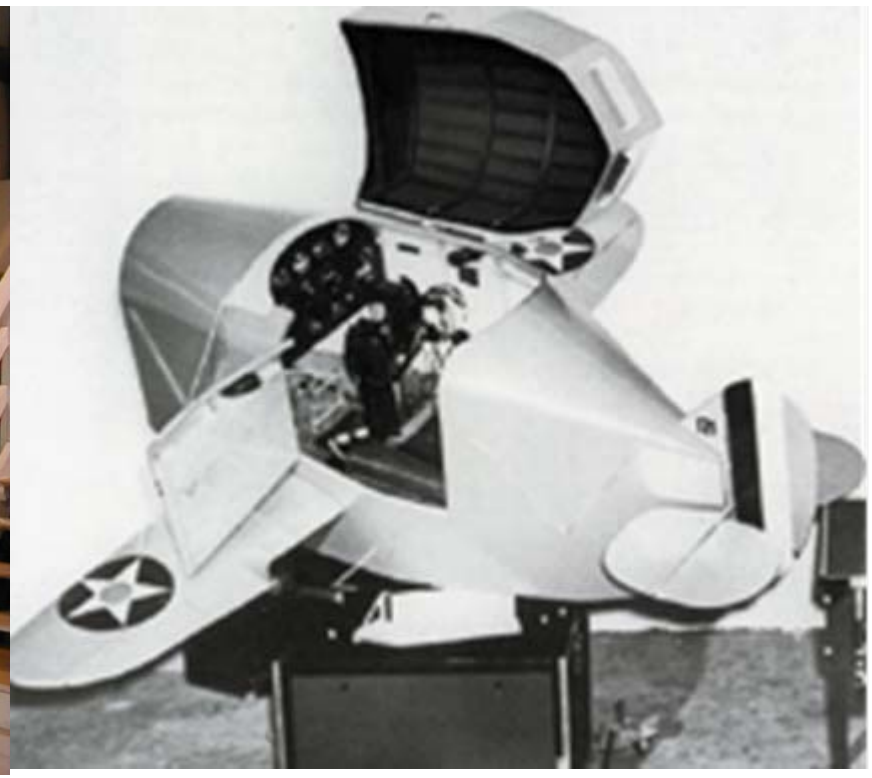


Curtis JN-4 Barnstorming ~ 1919



Link’s Blue Box Trainer

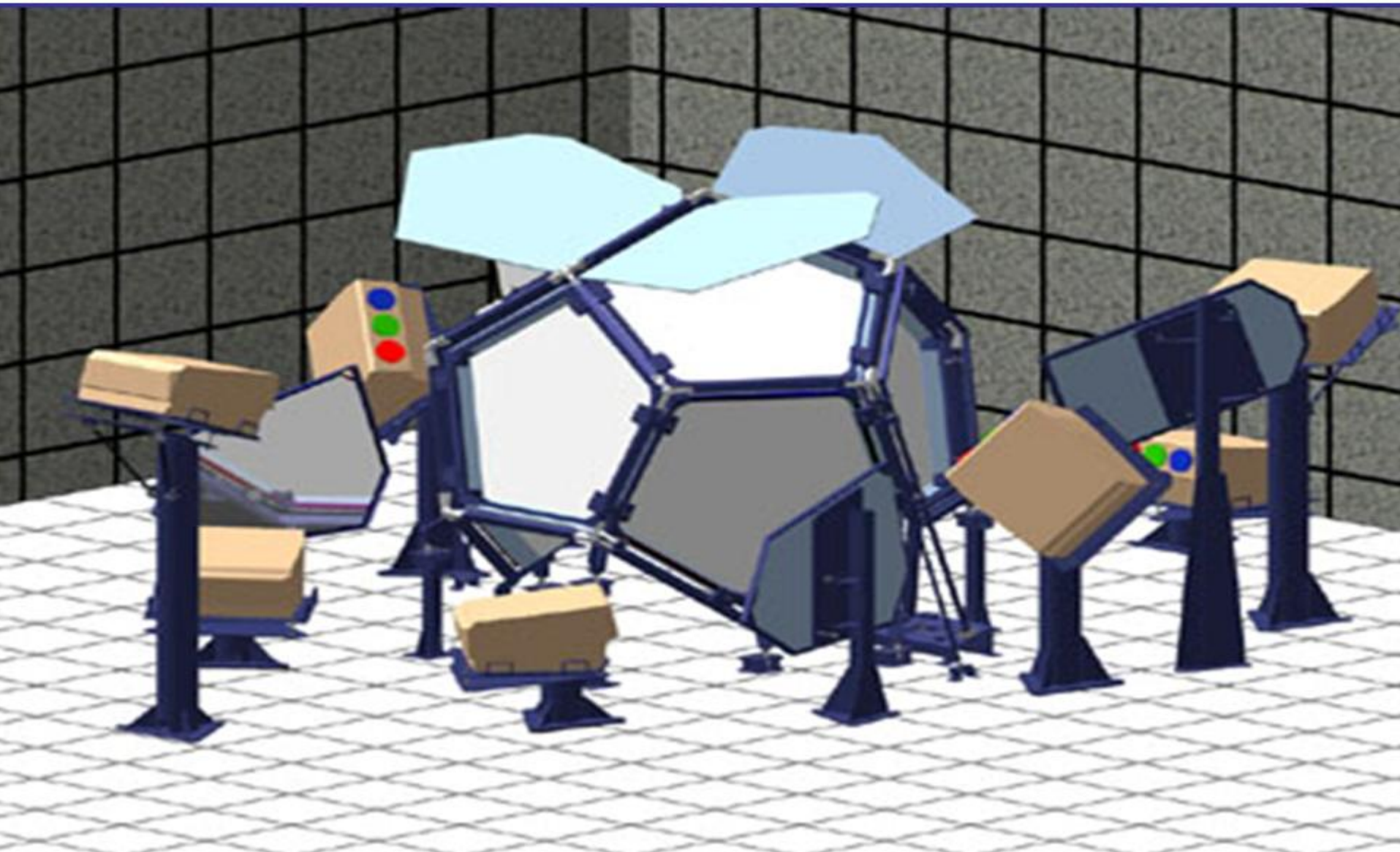




Link Trainer ~ 1940s

F-18 OFT Link “SimuSphere” design ~ 2001

External View Point



F-18C OFT - Pilot View



MH-60R Motion OFT Layout





MFS MH-60R OFT #2

Early US Navy Simulator Experience

- Early US Navy flight simulator evaluated by fleet pilots
- NATC started evaluating OFT/WST with flight test teams using flight test data in the 1970's
  - SH-2F Device 2F106 – First WST tested by test team
- Trainer acceptance criteria developed by NAWCTSD
- Criteria featured as OFT/WST built-in-test options

Early US Army Simulator Experience

- Considerable simulator fidelity work done by US Army/NASA Ames in 1980's &1990's
  - NASA Ames Vertical Motion Simulator (VMS)
  - US Army Aeronautical Design Standard 33
    - Handling qualities focus
- 1984 UH-60 NOE Simulation
  - Aircraft HQR's 1.5 to 2 better than simulator
- Low visibility simulation for hover & low speed
  - Fine-grained micro texture more important than FOV

OFT/WST Acceptance Criteria

- US Navy
  - NAWCTSD Guidelines Rotary Wing Aircraft
  - NAWCTSD Guidelines Fixed Wing Aircraft
- Federal Aviation Agency (USA)
  - AC 120-63 Helicopter Simulator Qualification
  - AC 120-40 Airplane Simulator Qualification
- Joint Aviation Authorities (Europe)
  - JAR-STD 1H Helicopter Flight Simulators
  - JAR-STD 1A Airplane Flight Simulators

Sample Helicopter Simulator Test Criteria

Sample Test	NAWCTSD	FAA AC No: 120-63	JAR-STD 1H
Performance			
Hover Torque	**3%**	**+/- 3%**	**+/- 3%**
Low A/S CP	**2% full travel**	**+/- 5%**	**+/- 5%**
Handling Qualities			
Trimmed CP	**2% full travel**	**+/- 5%**	**+/- 5%**
Critical Azimuth CP	**2% full travel**	**+/- 5%**	**+/- 5%**
Autorotation			
Rotor Speed	**1%**	**+/- 1.5%**	**+/- 1.5%**

Notation: CP – Control Position
A/S - Airspeed

On-Going U.S. Navy Small Business Innovative Research Project

- Topic N07-033 – Advanced Aircraft Simulator Flight Fidelity Evaluation Measures
- Four six-month Phase I contract awards made in early summer 2007
- Hopefully, two two-year Phase II contracts will be awarded following the Phase I work
- Research topic endorsed by NAVAIR PMA-205 Aviation Training Systems
- NAVAIR PMA-205 manages over 3 dozen OFT/WST, plus numerous other training devices

Simulator Project Focus Areas

- Aircraft type (helicopter, tilt rotor, VTOL, fixed-wing)
- Flight Test Maneuver (USNTPS, ADS-33, Operational)
- Maneuver Aggressiveness (timed non repeatable tasks)
- Control strategy (workload and bandwidth)
- Visual scene (fine grain texture, resolution, FOV, etc)
- Simulator component (visual, motion, aural, cockpit, etc)
- Time or frequency domain analysis options
- Cost and risk (VV&A using risk/benefit analysis)
- Pilot factor (flight time/type/conditions, attitude)
- Mission task element (Navy, Army, Air Force missions)
- Total simulator system fidelity (quantify cueing effects)
- Military flight operations quality assurance (MFOQA)

Potential Virtual Mission Applications

- Air-to-Air Combat
- Air-to-Air Refueling
- Nap-of-the-Earth
- Rotorcraft/Ship or Dynamic Interface
  - Rotorcraft
  - Ship
  - Airwake
  - Ship motion
  - Visual environment

Rotorcraft/Ship Simulation

- NAVTOLAND H-2 VMS Project 1982
  - Inadequate FOV – forward landing circle
  - Lack of texture – ship deck, hangar & sea
    - Caused pilots to rely excessively on HUD
    - HUD was considered ~ + 2 HQR points for task
    - Tried to used “ice floes” to provide ocean texture
  - Airwake model – excessive in magnitude & frequency
- The helicopter/ship landing technology was just getting started at this time

JSHIP Overview

- Joint Shipboard Helicopter Integration Process (JSHIP)
  - Joint Test & Evaluation Force
  - Sponsored by OSD Deputy Director, Developmental Test & Evaluation
  - Purpose to Increase the Interoperability of Joint Shipboard Helicopter Operations (Army/Air Force Helicopters with Navy Ships)

DIMSS Overview

Dynamic Interface Modeling & Simulation System (DIMSS)

- Define a Process for Establishing a WOD Flight Envelope Using Modeling and Simulation



- Demonstrate that the Process Works by Validating a WOD Flight Envelope Established by Simulation for the LHA/UH-60A Ship/Helicopter Combination
  - Use Vertical Motion Simulator at NASA Ames
  - Validate simulation against flight test data
  - Investigate minimum cueing requirements (visual, aural & motion)

JSHIP Simulation Results

None of the simulator configurations tested achieved similar subjective ratings as in the aircraft

The simulation results could not be used to generate operational flight envelopes





Military Flight Operations Quality Assurance (MFOQA)

- OSD focus since 2005 to help reduce overall mishap rate
- Builds on commercial aviation practices using operational trend analysis of enhanced flight data to better identify hazards and improve risk management
- Goal for simulator full MFOQA is 2009
- Initial aircraft demo conducted at HSL-41 in early 2006 using H-60 with JAHUMS

MFOQA

Military Flight Operations Quality Assurance





Fleet Operational Readiness Improvement

Proactive Hazard Identification and Elimination

MFOQA

Military Flight Operations Quality Assurance

A knowledge management process that uses downloaded flight data after *every* flight

to provide

aircrew, the squadron and the Fleet with *quantitative information*

regarding *aircrew* and *aircraft performance*

to improve

***training*, *operational readiness* and *safety*.**

Summary

- Pilots have used simulators since the 1930’s
- Trainer acceptance criteria same since 1970’s
- Questions on comparing FT & simulator data
- Large simulator technology database
- US Navy initiated a program in 2007 to develop advanced simulator flight fidelity measures to enhance flight trainer acceptance criteria
- The program team members will be searching for related reference material during the project life
- Improved virtual models will also have a positive impact for future flight test productivity & safety





Next Generation Air Transportation System: Meeting the Enterprise System Engineering Challenges

Gerald Friedman (MITRE)
Catherine Bolczak (MITRE)
Robert Humbertson (MITRE)
John Mack (MITRE)
Jay Merkle (FAA)

25 October 2007

CAASD

MITRE

Approved for Public Release; Distribution Unlimited. MITRE Tracking no. 07-1293

Pressure from Growing Traffic Congestion and Airline Delays

The New York Times

Flying the Crowded Skies: Challenges for Aviation



J. Emilio Flores for The New York Times

Air traffic controllers at the Los Angeles airport.

By MATTHEW L. WALD
Published: January 15, 2007

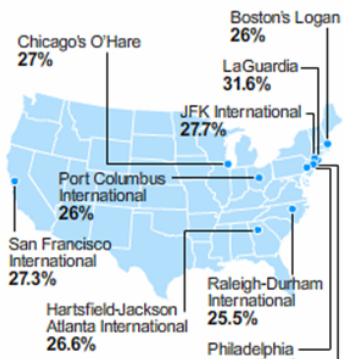
WASHINGTON, Jan. 14 — By 2025, government experts say, America's
three times as many planes, and not just the kind of traffic flying today. Th
of tiny jets, seating six or fewer, at airliner altitudes, competing for space v
drones that need help avoiding midair collisions, and with commercially o
carrying satellites and tourists into space.

USA TODAY

Updated 1/26/2007 2:35 PM ET

Airline Delays Set Record in 2006

Large airports² with the highest percentage of delayed flights January-November 2006:



By Alan Levin,

Airline delays inc
to record highs b
weather starting
airports and stra
passengers, acc
obtained by USA

By several meas
exceeded those
thunderstorms c
schedules that p
Congress threate
carriers.

TIPPING POINT
passengers

Statistics
Gelles, USA TODAY

% of flights on large
the federal Bureau

ed the nation in th
e federal data. At
inutes late.

AVIATION WEEK & SPACE TECHNOLOGY

06/28/2007

Record Delays Loom

Summertime and the traveling won't be easy in the U.S. National Airspace System

David Hughes/Herndon, VA.

With summer air traffic delays expected to set a record for the second year in a row, the FAA acknowledges that long-term relief will depend on the not-yet-assured NextGen ATC system.



THE WALL STREET JOURNAL.

July 17, 2007



THE MIDDLE SEAT
By SCOTT MCCARTNEY

Why Fliers Find Summer Travel Growing Tougher

Number of Cancellations
More Than Doubles
Amid Storms, Gridlock

THE WALL STREET JOURNAL.

July 21, 2007

HOT TOPIC

Why the Skies Have Gotten Crowded

By SARAH NASSAUER

Data this past week validated what many fliers already suspected -- the number of delays and cancellations in June may have been the worst ever. According to FlightStats.com, 20,301 flights were canceled in the U.S., more then double the number grounded in June 2006. Among the 40

James
lion's
012-18

Pressure from Delays and Cancellations on Airline Quality of Service Standards

The Washington Post

Flying Late, Arriving Light

Air Carriers Are Delaying More Flights and Losing Your Shirts



(By Laurence Kesterson -- Associated Press

By Del Quentin Wilber
Washington Post Staff Writer

Thursday, February 8, 2007; Page D01

Air travelers had a tough year getting

Airlines' on-time performance droppe
arriving late or not at all, according to
Statistics.

It was the worst year since 2000, whe
from getting to their destinations on t

The airlines also mishandled a massiv
1,000 passengers, the industry's worst
in lost bags stemmed from stricter sec
their luggage.

There was less consensus on the incre
and that's one of the reasons 2006 hit
Federal Aviation Administration, said

The Atlanta Journal-Constitution

Congress eyes standards for airline service

By BOB DART
The Atlanta Journal-Constitution
Published on: 04/20/07

Washington — Airlines have not kept their promises to protect passengers f
horrors, so Congress may need to set federal standards for customer servic
Transportation Department investigator told a House subcommittee Friday.

The New York Times

Federal Agency Investigating Airline Arrival-Time Promises

By JEFF BAILEY
Published: April 21, 2007

The Transportation Department said yesterday that it was investigating several domestic airlines for publishing unrealistic flight schedules — including ones that list arrival times the carriers know they cannot achieve — and said as many as eight could be fined for failing to provide accurate flight-delay information.

The agency is under pressure from Co
recent episodes where several carrier
Airways, stranded passengers for hou

The actions disclosed Friday do not d
which is being reviewed by the agency
after June 30.

Rather, these actions aim at airlines t
to customers, when asked, the on-tim
required.

A Transportation Department spokes
not to be identified, said the agency c
information on particular flights. The
statistic on 41 percent of the calls, the
involved.

THE WALL STREET JOURNAL.

February 6, 2007



THE MIDDLE SEAT
By SCOTT MCCARTNEY

A Report Card On the Nation's Airlines

Despite Financial Recovery, Many Carriers Still Plagued By Spotty Customer Service

110TH CONGRESS
1ST SESSION

H. R. 1303

To amend title 49, United States Code, to improve air carrier passenger services.

IN THE HOUSE OF RE[illegible]

[illegible] California for [illegible]self, Mrs. CUBIN, Mr. MARKEY, Mr. [illegible], Ms. ESHOO, Mr. GEORGE MILLER of [illegible], Ms. ZOE LOFGREN of California, Mr. [illegible] of Virginia, Mr. FATTAH, and [illegible] introduced the following bill; which was referred to the Committee on [illegible] and Infrastructure

A BILL

To amend title 49, United States Code, to improve air carrier passenger services.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Airline Passenger Bill of Rights Act of 2007".

Passenger Bill of Rights

Pressure from Airlines on ATM System Performance

CNNMoney.com

Delta Takes Steps to Mitigate Impact On Customers as Severe Weather Approaches Northeast

Delta Urges Congress to Modernize Air Traffic Control System

June 28, 2007: 12:03 PM EST

ATLANTA, June 28, 2007 (PR
customers booked on flights
U.S. to make adjustments to
weather expected in the regi
the Northeast corridor and a
flights could be canceled. Cu
cancellations may request re
without fee or penalty.

Impacted cities include the fo

- New York (JFK)
- New York (LGA)
- Newark
- Hartford
- Providence
- Boston
- Washington Reagan
- Washington Dulles
- Baltimore
- Philadelphia

"Delta's focus is always the c
continue to work to mitigate
delays. However, today's sto
Congress act to modernize th
Kolshak, Delta's executive vi
fundamentally unfair to our customers that we are operating in a system that was built in the 1940s and can't accommodate today's air travel demand without costly and frustrating delays and congestion that are beyond our control. The FAA has presented a plan to Congress that helps ensure airline passengers are provided with an updated, 21st century air traffic control system. We urge Congress to approve the FAA's plan to increase airspace capacity, especially in the Northeast, and to get away from the status quo and act boldly to modernize our nation's outdated air traffic control system."

U.S.News & WORLD REPORT

Airlines Attribute Delays to Poor Traffic Control

April 3, 2007 | 5:15 PM ET | Permanent Link

In response to an Airline Quality Rating report released yesterday that found that instances of delayed flights and lost baggage were up last year over 2005, the Air Transport Association, the trade group representing the major airlines, released a statement yesterday.

In short, the airlines attribute the uptick in delays to one of the most contentious political issues in transportation this year: the updating of the air traffic control system and just who should pay the bulk of the bill for the much-needed improvements.

"The 2007 Airline Quality Rating study once again focuses on the symptoms rather than the root causes of passenger and airline frustrations," ATA President and CEO Jim May notes in the statement. He says that since the majority of delays are caused by weather problems that the current system can't handle, Congress must now take its "historic opportunity" to "approve an action plan for the Next Generation Air Traffic Control system ... while ending the multibillion-dollar subsidy of business jets at the expense of the commercial airline passengers."

For the inside story on the big-time Washington battle over restructuring the FAA, see associate editor Angie C. Marek's March 30, 2007, article here. Marek tells us that bills addressing the subject should appear in Congress soon.

THE WALL STREET JOURNAL.

July 21, 2007
REVIEW & OUTLOOK

Gridlock in the Air

No one who has traveled by plane recently needs to be told that our commercial air-travel system
atistics support the anecdotal evidence of crowded airspace, taxiways and
inistrator Marion Blakey recently noted that 2006 was the worst year on
d cancellations and that 2007 bids to be worse still. On one day this past
lf the planes at JFK in New York City were on time. Nationwide for the
re than 30% of all flights were delayed. It's enough to make you think they
hour to every departure time.

course. But we're not sure that firing Ms. Blakey -- which is Chuck
n for addressing the problem -- would be any more effective. Ms. Blakey
anyone who will listen to fix some of the problems with the air-travel
efore this summer's delays put the overcrowding in the headlines and on

tough with the air-traffic controllers union, which has placed her on the least-
t of a number of Democratic politicians, including New York's Senator
lly, Ms. Blakey last year fought and won a battle with the controllers union
ay package that was eating up a vast portion of the FAA's budget.

r-increasing pay (it rose 75% between 1998 and 2005) left the FAA with less
pend on modernization projects that might actually alleviate some of the
ing "counterproductive," as Mr. Schumer claimed, Ms. Blakey's victory over
essary step toward to getting the air-travel system back on track.

really wants to do some good for New York's airports, though, he might talk
om Connecticut. The delays in New York and around the country are not
have a tendency to become tangled in the competing interests of Nimbyism,
ourse, money. When you combine those with Washington partisanship, the
the air.

the three main New York-area airports that Mr. Schumer is so concerned about. The airspace around New York, including the flight paths for getting in and out of the area, dates back decades, when traffic was much lighter. The FAA has been trying for years to "redesign" it, in its phrase, to allow more planes more ways to get in and out. But activists in Connecticut don't want the planes going over their houses, and neither, it seems, does anyone else. So redesign becomes a political football, and the planes sit on the taxiway.

The good news is that the FAA is supposed to issue a redesign rule for New York by the end of August. The bad news is that even if the new routes work as intended, the result will just be

Pressure of Global Warming Concerns on Flight Efficiency and Fuel Consumption

Internationally

FLIGHT INTERNATIONAL

Needless delays add to pollution

By David Learmount

Eurocontrol demands more efficiency from air traffic manage and fewer carbon emissions

Aircraft flying in European airspace last year poured thousands of t warming carbon dioxide into the sky unnecessarily just because of management inefficiency, according to the Eurocontrol Performanc Commission (PRC).

The report on calendar year 2006, published on 11 May, shows tha delays have been increasing for three years in a row, and PRC chai Williams says that the need to improve ATM efficiency is rising as a

This excess of emissions results from inefficiencies in the continent which mean every flight travels nearly 50km (27nm) farther throug needs to in order to reach its destination, the PRC reports. The Eur has set ATC service providers the target of eliminating this problem and 2010, saving an estimated 2.3 million tonnes of CO2 emissions airline costs by a billion euros.



© Gary Lewis / AirT

Europe's airlines are wasting tonnes of fuel each year due to

... and Domestically

USA TODAY

Updated 12/19/2006 9:13 AM ET

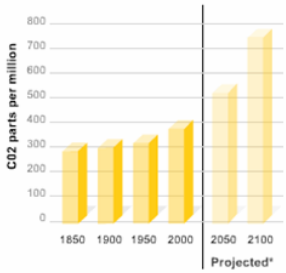
Concern grows over pollution from jets



By Andre Penner, AP file

A Boeing 737 lands in Brazil. Jet emissions such as carbon dioxide, nitrogen oxide and water vapor can contribute to climate change.

Carbon dioxide represents about 80 percent of the man-made greenhouse gases blamed for global warming. Though experts have called for the United States and other nations to cut emissions of C02, current trends show atmospheric C02 concentration would double by the end of the century.



* Projected concentration levels assuming continuing "business as usual" behavior.

Source: Scripps Institution of Oceanography and the Pacific Northwest National Laboratory's Global Change Research Institute at the University of Maryland.

By Ron Coddington and Josh Hatch, USA TODAY

By Gary Stoller, USA TODAY

Aviation and the environment are on course. The number of airline flights growing and expected to skyrocket o coming decades. Aircraft emissions and threaten by 2050 to become one largest contributors to global warming scientists have concluded.

Much remains unknown about climat and the role aviation plays, though cli scientists express particular concern emissions in the upper atmosphere, warming effect from some pollutants

Now, aviation is believed to be less a Earth's warming than power plants or traffic. But its emissions are consider New York-to-Denver flight, a commer generate 840 to 1,660 pounds of carb per passenger. That's about what an generates in a month.

With the projected explosion in world air pollution from aviation is a growin among scientists, and it's drawing inc scrutiny from governments, particular

"It's an issue that has to be addresse Brenda Ekwurzel, a climate scientist of Concerned Scientists, an environm advocacy group.

David Travis, a climate science profe University of Wisconsin-Whitewater, emissions "are currently one of the fa growing contributors to global warmir

The European Union is considering s on aircraft emissions, an action strongly opposed by the White House because of its potential effect on U.S. airlines.

Aviation Daily

News

Rep. Markey Wants FAA To Account For Global Warming In NextGen Plan

Aviation Daily
08/16/2007

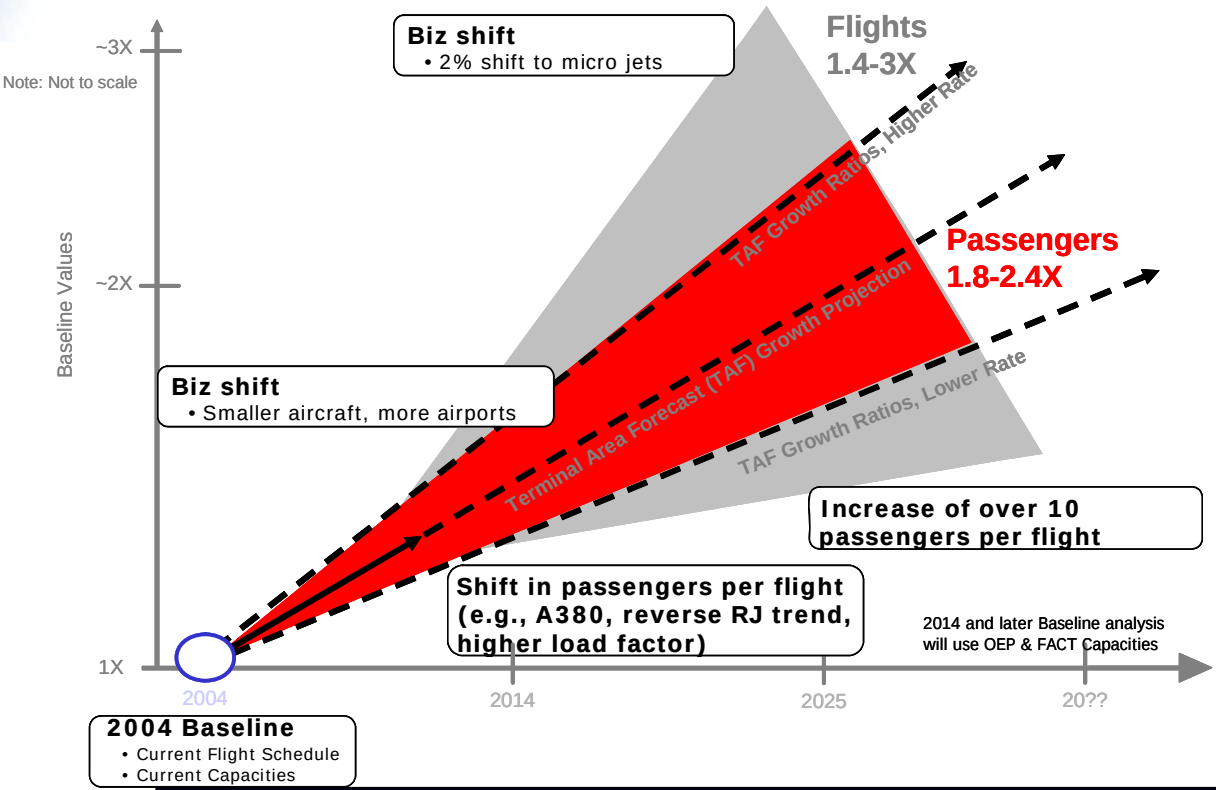
John M. Doyle

A House committee chairman wants the FAA to include global warming in its Next Generation Air Transportation system (NextGen) planning.

Rep. Edward Markey (D-Mass.) wrote FAA Administrator Marion Blakey Aug. 14 to express concerns that the agency wasn't taking global warming into account as it planned the future or air traffic control. "American aviation has made the word a smaller place and now it can make it a healthier place by taking action on global warming," said Markey, chairman of the house Select Committee on Energy Independence and Global Warming.

The letter asks FAA to report back by Sept. 4 on four questions: What does NextGen consider aviation's current and anticipated impact on global warming?; How many tons of carbon dioxide does aviation emit on a yearly basis in the U.S. -- both in the air and on the ground?; What strategies is NextGen considering to address emissions at airports?; and how far along is NextGen in developing a national roadmap on the viability of alternative fuels for aircraft?

Why NextGen?



- Growth in volume and complexity of operations
- Scalable to encompass a range of possible futures
- Broader diversity of:
  - Aircraft performance characteristics
  - Aircraft capabilities
  - Operator business models
- Space Operations
- Unmanned Aerial Systems

Transformation is Needed to Accommodate Projected Traffic Levels and Characteristics

MITRE

What is NextGen?



Transformation goals:

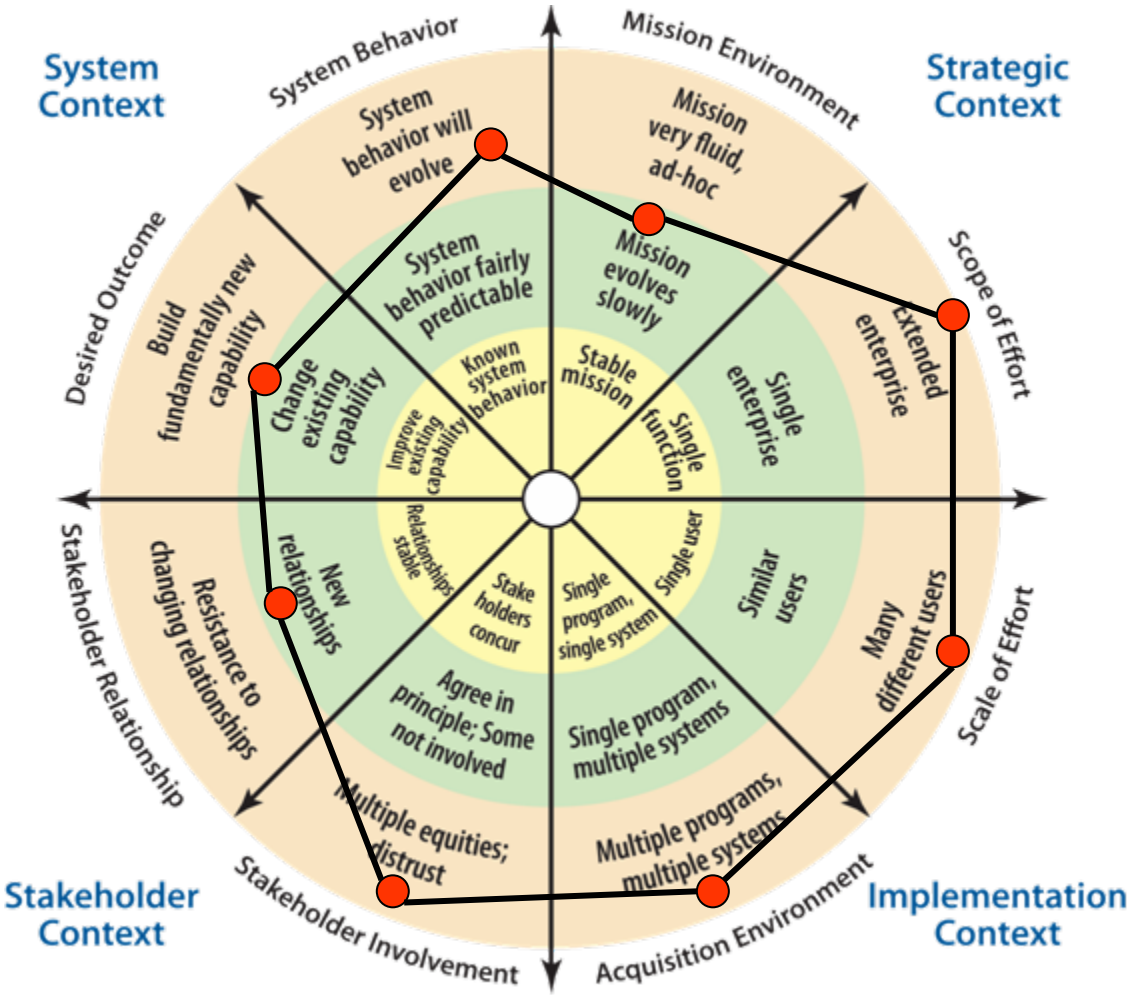
- Leadership in global aviation
- Scalable up to 3x increase in capacity
- Ensure our national defense (readiness and homeland security)
- Enhance the environment (noise, air quality)
- Improve safety
- Globally harmonized

Capabilities:

- Network-Enabled Information Access
- Performance Based Operations & Services
- Weather Assimilated into Decision Making
- Layered, Adaptive Security
- Position, Navigation, and Timing Services
- Aircraft Trajectory Based Operations
- Equivalent Visual Operations
- Super Density Arrival/Departure Operations

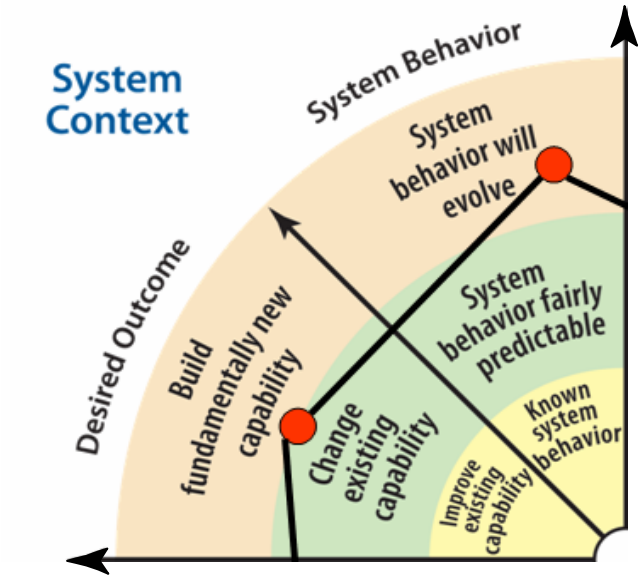
MITRE

NextGen Enterprise System Engineering Challenges



Enterprise System Engineering Profiler ™

NextGen Challenges: Strategic and System Contexts



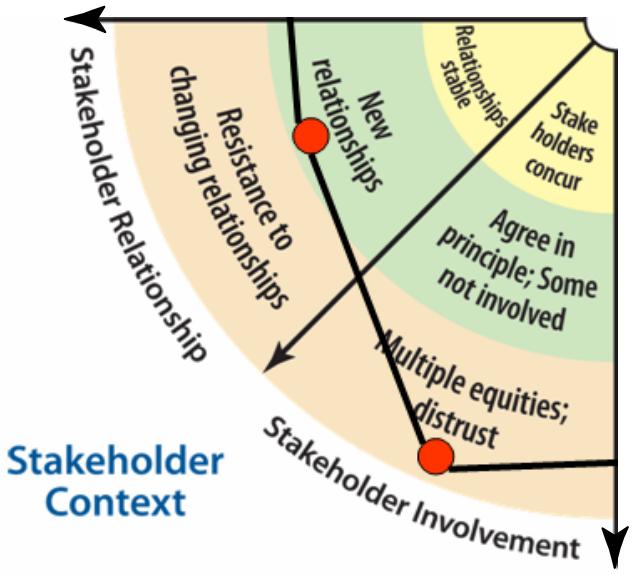


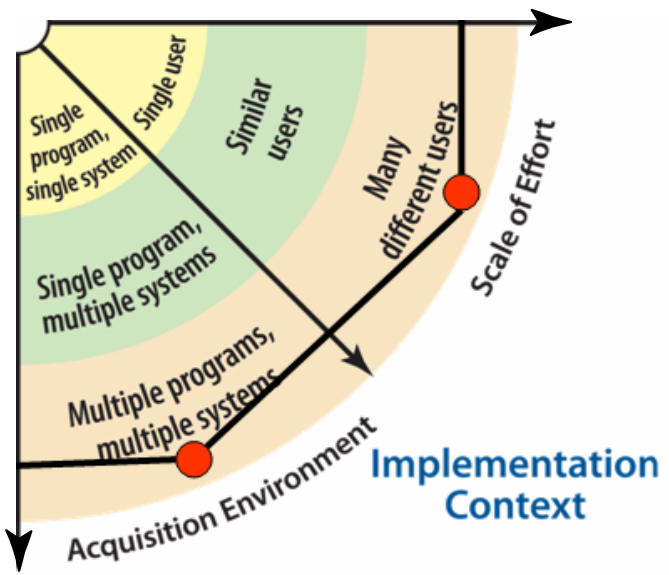
- **System Context**
  - **System Behavior**
    - **NextGen must be flexible to meet a range of air transportation system futures**
  - **Desired Outcome**
    - **Transformed air transportation system that leverages new technologies and requires policy and roles and responsibility changes**

- **Strategic Context**
  - **Scope of Effort**
    - **Interdependencies of all elements contributing to air transportation**
  - **Mission Environment**
    - **Mission evolving to accommodate new types of operations**

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NextGen Challenges: Stakeholder and Implementation Contexts





- **Stakeholder Context**
  - **Stakeholder relationship**
    - **Large and diverse stakeholder community**
  - **Stakeholder Involvement**
    - **Diversity of stakeholders leads to conflicting objectives; e.g.,**
      - **NextGen funding mechanisms**
      - **Aircraft equipage mandates**
      - **Airspace access**

- **Implementation Context**
  - **Acquisition Environment**
    - **Synchronization of research, development, and implementation of multiple government agencies and the private sector**
  - **Scale of Effort**
    - **Flexibility required to accommodate multiple user operating models**

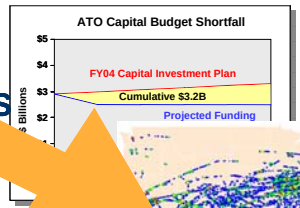
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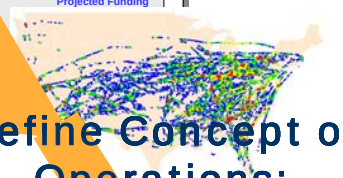
Process for Achieving NextGen



Measure Post-Implementation Performance, Service, and Cost of Segment

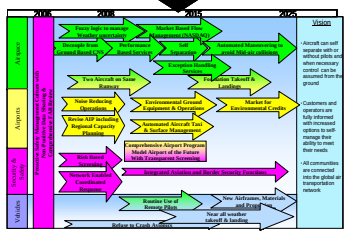
Baseline and Assess Today's Performance





Define Concept of Operations; Identify Operational Improvements

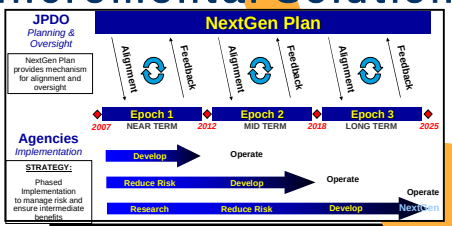




- **Define the "What"**
- **Architect & Analyze**
- **Define Solutions**
- **Execute & Measure**

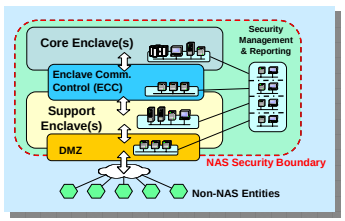
Develop Enterprise Architecture; Analyze Alternative Solutions and Assess Tradeoffs

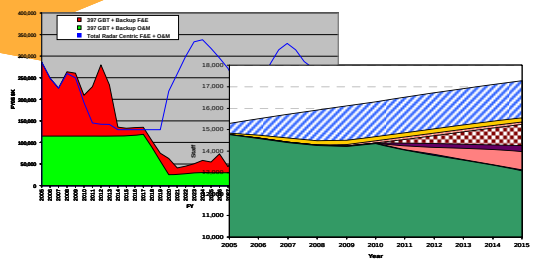
Define and Implement Incremental Solutions



Policy, Portfolio, Roadmaps, and Business Cases

Determine Program and Research Needs





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Baseline and Assess Today's Performance



- **Understand Federal agency and private sector plans, including architectures**
- **Baseline current capabilities and performance**

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Concept of Operations

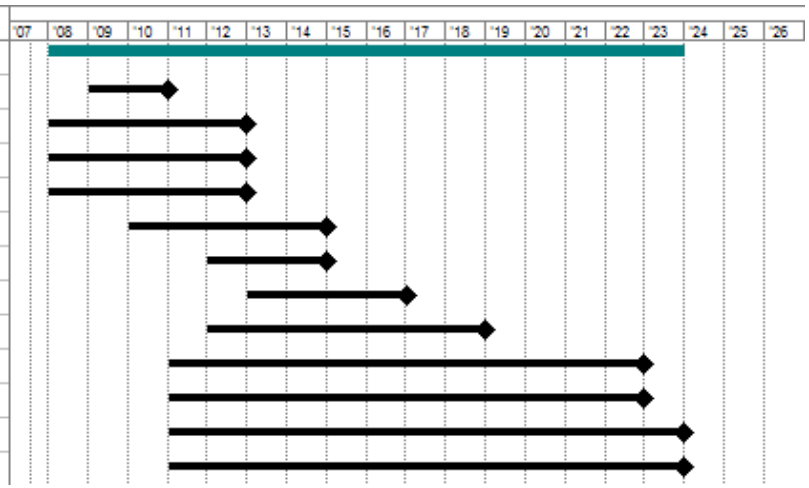


- Describes national airspace system (NAS) in 2025
  - Highlights differences from today's operations
- Presents an "aggressive" set of concepts
  - Maximize benefits and flexibility to users
- Identifies key research issues needing resolution
- Highlights areas for policy decisions
- Many possible futures
  - Down-selection and refinement of concepts to occur through research and policy decisions

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Operational Improvements

ID	Task Name
	Capacity Management
OI-0346	SUA Airspace Management - Level 1 Real-time Scheduling Information
OI-0310	Improved General Aviation Access to Traverse Terminal Areas
OI-0350	Flexible Routing
OI-0351	Airspace Reconfiguration - Level 1 Limited Dynamic En Route
OI-0361	Flexible Resource Allocation for Airspace Management
OI-0307	Airspace Reconfiguration - Level 2 Limited Dynamic Arrival/Departure
OI-0337	Flow Corridors - Level 1 Static
OI-0367	Airspace Reconfiguration - Level 3 Dynamic En Route
OI-0365	SUA Airspace Management - Level 2 Improved Coordination
OI-0366	Dynamic Airspace Reclassification
OI-0342	Airspace Reconfiguration - Level 4 Dynamic Arrival/Departure
OI-0368	Flow Corridors - Level 2 Dynamic



- **Definition – A change in operations that produces a beneficial result and moves the air transportation system toward the 2025 NextGen Goals and Objectives**
- **~ 130 OIs are grouped to describe the *operational* transition path toward the future**
- **OI roadmaps span the strategies and key capabilities described in the Integrated Plan**

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Enterprise Architecture



- Federal Enterprise Architecture Framework (FEAF) and extensions for air transportation
- Department of Defense Architecture Framework (DODAF) – selected and tailored operational, system, and technology views
- Federal Transition Framework (FTF) – Air Transportation Line of Business proposal

- Tool to relate and integrate NextGen Federal agency and private sector efforts
  - Planning, portfolio management, and system acquisition
  - Key purpose: support OMB investment decision process
- Models to describe the NAS from operational, information, systems, technology, and performance perspectives

Determine Program and Research Needs



- **JPDO working with government agencies and private sector to determine program and research needs**
  - **Considers agency specific strategic plans**
- **CONOPS has top-level research issues**
- **FY09 to FY13 Research and Development Plan developed to support budget formulation**
- **Demonstrations identified to assess operational concepts, system implementations, or technologies**

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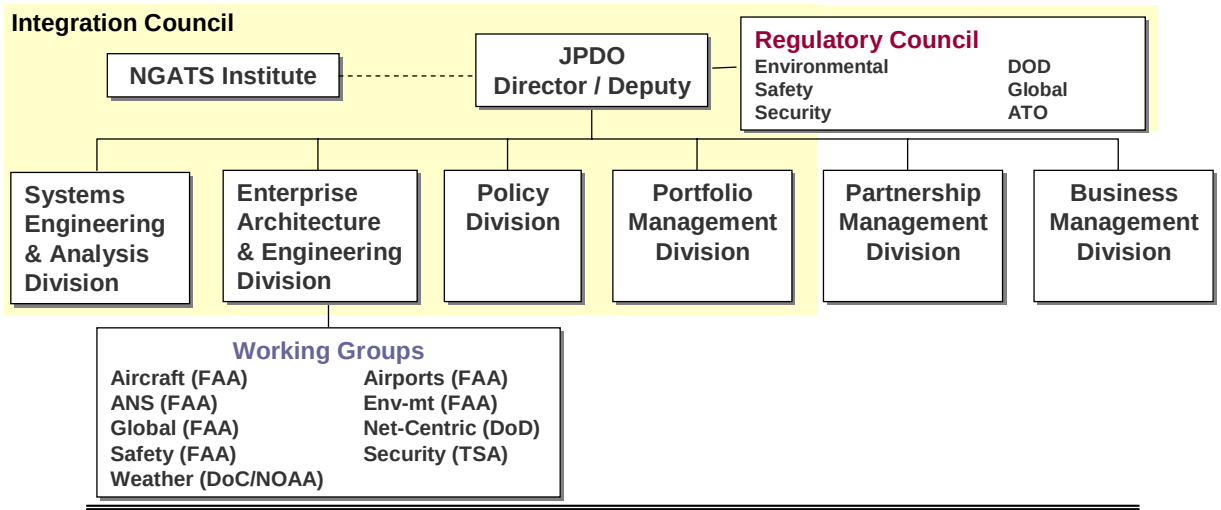
Define and Implement Incremental Solutions

- Full range of DOTMLPF solutions applies across public and private sectors
- Policy issues addressed in an integrated manner
  - Examples: surveillance integration, navigation system backup, and equipage for required performance
- Portfolio management
  - Investments selection (program and research)
  - Collaborative effort among stakeholders, including the agencies, and OMB
  - Business case includes benefits and costs
  - "Portfolio" view is needed to justify investments contributing to OIs – not a program by program view



- NextGen Integrated Work Plan
  - Time phased plan consolidating OI roadmaps, research plans, policy needs, and other implementation supporting material
- Agencies and private sector implement; JPDO monitors and assess progress, including performance and cost

JPDO Organization



Governance
- Senior Policy Committee
- Board of Directors

Advisors
- REDAC Executive Committee
- Institute Management Council

Inter-Agency Coordination
- Joint Architecture & Engineering Board

- Government leadership reflects participation from NextGen agencies
- Organization tailored to achieve enterprise transformation
- JPDO includes government, contractor, and Federally Funded Research and Development Center (FFRDC) managers and staff
- Working Groups responsible for domain-specific products
  - Include government, NextGen Institute, and FFRDC members
- Multilevel governance includes cabinet level leadership (SPC)

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NextGen Stakeholder Participation

Stakeholder	Roles and Responsibilities
Agencies	Develop and review overarching products, conduct government research, and implement government programs
Private sector	Develop and review overarching products, conduct private sector research, and implement private sector programs
Office of Management and Budget	Review NextGen EA and review of NextGen Business Case
Congress and Government Accountability Office	Conduct review of NextGen progress reports and selected products, and review of JPDO effectiveness
Department Inspectors General	Conduct review of JPDO effectiveness

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Lessons Learned

- **Governance must be established early to ensure the roles and responsibilities of participating government organizations and industry stakeholders are clearly defined and described**
  - **Boundaries and activities which delineate the "who does what"**
  - **Scope and depth of the interoperability required between multiple agencies' and industry, various activities and systems/applications**
  - **Information exchange required among participants**

- **JPDO could not reuse existing single agency processes and products without changes to plan and oversee implementation of NextGen**
  - **Single agency coordination processes and products were not sufficient to address mission needs, although most came from the participating agencies themselves**
  - **Need to consider public-private partnership, multi-agency operations, cross agency investments, and long term planning horizon influence**

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Lessons Learned

- **Multi-agency organizations require a common way to describe key aspects of cross agency planning**
  - **Common products and process flow**
  - **Level of detail varies by area – overlap with agency products expected**
  - **Concerns differs across stakeholders – White House, Congress, industry groups, etc.**
  - **Visibility into evolving products needed while protecting sensitive information**
- **JPDO continues to deal with complexity that increases with scope, diversity of stakeholders, time horizon, applicable technologies, policy areas, etc. – more complex than single agency effort**
  - **Processes continue to evolve to achieve the products that are understandable by the various agencies and industry**
  - **Long time horizon means that "design space" will not close until R&D complete**
- **Public-private partnerships require government and industry leadership and staffing**
  - **Work groups have government and private sector co-leads and participation**
  - **Industry representatives are members of the Integration Council**

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Summary

- **NextGen is a pathfinder for addressing large scale, multi-agency enterprise system engineering challenges**
  - **Joint and sometimes conflicting missions**
  - **Transformation of services**
  - **Reducing costs for government, industry and the public**
- **Multi-agency and public-private efforts involve higher complexity and additional products and processes compared to single agency programs**
- **Progress depends on satisfying multiple stakeholders while maintaining focus on most important products and impacts**

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For More Information

- **Joint Planning and Development Office:**
  - http://www.jpdo.gov
- **NGATS Institute:**
  - http://www.ncat.com/ngats/index.html

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DEPARTMENT OF DEFENSE
MERIT
Materials of Evolving Regulatory Interest Team



Emerging Contaminants Directorate

Carole.LeBlanc@osd.mil
703.604.1934

National Defense Industrial Association
10th Annual Systems Engineering Conference
October 25, 2007
San Diego, California

DoD's Emerging Contaminants Program

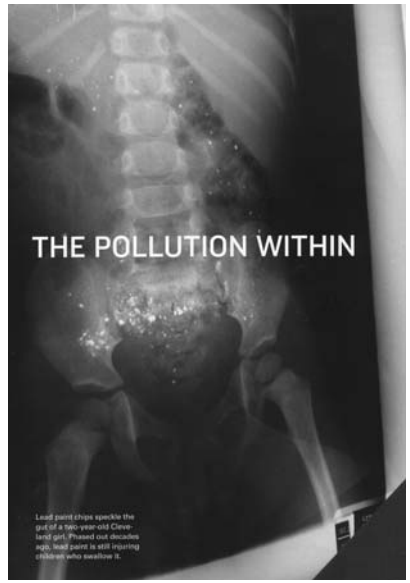
Carole LeBlanc, Ph.D.
Special Expert, Emerging Contaminants
Office of the Deputy Under Secretary of Defense
(Installations & Environment)

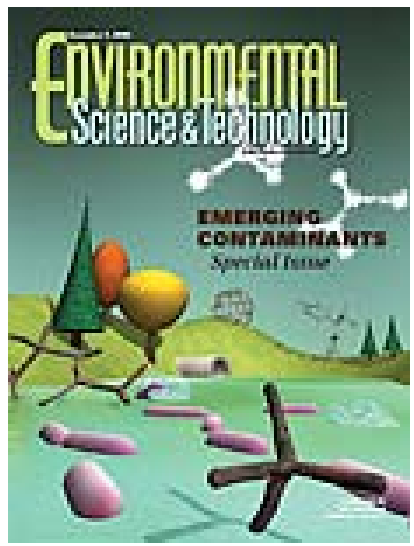
Presentation Overview

- **The Department of Defense's (DoD's) Interpretation of Emerging Contaminants**
- **Opportunities for Improving Risk Management (RM) Options at DoD**
  - Processes for Assessing and Managing Risks
  - 'Watch' and 'Action' Chemicals
- **EC Program Highlights**
  - Proactive Approach: What Program Managers (PMs) and Others Can Do
    - Materials of Evolving Regulatory Interest Team (MERIT)
    - Websites

National & International Interest in ECs

- **Press**
  - ES&T Magazine - Dec 06
  - National Geographic Magazine - Oct 06
- **Conferences/Hearings/Reports**
  - AWRA Spring Conference - June 07
  - USGS Survey of 139 streams in 30 states
    - » ECs found in 80% of streams
  - Renewable Nat'l Resources Foundation Report
- **Regulations/Mandates**
  - New Executive Order (January 24, 2007)
  - European Union – REACH (June 1, 2007)

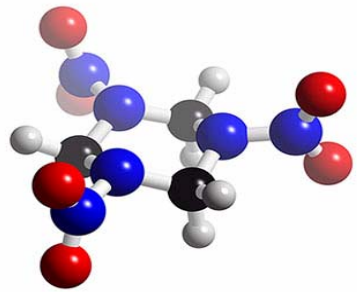




What Is an Emerging Contaminant?

At the Department:
Emerging Contaminants (ECs) are defined as

- Chemicals & materials with
  - Perceived or real threat to human health or environment
  - Either no peer reviewed health standard or an evolving standard
- May have
  - Insufficient human health data/science
  - New detection limits
  - New exposure pathways



How Can ECs Affect DoD?

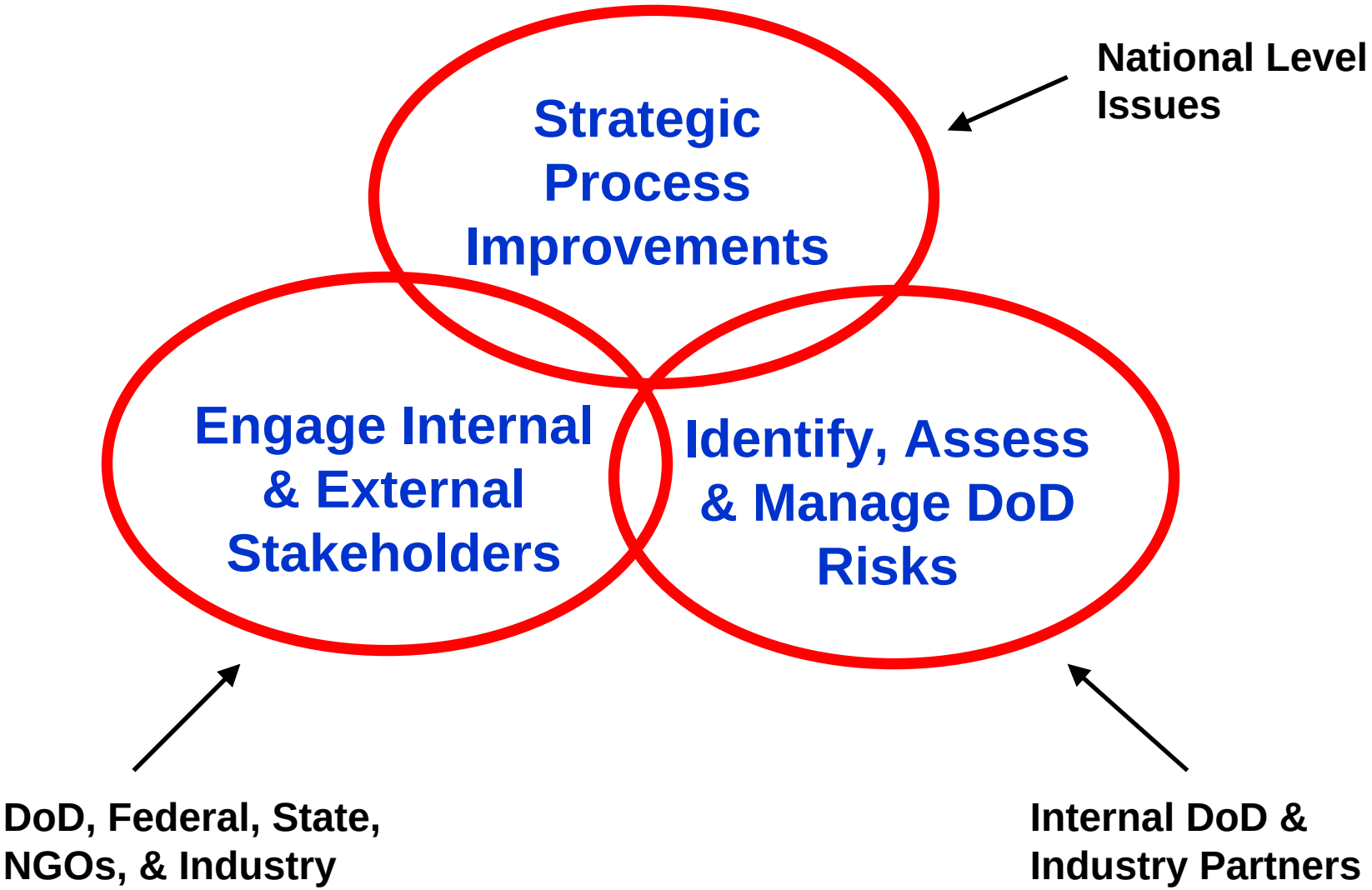
- Adverse health effects on operating forces, DoD employees, and/or public
  - Human health protection paramount
- Reduced training/readiness
  - Restrictions on use of ranges
- Restricted or non-availability of material
  - Adverse impact on mission-critical applications & industrial base
- Increased O&M and/or cleanup costs
  - Resource drain from mission needs

The Vision

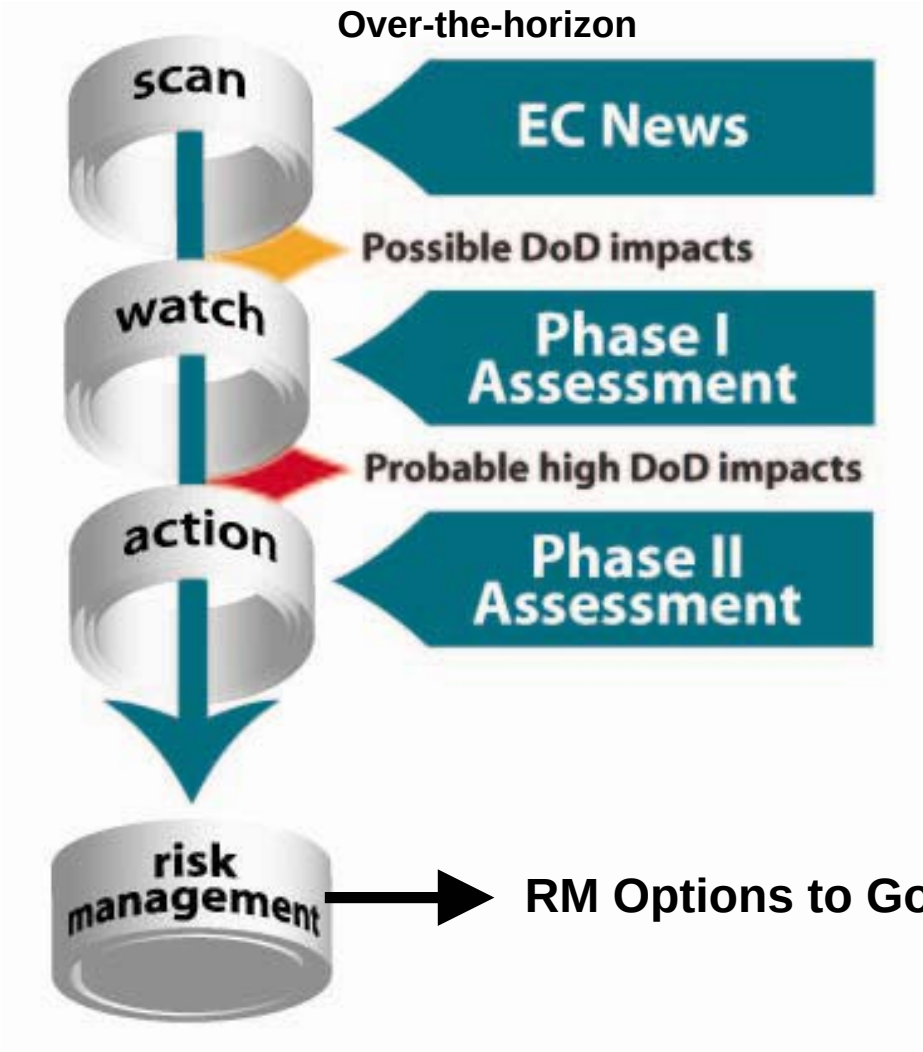
Imagine if the largest industrial complex in the nation could…

- ***Predict*** **which chemicals it uses, or might use, pose human health and environmental risks and have an evolving regulatory status**
- ***Develop*** **a consensus evaluation of types & magnitudes of the risks in using/releasing such chemicals**
- ***Develop*** **risk management options and invest in high-payback actions**
- ***Achieve*** **and** ***measure*** **risk reduction**

Strategic Priorities to Achieve the Vision



EC "Scan-Watch-Action" Process



Review literature, periodicals, regulatory communications, etc. to Provide early warning of ECs of possible interest to DoD

Monitor events; Conduct Phase I qualitative impact assessment to assess impacts to DoD

Conduct Phase II quantitative impact assessment with risk management options to create strategic investment options for enterprise consideration

Phase I EC Impact Assessment

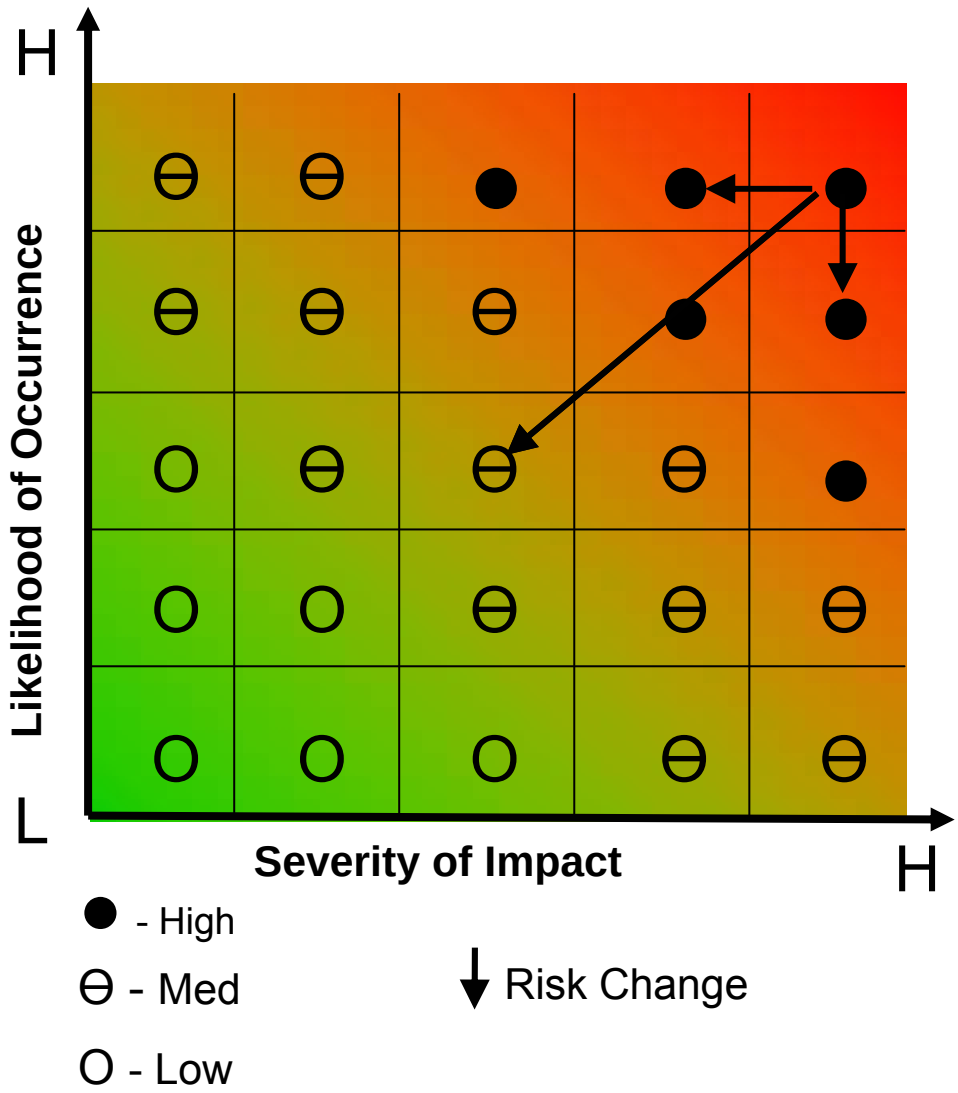
1. **Probability of Regulation/Re-regulation**
2. **Impact on DoD Functional Categories**

Environment Safety & Health	Readiness & Training	Acquisition	Production, O&M and Disposal	Cleanup
H	H	H	H	H
M	M	M	M	M
L	L	L	L	L

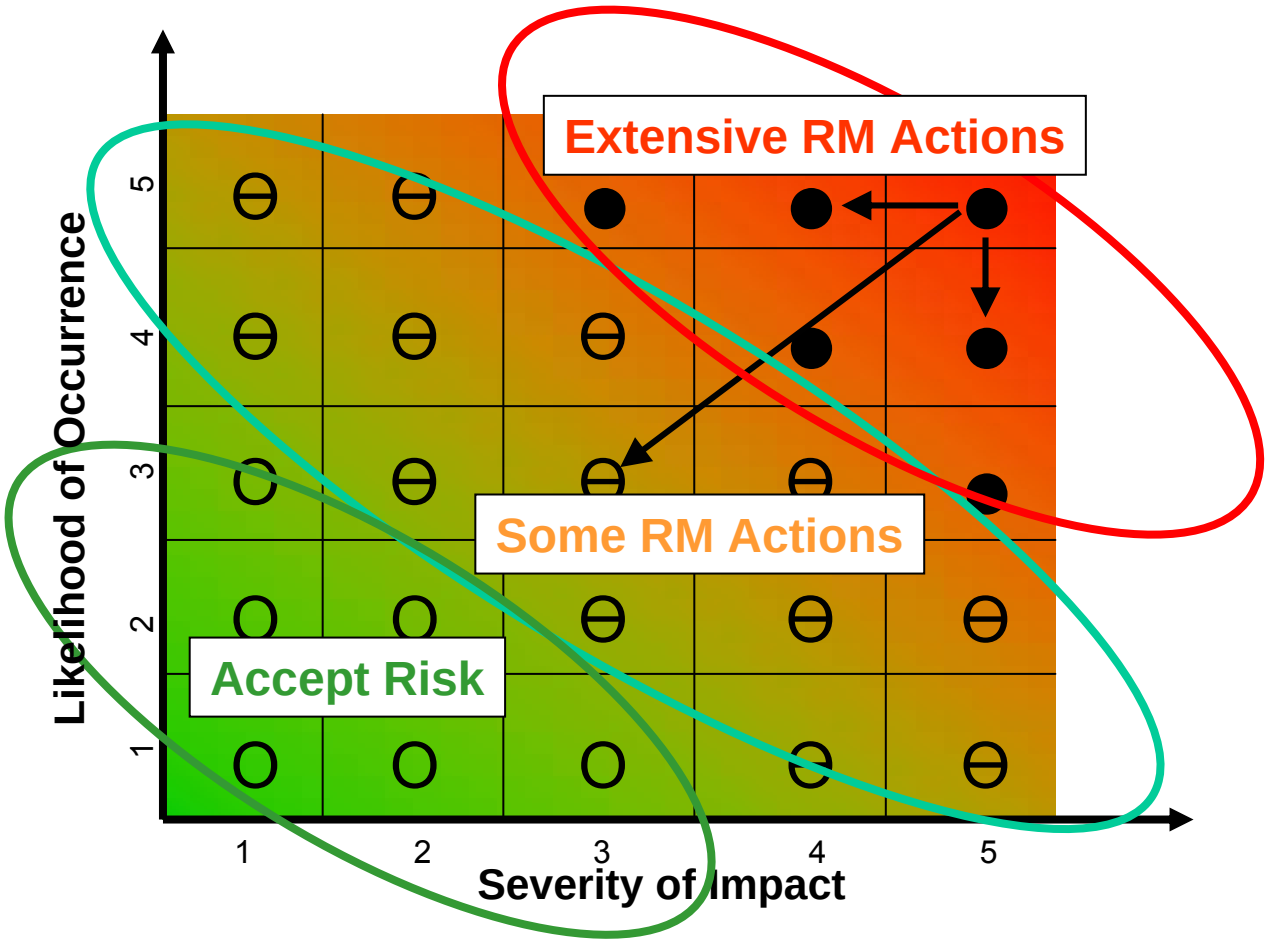
3. **Results** →
   - **Decision – Move to Action List?**
   - **Initial Risk Management Options**

Plotting EC Risk to DoD

- High risk at top right
- Risk management actions move ECs to lower left… lower risk
- Seek to quantify risk reduction



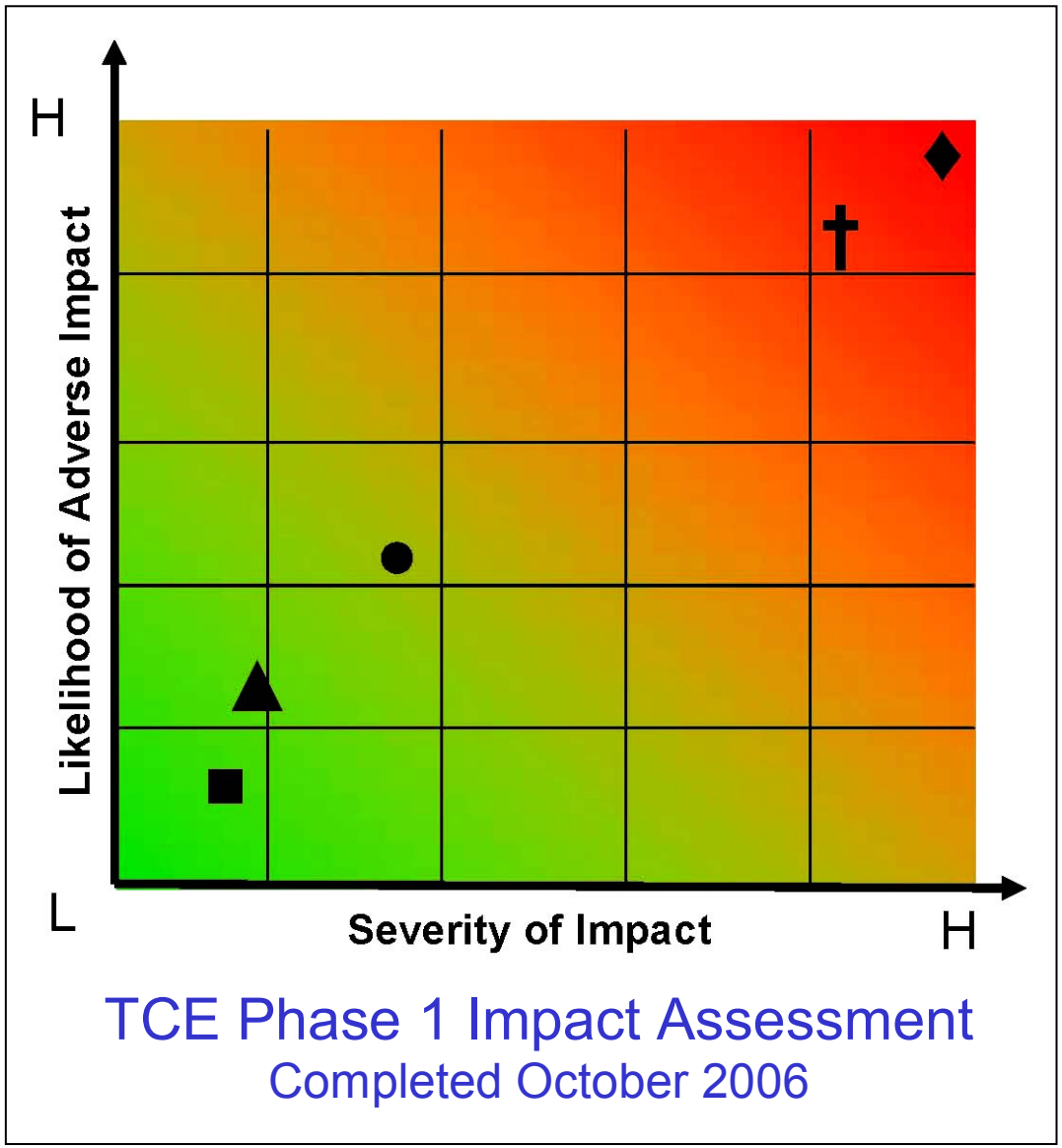
Integrated Risk Management (RM)



RM Options

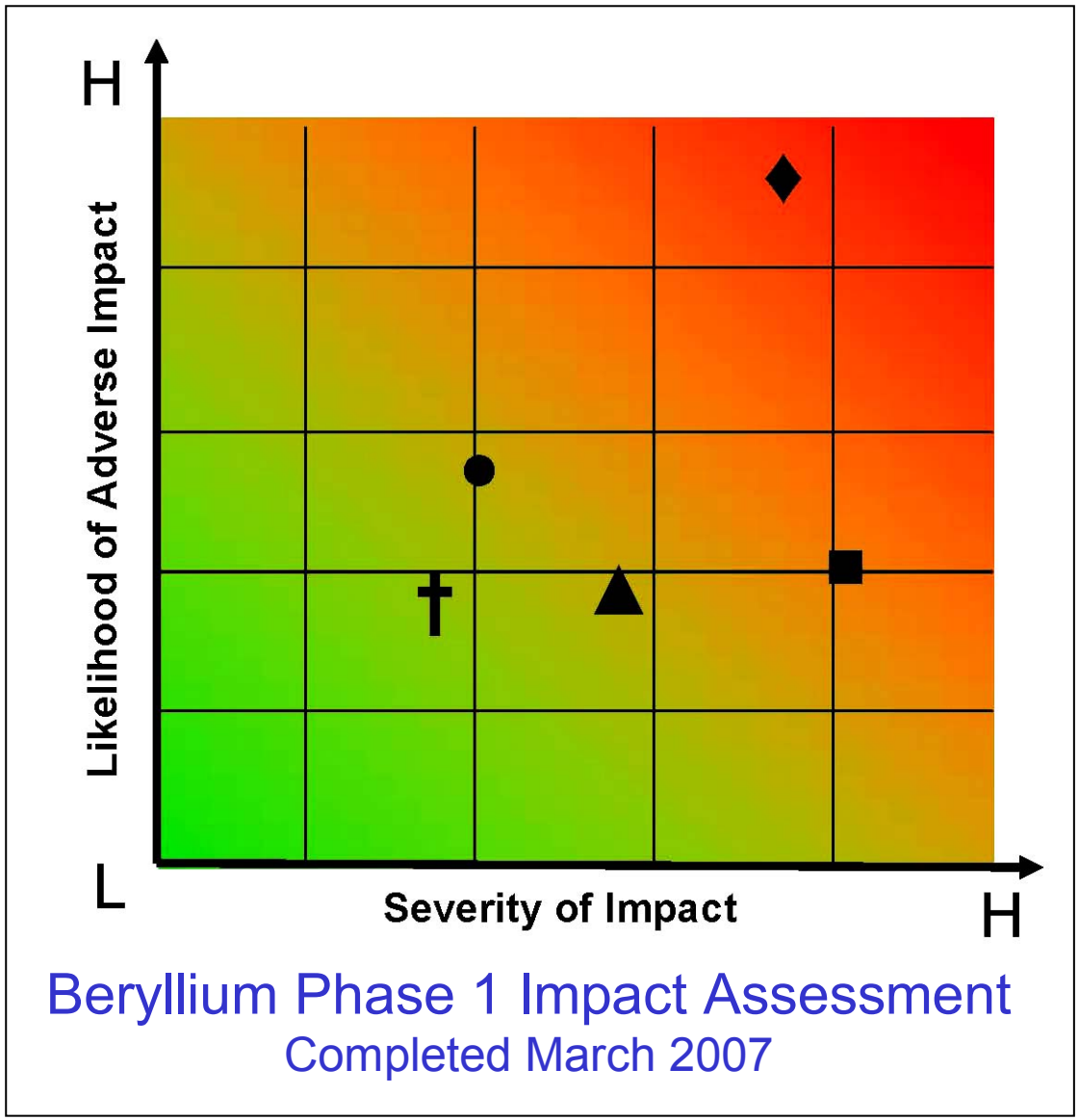
- Fill tox science gaps
- RDT&E
- Material substitution
- Process changes
- Regulatory engagement
- Stockpile material
- Exposure assessment & monitoring
- Personal Protective Equipment (PPE)
- Acquisition changes
- Benchmark with industry
- Risk communication
- Training

Example: TCE and the Relative Risks to EH&S and Cleanup



TCE Phase 1 Impact Assessment
Completed October 2006

Example: Beryllium and the Relative Risks to EH&S and Readiness & Training



Beryllium Phase 1 Impact Assessment
Completed March 2007

Legend
- ♦ ES&H
- ■ Readiness & Training
- ▲ Acquisition/RDT&E
- ● O&M of Assets
- † Cleanup

Chemical and Material Differences

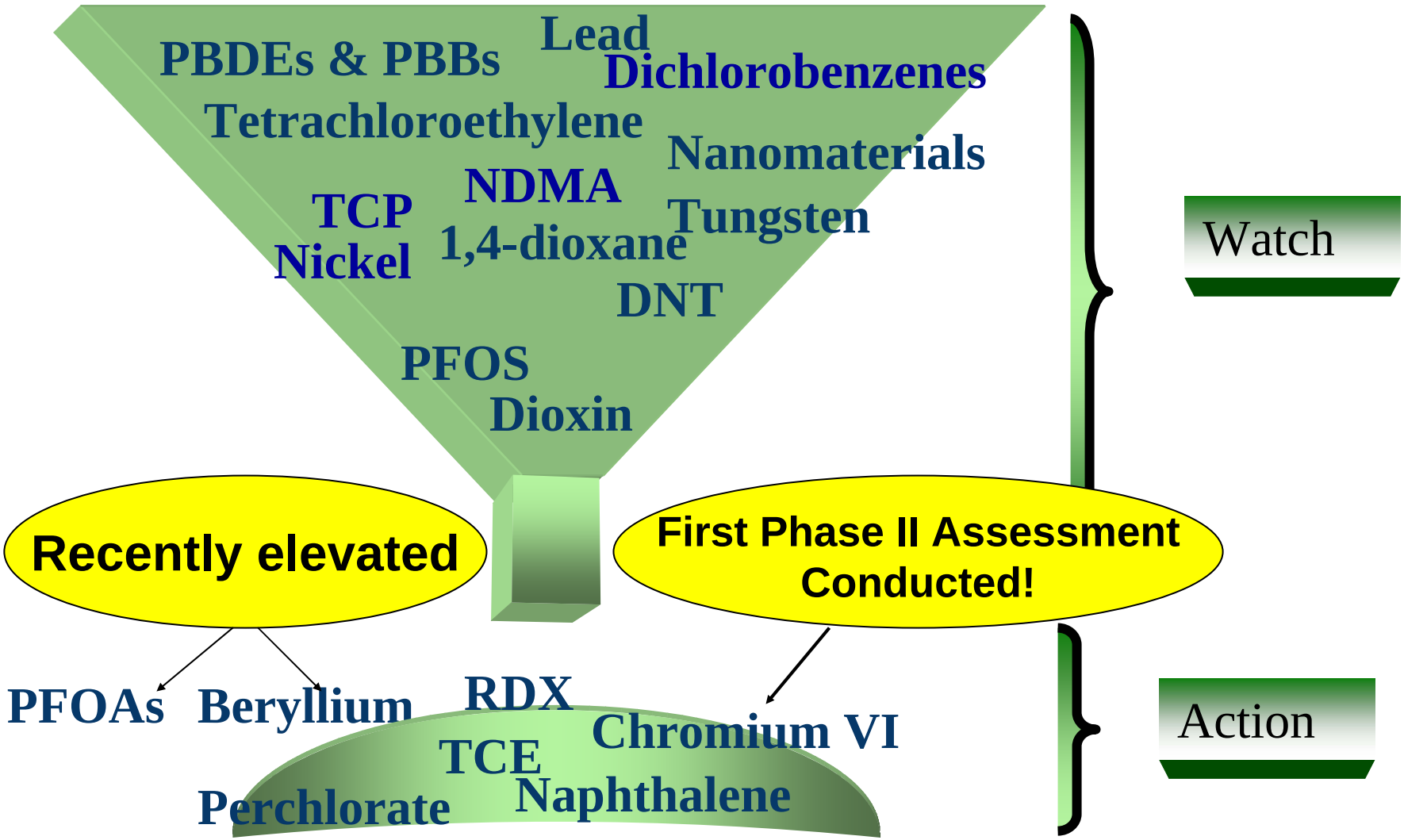
Watch List

- May impact DoD
- Limited analysis of impact – more qualitative
- Monitor external actions
- Updated regularly
- Short info sheets developed
- Minimal resources expended

Action List

- Likely to impact DoD
- Detailed analysis of impact – more quantitative
- Take RM actions
- Executive info sheets developed
- Significant resources may be expended
- “Material champion” assigned

Chemicals and Materials Identified Thus Far



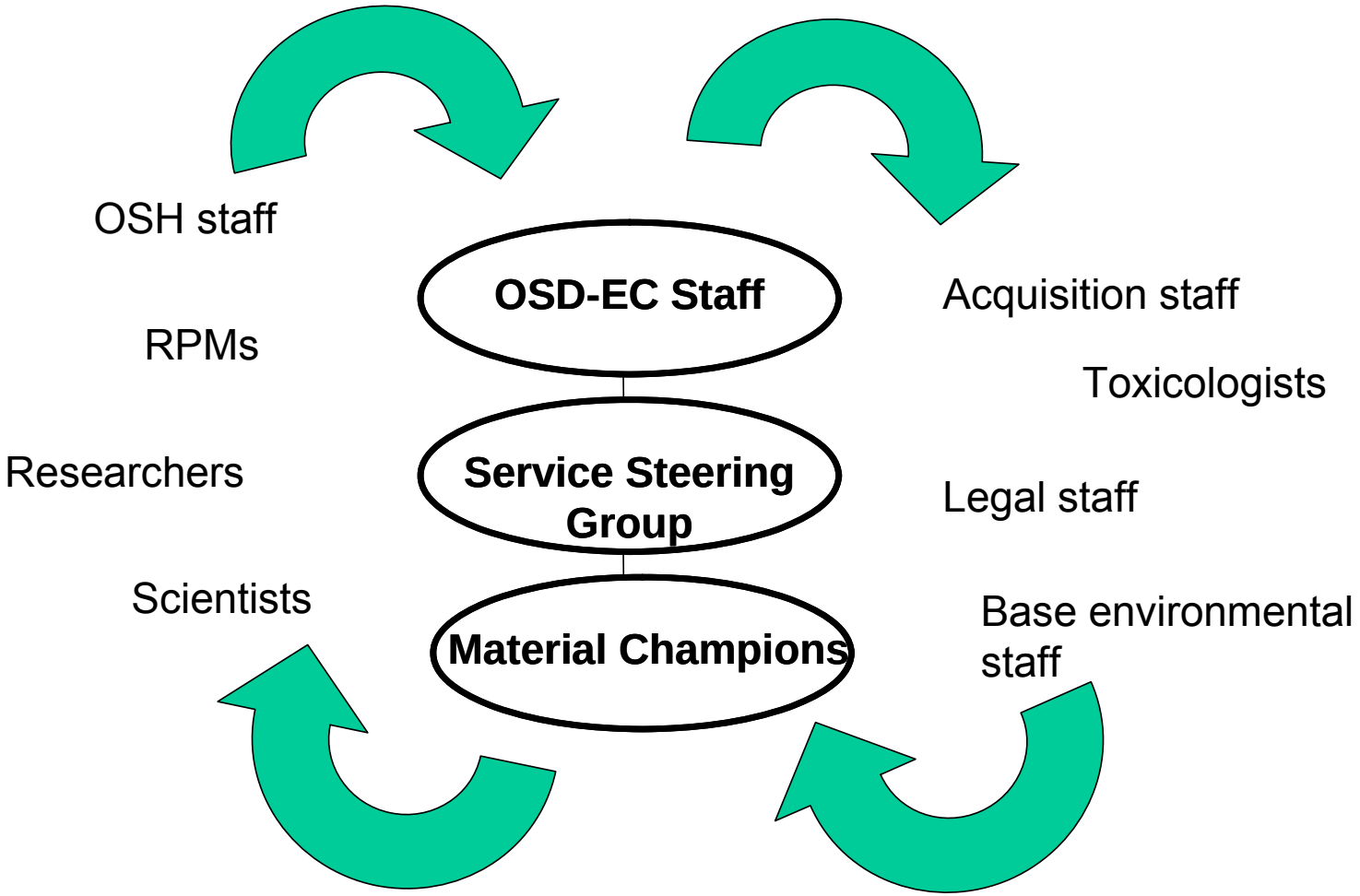
EC Program Summary

- **EC management required new thinking**
  - Make targeted investments before regulatory action
  - Base decisions on life cycle costs
  - Craft process for tracking, assessing and developing risk management options
    - » Leverage existing assets/resources
- **EC management required new organization**
  - Created Emerging Contaminants Directorate
  - Established funding line within DoD environmental budget
  - Launched executive level EC Governance Council to enhance corporate decision-making

EC Program Highlights

- **Keep Program Executive Offices (PEOs) and Program Managers (PMs) informed on**
  - New ECs
  - Risks
  - Risk management options
- **Some EC Products**
  - Newsletter
    - » Provides brief news events & links
  - Scan-Watch-Action List and Impact Assessments
  - Web Site
    - » EC database and information

Become Involved in the EC Process



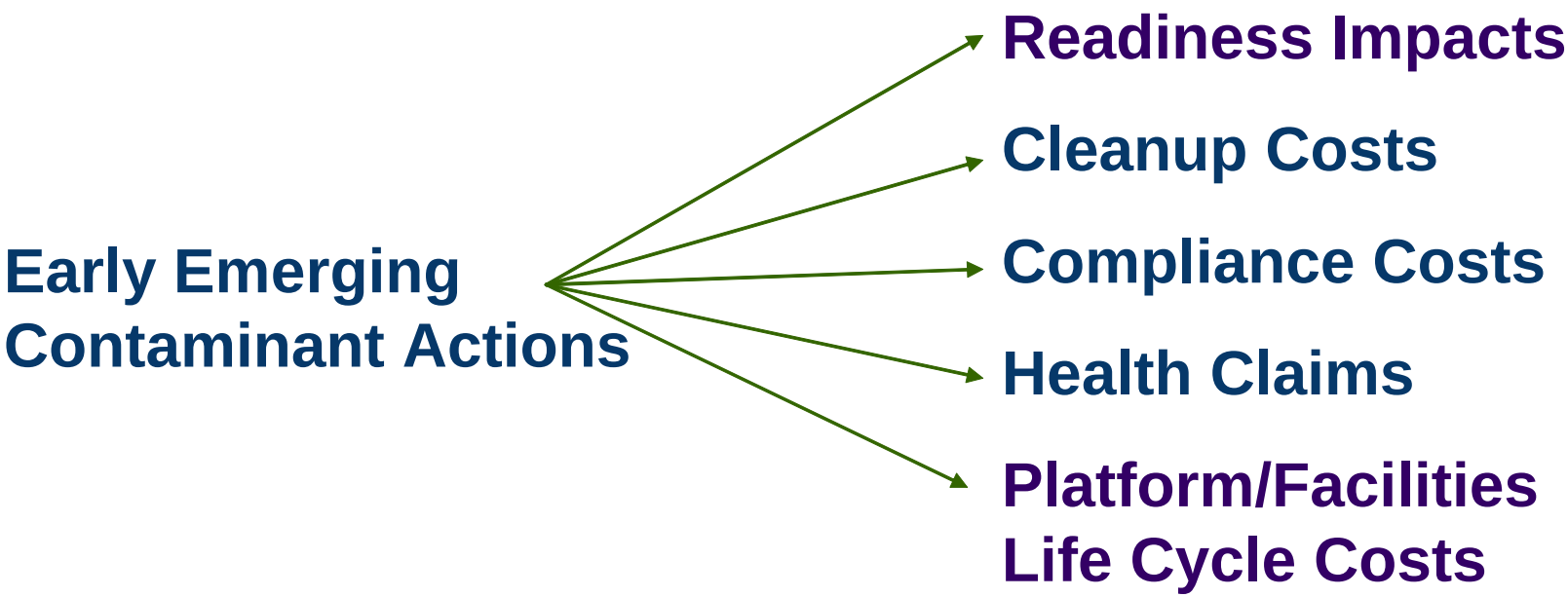
Including MERIT, a virtual team

DoD EC Web Sites



The Take Home Message

Proactive vs Reactive



$$$

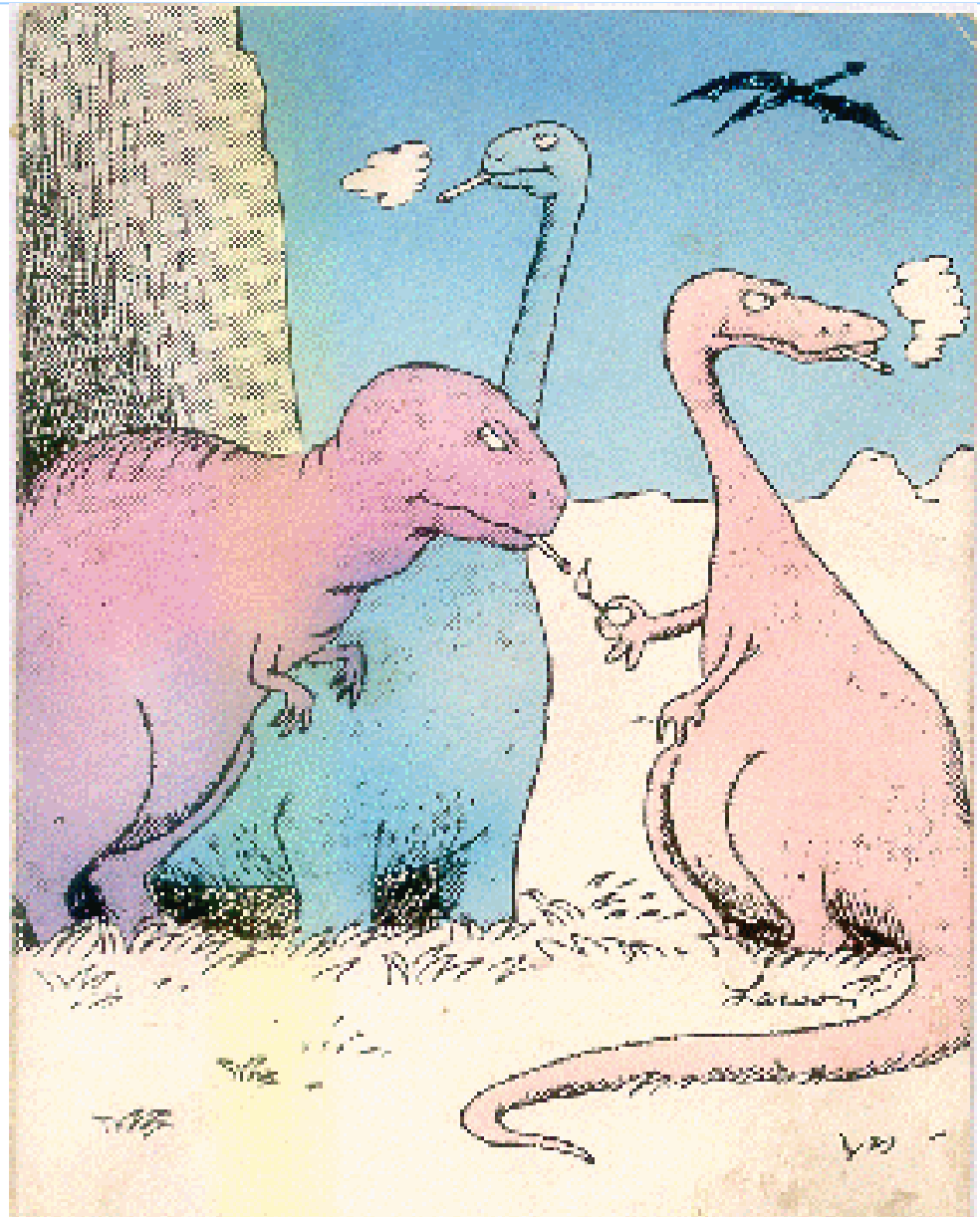
Small investment here

$$$

Large impact here

Potential Large Payback
Protects Mission, People and Assets

Otherwise…



The real reason dinosaurs became extinct.

USAF Type Certification of Commercial Derivative Aircraft

25 October 2007

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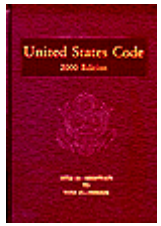
DISTRIBUTION A. Approved for public release; distribution unlimited (ASC/PAM Document Number ASC 07-0315 dated 25 Sep 2007).

Course Outline

- Airworthiness Authority – FAA and USAF
- Air Force Airworthiness Tools – TACCs and MACCs
- When Civil and Military processes collide
- Managing the seam, maintaining FAA pedigree and safety levels on military installations
- New FAA Order 8110.101
- Levels of Certitude – Civil and Military
- Issues when mixing fish and foul
- Summary
- Conclusions

Airworthiness Authority

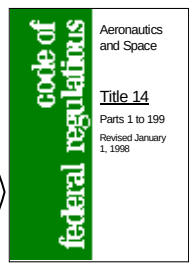
United States Code



Title 49 Department of Transportation

40113 FAA Administrator:
(a) Has discretionary authority
(b) May indemnify others to act…
44701 (a) in promoting safety may
(1) Establish minimum standards
(2) Issue regulations

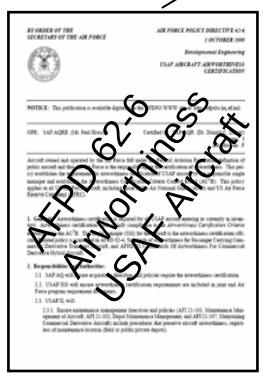
Code of Federal Regulations

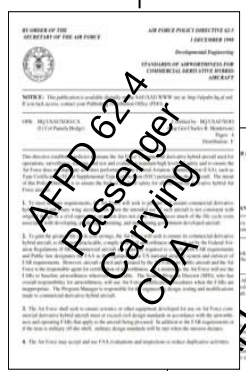


Title 14 Aeronautics and Space

Title 10 Department of Defense

8013 Secretary of the Air Force
(b)(3) Supplying, (3) Equipping,
(5) Training, (9) Administering
(including welfare)
(c)(2) Formulation of policies

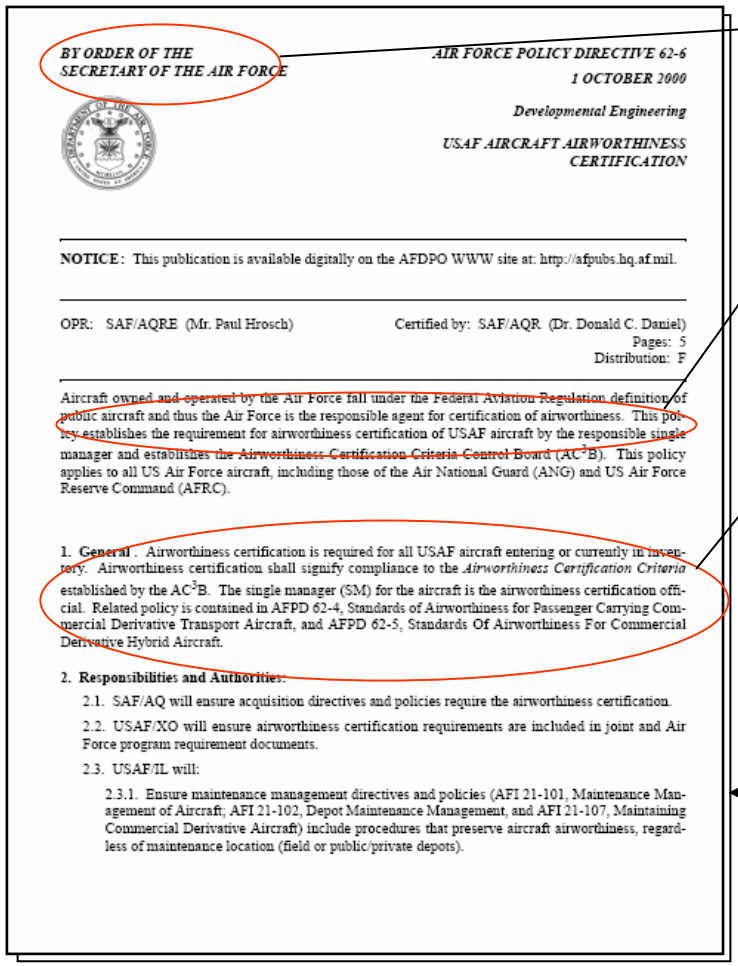

AFPD 62-6 Airworthiness USAF Aircraft


AFPD 62-4 Passenger Carrying CDA


AFI 21-107 Maintaining CDA


AFPD 62-5 Hybrid CDA

AFPD 62-6 USAF Aircraft Airworthiness Certification



BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE POLICY DIRECTIVE 62-6

1 OCTOBER 2000

Developmental Engineering

USAF AIRCRAFT AIRWORTHINESS CERTIFICATION

NOTICE: This publication is available digitally on the AFDPO WWW site at: http://afpubs.hq.af.mil.

OPR: SAF/AQRE (Mr. Paul Hrosch) Certified by: SAF/AQR (Dr. Donald C. Daniel)
Pages: 5
Distribution: F

Aircraft owned and operated by the Air Force fall under the Federal Aviation Regulation definition of public aircraft and thus the Air Force is the responsible agent for certification of airworthiness. This policy establishes the requirement for airworthiness certification of USAF aircraft by the responsible single manager and establishes the Airworthiness Certification Criteria Control Board (AC^3B). This policy applies to all US Air Force aircraft, including those of the Air National Guard (ANG) and US Air Force Reserve Command (AFRC).

1. **General**. Airworthiness certification is required for all USAF aircraft entering or currently in inventory. Airworthiness certification shall signify compliance to the *Airworthiness Certification Criteria* established by the AC^3B. The single manager (SM) for the aircraft is the airworthiness certification official. Related policy is contained in AFPD 62-4, Standards of Airworthiness for Passenger Carrying Commercial Derivative Transport Aircraft, and AFPD 62-5, Standards Of Airworthiness For Commercial Derivative Hybrid Aircraft.

2. **Responsibilities and Authorities:**

2.1. SAF/AQ will ensure acquisition directives and policies require the airworthiness certification.

2.2. USAF/XO will ensure airworthiness certification requirements are included in joint and Air Force program requirement documents.

2.3. USAF/IL will:

2.3.1. Ensure maintenance management directives and policies (AFI 21-101, Maintenance Management of Aircraft; AFI 21-102, Depot Maintenance Management, and AFI 21-107, Maintaining Commercial Derivative Aircraft) include procedures that preserve aircraft airworthiness, regardless of maintenance location (field or public/private depots).

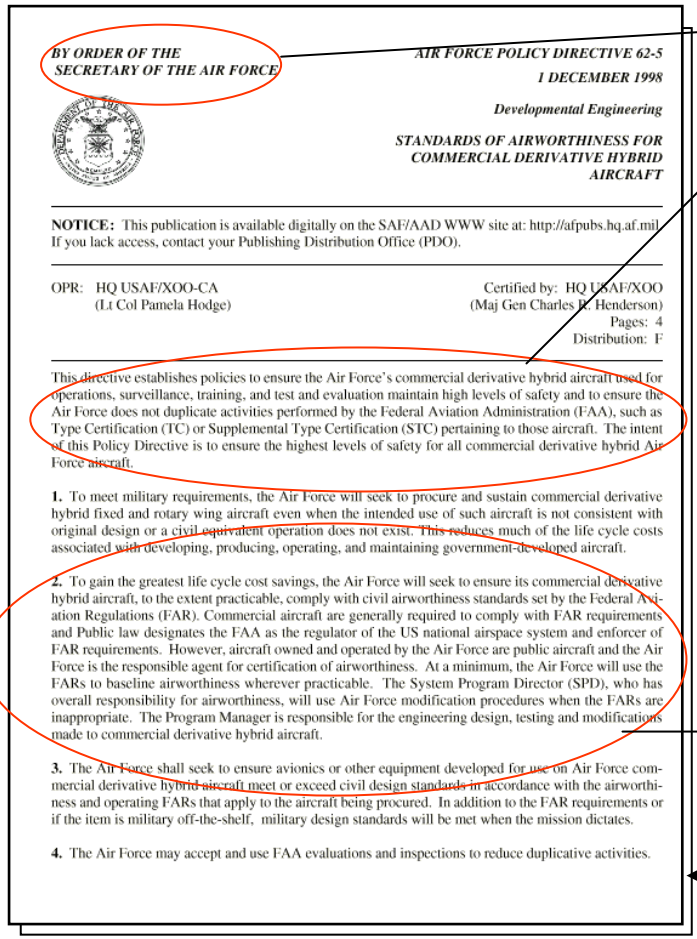
"By order of the Secretary of the Air Force"

"This policy establishes the requirement for Airworthiness Certification of USAF Aircraft by the responsible single manager"

"1. General: Airworthiness Certification …applies to all USAF aircraft…Related Policy..AFPD 62-4, AFPD 62-5.."

"Section 2.8 Aircraft Single Managers will:
…
2.8.8 Prior to first flight, make and document a positive determination of safety of flight **in accordance with ASC guidelines**.
…"

AFPD 62-5 - Hybrids



BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE POLICY DIRECTIVE 62-5
1 DECEMBER 1998

Developmental Engineering

STANDARDS OF AIRWORTHINESS FOR COMMERCIAL DERIVATIVE HYBRID AIRCRAFT

NOTICE: This publication is available digitally on the SAF/AAD WWW site at: http://afpubs.hq.af.mil. If you lack access, contact your Publishing Distribution Office (PDO).

OPR: HQ USAF/XOO-CA
(Lt Col Pamela Hodge)

Certified by: HQ USAF/XOO
(Maj Gen Charles R. Henderson)
Pages: 4
Distribution: F

This directive establishes policies to ensure the Air Force's commercial derivative hybrid aircraft used for operations, surveillance, training, and test and evaluation maintain high levels of safety and to ensure the Air Force does not duplicate activities performed by the Federal Aviation Administration (FAA), such as Type Certification (TC) or Supplemental Type Certification (STC) pertaining to those aircraft. The intent of this Policy Directive is to ensure the highest levels of safety for all commercial derivative hybrid Air Force aircraft.

1. To meet military requirements, the Air Force will seek to procure and sustain commercial derivative hybrid fixed and rotary wing aircraft even when the intended use of such aircraft is not consistent with original design or a civil equivalent operation does not exist. This reduces much of the life cycle costs associated with developing, producing, operating, and maintaining government-developed aircraft.

2. To gain the greatest life cycle cost savings, the Air Force will seek to ensure its commercial derivative hybrid aircraft, to the extent practicable, comply with civil airworthiness standards set by the Federal Aviation Regulations (FAR). Commercial aircraft are generally required to comply with FAR requirements and Public law designates the FAA as the regulator of the US national airspace system and enforcer of FAR requirements. However, aircraft owned and operated by the Air Force are public aircraft and the Air Force is the responsible agent for certification of airworthiness. At a minimum, the Air Force will use the FARs to baseline airworthiness wherever practicable. The System Program Director (SPD), who has overall responsibility for airworthiness, will use Air Force modification procedures when the FARs are inappropriate. The Program Manager is responsible for the engineering design, testing and modifications made to commercial derivative hybrid aircraft.

3. The Air Force shall seek to ensure avionics or other equipment developed for use on Air Force commercial derivative hybrid aircraft meet or exceed civil design standards in accordance with the airworthiness and operating FARs that apply to the aircraft being procured. In addition to the FAR requirements or if the item is military off-the-shelf, military design standards will be met when the mission dictates.

4. The Air Force may accept and use FAA evaluations and inspections to reduce duplicative activities.

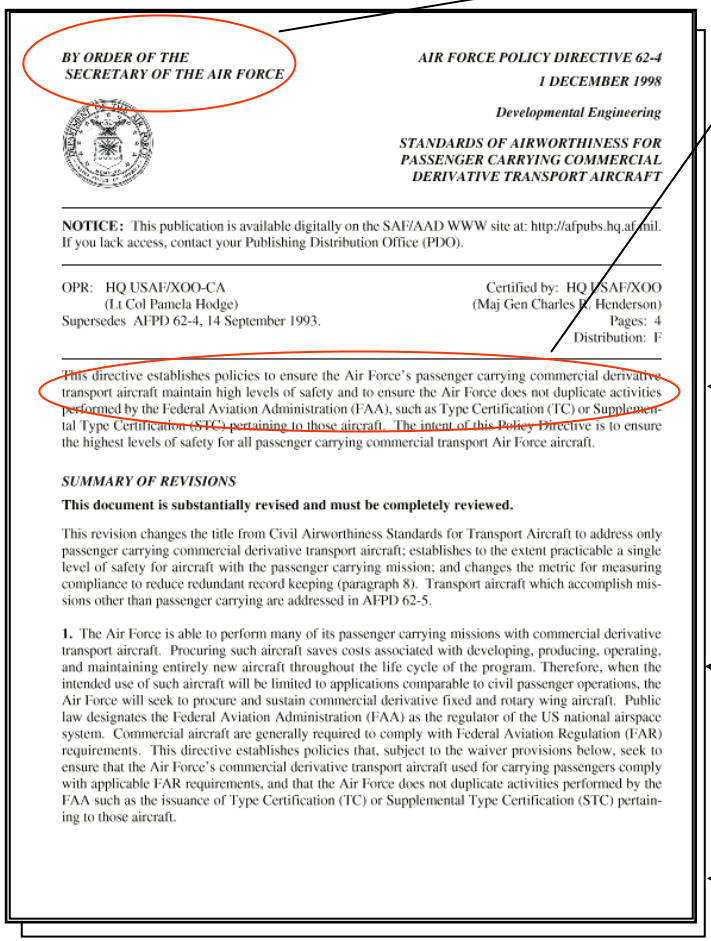
"By order of the Secretary of the Air Force"

"This directive establishes policies to ensure the Air Force's commercial derivative hybrid aircraft …maintain high levels of safety ... and to ensure the Air Force does not duplicate activities performed by the …FAA. …(to) ensure **highest level of safety** for all commercial derivative hybrid Air Force aircraft."

2. To gain the greatest life cycle cost savings, the Air Force will seek to ensure its commercial derivative hybrid aircraft, to the maximum extent practicable, comply with civil airworthiness standards set by the Federal Aviation Regulations (FAR). … At a minimum, the Air Force will use the FARs to baseline airworthiness whenever practicable. …"

4. The Air Force may accept and use FAA evaluations and inspections to reduce duplicative activities

AFPD 62-4 Passenger CDA



BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE POLICY DIRECTIVE 62-4
1 DECEMBER 1998

Developmental Engineering

STANDARDS OF AIRWORTHINESS FOR PASSENGER CARRYING COMMERCIAL DERIVATIVE TRANSPORT AIRCRAFT

NOTICE: This publication is available digitally on the SAF/AAD WWW site at: http://afpubs.hq.af.mil. If you lack access, contact your Publishing Distribution Office (PDO).

OPR: HQ USAF/XOO-CA
(Lt Col Pamela Hodge)
Supersedes AFPD 62-4, 14 September 1993.

Certified by: HQ USAF/XOO
(Maj Gen Charles E. Henderson)
Pages: 4
Distribution: F

This directive establishes policies to ensure the Air Force's passenger carrying commercial derivative transport aircraft maintain high levels of safety and to ensure the Air Force does not duplicate activities performed by the Federal Aviation Administration (FAA), such as Type Certification (TC) or Supplemental Type Certification (STC) pertaining to those aircraft. The intent of this Policy Directive is to ensure the highest levels of safety for all passenger carrying commercial transport Air Force aircraft.

SUMMARY OF REVISIONS

This document is substantially revised and must be completely reviewed.

This revision changes the title from Civil Airworthiness Standards for Transport Aircraft to address only passenger carrying commercial derivative transport aircraft; establishes to the extent practicable a single level of safety for aircraft with the passenger carrying mission; and changes the metric for measuring compliance to reduce redundant record keeping (paragraph 8). Transport aircraft which accomplish missions other than passenger carrying are addressed in AFPD 62-5.

1. The Air Force is able to perform many of its passenger carrying missions with commercial derivative transport aircraft. Procuring such aircraft saves costs associated with developing, producing, operating, and maintaining entirely new aircraft throughout the life cycle of the program. Therefore, when the intended use of such aircraft will be limited to applications comparable to civil passenger operations, the Air Force will seek to procure and sustain commercial derivative fixed and rotary wing aircraft. Public law designates the Federal Aviation Administration (FAA) as the regulator of the US national airspace system. Commercial aircraft are generally required to comply with Federal Aviation Regulation (FAR) requirements. This directive establishes policies that, subject to the waiver provisions below, seek to ensure that the Air Force's commercial derivative transport aircraft used for carrying passengers comply with applicable FAR requirements, and that the Air Force does not duplicate activities performed by the FAA such as the issuance of Type Certification (TC) or Supplemental Type Certification (STC) pertaining to those aircraft.

"By order of the Secretary of the Air Force"

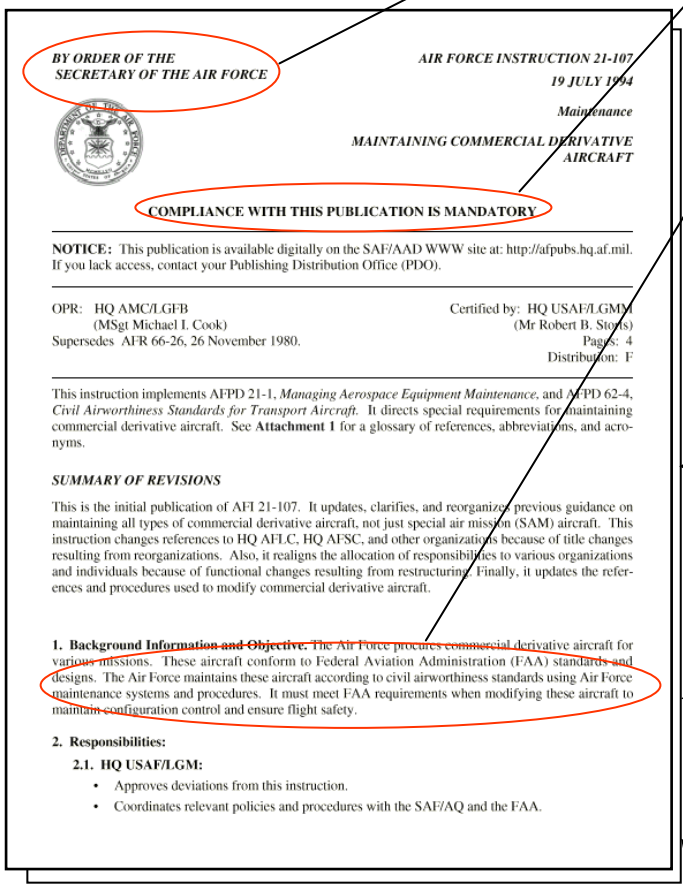
…To maintain high levels of safety and to ensure the Air Force does not duplicate FAA Activities

2. ..meet or exceed civil design standards in accordance with airworthiness and operating FARs.. ;military equipment may be used but must be reflected as deviations to type design...

3. ..avionics must meet or exceed FAR rqts…seek to obtain Equiv Level of Safety related to equipment carried on civil missions

6.3 … MAJCOM maintain to FAA Standards; 6.5 May request waiver after "all possible solutions to resolving FAR issues have been exhausted."

AFI 21-107 Maintenance



BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 21-107
19 JULY 1994

Maintenance

MAINTAINING COMMERCIAL DERIVATIVE AIRCRAFT

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

NOTICE: This publication is available digitally on the SAF/AAD WWW site at: http://afpubs.hq.af.mil. If you lack access, contact your Publishing Distribution Office (PDO).

OPR: HQ AMC/LGFB
(MSgt Michael I. Cook)
Supersedes AFR 66-26, 26 November 1980.

Certified by: HQ USAF/LGMM
(Mr Robert B. Stotts)
Pages: 4
Distribution: F

This instruction implements AFPD 21-1, *Managing Aerospace Equipment Maintenance*, and AFPD 62-4, *Civil Airworthiness Standards for Transport Aircraft*. It directs special requirements for maintaining commercial derivative aircraft. See **Attachment 1** for a glossary of references, abbreviations, and acronyms.

SUMMARY OF REVISIONS

This is the initial publication of AFI 21-107. It updates, clarifies, and reorganizes previous guidance on maintaining all types of commercial derivative aircraft, not just special air mission (SAM) aircraft. This instruction changes references to HQ AFLC, HQ AFSC, and other organizations because of title changes resulting from reorganizations. Also, it realigns the allocation of responsibilities to various organizations and individuals because of functional changes resulting from restructuring. Finally, it updates the references and procedures used to modify commercial derivative aircraft.

1. Background Information and Objective. The Air Force procures commercial derivative aircraft for various missions. These aircraft conform to Federal Aviation Administration (FAA) standards and designs. The Air Force maintains these aircraft according to civil airworthiness standards using Air Force maintenance systems and procedures. It must meet FAA requirements when modifying these aircraft to maintain configuration control and ensure flight safety.

2. Responsibilities:

2.1. HQ USAF/LGM:

- Approves deviations from this instruction.
- Coordinates relevant policies and procedures with the SAF/AQ and the FAA.

"By order of the Secretary of the Air Force"

"*Compliance with this publication is mandatory*"

1… AF maintains these aircraft according to FAA standards using AF maint systems and procedures;…must meet FAA rqts when modifying to maintain config control and ensure flight safety.

2. Resp; 2.2 AFMC obtains FAA Form 337 for work performed; Reviews extension rqsts for ADs, SBs, letters; 2.4 Field Units send escalation request to SPD through MAJCOM

3. Cert Rqts; maintain to certification rqts as close to FAA rqts as possible; maintain certification per AFPD 62-4; Use only FAA Certified contractors for maint;

4.Inspection Rqts: Must not allow inspection intervals longer than FAA intervals

Airworthiness Tools

- MIL-HDBKS
  - 514 Operational Safety Suitability and Effectiveness for the Aeronautical Enterprise
  - 516 Airworthiness Certification Criteria
- Airworthiness Certification Circulars
  - #4 Certification Basis
  - #x Modified Certification basis
- Policy Memorandums
  - AFMC/EN 28 Jan 2002, Review of TACC
  - ASC/CC 19 Jul 2001 Notification of Airworthiness Certification
- Each program generates its own Taylored Airworthiness Criteria Checklist (TACC) for the baseline and Modified Airworthiness Criteria Checklist (MACC) for follow on mods.

MIL-HDBK-514

- Section 11.2.1 “Judged to be airworthy if… meets approved set of criteria … defined in MIL-HDBK-516”
- Section 11.10.1 “Provide written notice to ASC/EN on certification”, gives guidance on reportable modifications
- Section 11.10.2 “… accomplished by developing and maintaining ASC/EN coordination on a (MACC) for each reportable modification”

MIL-HDBK-516
TACC and MACC

- Tailored Airworthiness Certification Criteria (TACC) – Use for New Air Force Aircraft – Certification basis
  - Documents airworthiness criteria, requirements and methods of compliance used in development of the aircraft
  - Provides a baseline for configuration control throughout the life of a system (ACC#4, pg1)
- Modified Aircraft Certification Criteria (MACC) – Use when Modifying Air Force Aircraft
  - Maintains sound airworthiness baseline
  - Documents changes to airworthiness criteria, requirements and methods of compliance
  - Documents seams between FAA approved areas and military approved areas.
  - Transient document – folded into TACC

ACC #4

- Airworthiness Certification Circular #4 – Certification Basis
  - Issued 11 Mar 04
  - Primarily aimed new aircraft, therefore TACCs
  - Calls out *MIL-HDBK-514* and *MIL-HDBK-516B* Enhanced
  - Refers to FAA Type Certification Basis for Commercial Derivative Aircraft
    - "FAA certification is a valid certification approach for criteria completely **satisfied by FAA** type certification on commercial derivative aircraft"

Completion of TACCs for CDA

- For the TACC boiler plate such as the cover and the airplane description follow the guidance right out of the HDBK – explain your system
- For the certification basis download it from the FAA Regulatory and Guidance Library (RGL).
  - http://rgl.faa.gov/
  - Select “Type Certification Data Sheets (Make/Model)” at the bottom of the lower right hand column
  - Search for your aircraft’s data sheet.
    - The search engine works well for common civil names: 172, 747-400, G-V, King Air, and some military names: KC-10A, C-12A
- Use the data sheet to verify serial numbers and the civil certification basis of the aircraft
  - General Amendment level is needed, but all the specific sub paragraphs don’t add much value to the TACC. The contractors will work the details with the FAA anyway.
    - CAR3b through Amnd 15, Part 21 up to Amendment 21-42, Part 23 incldng Amdmnt 23-56, Part 25 through Amendment 25-86, etc.

TACC/MACC Section 4

- Section 4 includes Tools, Quality, Systems Engineering and Manufacturing, Tech Manuals and Config – crossing over all disciplines
- The basic rule applies, but in the manufacturing section, care must be taken
  - When parts are installed on a CDA, they need to be produced under an approved production system.
  - All parts covered by FAA certification, need to be produced under an FAA approved production system.
  - If any non FAA approved parts are installed, don't let them fall through the crack. They need to be produced under a military approved production system.

Picking the Standards

- Once the applicable criteria have been identified the “tabs” corresponding to chapters in MIL-HDBK-516 need to be addressed
- The basic rule for cases where the criteria is met by FAA certification or an approved FAA process is:
  - For Standards where FAA Cert covers the criteria, an acceptable entry for the Standard is “FAA Certification (or approved process)”
  - An acceptable entry for methods of compliance is “Inspection of the FAA approving document”
    - This is the top sheet of the STC, TC, TSO, or what ever the FAA process relies on to document the approval
    - In some cases it may be a FAA Form 337, or even a Logbook entry,

If you have non compliant items

- Policy relies on limiting the non-FAA approved items (Para. 2 in both 62-4 and 62-5)
- Non conforming items will be listed on FAA Form 8130-2 “Conformity Certificate - Military Aircraft”
  - Standards for Non Conforming items must be “measurable parameters” (ACC #4)

If you don't get FAA Certification…

- The Standard and Method of Compliance for the FAA compliant areas of the aircraft are still the same i.e, proven by the FAA process
- For 62-4 Aircraft: non-FAA compliant areas must "meet or exceed civil airworthiness standards" (AFPD 62-4, Paragraph 2)
- For 62-5 Aircraft: "use the FARs to baseline requirements where ever practicable", and "the SM may use Air Force modification procedures when the FARs are inappropriate" (AFPD 62-5, Paragraph 2)

IT IS EXPECTED THE STANDARDS FOR THE 8130-2 ITEMS WILL MEET OR EXCEED FAA REQUIREMENTS (62-4) OR MEET MILITARY REQUIREMENTS (62-5) – IN EITHER CASE YOU NEED TO IDENTIFY WHAT THE AIRWORTHINESS REQUIREMENTS FOR THE 8130-2 ITEMS ARE, AND HOW THEY WILL BE MET

New FAA Order 8110.101
Type Certification Procedures for Military Commercial Derivative Aircraft

- **New FAA Order: Effective September 7, 2007**
- **Published and Available on FAA Regulatory and Guidance Library Under “Orders and Notices”**
- **Defines Role of the FAA Military Certification and Procedures for All Type Certification Approval for Military Conversion/Modification of Commercial Aircraft**
- **Contains FAA Procedures, Guidance, and Policy- Essential for Military Program Offices and Contractors Pursuing Commercial Derivative Programs**
- **Contact the FAA MCO for More Information**

Managing the Seam between Civil and Military Airworthiness Approvals on Commercial Derivative Aircraft

- **Issue: Military CDA are being modified with FAA issued design approvals, but items waived from FAA certification are often incorporated without military technical oversight**

- **Issue: Military CDA are being modified using "psuedo" FAA Field Approval Process**

- **Issue: Military Operators and Contractors are operating numerous commercial, military organic, and foreign aircraft with FAA experimental airworthiness certificates**

- **Issue: Contractors/Logistics Suppliers may be providing parts to military CDA which are not FAA approved parts**

- **Recognize Issues and Manage Airworthiness Seams**

Issue: What process are you using to ensure items waived from civil type certification (FAA Form 8130-2) receive military airworthiness approval?

- **FAA type certification is a closed loop airworthiness process for civil aircraft- it requires all modifications and installed equipment meet airworthiness standards defined by civil regulations**

- **Installed equipment cannot be 'waived' from FAA approval on civil aircraft and the aircraft allowed to operate with a standard (unrestricted) airworthiness certificate**

- **The two methods for obtaining FAA approval are**
  - **the structured type certification process with technical oversight (usually multiple aircraft applications), and**
  - **the FAA field approval process using qualified field personnel and airworthiness inspectors (for specific single aircraft only)**

- **NOTE: No FAA personnel or FAA designees can sign a field approval on an aircraft under foreign or military registration- will discuss later**

Issue: What process are you using to ensure items waived from civil type certification (FAA Form 8130-31 **formerly 8130-2**) receive military airworthiness approval?

- **Items which have been identified on the existing FAA Form 8130-31 "Military Statement of Conformity" are not certified and have not been examined by the FAA for airworthiness (recognizing that in some cases civil certification is not possible)**
- **As military CDA are often procured with intent that FAA certification will satisfy airworthiness approval criteria, there is often no plan presented for military qualification/approval of waived items**
- **Your military Program Office may or may not have the cognizance or technical resources to review or conduct the airworthiness approval**
- **Late FAA certification issues, poor program planning, or intentional contractor strategy may mean delays and $$$- your Program Office's nightmare. It may SEEM appropriate to accept system or component as a waived item and accept contractor oversight approval.**

Issue: What process are you using to ensure items waived from civil type certification (FAA Form 8130-31) receive military airworthiness approval?

- **First, consider certifying the modifications to the aircraft using civil airworthiness standards to the maximum extent practical**

- **FAA MCO has incorporated guidance into New FAA Order 8110-101 for Type Certification of Military Commercial Derivative Aircraft which allow various levels of certitude to maximize use of civil standards**

- **These levels of certitude are designed to ensure that modifications follow a closed loop process, type design presented for certification comply with all applicable FAA airworthiness standards, and provide clear definition of the civil and military airworthiness seam**

Levels of FAA Approval for Military CDA

- **Full Approval.** **The requirements for military modifications and associated systems and equipment that meet full FAA approval are:**

  - **Must meet the same requirements for a commercial modification to a civil aircraft. Include type design data, compliance substantiation, airplane flight manual supplements, maintenance and continued airworthiness documentation.**

  - **Meet all applicable airworthiness regulations.**

  - **The installation is compatible and eligible for use on a civil aircraft of same type without special restrictions or limitations.**

Levels of FAA Approval for Military CDA

- **Installation Approval: Military Use Only**

  The requirements for military modifications and associated systems and equipment that meet Military Use Only are:

  - **Must meet the same requirements as for a commercial modification to a civil aircraft. Include type design data, system and safety analysis, software validation, compliance substantiation, airplane flight manual supplements, maintenance and continued airworthiness documentation.**
  - **Meet all applicable airworthiness regulations.**
  - **Installation is NOT compatible or eligible for use on a civil aircraft of same type without special restrictions or limitations (authorization for use, operational limitations, maintenance requirements).**
  - **FAA may need help from the military to evaluate and determine compliance with this type of equipment because of the restriction on civil operation.**
  - **Installation approvals must have limitations and restrictions defined on the type design change, such as the supplemental type certificate description.**
  - **If the limitations and restrictions can be followed, these installations may be legally permissible to install on aircraft of civil registry.**

Levels of FAA Approval for Military CDA

- **Safe Carriage (Partial Approval).** **A partial approval, signifying that the military hardware and equipment comply with applicable regulations in a non-functional state. The requirements are:**
  - **The FAA examines the physical aspects of the installation including aerodynamic effects, structural provisions, cabin safety, and weight and balance.**
  - **The installation, as defined on the type design, complies with regulations and poses no hazard to the aircraft.**
  - **Approval includes any modifications made to aircraft structure or systems to accommodate installation of the equipment. Approval does not authorize or allow the installed equipment to operate.**
  - **Equipment must be disconnected from power sources, antenna couplers, and other interfaces with the aircraft and these interfaces on aircraft type design are safely capped and stowed.**
  - **Cockpit controls that are not included as part of the type design, if the equipment is controlled or will interface with the cockpit.**
  - **The type design may incorporate blanking plates or other means to show that the equipment is not approved for function, and cannot be enabled or operated from the cockpit.**
  - **Maintenance covers only that required for aircraft provisions (structure, mounts, wiring, etc.) removal, and physical attachment for securing equipment to the aircraft.**
  - **"Safe Carriage" approvals cannot be extended to weapons, pyrotechnics, or any other hazardous materials that would otherwise be prohibited from carriage on a commercial aircraft.**
  - **The receiving military airworthiness authority is responsible for design approval, equipment qualification, system integration, compatibility, system architecture, functionality, and interface with aircraft systems, operation, and airworthiness approval for the installed equipment.**

Levels of FAA Approval

- **Provisions Only (Partial Approval).**

  The FAA may also work with the applicant and the military to define "Provisions Only" approvals to support modifications to the MCDA to receive subsequent military equipment. Provisions Only approvals are not on-board installation approvals for the military equipment. Provisions Only approvals assess and approve aircraft structure, design characteristics, or system capabilities to handle defined and predetermined structural loads, interface or attachment provisions, and electrical power requirements. The requirements for Provision Only approvals are:

  - **Provide evidence to support relevant compliance findings with applicable civil regulations.**
  - **Address approvals in the airplane flight manual and instructions for continued airworthiness well enough to operate and maintain the FAA approved type design configuration.**
  - **Include the specific criteria for which the provisions are approved on the description of the type design change, or reference a document that establishes all interface points and design limits.**
  - **Ensure that the receiving military airworthiness authority is responsible for further modification to the aircraft using the approved provisions criteria.**

Issue: Is your military operator accepting a 'pseudo' FAA Field Approval process for CDA modifications?

What Is a Field Approval?

- **A field approval is FAA method for approval of a major repair or alteration made to a single civil aircraft, documented as part of the FAA Form 337 Return to Service**
- **FAA field approvals on U.S. registered civil aircraft are conducted under oversight and signoff of an FAA Flight Standards Inspector; field approvals are accomplished for approval of major repairs and alterations on an individual aircraft**
- **Technical data for substantiation of major repairs or alterations may be approved by authorized Designated Engineering Representatives for a aircraft of particular type design, but still require field approval for installation**
- **The FAA, FAA employees, or FAA designees are not authorized to signoff field approvals on foreign registered or military aircraft**
  - **Exceptions- foreign civil authorities with provisions in bilateral (e.g. Canada), and by request of foreign civil authority for their aircraft in the U.S.**
- **FAA Order 8300.10 provides mandatory instructions and guidance for FAA personnel regarding execution of field approvals- including requirements for technical involvement by FAA ACO engineering as complexity increases**
- **Modifications which go beyond the criteria for field approvals on civil aircraft must obtain type certification approval**
- **The FAA, FAA personnel, or FAA designees have no authority to approve major repairs or alterations to an aircraft under military registration**

Issue: Is your military operator accepting a ‘pseudo’ FAA Field Approval process for CDA modifications?

- **Some contractors have proposed following the “FAA Field Approval Process” for modifications to military commercial derivative aircraft as a method for airworthiness approval**
- **Some FAA Inspectors and FAA designees, with good intention, have attempted to support this in an effort to assist the operator**
- **WARNING: Proceed with risk and extreme caution. This may be a viable solution in some circumstances, but has a history of problems. Typically:**
  - **Multiple aircraft modified with inadequate documentation of type design/compliance, inadequate testing and/or substantiation**
  - **Complex modifications and system integrations which go far beyond the scope of what would be allowed by FAA field approval**
  - **Often proposed or implemented when schedule/mission need prevents appropriate procedures from being followed**
  - **No oversight or signoff by FAA; has led to abuse**

Issue: Military Users and Contractors are operating numerous commercial derivative, military organic, and foreign commercial/military aircraft with N number and experimental airworthiness certificates

- **Anyone with proof of ownership can apply and obtain FAA registration for any type of aircraft- registration is not authorization to fly**

- **Civil registered aircraft require a standard FAA airworthiness certificate to operate in national airspace- civil aircraft which may not, or cannot, comply with civil airworthiness standards may be issued experimental airworthiness certificate for specific purposes**

- **Experimental airworthiness certificates require operator to attest to airworthiness of aircraft, aircraft may be inspected, but type design is not reviewed, approved, or certified for airworthiness by the FAA**

- **Experimental airworthiness are issued for specific purposes defined by CFR Title 14 Part 21.191 with appropriate restrictions and operating limitations and must be renewed every year (R&D, Show Compliance, Crew Training, Exhibition, Air Racing, Market Survey, Amateur Built, Primary Kit Built, and Light Sport)**

- **Aircraft operated for Public Use operations do not require a civil airworthiness certificate and are the responsibility of the agency directing their operations.**

Issue: Military Users and Contractors are operating numerous commercial derivative, military organic, and foreign commercial/military aircraft with N number and experimental airworthiness certificates

- **What happens when operator of the civil registered experimental aircraft declares the aircraft "public use"?**
- **The aircraft becomes exempt from compliance with FAA civil airworthiness regulations and limitations of the experimental certificate**
- **The responsibility for configuration oversight, safety, maintenance, and risk management are assumed by the government agency operating, or contracting for use of, the aircraft**
- **If a military operator, or contractor, is operating the aircraft on behalf of an armed service, the Armed Service is the responsible airworthiness authority**
- **If your military operator or contractor says their "public use" aircraft operations are oversighted by the FAA, they are WRONG**

Issue: Military Users and Contractors are operating numerous commercial derivative, military organic, and foreign commercial/military aircraft with N number and experimental airworthiness certificates

- **Does your armed service have a system in place which monitors these experimental public use aircraft? Examples:**
  - **Special Operations Groups, Security, Intelligence, Covert or Clandestine Operations**
  - **Target Towing, Adversary Aircraft, Foreign Training Assistance**
  - **Research and Development, Special Temporary Need Leases, Etc.**
- **Do you know how many and which aircraft are operating in this capacity for your service?**
- **Does your airworthiness authority monitor configuration, operational safety, maintenance, or risk management for these aircraft?**
- **Do you have a system which requires flight releases or airworthiness oversight for these aircraft- owned, leased, or contracted service?**

Issue: Contractors/Logistics Suppliers may be providing parts to military CDA which are not FAA approved parts

- **Once FAA certifies type design, replacement parts sold for a type certificated product require manufacture under some kind of FAA Production Approval. Examples:**
  - **Production Certificate**
  - **Parts Manufacturer Approval (PMA)**
  - **Technical Standard Order Authorization (TSOA) [design and production approval]**
  - **Exception: Owner/Operator Produced Parts (inspected/approved at installation, not for sale)**
  - **Other Exceptions: parts manufactured under type certificate only (require direct inspection by FAA), Repair Station fabricated and inspected/approved on-site (not for sale)**
- **But, all FAA approved parts are manufactured under some kind of FAA approved quality system or direct inspection**
- **Processes, identification, and marking of approved parts are controlled in the civil airworthiness system, and for international export**

Issue: Contractors/Logistics Suppliers may be providing parts to military CDA which are not FAA approved parts

- **Number of cases identified where military contractor/supplier has not provided approved replacement parts for military CDA Examples:**
  - **Detail parts direct shipped from OEM subcontractor, bypassing FAA approved Production Inspection System**
  - **STC holder or supplier fails to obtain Parts Manufacturer Approval (PMA)**
  - **TSOA components installed without installation approval**
  - **Contractor claimed produced as Owner/Operator Produced Parts for military, but cannot be approved/inspected in compliance with Part 43 requirements**

- **FAA vigorously enforces and prosecutes violators on civil aircraft under FAA Suspected Unapproved Parts (SUPS) program**

- **FAA enforcement difficult or impossible on military CDA when parts leave civil system, maintenance occurs outside civil repair stations, no review of aircraft logbooks, no access to billing/shipping records**

Issue: Contractors/Logistics Suppliers may be providing parts to military CDA which are not FAA approved parts

- **Military Airworthiness Concerns for Unapproved Parts on CDA**
  - **Parts may or may not conform to type design, no FAA inspection**
  - **Military relying totally on contractor system (?), with no government oversight of manufacturing or inspection procedures**
  - **Discovery of Unapproved parts on military CDA could exclude eligibility for parts pooling with civil fleet**
  - **If discovered, flight critical or safety related impacts often difficult to determine**
- **FAA has taken enforcement action on unapproved parts supplied to the military- when civil investigation yielded enough evidence to prosecute**
- **FAA has also assisted military in pursuing contract fraud investigations when contract specified supply of FAA approved parts for military CDA**
- **Although civil regulations require compliance for parts on type certificated products under civil, foreign, or military registration, MCO recommends requirement be clearly incorporated in military procurement/logistics support contracts**

CONCLUSIONS

- By the USAF and the FAA working in partnership the integration of military and civil equipment can be safely accomplished on Commercial Derivative Aircraft
- Care is required to avoid the seams between the two safety systems

QUESTIONS



NAVSEA WARFARE CENTERS NEWPORT

Sensors & Sonar Systems DEPARTMENT

Innovation Strategies for Affordable Readiness

Presented to the

NDIA 10th Annual Systems Engineering Conference

25 October 2007

Presented By

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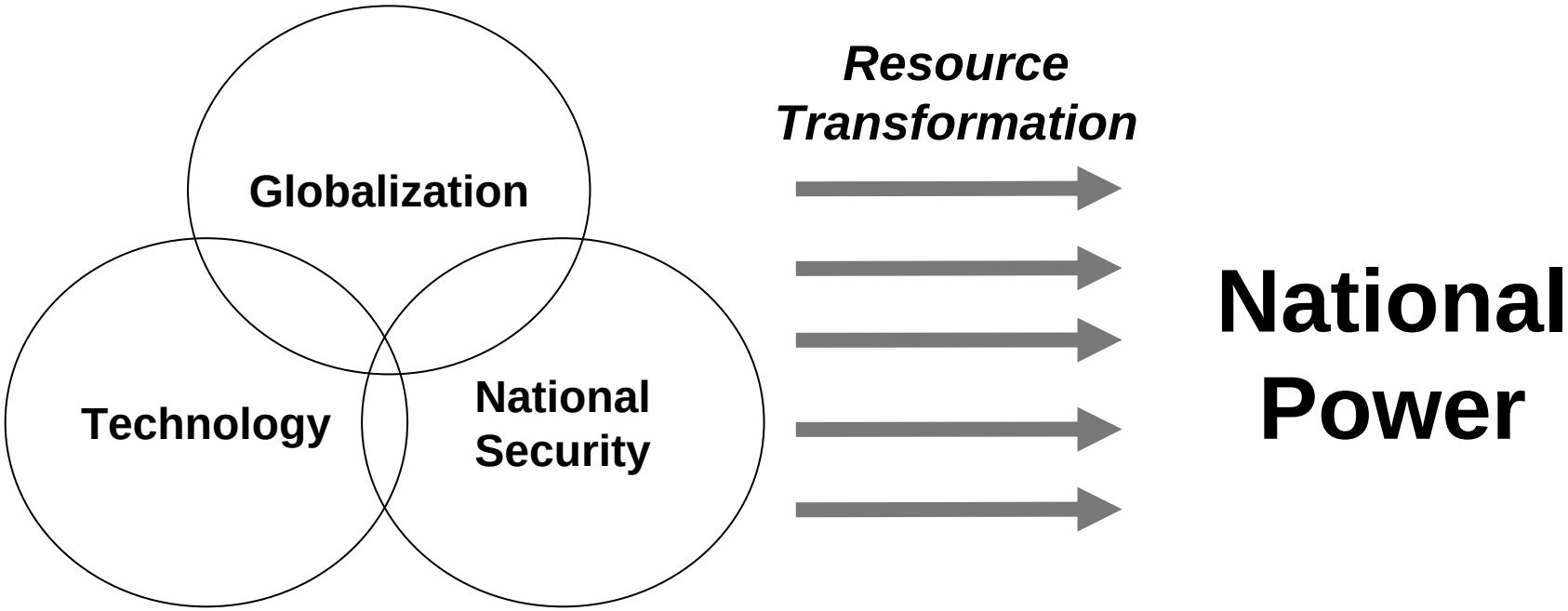
Naval Undersea Warfare Center Division, Newport RI

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Innovation for Readiness

The greatest benefits of globalization will accrue to countries and groups that can access and adopt new technologies.

CIA's National Intelligence Council
Mapping the Global Future, 2004



References:

Tellis, Ashley J, Janice Bially, Christopher Layne and Melissa McPherson, *Measuring National Power in the Postindustrial Age*, RAND Report MR 1110, 2000, ISBN 0-8330-2792-1

Lehman, Ronald F., *The Center for Global Security Research*, http://www.llnl.gov/

Innovation Equation



Innovation = f(Invention, Militarization/Commercialization, Diffusion)

Definitions



Invention **covers all efforts aimed at creating new ideas and getting them to work.**

Militarization/Commercialization **(exploitation) includes all stages of commercial development, application, and transfer [transition], including the focusing of ideas or inventions towards specific objectives. Commercialization also includes evaluating those objectives and transferring research and/or development results for eventual broad-based utilization.**

Diffusion **is the process in which an innovation is communicated through certain channels over time (and adopted) among the members of a social system.**

Reference:

Michael E. McGrath, *Product Strategy for High Tech-Technology Companies: How to achieve growth, competitive advantage, and increased profits*, Richard Irwin, Inc., 1995, p. 217.

Roberts, Edward B., *Generating Technological Innovation*, New York, Oxford University Press, 1987, p. 3.

Innovation Strategies
(Invention and Commercialization)



- **OPPORTUNITY DRIVEN (Requirements Pull)**
  1. *Identify general opportunities by listening to specific customer needs.*
  2. *Identify opportunity by generalizing a solution to a specific problem.*
- **PREDICTION DRIVEN (Technology Push)**
  3. *Identify opportunities based on the declining cost of technology.*
  4. *Identify new applications for emerging technology.*
  5. *Look for opportunities at the intersection multiple emerging technologies.*
- **TECHNOLOGY DRIVEN (Science and Technology, S&T)**
  6. *Efficiently search for solutions to perceived problems/opportunities.*
  7. *Stumble over a technology breakthrough.*
- **SYSTEM DRIVEN (Science and Technology, S&T)**
  8. *Organize design components together in a new way, using many core design concepts in a new architecture.*
  9. *Link significant resources from different disciplines, businesses and government agencies.*

Reference: Adapted from Michael E. McGrath, *Product Strategy for High Tech-Technology Companies: How to achieve growth, competitive advantage, and increased profits*, Richard Irwin, Inc., 1995, p. 217.

Rapid User Focused Invention and Militarization



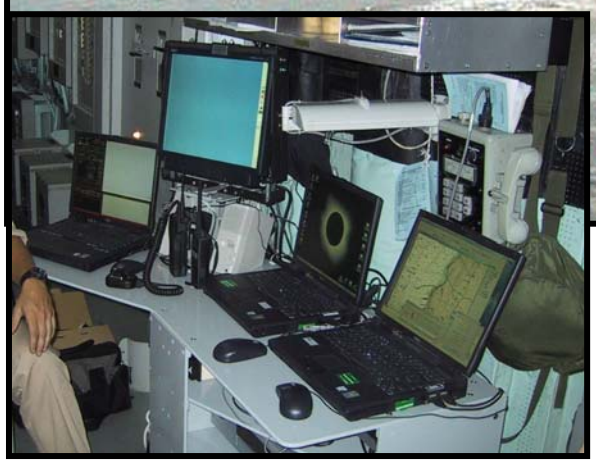
Rapid Radical Invention/ Commercialization = ***Opportunity Driven Specific Customer Need and CONOPS*** + ***Prediction Driven Technology Intersection***

Affordability from the intersection of existing military technologies:

- ***Reliability***
- ***Maintainability***
- ***Training***
- ***Support Infrastructure***
- ***Compatibility***
- ***Familiarity***
- ***Reduced Technology, Cost and Schedule Risk***
- ***Economies of Scale from Multiple Applications***

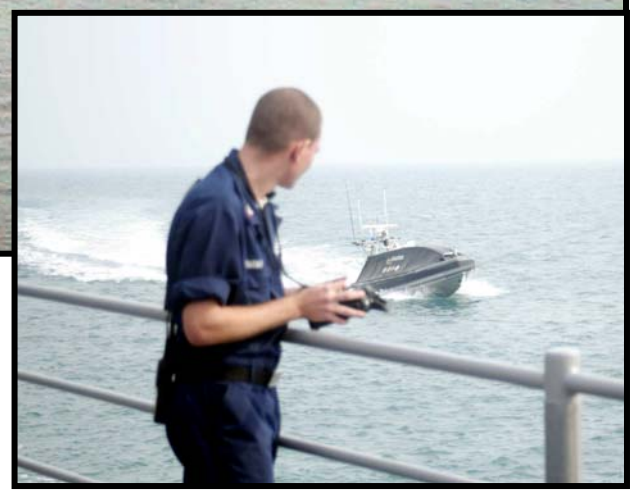
User Focused Example: Spartan Scout Unmanned Surface Vessel



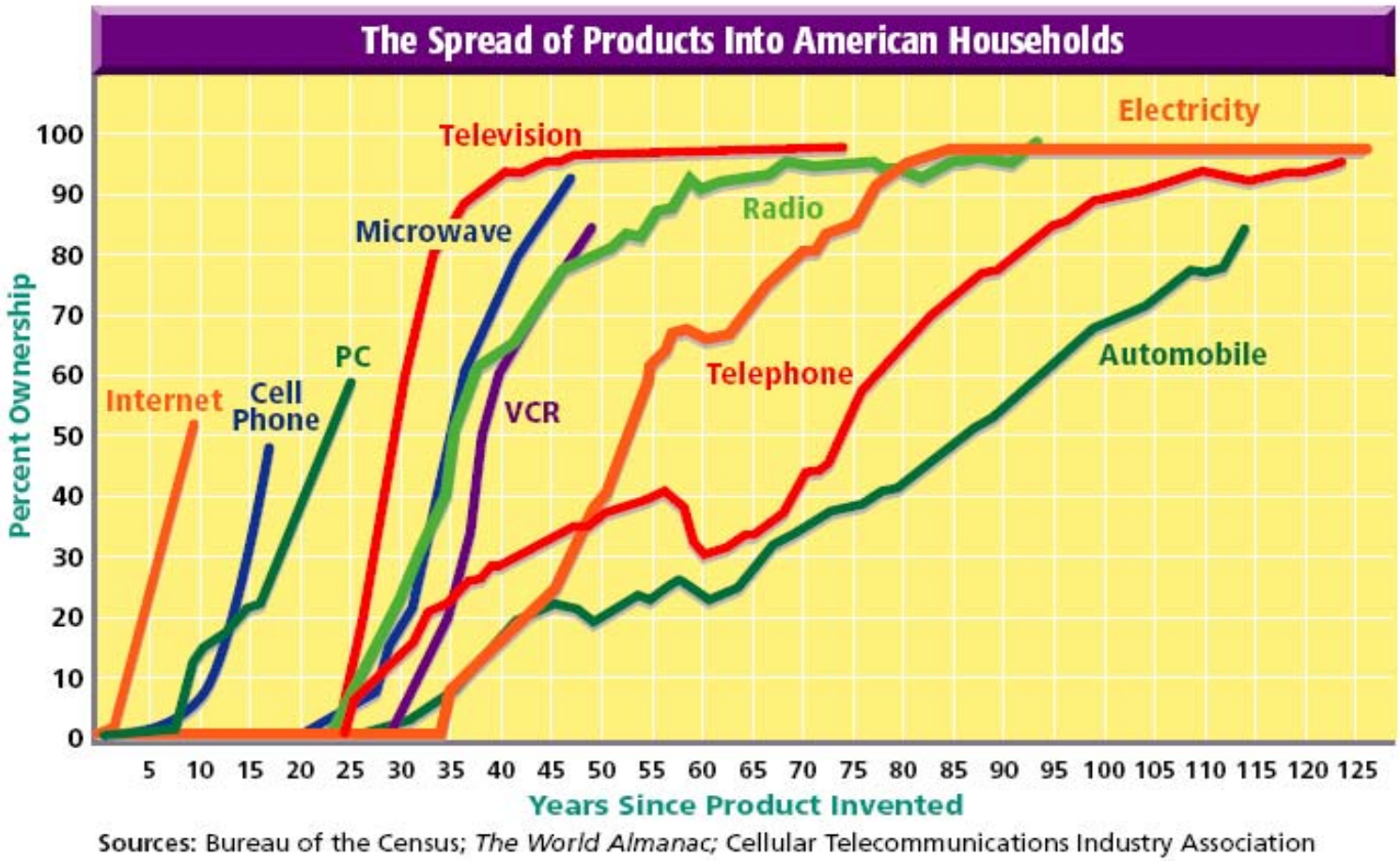


Workstation

Manual Control for L&R Ops



Diffusion of Technology Has Accelerated



Sources: Bureau of the Census; *The World Almanac;* Cellular Telecommunications Industry Association

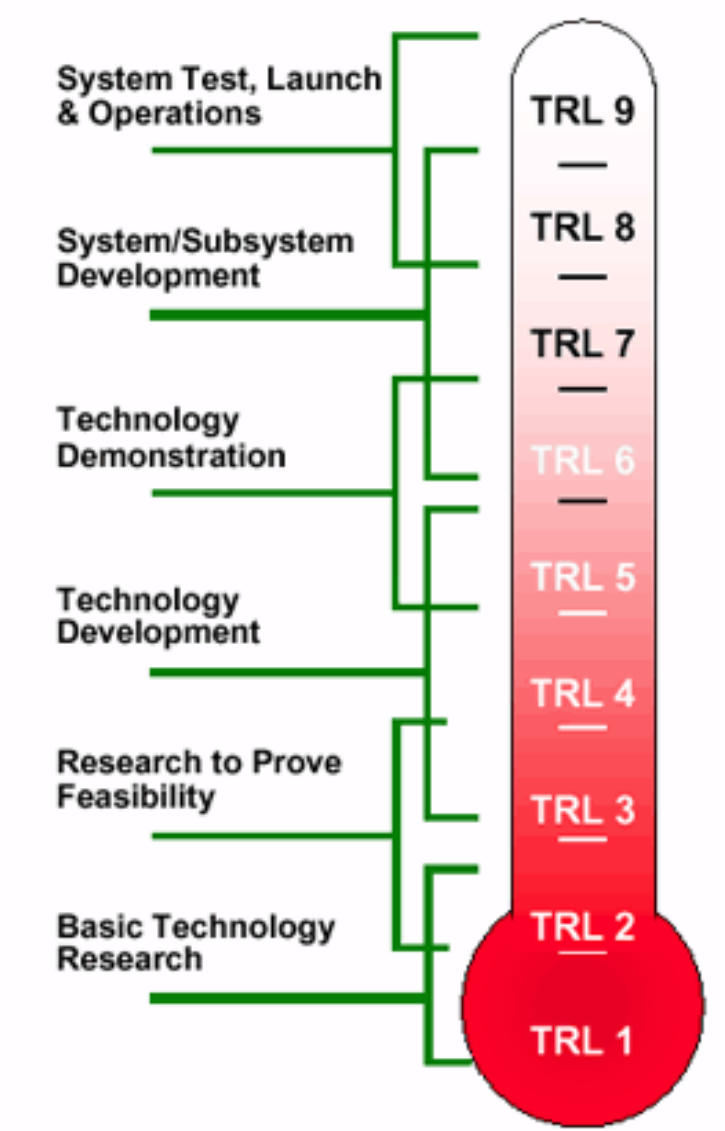
Rapid diffusion of innovation is the challenge.

Technology Readiness Levels vs. Attributes for the Diffusion of Innovation

The TRL system was adopted by the NASA space program for project tracking and management and was incorporated in NASA's 1991 Integrated Technology Plan.

There are nine different TRLs:

1. **Basic principles observed and reported**
2. **Technology concept/application formulated**
3. **Critical function proof of concept**
4. **Component validation in laboratory**
5. **Component validation in relevant environment**
6. **System prototype in relevant environment**
7. **System prototype in operational environment**
8. **Actual system completed and qualified via T&E**
9. **System proven through mission operation**



Reference: http://www.asc.nasa.gov/aboutus/trl-introduction.html

***Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs*, DoD 5000.2-R, 5 April 2002**

Perceived Attributes for the Diffusion of Innovation



1. ***Relative advantage***, **the degree to which an innovation is communicated as being more cost effective than the innovation it supersedes**
2. ***Effectiveness***, **the degree to which an innovation is communicated as being relatively more capable in achieving an ideal end state**
3. ***Observability***, **the degree to which the results of an innovation are communicated as being visible to others**
4. ***Trialability***, **the degree to which an innovation is communicated to allow experimentation on a limited basis**
5. ***Complexity***, **the degree to which an innovation is communicated as being relatively difficult to use**
6. ***Compatibility***, **the degree to which an innovation is communicated as being consistent with past experiences, existing practices, and needs of potential adopters**

Reference:
Rogers, Everett M., *Diffusion of Innovation*, Free Press, 2003.
Dearing, James, "An Exploratory Tool for Predicting Adoption Decisions," Science Communications, Vol. 16, No. 1, September 1994, 43-57.

Perceived Attributes for the Diffusion of Innovation



7. ***Reliability***, **the degree to which an innovation is communicated as being consistent in its results**
8. ***Divisibility***, **the degree to which an innovation is communicated as allowing incremental implementation of its components**
9. ***Applicability***, **the degree to which an innovation is communicated as having more than one use, or having use in more than one context**
10. ***Commutability***, **the degree to which an innovation is communicated as exhibiting a complementary relationship with other innovations**
11. ***Radicalness***, **the degree to which an innovation is communicated as being different from existing innovations**

The innovation-decision process is essentially an information seeking and processing activity in which an individual is motivated to *reduce uncertainty* about the advantages and disadvantages of the innovation.

Reference:
Rogers, Everett M., *Diffusion of Innovation*, Free Press, 2003.
Dearing, James, "An Exploratory Tool for Predicting Adoption Decisions," Science Communications, Vol. 16, No. 1, September 1994, 43-57.

Diffusion Assessment Example



Attribute	Intent or Perception (1-7)	Comment
Applicability	1	Highly Applicable, high utility
Reliability	6	Not strongly communicated
Compatibility	1	Compatible with existing concepts of operation
Divisibility	2	Alternate options communicated
Radicalness (reverse coded)	5	Communicated effort as being different
Complexity (reverse coded)	2	Not highly complex (context dependent)
Trialability	1	Use of systems in experimentation strongly emphasized
Observability	4	Not strongly communicated
Effectiveness	2	Analysis used to determine performance
Commutuality	1	Complementary nature strongly articulated
Economic Advantage	5	Not strongly communicated
Total	30	
Avg	2.73	

Reference:
Dearing, James, "An Exploratory Tool for Predicting Adoption Decisions," Science Communications, Vol. 16, No. 1, September 1994, 43-57.

Innovation Strategies for Affordable Readiness Summary



- **Respond to emerging threats with innovation:**
  - Invention
  - Militarization/Commercialization
  - Diffusion
- **Develop affordable products rapidly by:**
  - Identifying opportunity driven concepts via specific customer needs
  - Developing prediction driven products based on the intersection of technologies
- **Focus on diffusion attributes:**
  - Incorporate readiness levels as part of diffusion attributes
  - Reduce uncertainty for end users through the 11 attributes
  - Assess innovative concepts and products to determine the potential for diffusion

NAVSEA
WARFARE CENTERS
NEWPORT

Sensors & SONAR Systems DEPARTMENT

Development of Systems Engineers in the Sensors & SONAR Systems Department

Presented To:

NDIA Systems Engineering Conference

24 October 2007

Presented By:

Mr. Lawrence Lazar
Head, Sensors Systems Engineering Branch, Code 1541
lazarl@npt.nuwc.navy.mil, (401) 832-8771

Naval Undersea Warfare Center Division, Newport, RI

APPROVED FOR PUBLIC RELEASE

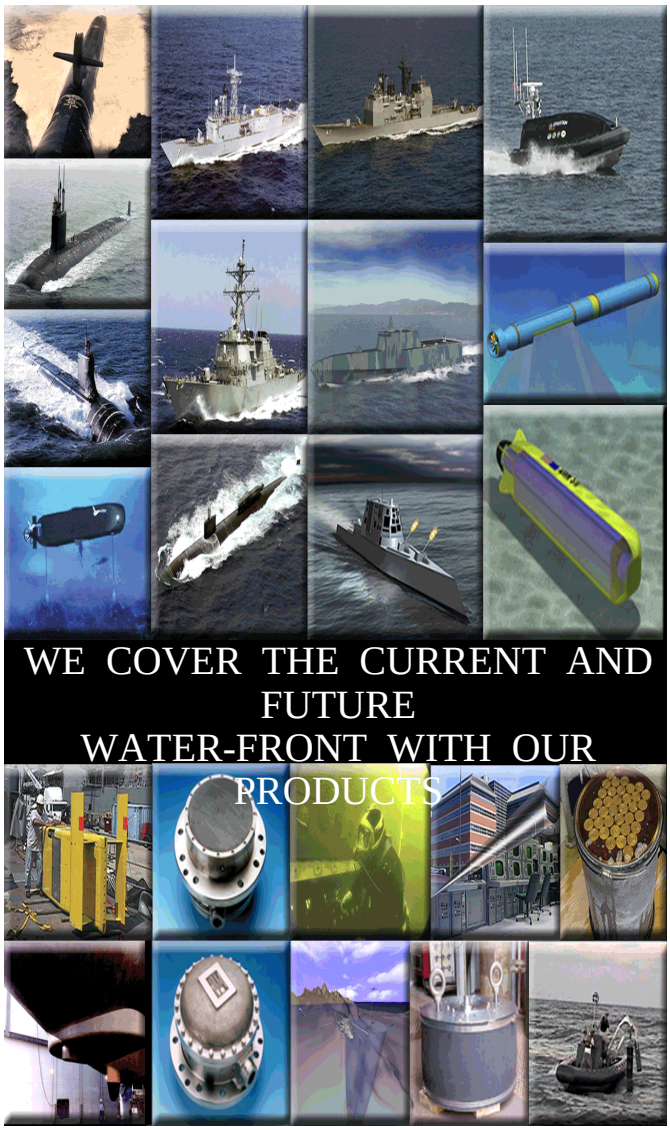
Sensors & SONAR Systems Department

NAVSEA WARFARE CENTERS NEWPORT

Our Main Thing is working with Industry, Academia, and Navy Labs to deliver solutions to the Warfighter where and when they are needed.

MISSION

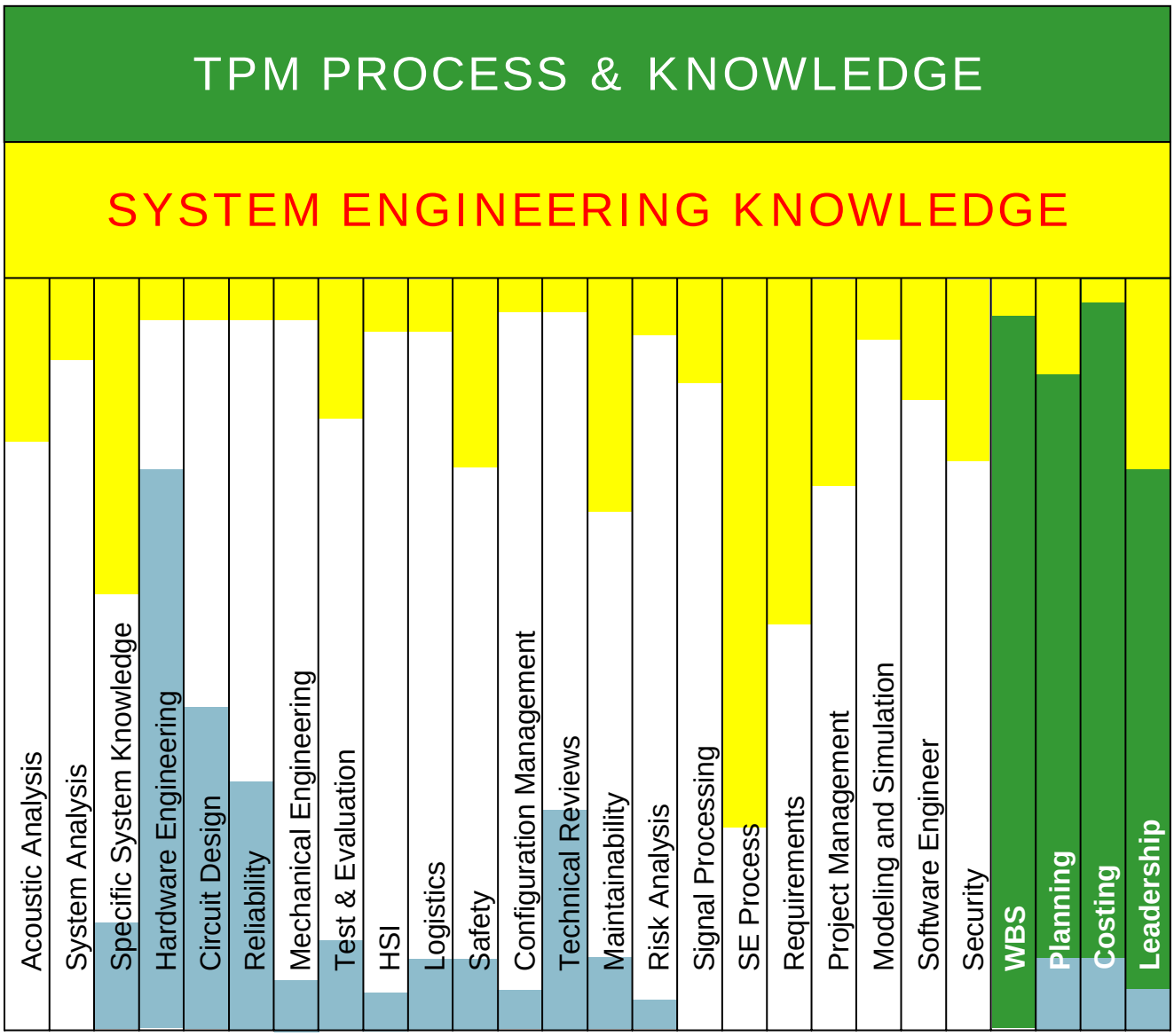
Conducts a full spectrum program of research, development, engineering, and test & evaluation directed toward underwater sensors and sonar systems applicable to all platforms as well as off-board distributed and unmanned systems, with equal emphasis on technology base, advanced development, full-scale development, and in-service engineering, supportability and life-cycle hardware and software support. Focuses on analysis, definition, development, system engineering, integration and testing. The mission focus is on all aspects of Undersea Warfare (USW) and associated areas of the Global War on Terrorism (GWOT).

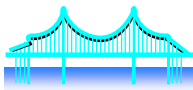


Products and Capabilities

- ✓ Active and Passive Acoustic Systems
- ✓ Environmental Acoustic Technology and Systems
- ✓ Hull-mounted, Fixed, and Towed Sonar Systems
- ✓ Offboard Sensors and SONAR Systems, Including Distributed Systems
- ✓ Human Systems Integration for Manned & Unmanned Systems
- ✓ Sonar Trainer Systems
- ✓ Transducers, Materials, Measurements, and Standards
- ✓ Underwater Acoustic Communications Systems
- ✓ Underwater Off-Board Sensors and SONAR Systems
- ✓ Underwater Non-Acoustic and Environmental Sensors
- ✓ Unmanned Vehicle Sensors and SONAR Systems

Systems Engineers Need A Depth of Knowledge





Good Systems Engineers Demonstrate

- Technical Expertise and Competence
- Solid Engineering Design Skills
- Willingness to Take on Leadership and Responsibility Roles
- Effectiveness Working in Dynamic Team and Interdisciplinary Environments
- Excellent Communications Skills

Not all engineers display the desire and aptitude
to be a Systems Engineer.

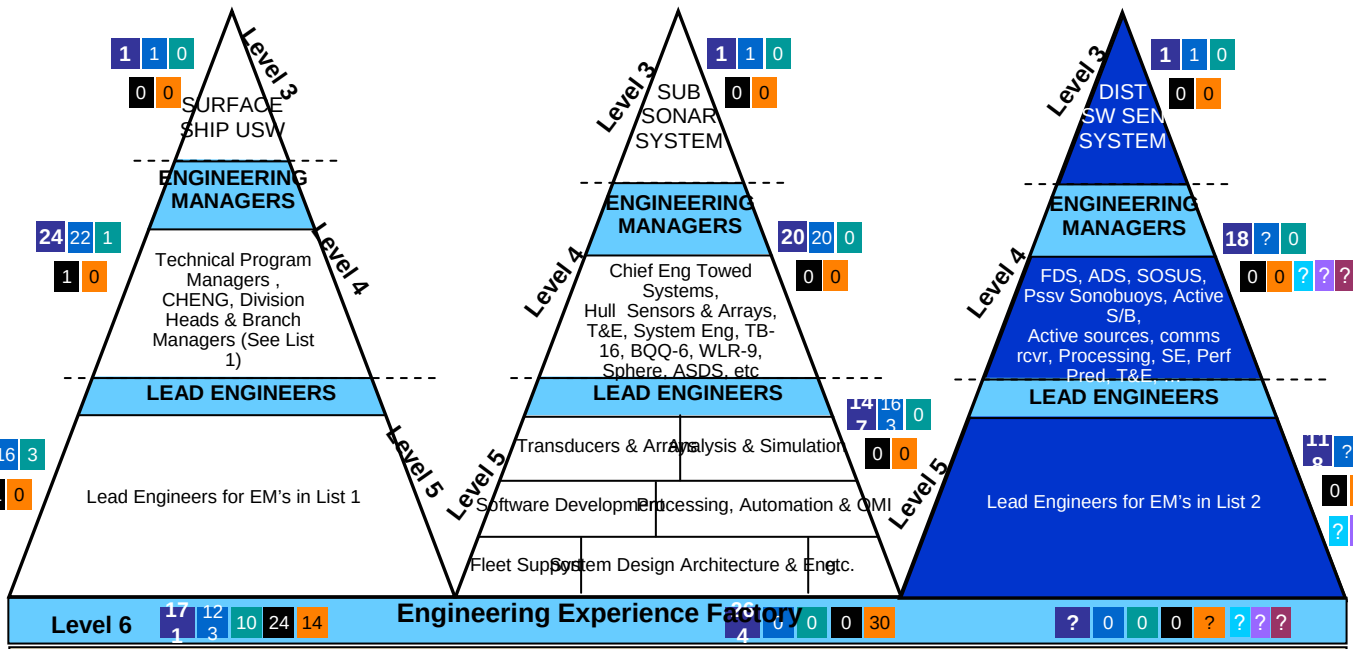
They are not merely “made’... innate qualities and
interest are necessary.

Typical System Engineering Career Development Timeline

Career Stage	Elapsed Time	Concurrent Age
New Hire	-	23
Develop Technical Experience in Engineering Discipline	5 - 8 years	28
T&E At-Sea Experience/System Installation/System Delivery	1 - 2 years	29
Rotational Assignments: • *Other Engineering Specialties* • *Operational Experience* • *On-Site Assignments (I.e. Field Team)* • *International Experience*	1 - 2 years	30
Technical Program Manager/Task Leader	2 years	32
System Engineer	2 years	34
TOTAL	11 - 16 years	34 -39

Combined Surface Ship USW, Submarine Sonar and Distributed USW Sensor Systems Tech Warrant Pyramid With At Risk Positions

TOTAL	NUWC/NPT	NUWC/KPT	NSWC DD	NAWC/PAX	SSC/SD	SSC/NF	CONT



Analysis
- ☐ Acoustic Analysis
- ☐ Sonar Performance Analysis
- ☐ Environmental Modeling & Assessment
- ☐ Hydrodynamic Data Analysis
- ☐ Mission Effectiveness Analysis
- ☐ Signature Analysis
- ☐ Sonar/Platform/Battle-group Engineering Assessments

Calibration & Measurement Facilities
- ☐ Array & Sensor Calibration

ILS
- ☐ CM
- ☐ COTS Supportability Analysis
- ☐ Fleet Technical Publications Support
- ☐ Logistics System Support
- ☐ Operational Guidelines & Employment
- ☐ Training
- ☐ Trainers

In Service Engineering
- ☐ Array Maintenance & Repair
- ☐ Fleet Introduction
- ☐ Fleet Liaison
- ☐ Fleet Support
- ☐ Production Engineering
- ☐ Restoration Engineering
- ☐ Systems Supportability

Installation
- ☐ OPALTS
- ☐ SHIPALTS
- ☐ TEMPALTS

Modeling and Simulation
- ☐ Finite Element Modeling & Assessment
- ☐ Model Development & Verification
- ☐ Modeling, Testing & Qualification
- ☐ Sonar SIM/STIM
- ☐ Structural Acoustics
- ☐ Target Physics Modeling & Research
- ☐ Towed Body/HD Models

Signal Processing
- ☐ Active Signal Processing
- ☐ Passive Signal Processing

Software Engineering
- ☐ Database Development
- ☐ Information Assurance
- ☐ Software CM
- ☐ Software Development
- ☐ Software Integration and Unit test
- ☐ Software Process
- ☐ Software Requirements (development, allocation & management)
- ☐ System Software Architecture

Sonar Array Technology
- ☐ Acoustic Measurement
- ☐ Acoustic Modeling & Research
- ☐ Acoustic Transducer Metrology and Standards
- ☐ Acoustic Windows
- ☐ Active Source Performance
- ☐ Advanced Arrays
- ☐ Array Structures
- ☐ Developmental Arrays
- ☐ Hull, Deployed, & Towed Sensor Engineering
- ☐ Sonar Projectors
- ☐ Sonar Self-Noise Performance
- ☐ Transducer & Array Materials
- ☐ Transducer Design
- ☐ Telemetry Technology
- ☐ Towed Sensors
- ☐ Sphere, Large Aperture/Conformal & Towed Arrays
- ☐ Fiber Optic Sensor

Sonar Engineering
- ☐ Acoustic Communication
- ☐ Advanced Processing
- ☐ Advanced Processing Builds
- ☐ Advanced Systems Prototyping & Eva
- ☐ Algorithm Development
- ☐ Array Handling Technology
- ☐ Automation
- ☐ Data Fusion/Contact Management
- ☐ Detection, Classification
- ☐ Display Engineering
- ☐ HF Imaging & ASW
- ☐ Mine Detection & Avoidance Sonar
- ☐ Multistatics
- ☐ Oceanographic Engineering
- ☐ Optical Application to Sensors
- ☐ Prototyping
- ☐ Rapid COTS Insertion
- ☐ Real Time COTS Processing
- ☐ Recon Docking & Side Scan Sonars
- ☐ Signal Conditioning Micro-Electronics Prototyping
- ☐ Sonar Systems Engineering
- ☐ Technology Insertion
- ☐ Tracking & Localization
- ☐ Platform Engineering

System Engineering
- ☐ Anti-Tamper Engineering
- ☐ COTS Engineering
- ☐ Sonar Power Amplifier Engineering
- ☐ Engineering Change Process
- ☐ FCA/PCA
- ☐ HSI Engineering
- ☐ Interface Engineering
- ☐ Legacy System Engineering
- ☐ Open System Architecture Engineering
- ☐ Reliability Engineering
- ☐ Requirements Allocation
- ☐ Risk Management
- ☐ Sensor Requirements
- ☐ Specifications
- ☐ SUBSAFE
- ☐ System Requirements
- ☐ System Safety
- ☐ TDA Support Technical Failure Analysis
- ☐ Technology Transition
- ☐ USW System Conceptual Development
- ☐ USW System Functional Decomposition
- ☐ USW System Integration
- ☐ Testing, Evaluation & Certification
- ☐ At-Sea T&E

System Engineering (Cont'd)
- ☐ Augmentation
- ☐ Data Acquisition & Analysis
- ☐ Environmental Sensors
- ☐ Test Planning
- ☐ Shock Qualification
- ☐ System Assessment Testing (in

Energy Generation

RF Communication

Floating Sensors

Bottom Sensors

Self Propelled Sensors

Airborne Deployment

Shipboard Deployment

Launchers

Surface Personnel 23 6 | 152 | 14 | 36 | 14

Submarine Personnel 45 8 | 428 | 0 | 0 | 30

Dist USW Sys Personnel ? | ? | 0 | 0 | ? | ? | ? | ?

Total Positions With Shared Experience Factory = 570+

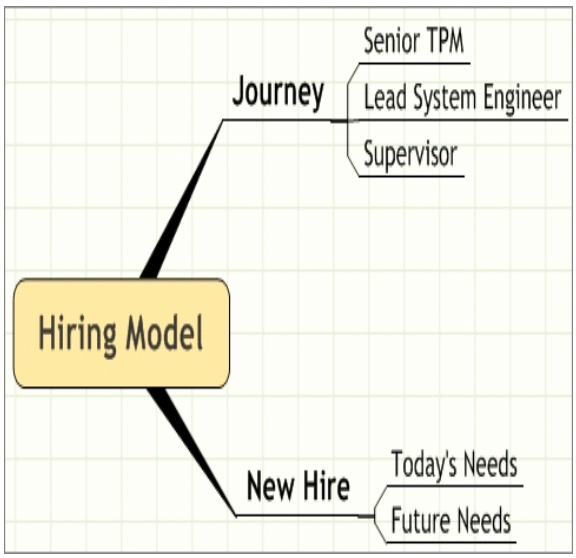
Currently At Risk
Projected At Risk
Capacity At Risk

Workforce Shaping

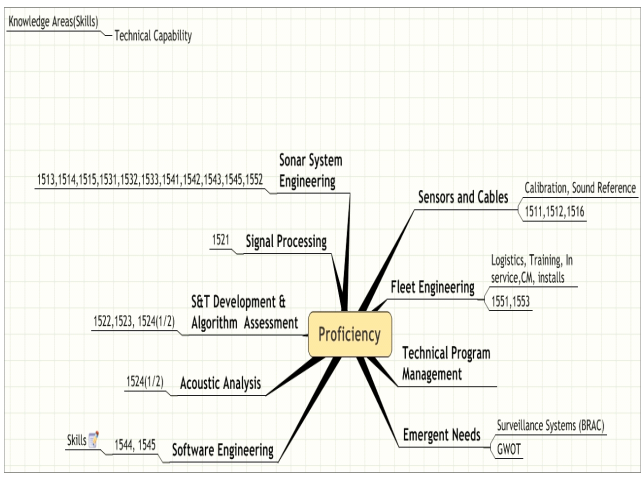
WORKFORCE SHAPING PLAN SUMMARY

- Workforce shaping changes the potentials and abilities of the workforce that can be applied to current Navy problems. Tools for changing the workforce include
  - *Hiring: Change the current mix of the workforce. Both external and internal acquisitions are used at both new and journey level persons.*
  - *Training: Increasing the education or skills of members of the organization through college training, specific skill training, or on the job experiences.*

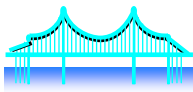
HIRING MODEL



PROFICIENCY NEEDS



Position	RISK FACTOR		
	Currently at Risk	Projected at Risk	Capacity at Risk
ANALYSIS			
Sonar Performance Analysis		X	
SIGNAL PROCESSING			
Active Signal Processing		X	
Passive Signal Processing		X	
SONAR ARRAY TECHNOLOGY			
Acoustic Transducer Metrology and Standards	X		
Fiber Optic Sensors		X	
SONAR ENGINEERING			
Sonar Systems Engineering		X	
SYSTEM ENGINEERING			
Sonar Power Amplifier Engineering	X		
Testing, Evaluation & Certification			X
At-Sea T&E			X
Mechanical Engineering			
Platform Installation Engineering		X	



Formal Training

- College Courses
  - Tuition for advanced degrees
  - Long term training
- Commercial Training – Short Courses
  - On-site courses
- Special Programs
  - SE and Program Mgmt degrees programs
- DAWIA
  - Most of our people fall under SPRDE
  - Required level III certification
  - Courses available

Tailored On-Site Training

5 October 2006 WORKING DRAFT V0.5

Sensors and Sonar Systems Department Systems Engineering Training Plan

Working With Industry, Academia, and Navy Labs to Deliver Solutions to the Warfighter Where and When They Are Needed

NAVSEA WARFARE CENTERS NEWPORT

Naval Undersea Warfare Center Division
Newport, Rhode Island

...Working Together to Deliver the Best Solutions Quickly

Prepared by, L. Lazar (1541) and G. Maris (1542)

Modules

Title	Status
Introduction to Sys Eng	Complete
DoD 5000 Summary Presentation	Complete
Navy Organization & Funding	Complete
T&E Fundamentals	Complete
Naval Organization & CWC Concept	Complete
Basic ASW	Complete
Sonar Fundamentals	Complete
Sonar Design Trade-offs	Complete
Acquisition Logistic Support	Outline
Human System Integration (HSI)	Outline
EQT	In Process

Title	Status
USW Systems Overview	Not Started
Requirements	Not Started
Development Models	Not Started
Modeling & Performance Prediction	Not Started
Sensors to Displays	Not Started
Program Management for SE	Not Started
Business Office	Not Started
Personal Development	Not Started
HSI	Not Started
Training	Not Started
SW Engineering	Not Started
Subsafe	Not Started
Sonar Automation	Not Started
	Not

Results

- 8 Sessions Conducted to Date
- Responses Generally Good
- Delays Due to Other Demands On Presenters/Organizers Time
- Some Variability In Quality
- Requests To Expand Program

NDIA 10th Annual Systems Engineering Conference

System Engineering Effectiveness

A Robust Process for Resolving Interface Design Issues in the Complex Concurrent LCS System Engineering Environment

Mr. William Traganza
Assistant Program Manager
Maritime Surveillance Systems (PMS 485)

CDR Joseph Conway USN (Ret.)
Director, Systems Engineering
AMRON

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Outline

- Introduction
- Background
- Impacts of concurrency on ADS Program (ACAT-1)
- Challenges to Traditional SE Process for handling concurrency
- New SE process developed to address problem
- Lessons Learned
- Recommendation

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FY08 Congressional Language

HAC Committee Report on Congressional Oversight

HR 1585 SEC. 127. LIMITATION ON CONCURRENT DESIGN AND CONSTRUCTION ON FIRST SHIP OF A SHIPBUILDING PROGRAM.

(a) In General- For any shipbuilding program that is a major defense acquisition program under section 2430 of title 10, United States Code, the start of construction of a first ship (as defined in subsection (b)) may not occur until the Secretary of the Navy certifies to the congressional defense committees that the detailed design of the ship is completed and approved by the relevant design certification agents, to a level determined by the Secretary to be acceptable for commencement of construction, via a report described in subsection (d).

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Traditional Concurrency Definition

- **<u>Degree of overlap</u> between processes of an acquisition program**
  - Development
  - Production
- **<u>Structuring the overlap</u> is a management judgment; (it is) a balancing of**
  - Risk of proceeding with certain production and other activities weighted against
  - Costs of delays caused by work force inefficiency

* **Source: DOD Report on Concurrency in Major Acquisition Programs, April, 1990**

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New SoS Concurrency Definition

- **<u>Degree of overlap</u> between interface development of two or more acquisition programs**
  - Two LCS configurations
  - ADS
- **<u>Structuring the overlap</u> is the objective of this paper**
  - SoS development is here to stay
  - Processes needed

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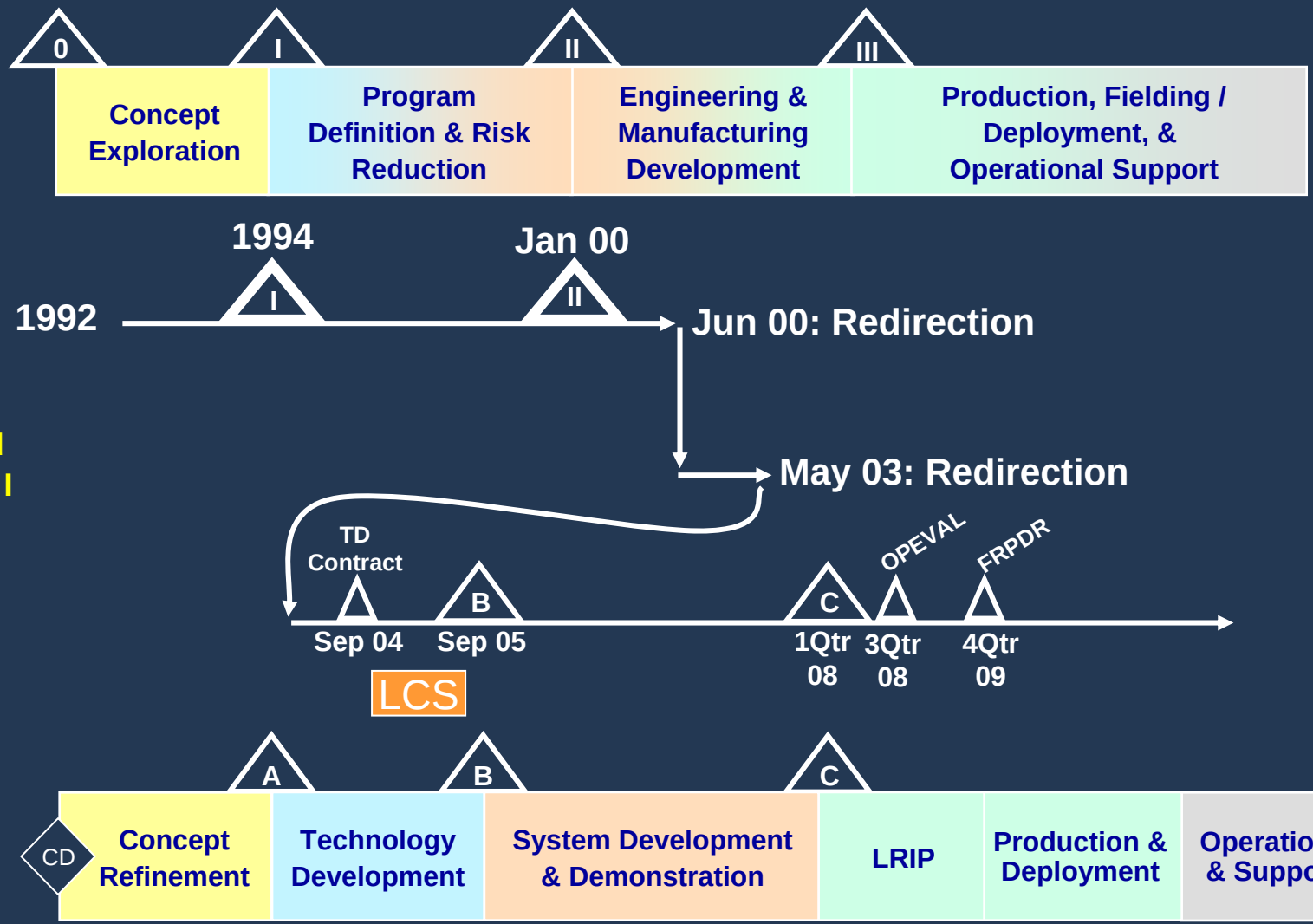
Objective

This paper will describe:

- **How PMS 485 managed the "SoS concurrent" design environment of an ACAT-1 sensor development for two competing LCS designs**
- **Lessons Learned**
- **Recommended SoS SE Process**

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ADS History / Timeline



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LCS History / Timeline

- Dec 02 New start authorized by Congress
- Feb 03 RFP for Preliminary Design
- Jul 03 Award 3 Preliminary Designs
- May 04 MS A / Program initiation / down select to 2
- Dec 04 Detail Design and Construction Option to LMCO
- Feb 05 Start Fabrication
- Oct 05 Detail Design and Construction Option to GD

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Potential Impacts of Concurrency on ADS Program (ACAT-1)

- **Cost:** Were ADS reserves for ADS changes for two lead ships enough? Did LCS PM reserve enough to pay for changes to MMs driven by his unilateral changes?
- **Performance:** How would LCS designs constrain ADS KPPs?
- **Schedule:** Would LCS be ready to support ADS Test events and OPEVAL dates IAW ADS' ACAT-1 Milestones?
- **Design Risk:** What changes would ADS be forced to implement to match LCS design instability and decisions after ADS CDR?
- **Process:** What processes would LCS PM adopt to implement CM while trying to satisfy the objectives of "transformational ship acquisition"?
- **Contractual Liabilities:** What impact would the LCS dual-lead ship acquisition strategy have on communication among the parties

An inter-program coordination process could mitigate these risks

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Interdependencies of 2 ACAT-1 Programs: Challenges of SoS Concurrency

- **Multiple Process:**
  - Total ship SE (TSSE) processes vs. traditional industry SE processes (EIA 632, IEEE 1220, etc.)
- **Multiple Definitions:**
  - e.g., “ICD”: Initial Capabilities Document, Interface Control Document or Installation Control Drawings
- **Multiple Interface Controls / Configuration Management:**
  - 4 spiraling / evolving baselines
  - 3 Configuration Control Boards

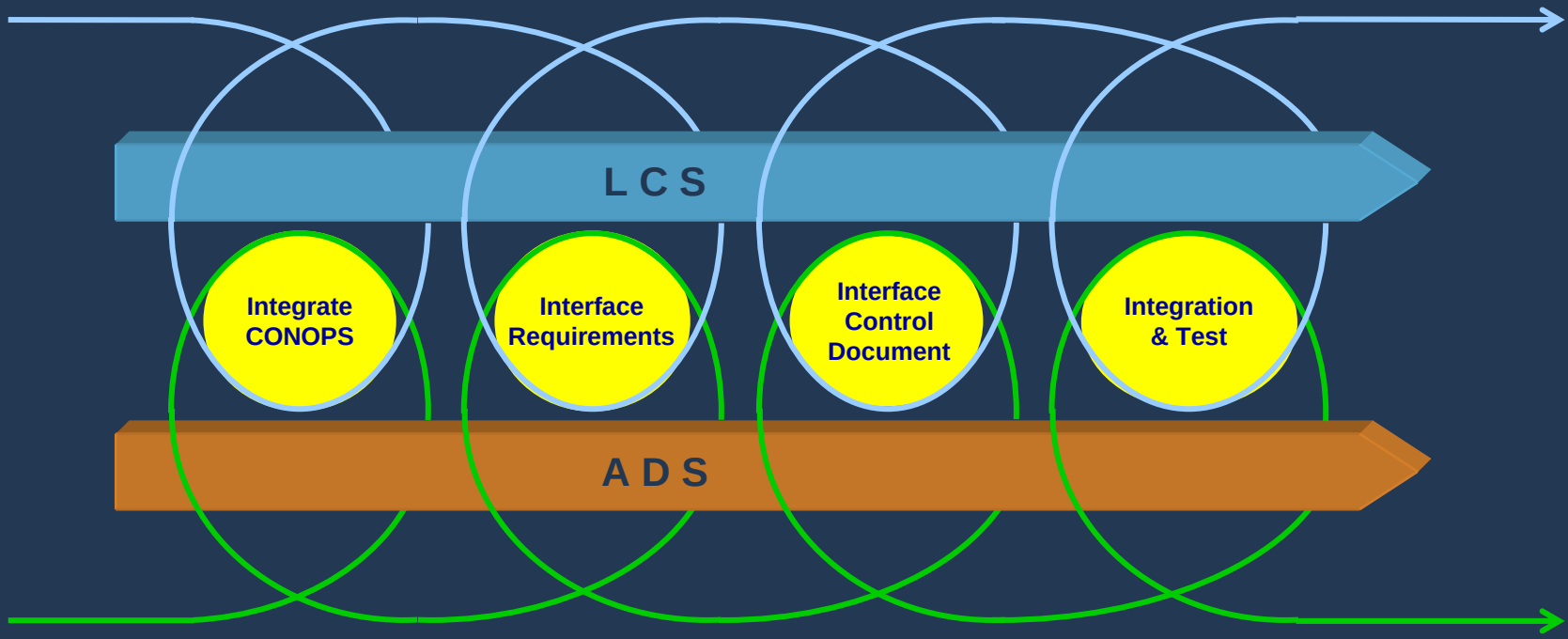
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Interdependencies of 2 ACAT-1 Programs: Challenges of SoS Concurrency (cont.)

- **Multiple Competing Schedules:**
  - Access to seaframes, integrated testing, PDT & T, ADS OPEVAL
  - Cross sponsor (OPNAV) and Fleet coordination
- **Multiple Competing OSD Acquisition Program Baselines (APB) / Reports / Milestones**
  - Generally do not recognize interdependencies of Systems of Systems development sponsored by different OPNAV offices
  - APBs do not anticipate changes forced upon a program due to changes by others

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Concurrent Spiral Development Touch Points

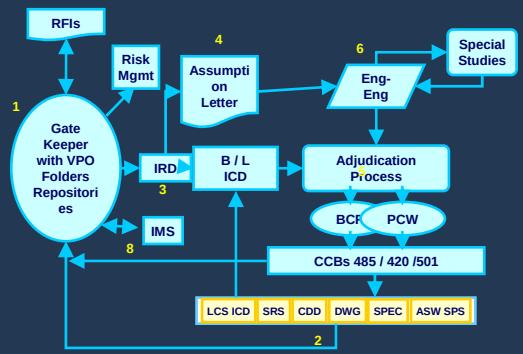


The most critical element of success was robust CM of designs, documents and processes

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8 Element SoS SE Process Developed

1. Created Gate Keeper process and VPO site (vs. serial information processing)
2. Established Cross Program Configuration Management
3. Developed Interface Requirements Document (needed for ADS contract in absence of a ship ICD. Addendum to the SPS for external interfaces)
4. Developed the Assumptions Process (to support PDR, CDR and detail design) and applied the BCR process to changes in assumptions
5. Developed Adjudication Process and forum (to allocate assumptions to formal documents under CM)
6. Created managed Engineer-Engineer forums
7. Performed special studies for critical issues
8. Integrated IMS



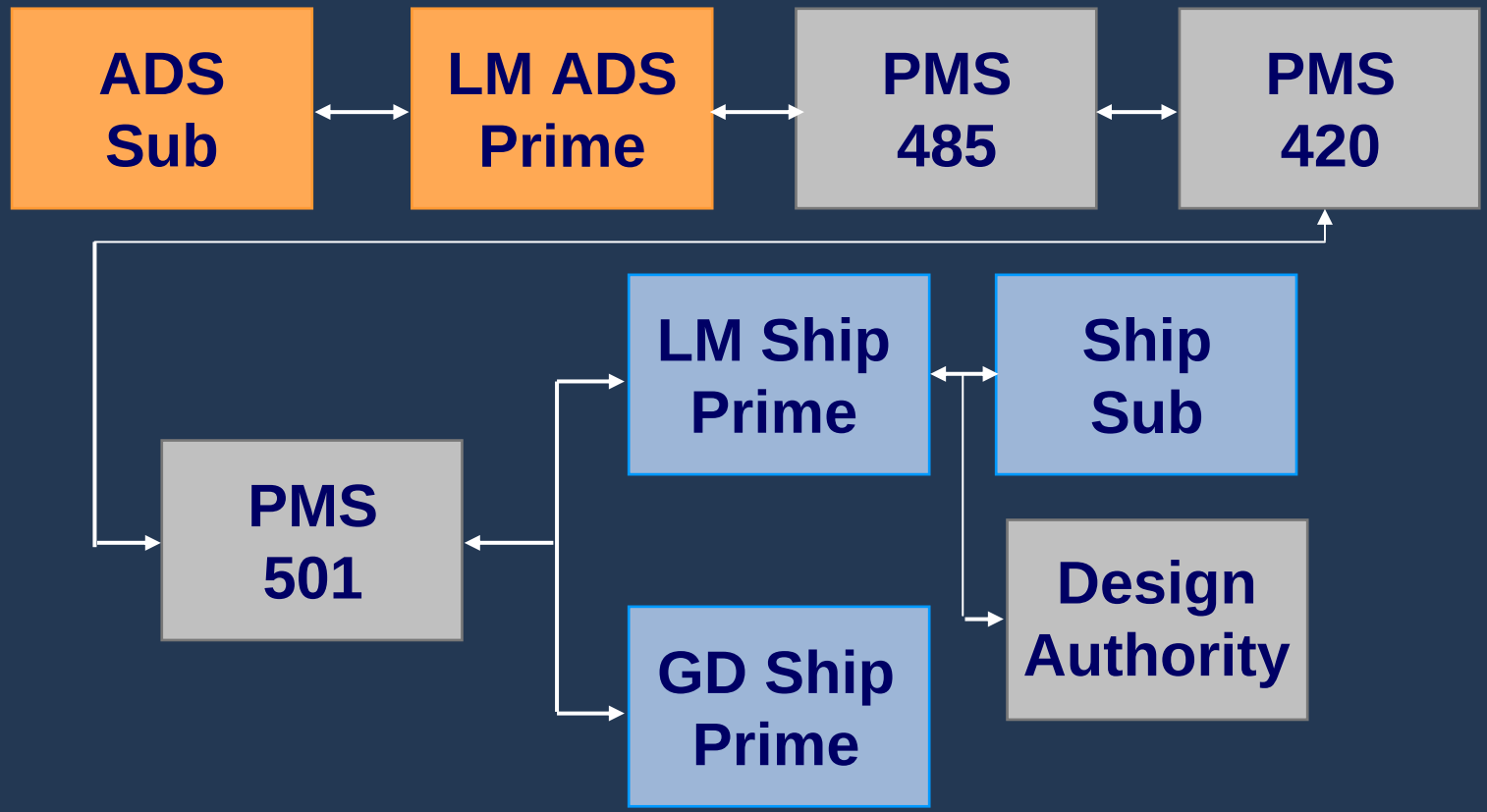
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1.0 Gate Keeper (IPT)

- Process created to shorten and enhance technical information exchange in a competitive acquisition process
- Traditional serial process was shortened by creating an IPT structure called “Gate Keeper”
- Short circuited time lag by providing a web-enabled Integrated Data Environment (IDE)
- Parties signed non-disclosure agreements among each other to limit access to and unwitting disclosure of competition sensitive data
- Meetings held monthly and telecons weekly

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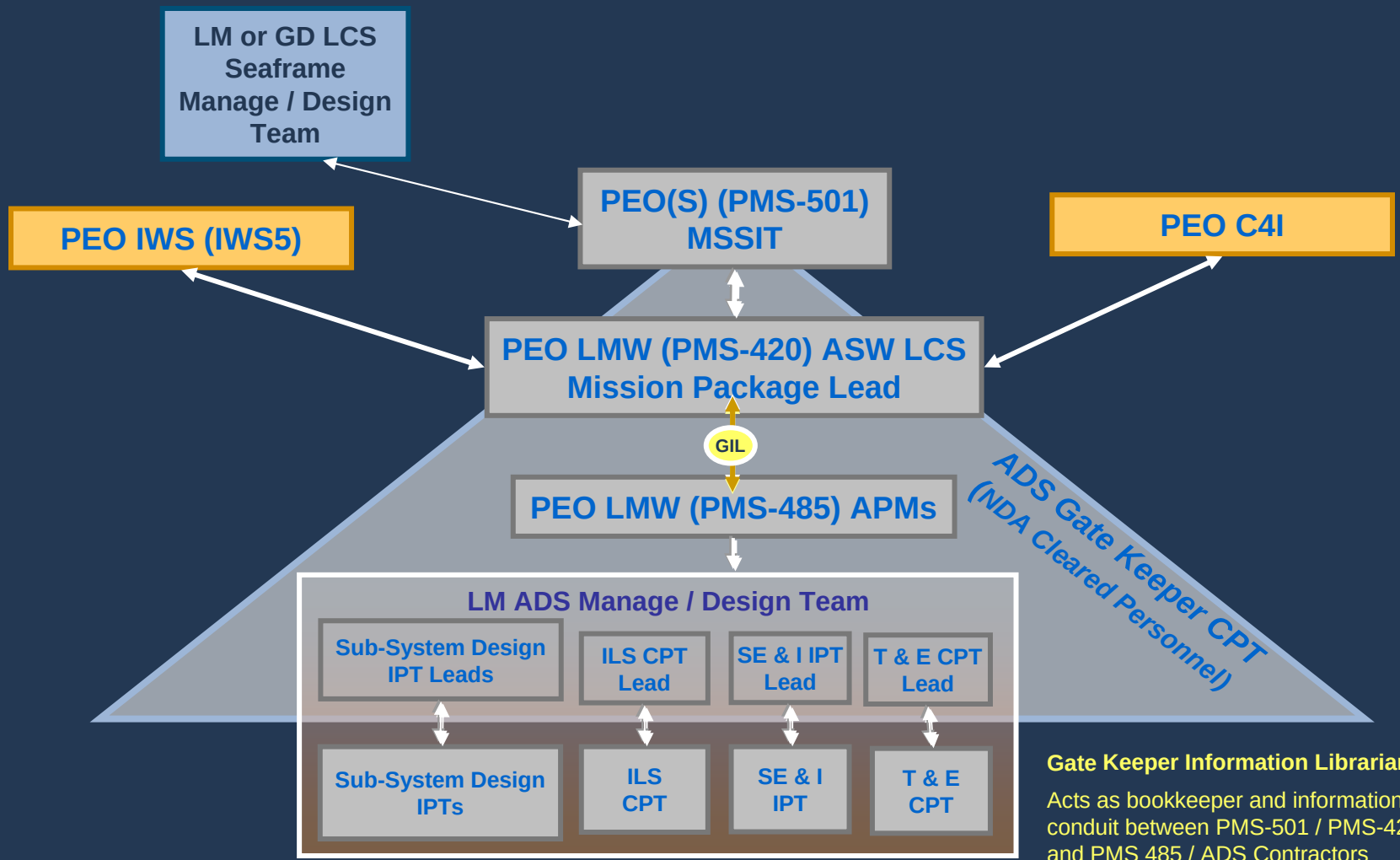
Traditional Serial Communications Path



Linear Slow Path, Information Details Lost

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Gate Keeper CPT



Gate Keeper Information Librarian (GIL):

Acts as bookkeeper and information conduit between PMS-501 / PMS-420 and PMS 485 / ADS Contractors

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2.0 Cross Programs CM

- **Four key elements**
  - Assign requirements between Seaframe and Mission Package
    - **Identified which documents and processes needed**
  - Identification of Critical Interface drawings and specs
  - Development and allocation of key assumptions to appropriate requirement, drawing, process specification, etc., and put under CM
  - Assignment of lead POCs with SE competency on partner CM forums

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2.0 Cross Program CM (cont.)

- **ADS SI Team worked cooperatively with the following CM programs:**
  - 501 MSSIT CM (via 420 and Local 485 Representative)
  - 420 ASW CM (Direct Member)
  - 501 C2 IPT CM (Direct Member)
  - Sea Frame CM (via 420 and Local 485 Representative)

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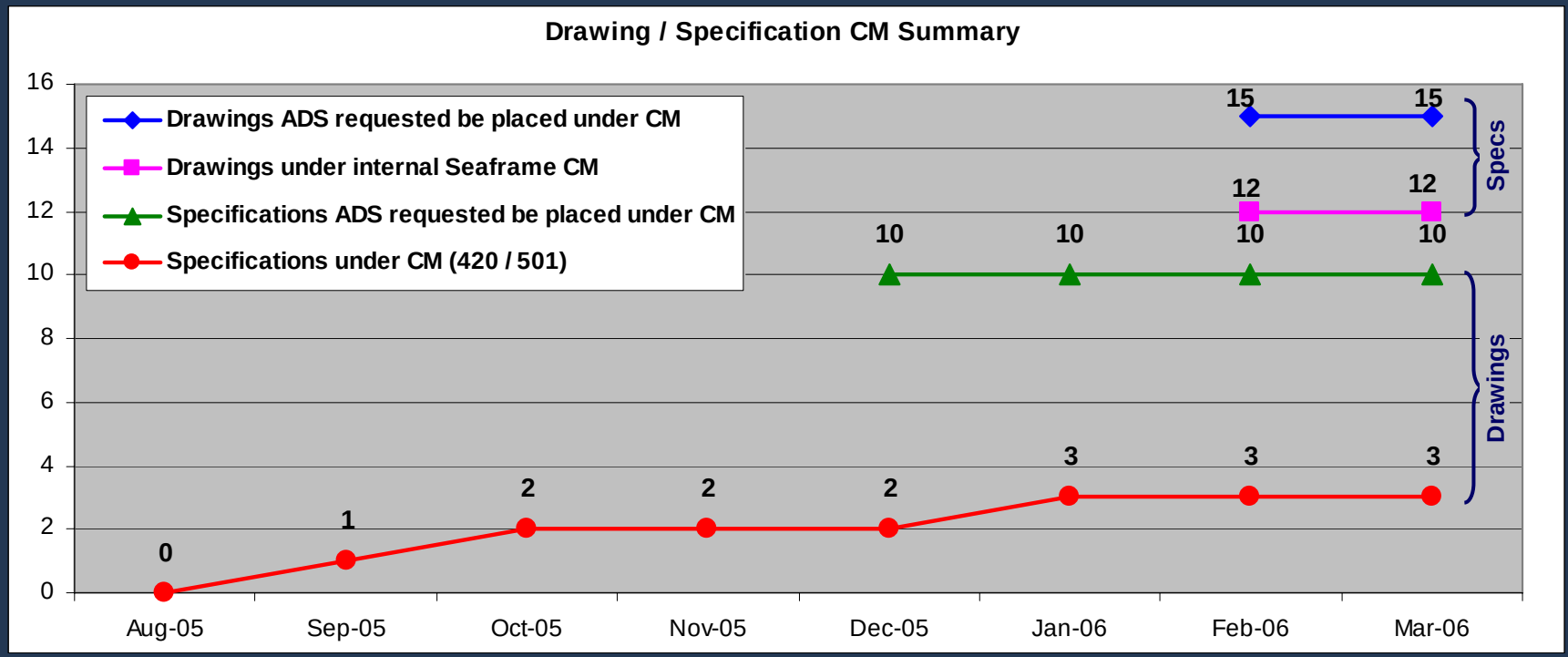
Mission Module Requirements and Design Documents

Code	Document	Version
PMS-501	Interface Control Document (ICD) For The Littoral Combat Ship (LCS) Flight Zero Reconfigurable Mission Systems	Version 1.2
	LCS Interface Drawing	Per Gate Keeper Drawings List
	Littoral Combat Ship Mission Package Interface Design Specification	Version 1.0
PMS-420	Requirements for the Littoral Combat Ship (LCS) Flight 0 – Spiral Alpha Anti-Submarine Warfare (ASW) Mission Package	15 Sep 05
	LCS Flight 0 Mission Package Computing Environment	20 Jan 06, Version 1.3
	On-Board ASW Mission Component Inter-Mission Systems / Modules Interface Requirements Specification (IRS) And Interface Design Document (IDS) for the Littoral Combat Ship Flight 0	10 Jan 06
	ASW Mission Package – MPCE General Purpose Set Flight 0 Computing Resources Allocation	14 Dec 05, Version 3.0
	MP ISS Programmer's Guide	7 Mar 05, Version 1.1
	Mission Package Infrastructure (MPI) Mission Module (MM) to MPI Interface Requirements Specification (IRS)	4 May 05, Version
	Mission Package Infrastructure (MPI) Mission Module (MM) to MPI Integration Requirements Specification (Int RS)	Undated; last change Chg 11; 30 Sep 05

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CM Status

- **PMS 485 / ADS requested CM on 10 Interface Specifications and 15 drawings**
  - PMS 501 / 420 provided periodic status



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3.0 Interface Requirements Document (IRD)

- Document created as a holding repository for interface needs of the ADS system in the absence of Installation Control Drawings or Interface Control Document
- Began in FY04

No.	Title	Notes
IRD22591	3.2.1.8.3 Storage Media Classification Level	
IRD22592	LCS shall provide ADS secure storage at the SECRET level for all off-line recording and archive storage media	Keep Requirement in ADS IRD. Rewrite as: ADS shall not require more than XX m^3 of secure storage at a secret level for ADS recording and archive storage media. Link up to new requirement in ASW MP SPS. Submit BCR: ASW MP shall not require more than XX m^3 of secure storage.

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ADS Interface Development

PDR was based on known requirements and IRD assumptions

- **Key issues requiring mitigating risk assumptions for SDD / CDR included:**
  - Pre-Staging of ADS Strings versus NAVSEA 901B Shock requirements and Mission Bay space
  - Topside and Mission Bay environmental conditions
  - Ability to maneuver / handle ADS equipment from all stowage locations using shipboard transport equipment
  - Compatibility of ADS and LCS computing, network and IA architectures
  - ADS RF Link Margin Requirements

PDR designs had gone as far as possible with existing information

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4.0 Assumptions Process

Extended SE principles to concurrent program developments

- Implementation responsibility was by:
  - MSSIT for PMS 501
  - ASW MP SE Group for PMS 420
  - ADS SI IPT / SE&I IPT for PMS 485
- New Assumptions were generated as programs matured
  - ADS update letters and tables developed
  - Updated sets were sent to PMS 420 and PMS 501 after final ADS PMO review
- Assumptions were allocated to appropriate owner for resolution, tracking and adjudication
- Eventually, these were incorporated into the ADS contract and turned over to the ADS prime for CM

Assumptions: Criteria effecting a system design that the parties are forced to adopt in the absence of stated requirement, specification, procedure or operating parameter (e.g. environment)

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Formalized Inter-Program Process

4 Nov 05

From: Program Executive Office,Littoral and Mine Warfare,Maritime Surveillance Systems Program Office (PMS 485)

To: Program Executive Office, Ships, Littoral Combat Ship Program Office (PMS 501)
Program Executive Office, Littoral and Mine Warfare, Littoral Combat Ship Mission Modules (PMS 420)

Subj: ADS MISSION MODULE ON LCS ASSUMPTIONS AND RESPONSIBILITIES

Encl: (1) ADS on LCS Assumptions, Rationale and Responsibilities Matrix

Background. ADS is a Mission Module (MM) of LCS ASW Mission Package…we have found that the LCS Interface Control Document (ICD)did not have sufficient details for the purpose of supporting the preliminary design of ADS…pending interface decisions may drive changes to *both* the ADS and LCS.

ADS is awarding a contract, assumptions and responsibilities have to be made for these pending interface decisions. Enclosure (1) provides rationale and CCB responsibility for each assumption…necessary to allow PMS-485's prime contractor to propose a technical and cost solution for the ADS SDD phase.

Changes. ADS SDD contract funding is based on these assumptions. Only the responsible CCB, as specified in Enclosure (1), can change these assumptions. Changes in these assumptions could result in ECPs. The respective CCB, will include PMS-485 to arrive at acceptable alternatives, funding sources, and/or schedule impact and resolution of schedule changes for those changes which may effect ADS.

By Direction

P. F. SEIDEL

Copy to:
RADM Hamilton, PEO Ships
RDML William Landay, PEO LMW
Ken Montgomery, PEO Ships, PMS 501M
Ken Michaud, PEO LMW, PMS 420

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Assumptions in 6-Month Period

Revised Totals (04-20-06)				
		CCB Responsibility		
Category	Total Lines	PMS 485	PMS 420	PMS 501
Total	96* (9)	20	27	57
Programmatic	15*	3	6	13
MPCE Computing	18*	6	8	5
Comms	22	4	2	16
Launch &Recovery	24 (9)	7	3	14
Qualification	4	2	1	1
Shock	5	3	1	1
MM Stations	5	0	0	5
S/H/L	8	1	1	6
Ship Equip.	2	1	0	1
Mission Package C2	17	0	8	9

* Number reduced by TI #9; others TBD

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Overview of ADS Assumptions (Communications Summary)

Section	Title	Requirement
3.2.2.2	ADS / LCS Data Telemetry	LCS shall provide 4 ea chassis locations (3 radio chassis and 1 controller chassis) in the radio room for the ADS radio. Each radio chassis will conform to ANSI / EIA-310 dimensions, 19 inches wide by 25 inches deep by 9 U high.
3.2.2.2	ADS / LCS Data Telemetry	LCS shall route an RF transmission cable between the special radio and the TIS buoy staging area.
3.2.2.2	ADS / LCS Data Telemetry	All RF Cables used on the ADS communications link shall have a minimum of -12 dB of shielding effectiveness.
3.2.2.2	ADS / LCS Data Telemetry	LCS shall provide 120 / 208 VAC 60 Hz 3 Phase and 120 VAC 60 Hz single phase to the ADS radio.
3.2.2.2.4	ADS Data Reception	The LCS shall supply 1 transmit antenna and a receive antenna suite with 360 degree coverage and adequate instantaneous bandwidth for ADS TIS telemetry.
3.2.2.2.4	ADS Data Reception	The LCS shall separate the ADS TIS receive antenna from any HF transmitting antenna by at least 100 feet.
3.2.2.2.4	ADS Data Reception	LCS shall suppress all EMI sources in accordance with MIL-STD-810.
3.2.2.3	ADS Shipboard Radio Frequency Antenna Characteristics	LCS shall provide shipboard radio frequency antenna with the following properties:
3.2.2.3	ADS Shipboard Radio Frequency Antenna Characteristics	LCS shall provide a continuous metal surface from the antenna mounting location to the water. This will provide a ground plane.
3.2.2.3	ADS Shipboard Radio Frequency Antenna Characteristics	The lengths of the LCS routed transmission cables between the ADS transmit and receive antennas and the special radio shall be less than 150 feet.
3.2.2.5.1	Mutual Interference	The LCS HF transmitter shall have a maximum power of 1 KW.
3.2.2.5.1	Mutual Interference	The LCS transmitters shall use a set of predetermined frequencies for spectrum overlapping the ADS operating range.
3.2.2.5.1	Mutual Interference	The LCS shall provide ADS with a list of planned radiation frequencies overlapping the ADS operating range.
3.4.2.1	ADS Hazard of Electro-Magnetic Radiation	LCS shall locate the ADS TIS transmit antenna so that personnel are safe from radiation hazards when driven by a 500 Watt PEP transmitter.

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5.0 Assumptions Adjudication Process

Assumption No.	Assumptions	Where Should Line Item Be Documented	ADS Person (APM & SI IPT) Resp for Insuring Implementation & Tracking	Rationale and / or Clarification

P.O.C. on ADS	CCB Responsibility	Change to ASW SPS, LCS ICD or Other Doc (Type in Doc)	BCR or ECP Submitted (Y / N & Date)	BCR or ECP Status	ASW SPS, LCS ICD, or Other Document Requirement Unique Identifier	Associated ADS Requirements Unique Identifiers

- ADS SI personnel were assigned to track assumptions from the assumptions table to ADS and LCS documents under CM
- PMS 501 worked collaboratively
- Status was reported bi-weekly at SI IPT teleconferences and quarterly at SI IPT meetings

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6.0 Engineer-Engineer Meetings

- LCS Cost-type contracts did not provide specific hours for Sea Frame teams to study or answer government questions to satisfy GFI to others
- PMS 501 / 420 / 485 recognized the need and established Engineer to Engineer Working Groups (Sea Frame / ADS)
- PMS 485 developed a SOW to ensure sea frame support to ADS on LCS integration which covered COMMS and L&R IPTs, in particular; others as needed
- PMS 501 conducted Industry Day meetings with Sea Frame teams to highlight specific technical questions and to identify need for special funded studies
- Additional SOWs were then generated to address Special Studies
- Additional resources were added to the Gate Keeper meetings to monitor & address these special areas

A process was developed to provide the detailed LCS Sea Frame data needed to successfully meet ADS CDR design requirements and SIT

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Example: ADS Communications

- **Lockheed Martin and Harris "RF sub-contractor" needed information necessary to compute RF link budgets and to design to its KPPs**
  - 6 simultaneous, 2MB / sec direct path communication channels from a buoy to ship over 30NM separated
- **Impacted LCS and ADS power, weight, range, antenna selection, EMI protection, cable shielding, 360 degree coverage, etc.**

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Example: LCS / ADS Industry Day Agenda

- **Communications (Segment C)**
  - ADS on LCS Communications System Overview
  - Antenna related topics
  - Spectrum topics — **Decision Brief**
  - Noise topics
  - Cabling & Interfaces — **Background Brief**
  - Radio Room related topics
  - Summarized findings
  - Identify Future Actions / Special Study Requirements
  - Determine Schedule need for future meetings
  - **Provide Meeting Minutes / Actions to Gate Keeper**

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Example: Buoy to LCS Link Budget

Buoy to LCS (6 ft monopole with 54 inch Dixie Cup)						
Frequency	**MHz**	**20.0**	**25.0**	**30.0**	**35.0**	**40.0**
Transmitter Power	W	50.0	50.0	50.0	50.0	50.0
Antenna Gain, nominal sea state	dBi	2.8	2.9	2.9	2.9	2.7
Cable Losses (Ant-PA, T/R switch)	dB	1.0	1.0	1.0	1.0	1.0
EIRP	**dBm**	**48.8**	**48.9**	**48.9**	**48.9**	**48.7**
Signal Bandwidth	KHz	500.0	500.0	500.0	500.0	500.0
Noise in Signal Bandwidth	dBm	-117.0	-117.0	-117.0	-117.0	-117.0
Quasi-Minimum Noise, QMN	dB	24.8	22.1	20.0	18.1	16.6
factor over QMN	dB	2.0	6.0	6.0	6.0	6.0
Total background noise level	dB	26.8	28.1	26.0	24.1	22.6
LCS Front End Losses (2:1 divider)	dB	5.0	5.0	5.0	5.0	5.0
Antenna Tuning Unit	dB	2.0	2.0	2.0	2.0	2.0
cable loss	dB	1.0	1.0	1.0	1.0	1.0
Preselector Loss	dB	10.0	10.0	10.0	10.0	10.0
LNA Noise Figure	dB	2.0	2.0	2.0	2.0	2.0
Receiver Noise Figure	dB	20.0	20.0	20.0	20.0	20.0
System Noise Figure	dB	27.6	28.8	26.9	25.5	24.5
Noise Power	**dBm**	**-89.4**	**-88.3**	**-90.1**	**-91.5**	**-92.5**
Rx Antenna Gain, 14 ft shipboard monopole	dBi	2.8	2.7	2.6	2.4	2.1
Path Loss, 40 N Miles	dB	111.0	115.0	119.0	122.0	124.0
Path Loss, 30 N Miles	dB	105.0	110.0	114.0	117.0	119.0
Receive Power (30 N Miles)	**dBm**	**-53.4**	**-58.4**	**-62.5**	**-65.7**	**-68.2**
System Design Margin	dB	0.0	0.0	0.0	0.0	0.0
Operating Range	dB	0.0	0.0	0.0	0.0	0.0
Es/No	dB	36.0	29.8	27.6	25.8	24.3
Required Es/No	dB	20.0	20.0	20.0	20.0	20.0
margin, 30 Nmiles - sea state 1, no ice	**dB**	**16.0**	**9.8**	**7.6**	**5.8**	**4.3**
margin, 40 Nmiles - sea state 1, no ice	dB	10.0	4.8	2.6	0.8	-0.7
6 Inches of Salt Ice	dB	0.5	0.5	0.5	0.5	0.5
Buoy Tilt of 20 degrees - sea state 4	dB	0.3	0.3	0.5	1.0	2.2
margin, 30 Nmiles - sea state 4, 6 inches salt ice	**dB**	**15.2**	**9.0**	**6.6**	**4.3**	**1.6**
margin, 40 Nmiles - sea state 4, 6 inches salt ice	dB	9.2	4.0	1.6	-0.7	-3.4

Link budget factors driven by LCS

Would there be enough gain to close link at range at the 2MB data rate?

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Example: 24 / 7 Operations

- [IRD20515] LCS shall remain within direct path signal range
- [SPS10448] Direct path signal range shall be 30 NMI (threshold), 45 NMI (objective)
- [IRD20534] LCS shall enable communications for Sea State 4 (threshold), 6 (objective)
- [IRD20536] LCS shall provide acceptable ADS antenna placement(s) for any azimuth
- [IRD20538] LCS shall enable communications for any heading change
- [IRD22538] LCS shall enable 24 / 7 communications for [classified]
- [IRD20968] LCS equipment supporting ADS activities shall be designed to prevent an ADS Operational Mission Failure from occurring due to loss of data reception for greater than 15 minutes

Would the LCS design support the ADS continuous operation requirement?

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Example: General Antenna Requirements

General LCS-ADS Antenna Placement Requirements	
IRD22537 BCR0026 #3	LCS shall supply 1 transmit antenna and a receive antenna suite with 360-degree coverage and adequate instantaneous bandwidth for ADS TIS Telemetry
IRD20518 BCR0026 #7	LCS shall provide a continuous metal surface from the antenna mounting location to the water
IRD20891 BCR0040 #1	The LCS sea frame shall provide the ADS shipboard antennas with protection from a direct lightning strike, in accordance with MIL-STD-464A, paragraph 5.4
IRD20922 BCR0026 #9	LCS shall locate the ADS TIS transmit antenna so that personnel are safe from radiation hazards when driven by a 500 Watt PEP transmitter

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Example: Transmit Antenna Details

Shipboard Transmit Antenna Properties	
IRD20519 BCR0038 #1	LCS shall provide a shipboard transmit radio frequency antenna with the following properties: ▪ Operating Frequency: 20 to 21 MHz and 29 to 30 MHz ▪ Antenna Gain: ≥ 3.0 dBi ▪ Antenna Tuning Unit (ATU) Loss: ≤ 1.0 dB ▪ Cable Loss (HPA to ATU): ≤ 1.0 dB ▪ Instantaneous Bandwidth: 600 kHz ▪ VSWR ≤ 2.0:1 ▪ Polarization: Vertical ▪ Azimuth Coverage: 360 degrees ▪ Elevation Beamwidth: > + / - 20 degrees ▪ ATU Input Impedance: 50 Ohms ▪ Power Capacity: ≥ 500 Watts

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Example: Receive Antenna Details

Shipboard Receive Antenna Properties	
IRD20519 BCR0038 #2	LCS shall provide a minimum of 2 shipboard receive radio frequency antennas with the following properties: ▪ Operating Frequency: 20 to 40 MHz ▪ Antenna Gain: ≥ 2.5 dBi ▪ 4:1 Divider Loss: ≤ 6.5 dB ▪ Cable Loss (to Receiver): ≤ 1.0 dB ▪ Instantaneous Bandwidth: 20 MHz ▪ VSWR ≤ 3.0:1 at output of antenna ▪ Polarization: Vertical ▪ Azimuth Coverage: 360 degrees ▪ Elevation Beamwidth: > +/- 20 degrees ▪ Divider Output Impedance: 50 Ohms ▪ Antenna Tuning Unit Losses: ▪ ≤ 1.5 dB @ 40 MHz ▪ ≤ 4.4 dB @ 20 MHz ▪ ≤ 2.2 dB @ 25 MHz ▪ ≤ 1.5 dB @ 30 MHz ▪ ≤ 1.5 dB @ 35 MHz ▪ ≤ 1.5 dB @ 40 MHz

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Example: Spectrum Requirements

LCS Shipboard Spectrum Requirements	
IRD20531 BCR0026 #2	The LCS HF transmitter shall have a maximum power of 1 KW
IRD20531 BCR0026 #1	LCS HF Link shall use a set of predetermined frequencies [per communications operational plan]

Requirements on ship Transmitters for ADS

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Example: Noise Environment

LCS Shipboard Noise Environment	
IRD20889 BCR0034 #5	During ADS operation, the LCS equipment shall not generate an E field greater than 6 volts / meter over the frequency range of 17.5 MHz to 45 MHz at the ADS receiver antenna locations
IRD22535 BCR0026 #11	All RF Cables used on the ADS communications link shall have a minimum of -120 dB shielding effectiveness

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Example: Cabling & Interfaces

Other Requirements	
IRD22535 BCR0026 #12	LCS shall route a RF transmission cable between the special radio and the TIS buoy staging area [on board the LCS]
IRD22535 BCR0026 #4	LCS shall provide 4 ea chassis locations (3 radio chassis and 1 controller chassis) in the radio room for the ADS radio. Each radio chassis will conform to ANSI / EIA-310 dimensions, 19 inches wide by 25 inches deep by 9U high
IRD22535 BCR0026 #5	LCS shall provide 120 / 208 VAC 60 Hz 3 Phase and 120 VAC 60 Hz single phase to the ADS radio
IRD20518 BCR0026 #8	The lengths of the LCS routed transmission cables between the ADS transmit and receive antennas and the special radio shall be less than 150 feet

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Example: Size, Weight and Power Estimates

- **Space**
- **Qty 2(1): 19” EIA 310D Racks**
  - 182cm height [excluding isolation]
  - 61cm depth [excluding handles & connectors]
- **Weight**
- **Less than 1500 lbs (1)**
- **Power**
- **< 1500 Watts average (1)**
- **< 3000 Watts in 60 msec peaks at 3 sec (typ) intervals**

(1) per LCS ICD Appendix C Section C.2.6.4

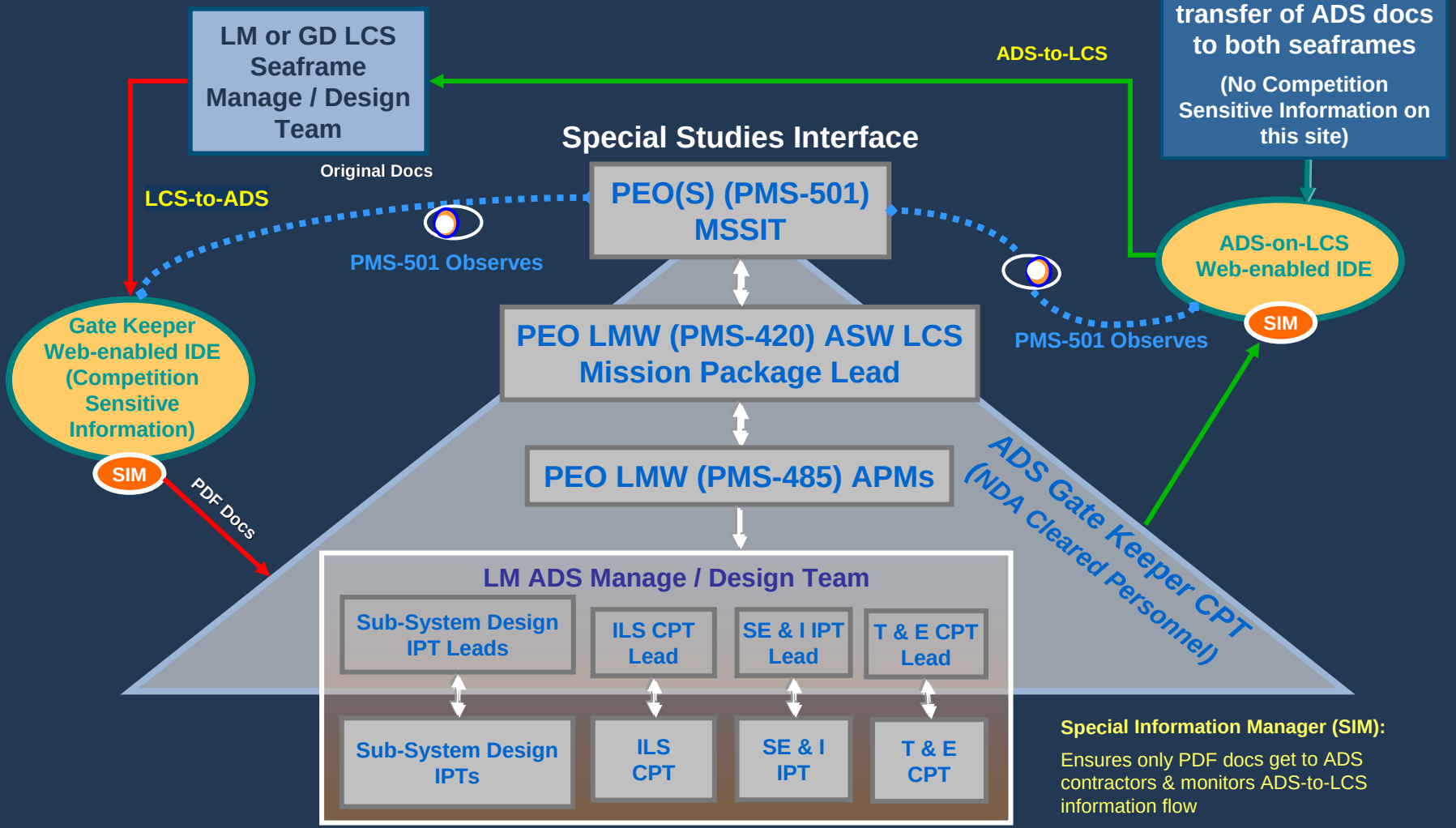
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7.0 Special Studies

- Notwithstanding SE-SE efforts, the parties could not deliver the design data needed to develop the ADS radio without in-depth knowledge of both ship designs and electromagnetic characteristics
- In early 06, Task Instructions were issued to both teams to conduct special studies using a Working Group structure administered by Gate Keeper
- Both teams studied Communications, Launch and Recovery issues resulting in sufficient information to successfully meet CDR design of the ADS radio and L & R subsystem with no claims for late GFI or major ECPs
- One ECP to LCS was issued to provide the critical Mission Module support changes in LCS 2

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Gate Keeper Communications Path Modified for Special Studies



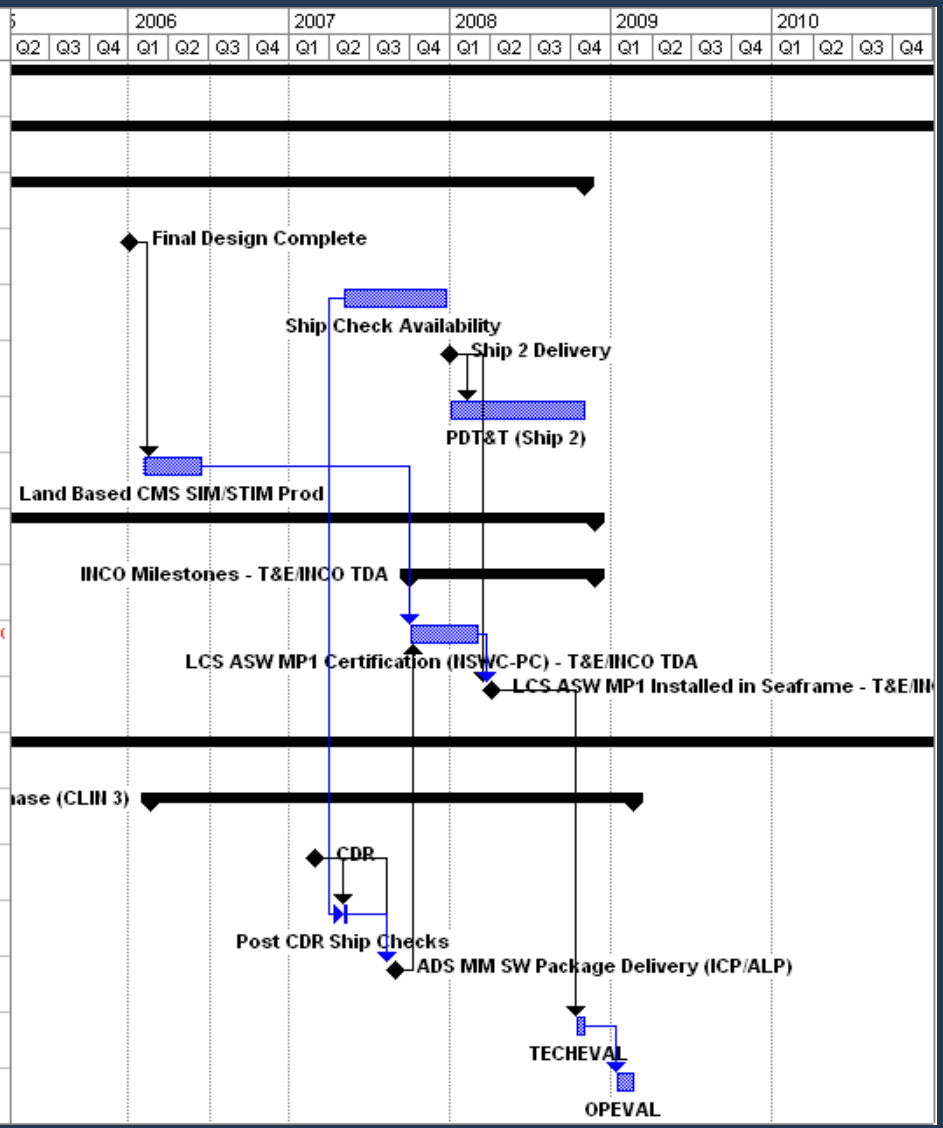
Special Information Manager (SIM):

Ensures only PDF docs get to ADS contractors & monitors ADS-to-LCS information flow

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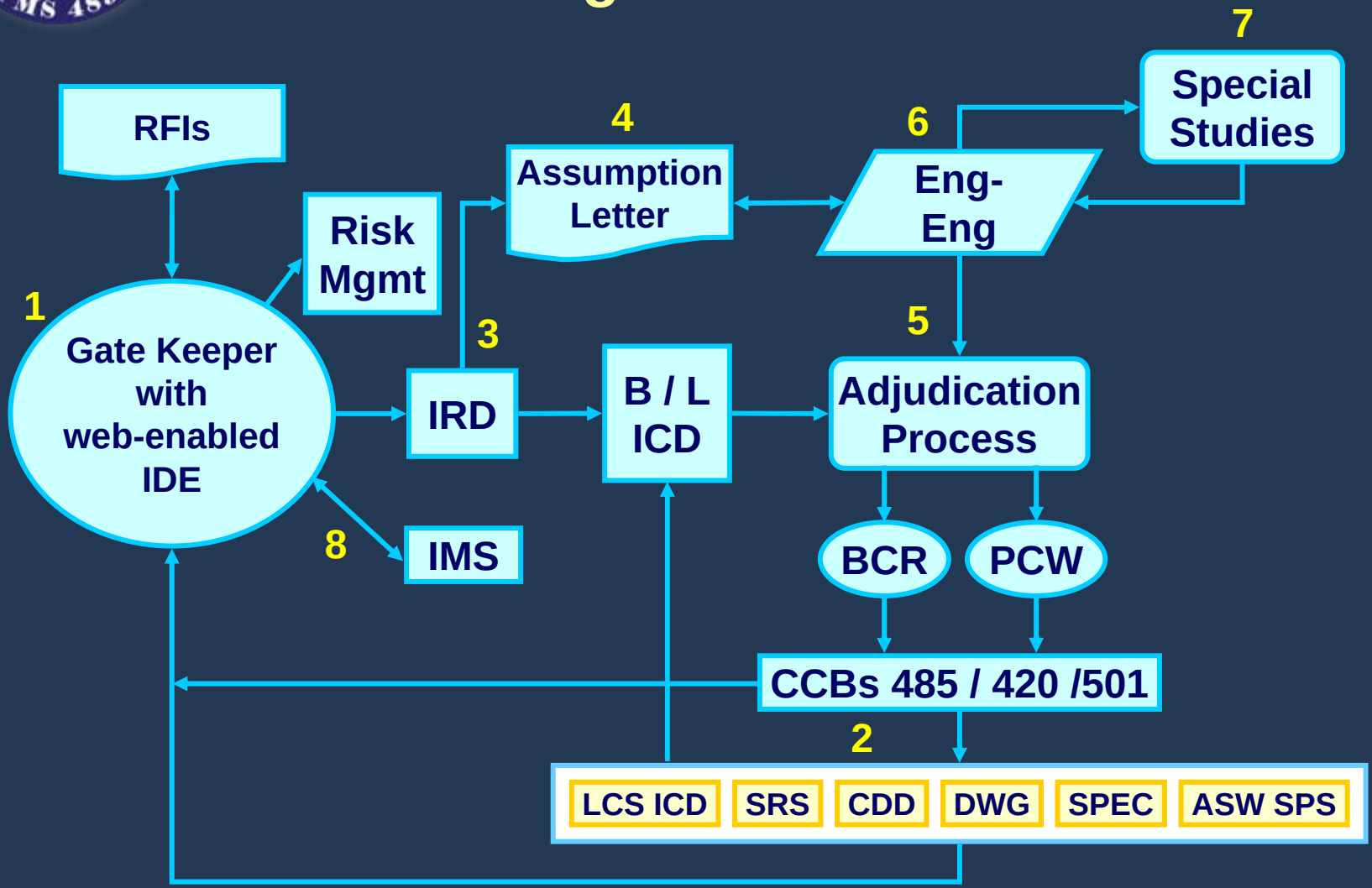
8.0 Integrated Master Schedule (IMS)

ID	Task Name
1	**Common Milestones**
2	**Seaframe Common Milestones (PMS 501)**
27	**Ship 2 (GD-1)**
28	Final Design Complete
29	Ship Check Availability
30	Ship 2 Delivery
31	PDT&T (Ship 2)
32	Land Based CMS SIM/STIM Prod
59	**ASW MP Common Milestones (PMS 420)**
73	**INCO Milestones - T&E/INCO TDA**
74	LCS ASW MP1 Certification (NSWC-PC) - T&E/IN
75	LCS ASW MP1 Installed in Seaframe - T&E/INCO
188	**ADS Common Milestones (PMS 485)**
206	**Systems Design Development Phase (CLIN 3)**
209	**CDR**
210	Post CDR Ship Checks
211	ADS MM SW Package Delivery (ICP/ALP)
219	**TECHEVAL**
220	**OPEVAL**



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SoS Concurrency Management Process



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Lessons Learned

- **Traditional NAVSEA and ship SE processes did not support concurrent SE of 2 interdependent ACAT-1 programs reporting to 2 sponsors and PEOs**
  - Outside of the traditional SYSCOM business practice
  - Will require more robust inter-related SE and T & E processes
- **Parties must mutually respect the rigors imposed by 5000.1 on each other**
- **Parties must agree in writing on capstone requirements and processes to be implemented**
- **Metric based CM must be imposed on critical docs, drawings and processes**

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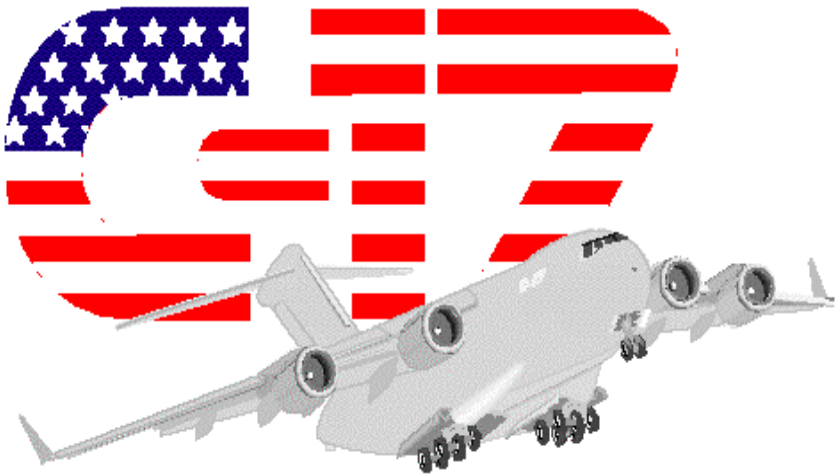
Recommendation

- **ASN (CHENG) may wish to include a section on concurrency in the SE Guide Book**
  - Lessons Learned and the ADS on LCS 8-Step process offers a tested process:
    - **The use of a IRD to capture inputs or changes to the Interface Control Matrix**
    - **Gate Keeper or similar management structure**
    - **Assumption documentation, adjudication and allocation to key documents**
    - **CM of Interfaces, documents and processes**

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Systems Engineering Conference

C-17 Systems Engineering Process
to Prioritize
Material Improvement Program (MIP) Projects



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Outline Slide

- Purpose of Briefing
- Background
- Provide User with recommendation on how to spend their Material Improvement Program (MIP) money
  - Starting point only, user makes final decision
  - Proved to be difficult
- Approach used to provide recommended MIP Priority

Purpose of Briefing

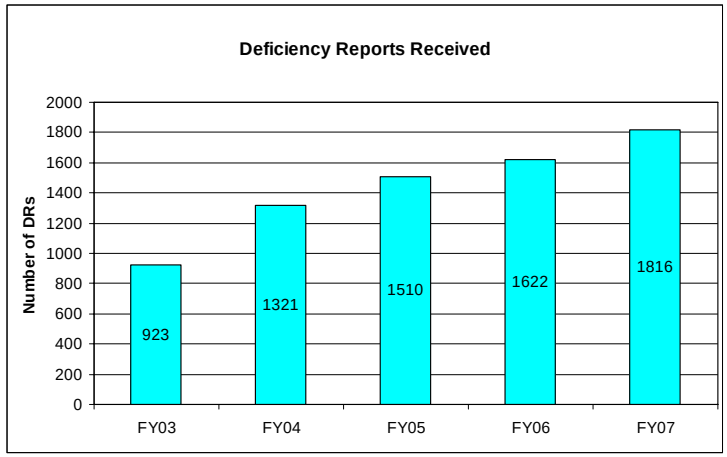
- **Outline the approach the C-17 is using to prioritize Material Improvement Projects (MIPs) for funding**

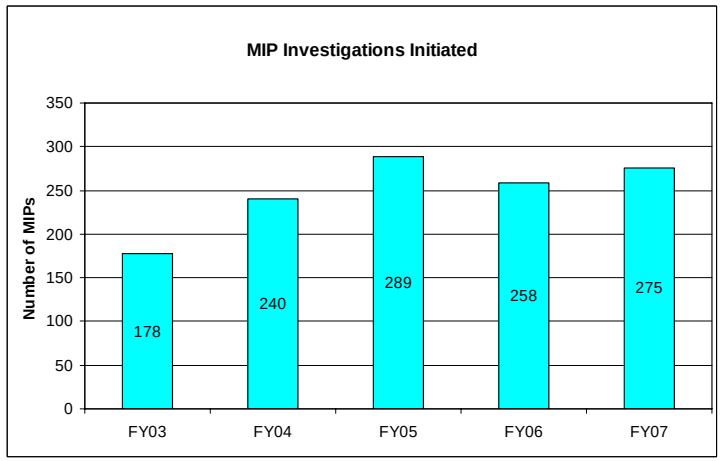
Definitions

- **Material Improvement Project (MIP) investigations are initiated when a Deficiency Report (DR) is determined to warrant further investigation.**
- **MIPs are planned engineering investigations to find root cause and corrective action or evaluate proposed enhancements.**

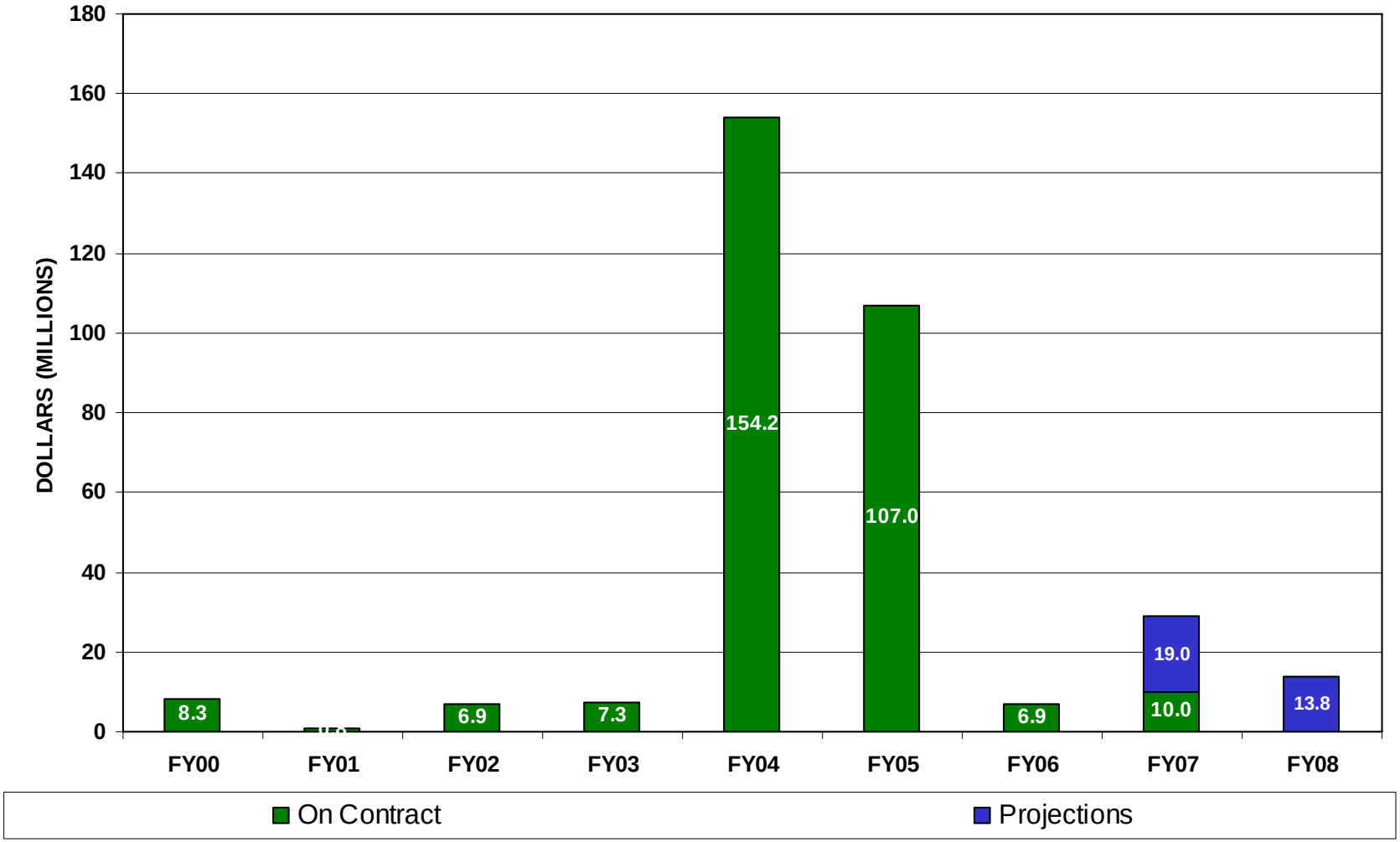
Background

- **Deficiency Reports continue to rise**
  - **1800+ in FY07**
  - **2000+ projected for FY08**
- **About 250 - 275 Material Improvement Projects initiated annually**
- **DRs & MIPs expected to rise as more aircraft are produced and as the jet gets older**





MIP Funding


180
160
140
120
100
80
60
40
20
0
DOLLARS (MILLIONS)
8.3
6.9
7.3
154.2
107.0
6.9
19.0
10.0
13.8
FY00
FY01
FY02
FY03
FY04
FY05
FY06
FY07
FY08
On Contract
Projections

Background

- C-17 Supportability Model previously used to for initial prioritization
  - Did not work well – Highest priority projects often ranked in middle of model
  - Specific concerns:
    - » Safety – Considers only the initial safety RHI
    - » R&M -- No “bang for the buck” comparison ability
    - » Subjectivity in many fields
    - » Does not consider MMH or RoR Cost
    - » Subjective factors used to evaluate operational impact
    - » Attempted to assign values to each field

Provide C-17 Systems Group Recommendation to HQ AMC

- Relatively easy to prioritize the top few projects
- Very hard to distinguish between lower than “top” priority, but still good projects
  - Particularly true when comparing fundamentally different systems (e.g. hydraulic pump reliability versus battery charger algorithm change)
  - Tried and failed to reach consensus with team looking at narrative description of change
- Clearly we needed a tool to help develop a priority recommendation

MIP Prioritization Tool

- **Two most common types of MIPs are R&M and Safety improvements**
  - **All R&M projects can be converted into dollar savings**
    - » **Those dollar savings can be converted into payback period**
  - **Safety projects can be quantified in terms of reduced Real Hazard Index (RHI)**

MIP Prioritization Tool

- **Other reasons exist for MIPs also**
  - **Eliminate dropped objects**
  - **Special interest item (Flight Crew or Maintenance working groups)**
    - » **Often these items are included in safety or R&M concerns**
  - **Over and Above funding drivers during depot maintenance**
  - **Pilot workload**
  - **Survivability / vulnerability**
  - **Other**
- **Difficult to convert these considerations into common terms**

MIP Prioritization Tool

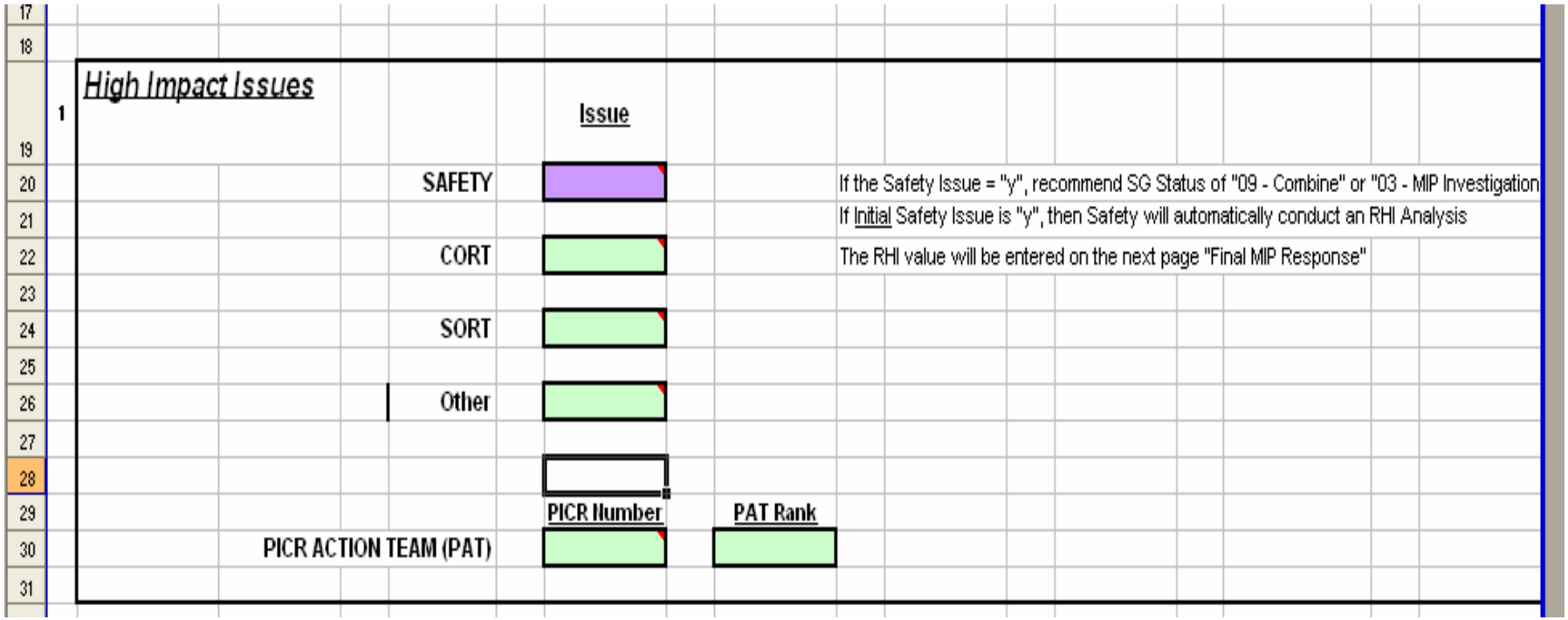
- **Nomenclature: Deficiency / MIP Payback Model (Link to DMPM)**
- **Excel Spreadsheet tool**
  - **Initial DMPM for new Deficiency Reports (DRs)**
    - » **“Is this DR worth investigating?”**
  - **Final DMPM for MIPs “Open Awaiting Funding”**
    - » **Calculates/summarizes key prioritization information**
    - » **Provides a “bang for the buck” estimate in terms of simple Payback Period calculation**

Top Section of Initial Evaluation DMPM

	A	B	C	D	E	F	G	H	I	J	K	L	O	P	Q	R	S
1			Boeing Proprietary - When populated with Data														
2																	
3			Initial DR Response										Revision: 0.9				
4																	
5		DR Title:											Date:				
6																	
7													DR Number:				
8			Name						Phone Number								
9		COG Engineer											Part Number:				
10		SG Engineer															
11		Safety Engineer											WUC:				
12		R&M Engineer															
13																	
14					Is there already an existing investigation/project in progress for this Failure Mode?									YES	Combine With DR#		
15														NO	Continue with this Worksheet		
16																	
17																	

Summary information at top of DMPM tool

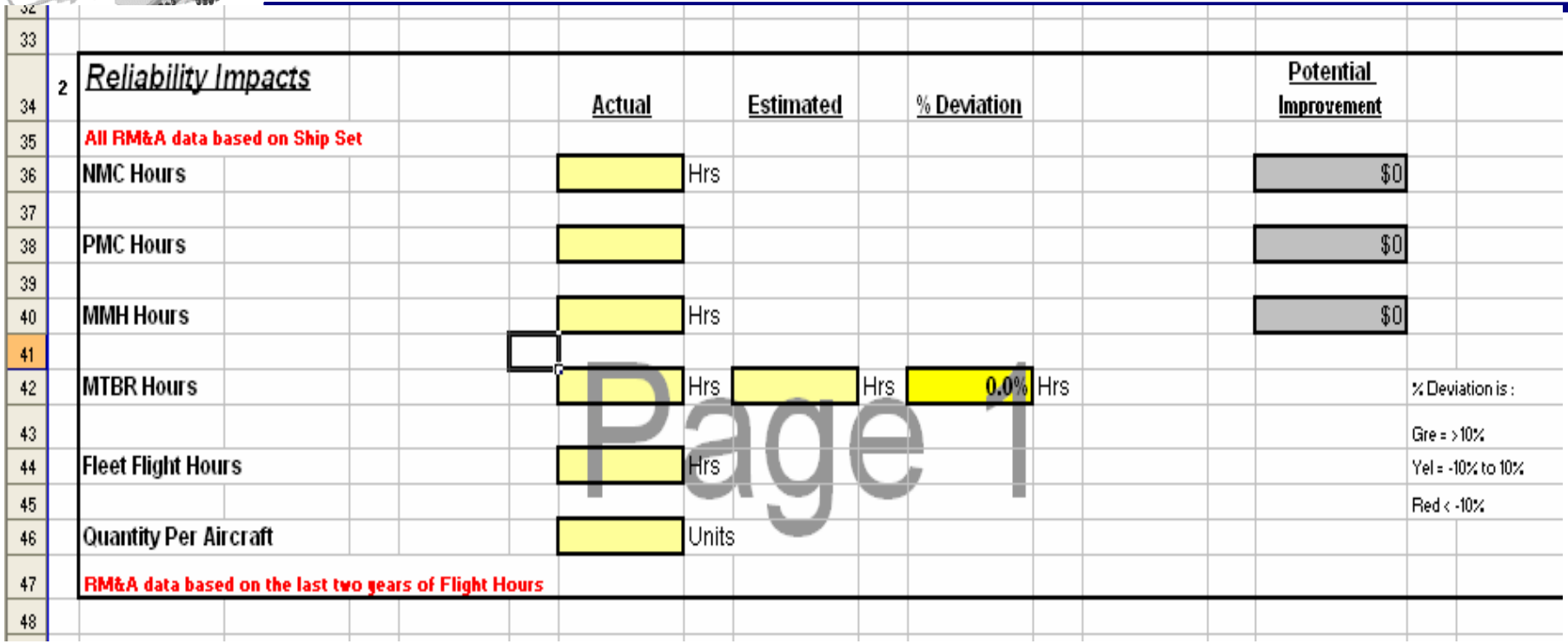
High Impact Issues Section of Initial Evaluation DMPM



If the answer is “Yes” to any of these questions – The Deficiency Report is investigated

- Other includes factors such as “Dropped Object” and “Pilot Workload”

Reliability Impacts Section of Initial Evaluation DMPM



2	Reliability Impacts	Actual		Estimated		% Deviation		Potential Improvement
	All RM&A data based on Ship Set							
	NMC Hours		Hrs					$0
	PMC Hours							$0
	MMH Hours		Hrs					$0
	MTBR Hours		Hrs		Hrs	0.0%	Hrs	
	Fleet Flight Hours		Hrs					
	Quantity Per Aircraft		Units					
	RM&A data based on the last two years of Flight Hours							

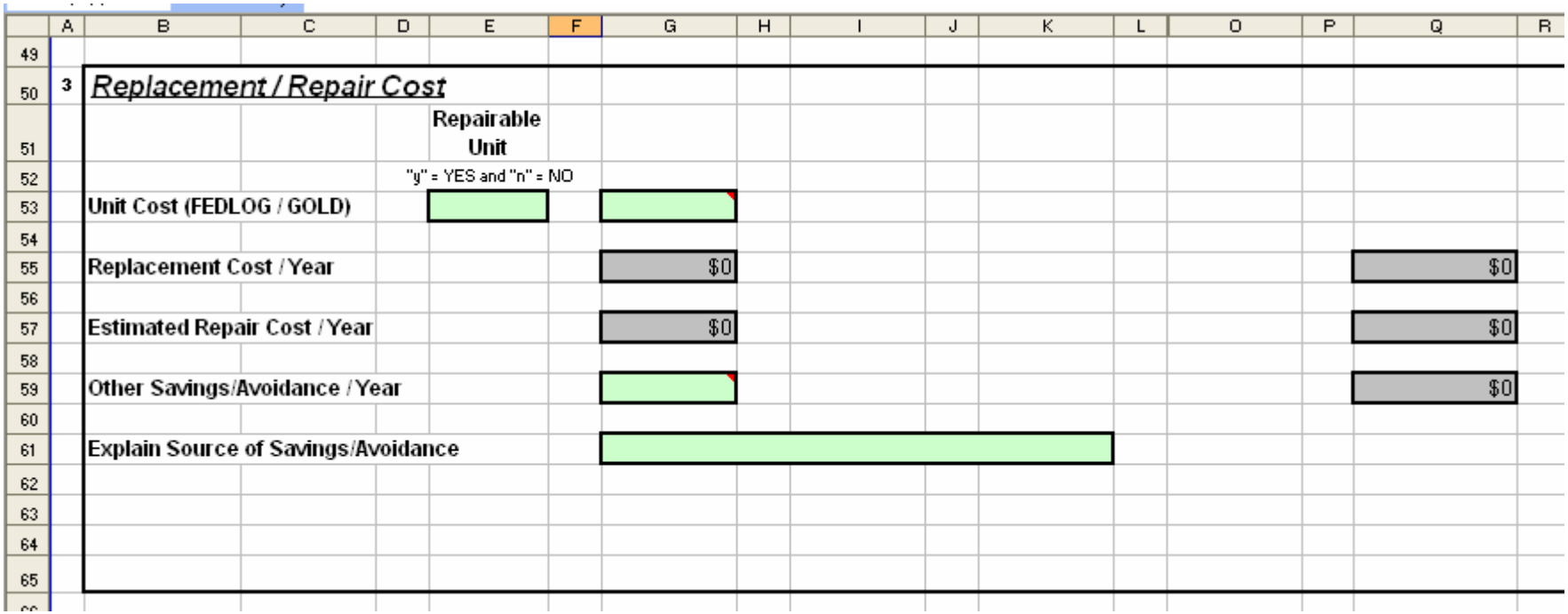
% Deviation is :
Gre = >10%
Yel = -10% to 10%
Red < -10%

Page 1

Converts Reliability Impacts into cost numbers

- Assumes solution will completely eliminate source of Not Mission Capable (NMC), Partially Mission Capable (PMC), and Maintenance Man Hours (MMH)
- Not Mission Capable Hours = $2000 each
- Partially Mission Capable Hours = $1000 each
- Maintenance Man Hour = $72 each

Replacement / Repair Cost Section of Initial Evaluation DMPM



	A	B	C	D	E	F	G	H	I	J	K	L	O	P	Q	R
49																
50	3	*Replacement / Repair Cost*														
51					Repairable Unit											
52					"y" = YES and "n" = NO											
53		Unit Cost (FEDLOG / GOLD)														
54																
55		Replacement Cost / Year					$0								$0	
56																
57		Estimated Repair Cost / Year					$0								$0	
58																
59		Other Savings/Avoidance / Year													$0	
60																
61		Explain Source of Savings/Avoidance														
62																
63																
64																
65																

Calculates the Repair / Replacement cost

- (Failures per FH) * (QPA) * (FH in a year) * (cost per repair/replacement)

Other Savings – e.g. fuel savings for a nacelle sealing improvement

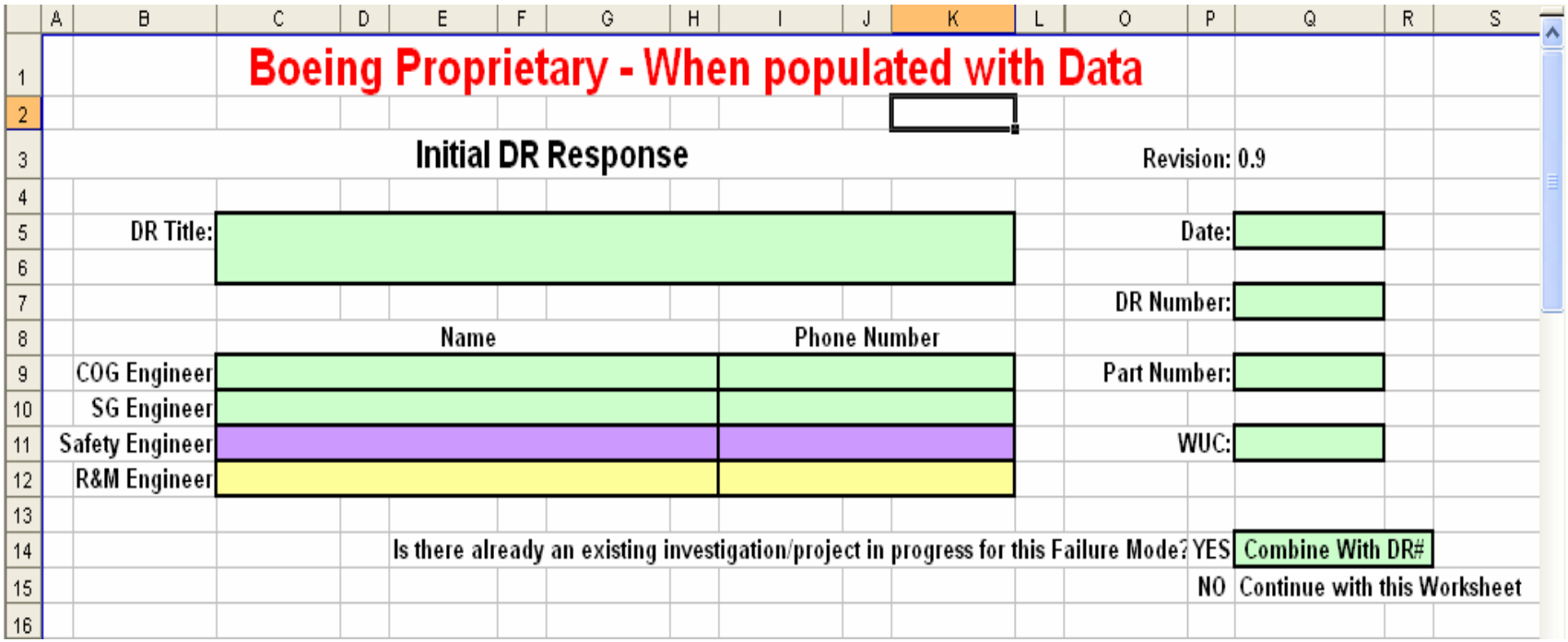
Summary / Total Section of Initial Evaluation DMPM

	A	B	C	D	E	F	G	H	I	J	K	L	O	P	Q	R
67																
68	4	*Summary Totals*														
69																
70										Potential Savings / Year					$0	
71																
72										Replacement / Repair Costs					$0	
73																
74										*Total Potential Savings / Year*					$0	
75																
76																
77																
78										MIP Investigation Recommended?				NO. ALTERNATIVES?		
79																
80		Instructions:														
81																
82		Section 1 (Lavender color) completed by Safety Engineering								Consider the following Alternative Solutions or Others Not Listed:						
83		Section 2 (Yellow color) completed by AVIET									a. Tech Pub Change (PCR)					
84		Section 3 (Green color) all header boxes completed AVIET									b. Technical Order					
85											c. PICR					
86											d. RIPTA					
87		The Grey boxes are calculations and do not get filled out.									e. Close DR					

Calculates the Repair / Replacement cost

- Total Potential Savings / Year = Sum of “Potential Savings / Year” + “Repair / Replacement Costs”
  - If total Potential Savings / Year exceed $100K – Investigate DR
- If any of the questions in the Top Section of the DMPM are “YES” – Investigate DR

Top Portion of Final Evaluation DMPM



Boeing Proprietary - When populated with Data

Initial DR Response

Revision: 0.9

DR Title:

Date:

DR Number:

	Name	Phone Number
COG Engineer		
SG Engineer		
Safety Engineer		
R&M Engineer		

Part Number:

WUC:

Is there already an existing investigation/project in progress for this Failure Mode? YES Combine With DR#

NO Continue with this Worksheet

Summary information at top of DMPM tool – Same as Initial Evaluation

High Impact Issues Portion of Final Evaluation DMPM

High Impact Issues		Issue	Current RHI	Predicted RHI After Fix
SAFETY				
CORT				
SORT				
Other				
		PICR Number	PAT Rank	
PICR ACTION TEAM (PAT)				

Only difference from Initial Evaluation Tool is Addition of Current Real Hazard Index (RHI) and Predicted RHI after fix

Reliability Impacts Section of Final Evaluation DMPM

2	Reliability Impacts		Actual		Reduced			Potential Improvement		Value of Potential Improvement	
	All RM&A data based on Ship Set										
	NMC Hours			Hrs	0	Hrs		0	Hrs	$0	
							Percentage Value of PMC				
	PMC Hours			Hrs	0	Hrs	50%	0		$0	
	MMH Hours			Hrs	0	Hrs		0	Hrs	$0	
		Trend Is:									
					Predicted		% Deviation				
	MTBR Hours		1	Hrs	0	Hrs	0.0%	Hrs			Red ≤ 5%
	Fleet Flight Hours		1	Hrs							
	Quantity Per Aircraft		1	Units							
	RM&A data based on the last two years of Flight Hours										

Page 1

Converts Reliability Impacts into cost numbers

- Engineer inputs estimated value for metrics after fix is incorporated
- For PMC hours, engineer also estimates percentage value of a PMC hour
  - For minor items it may be 20 percent, for more significant items it may be 75 percent
- Change from predicted value of MTBR hours is also calculated

Replacement / Repair Cost Section of Final Evaluation DMPM



3 *Replacement / Repair Cost*

	Repairable Unit			
Unit Cost (FEDLOG / GOLD)				
Replacement Cost / Year		$0	$0	$0
Repair Cost / Year		$0	$0	$0
Other Savings/Avoidance / Year		$0		$0
Source of				
Spares (FEDLOG):	Modify Existing Spares		$0	

Calculates the Repair / Replacement cost – Very similar to Initial DMPM

- Based on predicted level of improvement

Summary / Total Section of Final Evaluation DMPM

65	4	*Summary Totals*		
66			Value of Potential Savings / Year	$0
67				
68			Potential Improvement Cost (NRE)	
69			Potential Improvement Cost (Recurring)	
70			*Potential MIP Total*	$0
71			*Payback Period in Years*	0.0
72				
73			Potential Cost for Spares	$0
74			Potential MIP Total plus Spares	$0
75			Payback Period including Spares	0.00
76				
77				
78		Instructions:		
79				
80		Section 1 (Lavender color) completed by Safety Engineering		
81		Section 2 (Yellow color) completed by AVIET		
82		Sections 3 & 4 (Green color) completed by Project Manager or AVIET		
83		The Grey boxes are calculations and do not get filled out.		

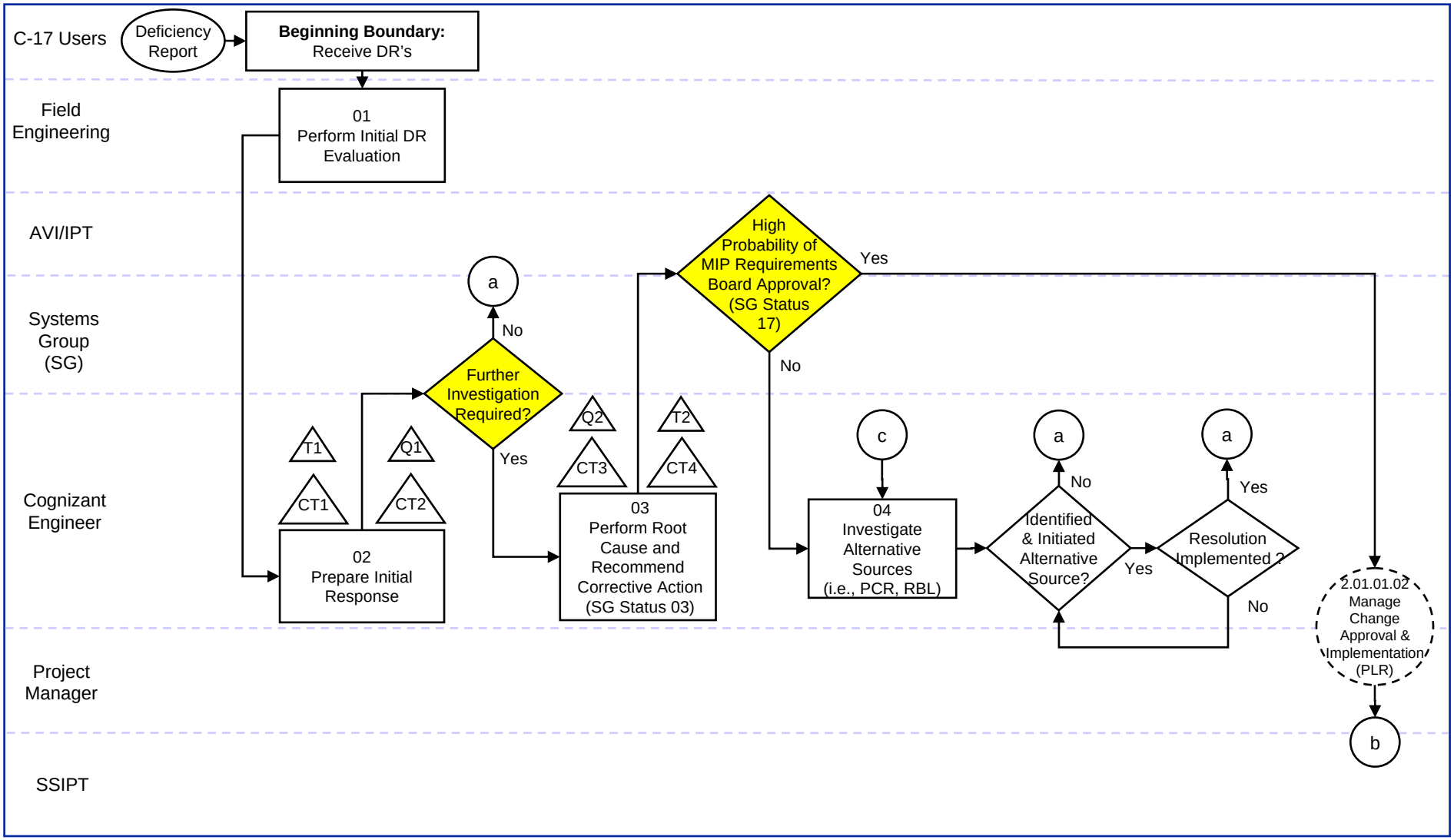
- Calculates Cost of MIP Implementation
- Calculates savings per year
- Calculates Payback Period
  - Both with and without spares cost (spares are not paid out of MIP funds)

Prioritization Process

- Group MIPs Open Awaiting Funding into four categories
  - Top Priority – Fund out of cycle if possible
  - Good Projects if funding is available (in-cycle)
  - More Information Needed to rank
  - Close as acceptable risk – We prefer to close these as early as possible
- Aircraft Systems IPT (ASIPT) rank their MIPs
  - ASIPT has the most MIPs
  - Each MIP has summary data from the DMPM at the top along with a narrative project description
- IPT Technical Leads meet and insert other MIPs into the list
  - A meeting is held with lead using command (HQ AMC) to present C-17 System Group MIP Priority recommendation

Back-Ups

DR/MIP Process

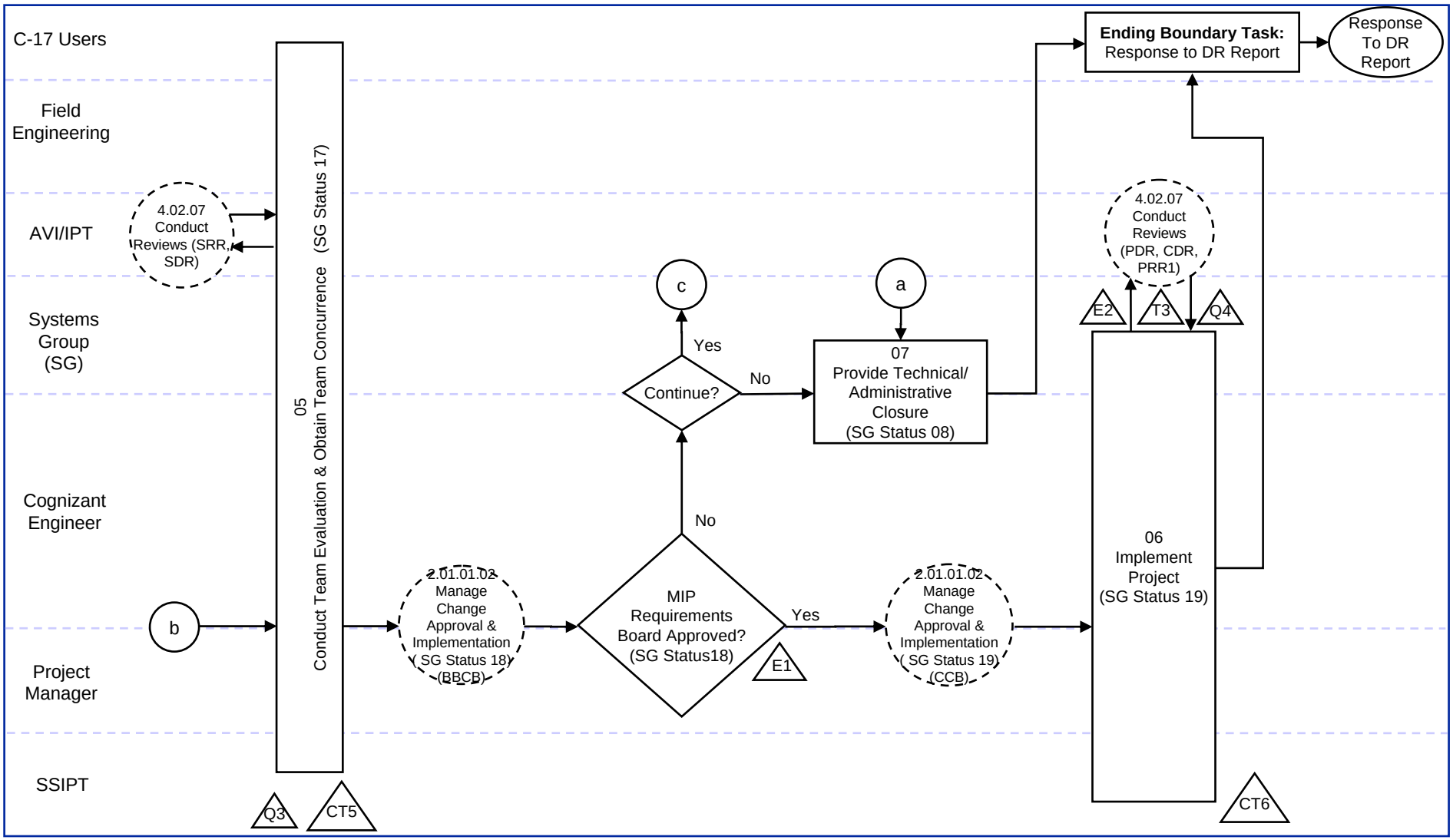


LEGEND

Input/Output | Task | Decision | Go to X.XX In-Process Interface | a Connector | R Record | Control Point

X32629 NEW (05 DEC 2005)

DR/MIP Process



X32629 NEW (05 DEC 2005)

LEGEND

Input/Output | Task | Decision | Go to X.XX In-Process Interface | a Connector | R Record | Control Point



10th Annual NDIA Science & Engineering / DoD Tech Expo
"Reducing Technology Risk in Acquisition Programs"

Testing Concept of Operations (CONOPS) in DoD's Net-Centric Environment

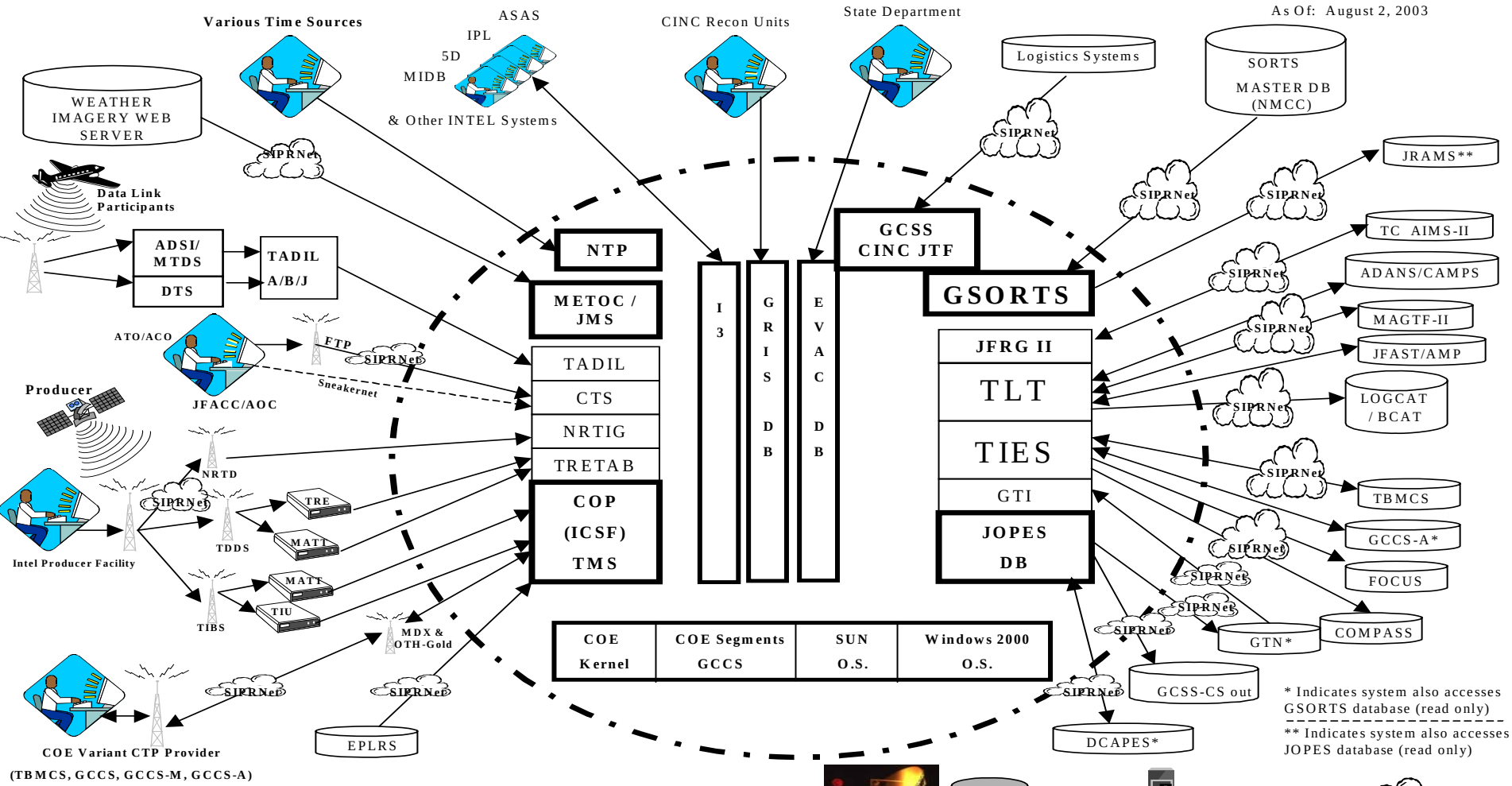
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SCRA
Collaborating To Advance Technology

October 22-26, 2007

We get lost in diagrams like this… don't we?

GCCS-J 4.x External Interface Architecture



External Interface – A system which provides data to, or receives data from, the GCCS.

Producers/Track Originators are Service/National assets

Infrastructure and Equipment is managed by Site

Comm Equipment is managed by Executive Agencies (varies)

SIPRNet is managed by DISA/ITESO

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Basic Doctrinal Requirements

DoD's responsibility is the management of violence. → **Regardless the of Technology**

Principles of War

- **Objective**
  Clearly defined, decisive and attainable objective. Each operation must contribute to the ultimate strategic aim. ...
- **Offensive**
  Seize, retain, & exploit the common objectives. Means to maintain freedom of action & achieve decisive results.
- **Mass**
  Synchronizing all the elements of combat power. Mass the effects not necessarily the forces.
- **Economy of Force**
  No part of the force should ever be left without a purpose
- **Maneuver**
  Movement of forces in relation to the enemy to gain positional advantage. Continually pose new problems for the enemy by rendering his actions ineffective & eventually defeating him.
- **Unity of Command**
  For every objective, seek unity of command and unity of effort. Unity of command means that all the forces are under one responsible commander
- **Security**
  Never permit the enemy to acquire unexpected advantage. Protecting the force increases friendly combat power..
- **Surprise**
  Strike the enemy at a time or place or in a manner for which he is unprepared
- **Simplicity**
  Prepare clear, uncomplicated plans and concise orders to ensure thorough understanding effectiveness

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What USJFCOM Does to Support the Joint War

First and foremost USJFCOM is the Joint Warfighter Advocate



Concept Development & Experimentation

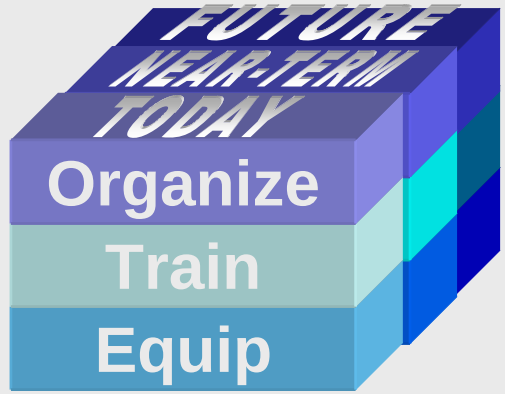
Integration & Interoperability

Training

Joint Enabling Capabilities

Joint Force Provider

Operational Analysis And Lessons Learned



JOINT CAPABLE FORCES

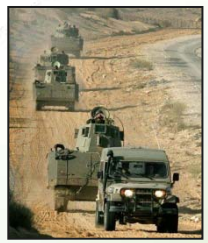
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Major Mission Command & Control (C2) Capabilities Areas



FORCE PROJECTION

Joint Operation Planning & Execution System (JOPES)



FORCE EMPLOYMENT

Air, Land, and Sea Operations
CAS Planning and Execution



SITUATIONAL AWARENESS

Common Operational Picture (COP)

SITUATIONAL AWARENESS

ADAPTIVE PLANNING

EXECUTION



FORCE READINESS

Readiness Assessment System (RAS)

Global Status of Resources and Training System (GSORTS)



FORCE PROTECTION

Early Warning and Integrated Air and Missile Defense



INTELLIGENCE

Integrated Imagery Intel (I3)

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DoD's Approach to Developing Net Centricity

Program Decision Memorandum (PDM) III, December 20, 2005, Tasked the Assistant SecDef for Networks & Information Integration / DoD Chief Information Officer (ASD(NII) / DoD CIO….
"To accelerate the provisioning & adoption of Core Enterprise Services (CES) across DoD.

In commercial industry speak, that means to start developing a System Oriented Architecture (SOA) approach for C2.

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Perspective

The DoD must continue to evaluate/assess technology's impact on the current war. And quickly adopt approaches that increase our combat capabilities









- Emerging technologies, like SOA and innovative CONOPS must accelerate, <u>together</u>
- Viable technologies must be rapidly integrated into current C2 practices, allied operations, training, and doctrine for **maximum** effectiveness
- Warfighter needs are dynamic, our coalition arrangements are unique, and the "funding-requirement-acquisition" process is unacceptable in the 'immediate' for the soldier on the patrol

We believe that Net-Centric Environment "e.g. SOA approach" is the next principal mechanism for enhanced Command Capability of Joint C2.

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Changing Business Model

Where we are		Where we need to be
Familiar		Less familiar
What we use	*FOCUS*	What we use and how we use it
Technology affects on system capability	*SOLUTION*	Technology + method + people affect on operational capability
Developers' perspective	*PERSPECTIVES*	Warfighter perspective
Hardware and software must be developed together	*CENTRAL RULE or CONCEPT*	Materiel and non-materiel must be developed together
SoS assessment - OT&E focus on the system	*APPROACH*	MCP assessment - Holistic focus on all components
System centric	*CENTRICITY*	Capability centric (Warrior)

Focus on Joint Warfighter's urgent operational need -- solution providers must forge a single 'integrated' enterprise to reduce risk in satisfaction of that need.

Changing the Business Model Requires:

(1) Willingness to work together to leverage each others core competencies

(2) Focus on Joint Warfighter as central driver – solution need originator and evaluator

(3) Commitment to providing meaningful services rather than inflexible "products"

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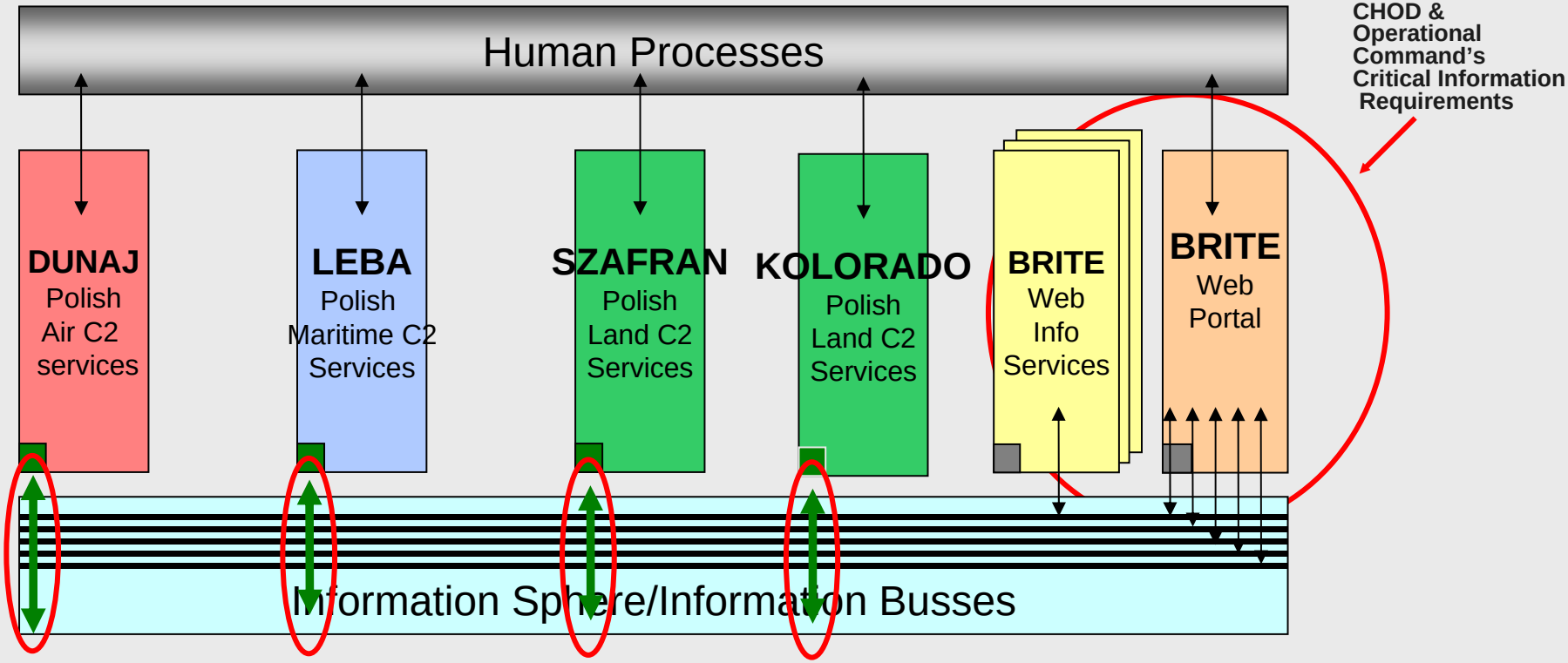
Poland's Case Study

- **TRANSFORMATION EFFORTS:**
  - ***Moving away from a Soviet based system***
  - ***Moving to a professional as apposed to a conscript based force***
  - ***Moving to a capitalistic based economic model***
  - ***Moving to asymmetric warfare***
  - ***Moving to a net-centric combat capable force***

- **At the request of Poland's Chief of Defense (CHOD), a combined NATO and USJFCOM, Poland's Military staff, plus Industry and Academia constructed a near term Common Operating Picture (COP).**
- **Constructed a near term SOA environment to integrate Poland's Air, Land and Sea into a combined Common Operational Picture.**
- **Supported Poland's role as a NATO member & US strategic partner**

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Poland's Case Study



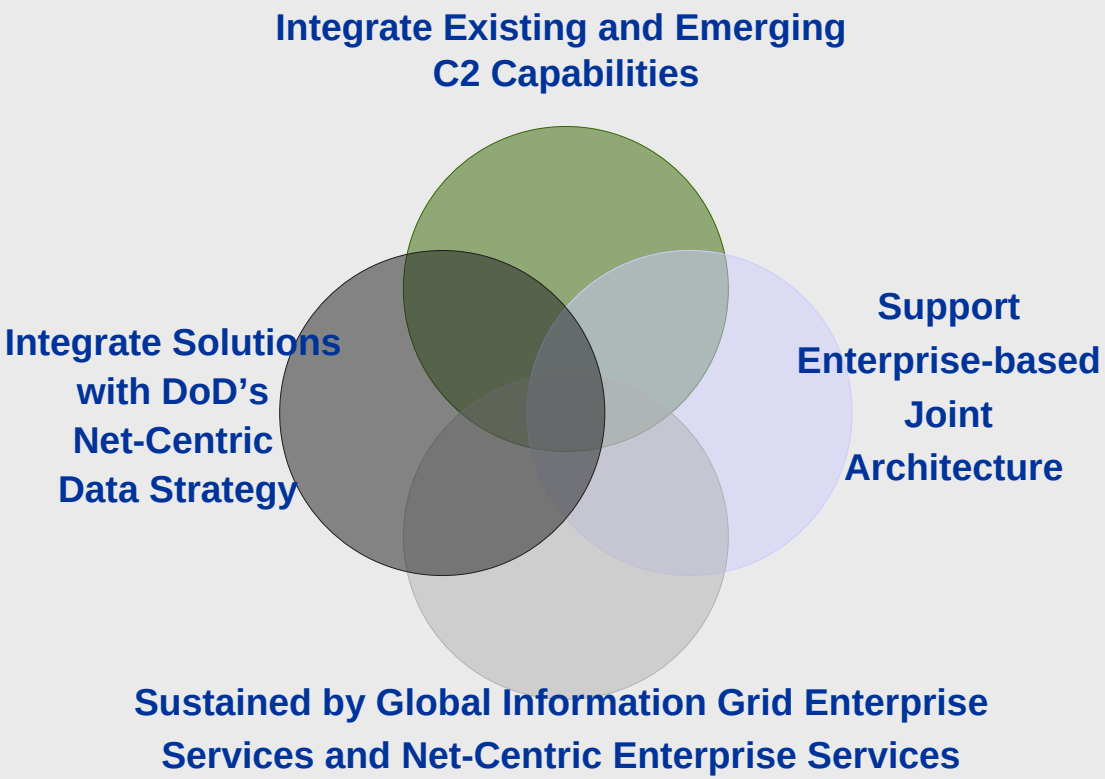
BRITE interface incorporated in every system

Automatic discovery add-ons

BRITE = Baseline for Rapid Iterative Transformational Experimentation

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DoD's Web Services Characteristic



These web systems and services will have a unique combination of characteristics that differentiate them from more conventional legacy client server applications. In particular, they tend to include:

- Architecture places data at the center of its design: Enterprise Resource Pattern (ERP) & Enterprise Service Bus (ESB)
- ERP standardizes access to any C2 domain object (APIs)
- ESB publishes messages based on an event/trigger
- Rapidly changing technologies, e.g. more actors, platforms, networks, and services not applications

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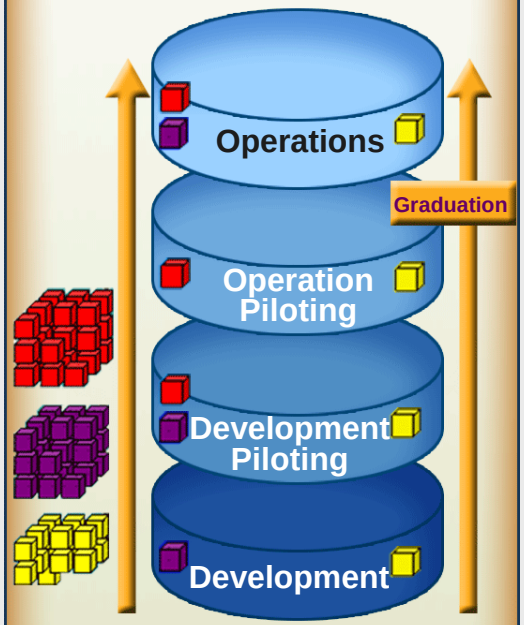
Joint Capability of Net-Enabled Command Capability (NECC)

Current C2 Systems

OTHER C2 SYSTEMS



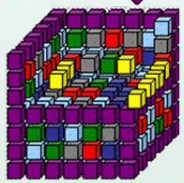
Systems Focus
Stove-piped systems
Information push



"The Sandbox"

Net-Enabled Command Capability

Systems transformed into discreet service capabilities



C2 Capabilities



Services used to support Joint 'business' processes



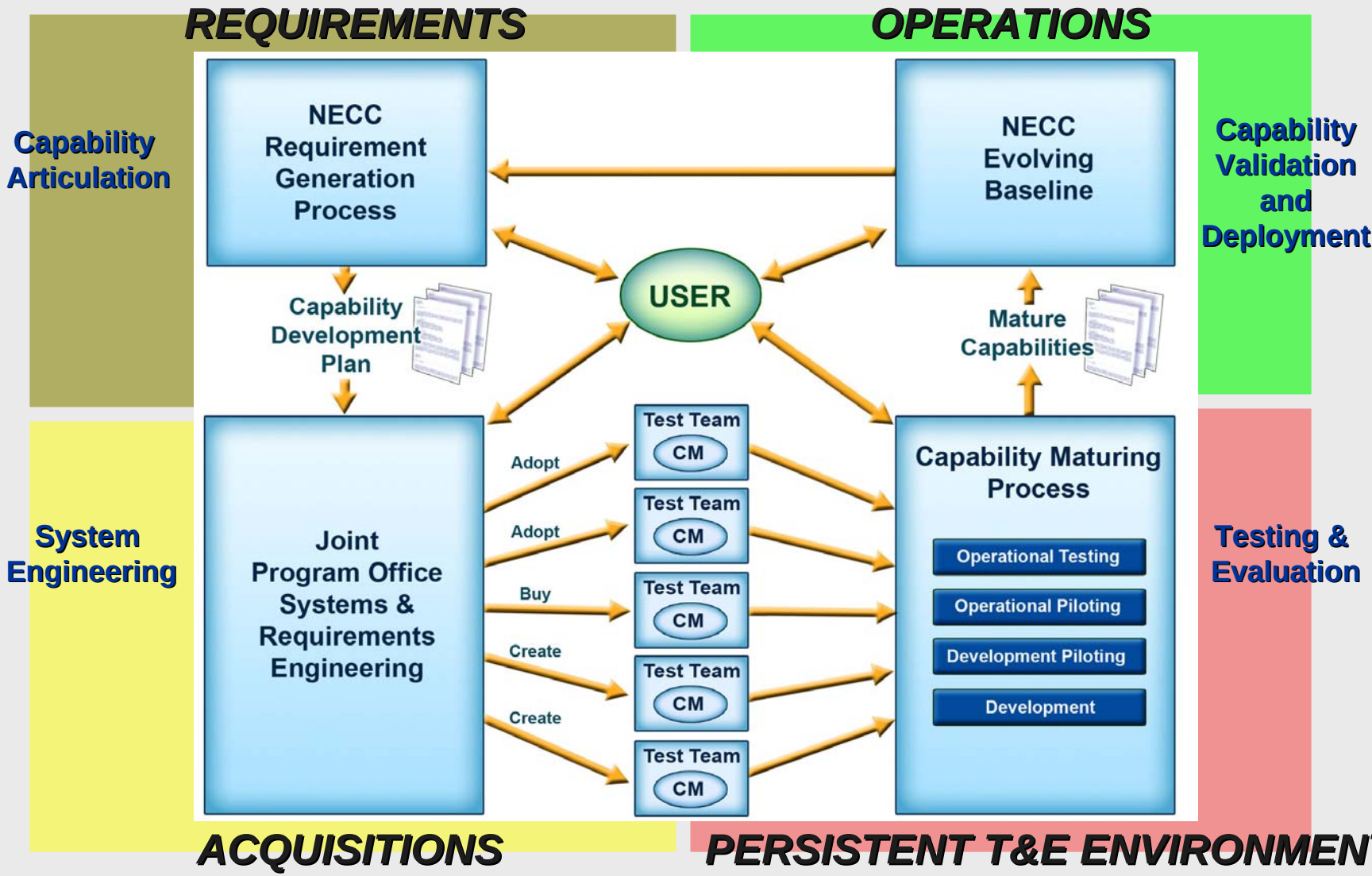
Operations Focus
Net & Data Centric
Information Pull

Joint Warfighters Command and Control Need Driven

With the net centric approach, user engagement occurs in the "sandbox" during the combined evaluation referred to as the "piloting" events.

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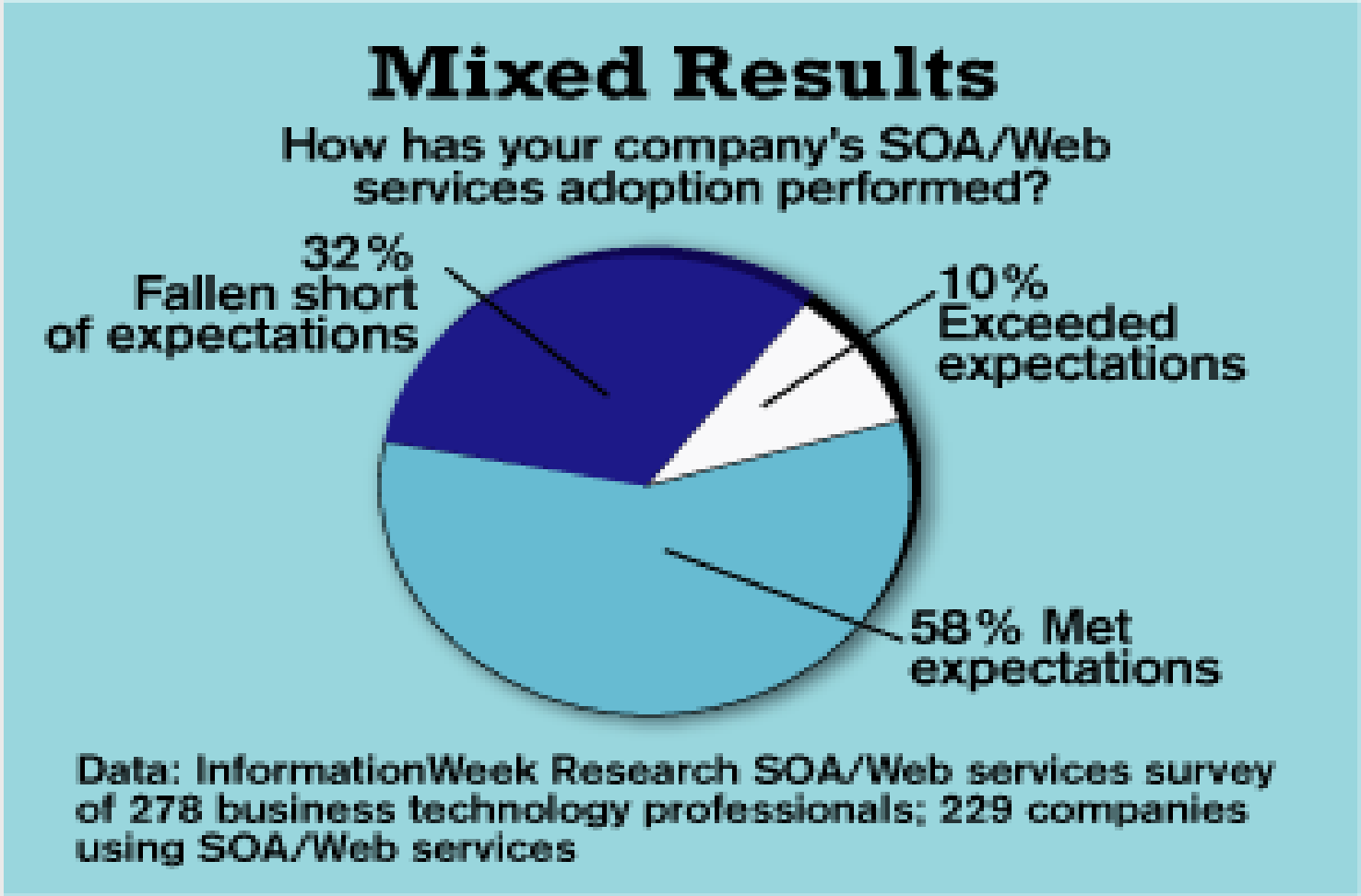
Integrated Enterprise Process



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Challenge/Approach

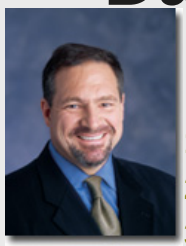
Industries Mixed Results



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Challenge/Approach

David Linthicum



Linthicum Group

Top 5 Mistakes w/ SOA,

1. Not enough trained IT/SOA architects to put on the problem.
2. "Manage by Magazine" approach to SOA.
3. Don't understand the unique nature of their problem domains.
4. Treat SOA as a project, not a journey.
5. Unable to define the value.

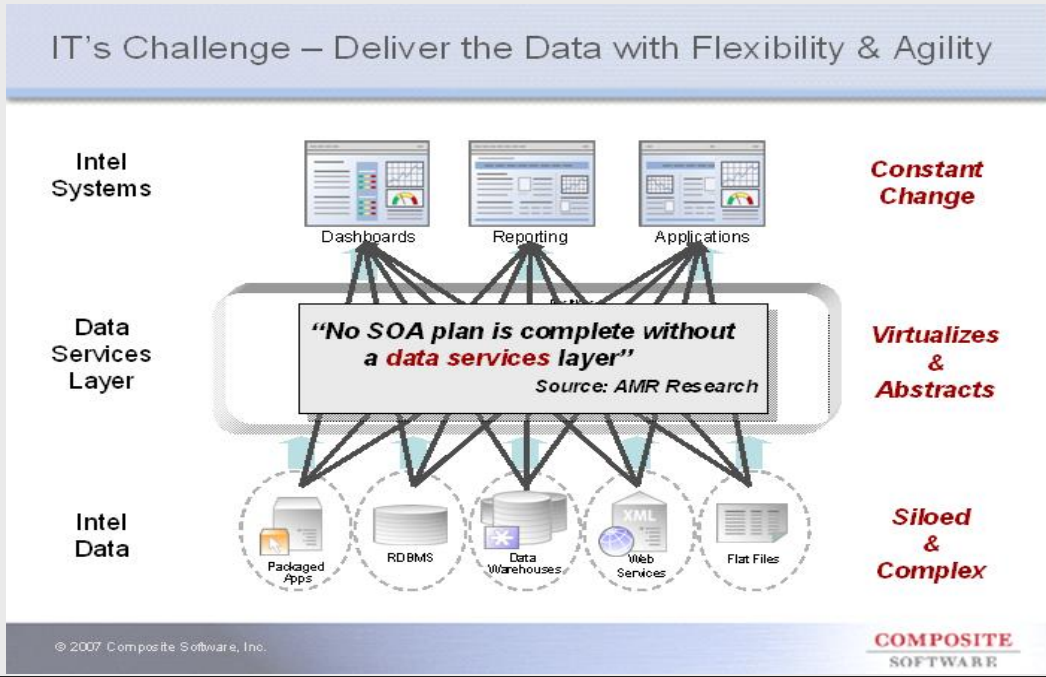
Oh, by the way: David said, "I Actively tracks 120 different SOA standards 20% to 30% are duplicative At any one point in time."



Jim Green,

Designing Reusable Software,

- Types of services:
(1) put data in, (2) get data out
- SOA & error handling => careful planning



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Challenge/Approach



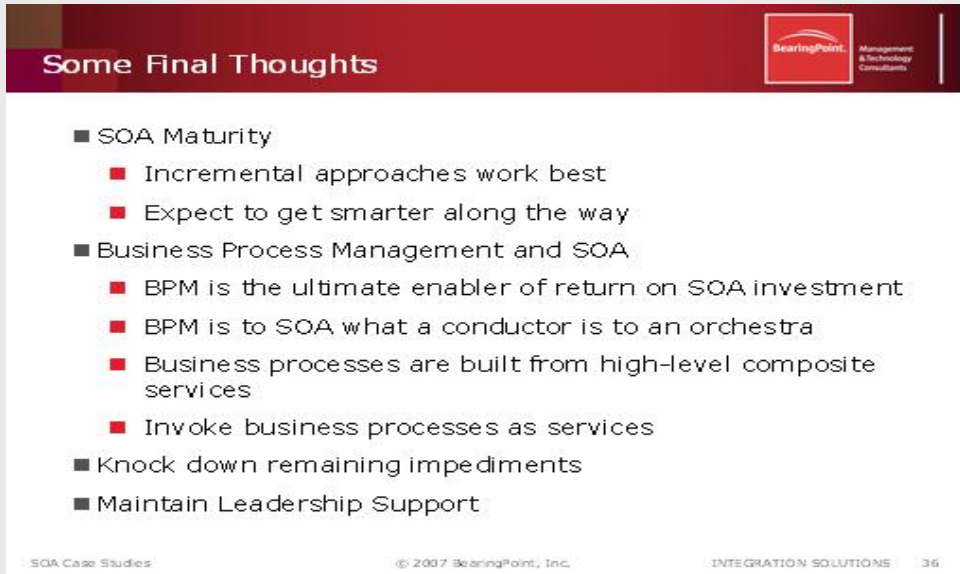
Hub Vandervoort, CTO, Progress/Sonic

- ***His Key concept was Enterprise Service Bus (ESB)***
  - **Service Requires alignment across 4 dimensions**
  - **Functional, (2) Structural (3) Behavioral (4) Performance**
  - **Interaction Model (-Request Reply, -Store & Forward, -Pub/Sub, –Bulk transfers)**

BearingPoint. Management & Technology Consultants

Steve Kahn, **Bearing Point**

- Discussed two SOA projects (Insurance Company & Commercial packaging firm)
- Focus on the business…, technology is never enough.



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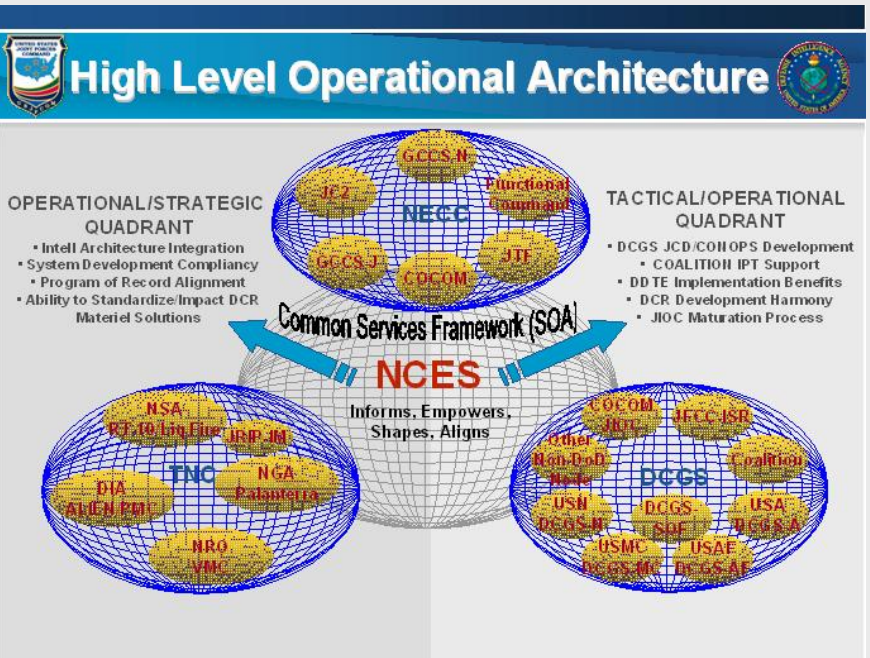
Challenge/Approach

Booz | Allen | Hamilton
90 years delivering results that endure

Melissa Soley, BAH, Trans-National COP

- **BAH Mission Engineering (ME) method is a bottom-up IER data capture approach**

  Very intensive data capture approach
- **Point of interest: 80% of an Intel Analyst's time is spent simply retrieving data not analyzing.**

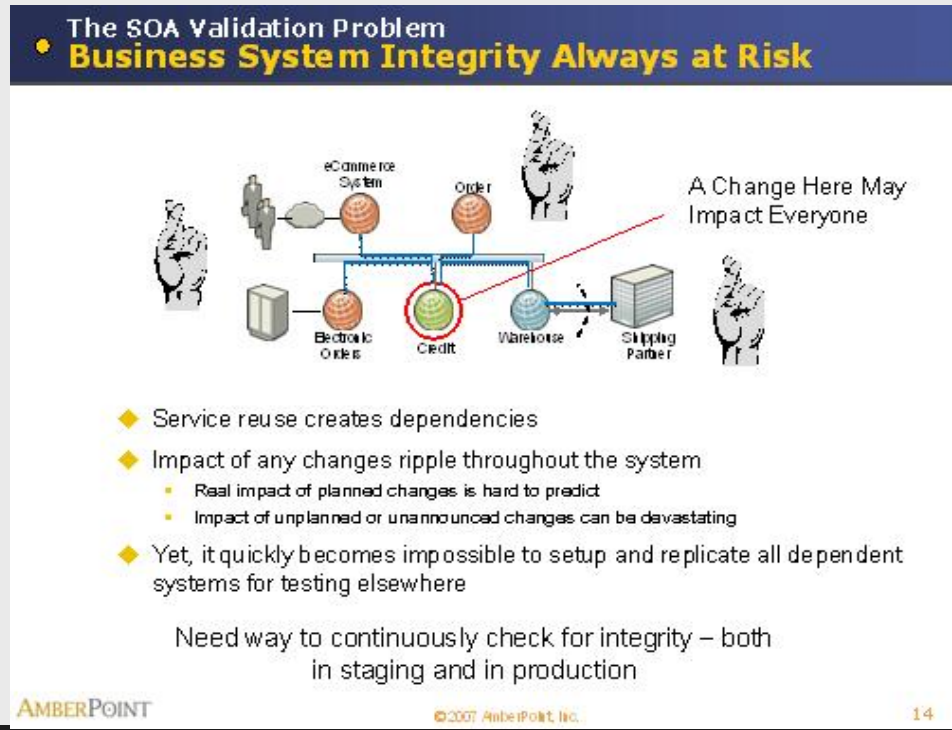


AMBERPOINT



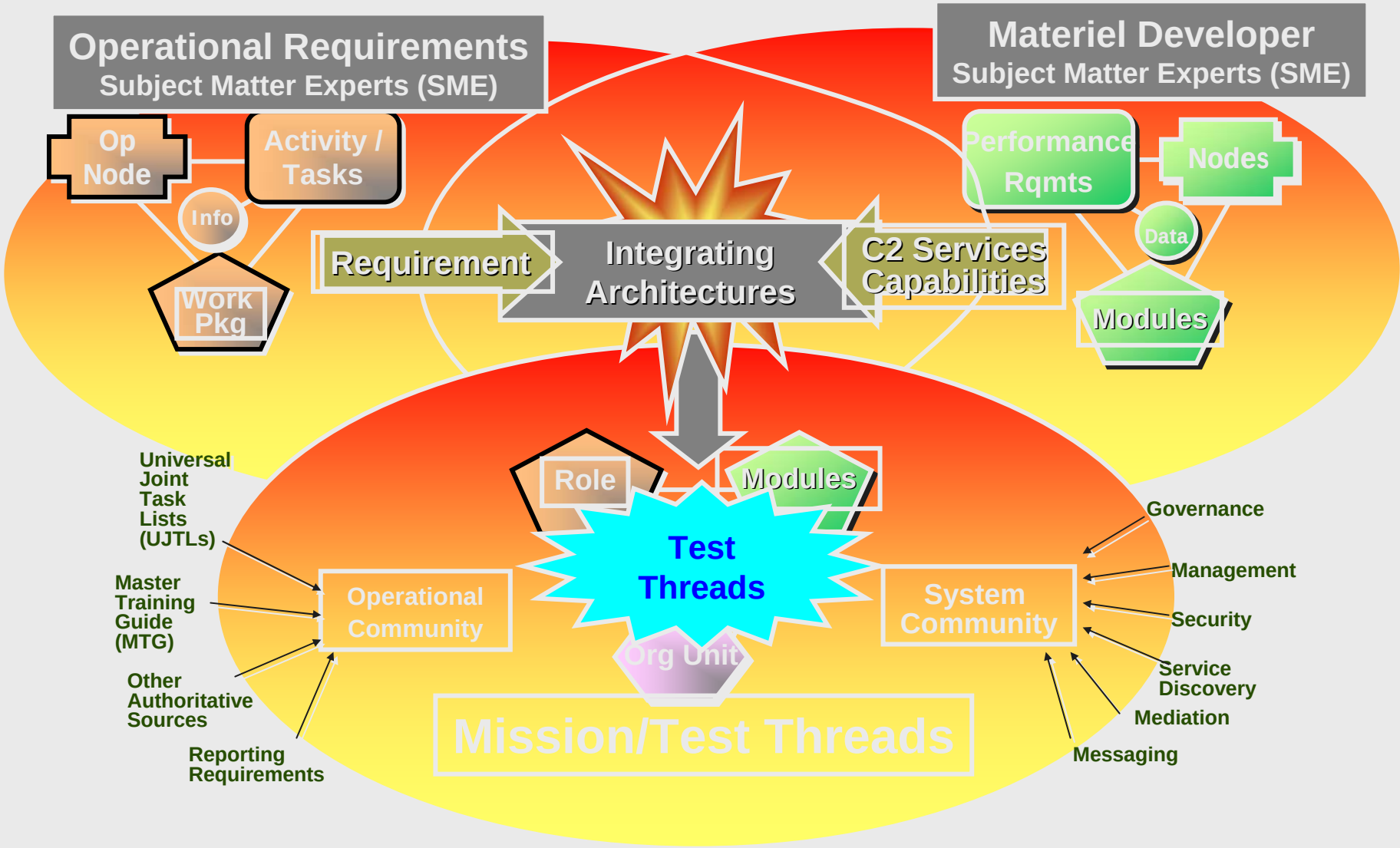
Sean Fitts, Amber Point

- ***Keys to SOA Runtime Gov'n***
  - **Visibility => what is going on & who is using it?**
  - **Control => Actions to prevent or correct issues**
  - **Integrity => Ensuring changes don't impact the whole infrastructure**



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What is our Testing Approach?



Testing CONOPS in DoD's Net-Centric Environment

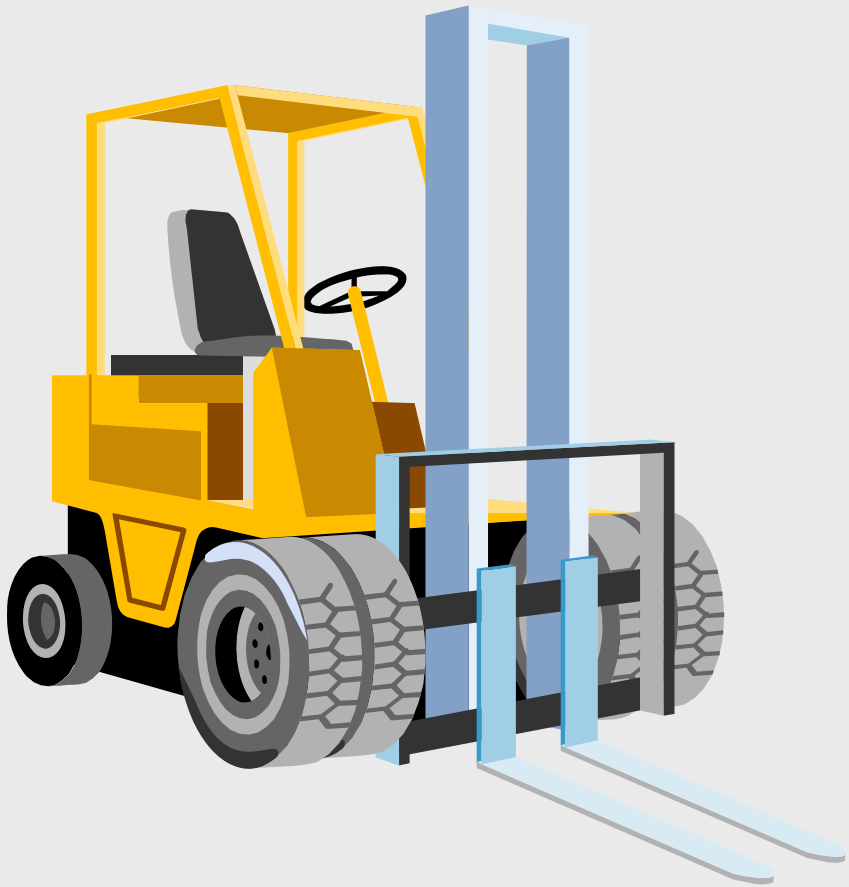
So what did he say?

- DoD's C2 environment has @ 7 million customers
- Our business is the management of violence
- JFCOM is the Joint Warfighter Advocate
- DoD is moving to Net Centric C2
- DoD will continue to adapt to change
- Poland's military transformation & movement toward Net Centricity
- NECC programmatic processes
- Industries views
- NECC testing concept
- DoD is in the early stages of SOA adoption

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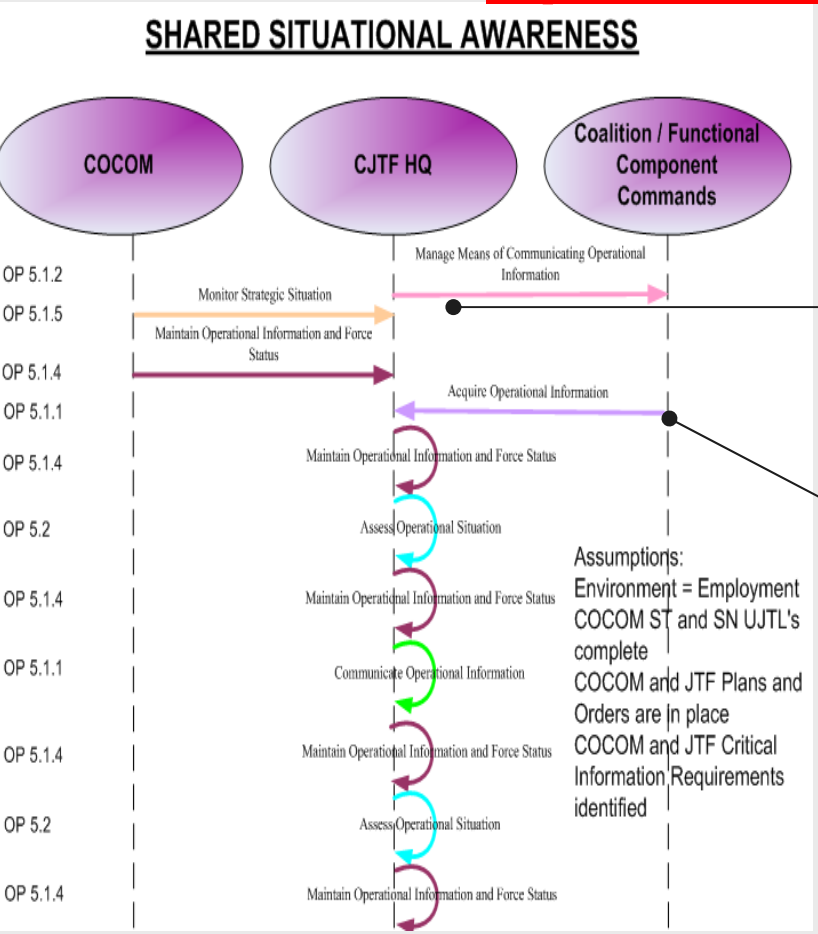


BACKUP SLIDES



What is our Approach?

Use an Operational Mission Thread Concept



Operational Event Trace Description (OV-6c)

Event Table

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Systems Thinking: The Art of Seeing

Robert J. Monson, Ph.D.
Lockheed Martin Tactical Systems

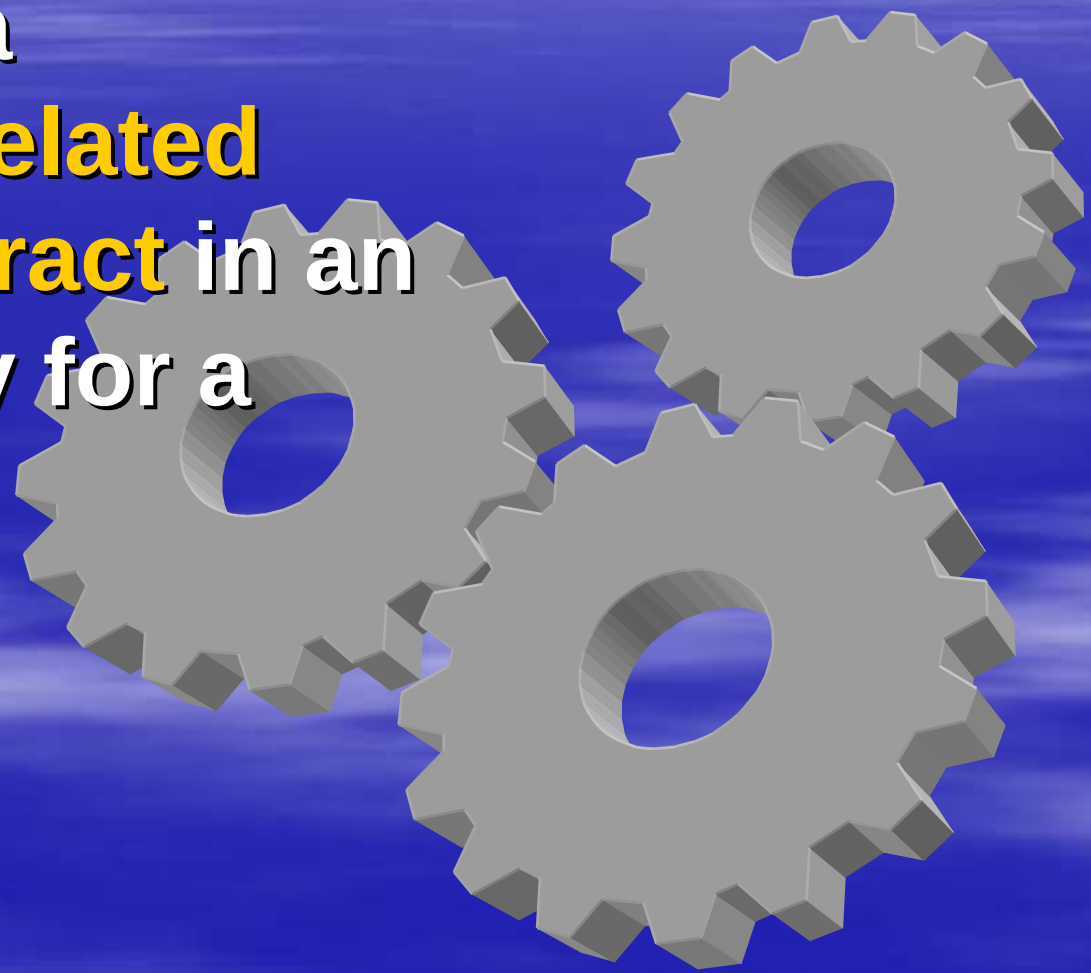
NDIA Systems Engineering Conference, October 2007
Paper #5617

Summary

- Systems Engineering and Projects
- Results of Concrete / Abstract Thinking
- Seeing Systems
- Whole-Brain Thinking
- Beginning the Development of Whole Brain Reasoning

System = Whole

- A system is a collection of related parts that interact in an organized way for a purpose



What is a System?

(American Heritage Dictionary)

- A group of interacting, interrelated, or interdependent elements forming a complex whole.
- A functionally related group of elements, especially:
  - The human body regarded as a functional physiological unit.
  - An organism as a whole, especially with regard to its vital processes or functions.
  - A group of physiologically or anatomically complementary organs or parts: *the nervous system; the skeletal system.*
  - A group of interacting mechanical or electrical components.
  - A network of structures and channels, as for communication, travel, or distribution.
  - A network of related computer software, hardware, and data transmission devices.
- An organized set of interrelated ideas or principles.
- A social, economic, or political organizational form.
- A naturally occurring group of objects or phenomena: *the solar system.*
- A set of objects or phenomena grouped together for classification or analysis.
- A condition of harmonious, orderly interaction.
- An organized and coordinated method; a procedure.
- The prevailing social order; the establishment. Used with *the*: *You can't beat the system.*

Connectedness
(Sherwood, 2002)

- If you wish to understand a system, and so be in a position to predict its behavior, it is necessary to study the system as a whole. Cutting it up into bits for study is likely to destroy the system's connectedness, and hence the system itself
- If you wish to influence or control the behavior of a system, you must act on the system as a whole. Tweaking it in one place in the hope that nothing will happen in another is doomed to failure—that's what connectedness is all about

Systems Engineering

- Related to Problem Solving
  - Connecting of disparate ideas / concepts
  - Relating previously unconnected elements
- Like Project Management on steroids
  - Understand what you intend to do
  - Plan the work required
  - Execute the plan
  - Learn as you go forward

What are the success and failure modes of typical endeavors?

Key Elements

(Standish Group CHAOS results, 1996)

- Top Success Factors
  - user involvement
  - executive management support
  - clear requirements
  - proper planning
  - realistic expectations
  - smaller project milestones
  - competent staff
  - ownership
  - clear vision and objectives
  - hard working, focused staff
- Top Failure Factors
  - lack of user input
  - incomplete requirements
  - changing requirements
  - lack of executive support
  - technology incompetence
  - lack of resources
  - unrealistic expectations
  - unclear objectives
  - unrealistic timeframes
  - new technology

Critical Success / Failure Factors in Projects

(Belassi & Tukel, 1996)

- Top management support throughout
- Proper goal definition and setting
- Accurate estimates
- End-user involvement
- Project manager on site
- Appropriate team selected
- Testing and training

Patterns of Software Systems Failure and Success

(Jones 1996)

- Project Management Failure Factors
  - no historical software measurement data
  - failure to use automated estimation tools
  - failure to use automated planning tools
  - failure to monitor progress of milestones
  - failure to use effective architecture
  - failure to use effective development methods
  - failure to include formal risk management
  - failure to use formal configuration management
  - more than 30% creep in requirements

Principal reasons for DOD software project failures

Report of the Defense Science Board Task Force on Acquiring Defense Software Commercially (1994)

- Poor requirements definition
- Inadequate software process management
- Lack of integrated product teams
- Ineffective subcontract management
- Too little attention to software architecture
- Poorly defined, inadequately controlled interfaces
- Limited or no tailoring of military standards

Software Systems Failure Modes

(Website: http://suraj.lums.edu.pk)

- Hostile culture
  - Punishing bad news messengers
- Poor reporting structure
  - Sponsors are not involved
- The Success of Any Project is Linked to the People
  - Take care of the people to succeed
- Over-commitment
  - Unclear expectations and understanding of the scope
- Decision Making Escalation
  - Movement becomes more important than progress
- Political Pressures
  - Hidden Agendas
- Technology-focused developments
  - Ignoring the Human
- The lure of the leading edge
  - It can be costly and heartbreaking

Software Systems Failure Modes

(Website: http://suraj.lums.edu.pk)

- Complexity underestimated
  - Simplified by individuals who are not informed
- Inadequate consultations with major stake holders
  - User needs in the dark
- Design by committee
  - No major responsibility holder
- Technical fix for a management problem
  - Lack of whole picture thinking
- Staff turnover
  - Lack of engagement
- Competency
  - Decisions made by the wrong people
- Receding deadlines
  - Soft plans with malleable objectives and milestones
- Inadequate testing and training
  - Not having discipline in our development
- Communication problems and work group problems
  - As always…

Left Brain Style

- Responds to verbal instructions
- Problem solves logically and sequentially
- Looks at differences
- Is planned and structured
- Prefers established, expected information
- Prefers talking and writing
- Prefers multiple choice tests
- Controls feelings
- Prefers ranked authority structures
- Sees cause and effect
- Is a splitter, distinction is important
- Draws on previously accumulated, organized information

Right Brain Style

- Responds to demonstrated instructions
- Problem solves with hunches, looks for patterns
- Looks at similarities
- Is fluid and spontaneous
- Prefers elusive, uncertain information
- Prefers drawing and manipulating objects
- Prefers open ended questions
- Free with personal feelings
- Prefers collegial authority structures
- Is a lumper, connectedness important
- Is analogic, sees correspondences, resemblances
- Draws on unbounded patterns, clustered around images

Consolidating all these reports: Right and Left Brain Activities

Hostile culture	Lack of Right Brain
Poor reporting structure	Lack of Right Brain
The Success of Any Project is Linked to the People	Lack of Right Brain
Over-commitment	Lack of Right Brain
Decision Making Escalation	Left Brain Knee Jerk
Political Pressures	Lack of Right Brain
Technology-focused developments – Ignoring the Human	Lack of Right Brain
The lure of the leading edge	Lack of Right Brain
Complexity underestimated	Lack of Left Brain
Inadequate consultations with major stake holders	Lack of Right Brain
Design by committee	Lack of Right Brain
Technical fix for management problem	Lack of Right Brain
Staff turnover	Lack of Right Brain
Competency	Lack of Left Brain
Receding deadlines	Lack of Right Brain
Inadequate testing and training	Lack of Right Brain
Communication problems and work group problems	Lack of Right Brain

Success/Failure Conclusions

- Factors in systems project failures are largely a lack of connecting issues between right and left brain:
  - User involvement / Requirements management
  - Management support / Communication
  - Change / Adaptation

Is this a growing problem? Project completion statistics

(Marchewka, 2003)

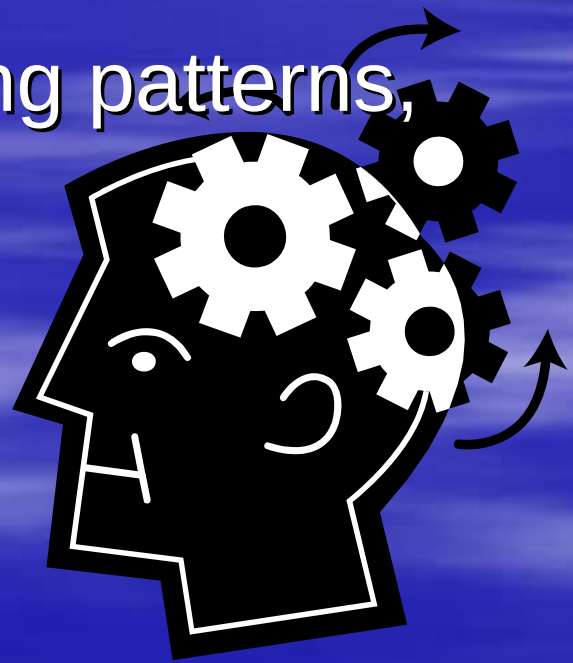
Project Size	Avg Budget	Avg Actual Cost	Avg Over Budget	Avg Over Sched	Original Scope Realized	Completed On-time On-budget	Completed Over-budget Late, not all Functions	Cancelled Before Completion
Small	$203K	$435K	214%	239%	74%	28%	51%	22%
Med	$740K	$1.36M	182%	202%	65%	16%	47%	37%
Large	$1.3M	$2.3M	177%	230%	42%	9%	62%	30%

What do we intend to do about it?

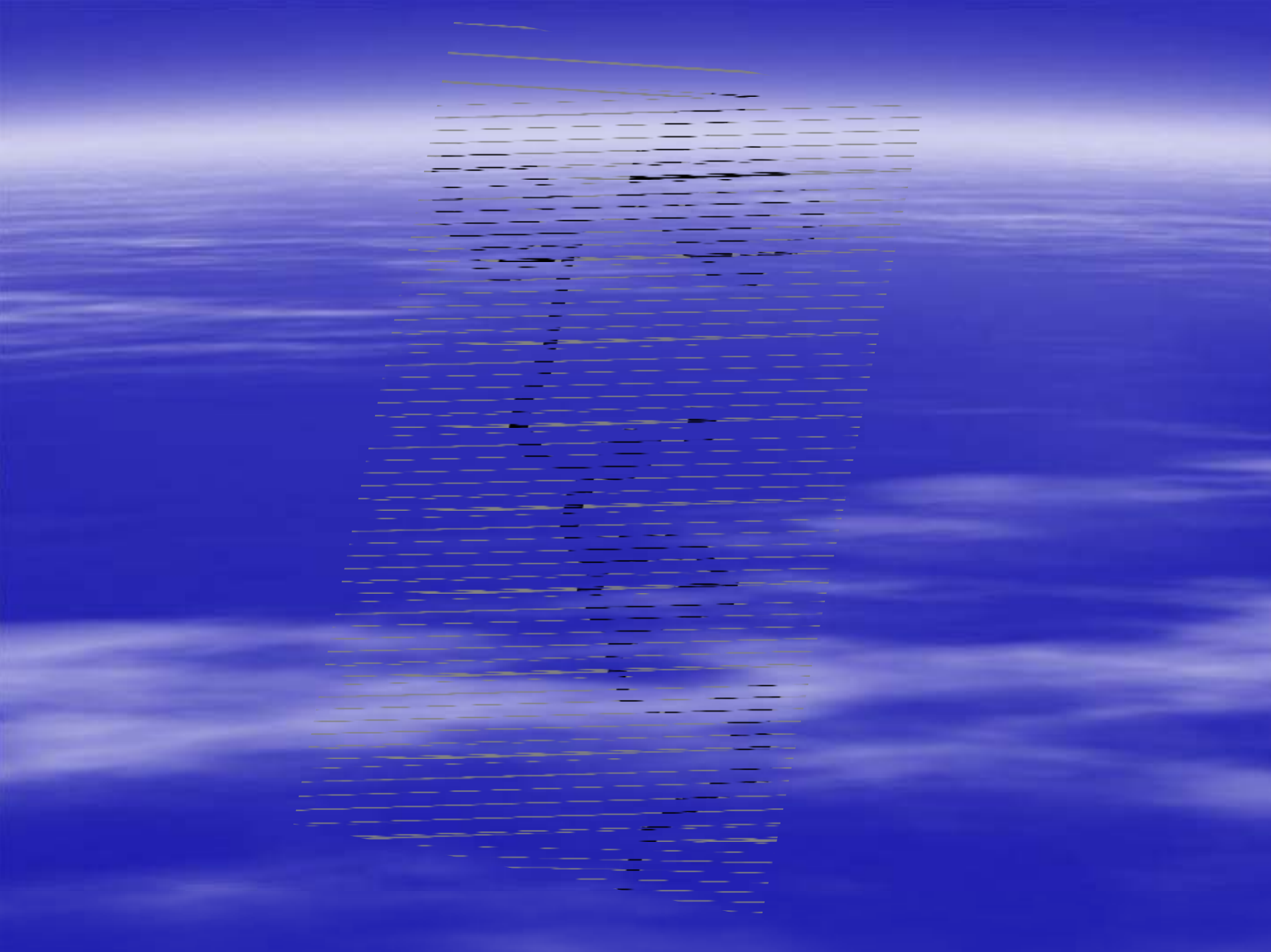
- Understand the right and left brain
- Understand how we truly solve problems, which is a combination of both sides
- Define those areas of right brain activity that will enhance our ability to develop systems successfully

The Human Brain

- A self organising, self patterning system
- A good pattern maker but a poor pattern breaker
- Creativity => the art of breaking patterns, habits and certainties
  - Left Brain versus Right Brain




I
LOVE
PARIS IN THE
THE SPRINGTIME





A brief History of Thought: Ancient, Mediaeval and Modern Periods

- Early Philosophers: 400 BC- Plato, Socrates, Aristotle
  - The Development of Logic and Vertical Thinking
- The Dark Ages and the Renaissance: Copernicus to Galileo
  - Suppression of analytical thinking
- The Industrial Revolution
  - The rapid expansion of knowledge applications
- The Information Revolution and the Knowledge Economy
  - The Future – What kind of thinking is required?

Lateral Thinking

(Edward de Bono, 1970)

- Lateral Thinking
- Follows least likely paths
- Frequently incorrect
- Non sequential
- Provocative
- Generative

- Vertical Thinking
- Follows most likely path
- Always correct
- Sequential
- Analytical
- Selective

Lateral Thinking: The 4 Golden Rules

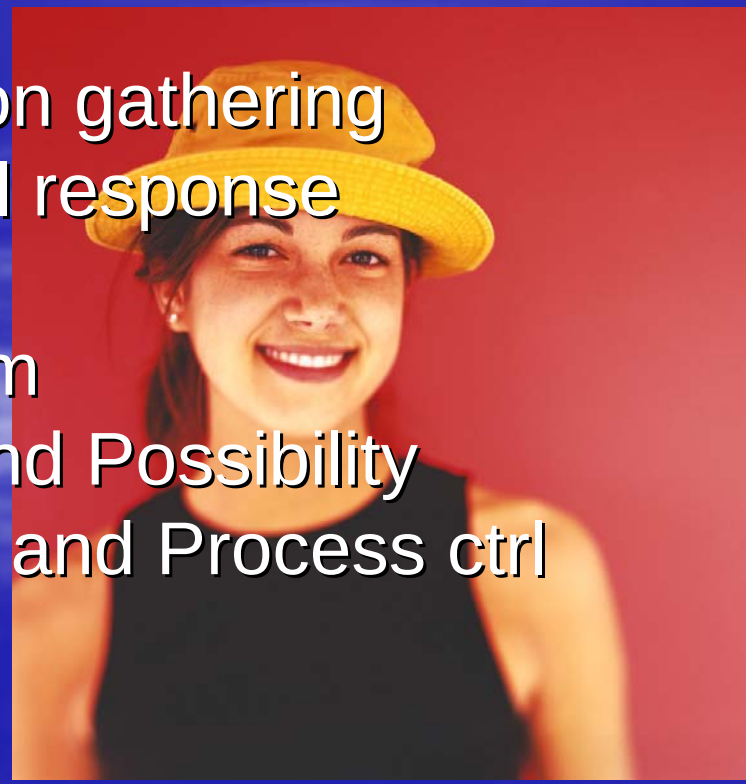
- Check your assumptions!
  Especially the more experienced / intelligent you are!
- Ask Searching questions
  To gain better insight
- Deliberately adopt a different point of view
  Change your perspective; “What If?”
- Borrow with Pride: Adopt, Adapt, Improve!



De Bono's 6 Thinking Hats

- Most group thinking and discussion is adversarial: wearing a metaphorical "hat" encourages parallel thinking…….

- The WHITE Hat: Information gathering
- The RED Hat: Emotional response
- The YELLOW Hat: Optimism
- The BLACK Hat: Pessimism
- The GREEN Hat: Growth and Possibility
- The BLUE Hat: Overview and Process ctrl



Gorilla Spotting!

(Wiseman, 2004)



- We all have Blind Spots: sometimes we miss the obvious!

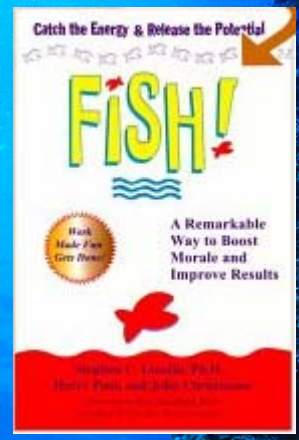
  Creativity is not about “wild and whacky” ideas……
- Be mindful of a problem; don’t focus or forget it – be aware and open to opportunities….. chance favors the open mind
- A Primed Brain + Time + Freedom = Eureka moments
- The seeds of great discovery are constantly floating around us, but they only take root in minds well prepared to receive them

  - Joseph Henry



The FISH Philosophy!

(Lundin, 2003)



- Choose your attitude
- Play
- Be Present
- Make their day

Each of these methods are proposing a different way (a more complete way) of thinking about your problem…

CREATIVITY

- Imagination is more important than knowledge

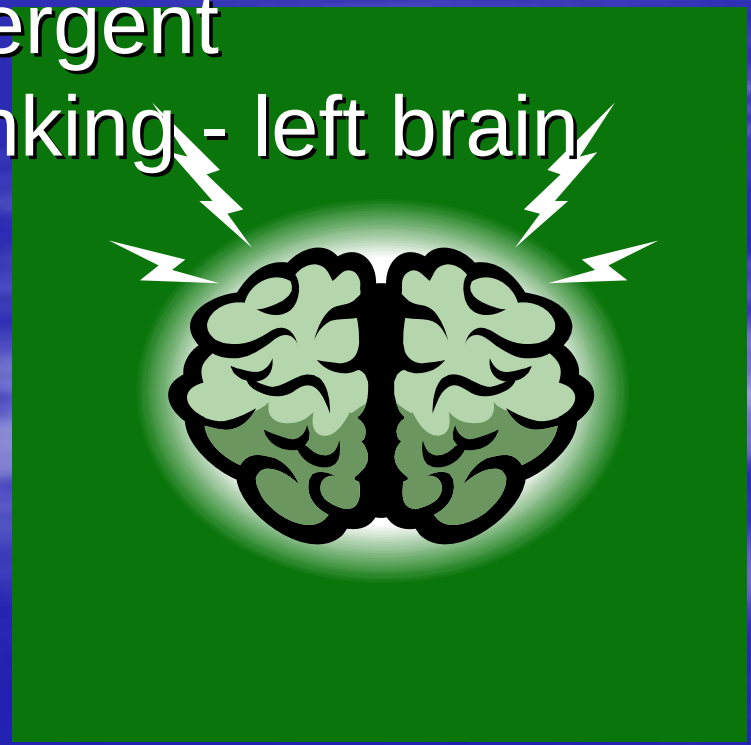
  - Albert Einstein

- Imagination is to create something which did not exist previously, but which can be realized through Design and Engineering

- Knowledge is memory of something which exists

CREATIVITY

- Imagination requires divergent, intuitive and creative thinking - right brain activity
- Knowledge require convergent deductive and logical thinking - left brain activity



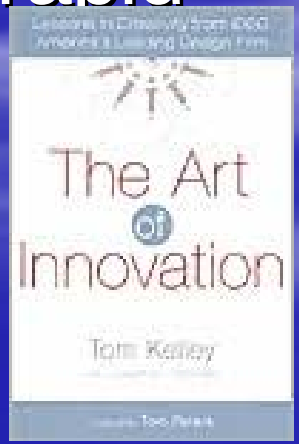
Related studies supporting the idea that Whole Brain Reasoning is key:

- The Art of Innovation
  - IDEO Corporation methods of success
- Deep Survival
  - Surviving is a Systems solution
- Arts and Music Education
  - Startling results demonstrating the benefit of combining right and left brain activities

The Art of Innovation

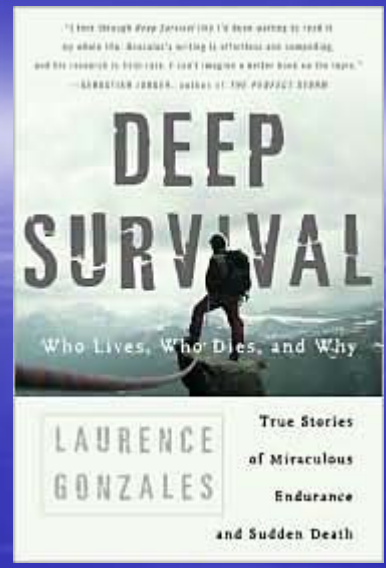
(Kelley, 2001)

- Understand the market, client, technology, constraints of the problem (left brain)
- Observe real people in real-life (right brain)
- Visualize new concepts and the customers who will use them (right brain)
- Evaluate and refine the prototypes in rapid iterations (left brain)
- Implement the new concept for commercialization (both sides)



Deep Survival

(Gonzales, 2005)



1. Perceive

   Look, See, Believe. Be Observant and Cognizant

2. Stay Calm

   Use Humor, Use Fear to focus the mind

3. Think/Analyze/Plan

   Get organized, set small achievable objectives

4. Take Action

   Take bold and cautious actions

Deep Survival

5. Celebrate your successes

   Take joy in completing tasks

6. Count your blessings

   Be grateful, help others more than yourself

7. Play

   Sing, mind games, poetry, mathematics

8. See the beauty

   Treat it like a vision quest

Deep Survival

9. Believe you will succeed
   Develop a deep conviction of success
10. Surrender
   Let go your fear, put away the pain
11. Do whatever is necessary
   Be determined, have the will and the skill
12. Never give up
   Let nothing break your spirit, there is always one more thing you can do

Classifying by Abstract / Concrete

Left Brain Activities

- Think/Analyze/Plan
- Take Action
- Celebrate your successes
- Believe you will succeed
- Do whatever is necessary
- Never give up

Right Brain Activities

- Perceive
- Stay Calm
- Count your blessings
- Play
- See the beauty
- Surrender

Results of the mixture of art and science (various websites, 2007)

- Study of 37 student's IQ scores over 8mos
  - First group given no music lessons – 6% increase in spatial reasoning scores
  - Second group given music lessons – 46% increase in spatial reasoning scores
- Medical School acceptance
  - 66% of music majors accepted (highest %)
  - 44% of biochemistry majors accepted

More results

- Music and visual arts education given to first graders who underperformed in Kindergarten
  - After one year were 22% better at mathematical competency than their peers
- 1993-95 study on three groups of preschoolers
  - 1st group – no training – IQ ^ .5 pts
  - 2nd group – computer lessons – IQ ^ .35 pts
  - 3rd group – music lessons – IQ ^ 3.62 pts

More results…

- Students with musical performance experience
  - 53 points higher on SAT verbal portion
  - 39 points higher on SAT math portion
  - Than students without musical performance exp
- Students with coursework in music appreciation
  - 61 points higher on SAT verbal portion
  - 42 points higher on SAT math portion
  - Than students without music appreciation courses

Clearly there is something of significant value in Whole-Brain Reasoning…

The Art and Science of understanding a System

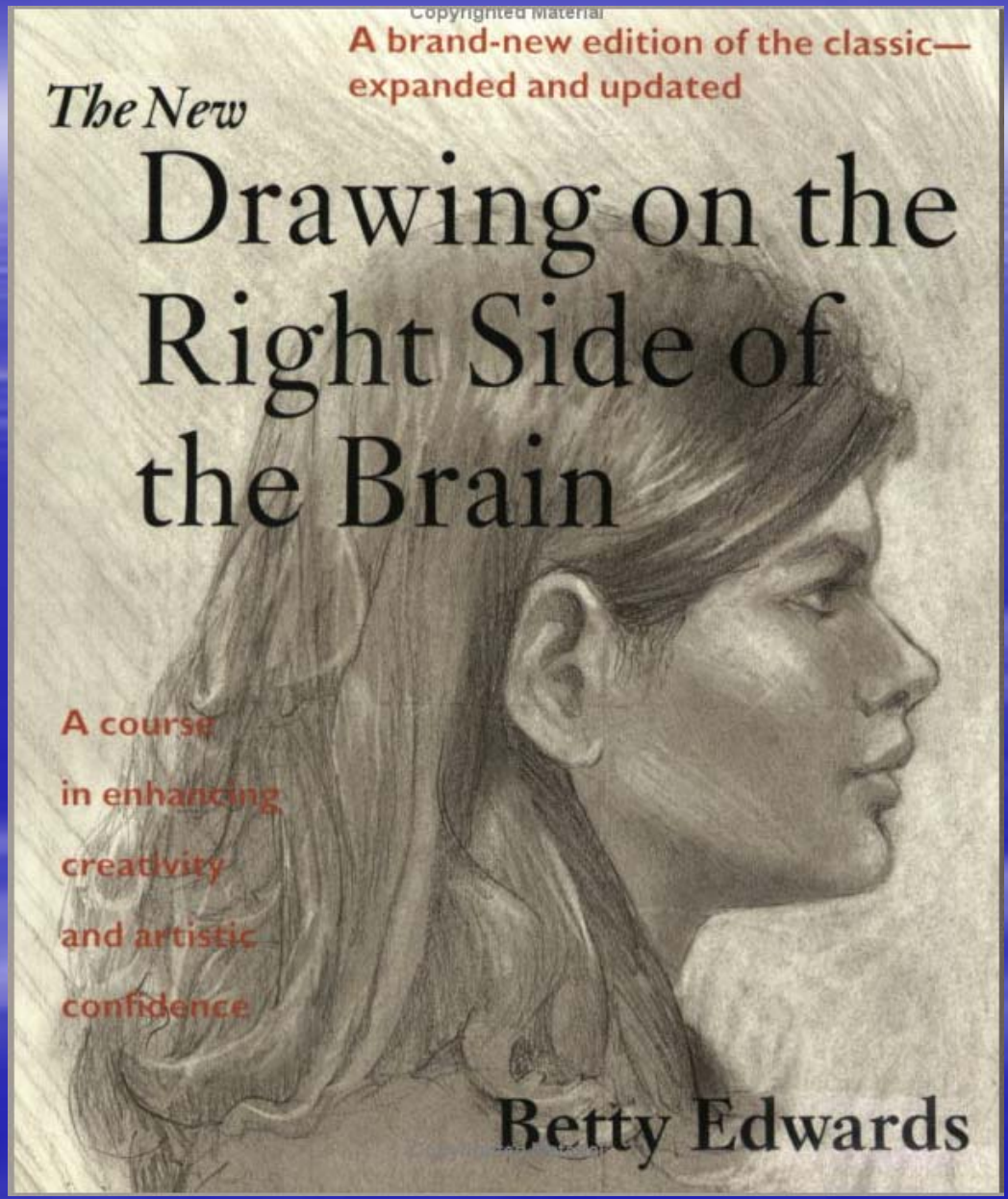
- Success in any endeavor is first and foremost a matter of accurate seeing
- Learning to really see what is in front of us allows us to better understand the world around us and the essence of our problem
- This is a departure from linear thought, and results in a crossing of both artistic and scientific reasoning

To solve a problem

- To solve a problem one has to
  - See exactly what the problem is
  - Imagine the system and the problem
  - Imagine the solution to the problem
  - With your eyes you see what isn't working, you make it work in your mind, and you simply have to identify the difference
- This is 'Whole-Brain' Reasoning

Whole Brain Reasoning

- Nuts and bolts observational analysis from the left side of the brain
- Free association image building from the right side of the brain
- This is a departure from traditional linear-thinking, sequential models
- A mixture of **art** and **science**


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A brand-new edition of the classic—
expanded and updated
The New
Drawing on the
Right Side of
the Brain
A course
in enhancing
creativity
and artistic
confidence
Betty Edwards

Five basic skills of drawing

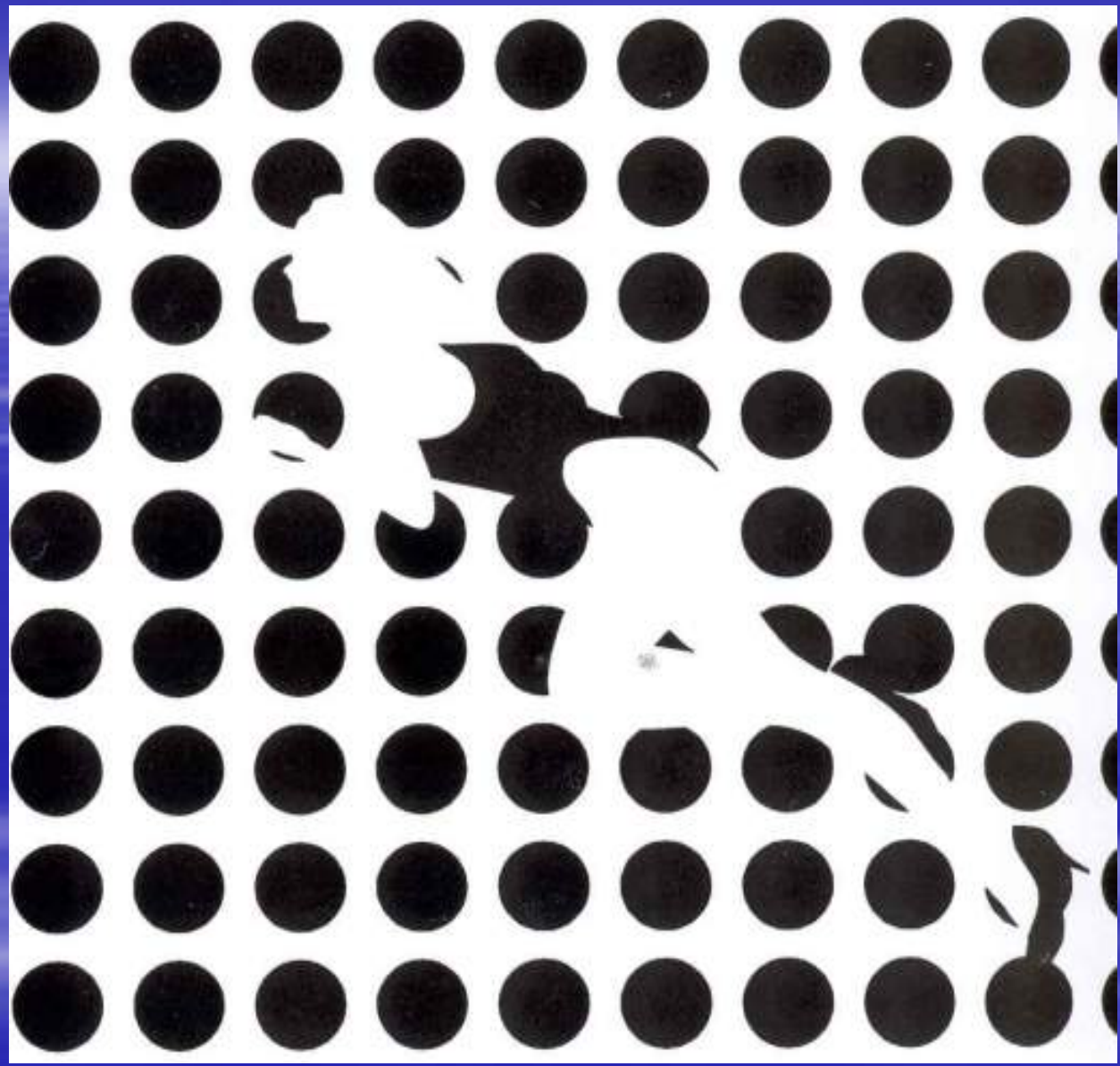
- The perception of edges
- The perception of spaces
- The perception of relationships
- The perception of lights and shadows
- The perception of the whole, or gestalt

Translating that into the five basic skills of Design

- The perception of interfaces
- The perception of context
- The perception of relationships
- The perception of light and dark, with regard to design intent
- The perception of the whole, or gestalt

This is what Systems Engineering is all about

- The combination of art and science to create:
  - Comprehensive
  - Cohesive
  - Creative
- The ability to combine the art and science is what differentiates the star performers from the average performers



We must understand when we see things that aren't really there



Image copyright Bev Doolittle



Whole-Brain Thinking

- Consider both the art and the science
- See what you are not seeing, due largely to
  - Incorrect mental models
  - Lack of focus
  - Lack of understanding
  - You simply have not posed the right questions
- Take a moment and simply reflect



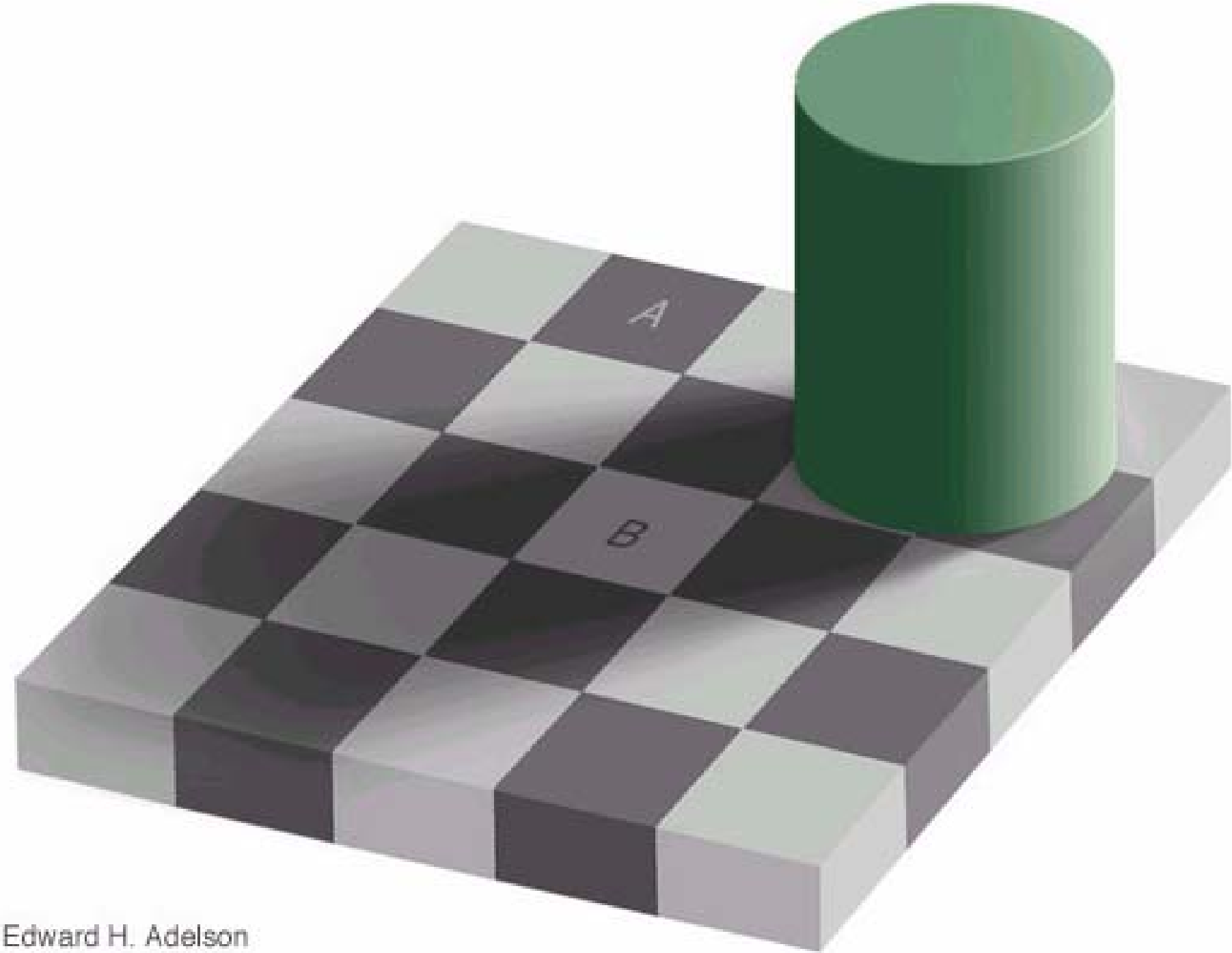
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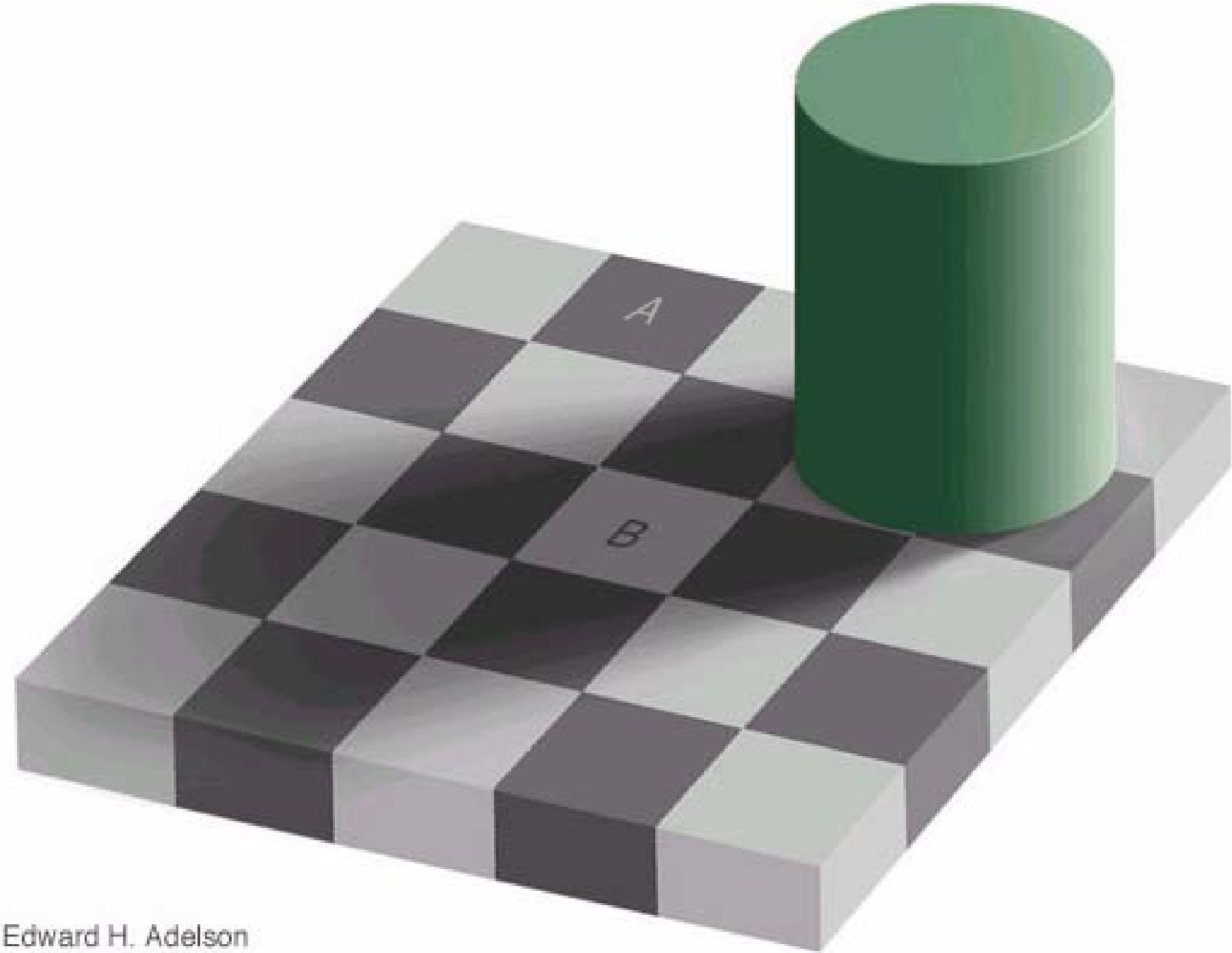
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Image copyright Bev Doolittle



Edward H. Adelson



Edward H. Adelson

Creativity and Innovation

The ability to look at the same thing, and to see something completely differently

A mystery…

Dr.Haledjian was in Inspector Winters' office waiting for the next case to solve when Inspector Winters came in with Jacques Strap. "He's charged with murdering Frank Buzz," snapped the Inspector.

"It's a mistake," cried Jacques.

"So then what were you doing in an alley with a gun and a dead man?" asked the Inspector.

"It wasn't my gun , and I'll tell you the truth. I was walking past the theater when I saw two men run past me. The second man was carrying a gun. So I followed them. They turned into an alley and the second man fired six shots at the other. The first man dropped dead to the ground. The murderer was about to walk away when he caught a glimpse of me. Knowing there was no escape, he threw his Colt .45 at me and ran to the fire exit door of the theater. There he pushed open the door and went inside. I was still holding the gun when a cop came running up the alley," finished Jacques.

"I tell you I'm innocent."

"Give me a break", said Dr.Haledjian. "This story is impossible."

Example: Apple Visual Design



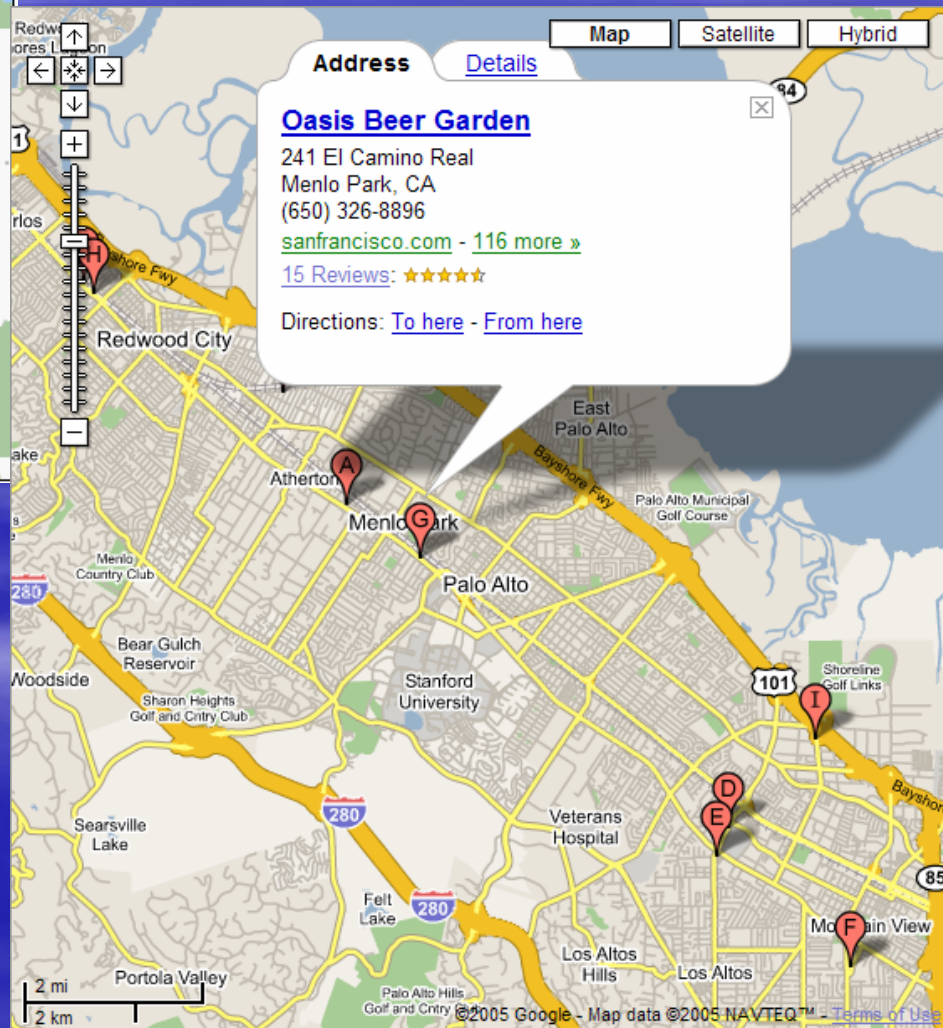






Example: Google Maps





Example: JSF











Example: Chrysler PT Cruiser













Retro: Patterns Learned

- 1939 Ford Coupe
- 2001 Chrysler PT Cruiser





Lawnmower Purchase

- You are asked
  - 18” deck or 22” deck?
  - Mulching blade required?
  - Do you want variable rate populsion?
  - Side or rear exhaust?
  - Electric or gas?
  - 2 or 4 cycle?

Lawnmower purchase

- You should ask
  - Why do you want a lawnmower?
  - What is your yard like? Lots of trees? Hills?
  - Do you like to mow, or is it a chore?
  - How long do you need to own a mower?
  - Who will do the mowing of your lawn?
  - Where is the nearest power outlet?

This is Systems Engineering

- The perception of interfaces
- The perception of context
- The perception of relationships
- The perception of light and dark, requirements, verification, validation
- The perception of the whole, or gestalt

Systems Engineering

- Has an existing methodology
- But requires us to see things differently
- And requires us to combine elements and perceive the system in ways not normally familiar to us
- We can borrow from the artistic world to better understand Systems from a whole-brain perspective

Summary

- Systems Engineering and Projects
- Results of Concrete / Abstract Thinking
- Seeing Systems
- Whole-Brain Thinking
- Beginning the Development of Whole Brain Reasoning

In Closing

He who works with his hands is a laborer

He who works with his hands and head is a craftsman

He who works with his hands, head and heart is an artist.

- St. Francis of Assisi

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LMI

GOVERNMENT CONSULTING

THE OPPORTUNITY TO MAKE A DIFFERENCE HAS NEVER BEEN GREATER



PROGRESS TOWARD AN EMPIRICAL RELATIONSHIP BETWEEN RELIABILITY INVESTMENTS AND LIFE-CYCLE SUPPORT COSTS

Jim Forbes and Andy Long

10th Annual Systems Engineering Conference
October 22-25, 2007
San Diego, CA

Project Phases

- Phase I:
  - Sponsored by DOT&E
  - Using empirical data, investigated the relationships between reliability investment and life cycle support costs.
  - Analyzed the root causes of not meeting R&M requirements.
- Phase II:
  - Co-sponsored by DOT&E and AT&L
  - Building on results from phase I, developing a mathematical model that can be used to predict the investment in reliability required to achieve a given amount of reliability improvement/growth.



Study Approach

- Two overarching constructs
  - Achieved reliability = *f* (goal setting, technology, reliability effort)
  - Support cost = *f* (usage, product design, support process design)
- Gap analysis between the earliest and the most recent data available
- Statistical analysis of reliability investment and reliability improvement

Limitations

- Data availability and quality. Problems with incomplete, corrupted, and missing data were pervasive.
- Small sample size--empirical data limited to six case studies.
- LCCs were estimated by CASA model--not actuals.
- Assumed reliability investments were the cause for observed reliability improvements.
- When LRU-level costs were not available, subsystem level costs were allocated to the LRU level.

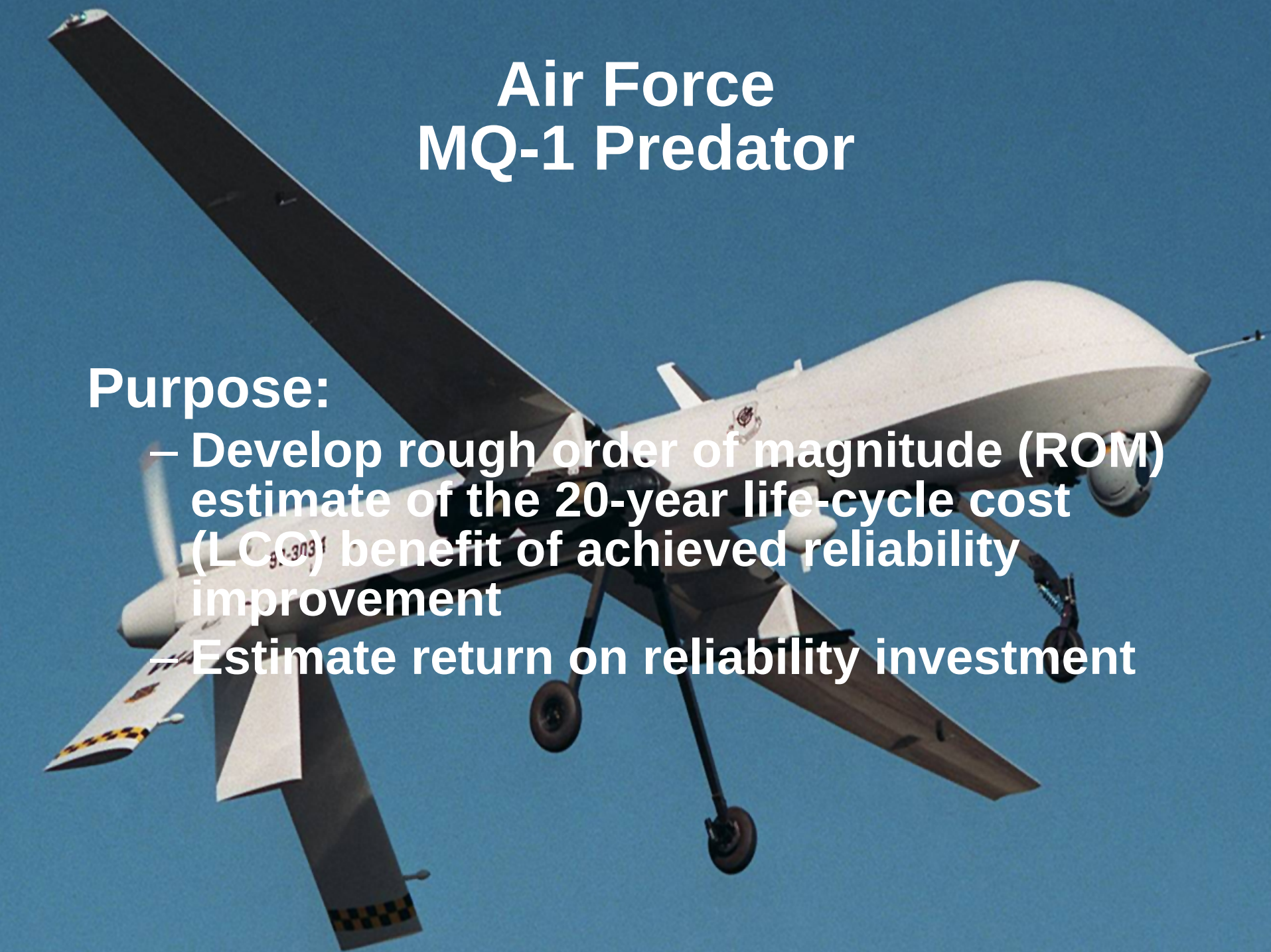
CASA = Cost Analysis Strategy Assessment Model

Bottom Line Up Front

- Reliability goals did not appear to be driving either management or engineering effort.
- Availability and use of mature technology was not an issue.
- Programs significantly improved system reliability.
  - Improvement ranged from 50% to 674.5%
  - Improvements were partially the result of enhancements to resolve performance limitations.
  - In four of five cases, programs made a deliberate effort to improve reliability in its own right—2 of 4 cases after OT or IOC.
- Programs significantly reduced life-cycle support costs.
  - Percent reductions ranged from 23% to 86%.
  - However, under investment in reliability may be large (discussed later).

Case Studies

- Predator
- Global Hawk
- CH-47F (characterized improvement but did not model LCC)
- MH-60S
- FBCB2
- Complex Ground Vehicle Electronics System

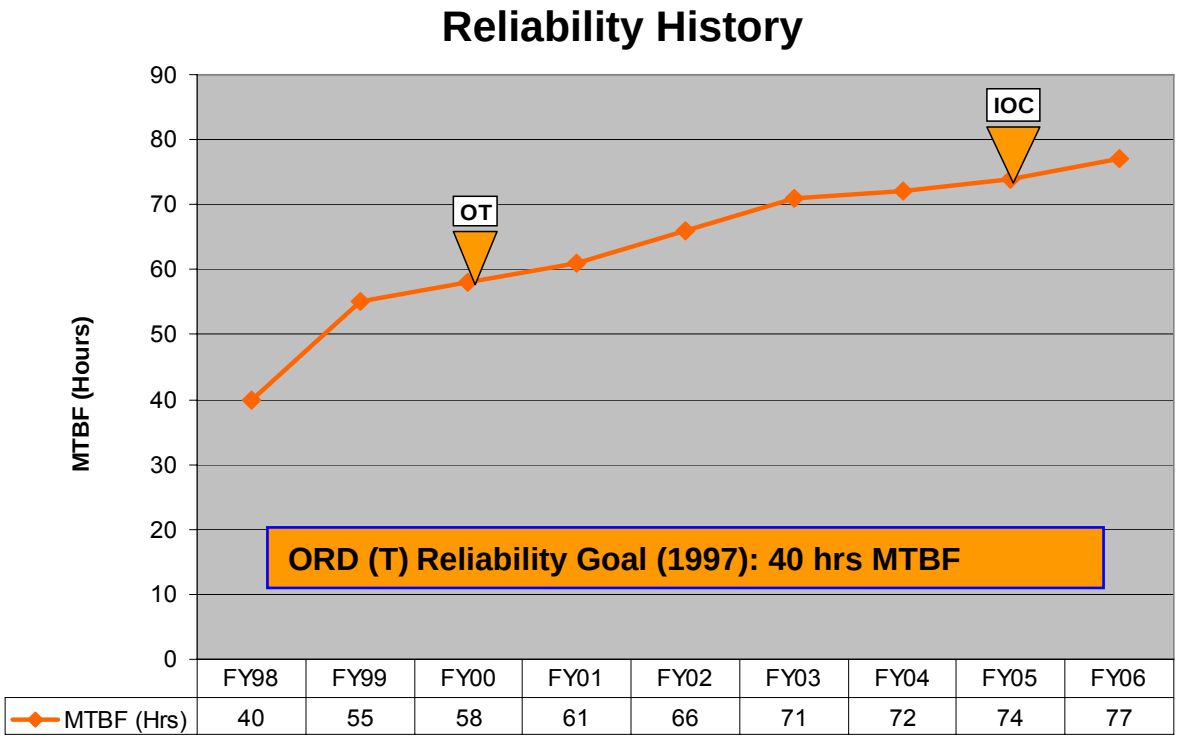


Air Force
MQ-1 Predator

Purpose:

- Develop rough order of magnitude (ROM) estimate of the 20-year life-cycle cost (LCC) benefit of achieved reliability improvement
- Estimate return on reliability investment

Predator Analysis



Reliability Investment and Support Cost Reduction								
Case Study	MTBx Hours			CASA 20-Year Support Cost (costs in FY03 M $, discounted 7%			Economics (FY03 M $)	
	Was	Is	Percent Change	Was	Is	Percent Change	Reliability Investment	ROI
Predator	40	77	92.5%	$1,463,940	$576,663	60.6%	$39.1	22.7:1



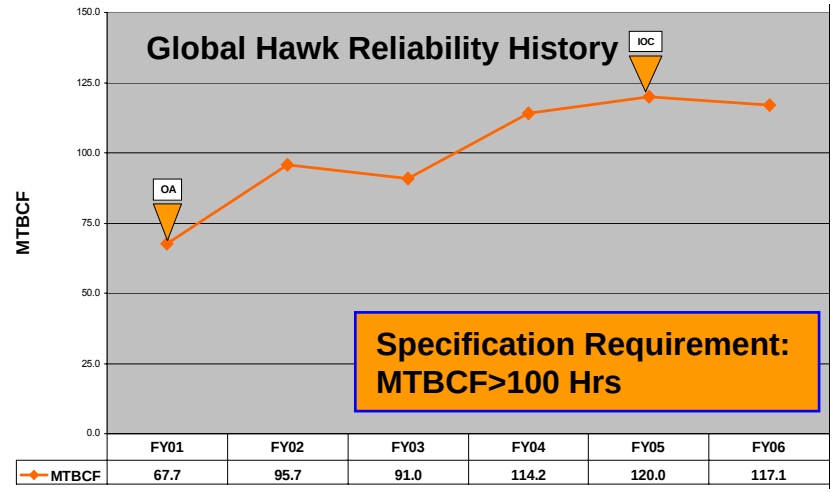


Purpose:

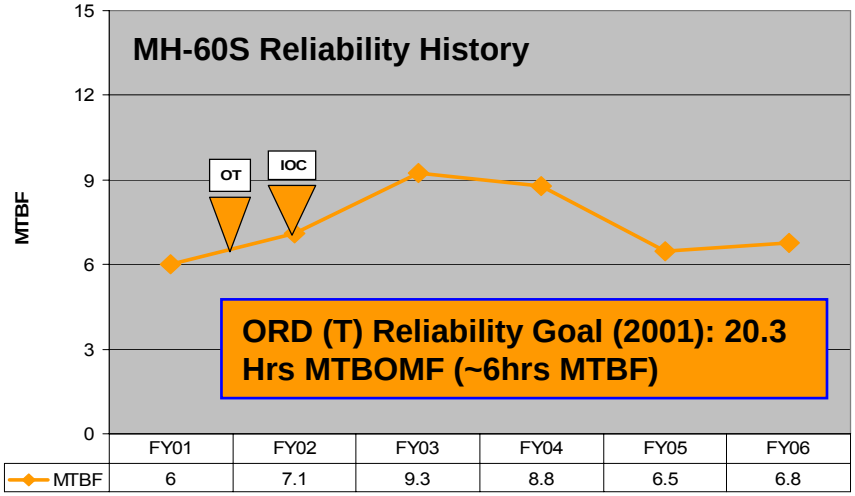
- Develop rough order of magnitude (ROM) estimate of the 20-year life-cycle cost (LCC) benefit of achieved reliability improvement
- Estimate return on reliability investment



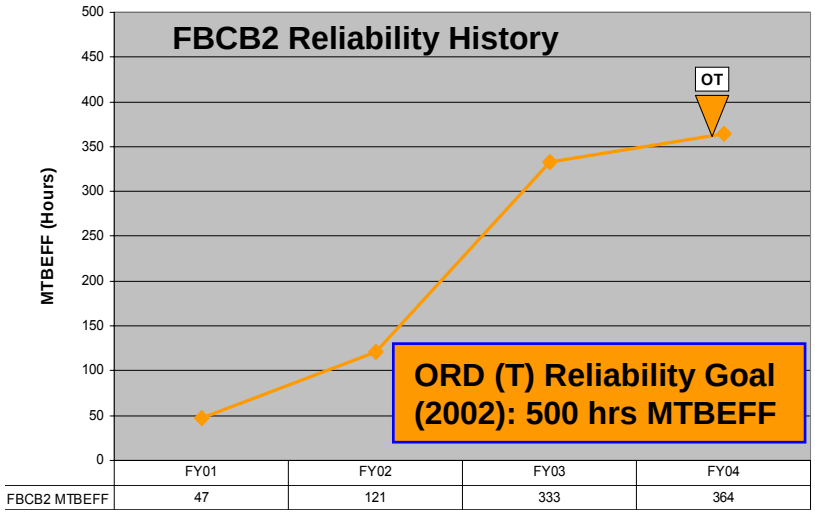
Global Hawk, MH-60, and FBCB2



	FY01	FY02	FY03	FY04	FY05	FY06
MTBCF	67.7	95.7	91.0	114.2	120.0	117.1



	FY01	FY02	FY03	FY04	FY05	FY06
MTBF	6	7.1	9.3	8.8	6.5	6.8



	FY01	FY02	FY03	FY04
FBCB2 MTBEFF	47	121	333	364

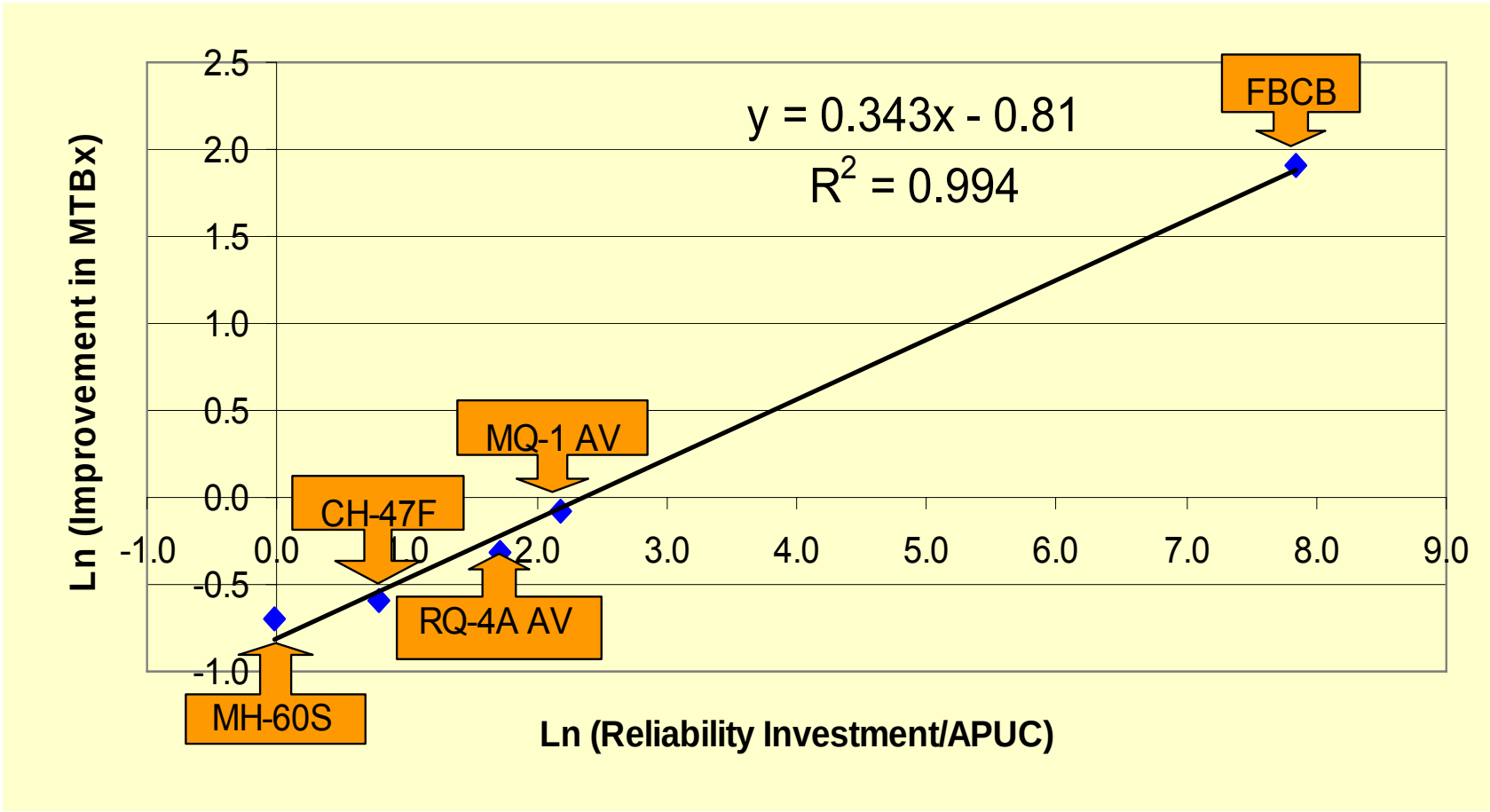
Reliability Investment and Support Cost Reduction

Case Study	MTBx Hours			CASA 20-Year Support Cost (costs in FY03 M $, discounted 7%			Economics (FY03 M $)	
	Was	Is	Percent Change	Was	Is	Percent Change	Reliability Investment	ROI
Global Hawk	67.7	120	77.3%	$2,547,380	$1,958,759	23.1%	$121.9	5:1
*MH-60	2.4	3.6	* 50%	$384,602	$64,672	83.2%	$6.6	49:1
FBCB2	47	364	674.5%	$13,060,351	$1,880,763	85.6%	$87.4	128:1

* Improvement over HH-60 for like components

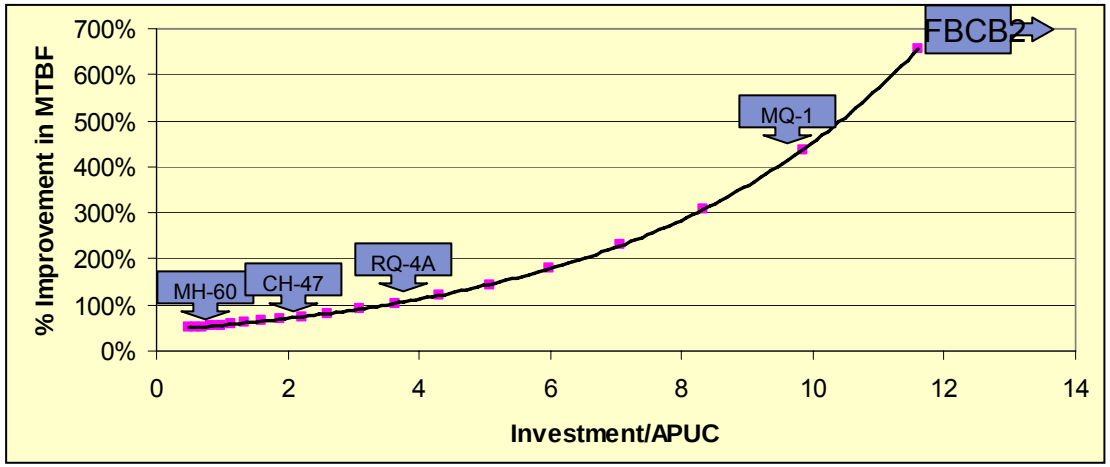
Reliability Improvement vs. Investment Phase I

(Excluding Complex Ground Vehicle Electronics System)



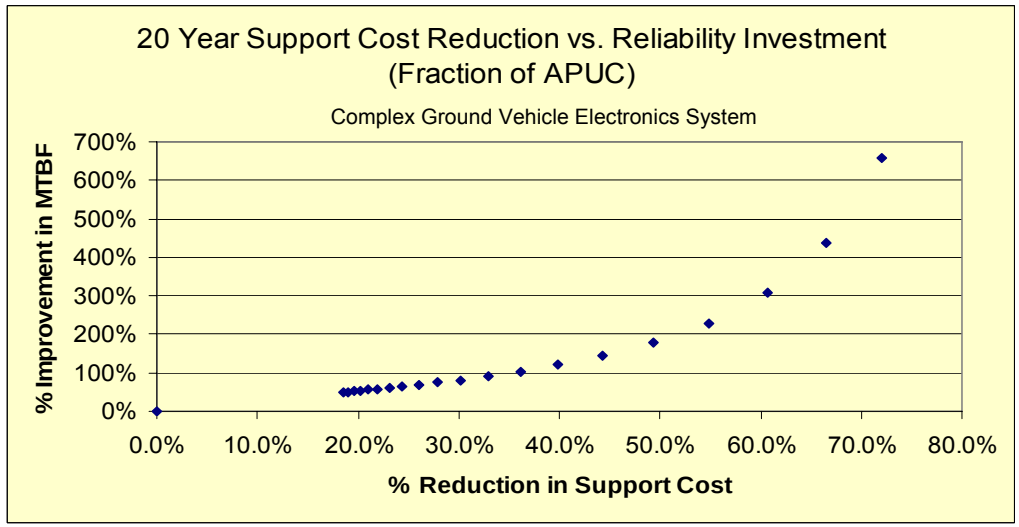
Translating Reliability Investment Into Support Cost Reduction (Complex Ground Vehicle Electronic System Example)

Phase I



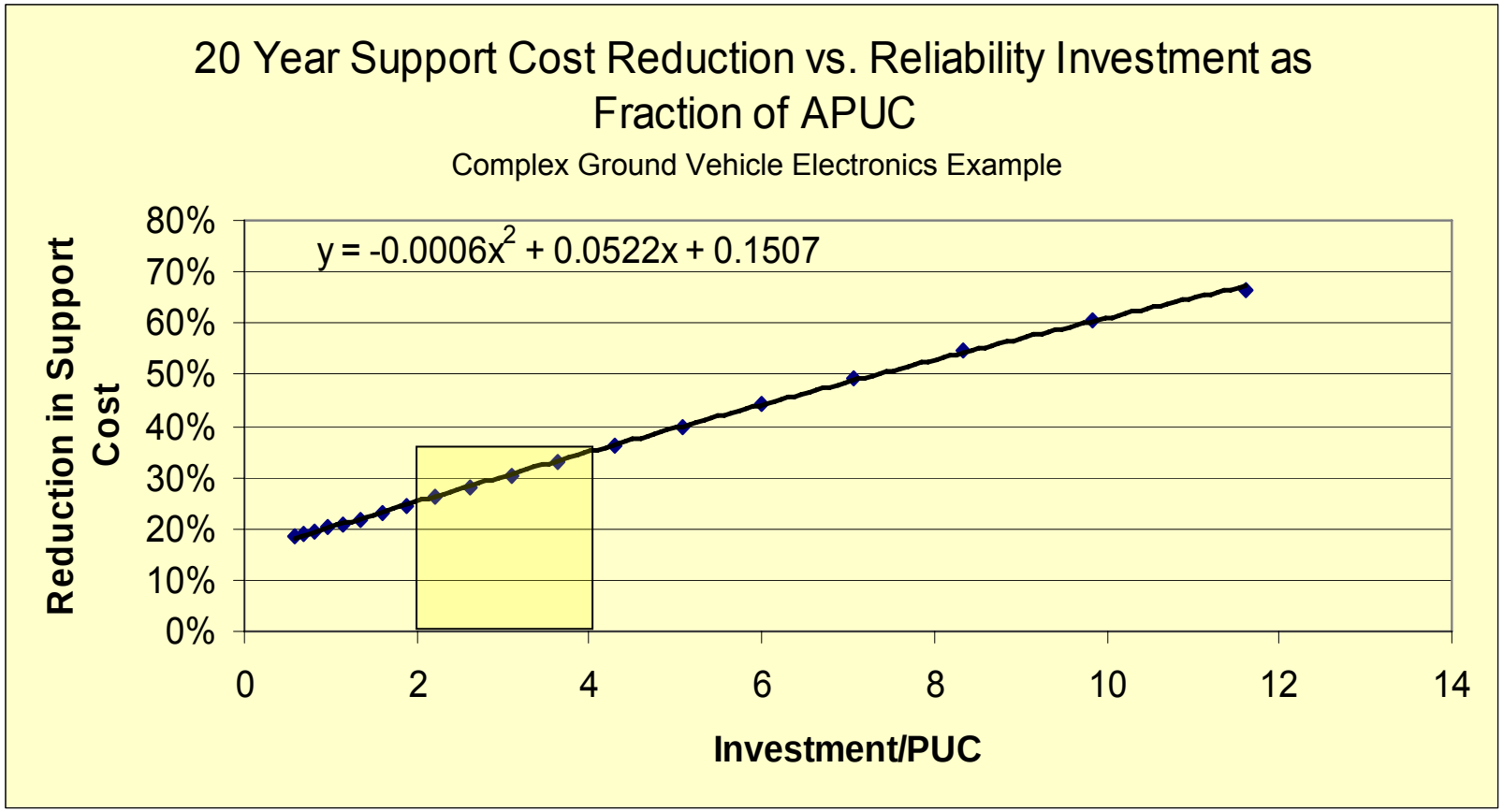
Potentially technology and application neutral

Most likely technology and application dependent



Translating Investment as Fraction of APUC Into Support Cost Reduction

Phase I



Preliminary Results

Conclusions

- Achieving Reliability
  - Goals
    - All five case studies for fielded systems had established goals
    - …but did not manage to requirements
  - Mature technology: available and incorporated
  - Effort
    - With possible exception of FBCB2, reliability effort was not evident during design
    - Two cases with reliability effort did it after OT/IOC
- Reliability and ROI
  - Clear evidence that reliability investment reduces support cost
    - ROIs of 5:1 to 128:1 on reliability improvement effort
    - 30% to 80% (or more) reduction in support cost achievable
  - Reacting to unreliability after OT/IOC rather than preventing it up-front is probably leaving significant support cost reduction unrealized

Project Phases

- Phase I:
  - Using empirical data, investigate the relationships between reliability investment and life cycle support costs.
  - Analyze the root causes of not meeting R&M requirements.
- Phase II:
  - Building on results from phase I, develop a mathematical model that can be used to predict the investment in reliability required to achieve a given amount of reliability improvement/growth.

Model Comprises Four Sub-models

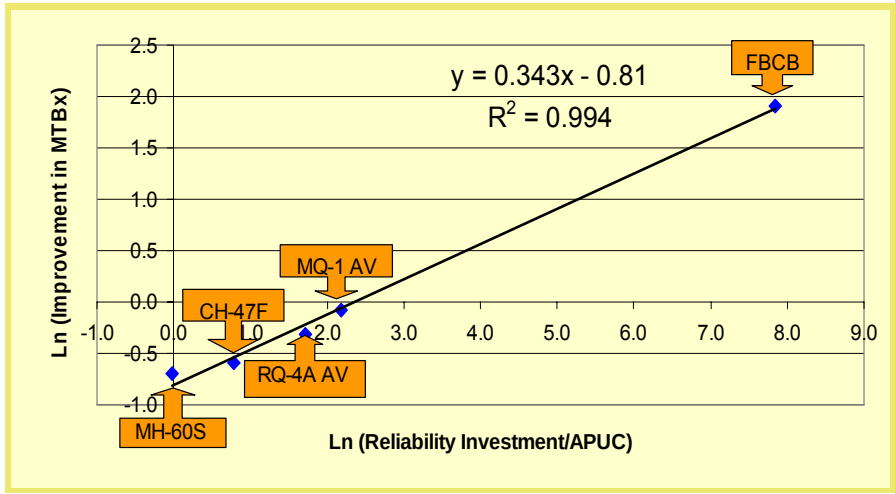
1. A basic model that computes reliability development effort and cost as a function of program size and desired reliability improvement
2. An intermediate model that computes development effort as function of program size, desired reliability improvement, and a set of relevant cost drivers
3. A detailed model that incorporates the characteristics of the intermediate version with an assessment of the cost driver's impact on each step (analysis, design, etc.) of the reliability engineering process
4. A companion production/support cost model to estimate
   - delta investment in production (e.g., for retrofit and spare parts) and
   - change in operations and support cost.

Study Plan

- Phase IIa (DOT&E-funded)
  - Basic model
    - Extension of work done under cost of unreliability task
    - Robust the underlying set of data from 8 programs and projects to about 16
    - Provide cost estimating relationship usable by program managers, including
      - Applicability
      - Statistical properties
      - Limitations
  - Target completion February 2008
- Phase IIb (AT&L-funded)
  - Intermediate model
  - Companion production/support cost model
  - Target completion June 2008
- Potential follow-on
  - Detailed model…if warranted by results of phase II

Phase IIa Approach: Focus on Investment to Reliability Relationship

- Extend cost of unreliability study, analyze in-service programs
  - Reliability improvement
  - Cost to achieve the improvement
- Key elements
  - Emphasize homogeneity of data
    - Same cost content across programs
    - Consistent reliability counting rules within a program
  - Look for disconfirming evidence: programs that do not appear to follow the log-log relationship between normalized investment and improvement, reasons why



Cost Content

- Funds identified for reliability improvement
- Funds budgeted for test related to reliability improvement
- Related systems engineering funds

Relationship	Source of data/Comments
Investment to reliability improvement	Across air, sea, ground domains; confirm domain independence
Reliability improvement to cost of ownership reduction	Single domain (air?); characterize within domain behavior Gather data in phase I, limited analysis

Summary

- Phase I
  - Using empirical data, investigated the relationships between reliability investment and life cycle support costs.
  - Analyzed the root causes of not meeting R&M requirements
- Phase II
  - Extending work from phase I
  - Developing a cost estimating relationship usable by program managers, including
    - Applicability
    - Statistical properties
    - Limitations



Additional Slides

Reliability Overview by Case Study

Dimensions	Reliability Goal ORD (T)	Technology Readiness	Management Effort	Fail Rate Reduction
Cases				
Predator (Air Vehicle)	40 hrs MTBF	• Advanced Concept Technology Demonstration (ACTD) system acquisition. • After initial fielding, ACTD platform upgraded with better performing and more reliable Engine, Communications, Flight controls, and Sensor Payloads.	•As evidenced in budget justifications, concerted emphasis was placed on improving overall system reliability as part of improving performance.	48.1%
Global Hawk (Air Vehicle)	Effective Time on Station (ETOS) > 85%; MC>85%; Translate to MTBCF>100 Hrs (Spec)	• Advanced Concept Technology Demonstration (ACTD) system acquisition. • After initial fielding, ACTD platform upgraded in Block 10 spiral with better performing and more reliable Electrical Power, Communication (Data Link) Improvements, Flight controls, and Sensor Management Unit (SMU) configuration.	•PM/OEM data and budget justifications indicate numerous trade studies and other engineering initiatives to improve performance and reliability.	43.6%
Ch-47F	The original goal 44 hrs MTBMA was changed in 2006 to 30 hrs MTBMA	• Remanufacture of CH-47D to Ch-47F airframes and new zero time CH-47F aircraft • New Platform Airframe to reduce vibration, Common Avionics Architecture System to improve avionics, upgraded 714B Engine with enhanced lift capability and reliability, Engine Air Particle Separator to improve engine reliability, and reliable Electrical Power Supply and Distribution system	• PM Improved Cargo Helicopter (ICH) contracted with Avion, INC in 2002 to baseline and manage RAM data collection and analyses. • Failure Modes Effects Analysis (FEMA) currently being used to identify reliability bad actors, although not used to drive initial design.	35.8%
MH-60S	20.3 hrs MTBOMF (~6hrs MTBF)	• Remanufacture of HH-60 H aircraft • Investments in CPU, PWR SYS, DRIVE SHAFT ASSY, NAV COMPUTER, STABILATOR AMPLIFIER, BEAM-AXLE AASY, FLOOR ASSY, and IR TRANSMITTER improvements have improved aircraft performance and supportability. • Overall aircraft reliability has shown moderate reliability gains due to unreliability of older subsystems.	• Did not find specific budget justifcation for reliability improvement • NAVAIR PMA-299 is working with the Army and other Navy programs to share investment expenses to improve reliability of bad actors such as retaining bolts, gaskets, and bearings.	33.3%
FBCB2	500 hrs MTBEFF	• Beginning with tests and reliability demos on competition systems, investments in components ruggedized for operating environments, improved power supply, redesign of internal components to dissipate heat and removable hard drives and dust filters were made to improve LRU reliability and overall system performance.	• Using data from reliability demonstrations, field tests and operational tests and analyses to drive reliability improvement. • As evidenced in budget justifications, investments are being made in hardware and software reliability improvements.	87.1%

Data Availability by Platform/System

Platform	Usage Data Density, OPTEMPO	Product Data Failure rate, MTBF, MTTR, MR	Support Process Data CWT, Cycle Times, NRTs
MQ-1 Predator	Gaps in flying hours data in AFTOC. Useable data provided by MAJCOM.	Usable data available from OSD Studies, PM, and other sources	Limited visibility into contractor support processes. Used default values.
RQ-4A Global Hawk	Gaps in data. Flying hour counting rules vary by operational unit. (Beale reports pre and post flight operations in FH data; Edwards does not.)	Reliability data parameter measured in the field (MTBF) not consistent with the parameters used to establish ORD requirement (ETOS>100 hrs)	Limited visibility into contractor support processes. Used default values.
FBCB2 Appliques	OT Other than for OT, unable to locate usage data. Does not appear to be captured.	Used DT/OT data available from AEC and IDA. Data differs by source for same test events.	Limited visibility into contractor support processes. Used default values.
MH-60S	Usable data available from PMA 299	Reliability data parameter measured in the field (MTBF) not consistent with the parameters used to establish ORD requirement (MTBOMF)	Usable data available from PMA 299
Stryker	FY 2002 to FY 2005 CLS data unavailable. CLS Data for FY 2005.5 to FY 2006.5 for two Stryker brigades.	Limited data available, pedigree suspect or unknown	Limited visibility into contractor support processes. Because of other missing data did not model.
CH-47F	OT data available for 5 aircraft: 2-EMD Aircraft 2-zero time CH-47F Aircraft 1-Hybrid Aircraft, CH-47D outfitted with a CAAS cockpit	Reliability data parameter measured in the field (MTBF) and ORD requirement (MTBMA) are used interchangeably. Unclear whether data contain all failures or only those causing mission abort.	Data appear to be unavailable

Usable data available from standard source
Usable data available from PM or other sources
Data problematic: incomplete, inconsistent, pedigree suspect or unknown
Data appear to not be available



OSD DT&E: Implementing the Technology Maturity Vector

Joe Terlizzese
Support to
Deputy Director, Developmental Test & Evaluation
OUSD(AT&L)/Systems & Software Engineering

October 25, 2007

Outline

- SSE Mission
- Systems Engineering Revitalization
- Emerging Systemic Issues
- DT&E Revitalization Focus
- DT&E Technology Maturity Initiative
- Pending Guidance Changes

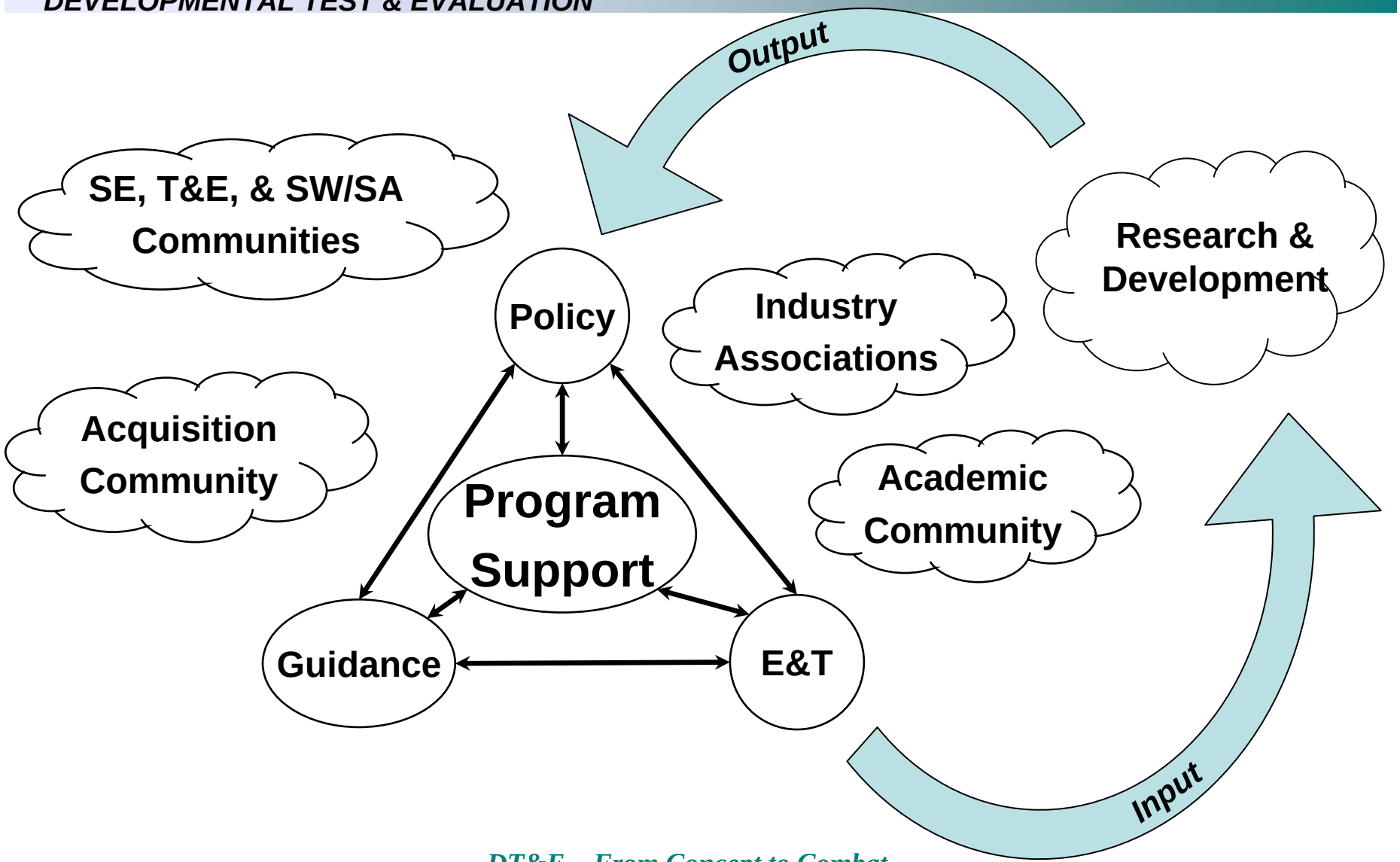
Systems and Software Engineering
Mission Statement

DEVELOPMENTAL TEST & EVALUATION

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

Evolving System Engineering Challenges

Systems Engineering Revitalization Cycle



Top 10 Emerging Systemic Issues

DEVELOPMENTAL TEST & EVALUATION

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

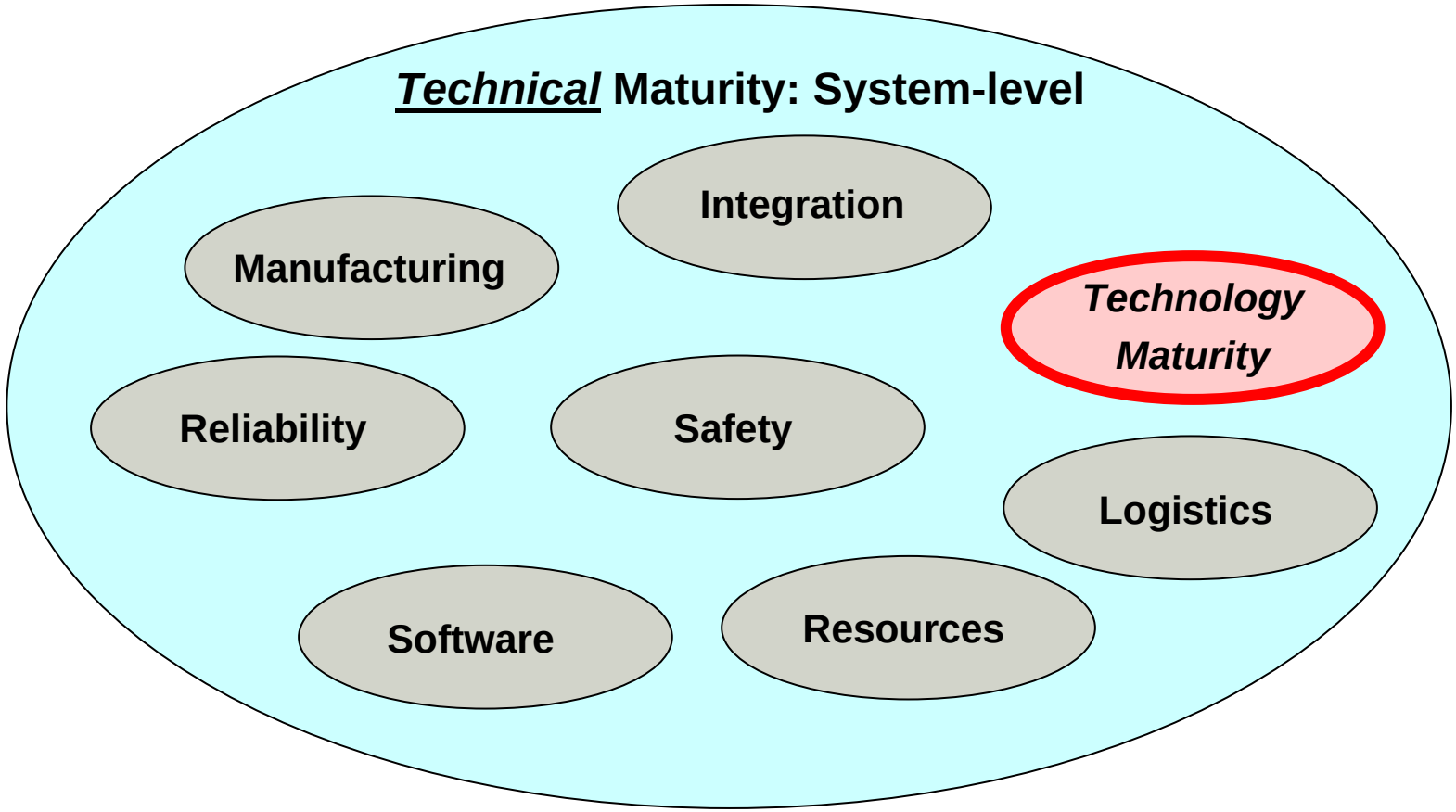
Major contributors to poor program performance

DT&E Revitalization Focus

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

DT&E Revitalization Vectors

Technology vs. Technical Maturity



Technology Maturity is a component- or subsystem-level issue

Reduce Risk of Immature Technology in Systems Development

- **Immature technology is a primary source of cost and schedule risk**
  - **GAO -- DAPA**
  - **QDR -- SSE Program Support Reviews**

- **"Programs that started development with immature technologies experienced an average acquisition unit cost increase of nearly 21 percent" (GAO-05-301, March 2005)**

- **Milestone B – USD(AT&L) certification that *"the technology in the program has been demonstrated in a relevant environment"* - Technology Readiness Level (TRL) 6 (FY06, PL 109-163, Section 801)**

DT&E Technology Maturity Initiative

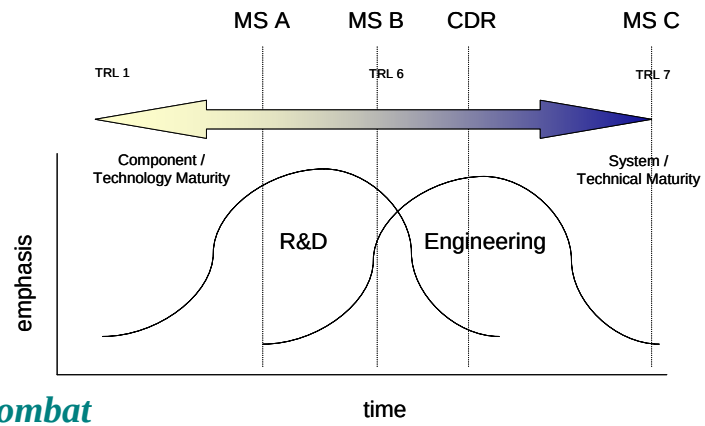
DEVELOPMENTAL TEST & EVALUATION

Purpose

- Add Technology Maturity focus into the Systems Engineering and DT&E processes to:
  - Reduce technical, cost, and schedule risk
  - Increase the rigor of SE
  - Plan for alternatives in the event of TM difficulty
  - Verify TRLs during DT&E

Scope

- Leverage existing acquisition review structure
- Use existing DDR&E Technology Readiness Assessment (TRA) methodology

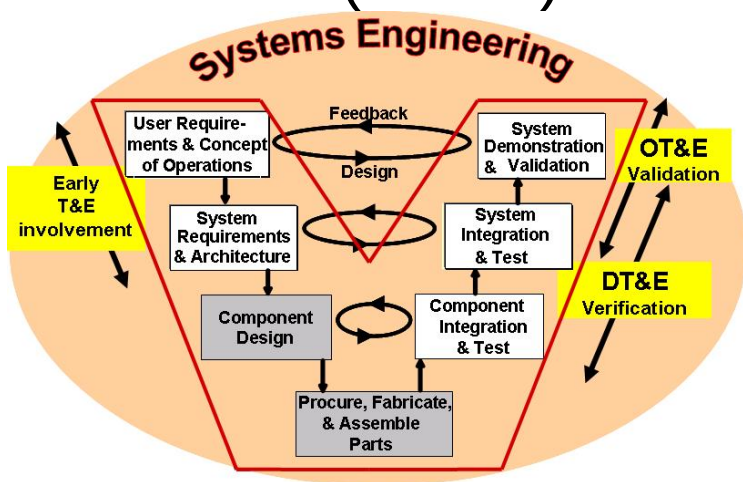


Pending Guidance Changes

- Defense Acquisition Guidebook
  - Chapter 4 (SE)
    - For immature critical technology elements (CTE), identify mature alternative
    - If a CTE is not likely to reach TRL 6 before MS B, substitution of the mature alternative may be required
  - Chapter 9 (T&E)
    - Validate technology maturation during Technology Development phase
      - DT supports decisions to shift to alternative technology

Increased TM emphasis in OSD Oversight

- Program Support Review (PSR)
  - ID Critical Technology Elements?
  - Current TRLs known?
  - ID Mature alternative components/sub-systems?
  - TRL monitoring, Alternative decision date?
- Assessment of Operational Test Readiness (AOTR)
  - TM verification results
  - DT&E performance results
  - IOT&E predictive analysis/M&S



Sensor Resource Allocation as a Driver in System Concept Development

Ravi Moorthy
Mark Russell
Jay Davidson
Lockheed Martin – MS2

Topics

- *Abstract*
- *Definitions*
- *Scenarios and Mission*
- *Multi Mission Scenario*
- *Sensor Resource Problem*
- *System Considerations*
- *Engagement Timeline*
- *Autonomous Engagement*
- *Sensor Resource Management*
- *Event Time Preliminary Analysis*
- *Event Time Derived Analysis*
- *System Concept Development*

Abstract

Operation of a Primary mission concurrently with an added mission like Anti Air Warfare (AAW) operations and other missions requires a balancing of competing system assets

This paper provides a methodology to assess the individual mission requirements and derive the capability assessment of multi mission scenarios

This paper also describes the drivers for such multi mission capability of the Aegis or similar naval combat systems

Overall capability to protect the ship and other protected assets as influenced by situation dependent sharing of system resources and other system constraints is discussed

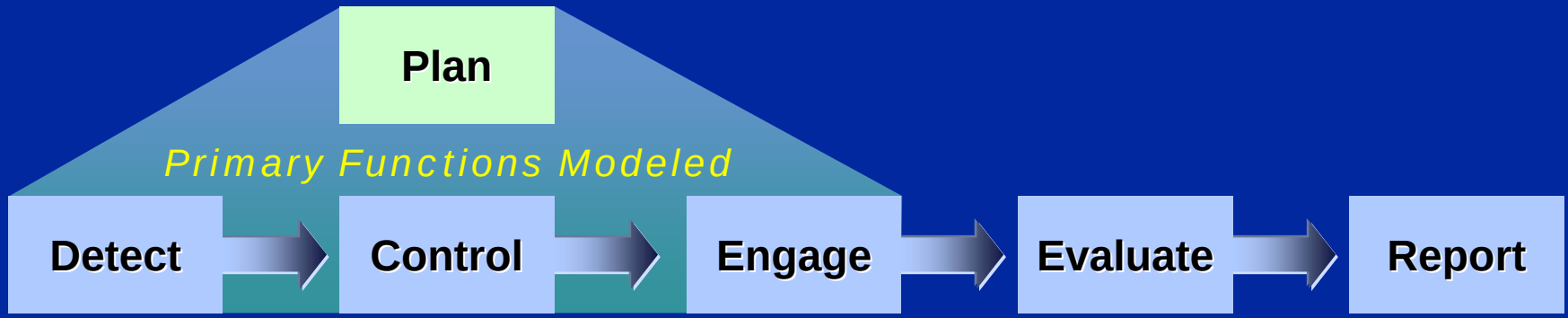
A brief description of the system level simulation model is also provided

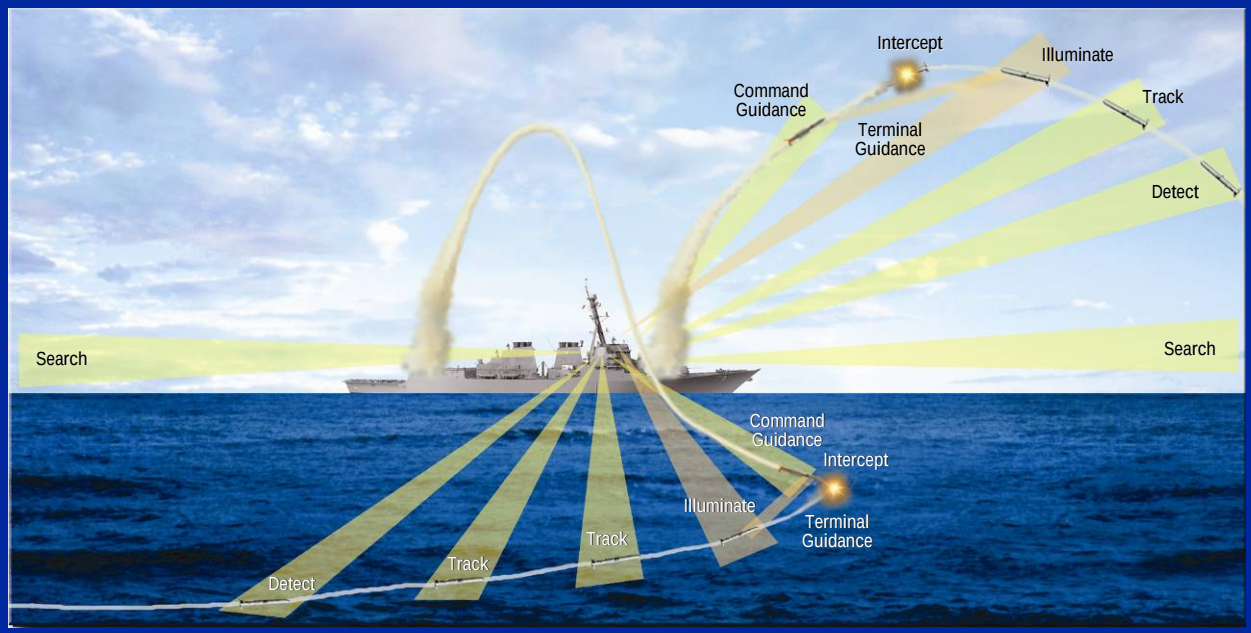
Definitions

- ***AAW – Anti Air Warfare***
- ***Sensors – Scanning and Tracking Radars***
- ***Autonomous – Organic***
- ***Multi Mission – Combined Missions requiring Simultaneous Tracking and engagements***
- ***Radar Resource Usage – Radar Time required to schedule the beams for search and track***

Scenarios and Mission

AAW Engagement General Timeline Model





Multi Mission scenario

- *A ship tasked with the primary mission may need almost all of its radar resources dedicated to that single mission*
- *To engage in an AAW mission, it would be necessary to commit another ship from the fleet operations*
- *Multiple ships will be required to perform multiple missions*
  - *Therefore it is necessary to consider reallocating the radar resources to support the AAW mission*

Multi Mission Scenario

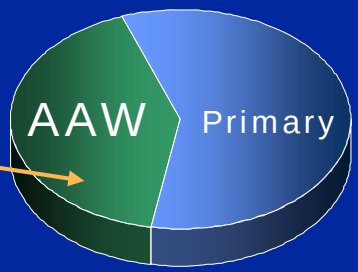
- ***Capability analysis was performed of the extent to which various levels of radar availability can be effectively utilized to defend against a breadth of AAW threat scenarios***
- ***The corollary to this is the effect on the primary mission performance of concurrent AAW missions***

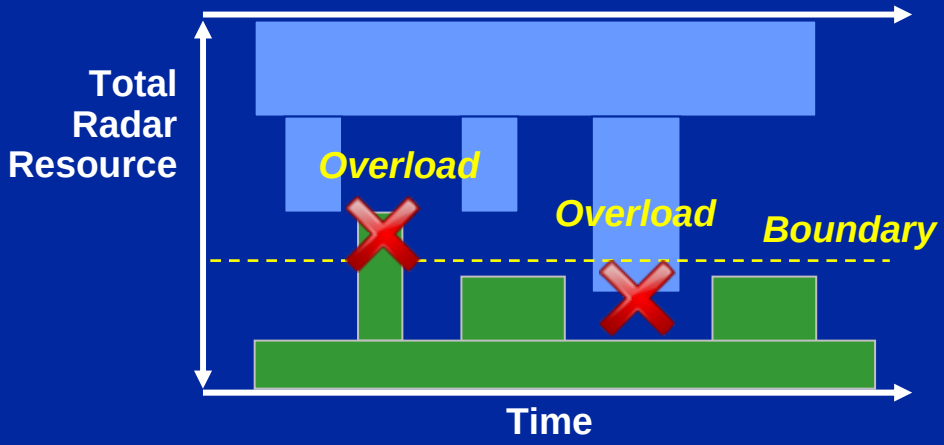
System Resource Management (1 of 2)

- ***Continuously monitor Multi Mission Sensor Resource usage***
- ***Dynamically re-allocate Multi Mission resources by predetermined mission priority***

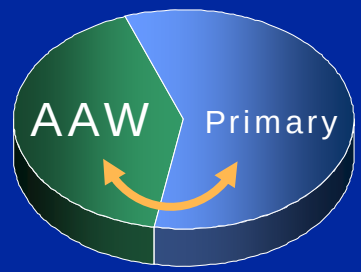
Concept 1: Fixed Mission Priority

Pre-Allocated

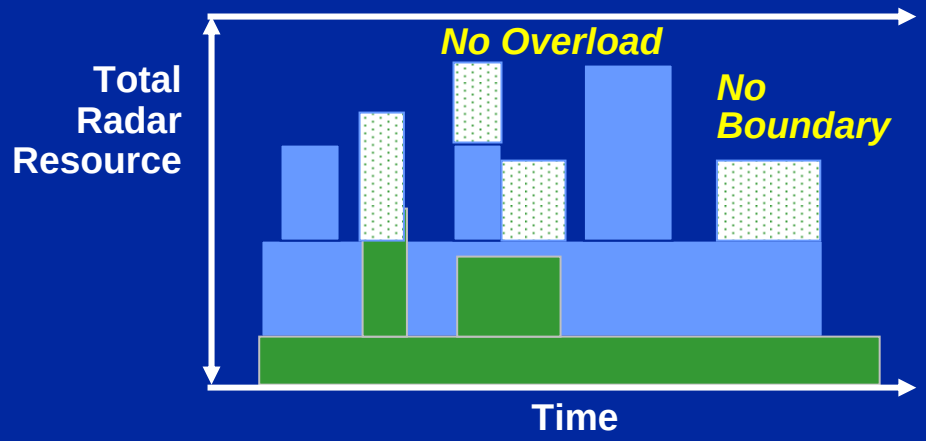




Concept 2: Dynamic Allocation

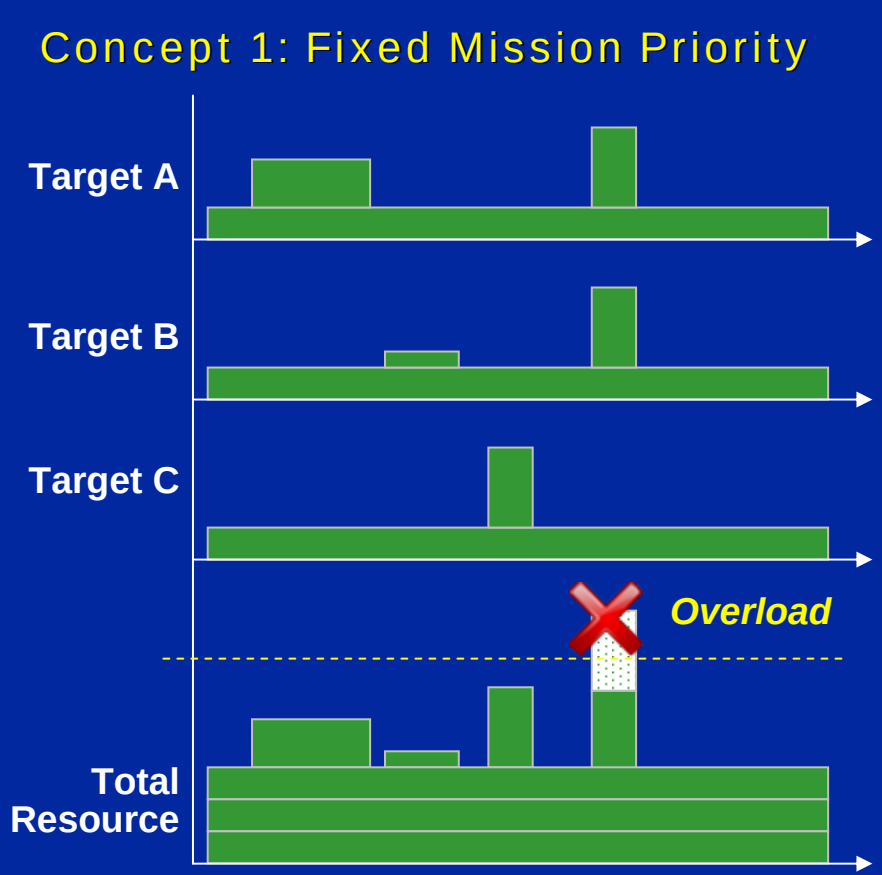


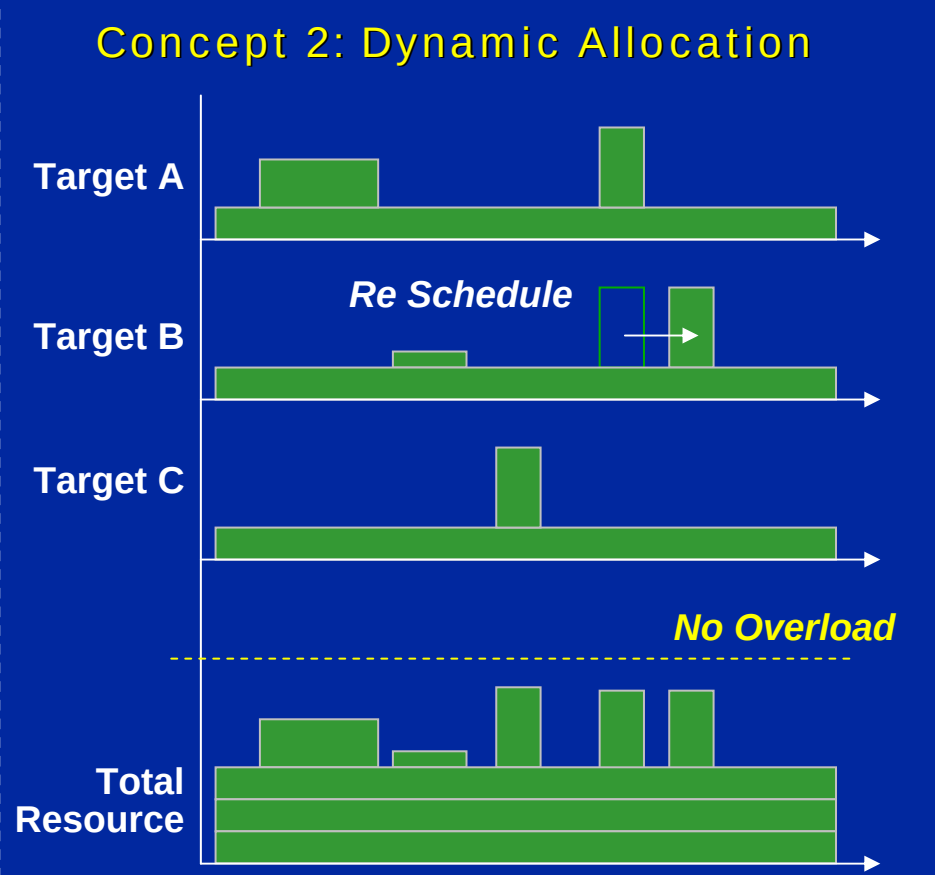
Dynamic Allocation



System Resource Management (2 of 2)

- ***Continuously monitor Multi Mission resource usage***
- ***Analyze dynamic schedule to avoid resource overload in Multi Mission Scenarios***

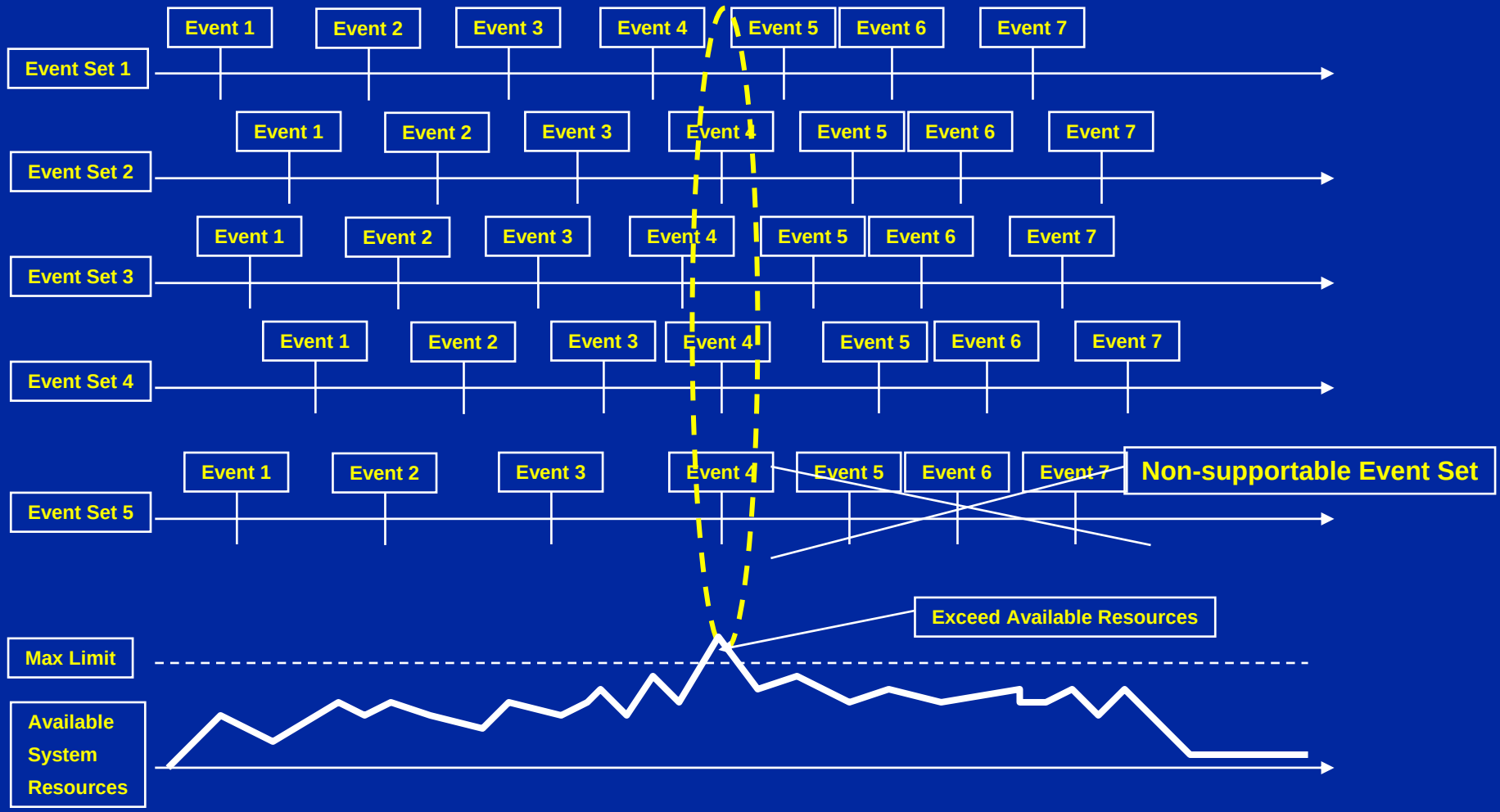




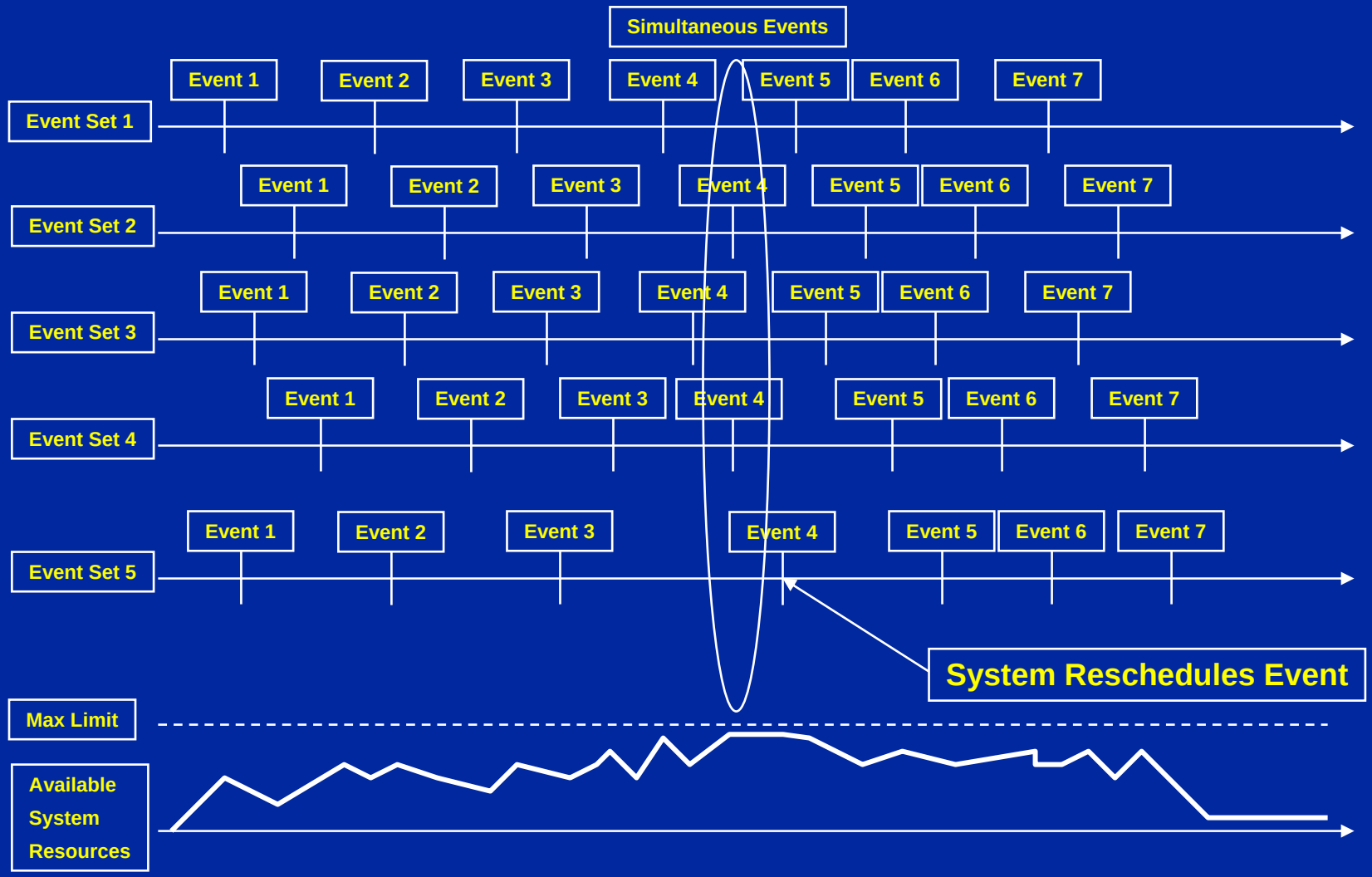
Sensor Resource Management

- *Continuously monitor sensor resources i.e. sensor usage*
- *Dynamically schedule Multi Mission resource between AAW and Primary mission by designated mission priority*
- *Dynamically re-schedule system activity to avoid Multi Mission resource overload*
- *No fixed capability boundary for target tracking and engagement*
- *Preserve Multi Mission system resources for committed weapon system actions*

Event Timeline
(Concept 1: Fixed Mission Priority)



Event Time Line (*Concept 2: Dynamic Allocation*)



System Concept Development

- ***In a Multi Mission environment engagement completion is based on sensor resource scheduling priority***
- ***Event times are delayed to allocate needed resources required to complete the event timeline***
- ***Missions do not always get 100% allocation of resources***

About the Authors

Ravi Moorthy

- ***Lead Systems Performance Analyst in Modeling and Operations Analysis in System of Systems Engineering of LM-MS2. Current Responsibilities Include Systems Engineering, System Performance Assessment and Analysis with System Simulation Models***
- ***B.E in Electrical Engineering from India; M.E.E from University of Delaware; MBA from Monmouth University and M.S. in Computer Sciences from NJIT***

Implementing and Measuring a Test Program in a Sustainment Environment

23 Oct 07

Jim Miller
Chief Engineer
727 ACSG/EN
Phone: (405) 736-7996
james.c.miller@tinker.af.mil

What Sustainment Environment?



727th Aircraft Sustainment Group

Col. James Fulton
Commander

Ms. Jerri Hulme
Deputy Director

Mr. James Miller
Chief Engineer

PROVIDING EFFECTIVE & EFFICIENT WEAPON SYSTEM SUPPORT

727 ACSG Mission

- Single Manager for Sustainment and Modernization of
  - 250 USAF Commercial-Derivative Aircraft
  - HF Global Communications System Network
- Preserves FAA Certification and Operational Safety, Suitability & Effectiveness (OSS&E) of Commercial Derivative Aircraft
- 4 Squadrons Manage Services Acquisition



"Cradle-to-Grave CLS Support"

Weapon System Support

727th Aircraft Sustainment Group
Contractor Logistics Support (CLS)

Weapon Systems
- KC/KDC-10
- VC-25
- E-4B
- C-9
- C-12
- C-20
- C-21
- C-26
- C-38
- E-9
- T-41
- T-43
- T-51
- TG-10
- TG-15
- UV-18
- Peace Lotus
- HFGCS



Customers
- AMC
- ACC
- ANG
- AFRC
- AETC
- USAFE
- PACAF
- AFMC
- USAF ACADEMY
- AF FLIGHT STD AGENCY
- ARMY
- NAVY
- US MARINE CORP
- DIA
- DSCA
- FMS
- USSOCOM

727 ACSG Responsibilities



Weapon System's Missions

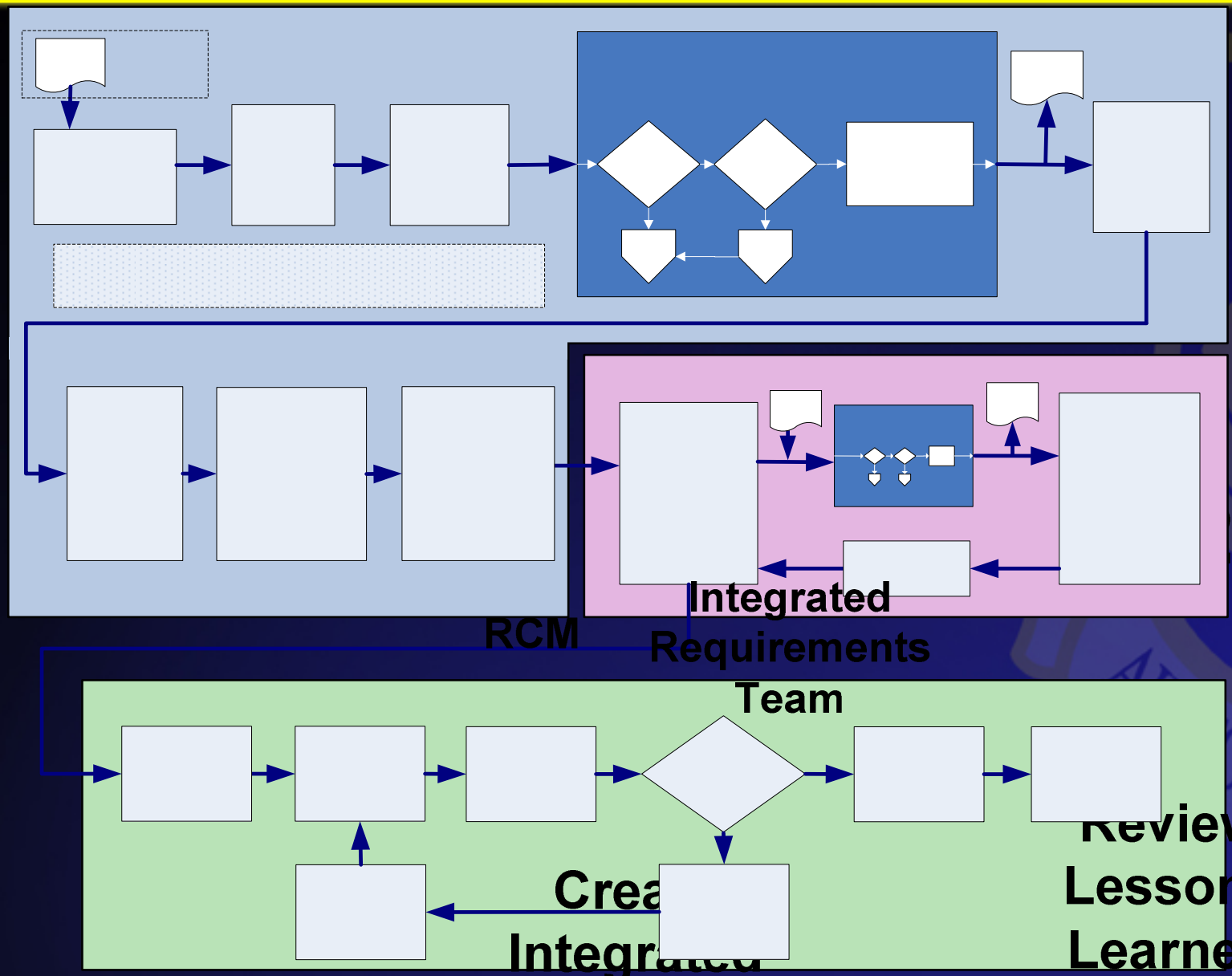


So What is the Problem?

- Sustainment environment different
  - Not one big pass/fail test
  - Most tests associated with mods
- Our organization had an ad hoc, contractor dependent, aircraft unique test approach
- Instigated a step-by-step Operating Instruction
  - Approach
  - Management
  - Expectations
  - Throughout the organization
- Implemented tangible approach that is:
  - Aimed at the working level
  - Applicable throughout entire organization
  - Accounts for progress through metrics
  - Always starts with requirements



Test Process Flowchart



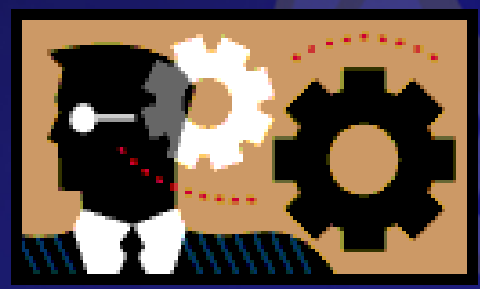
Step 1: Build an Integrated Test Team (ITT)

- Program Manager formally establishes ITT in writing
  - Standard Letter
- ITT consists of, at a minimum:
  - Program Manager
  - Project Engineer
  - Center Test Authority
  - Responsible Test Organization
  - Representative from the customer
  - Representative from the contractor

Planning Phase

Step 2: Review Lessons Learned

- Everyone thinks their test is unique—but they are usually wrong
- Review established lessons learned for:
  - Quantifiable criteria (e.g. noise)
  - Testing Techniques (e.g analysis, M&S…)
  - Test Methods
  - Previous Problems
  - Operational Scenarios



Planning Phase

Step 3: Define Test Requirements

- **Review established Requirements Correlation Matrix (RCM)**
  - **Ensures test requirements has direct link to source requirements**
- **For each requirement ask:**
  - **Is it quantified?**
  - **Is it verifiable/testable/measurable?**
  - **What verification method?**
- **If need be, send requirements back to program manager for clarification**
- **For risky verifications/testability, send risk to Risk Management Team**

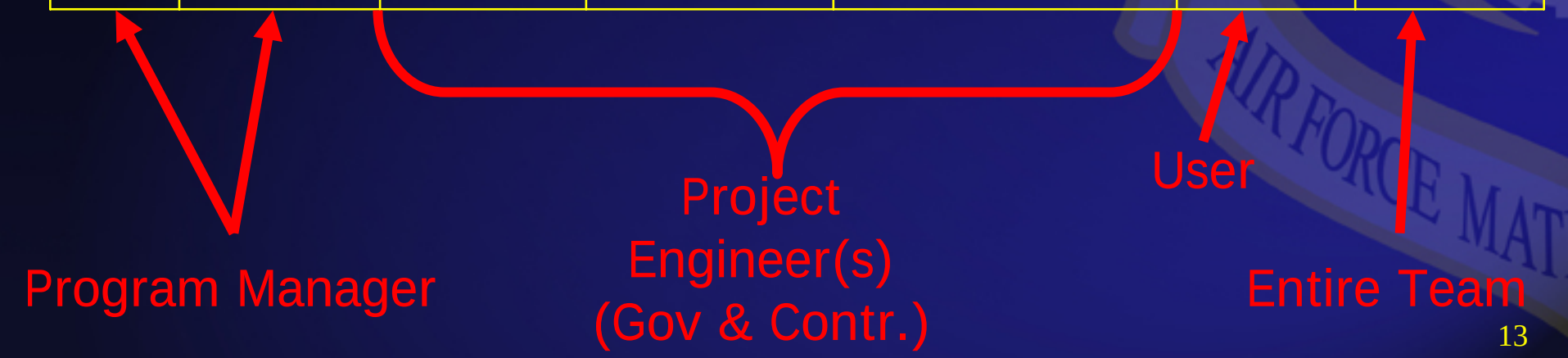
Planning Phase

Define Requirements

- Break intial requirements down into a Requirements Correlation Matrix (RCM):
  - Spreadsheet with following columns:
    - Requirement
    - Requirement Source
    - Derived Requirements
    - Quantification
    - Operational Conditions
    - Initial Risk Assessment
- Give RCM to
  - Test Team for their planning
  - Risk Mngt Team for their planning

RCM

Req Title	Req Source	Derived Req	Req Definition	Quantification	Op Cases	Risk (R/Y/G)



Step 3: Define Test Requirements

- Review established Requirements Correlation Matrix (RCM)
  - Ensures test requirements has direct link to source requirements
- For each requirement ask:
  - Is it quantified?
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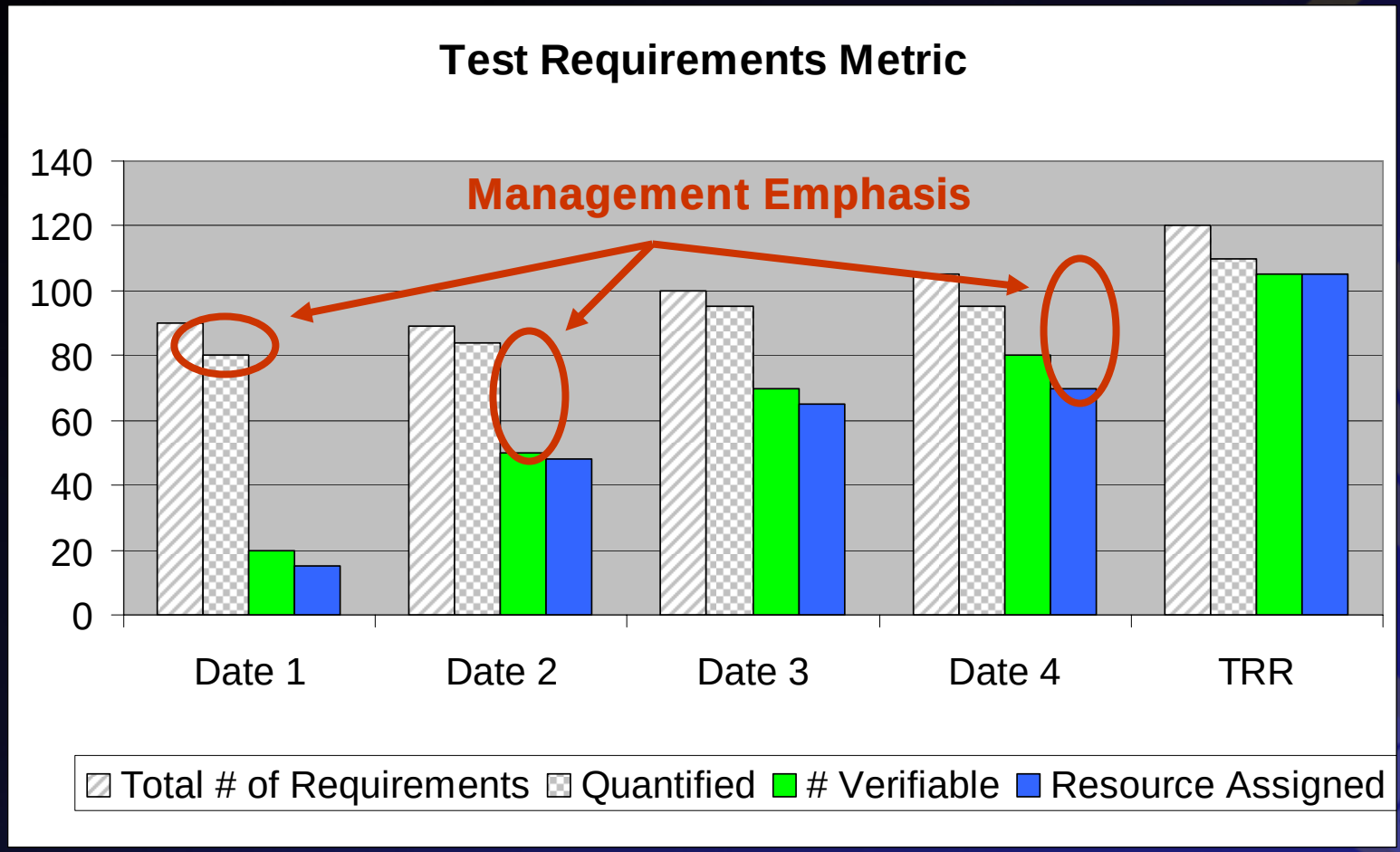
Planning Phase

Step 4: Develop Test Metrics

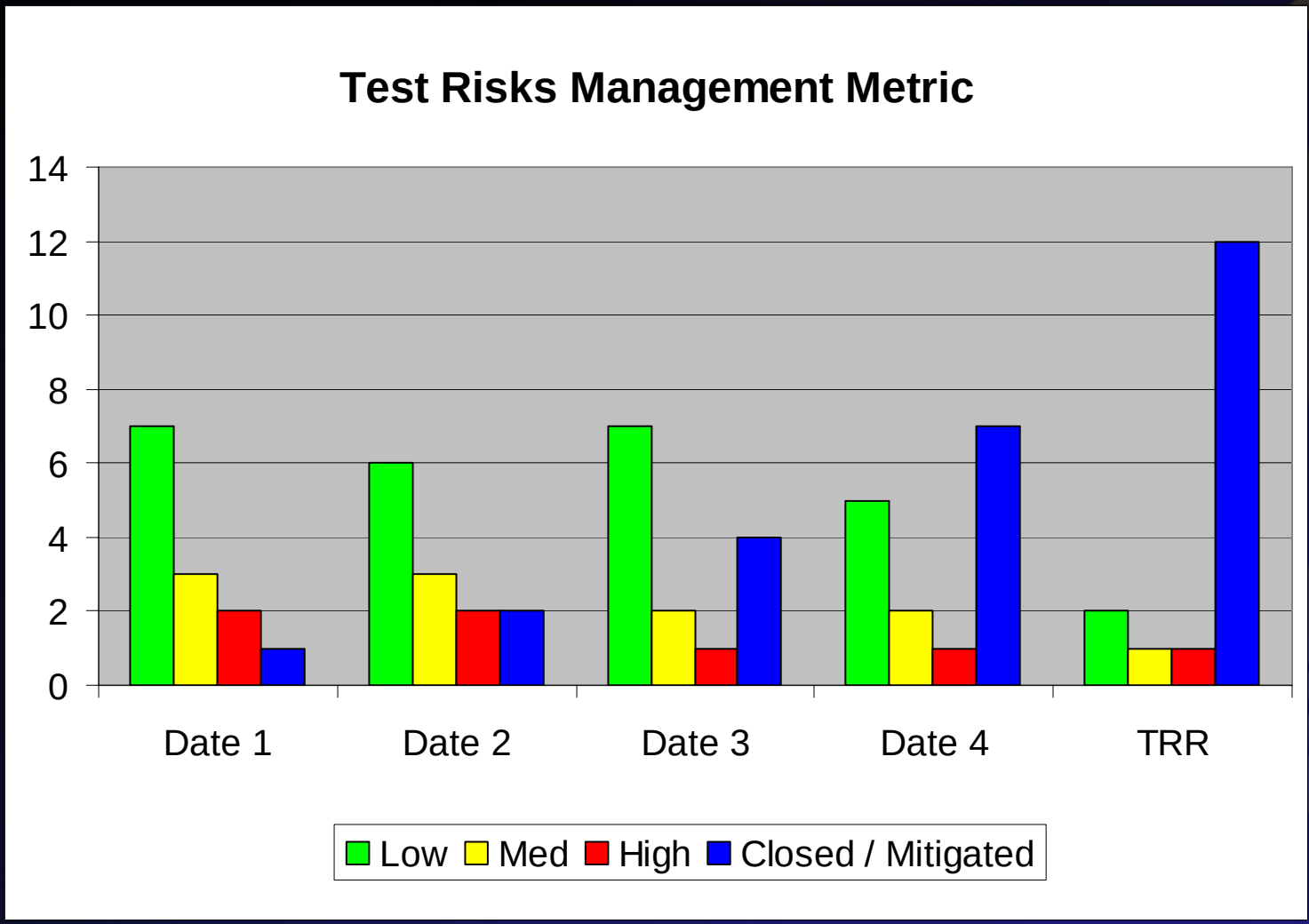
- Three minimum metrics
  - Test Requirements Metric
  - Test Risk Management Metric
  - Deficiency Report Metric
    - Required only during the Test Execution Phase
- Update the RCM
- Metrics shown to management at quarterly Weapon Systems Review
  - Shown elsewhere as required (PMRs, PDRs, CDRs, TIMS, TRRs, etc)

Planning Phase

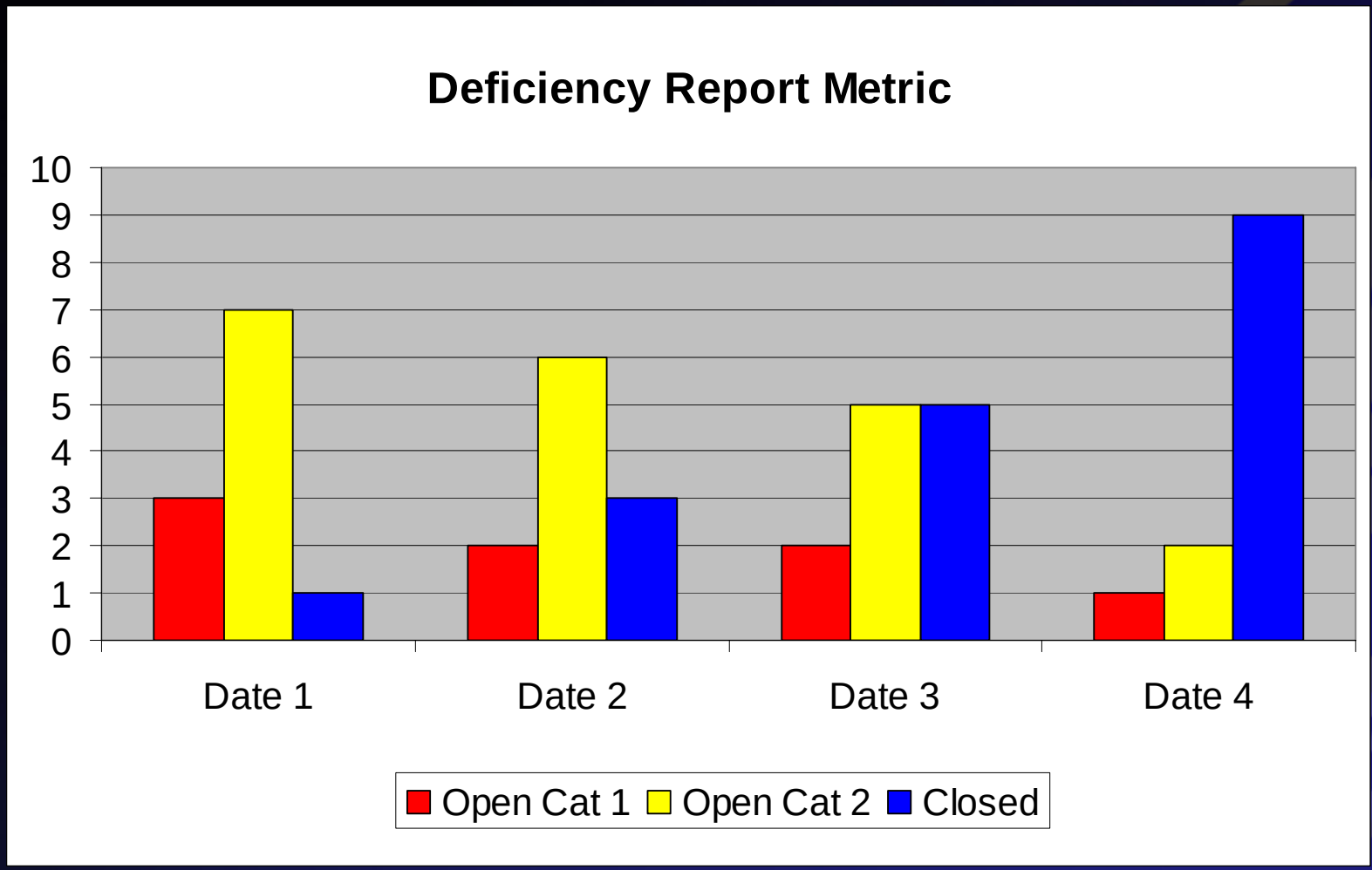
Test Requirements Metric



Test Risks Management Metric



Deficiency Metric Report



Step 5: Create TES or TEMP

- Tailored to size of project
- Documents strategy for conducting test
- Documents Roles and Responsibilities
  - How Redlines handled
  - How DRs handled
  - Use of TIMs
  - Scheduled Test Events (TRB, TRR, etc..)
  - Mishap Accountability
- Rationale for test verification methods (inspection, analysis, demonstration,test)

Planning Phase

Step 6: Integrate Test Plan IMS & Funding

- **Program Manager will:**
  - **Ensure the test program schedule in the TES/TEMP is incorporated into IMS**
  - **Work with contractor's processes/timelines—not duplicative**
  - **Ensure appropriate test program funds are available to support TES/TEMP**
  - **Schedule technical interchange meetings as required**

End of Planning Phase

Step 7: Technical Reviews

- Testing Addressed in Periodic Reviews
  - System Requirements Review
  - System Design Review
  - Preliminary Design Review
  - Critical Design Review
  - Safety Reviews
- ITT meets periodically to review that all requirements are:
  - Tested
  - Quantified
  - Verifiable/testable/measureable
  - Resourced
  - Risks mitigated

Design Phase

Step 8: Update TES/TEMP

- Update at, or immediately after, each review
- Update RCM as required
- Update all metrics



Design Phase

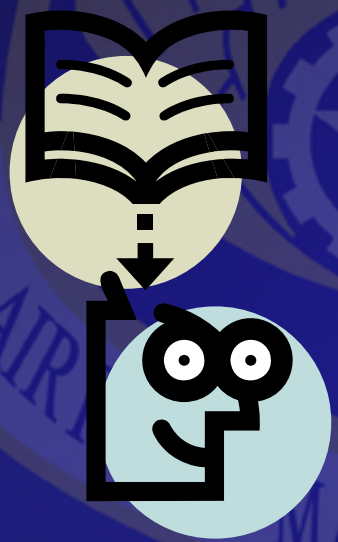
Step 9: Test Readiness Review (TRR)

- TRR required before any formal test
- OI has a clear checklist for TRR
  - Approved test procedures
  - Test scheduled defined
  - Hardware installation complete
  - Software configuration is stable (passed FQT)
  - Support requirements defined and scheduled
  - Test team identified
  - User training integrated
  - Mishap accountability identified
  - Etc.

Execution Phase

Step 10: Test Execution

- Execute the Test
- Document Deficiencies
  - Important to have a formal process
  - Hold deficiency reviews
  - Correct deficiencies
  - Retest the system



Execution Phase

DR Quad Chart

E-4B 1677 MB1 Deficiencies
VHF/FM Red to Black Audio (DRB-139)

Deficiency – Category I

Description
- During transmissions via VHF/FM through the Black Switch w/ the radio in secure mode the signal bleeds over onto the unsecure channel
- Not E-4 unique issue
  - Proposed solution part of s/w release for all fielded radios

Requirement
- Derived security/certification requirements

Exit Criteria
- Transmit via VHF/FM through the Black Switch w/the radio in secure mode without the signal bleeding over onto the unsecure channel

Technical ●

Actions to date
- Identified after the installation of the new VHF/FM radio
  - Issue identified to radio manufacturer (Wulfsberg)
  - Wulfsberg identified a s/w solution
- Minor software anomalies discovered in prototype testing

Way Ahead
- Wulfsberg setting up representative test lab
- Scheduled to complete lab testing by 9 Dec 05
- A/C integration testing scheduled by 16 Dec 05

Technical POC: Jim Barnaby

Funding ●

Funding: Solution covered under warranty

POC: John Smith (E-4 SPO) DSN: 336-2547

Schedule ●

Aggressive: 28 Nov 05
Moderate: 6 Dec 05
Low Risk: 6 Jan 06

Updated 16 Nov 05 CU

Step 11: Test Report and Lessons Learned

- Tests are not snowflakes
- Lessons Learned repository contains:
  - Possible tests to consider
  - Potential test plans
- Repository is not program specific, but for entire organization
- Future plans are to make the lessons learned repository a database with keyword searches

Execution Phase

What's Next



- Continue implementation throughout organization
- Continue Measure/Track results
- Populate Lessons Learned database
- Refine as needed
- Document successes
  - We are having some!

Test Management can be implemented, applied AND make a difference

Summary

- 727th ACSG developed grass-roots means to implement Test Management as part or our Systems Engineering in Sustainment Environment
- Clear-cut, tangible processes steps for the working-level
- Metrics to measure progress for management
- It works

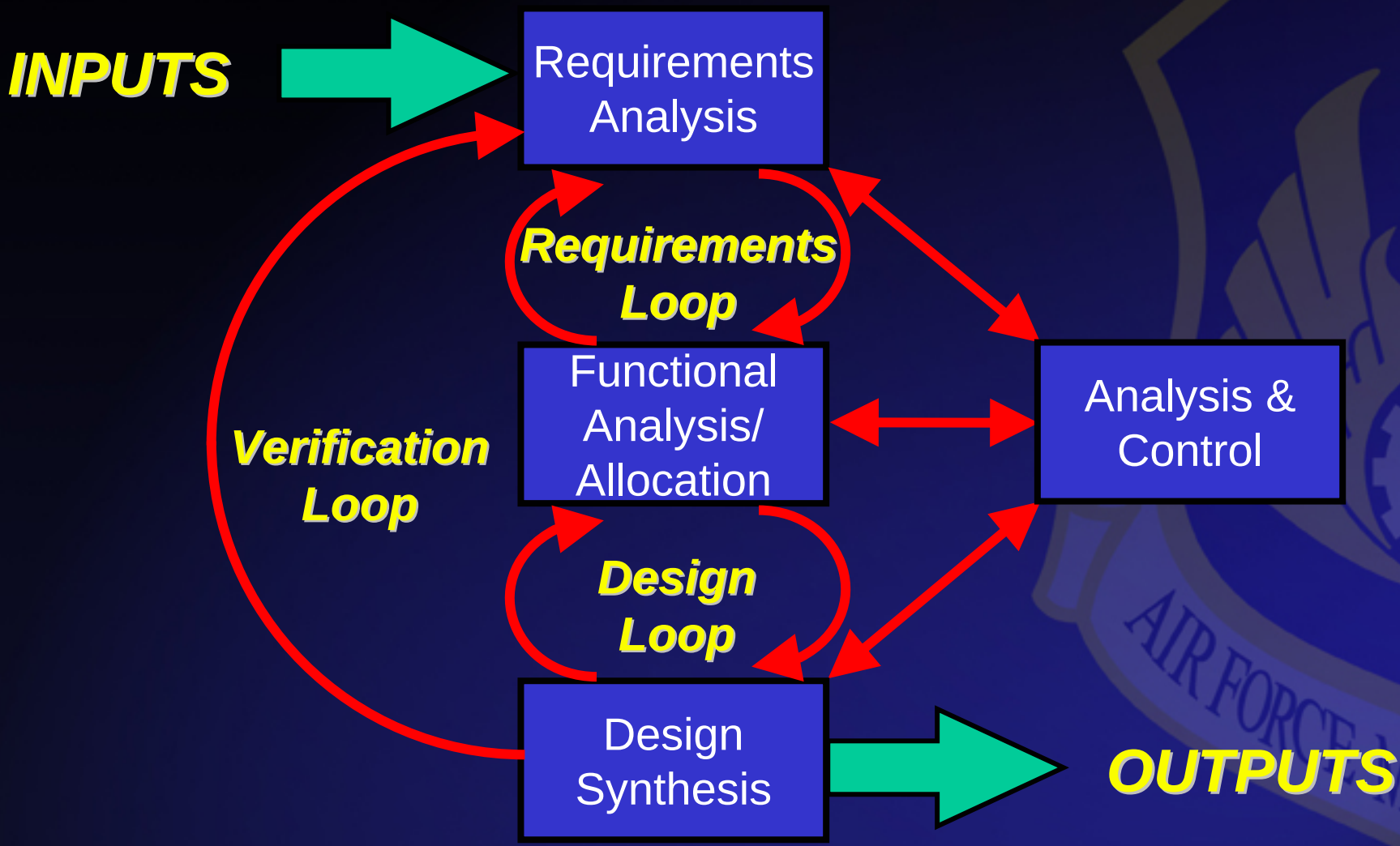


In Place and In Use Now



Questions?

Basic Systems Engineering Process



Agile Governance for SOA-Based Military Systems of Systems

Robert Beck, Jessica Byrnes,
Sue Metzger, and Elliot Sloane
Villanova University

Outline

- Background
- Net Centric operations
- Service Oriented Architecture (SOA)
  - Modeling and Simulation
- Systems of Systems (SoS)
- Co-evolutionary development
  - Agile development strategy
- Governance
  - Agile Governance for SOA (AGSOA)

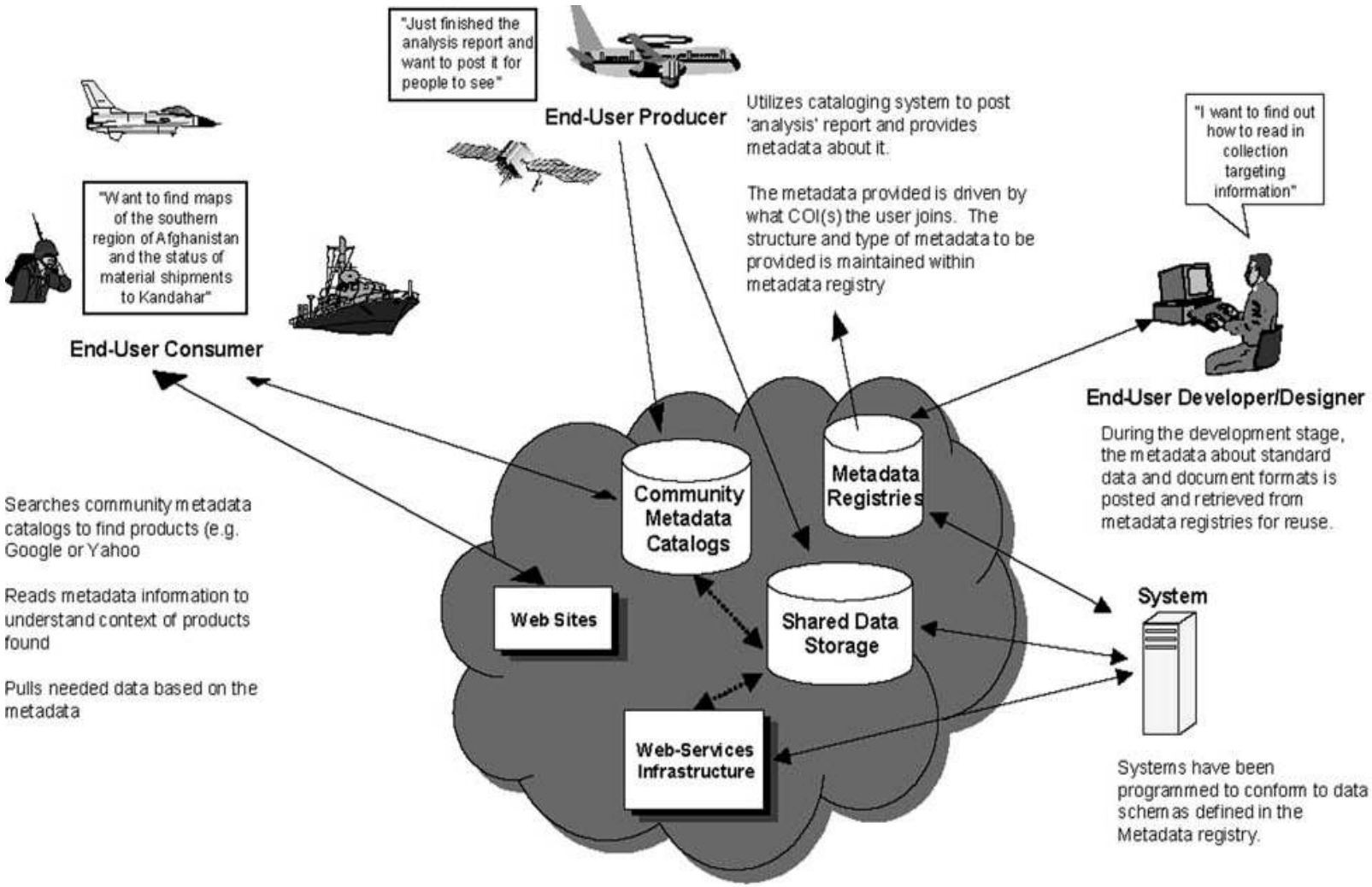
Background

- **ARCES** Program (**A**pplied **R**esearch in **C**omputing **E**nterprise **S**ervices)
  - Research contract: AF ESC to Villanova
- Addresses inhibitors and threats to emerging **SHARED** military IT applications
  - Modeling and simulation
  - Compression
  - Communities of interest; granularity of information
  - Security
  - Strategies for effective co-evolutionary development

Presentation Focus

- Not modeling and simulation
  - Very interesting and successful results
  - Net-Centric Validation Conference
    - September 27-28, 2007 at Villanova
- But ***why*** some Net-Centric warfare developments are not moving as rapidly as expected
- And how to deal with the problem

Net Centric Warfare



Net Centricity → SOA

- Net centricity is evolving to the more fluid service oriented architecture (SOA) based systems

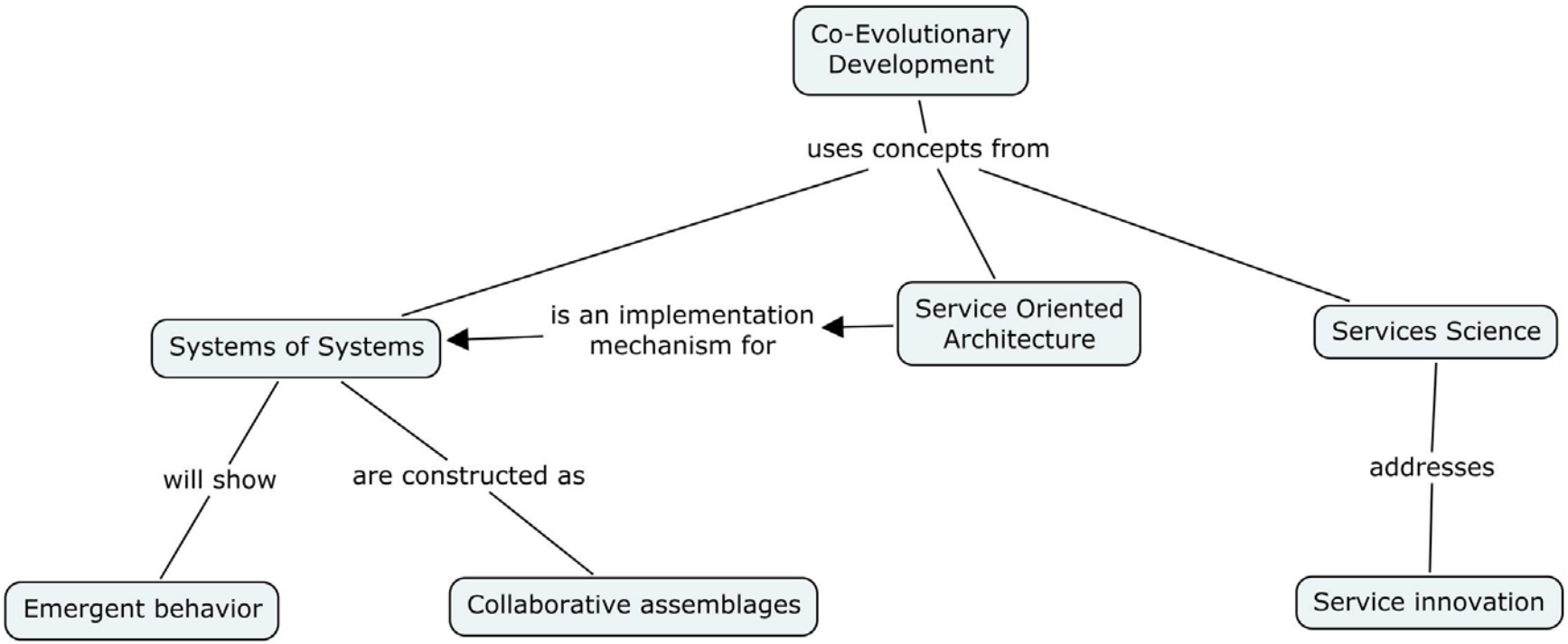
However,

- Net centricity does not imply SOA
  - Can be server to server based
  - Can be client/server based

A SOA Primer

- Naturally systems of systems
- Complex interdependencies
- Require overarching governance structure
  - Better imagined as a foundation
- Distributed development
- Co-evolutionary (multiple overlapping spirals with short time frames)

Understanding Co-Evolutionary Development



A SOA Primer (2)

- Example: Create a delivery tracking and support system through a combination of services
  - Traffic.com
  - Google Earth
  - Mom's Mileage Management (MMMgood.biz)
- *Notes*
  - Delivery service depends on real-time view
  - Shared resource
  - Large number of simultaneous consumers / providers

SOA's Systems of Systems Engineering Challenge

- By definition, SOA systems are
  - interdependent
  - greater than the sum of the parts
- But interdependence creates
  - novel risks to stakeholders
  - especially to service providers
    - difficult to measure and reward performance, value, or blame
    - difficult to troubleshoot
    - difficult to resolve problems

SOA-based Military Systems

- Publish and subscribe paradigm
- Perpetual interdependencies
- AF-ICE (Integrated Collaborative Environment)

Systems Integration Issues

- Complex, multi-owner systems of systems
- Emergent requirements
- Rapid change
- Reused components
- High assurance of qualities of safety, security, reliability, availability, maintainability, performance, adaptability, interoperability, usability, scalability

See references: Barry Boehm, October, 2007

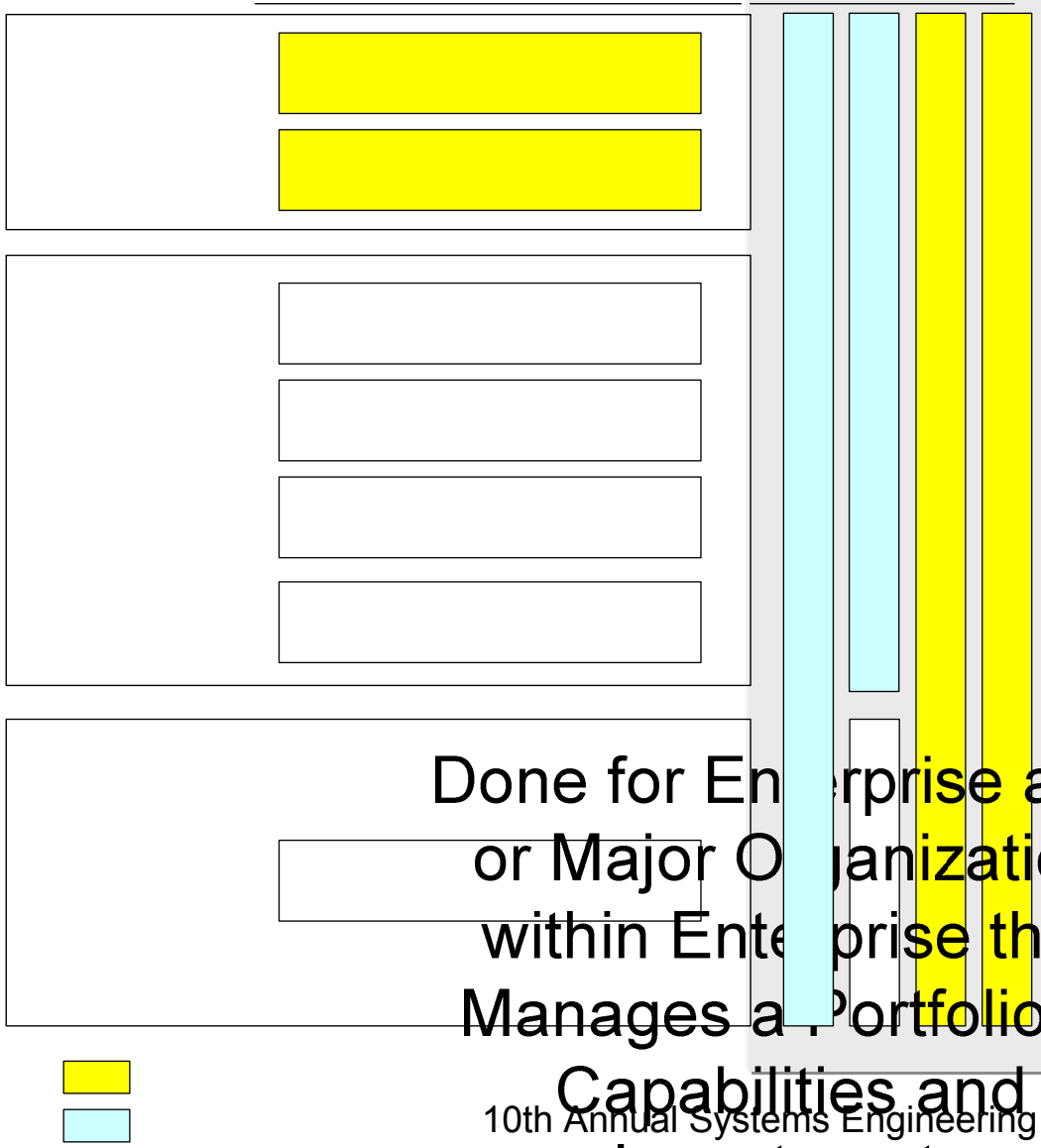
SOA Governance

Actions taken to

- establish
- interpret
- enforce

Rules for

- *development*, which is distributed
- *implementation*, which requires cooperation of many natural competitors (co-opetition)
- *operation*, which depends on services managed by many parties



Governance as foundation

vs.

Governance as supervision

Life Cyc

Federate

Stra

Federated

Arch

Done for Enterprise and/ or Major Organization within Enterprise that Manages a Portfolio of Capabilities and Investments

SOA Governance Challenges/Tasks

- Security infrastructure
- Service versioning
- Service funding
- Co-evolutionary development
- Performance monitoring and load balancing
- Business process re-engineering
- Business continuity planning
- Disaster recovery

Agile Governance for SOA

- Constant incremental change management and improvement in governance actions
- 30-day sprints
- Constant communication with stakeholders
- Stakeholders are:
  - Service providers
  - Large system integrators
  - Small system integrators
  - System users

AGSOA Influence

- Provides rules and services that are constantly being adapted to
  - Changes in technology
  - Changes in customer needs
  - Changes in external environment
  - Changes in the installed and documented base of software

AGSOA

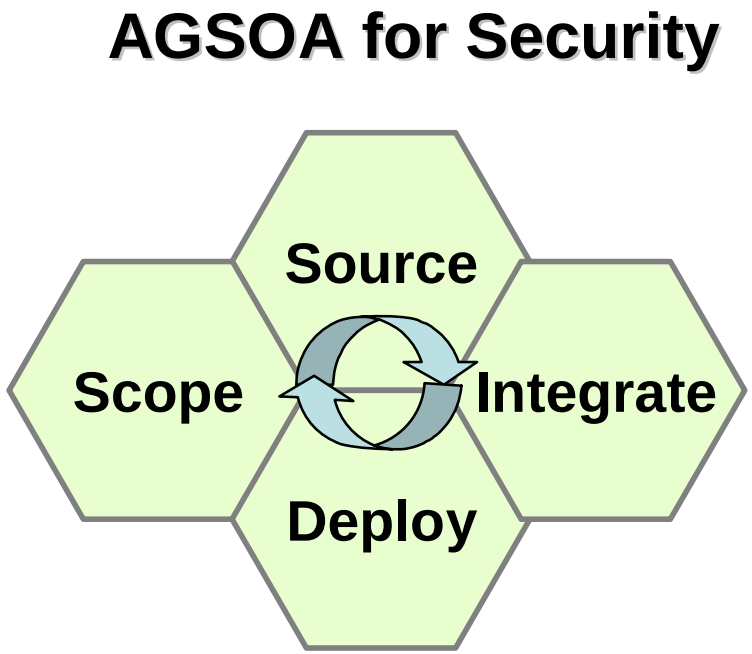
- Governance as a Service
  - to multitude of projects
  - vetting of standards
  - qualifying open source and off-the-shelf systems
- Compare with Software as a Service (SaaS)

Effective Governance Components

- Adaptation to changing social, cultural, technical and business complexities
  - Gmail vs. Hotmail
- Trust management and resolution for stakeholders
  - Intellectual property sharing and valuation
- Conflict arbitration and resolution
  - Reaching agreement on platform releases for widely varied requirements

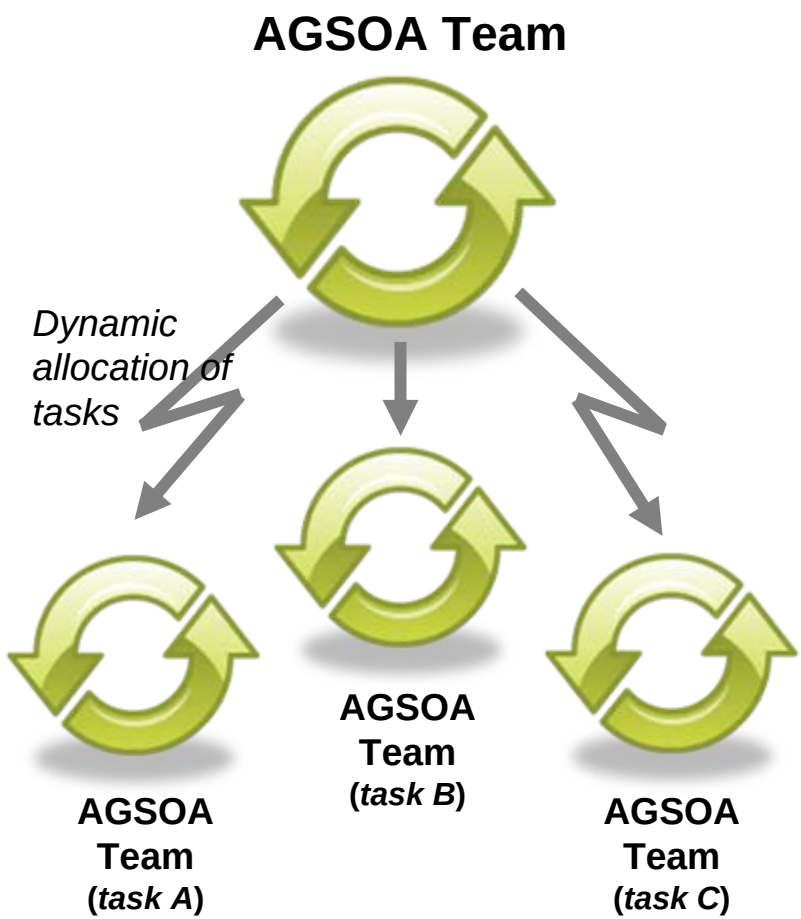
Example: AGSOA for Security

- Sets rules
- Collect metrics
  - for incentives, accountability and risk management
- Contracts services



AGSOA may demand expertise- and resource-sharing across business and technical boundaries

- Multiple simultaneous AGSOA teams likely
- A “super-team” may be dynamically created to solve an interim problem with resources drawn from other teams
- Resources expected to be returned when task is accomplished



Why Agile Governance for SOA?

- Tasks/goals of Net-Centric Warfare are agile
  - to meet rapid enemy re-configuration
  - to seize emergent targets of opportunity
- Traditional SOA Governance (for Retail and Manufacturing) presumes
  - longer time frames (months vs. days)
  - more stable goals
  - better defined rewards

Why Agile (2)

- Agile SOA governance assumes governance tasks, priorities, and resources
  - will be tuned at least as frequently as Net-Centric Warfare goals change
  - will accommodate unexpected technology problems
    - capacity overload
    - patch bugs

AGSOA Examples

- Porting Tri-Services IM and Email to iPhone
  - New contracting (now dealing with Apple)
  - Continuing V&V (responding to frequent iPhone revisions)
- Shifting secure “Munitions on Target” resources to shared SOA platforms
  - Contracting with dozens of contractors for interface design and V&V that affects hundreds of mission critical platforms

AGSOA Governance Services

Examples include:

- Providing contract negotiation across many disparate applications that need to share a common resource
  - Identity management systems, for example
- Integrating large numbers of disparate simultaneous projects and project milestones that cross vendor boundaries but must work together in a SOA system
- Managing shared *Software as a Service* resources to ensure that stakeholders are fairly compensated or charged in an accurate or timely fashion

Different projects will need and consume differing amounts of AGSOA services at differing times in their project lifecycle, centralized and shared for efficiency, but AGILE to meet unique needs.

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NDIA 10th Annual Systems Engineering Conference



Reducing Acquisition Costs Through Incremental Migration to SOA

Presented by
Tim Greer
Lockheed Martin Corporation
25 October 2007



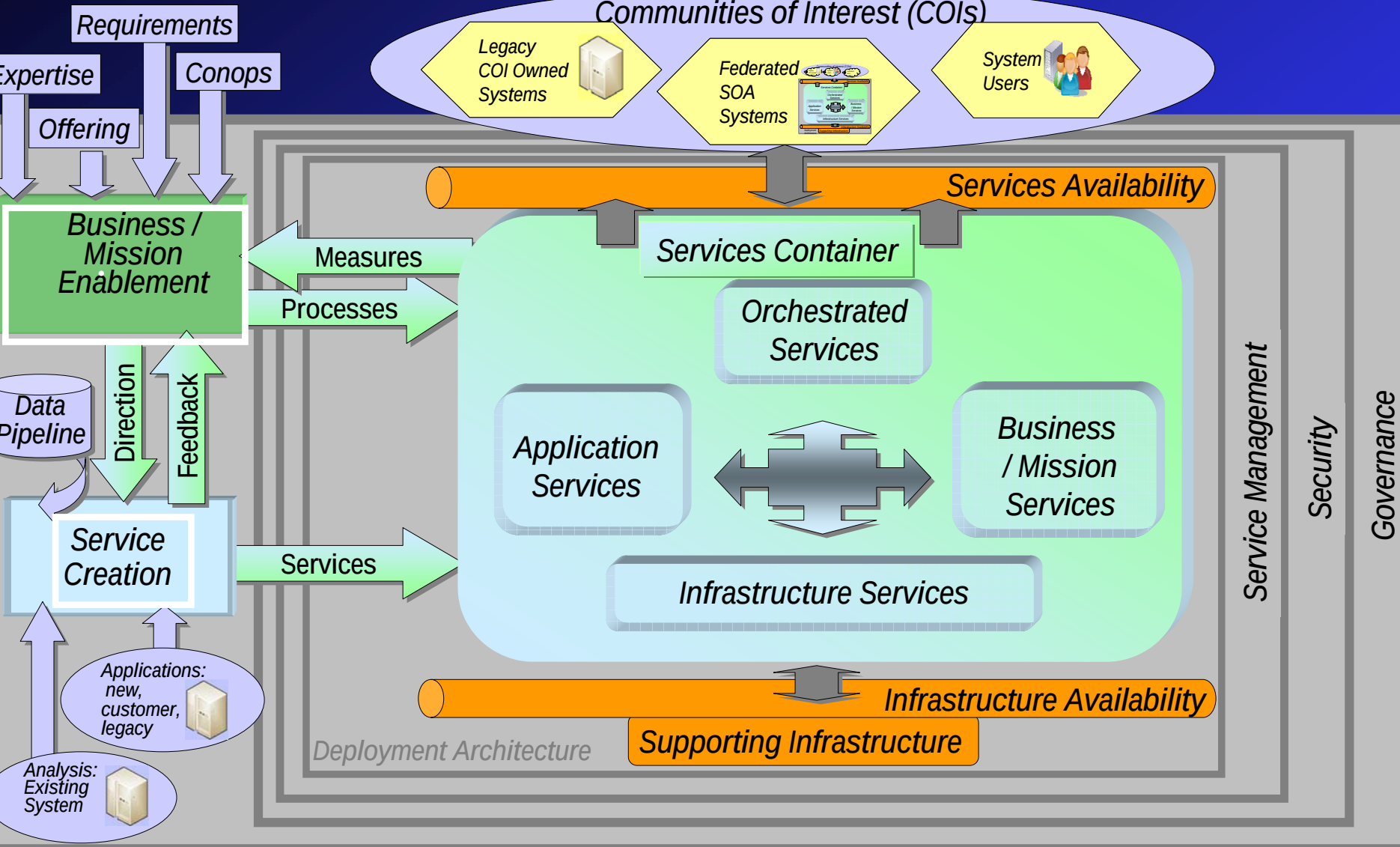
Presentation Outline

LOCKHEED MARTIN

- Overview of Service Oriented Architecture (SOA)
  - Common Reference Architecture
- Methods of migrating from System of Systems PORs to SOA
- Program acquisition costs for migration of POR's to SOA
- Mitigation of acquisition costs
- Program Examples
  - Global Combat Support System – Air Force (GCSS-AF)
  - An Army Program

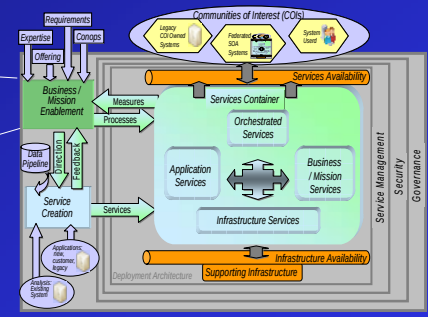
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Common Reference Architecture



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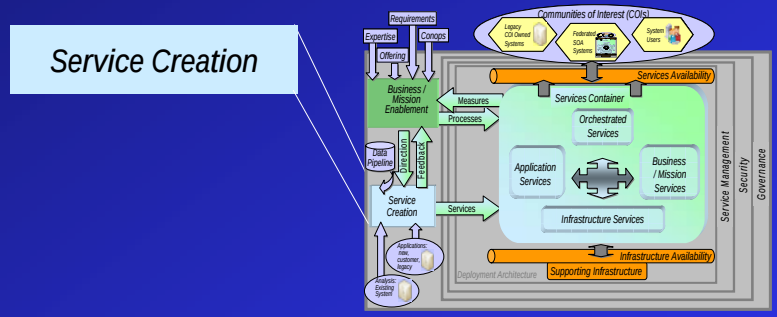
Business / Mission Enablement



- Business or Mission Enablement Element – Supports the definition, modeling, and analysis of services and service-oriented architectures that meet the business / mission needs
- This element of the architecture will be updated as the SOA is in use to optimize the performance of the services for accomplishment of a desired mission
- As new services come online the system will continuously be redesigned to take advantage of the latest technologies being employed.

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Service Creation

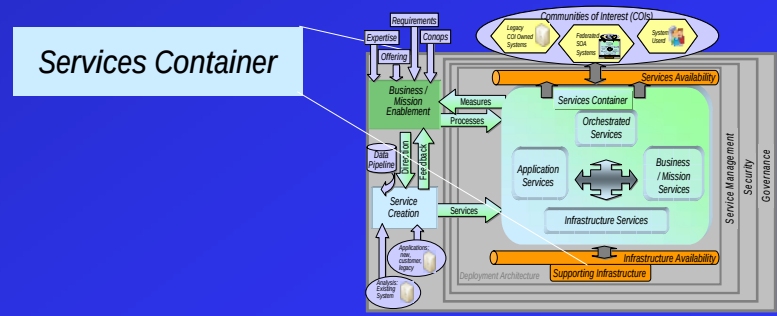


- Service Creation Element - Service creation encompasses the engineering tasks required to develop a new service, incorporate an existing service, or to convert a legacy application into a service

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Services Container

- Services Container Element - Assembly of services based on business / mission enablement processes and supported by an infrastructure framework. Various combinations of services, business logic, and workflow are combined to provide service availability to the COIs

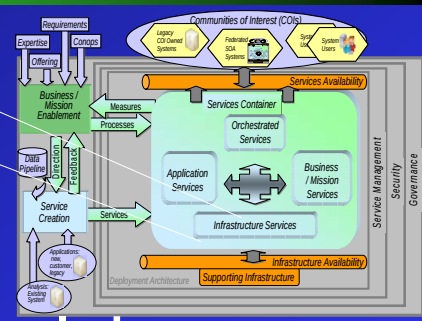


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Infrastructure Services

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Infrastructure Services



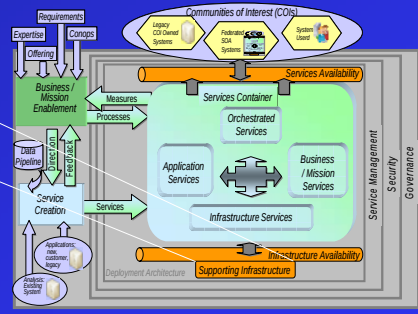
- Infrastructure Services - The basic, underlying services that enable the accessibility, interactions, communications, and runtime operations of a SOA
  - Security
  - Mediation
  - Service Management
  - Information Delivery
  - Discovery
  - Data Management

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Supporting Infrastructure

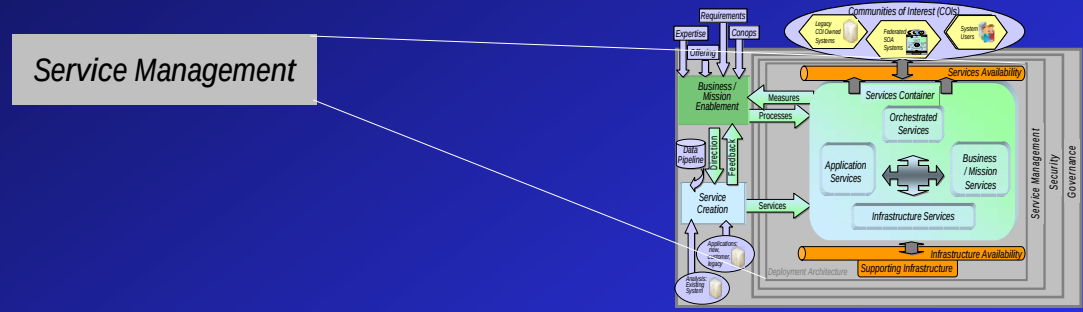
- Supporting Infrastructure - Products and technologies used in the storing, transmitting and utilizing of information that supports the runtime operations of a SOA
  - Service Bus
  - Registry
  - Repository
  - System Management
  - BPEL Engine
  - Collaboration
  - Application Services
  - Web Support
  - Transport
  - Storage

Supporting Infrastructure



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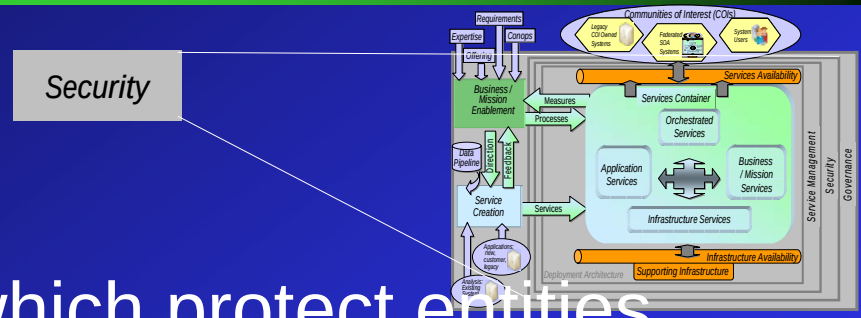
Service Management



- Service Management - Configuring, monitoring, maintaining and managing of services and the service infrastructure
  - Business Activity & Event Monitoring
  - Fault Management
  - Configuration Management
  - Service Level Agreement Management
  - Performance Management

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Security

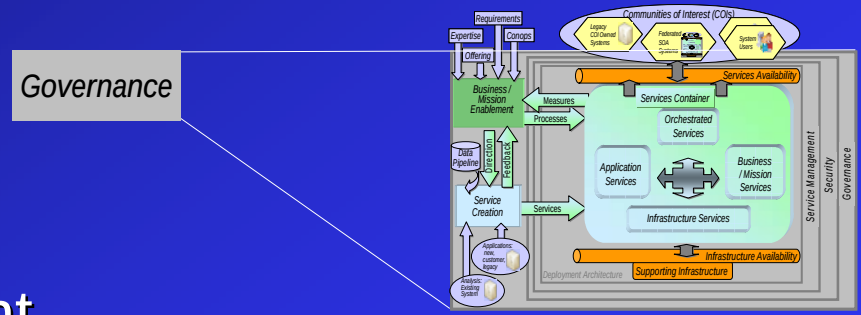


- Security – Mechanisms which protect entities within the SOA environment, including consumer, provider, services and information; and, additionally provide interface between security services from different enterprises
  - Policy Management
  - Assured Information Sharing
  - Availability
  - Network Defense

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Governance

- Governance - Collection and enforcement of policies which the enterprise, services, and data owners must abide by to guarantee success at all tiers of the SOA
  - Design and development practices
  - Technology selection
  - Policy management
  - Contract management
  - Configuration management
  - Release management
  - Runtime management
  - Problem management
  - Change management



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Migration Methods

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- Build Infrastructure – Leave POR in Place
- Build some infrastructure for new services – wrappers on non-SOA components
- Build services for certain components – add infrastructure later
- Wait until infrastructure is in place – build services that work

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Transformation Use Case: Life-Cycle Levels of Integration (LLI) Continuum

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Level 5

Discoverable Services
- Context independence
- Constraints on how Components are built
- Bus-based

Level 4

Interoperable
- Identity Mgmt; Data Exchange; Method Exchange
- Interface Registration Constraints
- Bus-Based Implementation
- Interface Payload Control
- Containers, Connectors

Level 3

Interconnected (All types)
- Local Service Registry becomes Service Proxy
- Hub-based implementation (Runtime Interface Registry; Dispatcher)
- Full SOA Design and Runtime Documentation Required

Level 2

Controlled (Enterprise Configuration Management)
- Still point-to-point
- No hard-coded interface connections
- Common Local Service Registry as a config. file
- Common Interface Design time documentation
- Basic Design time information

Level 1

Specified
- Common Specification Format
- Control over the Service Components Built
- Basic Design-time Documentation
- No control over runtime implementation
- Point-to-point, program-to-program

Level 0

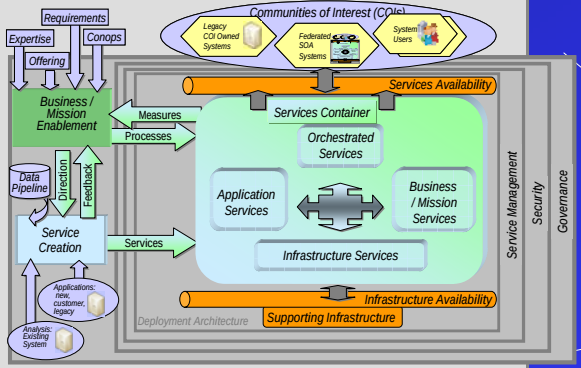
No integrated interface information

- *Integration is a set of enterprise characteristics*
- *These characteristics are additive: Level 5 integration contains Level 4; Level 4 contains Level 3; …*

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Transformation Use Case: Legacy System Enterprise Application Integration

- How does one integrate legacy applications and data?
  - For purposes of this use case assume the following:
    - *Current Enterprise State that is at Level 2 or below on the LLI Continuum*
    - *Program centric Domain expertise & huge legacy portfolio (S/W development)*
    - *Multiple SOA systems; not stovepipe -> reuse opportunity, maturity models, guidelines*
  - Apply integration strategies to system components that meet the criteria



SOA End State *(Legacy-Focused)*

Business Process Management (BPM)
Business Activity Monitoring (BAM)

Presentation (Portal)

Enterprise Web Services Infrastructure

Business Services (Service-Oriented Architecture)
Business Events (Event Driven Architecture)

Community WS Infrastructure

Enterprise Integration Technology

Enterprise Application Integration (EAI)

Data Integration

Legacy System

Computing Infrastructure
(Virtualized and policy based serving, storage, networks, data management, administration)

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SOA implemented at multiple tiers

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Inter-Enterprise SOA Infrastrucuture
(Simpler, looser governance)

Inter-Enterprise Business Services

New Business Applications

Enterprise SOA Infrastructure
(Richer but not pervasive, more governance)

Enterprise Infrastructure Services

Enterprise Business Services

Heritage Business Service I/F

Ind System SOA Infrastructure

Heritage Business Applications

Ind System Infrastructure Services

Ind System Business Services

Enterprise

Inter-Enterprise Business Services

Partner Business Applications

Enterprise SOA Infrastructure
(Richer but not pervasive, more governance)

Enterprise Infrastructure Services

Enterprise Business Services

Heritage Business Service I/F

Ind System SOA Infrastructure

Heritage Business Applications

Ind System Infrastructure Services

Ind System Business Services

Partner Enterprise Y

Multiple Tiers allow incremental SOA advancement

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Software Cost Drivers for Legacy System Migration

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- Operating Systems – upgrades, licensing fees
- COTS Products – licensing fees, maintenance contracts
- DBMS – licensing fees, maintenance contracts
- GOTS Products – upgrade schedule – POM Cycle
- New Development – POM Cycle, JCIDS
- SOA Infrastructure Development

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Mitigation of Software Costs

- Operating Systems – Upgrades, Licensing Fees
  - Consolidation on fewer OS's
- COTS Products – Licensing Fees, Maintenance Contracts
  - Enterprise licensing
- DBMS – Licensing Fees, Maintenance Contracts
  - Data Access Service => Reduce DBMS's
- GOTS Products – Upgrade Schedule – POM Cycle
  - Wrappers Standardize Interfaces
- New Development – New Requirements, JCIDS Process
  - New WS reduce deployment cycle time – Portal may address reqmnts
- SOA Infrastructure Development
  - Tiered architecture reduces initial investment

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Program Examples

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- The following examples show the degree to which the principles discussed thus far have been implemented and how effective these efforts have been to date
  - Global Combat Support System – Air Force (GCSS-AF) – SOA migration project was initiated in 2003
  - An Army Program – Migrating to SOA and scheduled to deploy to Iraq in 2009.

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GCSS-AF

https://www.gcss-af.com/cfs/outreach/index.cfm

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GCSS-AF SOA Journey

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Stage Name	Business Silos	Standardized Technology	Optimized Core	Business Modularity
IT Capability	Local IT Applications	Shared Technical Platforms	Enterprise-wide Hardwired Processes and Data	Plug and Play Business Process Modules
Business Objectives	ROI of Local Business Objectives	Reduced IT Costs	Cost and Quality of Business Operations	Speed to Market and Strategic Agility
Funding	Individual Applications	Shared Infrastructure Services	Enterprise Applications and Data Stores	Reusable Business Process Components
Key Management Capability	Technology-Enabled Change Management	Design and Update of Standards; Funding Shared Services	Core Enterprise Process Definition and Measurement	Management of Reusable Business Processes
Who Defines Applications	Local Business Leaders	IT and Business Unit Leaders	Senior Management and Process Leaders	IT, Business and Industry Leaders
Key IT Governance Issues	Measure and Communicate Value	Global Responsibilities	Align Project Priorities with Architecture Objectives	Define, Source and Fund Business Modules

Source: Architecture as Strategy by Ross, Weill, Robertson, HBS Press, June 2006

https://www.gcss-af.com/noosphere/space/SOA+Journey

Web Page by John Wunder, Lockheed Martin Corporation Copyright 2007

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ROI of Local Business Objectives:

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- ROI is sub-optimized to within program, unit, lifecycle boundaries. Interfaces optimized to specific method needs reducing by bytes size of message while proliferating protocols leading to hundreds of different interfaces on dozens of protocols burdening source systems interface code that is over 70% of their function, causing exceedingly high operations cost and setting up a closely coupled brittle structure that is exceeding expensive to move forward. Each phase of the lifecycle optimizes for itself. Shorter delivery schedules or cheaper product costs are not considered in relation downstream impacts

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Reduced IT Costs:

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- Commoditization of IT Infrastructure Enterprise licenses for software and hardware. Reduced O&S cost through common infrastructure. Reduced assembly cost through eliminating '*botique engineering*'

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Cost & Quality of Business Operations:

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- BEA (DoD Business Enterprise Architecture) eLog21 and other like minded functional initiatives focused on mission processes, people and information and measured success not in lines of code, deliveries or response time but rather in mission effectivenes and asset status, particularly aircraft.

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Strategic Agility:

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- Velocity, Velocity, Velocity was our mantra. It allowed us to make and correct mistakes faster and with the built in feedback we had we consistently moved forward. Have not reached the Chief's vision of changing information flows in hours and days but it is on the horizon.

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Individual Applications:

- We were going to modernize all applications and every modernization was a separate program. 'Silver bullet' approaches program by program. Specific examples were:
  - 1. GOLD for IMDS and SBSS
  - 2. Teradata for FIRST
  - 3. AF Portal for OLVIMS
  - 4. J2EE for CAS
  - 5. Homegrown Portal

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Shared Infrastructure Services:

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- Key here is consistency and communication. Industry and the customer will evolve toward a common definition of the services you provide. You need to have a communication plan that is adaptive enough to adjust but managed enough that there is agreement as to context, content and use of the services you provide. Agreement is way more important than having the right definition. It is way too easy to fall into '*analysis paralysis*' trying to define the essential services. It is way better to evolve a service oriented organization that is always providing better services.

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Enterprise Applications & Data Stores:

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- Major portfolios aligned and individual initiatives were terminated. Whole communities like A4/7 (Old Installations and Logistics) went on bare bones sustainment of legacy systems to free funds for Expeditionary Combat Support Systems. Rigorous funding tied to effect producing capabilities is managed through a hierarchical portfolio process culminating in the Senior Working Group (SWG) which meets once a month with the SecAF and reports status.

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Another DoD Program Migrating to SOA

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SOA Goals

- **Integrated Portal**
  - Create an integrated Portal available to both internal and external users
  - Portal presents both domain-specific and multi-domain JSR 168 compliant portlets
    - JSR 168 promotes capability of using portlets in different Portal frameworks
- **Integrated Data Access**
  - Develop single multi-domain search interface compliant with NCES Content Discovery and DDMS
    - Establishes architecture for integration of NCES compliant data sources and integration of DCGS-A nodes into larger enterprise searches
- **Introduction of SOA Infrastructure Toolset**
  - Commercial Enterprise Service Bus (ESB) used to realize Multi-INT objectives though content-based routing and orchestration of domain services using BPEL 1.1 compliant workflow
    - BPEL compliance promotes capability of porting workflow to different workflow engines
  - Use of UDDI compliant service repository
    - UDDI Repository wrapped in NCES defined services to abstract complexities of UDDI and promote portability to different repository implementations
- **Establishment of SOA Governance Procedures**
  - Government and industry jointly own process for specification and validation of service interface standards
- **Implementation of a Layered DIB Compliant Architecture**
  - User Facing Layer – Portal and Desktop Visualization Framework (MFWS/VIPER)
  - Processing Layer – Service Orchestration
  - Data Layer – Publication of Metadata to DIB MDC for inter-service DCGS interoperability
  - Core Layer – SOA security model based on NCES Security Services

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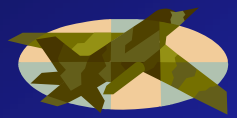


Multi–Tier Architecture

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EXTERNAL USERS



EXTERNAL SOURCES



EXTERNAL SYSTEMS

USER FACING

- PORTAL FRAMEWORT
- CLIENT FRAMEWORK
- STAND ALONE CLIENTS

DOMAIN COMPONENTS

- DOMAIN ORCHESTRATION
- DOMAIN WEB SERVICES
- LEGACY APPS

CROSS DOMAIN COMPONENTS

- CROSS DOMAIN ORCHESTRATION
- CROSS DOMAIN WEB SERVICES

DATA ACCESS COMPONENTS

- METADATA FRAMEWORK
- DATA ACCESS WEB SERVICES
- LEGACY DATA ACCESS COMPONENTS

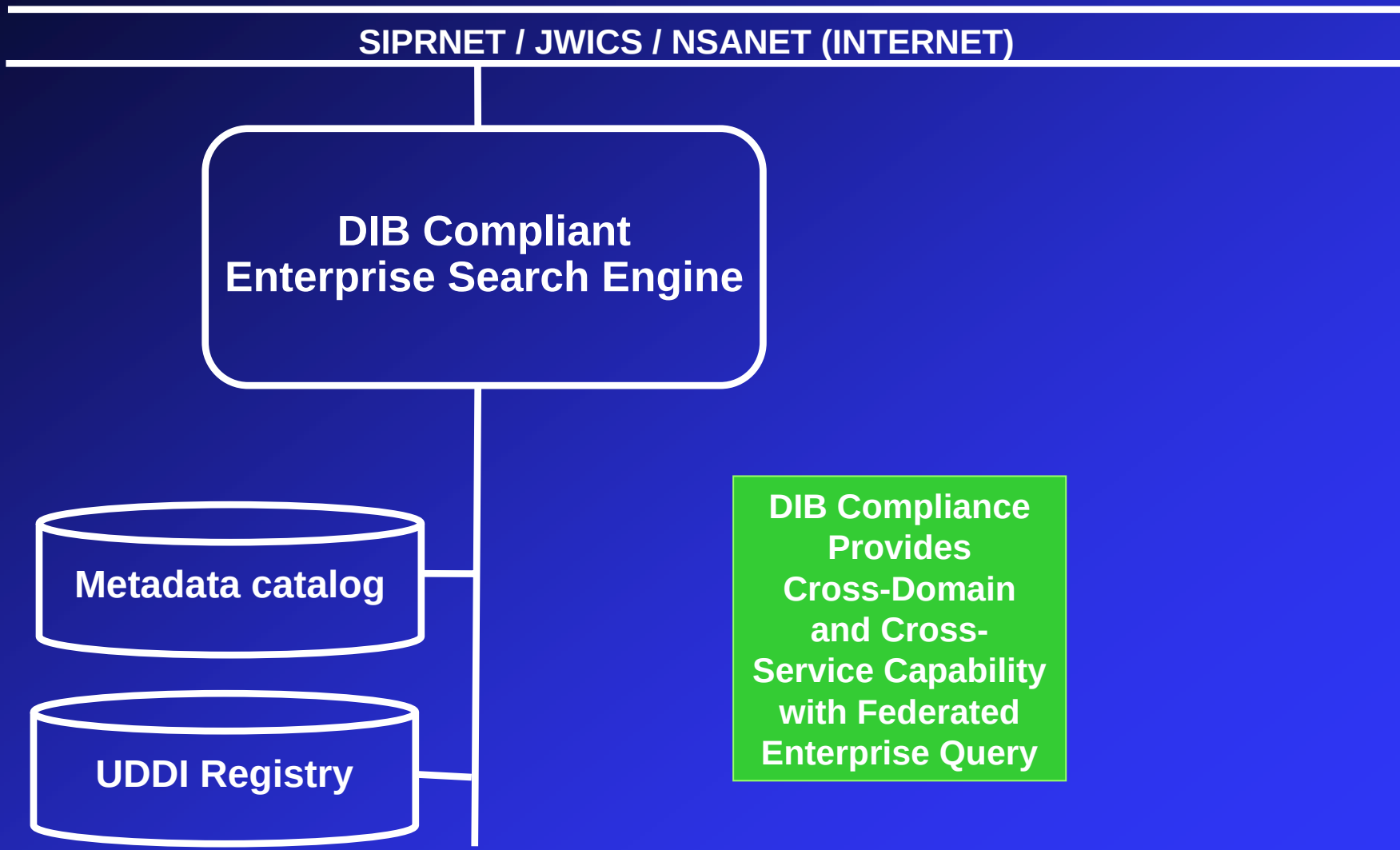
DATA BASES & INFRASTRUCTURE SERVICES

- SECURITY
- DATA MANAGEMENT & INFO EXCHANGE
- SERVICE AND SYSTEM MANAGEMENT

ENTERPRISE SERVICE BUS

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Enterprise Search Capability



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Consolidated Infrastructure

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New Software Components Utilize Common Infrastructure

- **Visualization**
  - Overlay Manager
  - Symbol Manager
  - NRT Viz Stream
  - Intel Folders
- **Information Exchange**
  - Information Gateway
  - Report Manager
  - Message Logger
  - Message Pub/Sub
  - Address Book

  Message Transform
- **Data Management**
  - Metadata Pub/Sub
  - Metadata Discovery
  - User Alert Management
  - Alert Services
  - ISR Data Services
- **Service Management**
  - Service Publish
  - Service Inquiry

SECURITY

ESB

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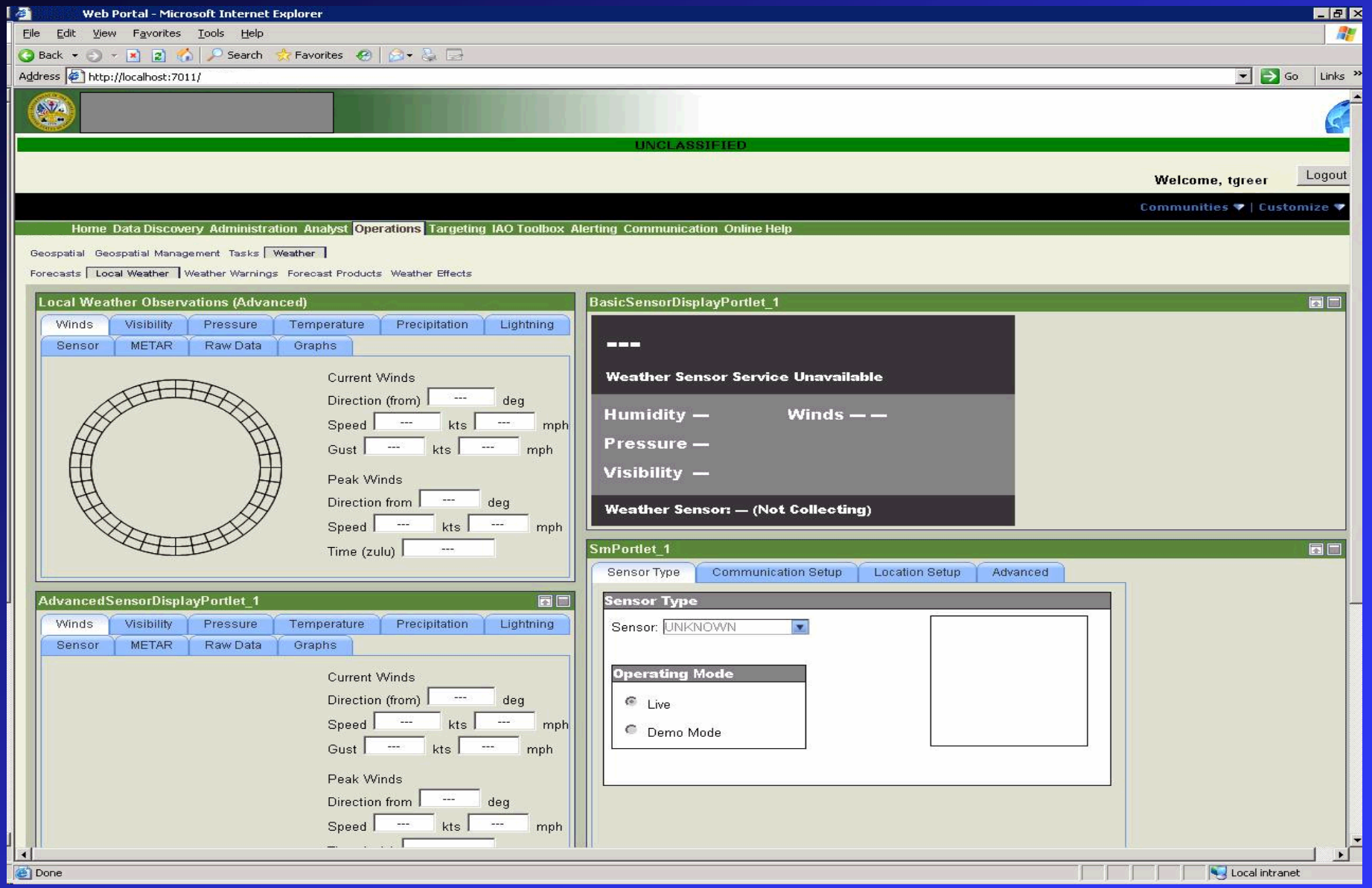
Portal Framework

LOCKHEED MARTIN

- Portal Provides Standard Visualization for Each Domain
- Customizable to the User Profile
- Accessible from Any Workstation on the Network (Including Laptops)
- No Need to Deploy Client Applications
  - New Capabilities Added Quickly
- Maintains Version Control
- Can Realize Some Level of Data Fusion at the Visualization Layer

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Portal Pages



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ESB Use

- ESB used to implement common service orchestration patterns
  - Content-Based Routing
  - Composite Application
- Service Orchestrations implemented to maximize portability
  - BPEL 1.1 used to specify orchestrations (business processes)
  - Use of vendor extensions strictly controlled and documented
  - Transformations into Program Specific Data Model done at Gateway and Data Manager components to minimize dependencies on transformation engines unique to COTS ESB variant
- Caching of UDDI service binding information used to improve performance
  - Implement using Web Service caching technology
  - IBM "*dynacache*" used to cache NCES UDDI Abstraction Services
    - *Redundant UDDI queries returned from cache as opposed to hitting the registry for every query*

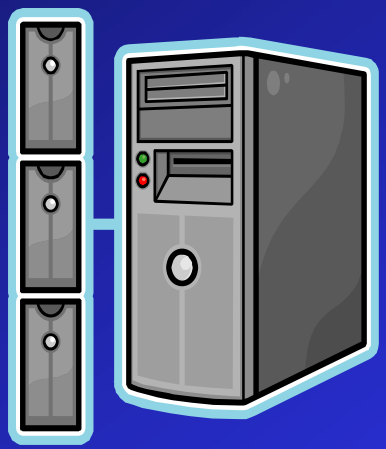
Actions taken to alleviate SOA performance and portability concerns include pushing transformations down into services and implementing web service caching of UDDI interfaces

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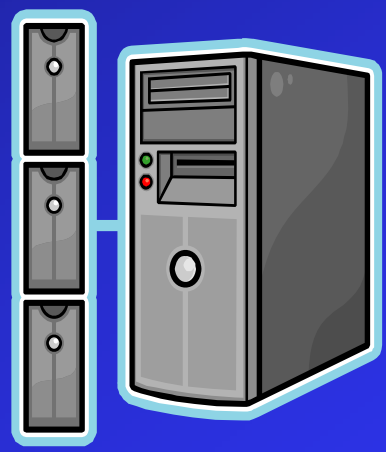
Virtual Machine Ware Reduces HW

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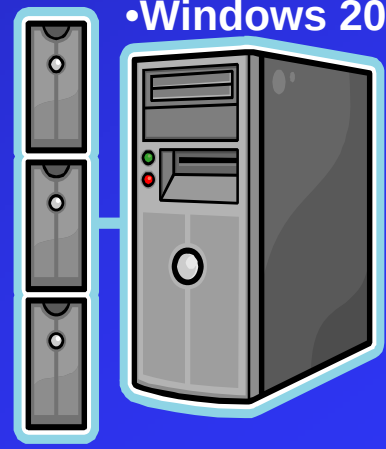
- WebLogic Portal Server
  - •84 Portlets
  - •Log4J
  - •Windows 2003
  - •2 Cores
  - •8 GB



- WebLogic Application Server
  - •Six Web Apps
  - •24+ Web Services
  - •Log4J
  - •Windows 2003
  - •2 Cores
  - •8 GB



- JBOSS App Server
  - •23 Web Apps
  - •Sensor Platform Model
  - •Sensor Platform Model UI
  - •Logger
  - •Saba
  - •AAR
  - •Windows 2003



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More Capability – Fewer Vehicles

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Mobile Unit Transport Requirements

CURRENT

- 14 Vehicles
- 12 Pull Behinds
  - 4 Trailers
  - 7 Power Generators
  - 1 Comms Unit

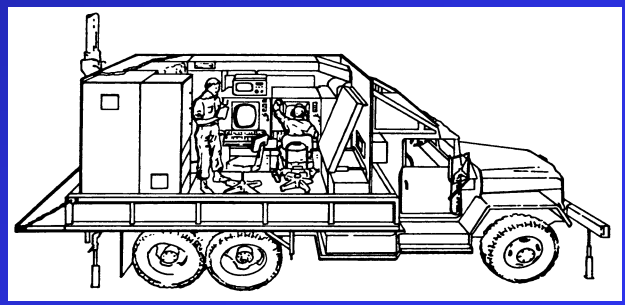
TOTAL = 26 UNITS

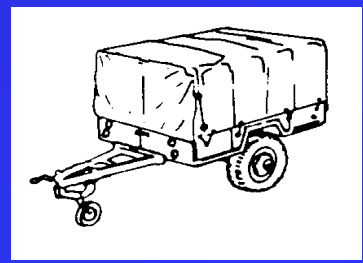
MIGRATED CAPABILITY

- 7 Vehicles
- 8 Pull Behinds
  - 2 Trailers
  - 5 Power Generators
  - 1 Comms Unit

TOTAL = 15 UNITS







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Integration and Test Improvements

- Standards Compliance reduces integration time
  - Automated Test Tools Used to evaluate Web Services for OASIS Standards Compliance
  - Automated Test Tools Used to evaluate Portlets for JSR 168 Compliance
- Web Services reduces integration time by encapsulating the changes to allow late introduction of a capability or removing of a planned capability without incurring compile time errors.
- Reduced regression testing when updates are made to services that do not affect other services
- The focus of the evaluation for accreditation is data centric instead of system centric.

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CONCLUSION

- The initial investment in SOA infrastructure can be reduced through a combination of mitigation techniques
- Migration to SOA can increase capabilities without increasing the overall system footprint
- Initial investment in infrastructure may realize immediate operational benefits
- The anticipated long term beneficial effects of SOA migration are proving to be realized in programs that have made the investment
- Multi-Tier SOA architecture can limit the initial investment and position a program for long term combinatory explosion of capabilities as other programs come online

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Computer Modeling to Solve Problems with the T-38 Propulsion Modernization Program



U.S. AIR FORCE

Presented on October 25, 2007
at the NDIA 10th Annual Systems Engineering Conference
by Randy Wimer
USAF Propulsion Engineer
Co-author: Andy Hall
USAF Propulsion Engineer

Briefing Topics

- Briefing Objective
- Systems Engineering
- T-38 Facts
- T-38 Propulsion Modernization Program (PMP) Background and Hardware Configuration
- T-38 PMP – Three Issues
- Independent Review Team
- Findings:
  - Issue #1 - Engine Bay Overheating
  - Issue #2 - Single Engine Takeoff Speed (SETOS) Performance
  - Issue #3 - J85 Engine Reliability
- Lessons Learned
- Summary

Briefing Objective

Share lessons learned from recent T-38 trainer propulsion modifications

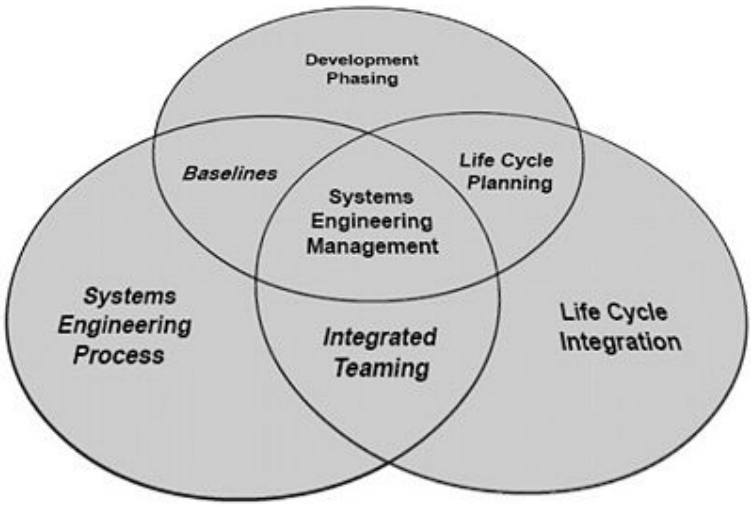
1. Proper systems engineering - early and throughout the program
   - Lack of computer (math) modeling – main tool in solving three unrelated technical problems
2. Integration design authority should be required – both government and contractors
3. Interface Control Document (ICD) should have been used
4. Performance requirements should be included as a contract requirement

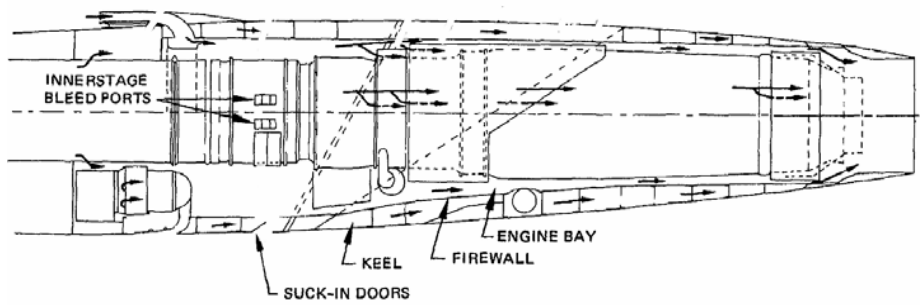
Systems Engineering

- Is an interdisciplinary field of engineering, that focuses on the development and organization of complex artificial systems

- Integrates other disciplines and speciality groups into a team effort, forming a structured development process that proceeds from concept to production to operation and disposal

- Considers both the business and the technical needs of all customers, with the goal of providing a quality product that meets the user needs.





T-38 Facts

- Primary Function: Advanced jet pilot trainer
- Builder: Northrop Corporation
- Engines: Two General Electric J85-GE-5 turbojet engines with afterburners
- Length: 46 feet, 4 inches
- Maximum Takeoff Weight: 12,093 pounds
- Maximum speed: 812 mph (Mach 1.08 at sea level)
- Range: 1,093 miles
- Date Deployed: March 1961
- Production ended: 1972
- USAF Inventory: ~500 (More than 1,100 were delivered to the US Air Force)
- National Aeronautics and Space Administration uses T-38 aircraft as trainers for astronauts and chase planes on programs such as the space shuttle

T-38 Propulsion Modernization Program Background

- Managed by Ogden Air Logistics Center (OO-ALC) at Hill AFB

- 10 Year Contract 2001-2010

- Engine upgrade kit, inlet, ejector

- Aircraft modification at Randolph AFB
  - About 1/3 of USAF fleet modified when independent review team was formed in August 2005
- Government changed ownership and organizational structure 3 times (to date)

T-38C Talon

PM and EN Authority: OO-ALC

PMP Integration: OO-ALC

PMP Ejector

Developed: GE, Builder: GE

PM Authority: OC-ALC

EN: OO-ALC

Installation: LSI

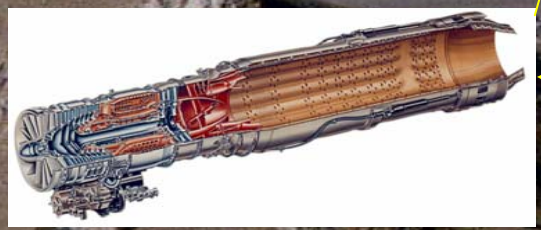
PMP “Fat Lip” Inlet Mod

Developed: NASA

Builder: CPI

PM/EN Authority: OO-ALC

Installation: LSI



PMP J85-5R Engine

Developed/Manufactured: GE

Engine PM: OC-ALC

Upgrade Kit PM: PRSS (Contracting)

EN: OC-ALC

Installation: Laughlin/Columbus AFB

PMP Inlet



GE-J85-5R PMP Engine Kit

← **Green Box = USAF PMP Sub Kits**

Spooled Rotor
Complete Set of Blades
Stage 8 Static Seal

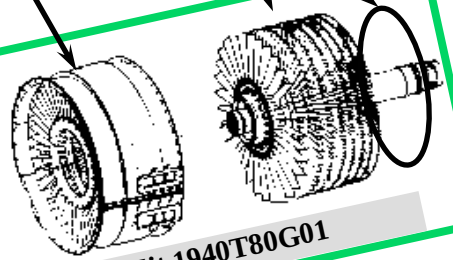
Cast Mainframe
Inco Material

Combustion Liner Assy
Longer Life

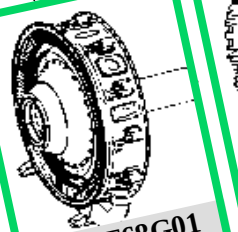
Turbine Casing
Stage 1 & 2 Nozzles,
Shrouds &
Split-line Hardware

Stator Casing (AM355)
Inco Vanes
Split-line Hardware

CDP Seal



Kit 1940T80G01



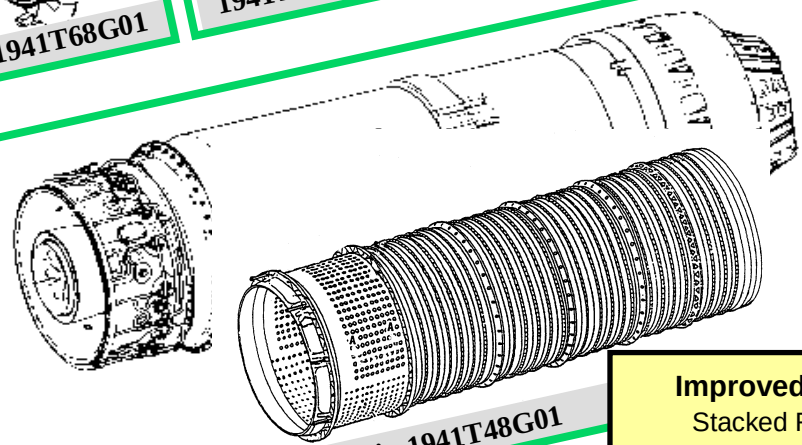
1941T68G01



1941T69G01



Kit 1941T49G01



Kit 1941T48G01

Improved Afterburner
Stacked Ring AB Liner
VEN Leaves
AB Casing Finger Seals

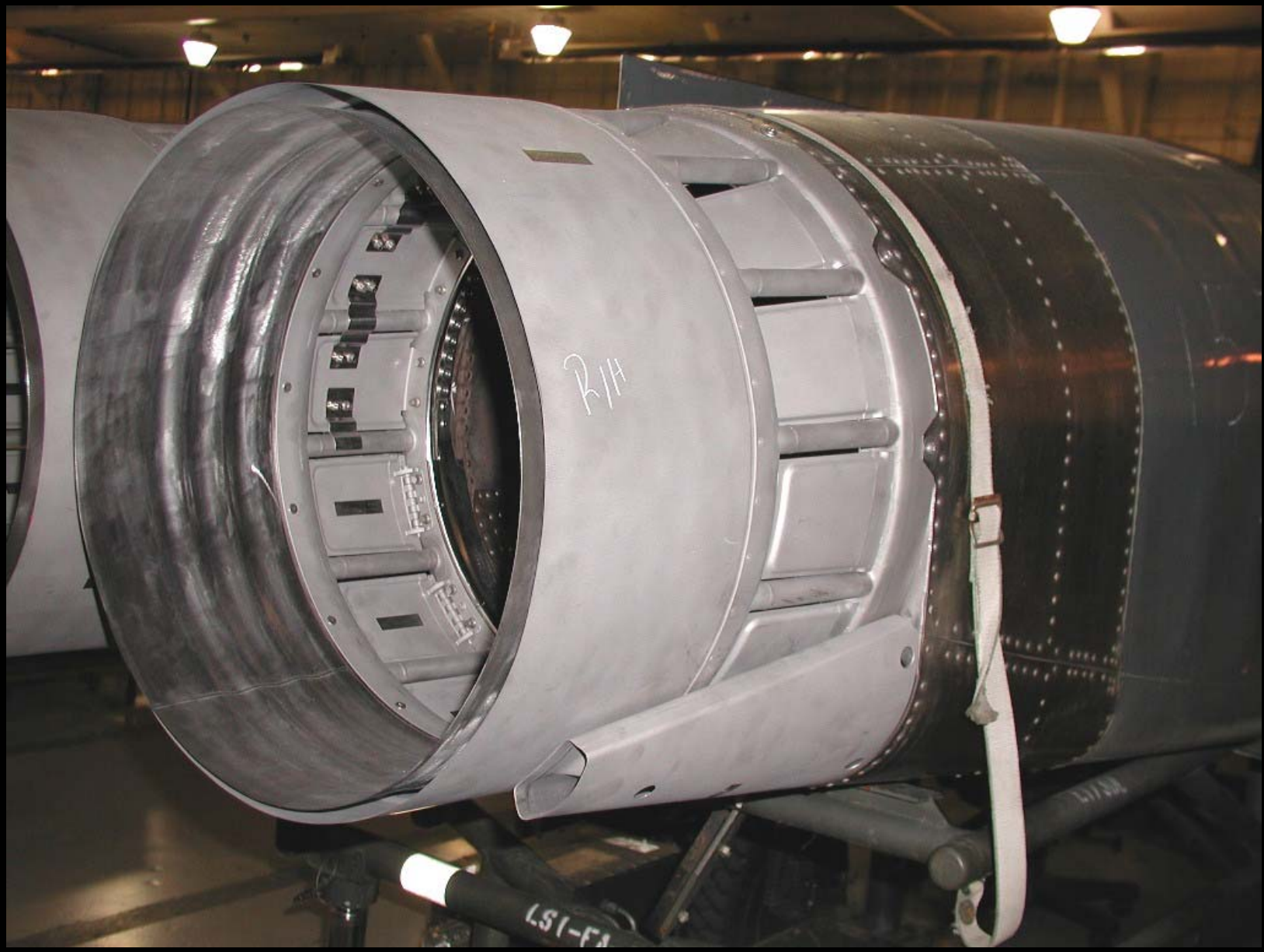
Ignition Electrical System
Exciter, Main & AB Plugs & Leads

Kit 1941T47G01

J85 PMP Engine



PMP Ejector Nozzle



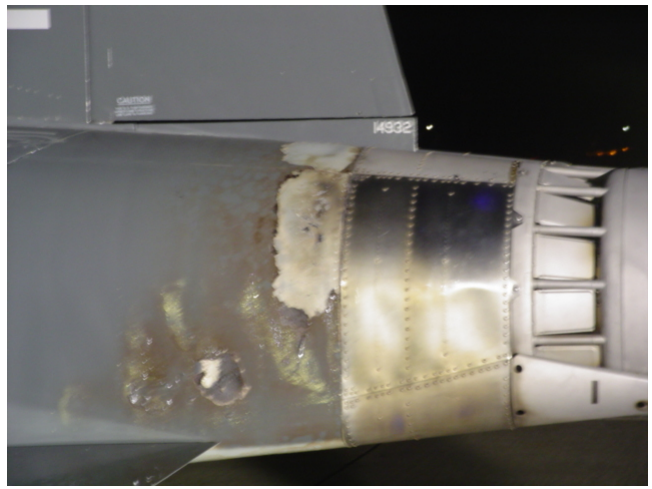
T-38 PMP Upgrade Hangar at Randolph AFB



T-38 PMP Issues

- Three issues arose during initial deployment of PMP aircraft

1. Engine bay overheating



2. Single Engine Takeoff Speed (SETOS) Performance

3. Modified engine did not meet 230 hour Mean Time Between Removals (MTBR) requirement

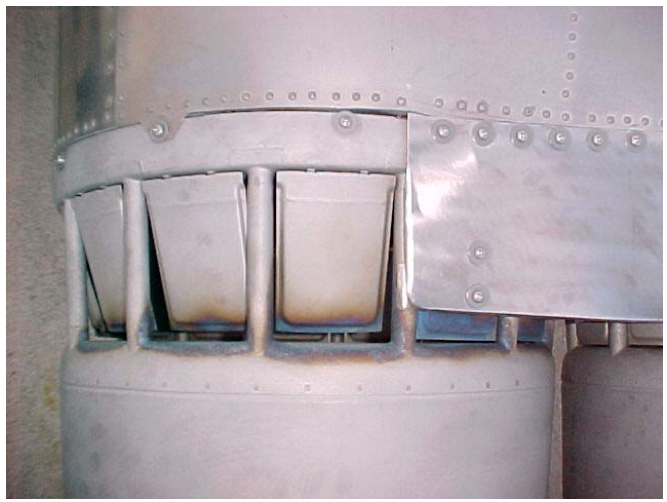
Independent Review Team

- T-38/J85 IRT (Independent Review Team) formed in August 2005
- Composed of ten USAF senior engineers
  - Support from NASA and contractors
- Purpose was to help solve technical issues with T-38 PMP
- Team held periodic reviews and site visits to GE, Hill AFB, Laughlin AFB, Randolph AFB, and Edwards AFB
- IRT wrapped up in early 2007

T-38 PMP Issue #1– Engine Bay Overheating

- Two issues: Cockpit engine fire lights and engine bay overheat events
  - 8 Ground Occurrences
  - 32 In Flight Occurrences – all on functional check flights (FCF)





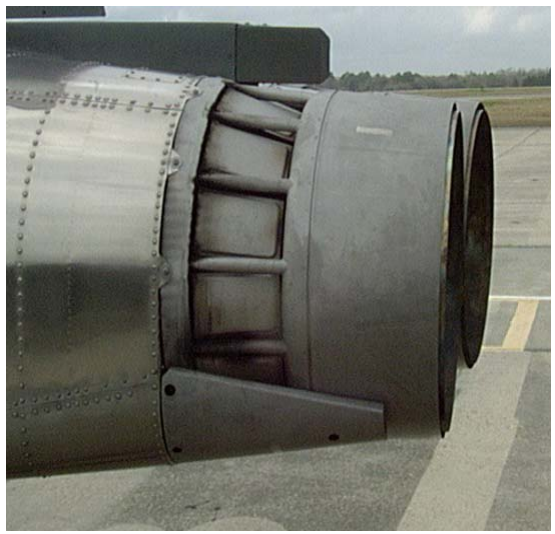
Engine Bay Overheating Cause

- PMP introduced a new inlet and ejector that reduced cooling airflows in engine bays and in keel cooling spaces. This decreased the tolerance of the system to heat-elevating conditions.

Modified ejector



T-38A



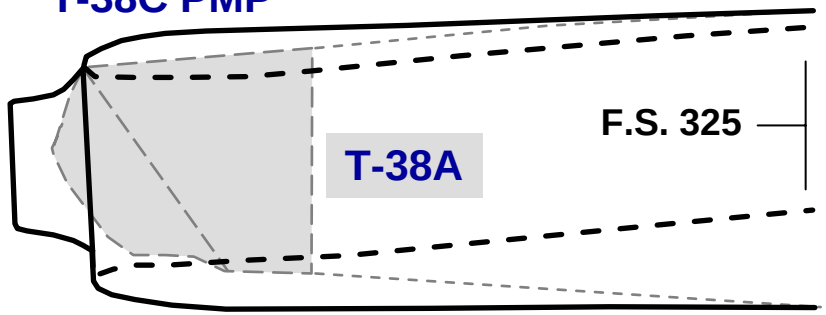
T-38C PMP

T-38A / T-38C Inlet Comparison





T-38C PMP



T-38A



T-38C PMP



From T-38A to T-38C:

- + 15% capture area
- + 5% throat area

T-38 Boat Tail



Engine Bay with Boat Tail and Engines Removed



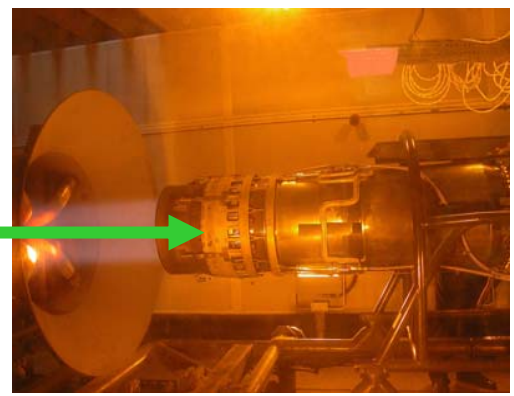
Engine Bay Overheating Findings

- No Single Solution, No Smoking Gun

- System Problem With Multiple Contributions

  - New ejector reduced engine bay cooling airflow
  - New inlet reduced keel cooling airflow
  - Hot air leaks around Variable Exhaust Nozzle (VEN) assembly compounded problem
  - Engine bay cooling degraded over time due to old aircraft (“tired iron”) – several leak paths
  - Part to part variability
  - Air framer not initially involved

Hot leaks forward of VEN housing

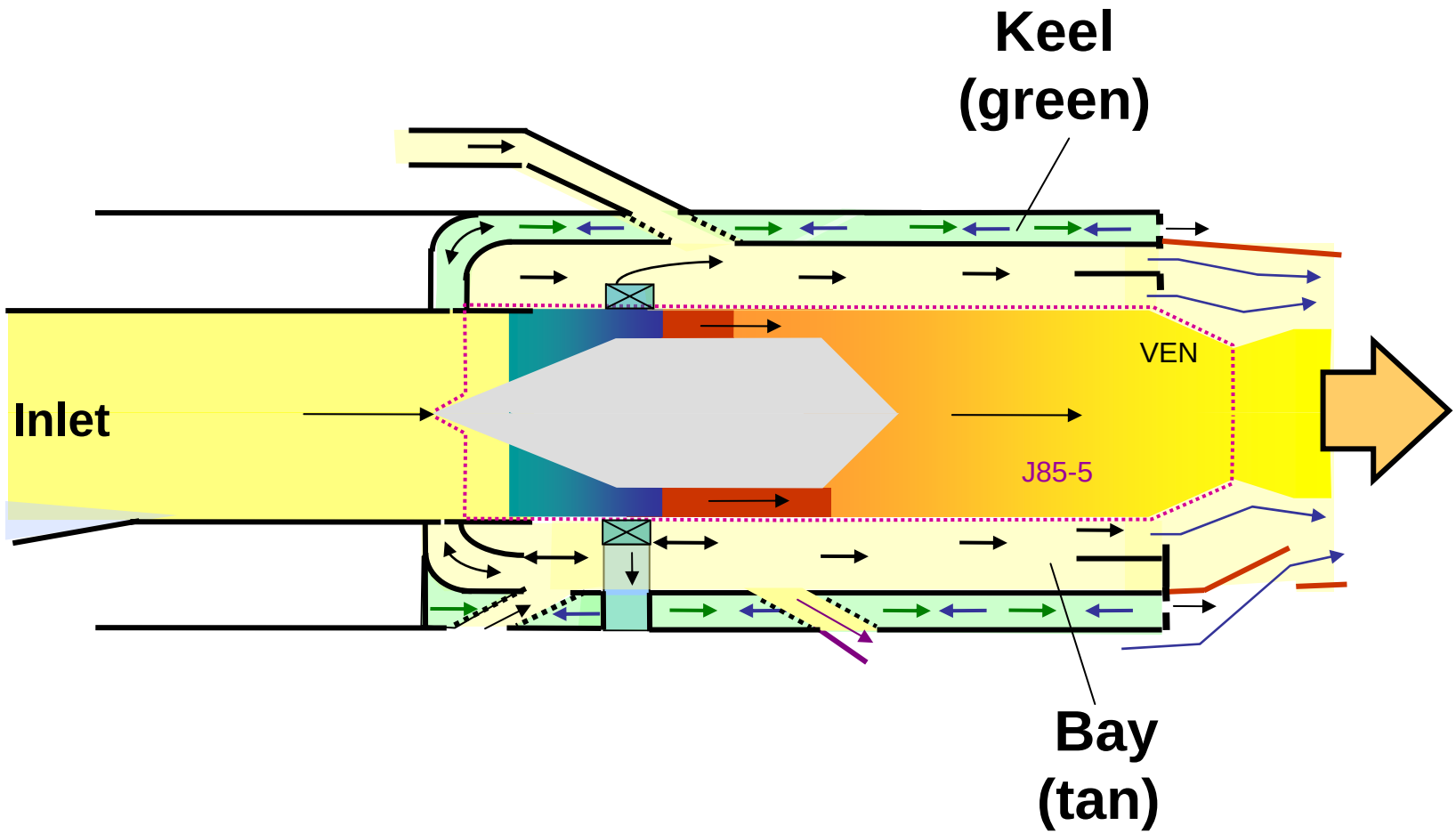


T-38 Boat Tail (Old hardware!)



Engine Bay and Keel Space

Blue arrows indicate keel airflow reversal under certain conditions



Engine Bay Overheating Approach

- Ground test program – collaborative NASA/USAF/GE effort
  - Aircraft Configuration Effects
  - Engine Variability Effects (VEN Leaks)
- Flight test program at Edwards
- Aero-thermo modeling

IRT Engine Bay Overheating Recommendations

- Validate thermal model in order to determine optimum solution
  - Operational solutions (i.e. different FCF profile) need to be evaluated first and design solutions second
- Recalibrate trigger temperature for fire warning system
- Separate fire safety concerns vs overheat concerns
- Fire safety needs to be determined from validated model and design standards

T-38 PMP Issue #2 - Single Engine Takeoff Speed (SETOS) Performance

• Problem: Lack of confidence by operator that PMP performance threshold was being met

• Operational Requirements Document (ORD) Requirement for hot day takeoff performance: Allow takeoff (12,500lb T-38 with no wind and 1,000 ft pressure altitude at Randolph AFB) at:

8 degrees F hotter (threshold)

12 degrees F hotter (objective)



What is SETOS?

- SETOS = Single Engine Takeoff Speed

- The faster of 2-engine takeoff speed

OR

- The speed at which a T-38 should climb at 100 feet per minute
  - Out of ground effect
  - Flaps extended 60 percent (takeoff flaps)
  - Landing gear extended, gear doors closed
  - One engine at MAX, the other windmilling

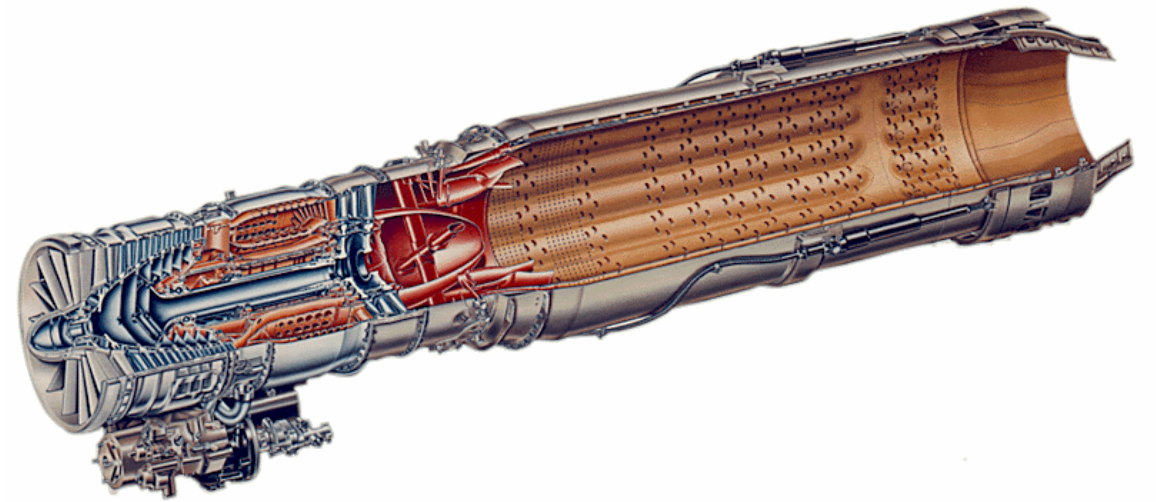
T-38 PMP Issue #2 - Single Engine Takeoff Speed (SETOS) Performance

- Physics:
  - PMP inlet has improved inlet recovery at takeoff conditions
  - Initial flight testing and data analysis did not adequately verify improvement (inadequate modeling)
  - Initial contractor model could not be calibrated
  - Edwards AFB created a performance model and conducted more flight test, verifying the takeoff thrust improvement
  - No wind tunnel testing done
  - Measured thrust minus drag acceleration in flight testing and engine model – used to develop and validate the full scale aircraft drag polars
  - Aircraft performance models included not only engine net thrust but also inlet recovery, boat tail drag, inlet spillage drag, and secondary airflow ram drag and their engine power setting dependencies

T-38 PMP Issue #2 - Single Engine Takeoff Speed (SETOS) Performance

- Model:
  - Updated USAF aircraft performance model
  - Confirmed new model's ability to predict takeoff performance
- Flight test data and analysis show SETOS requirements met or exceeded
- Findings:
  - ORD requirement to improve hot day takeoff performance has been achieved. Improved threshold by 17 degrees F
- IRT also recommended that contractor create up to date aircraft performance model for T-38C PMP aircraft configuration

T-38 PMP Issue #3 - J85 Engine Reliability



J85 engine did not meet 230-hour Mean Time Between Removals (MTBR) Operational Requirements Document (ORD) threshold

- Constant at 155 hours
- PMP upgrade focus was meeting maintenance intervals and shop cost reduction
- Will never get to 230 hours without additional work (never put on contract)
  - -- Engine controls not improved
- Maintenance model did not exist

T-38 PMP Issue #3 - J85 Engine Reliability

- USAF did not include MTBR requirement on GE contract
- Root Cause:
  - PMP engine MTBR currently same as legacy engine
  - Majority of removals are Unscheduled Engine Removals (UERs) - 86%. Top UER drivers are accessories and quick engine change (QEC) items (e. g. fuel flow transmitter)

Findings - J85 Engine Reliability

- Solution: A J85 maintenance model was Applied to the J85 engine
- Recommendations:
  - Replace gear boxes with rebuilt units which have fuel pumps and fuel controls with design improvements
  - Improve igniter system
  - Implement ASAP to maximize return on investment
  - Investigate use of contractor performance base logistics (PBL)

Lessons Learned

1. Proper systems engineering early and throughout the program
2. Integration design authority should be required
3. Interface Control Document should be used
4. Performance requirements should be included as a contract requirement

Lessons Learned

5. Use of computer (math) modeling
   - Modeling did not exist for all 3 issues
     -- Engine Bay Flow - model created
     -- SETOS - model used to extrapolate flight test results
     -- Engine Reliability – Existing model applied to J85 engine
   - Airplane designed over 40 years ago
     -- Updated models needed
     -- Part variability

Summary

- USAF did not use adequate systems engineering for T-38 PMP
  - Five major lessons learned
- IRT formed to assist in solving three technical issues
- PMP continuing to upgrade T-38 trainers

T-38C





Generic Sensor Model

Stanley N. Hack, D.Sc.
Keith Josef, Ph.D.
Philip Nation
Vinay Shah
Paul Juckiewicz
Yena Park
Jeri Anne Moses
Bradly Pietras
Walter Osadciw

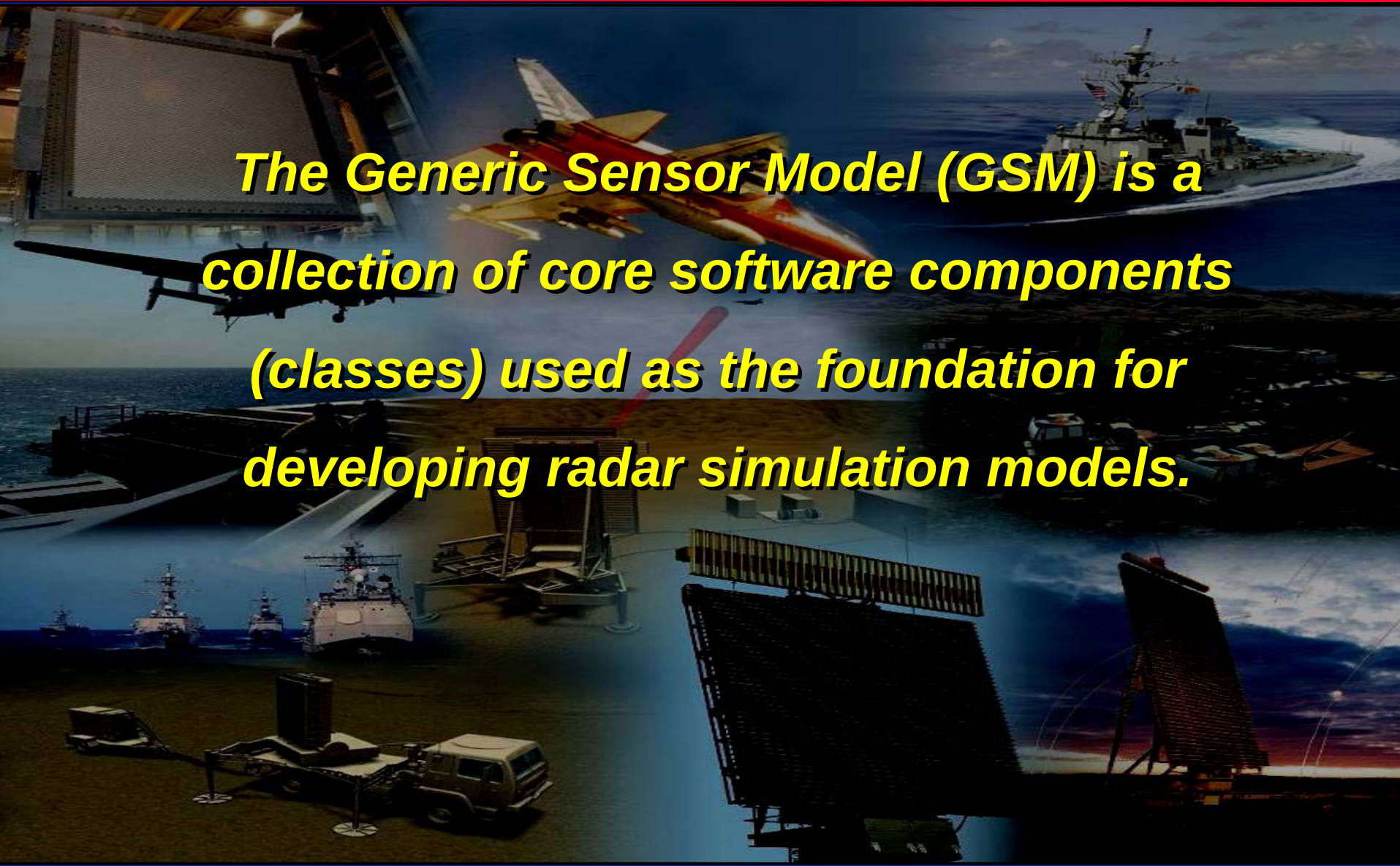
25 October 2007

LOCKHEED MARTIN

MS-2 Radar Systems
Syracuse, New York

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Generic Sensor Model (GSM)



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Generic Sensor Model (GSM)

OVERVIEW

- *Model Description*
- *Operating Modes*
  - *Stand-Alone*
  - *System-of-Systems*
- *Model Components*
- *Model Flow*
- *Model Flexibility*
  - *Extensibility*
  - *Changeable Components*
  - *System Adjustable Parameters*
- *Analyses*

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Generic Sensor Model (GSM)

The Generic Sensor Model (GSM) is a collection of core software components (classes) used as the foundation for developing radar simulation models.

MODEL UTILITY

- ***Scenario Testing***
- ***Algorithm Testing and Comparison***
- ***Interoperability Evaluation***
- ***Mission Planning***

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Generic Sensor Model (GSM)

The Generic Sensor Model (GSM) is a collection of core software components (classes) used as the foundation for developing radar simulation models.

FEATURES

- ***Event Driven***
- ***Parameter Based***
- ***Scalable***
- ***Modular***
- ***Extensible - Uses Object Oriented Design (C++ based)***
- ***Can Incorporate Tactical Software***
- ***Can be Incorporated into system-of-systems environment (High Level Architecture (HLA) interface)***
- ***Fidelity - configurable from low to high***
- ***Unclassified***

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Generic Sensor Model (GSM)

The Generic Sensor Model (GSM) is a collection of core software components (classes) used as the foundation for developing radar simulation models.

COMPONENTS

- *HLA Interface*
- *Beam Scheduling*
- *Ray Trace Beam Propagation*
- *Detection Processing*
- *Tracking*
- *Cueing*
- *Communications*
- *Data Logging*
- *Dynamic Environment (Atmosphere, Weather, clutter)*
- *Terrain maps (DTED)*

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Generic Sensor Model (GSM)

The Generic Sensor Model (GSM) is a collection of core software components (classes) used as the foundation for developing radar simulation models.

OPERATING MODES

Stand-Alone Mode

- *All inputs via XML and data files*
- *All outputs to log files*
- *Operates on a single Windows™-based platform*

System-of-Systems Mode

- *HLA federated configuration*
- *Operates in Lockheed Martin's Integrated Missile Defense Testbed (IMDT)*

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Generic Sensor Model (GSM)

Integrated Missile Defense Testbed (IMDT™)

IMDT Addresses All Phases of BMDS Mission

1. *Plan the Battle* – *Integrated Defense Planner (IDP)*
2. *Fight the Battle* – *IMDT Federation*
3. *Assess the Battle* – *Post-Simulation Analyses*

IMDT Provides Accurate BMD Planning, Performance And Evaluation Support

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Generic Sensor Model (GSM)

Integrated Missile Defense Testbed (IMDT™)

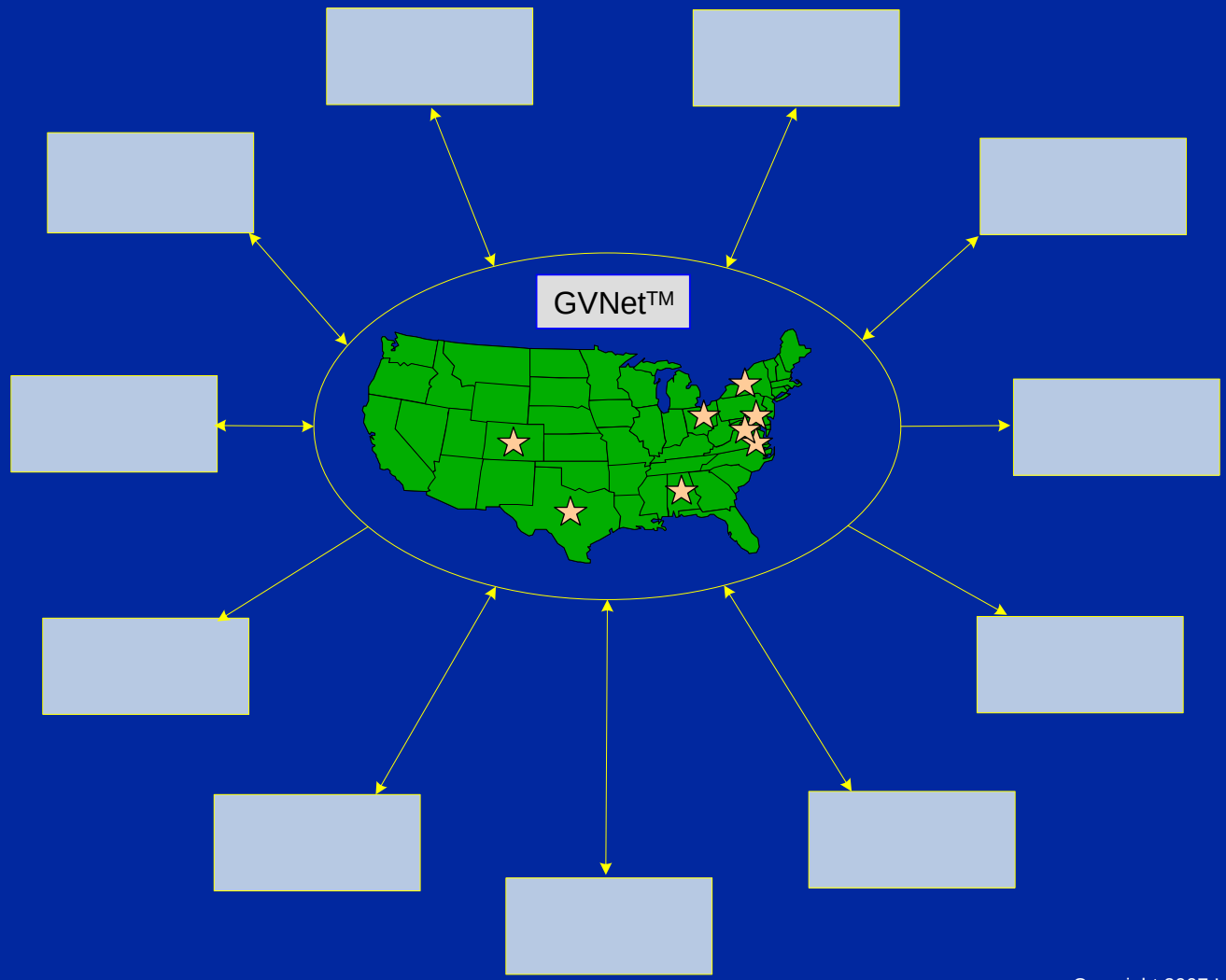
IMDT Federation

- *Distributed high-fidelity system-of-systems modeling and simulation testbed for BMD*
- *HLA and the GV-Net™ allow distribution of the simulation models to their developers' (subject matter experts') locations*
- *Includes sensor, weapon systems, communications, and C2BMC high-fidelity models. System controller, analysis suite, and visualization.*

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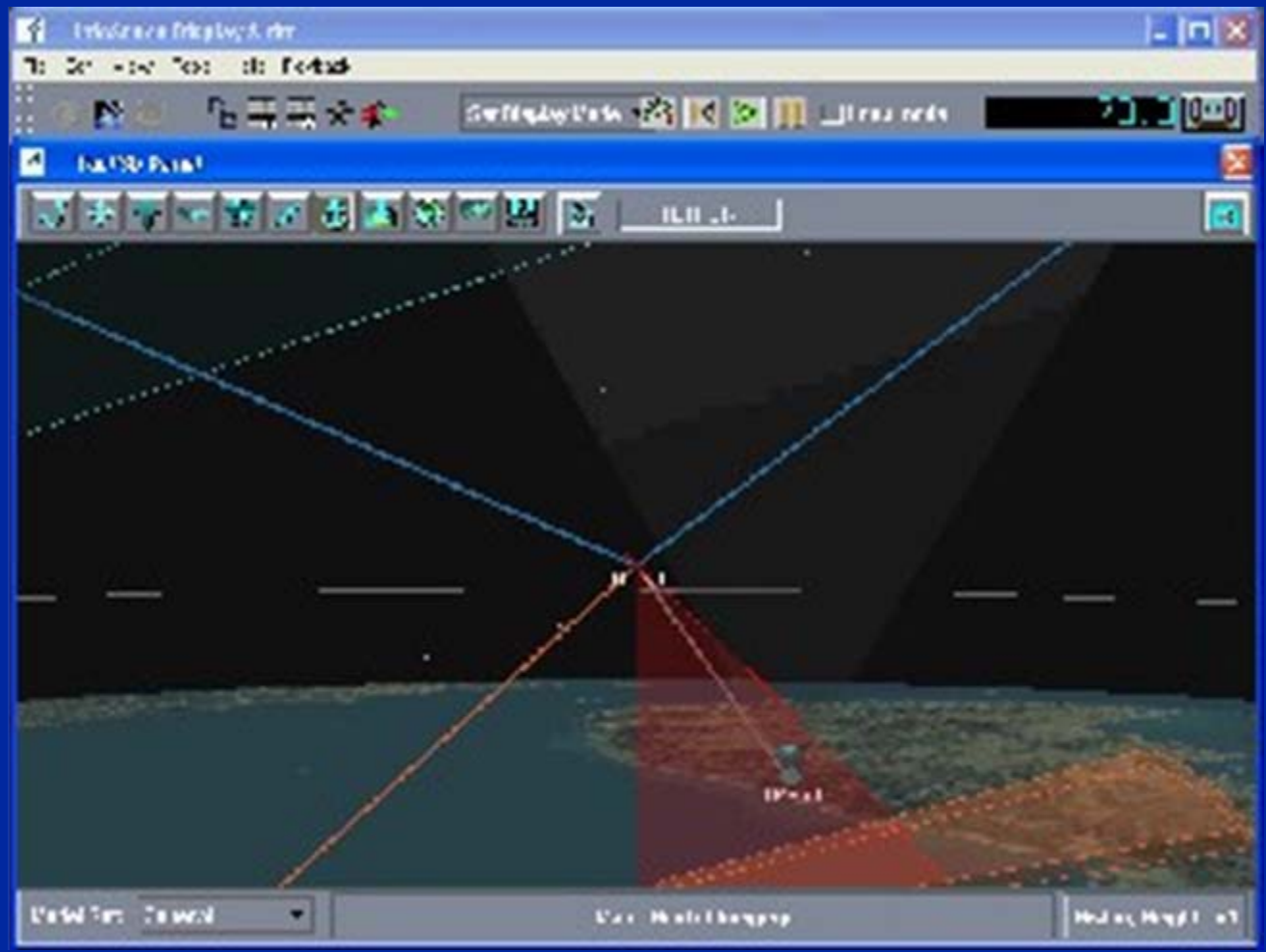
Generic Sensor Model (GSM)

IMDT™ Distributed Network



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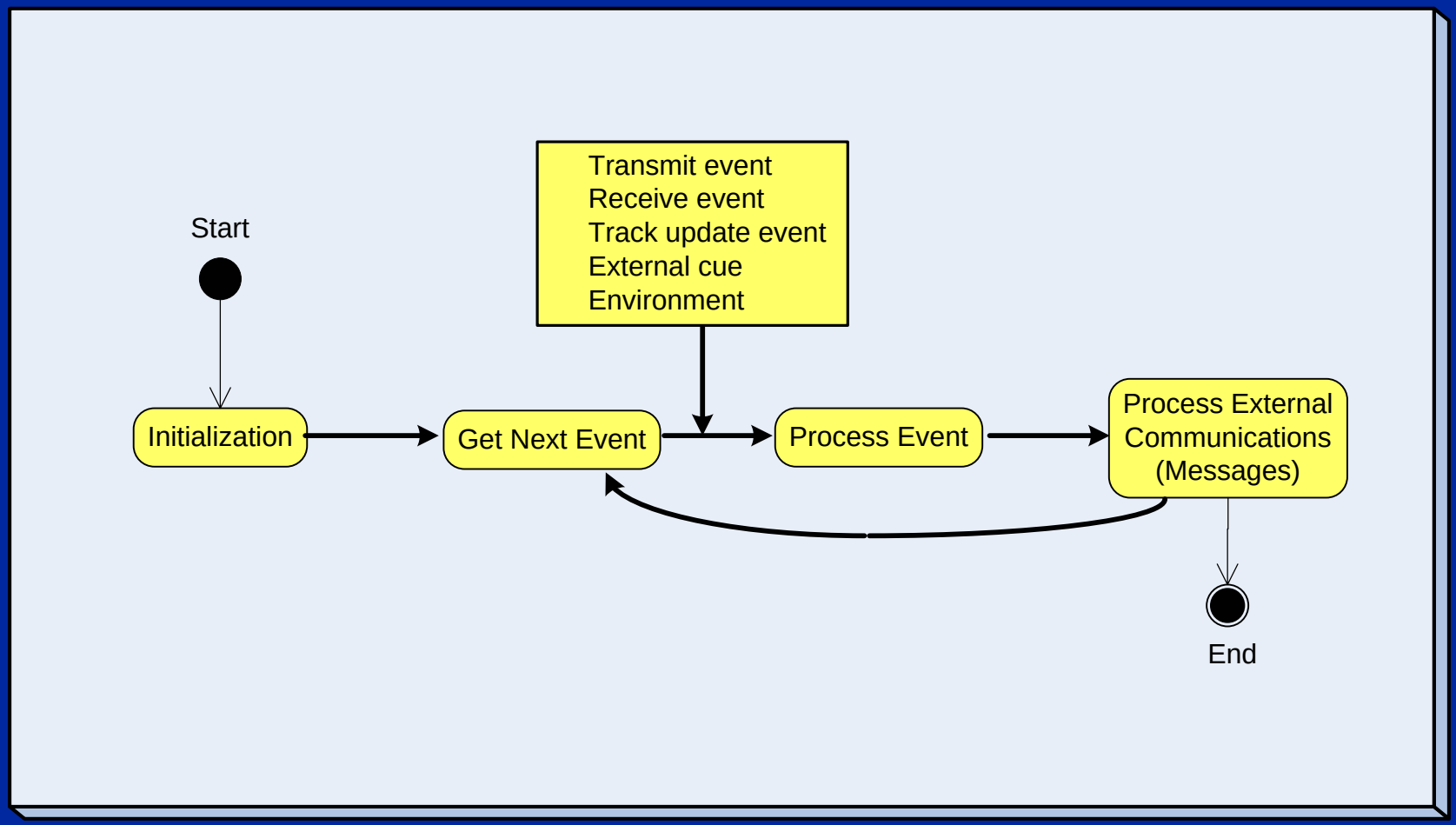
IMDT Video



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Generic Sensor Model (GSM)

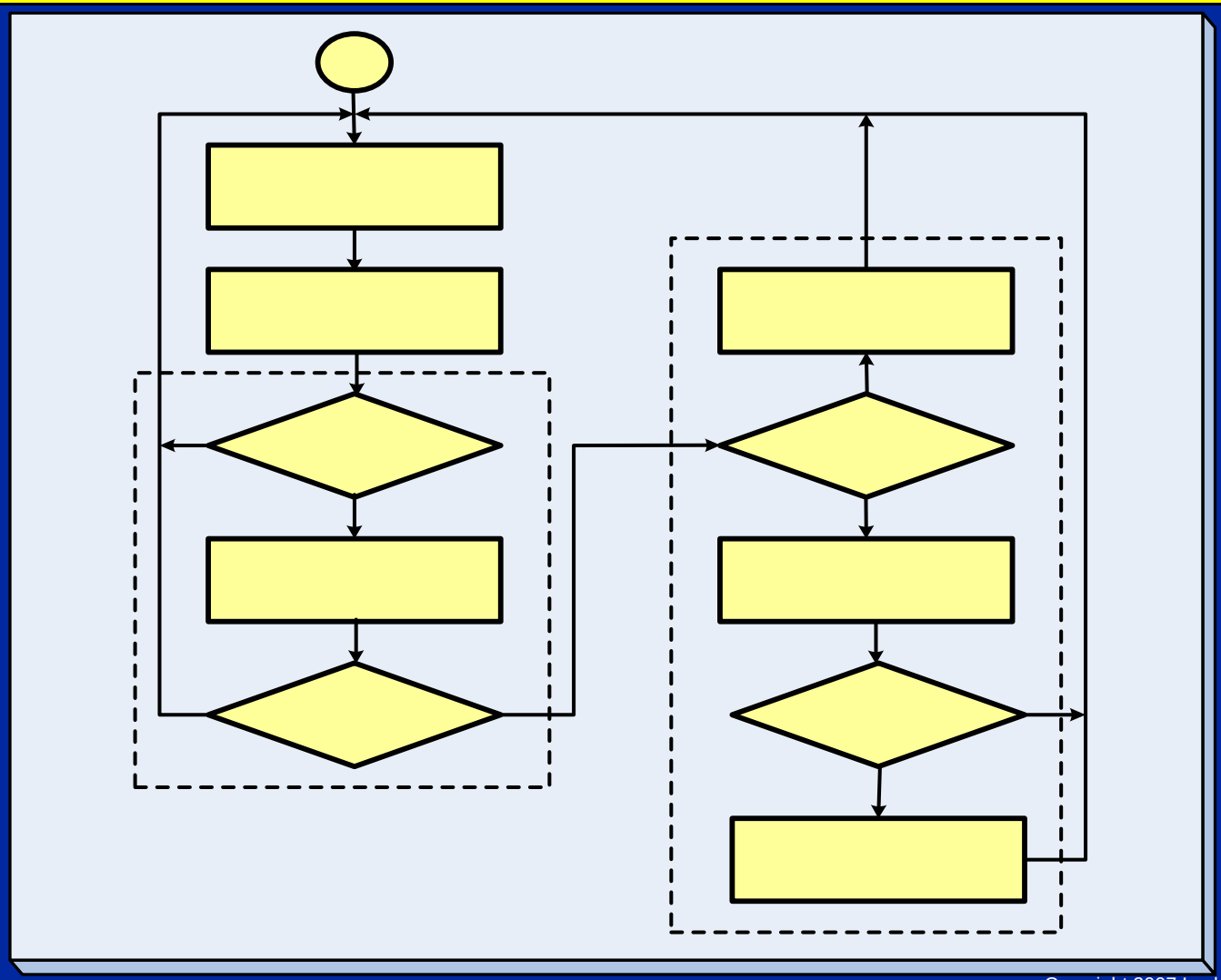
Generic Sensor Model Flow



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Generic Sensor Model (GSM)

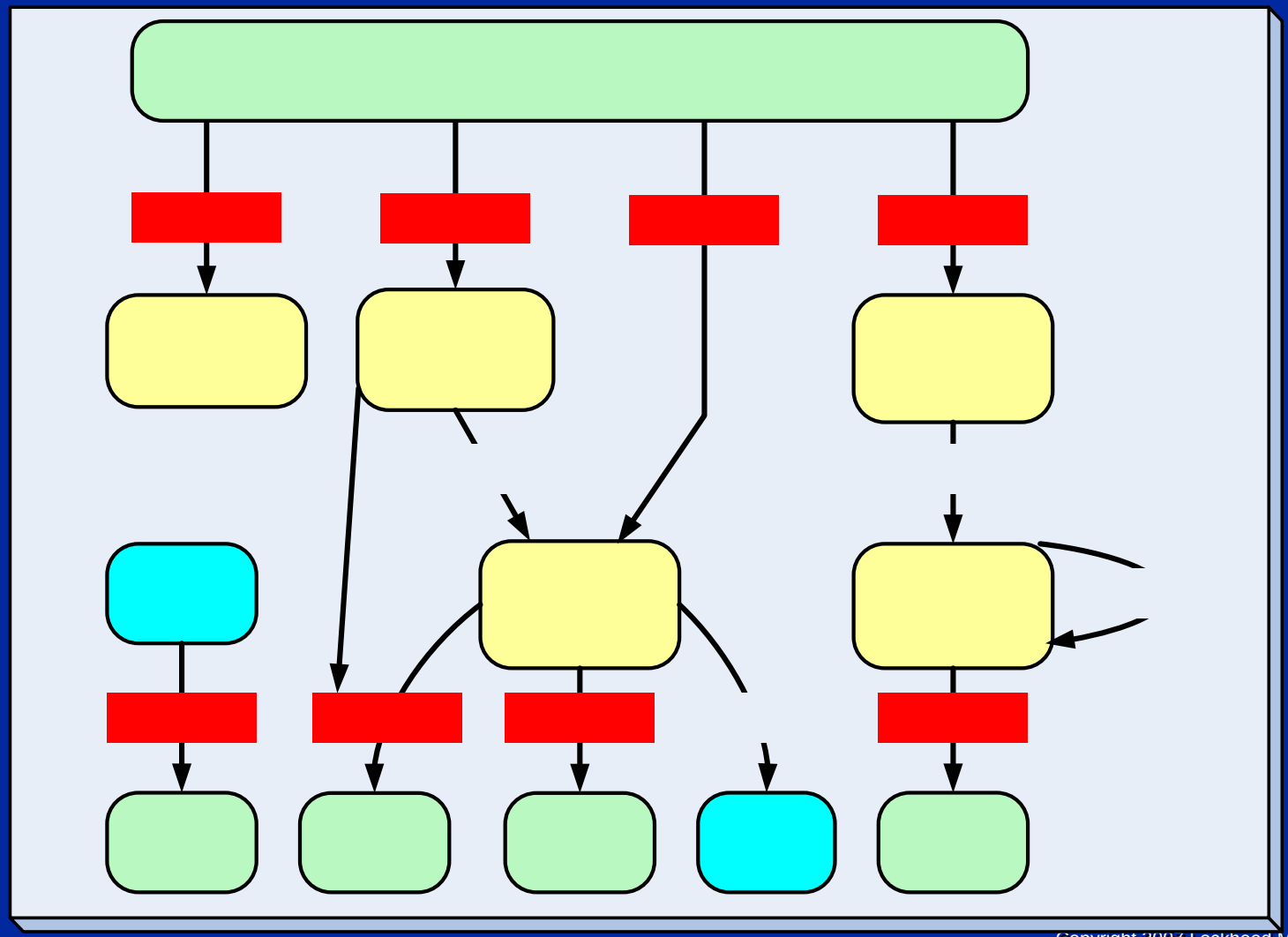
Generic Sensor Model Transmit Event Flow



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Generic Sensor Model (GSM)

Generic Sensor Model Event Processing



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Generic Sensor Model (GSM)

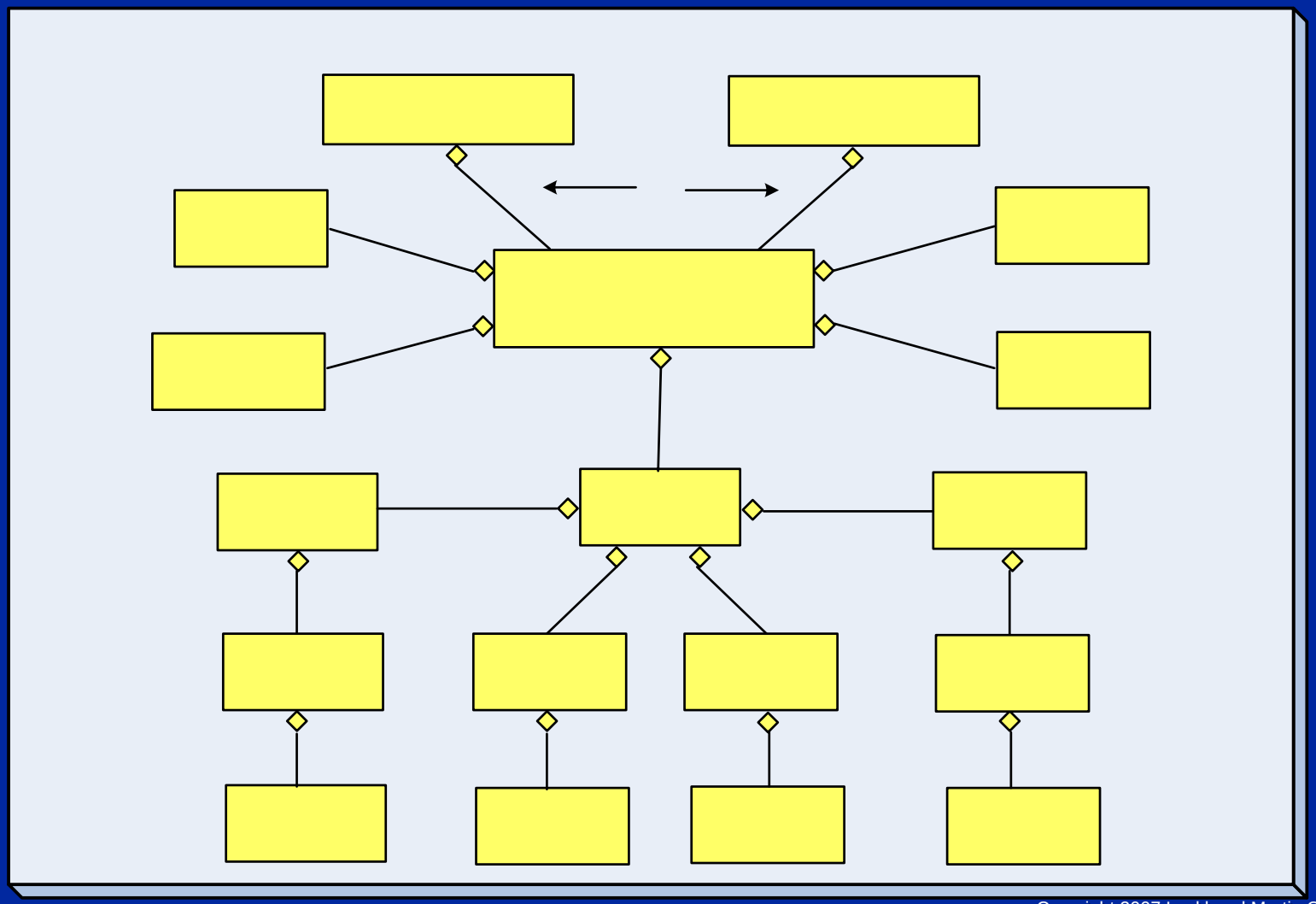
Generic Sensor Model Components

- ***Physics-Based Components***
  - ***Beam scheduling***
  - ***Beam propagating***
  - ***Signal calculations***
  - ***Tracking***
- ***Effects-Based Components***
  - ***Measured state***
  - ***Single-scan correlation***
  - ***Multi-scan correlation***

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Generic Sensor Model (GSM)

Generic Sensor Model Components



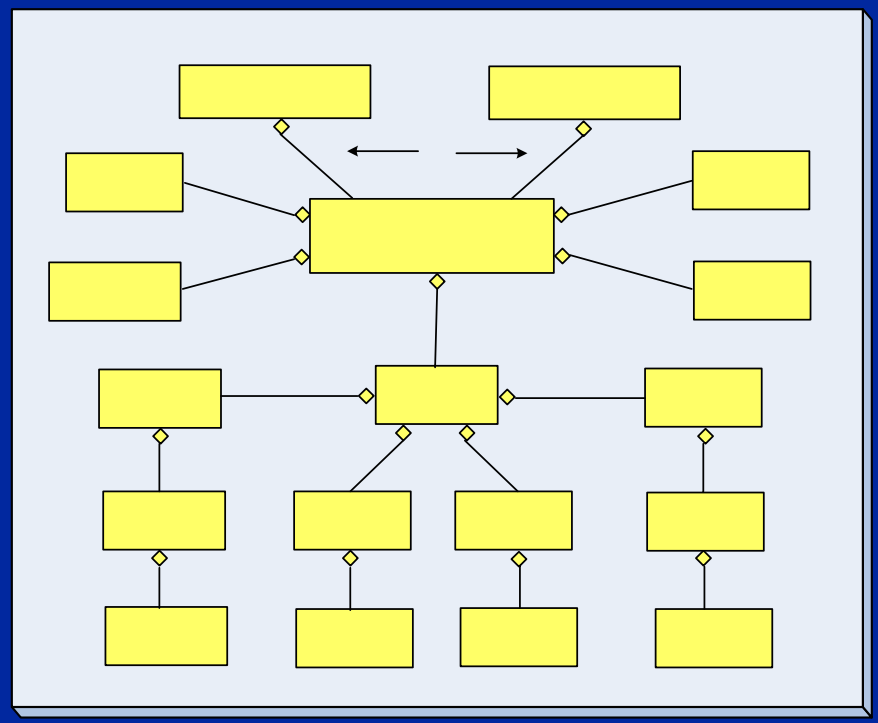
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Generic Sensor Model (GSM)

Generic Sensor Model Components

Flexibility and Extensibility

- **Beam Scheduler**
  - Phase / Rotate
  - Phase / Phase
  - Phase / Phase / Rotate
  - Track Filter
- **Kalman Filter**
  - Interacting Multi-Model (IMM)
  - Non-Linear Ballistic Model
- **Model Extensions**
  - External Cue
  - IFF



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Generic Sensor Model (GSM)

Generic Sensor Model Parameter Examples

- **Sensor**
  - Transmitter – power, duty cycle, …
  - Antenna – size, element count, …
- **Waveforms**
  - Selection
  - Beam Parameters – frequency, bandwidth, …
- **Tracker Characteristics**
  - Initial Conditions – weights, …
  - Operating Parameters – time constants, …
- **Threats**
  - Number
  - Characteristics
  - Trajectories

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Generic Sensor Model (GSM)

Generic Sensor Model Analyses

- **Component Performance Analyses**
  - Detections – SNR, P_D, …
  - Tracker – initiate track, drop track, …
- **Algorithm Analyses**
  - Baseline updates
  - Extended functionality
- **Mission Planning**
  - Assumption verification
  - Parameter development
- **Scenario Analyses**
  - Targets – number, location, type, …
  - Assets - number, location, type, …
  - Communications – latency, availability, …

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Generic Sensor Model (GSM)

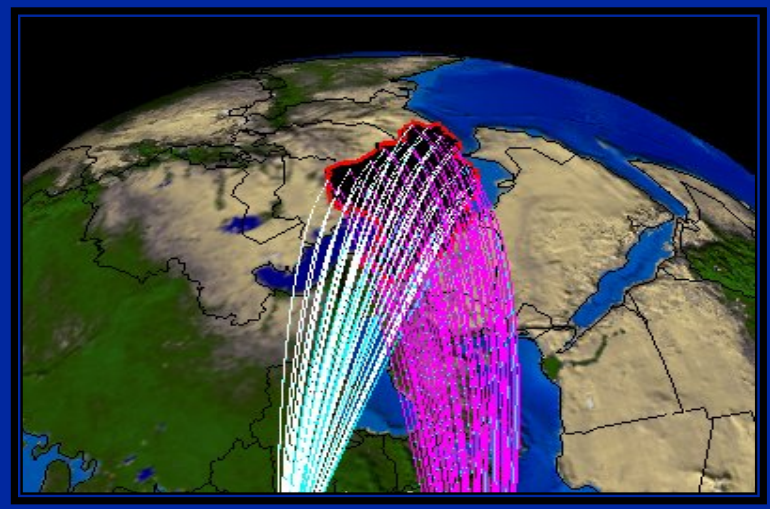
Generic Sensor Model Analysis Examples

- Stand-Alone Operating Mode
  - Performance assessment
    - Track initiation
    - Coverage
    - Detection probability
  - Enhanced/Modified Capability evaluation
    - Tracking
- System-of-Systems Operating Mode
  - Interoperability

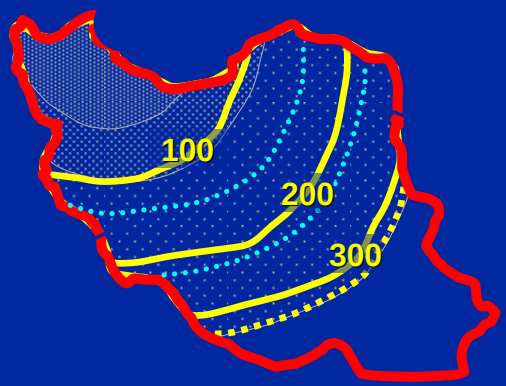
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Stand-Alone Mode Performance Example

- *Individual missiles launched throughout the region of interest*
- *Missiles impact one of two cities (white, pink)*
- *Radar at a specified location*



Track initiation Time

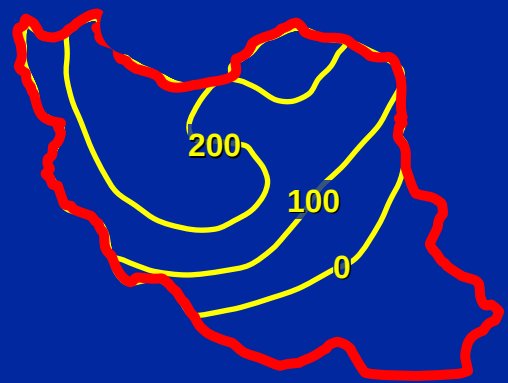


Pd A

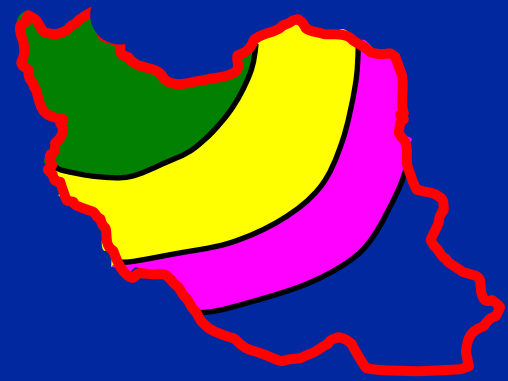
Pd B

Pd C

Track Duration



Track Coverage



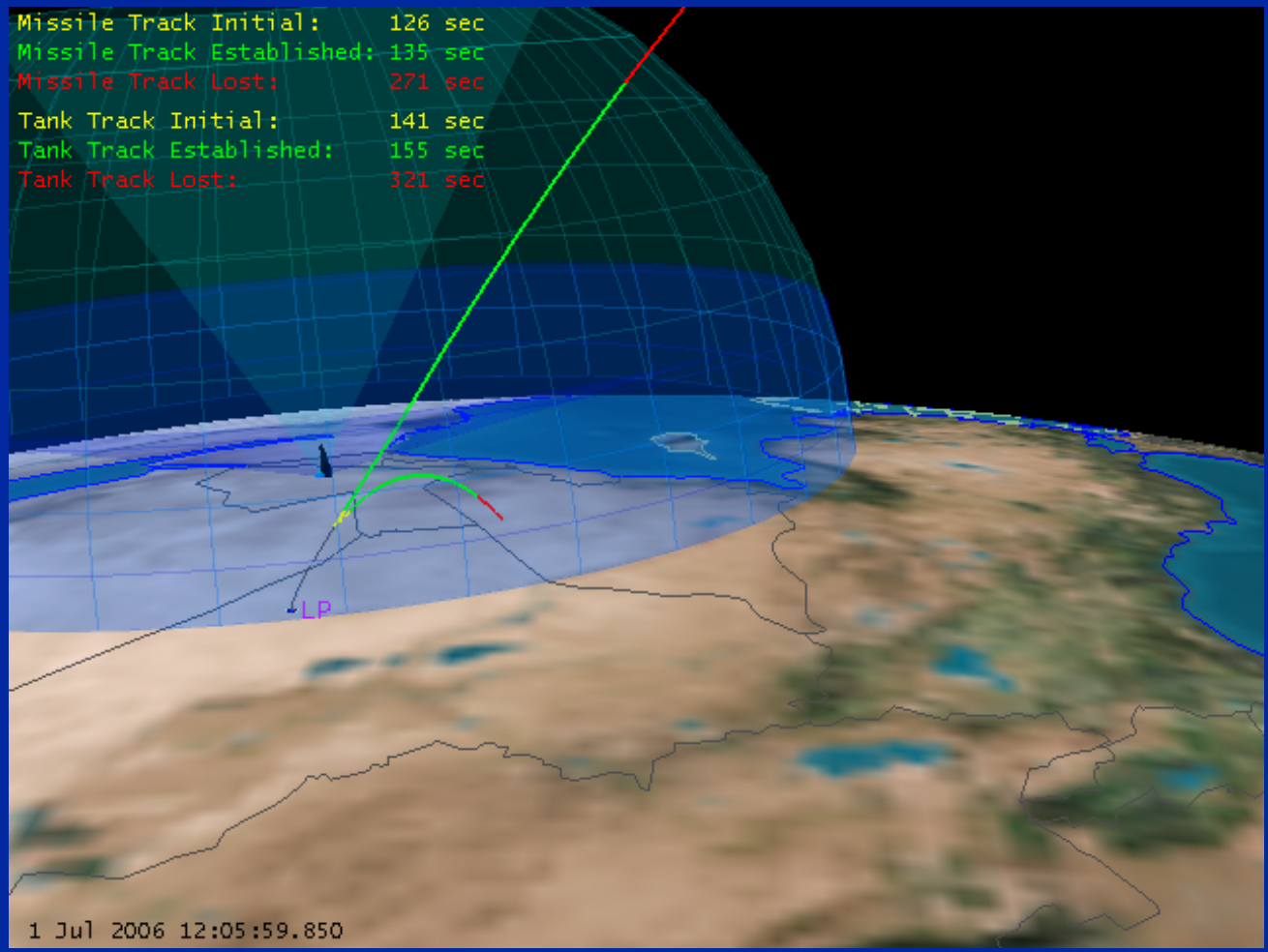
Track boost and midcourse phases
Track boost phase only
Track midcourse only

NOTE: All data are notional.

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Stand-Alone Mode Performance Example Video

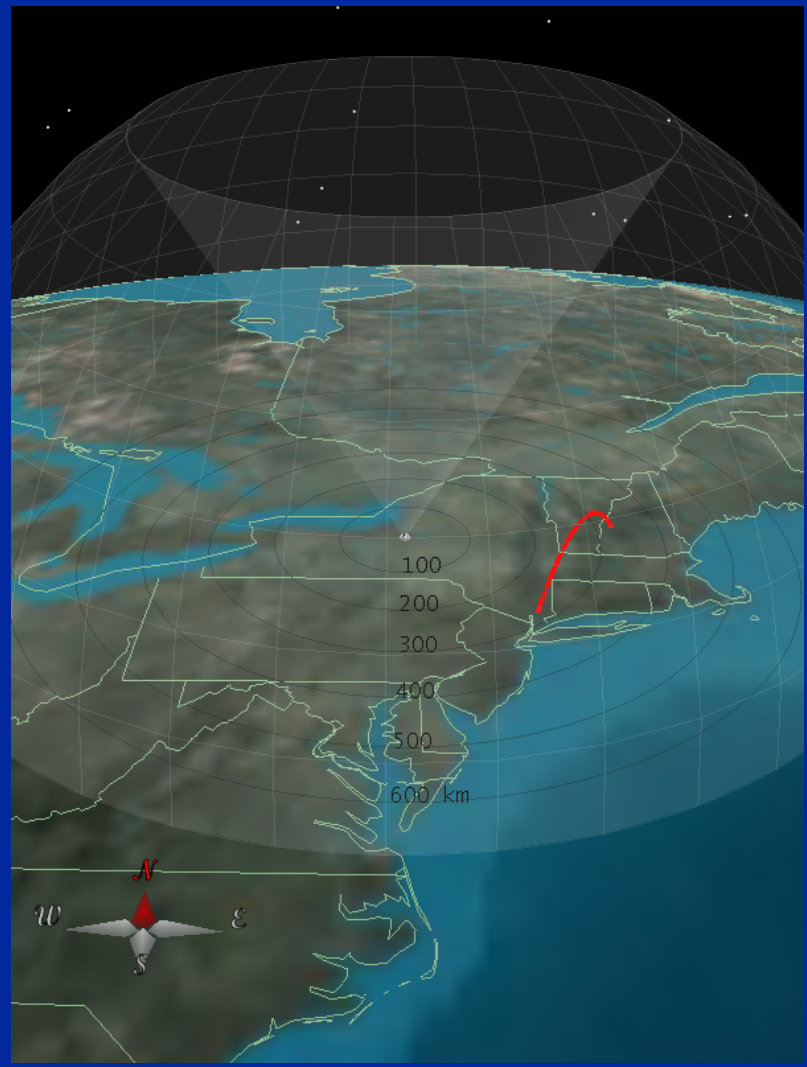
NOTE: All data are notional.



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Stand-Alone Mode Enhanced Capability Example

- *N Monte-Carlo runs using Tracker 1*
- *N Monte-Carlo runs using Tracker 2*
- *Evaluate*
  - *Probability of track initiation*
  - *Track initiation time*
  - *Track duration*
  - *Track drop time*
  - *Track quality*
  - *…*

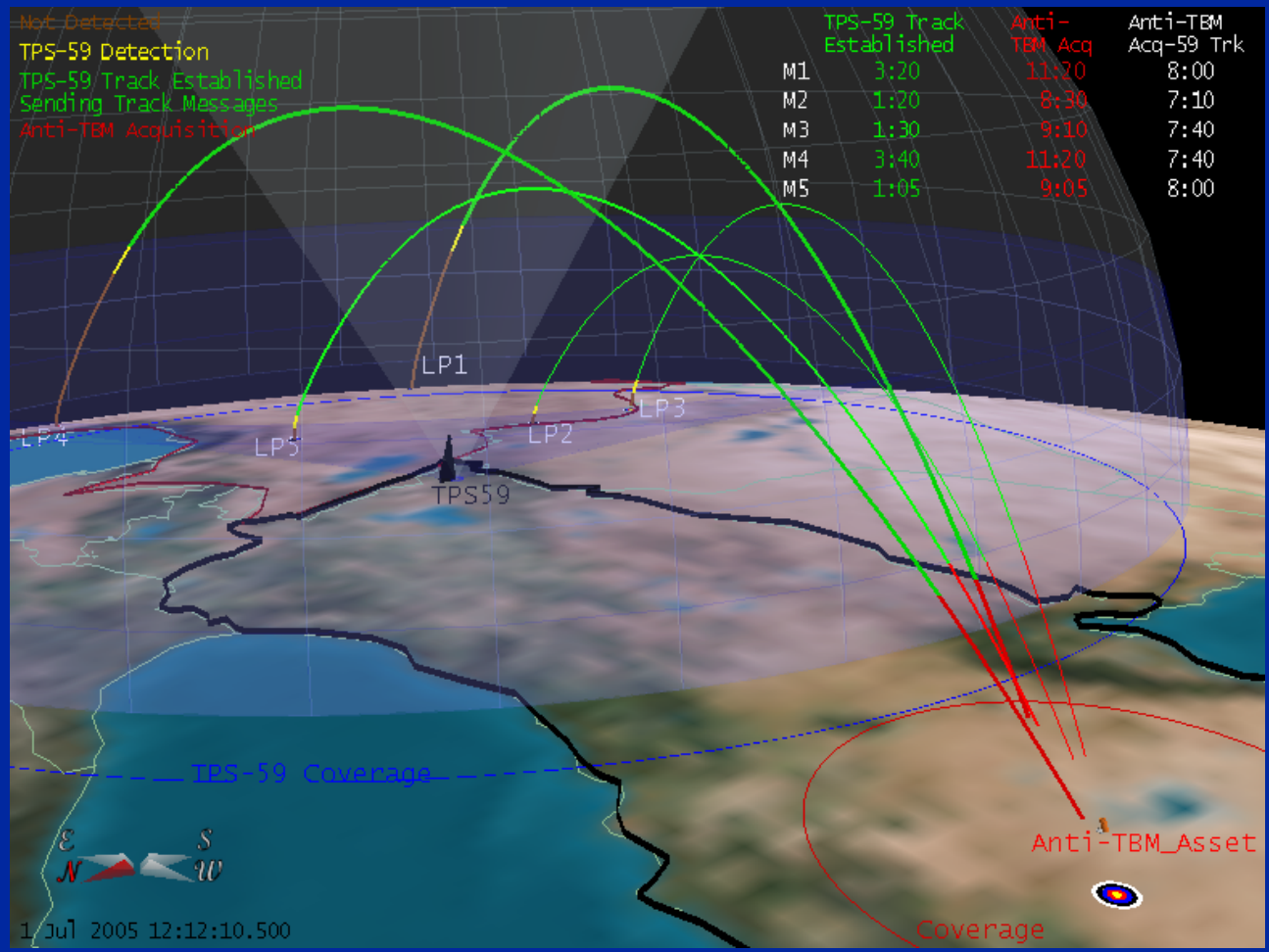


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Interoperability Video

NOTE: All data are notional.



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Generic Sensor Model (GSM)

Summary

- ***Generic Sensor Model (GSM) provides a flexible, extensible framework for instantiating sensor models***
  - *Object-Oriented design*
  - *Parametrically driven*
  - *Stand-Alone mode*
  - *Federated mode*
- ***Integrated Missile Defense Testbed (IMDT) provides a distributed system-of-systems environment***
  - *High-Level Architecture (HLA)*
  - *Global Vision Network (GV-Net™)*
  - *Addresses all phases of the BMD mission*
    - *Plan the Battle*
    - *Fight the Battle*
    - *Assess the Battle*

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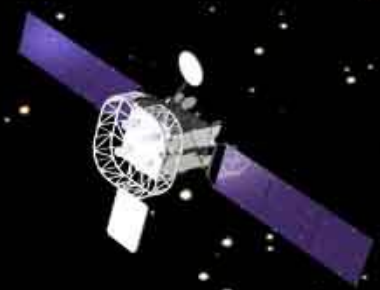


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Communications Satellite Program Office (PMW-146)







Managing Requirements to Manage Scope in the Case of MUOS

25 October 2007

CDR Trip Braund
MUOS Systems Engineer
Christy Howard
Maxim Systems, Inc
Debra Shannon
Maxim Systems, Inc

Distribution Statement A: Approved for public release, distribution unlimited (04 Oct 07).

PMW-146-D-07-0184

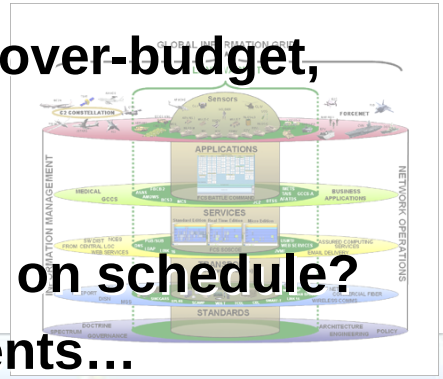
CLASSIFICATION (U)
Classified by: PMW-146

Agenda

- Our Goal for Today
- MUOS in a Nutshell
- Our Challenges
- Our Approach to Requirements Management
- Lessons Learned
- Challenges Ahead

Why We're Here

- **The history of DoD acquisition is littered with over-budget, late and failed projects**



- **Why do projects fail to stay within budget and on schedule?**

  Frequently, the answer is related to requirements…
  - **Requirements that are unachievable from the start**
  - **Poor management of changing and emerging requirements**
  - **Lack of contractor oversight by the acquisition program office**

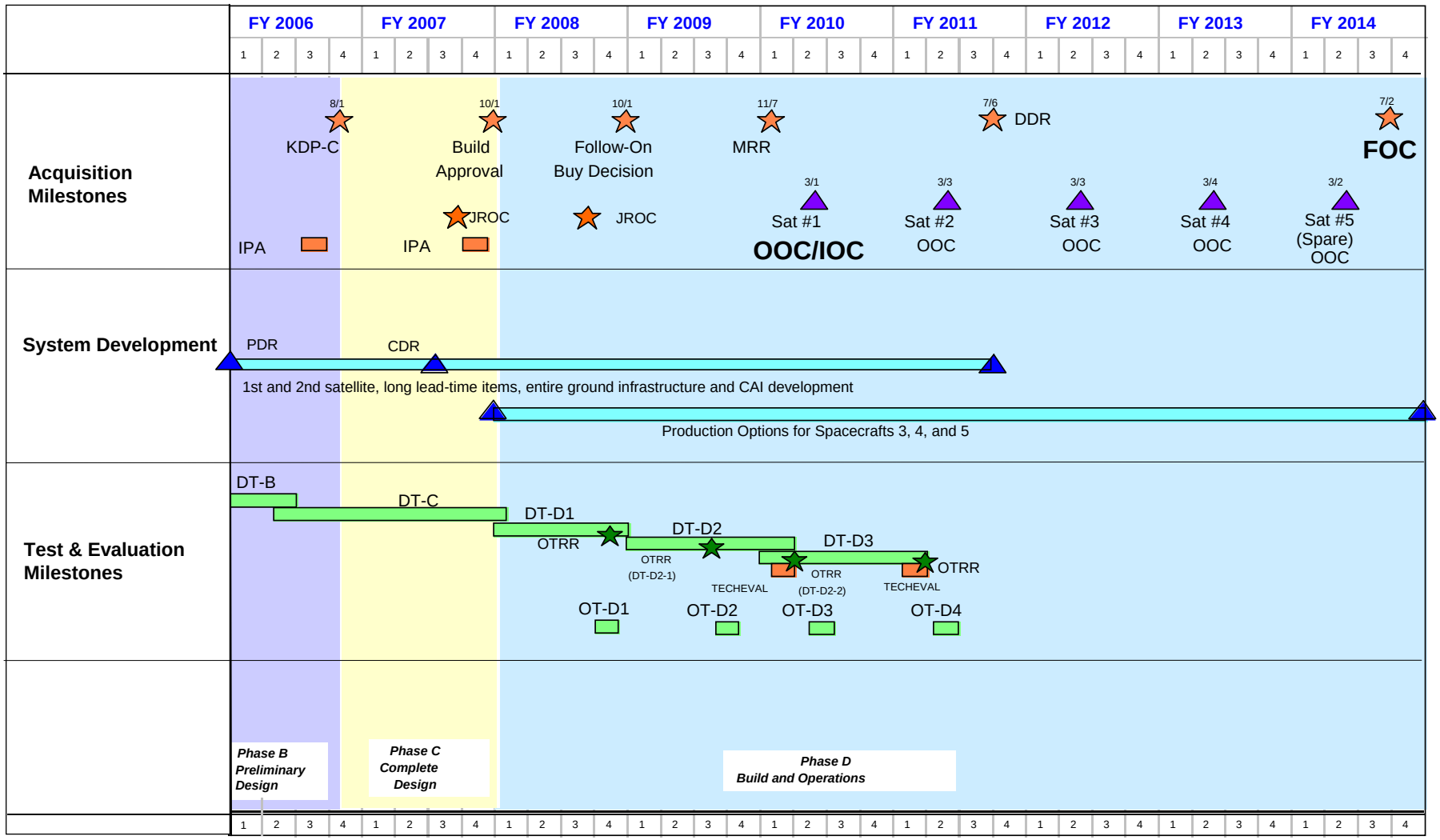
- **Today we will discuss what the MUOS program has done in an attempt to avoid these pitfalls, which we believe has helped the program stay, thus far, on budget and on schedule**

Mobile User Objective System

- A Major Space Defense Acquisition Program
- Tomorrow's Narrowband SATCOM constellation to replace current Ultra High Frequency (UHF) Follow-On (UFO) constellation
  - Will provide 10x legacy capacity and significantly improved availability
  - On Orbit Capability (OOC) in 2010
  - Full Operational Capability (FOC) in 2014
- Critical Design Phase initiated in Nov 05/completed May 07
  - Contract for MUOS Development awarded to Lockheed Martin Team, including Boeing Satellite Systems and General Dynamics
  - Development of MUOS satellites, ground systems, and user terminal waveform
- Key Decision Point (KDP) – C board completed Aug 06

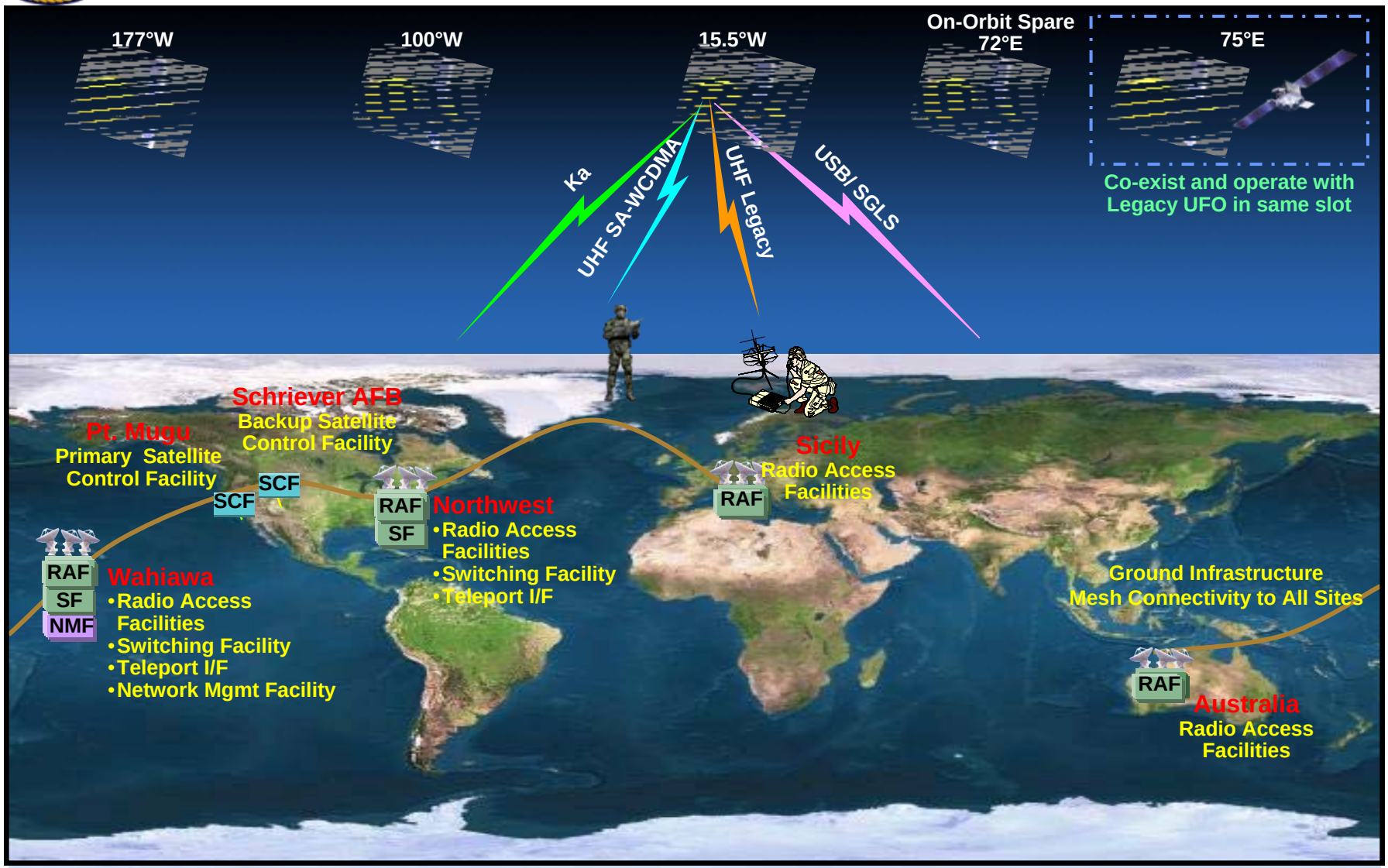
The MUOS program remains on budget and schedule through KDP-C and the critical design phase

MUOS Program Schedule



OOC: 2010 **FOC: 2014**

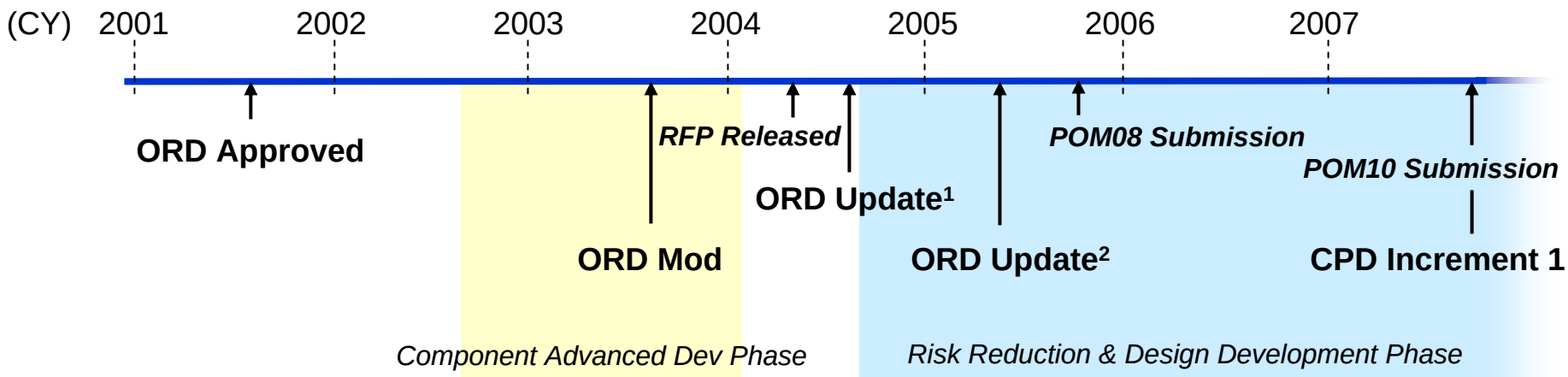
MUOS Architecture



Our Challenges

- Fixed Project Schedule and Budget
  - Aging legacy constellation drives 2010 need date for MUOS capabilities
  - Budget is always limited
- System-of-Systems
  - MUOS is not a stand-alone system
  - End-to-end capability dependent on user terminals (JTRS) and DoD Teleports
- Changing Requirements
  - MUOS ORD has been updated two times since release of contract RFP
- Shifting Strategic Directions
  - Introduction of the Net-Ready KPP
  - Evolution of the Global Information Grid (GIG)
  - Movement toward packet-switched technologies
- Large and Complex Project With a Distributed Team

MUOS Requirements Timeline



[1] MUOS was grandfathered from having to convert to a CDD; this update addressed only non-key performance parameter (KPP) requirements.

[2] This ORD update replaced the Interoperability KPP with the Net-Ready KPP.

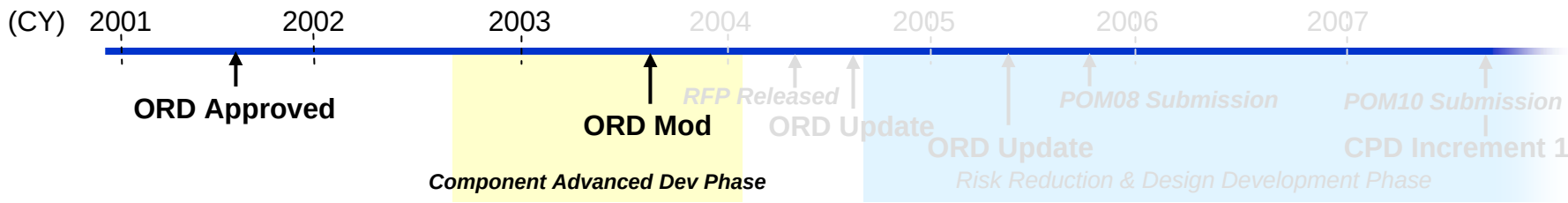
Our Approach to Requirements Mgmt

The Big Picture

- MUOS Program Management is committed to controlling scope
  - Managing requirements is key to controlling scope, but…
  - A degree of flexibility is critical
- Our Requirements Management goes well beyond simply maintaining documents and databases
  - Our team includes technical experts to manage the *content* of the requirements
  - We utilize and customize tools to provide the program office comprehensive insight and oversight of requirements
- Requirements are being managed throughout the program's entire life cycle

Our Approach

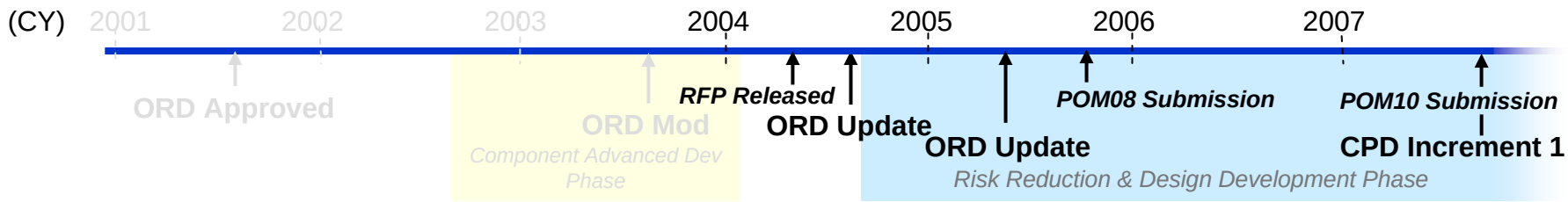
Unachievable Requirements…



- We participated in all early operational requirements meetings with warfighter representatives (COCOMS, services, OSD, etc.)
  - Raised issues with requirements that were deemed to push the limits of technology at the time, which influenced the initial operational requirements (ORD)
- CAD phase was an opportunity for us to further refine the requirements with 2 contractor teams
  - Provided insight into how the requirements were driving the architectures
- As potential architectures matured, we worked with the resource sponsor and user community to address requirements that were significantly impacting architecture designs and costs
  - Successfully reduced 2 requirements (1 a key performance parameter) as a result of both cost as an independent variable (CAIV) and technical feasibility studies

Our Approach

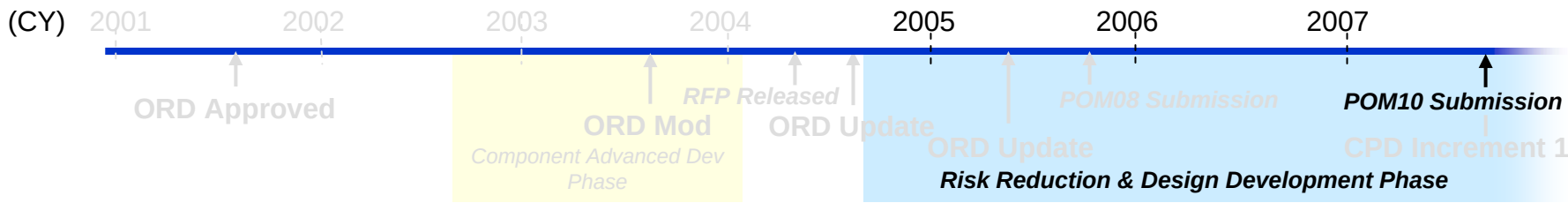
Changing and Emerging Requirements…



- MUOS has successfully managed 2 post-RFP ORD updates
  - Contractor performed impact assessment of new & changed requirements
  - Results allow us to make informed budget, schedule, performance and risk decisions and elevate issues
    - We are allocating requirements to 2 Increments
      - Current capability is documented in the MUOS CPD Increment 1
      - Remaining requirements, when funded and contracted, will go into CPD Increment 2
    - Requesting funds through resource sponsor via POM inputs
- We track applicable policies and DoD directives and work closely with NSA…
  - incorporating derived requirements, when possible
  - raising issues, as necessary

Our Approach

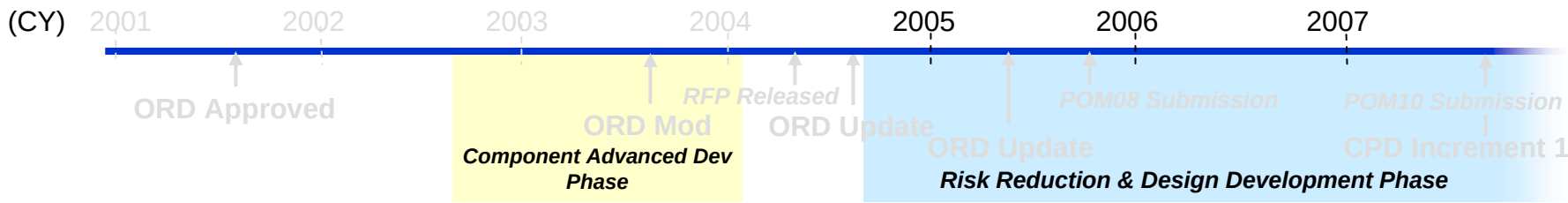
Changing and Emerging Requirements…



- We acknowledge we are part of a system-of-systems
  - We work hard to remain aware of JTRS and Teleport architecture development and changes and address issues as early as possible
    - Established the MUOS Acquisition Council
    - Active Interface Control Working Groups
  - We stay ahead of Net-Centric directives to minimize impacts while making smart decisions – i.e., evolving with our environment within our constraints
    - Example is early decision to change to an entirely packet-switched architecture
- Moving ahead, we continue to communicate with the user community on emerging requirements
  - Conducted meeting with warfighter reps to understand their priorities, which will influence POM10 submission and future allocation of funds

Our Approach

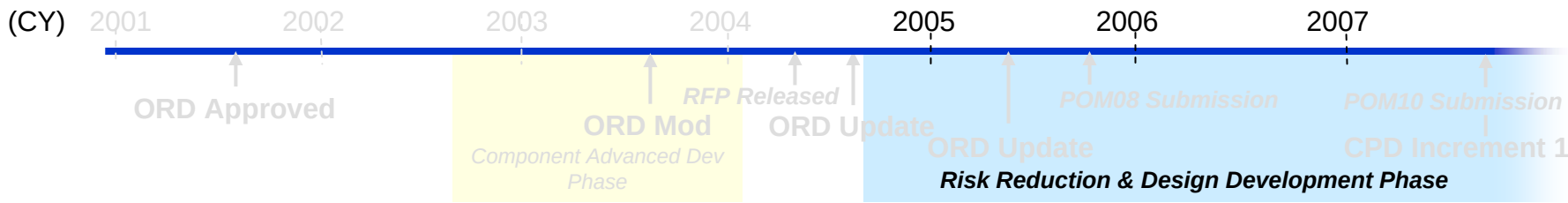
Contractor oversight by the program office…



- We translated the operational requirements into more detailed and testable requirements via the contract performance specification
  - Frequently requested clarifications of the requirements by participating in every ORD meeting, email, phone calls, etc.
  - Involved subject matter experts across the program office team
- We have a very productive relationship with STRATCOM's MUOS representative, ensuring we consider the user's perspective
  - He frequently participates in IPT meetings and attends design conferences
- We continually foster frank and open communications with the contractor
  - Contractor not only requests clarification of requirements, but also…
  - Contractor has proposed refinements to requirements to allow improved design and/or cost savings

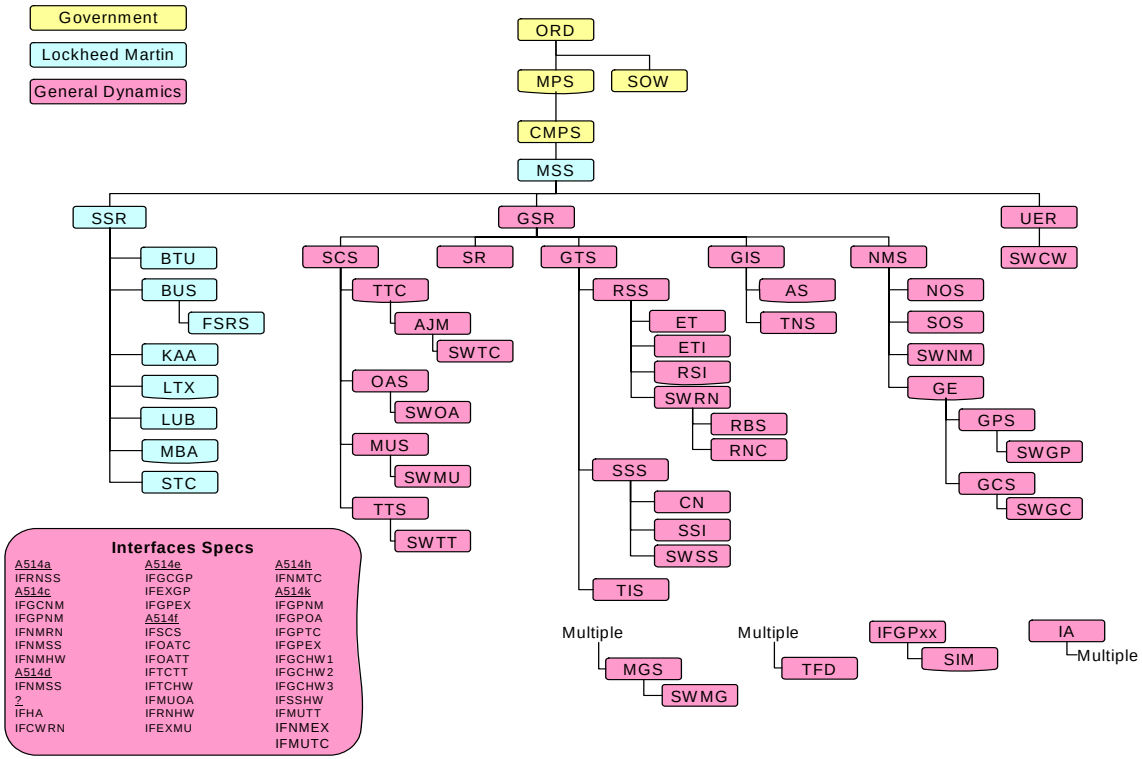
Our Approach

Contractor oversight by the program office…



- We work very closely with the developer to ensure proper treatment of contract requirements
  - Tracking requirements flow and interpretation through all levels of specification: system, segment, subsystem, software and hardware
    - Are contract specifications fully captured?
    - Have extraneous requirements been added?
    - What are the implications of a high-level requirements change or a low-level design change?
  - Strong participation in and oversight of requirement verification plan development
- Tools are key to our processes

Requirements Management Tool
Utilize and Customize



- **Large Program**
  - **160 specifications**
  - **500,000 rqmts**
- **Distributed Team**
  - **3 DOORS databases**
  - **weekly integrations**

→ **21,000 lines of code**

Tools are a must!

Requirements Management Tool
Involve the Requirements Managers



Requirement Managers

- active IPT members
- help the IPTs use the tools

Collaborate to use the tools

Requirements Management Tool
Customized Reports

SWGP/SWGC	CMPS Short text
[SWGP1010] Geo Processing CSCI shall archive received Mission Support Data, including:	**[SYS508], [SYS510]**

1. MUOS epl
2. UFO ephe
3. Deleted
4. IERS data
5. Smoothed
6. active grou

[SWGP1015] requests in ac
Processing Sc
[SWGP1020] archive in acc
Processing Sc
[SWGP1025] results in acc
Software Des
[SWGP1030] between the p
[SWGP2115] receive intern
Appendix B c
Description (r
[SWGP2120] internal comp
Geolocation F
294).
[SWGP1050] two simultane
[SWGP1055] timeline that i
time, stop tim
[SWGP1060] Processing co
[SWGP1065] run a task to p

[MSR8500] MUOS shall require 30% less than the number and type of satellite control and network management and control operations and maintenance personnel required for UFO.

[GSR8500] The MUOS Ground System shall require a staff of 103 or fewer full-time personnel to support full system op

[GT7010] The Ground Infrastr includes the capability for auto provided servers and workstati

[GT7010] The Ground Transp the capability for automatic up and workstations.

[RS7020] Any server, wo Subsystem shall implemen

[RS7021] Any server, wo Subsystem shall implemen software from the NMS.

[SS7044] Servers, and wo implement virus protection

[SWSS1400] Upon in Switching Software sh (MUOS Application S

[MAS1400] Upo MAS shall accept

[SWSS1430] Upon v indication of virus det

[MAS1430] Upo detection to the N

[SWSS1410] Upon in Server), the Switching function from the Net

[MAS1410] Upo accept configurat Management CS

	A	B	C	D	E	F	G	H
1	Drop Page Fields Here							
2								
3								
4	MOE ID	CMPS All VTEs						
5	[MOE 10-1 (O)]	(blank)						
6	[MOE 10-1 (T)]	TS064 (SPT4-Post-Environmental, N/A,						
7	[MOE 10-2 (O)]	SCS010 (Build 1 (SCS) GS FAT)						
8		SCS050 (Build 1 (SCS) GS FAT, SPT4-						
9		TS120 (Build 2 GS FAT, Build 1 GS FAT,						
10		(blank)						
11	[MOE 10-2 (T)]	SYS620 (Build 1 GS FAT)						
12	[MOE 1-1 (O)]	(blank)						
13	[MOE 1-1 (T)]	(blank)						
14	[MOE 2-1 (O)]	(blank)						
15	[MOE 2-1 (T)]	SYS490 (Build 3 GS FAT, Build 1 UES						
16		(blank)						
17	[MOE 2-2 (O)]	SYS090 (Build 3 GS FAT, Build 1 UES						
18		SYS105 (Build 3 GS FAT, Build 3 GTS						
19	[MOE 2-2 (T)]	SYS090 (Build 3 GS FAT, Build 1 UES						
20	[MOE 3-1 (T)]	SYS574 (Build 3 GS FAT)						
21		SYS580 (Build 3 GS FAT)						
22		SYS582 (Build 3 GS FAT)						
23		SYS588 (Build 3 GS FAT)						
24		UES015 (Build 1 UES FQT)						
25		(blank)						
26	[MOE 3-2 (T)]	SYS052 (Build 2 GS FAT, Component						
27		SYS053 (Component Test (COMP), SPT4-						
28		SYS058 (Component Test (COMP), SPT4-						
29		TS030 (Build 1 GS FAT, Build 2 GS FAT, Build 3 GS FAT, Build 1 UES FQT, SPT4-						
30		(blank)						
31	[MOE 3-3 (O)]	(blank)						
32	[MOE 3-3 (T)]	(blank)						
33	[MOE 4-1 (O)]	(blank)						
34	[MOE 4-1 (T)]	SYS081 (Build 1 GS FAT, Build 3 GS						
35		SYS110 (Build 3 GS FAT)						

MOE-to-CMPS | Raw Data

Ready

PivotTable Field List

Drag items to the PivotTable report

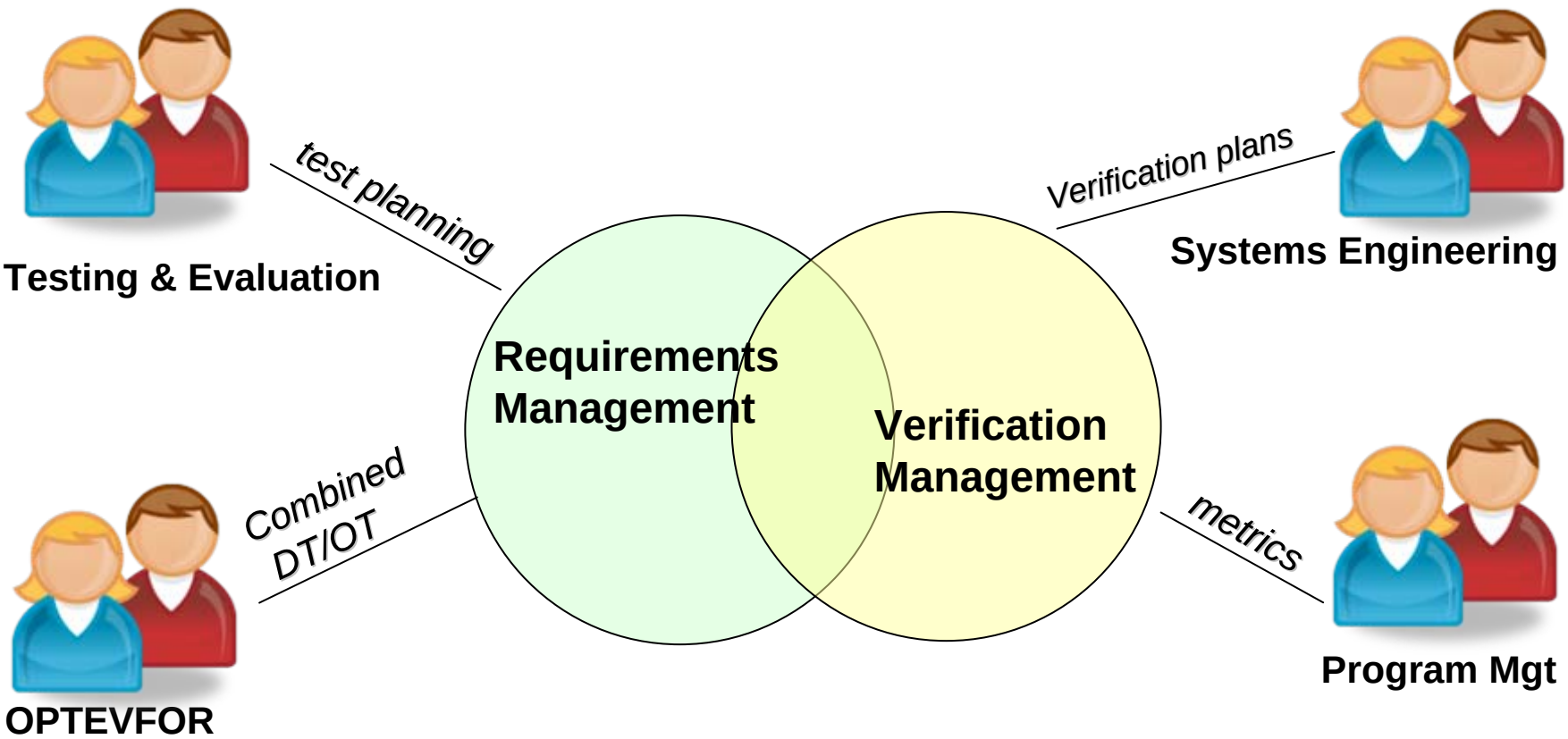
- MOE ID
- MOE Requirement
- ORD REQID
- ORD Requirement
- MPS REQID
- MPS Requirement
- CMPS REQID
- CMPS Requirement
- CMPS GSS VTEs
- CMPS UES VTEs
- CMPS STS VTEs
- **CMPS All VTEs**
- S-RVP VL
- S-RVP VM

Add To | Row Area

- **Tabular traces**
- **Hierarchical traces**
- **Pivot tables**

Customized reports have become a central aspect to the daily management of MUOS

Requirements Management Tool
Customize the Requirements Database



Expanded existing tools to address changing Program office needs

Lessons Learned

- The Positive
  - Program management must be committed to managing project scope, yet have enough flexibility to respond to the changing environment
    - Examples: change to IP technology, evolving interfaces with DISN services
  - Rigorous interaction with the requirements community is crucial
    - Manage expectations by ensuring requirements are feasible, affordable and understood
  - Meticulous oversight of top to bottom requirements is a necessity
    - Tools are essential here: requirements traces, verification pivot tables, etc.
  - Invest in a robust Requirements Management System
  - Foster a cooperative environment that is receptive to change
    - Cooperation among SETA contractors significantly enhances productivity
    - Development contractor suggestions have resulted in many improvements
- Needs Improvement
  - Escalation of process problems
    - At times we wasted months trying to resolve process issues with the developer
  - Coordination with other projects
    - No overarching integrator

Challenges Ahead

- Broader systems engineering issues to keep our large, highly complex project on budget and schedule
  - We're already facing issues that are impacting budget and schedule
    - Technical issues
    - Security issues
- Continued reliance on other projects
  - User terminal developments are well behind MUOS development
  - Teleport funding is out of sync with MUOS development
  - Lack of an overarching integrator increases this challenge
- Dealing with future new requirements
  - New requirements have been proposed
  - We are currently working through a process to address these, potentially developing a CDD for a block upgrade

How To Talk To A Program Manager

10th Annual Systems Engineering Conference
October 22-25, 2007

John Mishler
Anita Carleton
Bill Nichols

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You can’t always get what you want . . .

You can’t always get what you want,

But if you try sometimes, well, you just might find,

You get what you need!

(M. Jagger/K. Richards: 1968)



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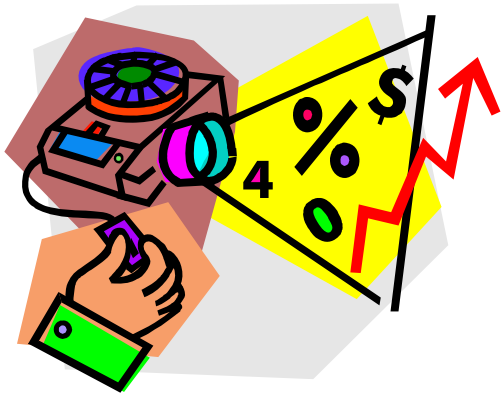
What Does a Program Manager *Want*?

A high quality product delivered within cost and schedule.



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A Program Manager Also *Needs*…



Accurate, high-quality data and information to keep the program or project on-time and on-budget.

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Topics

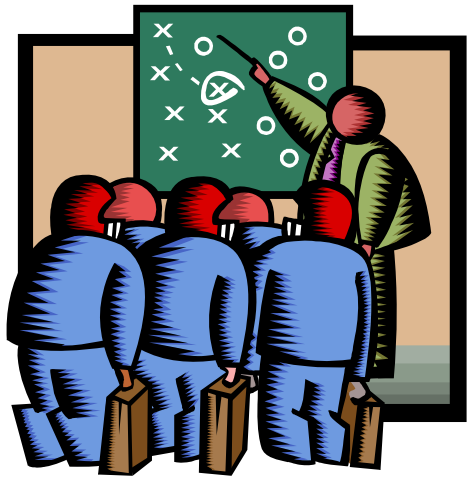
- Key Systems Development and Program Management Issues
- Metrics for Managing Cost and Schedule Issues
- Project Planning Principles and Application
- Project Tracking Principles and Application
- The Way Forward . . . *Team Process Integration*

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Key Issues in Managing Projects/Programs - 1

Management may not be used to working with data . . .

Management doesn't know what to ask for . . .



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Key Issues in Managing Projects/Programs - 2

Different levels of management & needs for data/information

- Frequency and type
  - Project
    - cross-project reviews
    - Quarterly
    - program/milestone
- Organizational Level
  - First level management: team level
  - Second level: middle management—whoever the team reports to; responsible for half dozen projects; matrix management issues
  - Third level: organization level, business managers, people who manage the budget and people who manage the process



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Key Issues in Managing Projects/Programs - 3

Acquisition

- What did you ask for in the RFP or task order?
- Contractor and sub contractor relationships & reporting

Data analysis, summary & presentation

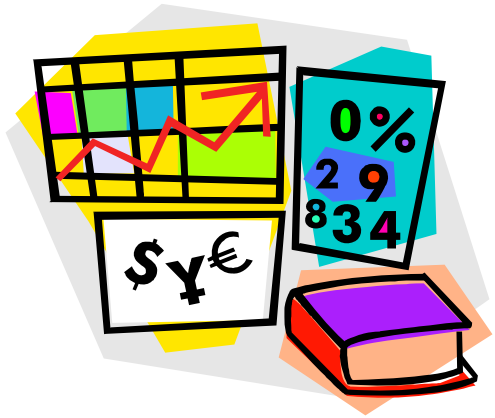
- Dashboard/scorecard
- Stoplight charts
- *Better* (e.g., PQI, PDF, defect densities, customer satisfaction . . .)
- *Faster* (e.g., test time reduction, rework time, ratio of development time to total time, …)
- *Cheaper* (e.g., cost in FTE months or $$ to produce 1,000 task hours of work, …)

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What Data Should be Collected, Analyzed, and Presented?

Primarily status/performance data and information:

- Where are you in your program/project?
- How do you know?
- Show me!
- EARLY WARNING!





Project/Program Performance

- Schedule
- Quality
- Cost
- Features
- Risks

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Other Questions . . .

What is the availability of resources for a particular project?

What is the productivity?

How good is my organization?

What is the estimation accuracy?

What is the cost to develop x, y, z?

How large are our products?

How are we performing (size, effort, schedule, quality, …)?



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All Projects Have Cost and Schedule Issues

- Most projects are underestimated, usually by a lot, only few are close.
- Many project plans are missing an unknown, some unknowns are disasters, and all will have impact.
- Many projects are late before they start, some know it, and some don't.

All projects have issues. The question is:

"How will you manage the trouble you're in?"

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Cost and Schedule Trouble

When the program manager wants to know . . .

"What is the status of your project?"

"How do you know?"

"Show me!"



. . . How will you respond?

It's a question of how to

- identify the real issues and alternatives
- define a realistic course of action
- take it

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Topics

Key Systems Development and Program Management Issues



Metrics for Managing Cost and Schedule Issues

Project Planning Principles and Application

Project Tracking Principles and Application

The Way Forward . . . *Team Process Integration*

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Conventional Wisdom

Advice is plentiful and full of good intent. So what's wrong with the following guidelines?

Program Management Critical Success Factors	
Cost and schedule estimates are realistic and current.	
Demonstrable Indicators	**Possible Sources of Evidence**
Does the scope of the estimate cover all activities throughout the system life?	Costed Through-Life Management Plan.
Were independent methods used to produce and check cost and schedule estimates?	Estimates available for reviewer.
Have the estimates been independently validated?	Independent Technical Review, Quality Assurance Review.
Are there mechanisms to monitor and adjust assumptions and estimates?	Process documentation / Quality System

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Partial List of Answers . . .

- Lagging indicators
- Metrics disassociated from work and those performing it
- Latency in reporting
- Mechanism to adjust estimates and replan over the life of the project?
- How can we do better next time?

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SEI Core Metrics



Size



Effort



Quality



Schedule

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Estimated and Actual Size

What PM's Should Expect

Size is a measure of the magnitude of the deliverable

- for software: lines of code or function points
- for other intellectual work: document pages, presentation slides, computer tests or simulations, etc.

Size is estimated and reported for each component.

The actual size is measured and reported for each component.

Size data are used to

- estimate effort
- normalize other measures
- track progress



Intellectual work can be measured according to accounting categories.

- Base <measure>
- Reused <measure>
- Added <measure>
- Modified <measure>
- Deleted <measure>

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Estimated and Actual Effort

What PM's Should Expect

Effort is a measure of time "on task."

The recommended effort measure is a *task hour.*

Task hours should be measured and reported by

- WBS task
- process phase
- project week



How many task hours are there in a 40 hour week?

About 15 to 20!

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Estimated and Actual Schedule

What PM's Should Expect

Schedule shows the work completed or planned to be completed in a given period.

Schedule accuracy depends on granularity of tasks.

Recommended task granularity

- From 10 to 20 hours for near-term tasks
- From two to four weeks for remaining tasks.

Estimated and actual task dates are reported.



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Estimated and Actual Quality

What Acquirers Should Expect

Defects are a measure of quality.

Definition: when the product must be changed to ensure proper design, implementation, test, use, or maintenance, a defect has been identified.

Estimates of the number of defects injected and removed in each phase and component should be reported.

Actual defects found in each component, and each phase, and the phase in which the defect was injected should be reported.



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Derived Measures

The core metrics support many derived measures that can be used by the acquirer to evaluate plans and track program status.

Examples include

- planned value, earned value, and predicted earned value
- estimation accuracy for size, time, and quality
- time in phase distribution
- defect density
- defect removal rate
- review rates
- process and phase yield
- cost of quality
- percent defect-free
- defect removal profiles
- quality profile and process quality index

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Topics

Key Systems Development and Program Management Issues

Metrics for Managing Cost and Schedule Issues



Project Planning Principles and Application

Project Tracking Principles and Application

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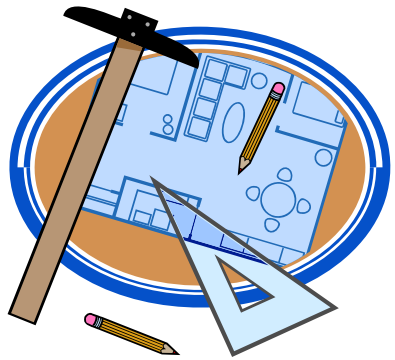
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Project Plans

A Program Manager should expect to find the following:

- Most project plans are underestimated.
- Many project plans are missing the unknowns.
- Many projects are late before they start.

The problem is that many project plans ignore well-known principles of project planning and are therefore un-executable.



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Project Planning Guidelines

Projects are dynamic, so are good project plans.

Accuracy improves with detail, so make detailed plans and estimates; use historical data.

Quality must be managed by the numbers, so make a quantitative quality plan.

The best plans are made by the people assigned to do the work.

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Dynamic Plans

If you can't make accurate plans, plan often.

Many projects (especially software projects) are subject to considerable change.



Every change will affect the cost and schedule.

Every cycle will include new information.

Projects should produce new plans every few months.

- a detailed near-term plan
- a high-level plan to the end of the project

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Detailed Plans

Detailed plans are more accurate.

They are more likely to be complete.

There is greater opportunity for over-estimates and under-estimates to cancel.

Detailed plans provide

- deeper insight into the work
- better guidance during execution
- more accurate tracking
- basis for getting out of trouble

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Detailed Estimates

Like detailed plans, detailed estimates are more accurate for the same reasons.

There are many estimating methods available.

The best methods

- use historical data
- have a feedback loop
- are systematic methods or processes that reduce bias and can be improved
- are appropriate for, and calibrated to, the work

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Estimating Bias

Most estimates tend to be optimistic.

The key to accurate estimates is not the accuracy of each estimate.

The key to accurate estimates is detail and consistency.

To improve consistency, the engineer must reduce estimating bias.

To reduce estimating bias the developer should

- make size estimates first
- base effort on size
- next estimate resources
- use estimated effort and resources to create a schedule

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Quality Principles

Many intellectual products ignore quality until final review (or test).

You can't test in quality; if you try to you will

- increase cost and schedule by 40% to 50%
- make the plan even more unpredictable
- pay the contractor for avoidable rework
- field a defective product

To get a quality product out of test, you must put a quality product into test.

To put a quality product into test you must measure and manage quality at each step of the process.

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Quantitative Quality Plans

Quality without numbers is just talk.

If you want a high-quality product you must ask for quality data.

To do this you need to know

- what quality data to ask for
- how to evaluate the quality data you're given

The core metrics are a good start.

- defects injected and removed
- by phase and component
- both estimated and actual

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Quality Benchmarks (software example)

These quality benchmarks are derived from the SEI's TSP research for software projects.

They are based on results obtained from software project teams and individual developers.

They can be adapted to evaluate or track other kinds of project plans.

Sample TSP Benchmark Data	
Measure	**Benchmark**
Review rate	200 LOC/Hr.
Code injection rate	2/Hr.
Code review removal rate	4/Hr.
Code inspection removal rate	1/Hr.
Code review and inspection yield	70%
Unit test removal rate	3/Hr.
Unit test yield	50%
Integration and System Test removal rate	>10 Hr. per defect
Integration and System Test yield	< 50%

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Evaluating Plans -1

The objective is to determine if the plan represents a reasonable commitment.

Is it complete, detailed, accurate, robust, and capable of producing a quality product?

Size estimate

- Was size estimated?
- How were the estimates made?
- Are the size estimates detailed?
- Was historical data used?
- Who made the size estimates?

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Evaluating Plans -2

Effort estimate

- Was effort estimated?
- How were the estimates made?
- Are the efforts estimates based on size?
- Are the efforts estimates detailed?
- Was historical data used?
- Who made the effort estimates?

Quality plan

- Does the plan include estimates of defects injected and removed by phase?
- How were these estimates made?
- Are they based on either size or effort?
- Was historical data used?
- Who made the estimates?
- How is the effort distributed? (gets to quality and rework)

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Probing Questions for a Plan Review

What Acquirers Should Look For

1. What are the size estimates for the principal products and how did you arrive at these estimates?

2. How do you know if you have included all of the necessary tasks?

3. What is the basis for your task estimates?

4. How did the team arrive at the schedule?

5. How did you estimate the number of weekly task hours?

6. What could management do to help maximize your weekly task hours?

7. Have you looked at alternative plans?

8. Could you accelerate the schedule, and if so, what would it cost?

9. What is your quality plan and how did you produce it?

10. What is your security plan and how did you produce it?

11. What are the key risks and your mitigation plans for them?

12. Have you considered prototyping or reuse?

13. What is the likely error in the size, time, and schedule estimates?

14. When will you have learned enough to make a more accurate plan?

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Commitment

Intellectual product development is a team sport.

Motivated teams are more productive and produce better products.

When teams are empowered to make their own plans they are motivated to meet their commitments.

Costs and schedules are established before the project is staffed and are difficult to change.

The question is, how early do you want to know about cost and schedule trouble?

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Getting Out of Trouble

Projects don't get behind overnight, they slip day by day.

If you manage the days, the weeks, months, and years will take care of themselves.

The key is early warning.

- The review period must be short.
- Detailed weekly data are needed.



The most common causes of schedule slip

- estimation error (size, effort, hours available per week)
- quality problems

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Early Warning

Projects get in trouble for many reasons.

What indicators provide early warning of cost, schedule, or quality problems?

- earned value progress tracking
- resource tracking
- software
  - defect removal profile
  - percent defect-free



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Earned Value Progress Tracking

The SEI recommends the use of *earned value* for tracking project progress.

Earned value (EV) is a method for tracking progress based on the contribution that each task makes towards completing the project.

EV provides a precise way to

- measure project status
- estimate project completion dates

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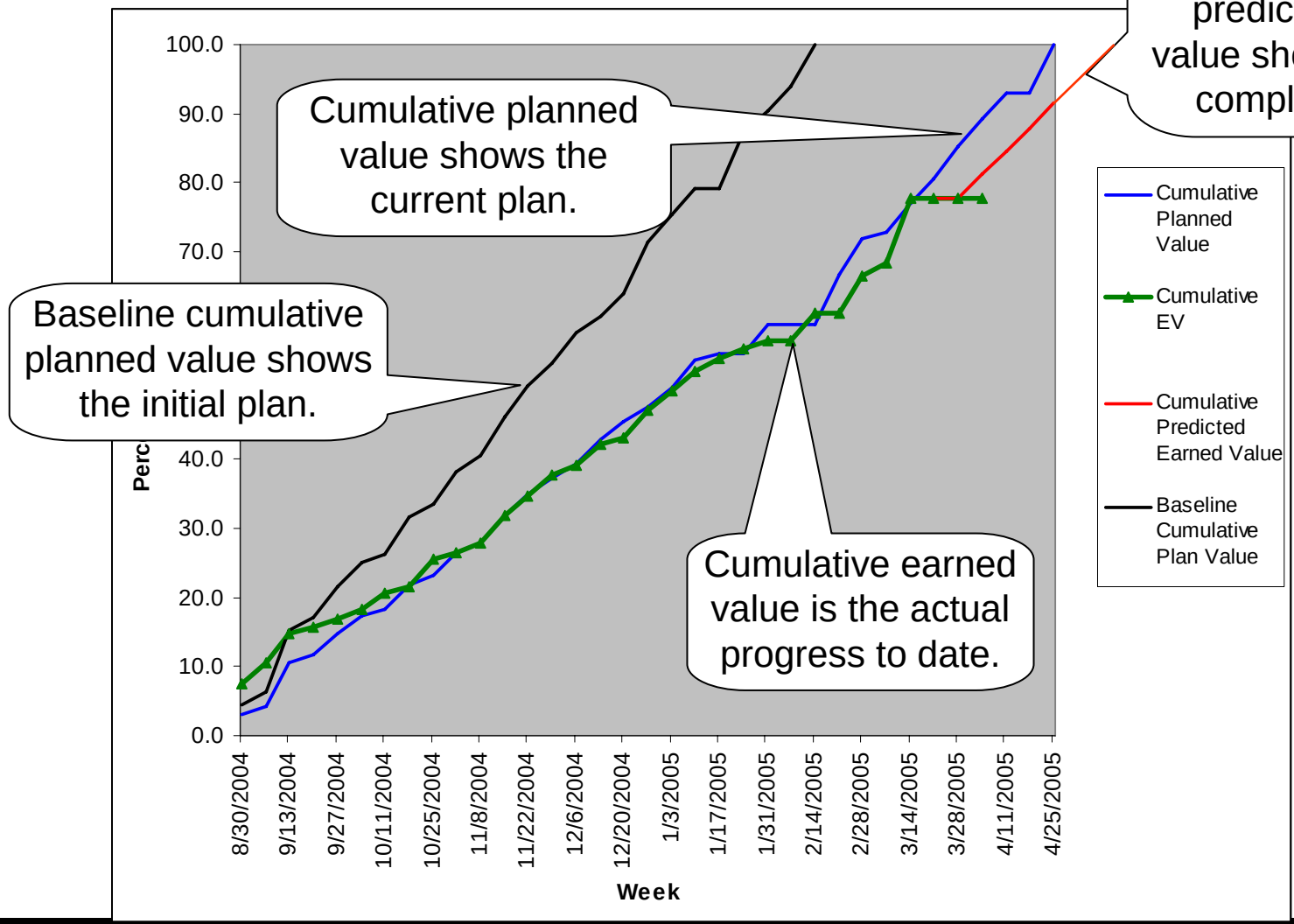
Earned Value Guidelines

The SEI recommends the use of the following earned value guidelines.

- A task's EV is the task's estimated hours divided by the total estimated hours for all tasks in the project.
- The project earns the value for a task when it is completed, there is no partial credit.
- The EV credit is the same, regardless of the time the task actually takes.

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Earned Value Tracking (toward a milestone)



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EV Tracking Considerations

Causes of EV slip

- difference in estimated vs. actual effort
- difference plan vs. actual resource hours
- blocked tasks

EV limitations

- assumes future is like the past
- insensitive to future estimation error or resource deltas
- poor quality in test can be a significant impact

EV must be applied consistently across projects and programs!

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Status Tracking at a granular level

Here's an example of how teams can track their status weekly using a defined process and a weekly status summary in a support tool.

TSP Week Summary - Form WEEK

Name	Carol
Team	PSP Ghost
Status for Week	15
Week Date	3/10/2003
Date	4/7/2003
Cycle	

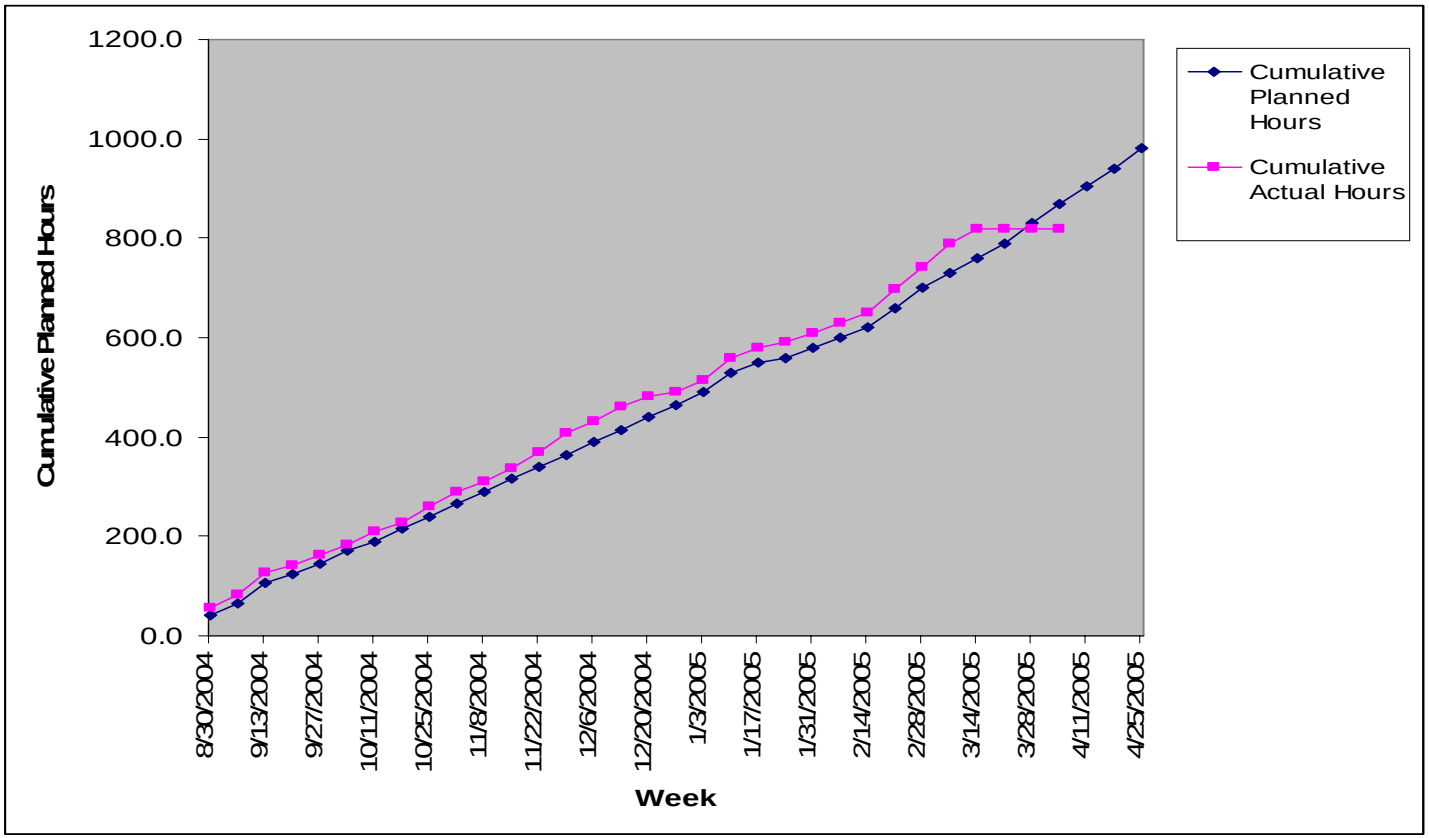
Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	151.0	86.0	1.76
Schedule hours this cycle to date	1526.0	1594.8	0.96
Earned value for this week	6.9	4.2	1.64
Earned value this cycle to date	79.5	84.3	0.94
To-date hours for tasks completed	1580.7	1568.1	1.01
To-date average hours per week	101.7	106.3	0.96

Assembly	Phase	Tasks Completed or Due	Resource	Task Plan Hrs.	Task Actual Hrs.	Earned or Plan Value	Planned Week	Plan vs. Actual Hrs.
Main Form	CODEINSP	Main Form Code Inspection	SA	1.5	2.4	0.1	10	0.63
OEMMOO Delivery.asp	UT	OEMMOO Delivery.aspx (FE-Server) U	NK	8.9	3.0	0.5	13	2.91
OEMMOO Delivery.asp	DLDINSP	OEMMOO Delivery.aspx (FE-Client) DI	NK	0.0	0.0	0.0	13	
OEMMOO Delivery.asp	CODE	OEMMOO Delivery.aspx (FE-Client) C	NK	7.5	5.7	0.4	14	1.32
OEMMOO Delivery.asp	CR	OEMMOO Delivery.aspx (FE-Client) C	NK	3.8	1.7	0.2	14	2.26
OEMMOO Delivery.asp	COMPILE	OEMMOO Delivery.aspx (FE-Client) C	NK	1.3	0.9	0.1	14	1.44
OEMMOO Delivery.asp	CODEINSP	OEMMOO Delivery.aspx (FE-Client) C	NK	0.0	0.0	0.0	14	
OEMMOO Delivery.asp	UT	OEMMOO Delivery.aspx (FE-Client) U	NK	5.9	6.8	0.3	14	0.87
Query Object	TD	Query Object Test Development	MB	0.0	0.0	0.0	14	
Query Object	CODEINSP	Query Object Code Inspection	MB	0.0	1.2	0.0	14	0.00
Query Object	UT	Query Object Unit Test Dialogs	MB	1.1	1.7	0.1	14	0.66

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Resource Management

Here's another example of how teams can track resource utilization weekly using a defined process and a weekly status summary in a support tool.



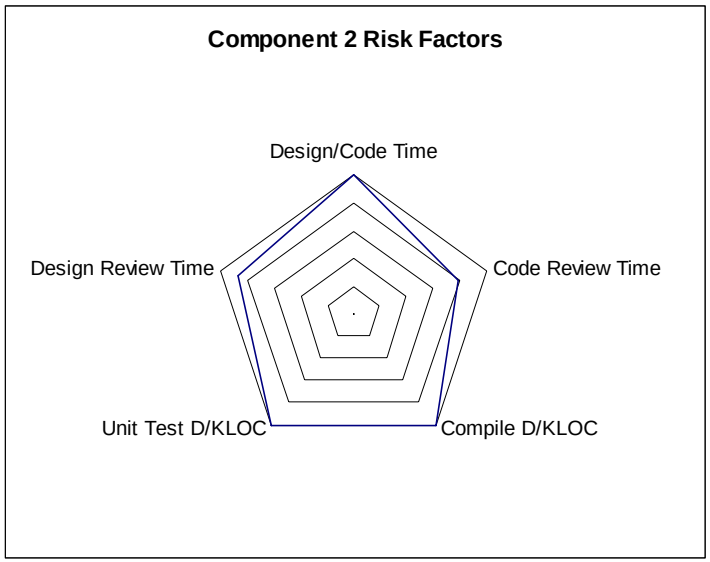
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Quality Management

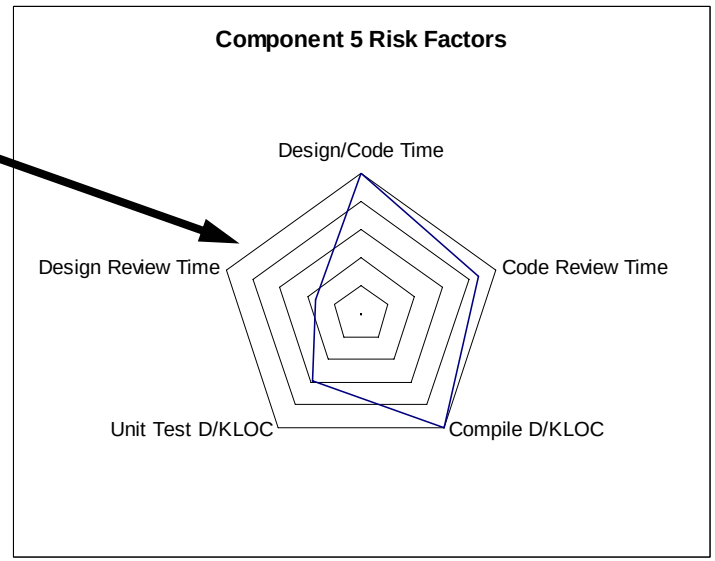
Here's another example of how Software Development teams can use a Quality Profile as an early warning indicator of post-development defects.

The quality profile uses five software quality benchmarks.

Satisfied criteria are plotted at the outside edge of the chart.



Inadequate design review time results in design defects escaping to test and production.

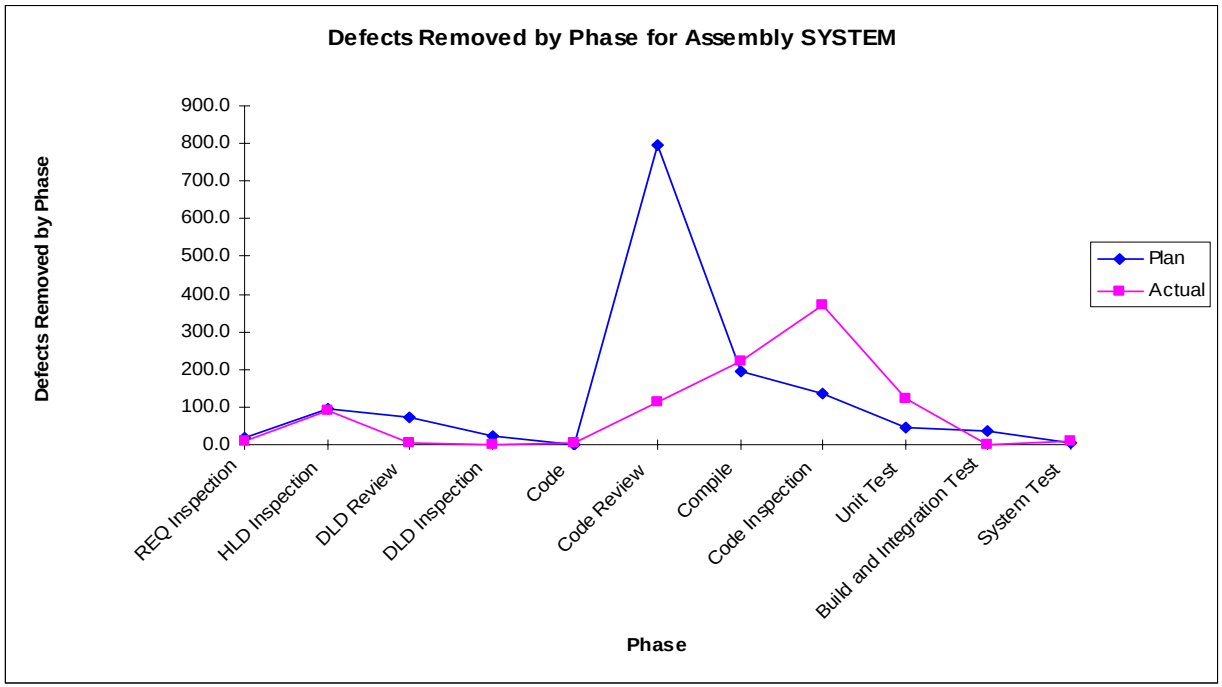


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Defect Removal Profile

Again, using a Software Development example, a Defect Removal Profile may be used to track

- plan and actual defects removed by phase
- early vs. late defect removal plan

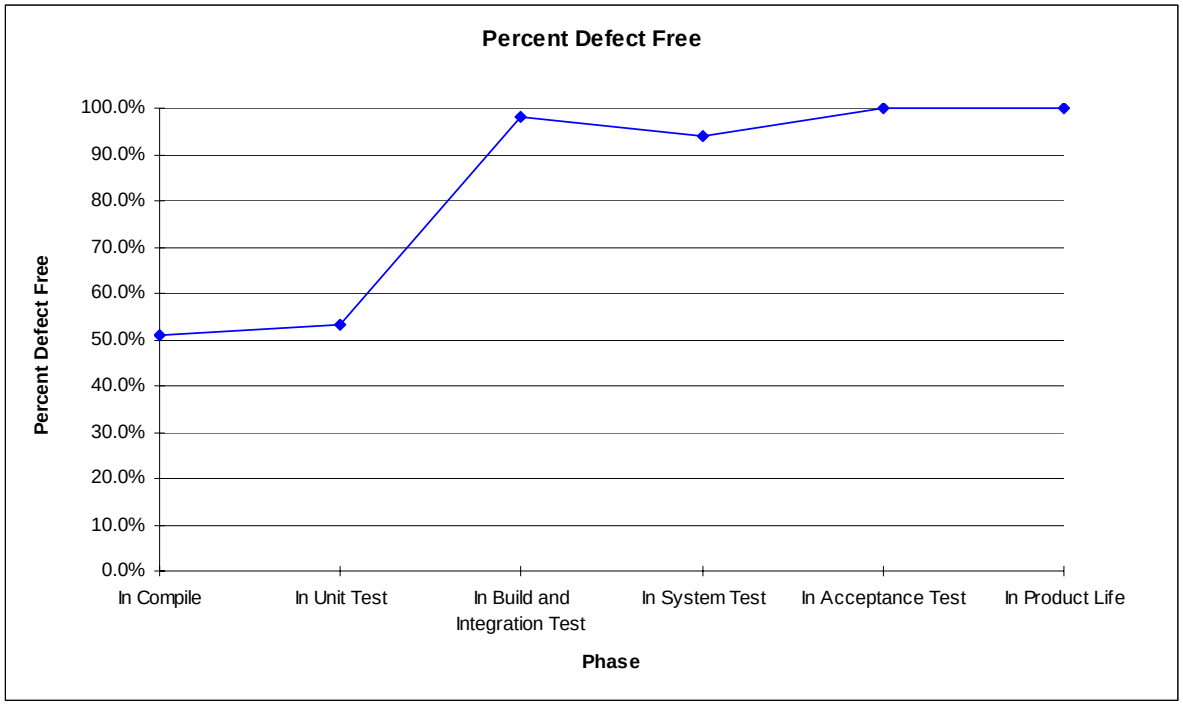


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Percent Defect Free

Similarly, teams can use a Percent Defect-Free profile to track

- percentage of components that are defect-free in test
- pre-test process quality



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Probing Questions for a Status Review

What Acquirers Should Look For

1. What percentage of the project has been completed based on earned value?

2. How does the earned value compare to planned value?

3. What is the end date based on predicted earned value?

4. How do planned resource hours compare to actual resource hours?

5. How do actual hours for completed tasks compare to estimated hours for completed tasks?

6. What is the gap between actual resource hours and actual hours for completed tasks?

7. How does this gap compare to the average actual hours per week?

8. How do size estimates compare to the actual size of completed components?

9. What is the correlation between actual size and actual hours for completed components?

10. What is the correlation between the planned size and actual hours for completed components?

11. How do planned defects compare to actual defects for completed phases and components?

12. What is the actual review rate for inspections and reviews?

13. What percentage of components are defect-free at unit test, integration test, system test, …?

14. How does the actual defect removal profile compare to plan for completed components?

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The Way Forward . . . *Team Process Integration*

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What Should Be the Way Forward?

Alternatives should address deficiencies in “conventional wisdom”

- Based on data collected as work is done
- Used to change development behavior
- Predictive metrics, not just reactive (leading vs. lagging)
- Using proven, repeatable methods
- Incorporating planning and tracking principles we have just discussed
- Addressing institutionalizing change

If we don’t address these issues, we are doomed to repeat the mistakes of the past . . .

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What Alternatives Exist?

One example is the Team Software Process (TSP), an integrated set of practices for developing software.

TSP is an process-based solution to common software engineering and management issues.

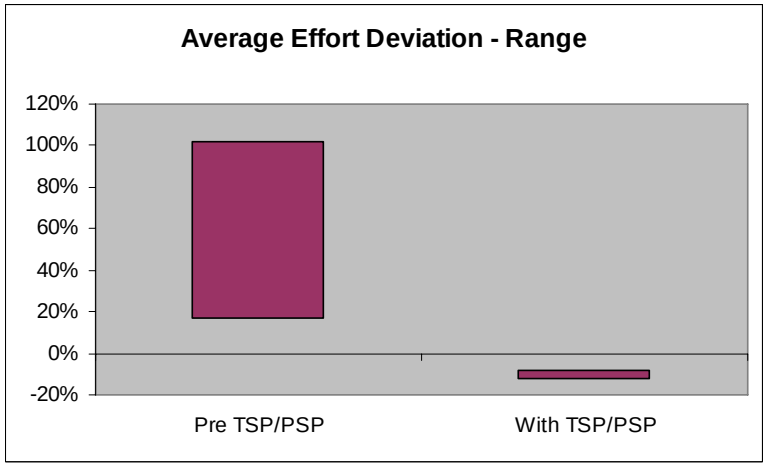
- cost and schedule predictability
- productivity and product quality
- process improvement

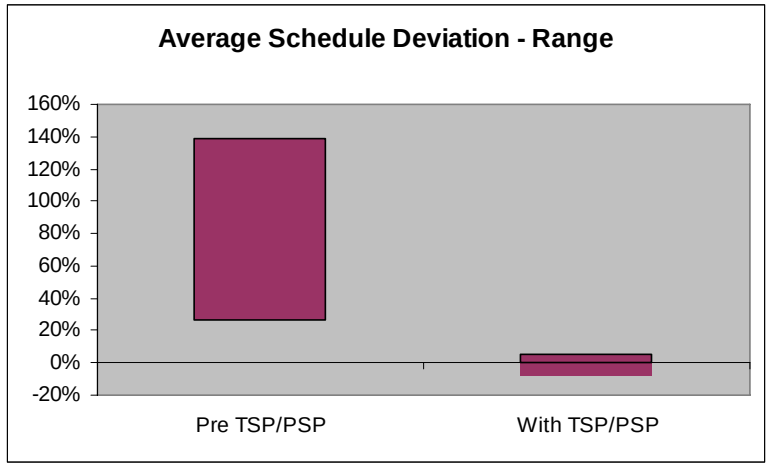
Unlike other methods, TSP

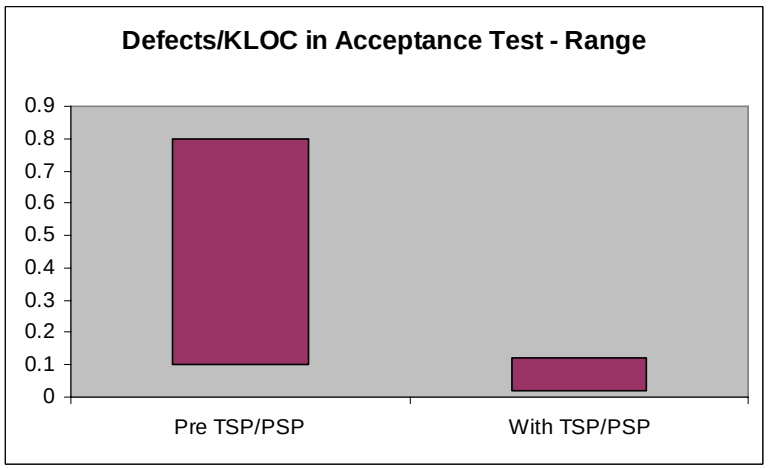
- teams are self-directed.
- emphasizes measurement and quality management.
- provides immediate and measurable benefits.
- accelerates CMMI-based improvement.

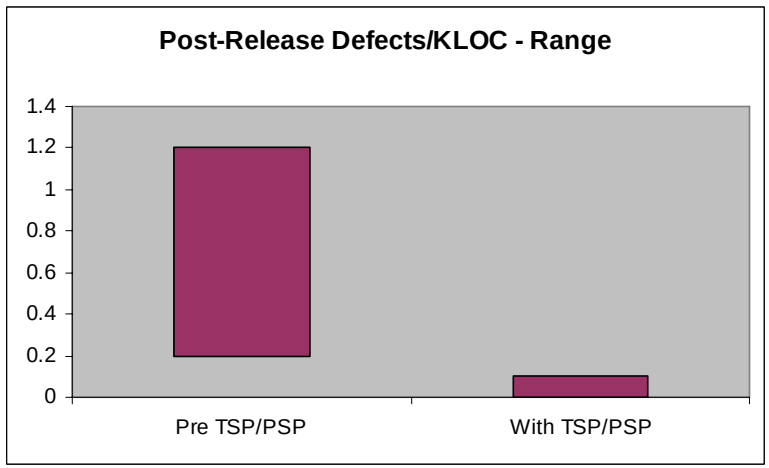
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TSP Improves Performance









Source: CMU/SEI-2000-TR-015

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TSP Performance Comparison

Performance Category	Typical Industry Performance[1]	Study Baseline (2000) [2]	TSP Impact Study (2000)[3]	TSP Impact Study (2003)[4]
Schedule Error	180% avg.	27% to 112%	5% avg.	6% avg.
Effort Error	130% avg.	17% to 85%	-4% avg.	26% avg.
System Test defects per KLOC	5 to 25 approx.	NA	0.0 to 0.9	0.4 avg. 0.0 to 0.9
Released defects per KLOC	1 to 7	0.2 to 1+	0.0 to 0.35	0.06 avg. 0.0 to 0.2

1. Gartner Group
2. Control projects from CMU/SEI-2000-TR-015, a study of 18 TSP projects in four organizations conducted in 2000.
3. TSP projects from CMU/SEI-2000-TR-015, a study of 18 TSP projects in four organizations conducted in 2000.
4. TSP projects from CMU/SEI-2003-TR-014, a study of 20 projects in 13 organizations conducted in 2003.

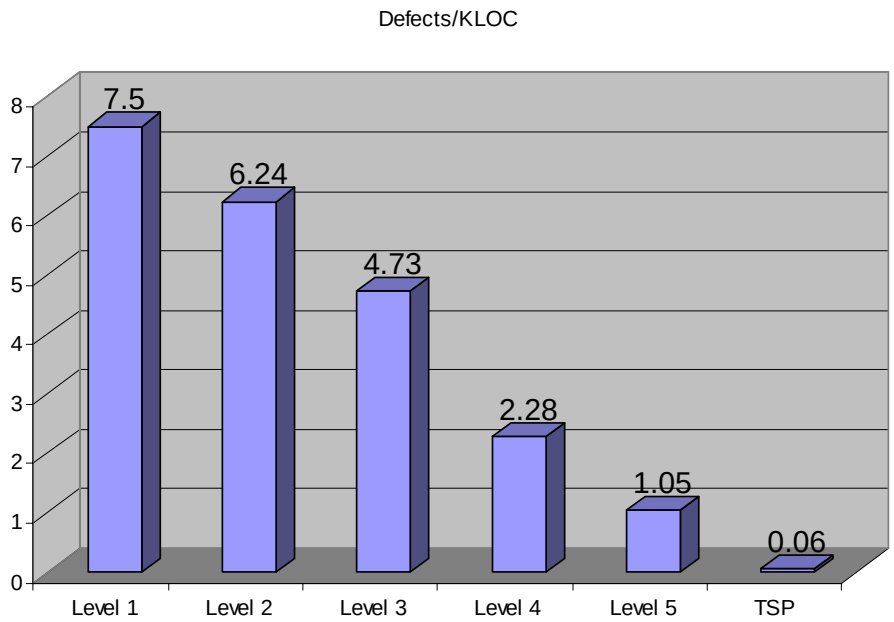
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TSP Improves Quality

An analysis of 20 projects in 13 organizations showed TSP teams averaged 0.06 defects per thousand lines of new or modified code.

Approximately 1/3 of these projects were defect-free.

These results are substantially better than those achieved in high maturity organizations.



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TSP Principles

Software is developed by individuals and teams. To improve overall performance, improve individual and team performance.

Empowered teams, coaching, and rational management are the most effective way to manage engineering teams.

Process is a performance determinant…an ad-hoc chaotic process cannot produce predictable, high-quality results.

Measurement is necessary for high-performance.

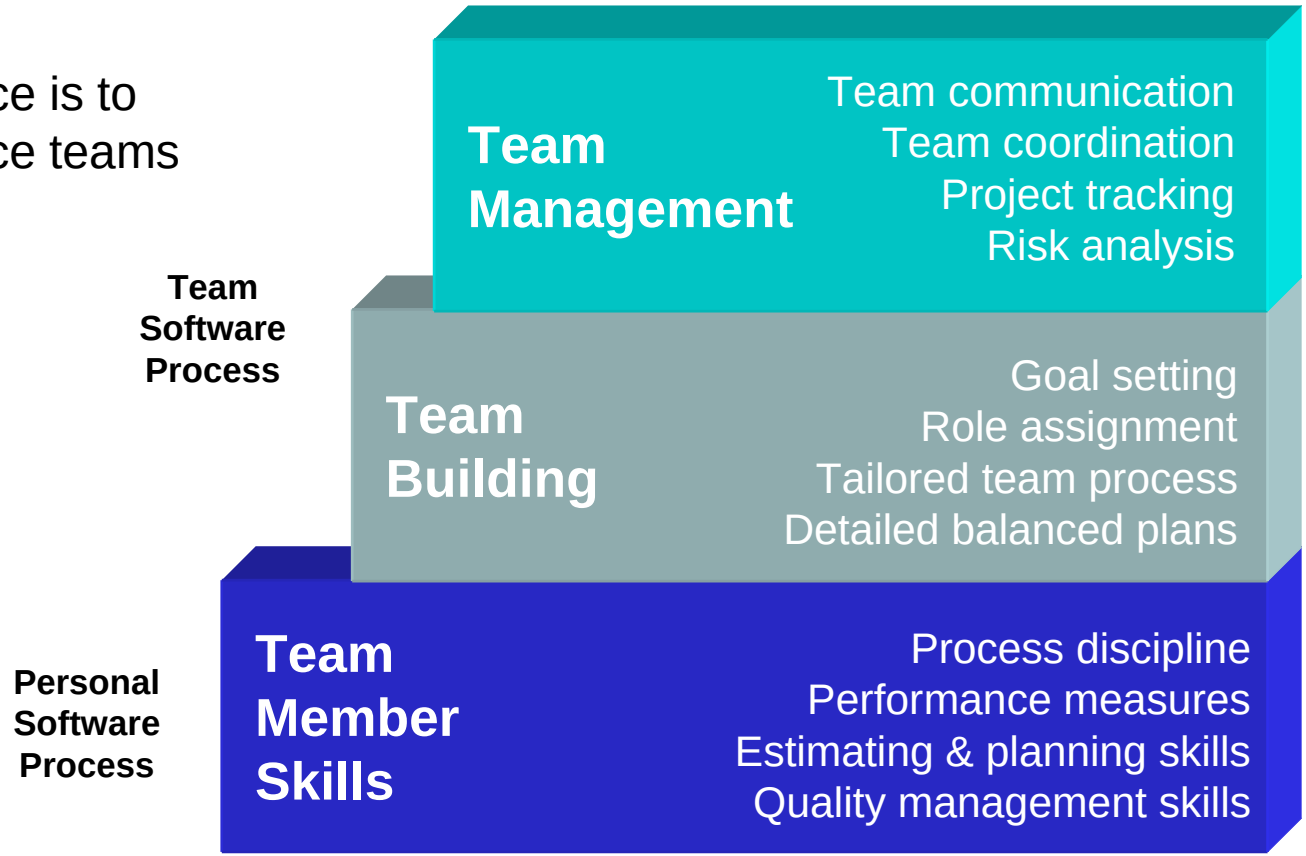
To get a quality product out of test, you must put a quality product into test.

Quality must be measured and managed at every step.

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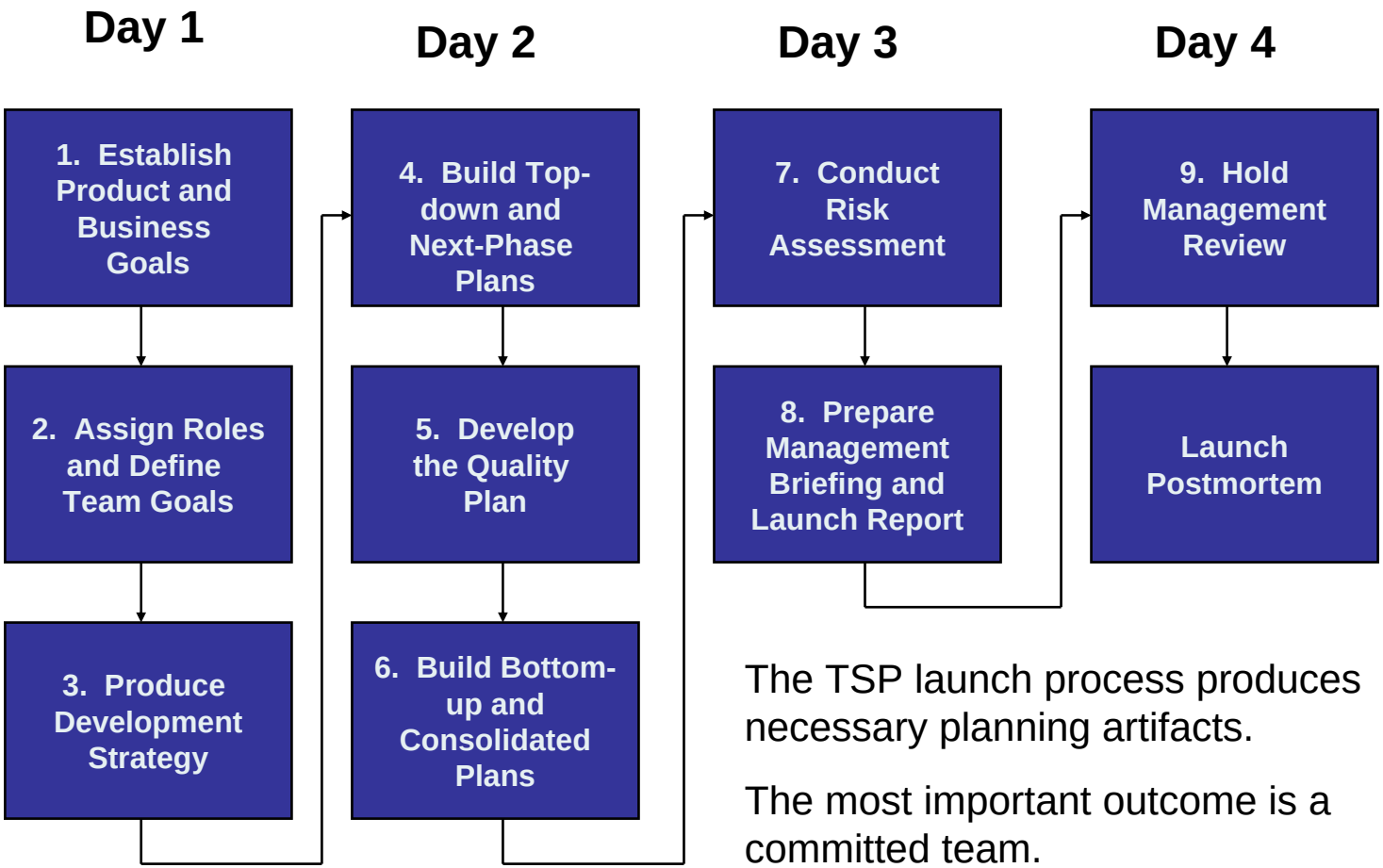
Building High-Performance Teams

The TSP strategy for improving performance is to build high-performance teams from the bottom-up.



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The TSP Launch Process



The TSP launch process produces necessary planning artifacts.

The most important outcome is a committed team.

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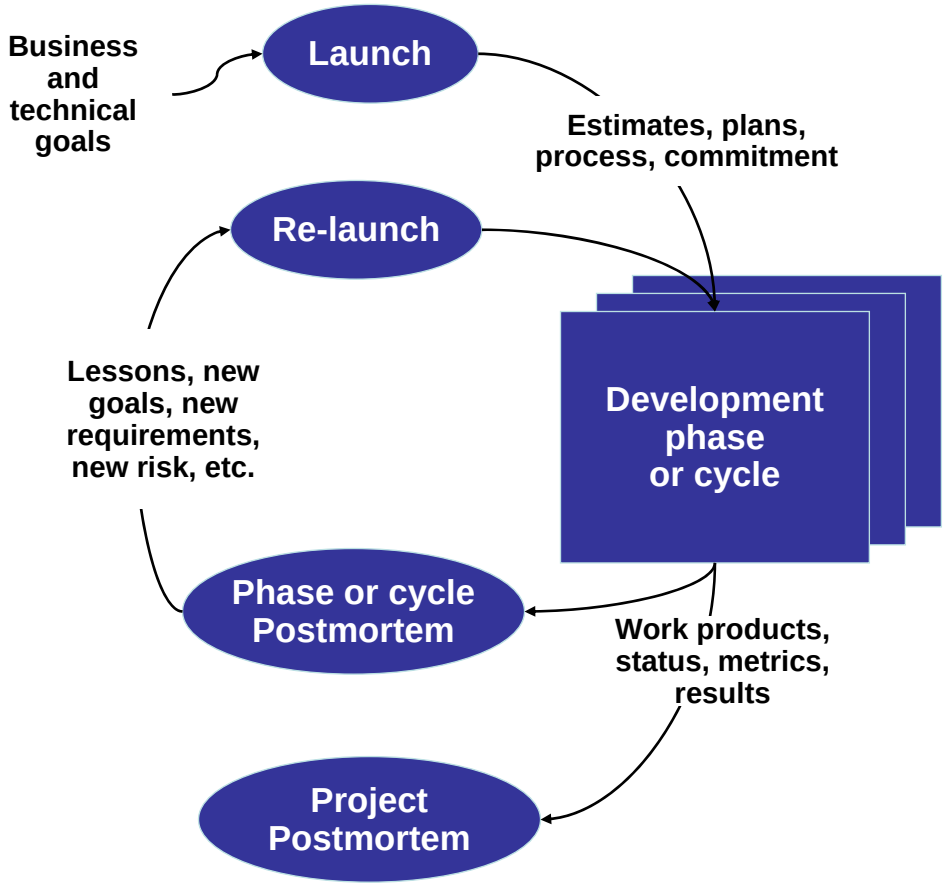
TSP Process Structure

The TSP process elements can be organized into whatever process structure makes the most business and technical sense.

The phases can be implemented iteratively in small cycles, in a spiral with increasing cycle content, or sequentially as in a waterfall,

TSP projects can start on any phase or any cycle.

Each cycle starts with a launch or re-launch and ends with a postmortem.



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Reasons for extending the TSP Method to the Systems Engineering Domain

Cost-benefit numbers exist from TSP on software projects

Requests from existing product teams using TSP to extend to their Systems Engineering (and other) process areas

Increasingly difficult to solve software problems without addressing systems engineering issues

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Extending TSP Method to the SE Domain—Team Process Integration (TPI)

How do we tailor TSP for other, non-software disciplines?

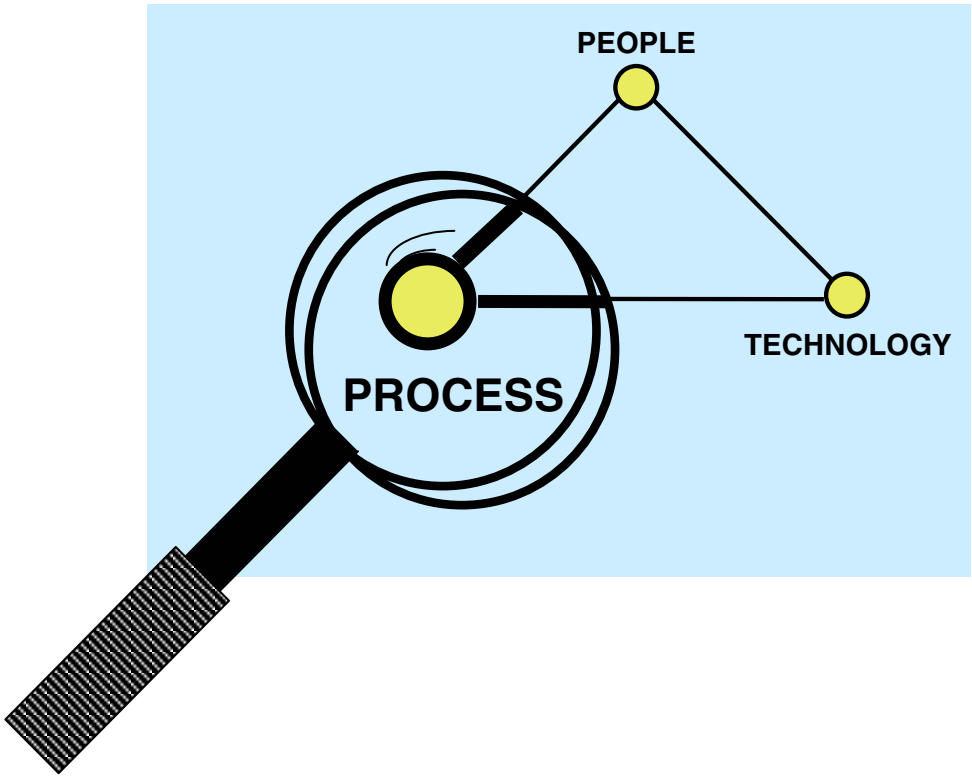
The research challenges include:

- Processes
- Measurement
- Role Definition
- Training
- Tool Support



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Research Challenges - Processes



- Develop prototype processes/scripts for SE and other engineering disciplines

- Use “traditional” TSP Launch Process

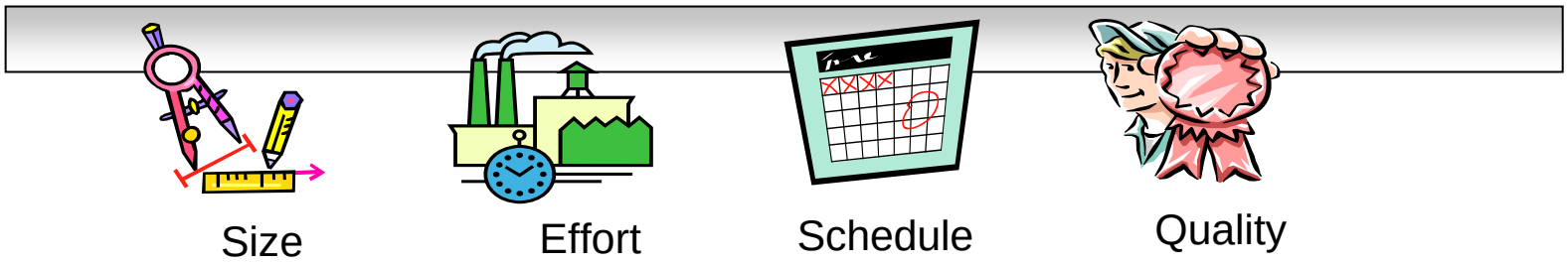
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Research Challenges – Measurement - 1

Schedule and effort measures are essentially unchanged.

Lines of Code/Function Points would not serve as relevant size measures for SE. Formulate size measures for SE. Examples:

- DOORS objects
- Requirements
- Items Verified



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Research Challenges – Measurement - 2

Quality measures in SE

- Define what “quality” means in SE
- Where in the process do you collect data?
- What are the derived quality measures (e.g., defects/DOORS object?)
- Establish initial quality baseline

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Research Challenges – Measurement - 3

What are the quality goals?



Examples:

- Goal: Accuracy in the work

  Measure: # of problem reports against requirements and test documents

- Goal: Conformance to standards

  Measure: # of defects in peer reviews; # of defects in requirements and test documents, etc…

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Research Challenges – Role Definition

Apply four primary roles—planning, process, quality, support

Assess applicability of remaining roles and define additional roles needed for SE.

- Add Requirements Manager
- Combine Design and Implementation roles into one role
- Expand Test Manager role as needed, e.g.,
  - Flight Test Manager
  - Lab Test Manager

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Research Challenges – Training - 1

Currently, training is geared to software teams.

So challenges include:

- building conviction and discipline in teams that don't write software programs
- providing just the right amount of training to get a team started
- supplementing with additional training modules as needed

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Research Challenges – Training - 2

Develop “JIT” training to support SE teams

Develop Leadership Seminar and Team Member Training to focus on:

- providing the fundamentals of TPI
- launching a team
- maintaining a plan



Follow-up with additional, “JIT” training, e.g.,

- Inspections
- Measurement, data analysis, and reporting
- Checkpoints and Postmortem Analysis
- Tool

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Research Challenges – Support Tool

Develop an extensible tool that allows for:

- Defining any process
- Collecting data unobtrusively
- Defining a measurement framework



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TPI Project Goal

Extend TSP method and practice to other domains

- Demonstrate that distributed teams using
  - **Tailorable** process scripts
  - Metrics
  - Automated tool support

  can deliver **quality** products and services on **cost** and **schedule**

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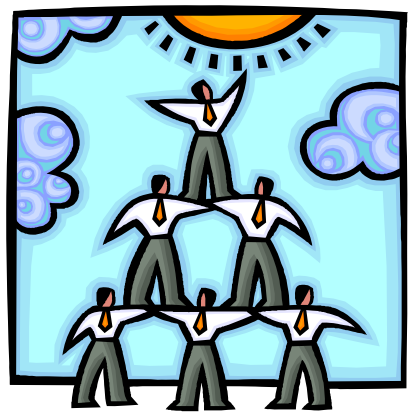
TPI Fundamentals

To be successful, teams need

- clear goals and roles
- agreed-upon processes and plans

Build self-directed teams

- team members own their own processes and plans
- team members understand their goals and roles
- team members voluntarily commit to their goals
- team members believe their commitments are achievable



The TPI launch builds self-directed teams.

Team members of self-directed teams practice disciplined personal processes.

TPI data rolls up to the project and program level.

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TPI Systems Engineering Pilots

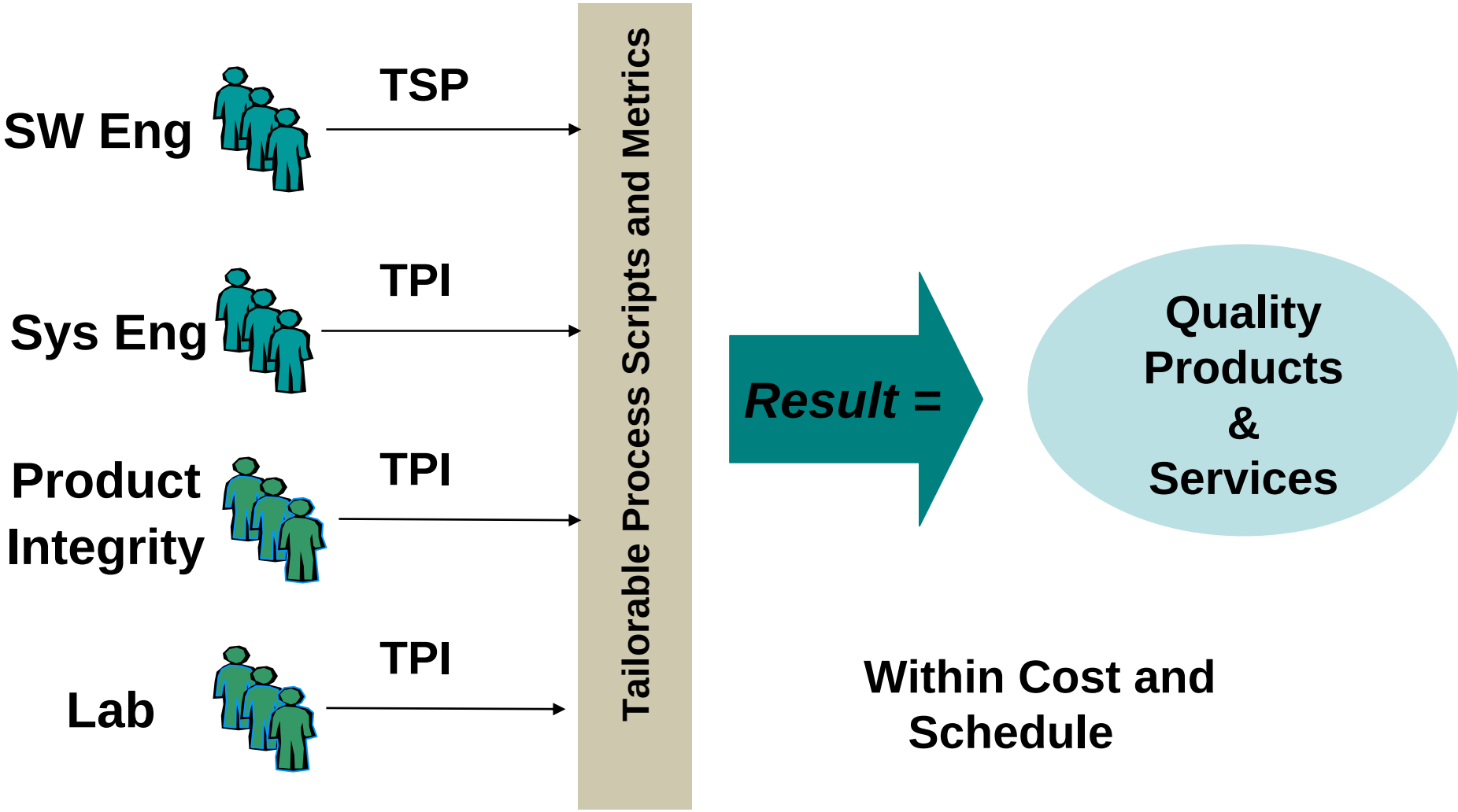
Conduct a series of pilot projects to determine if extending TSP practices to Systems Engineering and other engineering disciplines results in measurable improvement

- Engineering Discipline A
- Engineering Discipline B
- Systems Engineering/Integration
- Product Integrity
- Lab Team
- Test Team

Use these results to establish common processes/measures within and across projects/programs

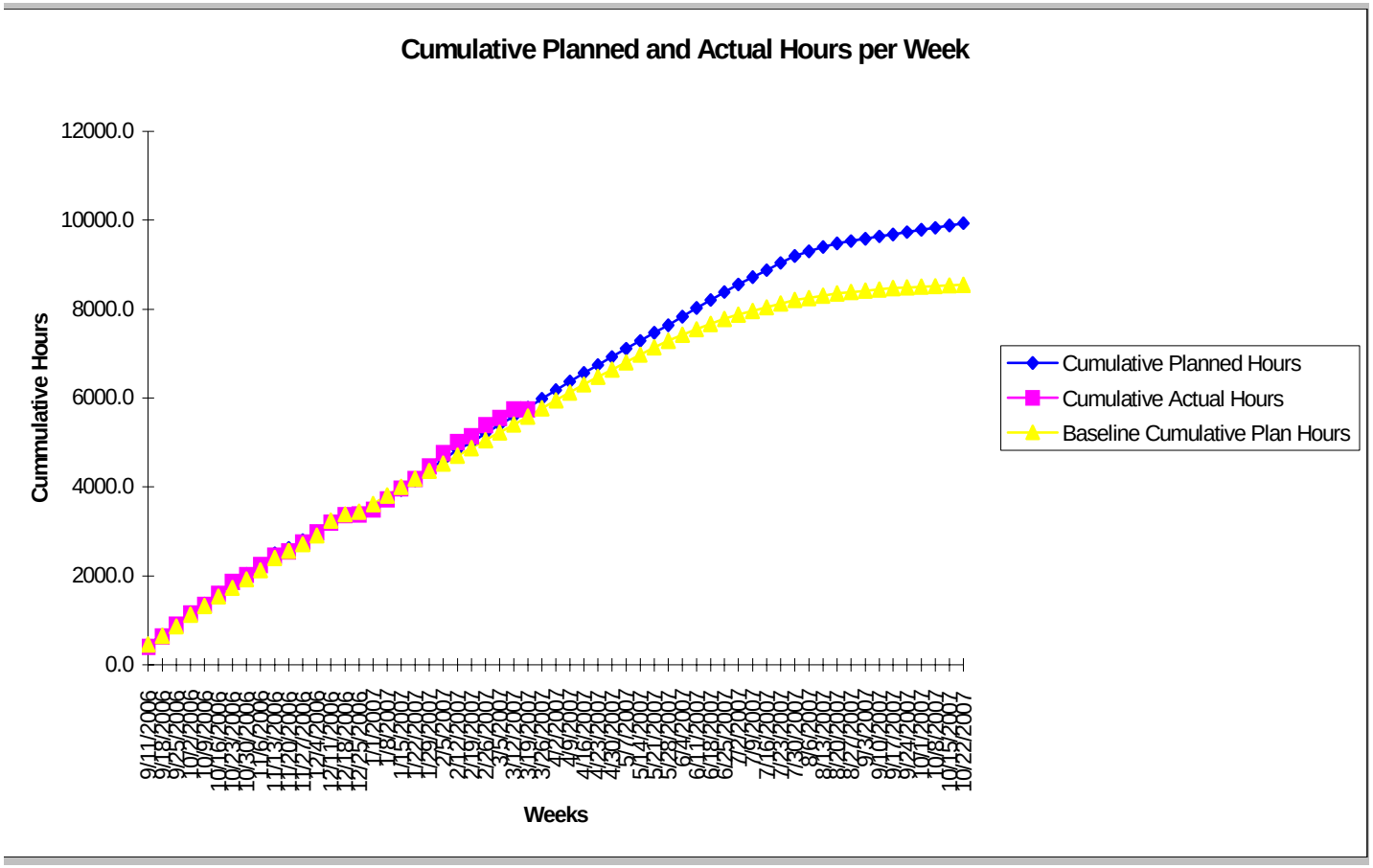
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Pilot TPI Implementation Approach at Org A



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Preliminary Results from Org A



Team has been consistently meeting or exceeding planned task hours (Faltering EV trend is not due to failing to meet task hour commitment.)

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Org A Qualitative Benefits - 1

High value in launch process – management communicating plans and priorities, team developing plans, coordinating & integrating across program/project teams

Tracking the work is helping team members to stay on track

- "I need to stop doing X to get back on track."
- Very easy to see the impact daily and weekly of not working to the plan
- Realization that one can't keep doing extra tasks without impact to the plan

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Org A Qualitative Benefits - 2

Team meeting—weekly coordination/communication with team members and off-loading/balancing of tasks

Team members functioning as a self-directed team by taking on team management roles--Planning Manager, Process Manager, Test Manager, and Lab Manager roles being executed

Better estimates for second launch cycle based on having . . .

- Common processes
- Common language
- Common metrics . . . within team and across teams and the entire program

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Lessons Learned

First Launch – estimates based on time, experience, and engineering judgment

Second Launch – estimates based on data from the first launch and proxies developed for systems engineering work

- Resulted in plan coming in much closer to desired schedule dates
- Better able to define work
- Agile team able to adapt easily to program/personnel changes—i.e., saves the team six months of defining new work for new team member
- Making course corrections as needed

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Team Leader Feedback from Org A



"Prior to TPI, we made estimates in a bubble."

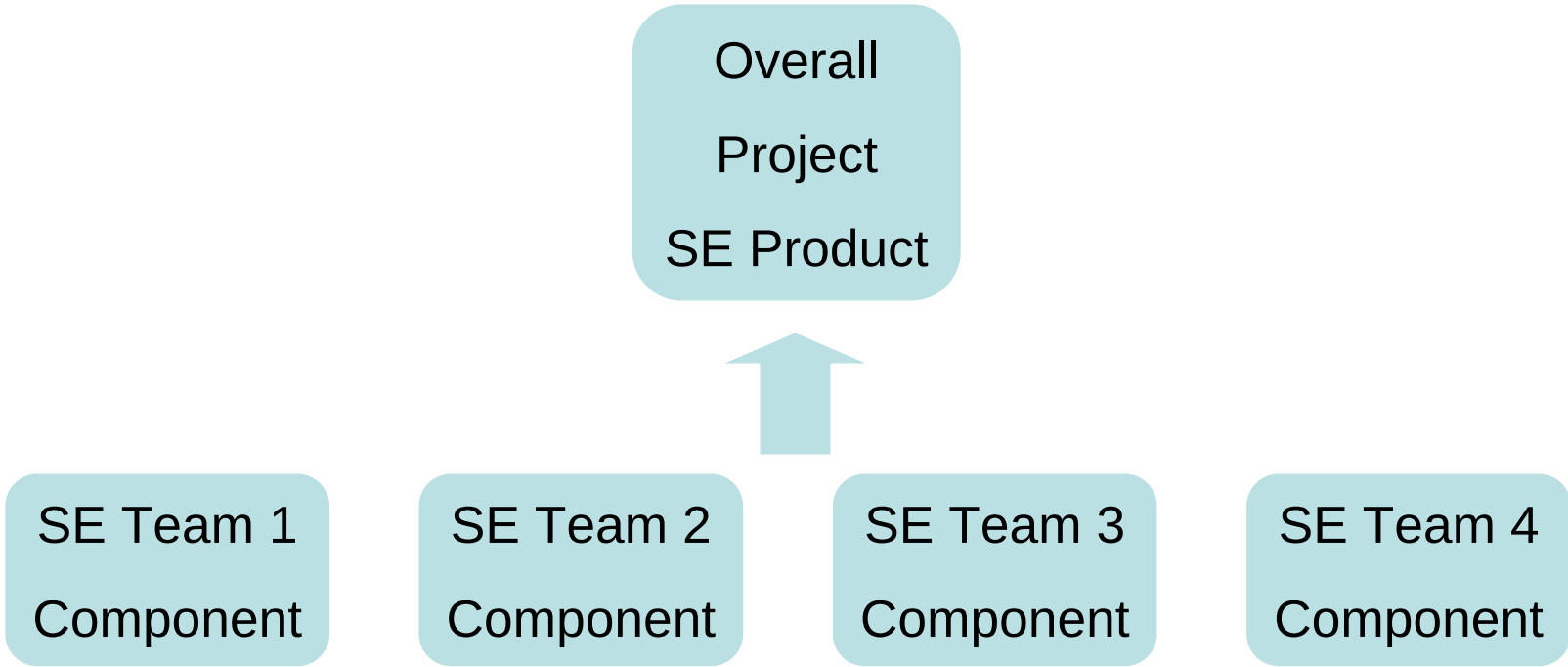
"Now we are establishing and maintaining baselines for all of our releases which allows us to make better estimates and more realistic plans and schedules."

"We have a team concept across our program with all of the subteams (SE, PI, SW, Test, Lab, …). We also have a common set of processes and metrics to help all of the teams better communicate and address dependencies across the teams."

"We are starting to roll-up our team data.
Next, we need to roll-up data across all of the teams in the XYZ Program."

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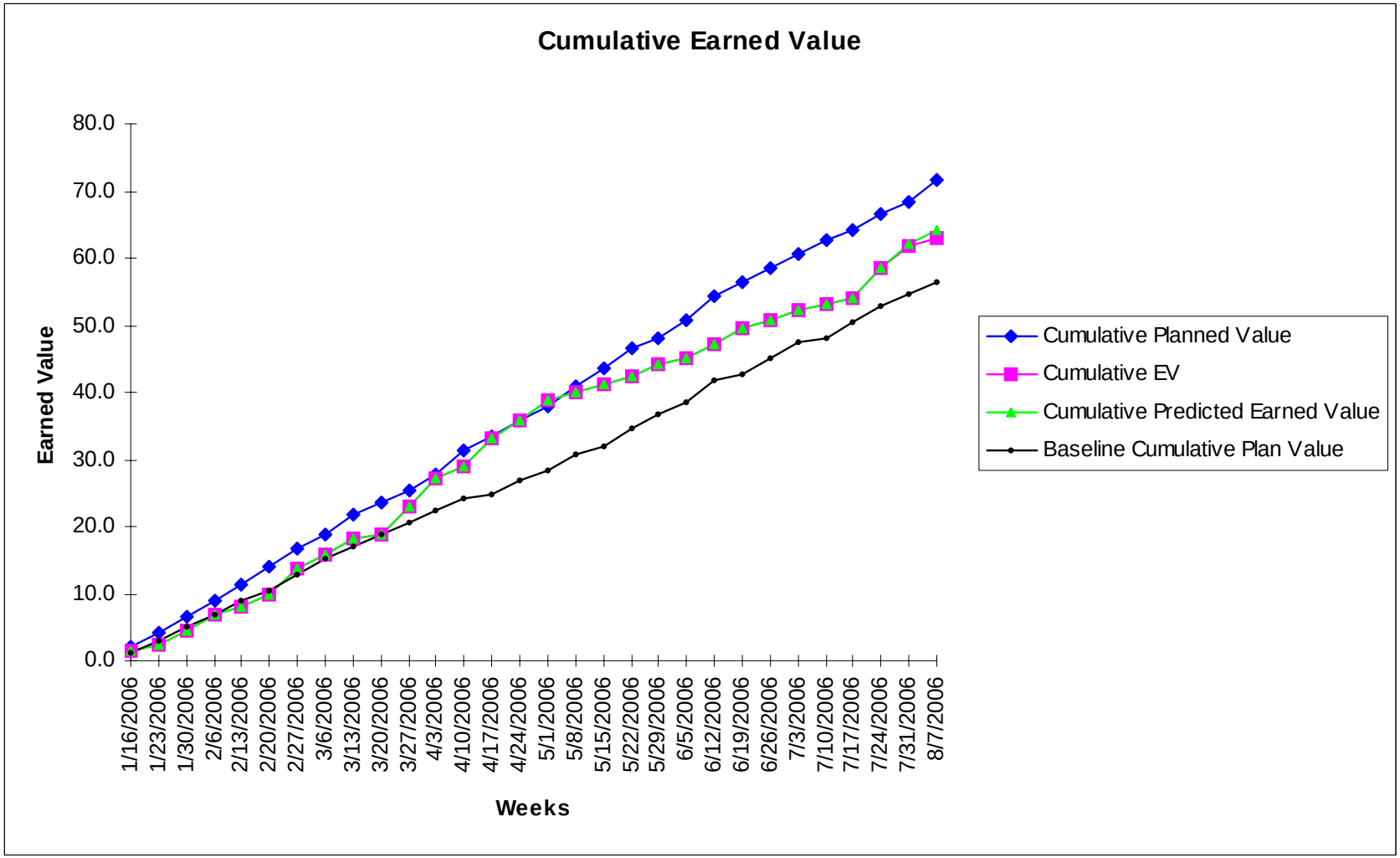
Pilot Approach at Org B



- Using TPI for 2+ yrs
- Extended to 6 teams and growing

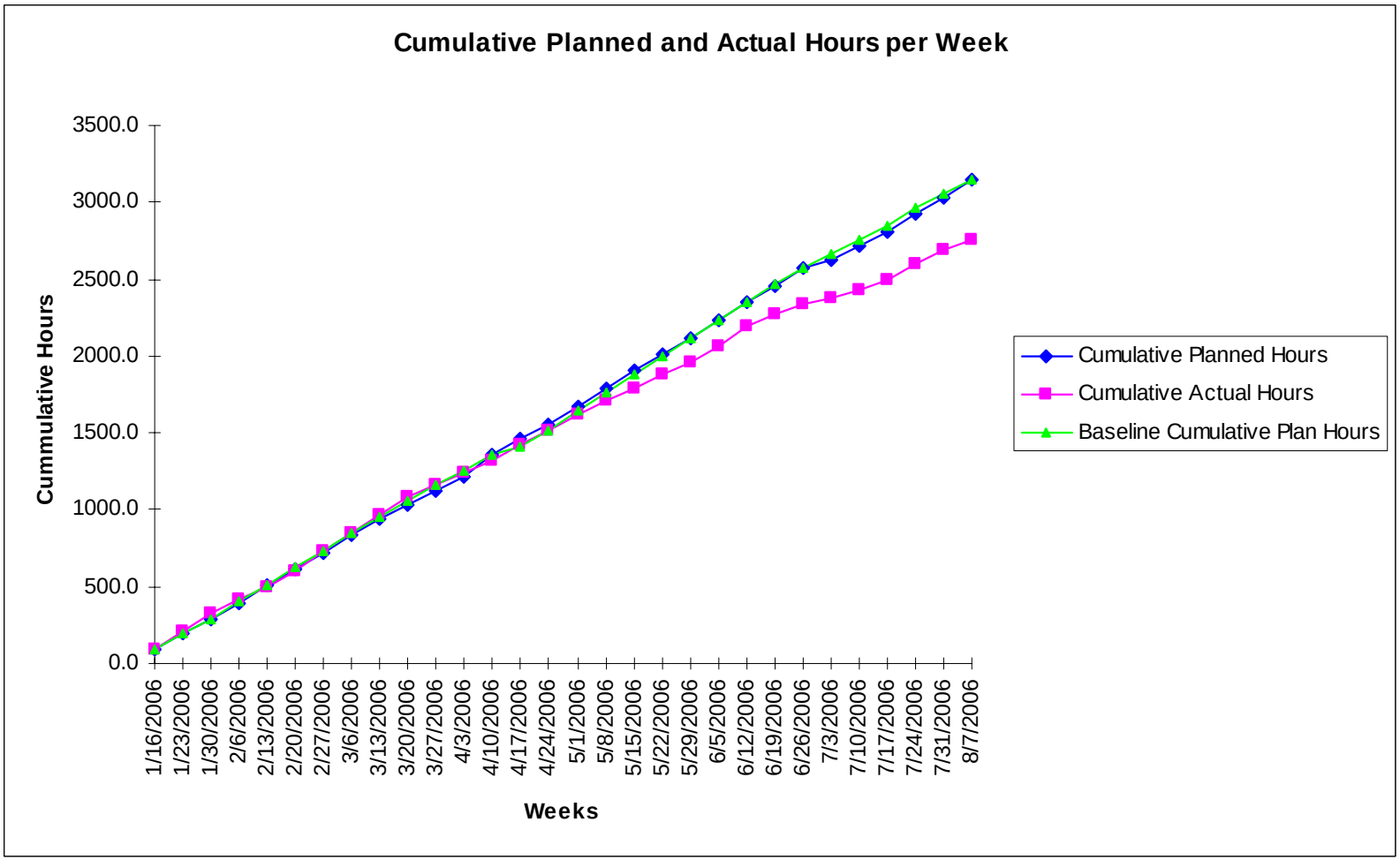
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Preliminary Results from Org B (SE Domain)



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Another example from Org B



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Comments on Previous EV Chart

Schedule performance diverged from the plan at the time this sample was taken.

The team was unable to apply the planned hours.

This often results from resource allocation to other projects.

This information permits the project manager and the program manager to make informed decisions when allocating scarce resources among multiple projects.

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TPI Approach Shows Promise

Eights teams are pilot testing TPI

The launch process is applicable in any engineering domain to:

- produce an executable team plan
- get management's agreement to the plan
- to build an enthusiastic, self-directed team

Provides data that PM's, team leads, team members can use

Provides common language and framework across teams

A support tool is being prototyped

- based on MS Access
- can be adapted to any engineering discipline

Training has been developed and tailored for SE and other teams
(e.g., Senior Leadership Training, Team Member Training, Tool Training)

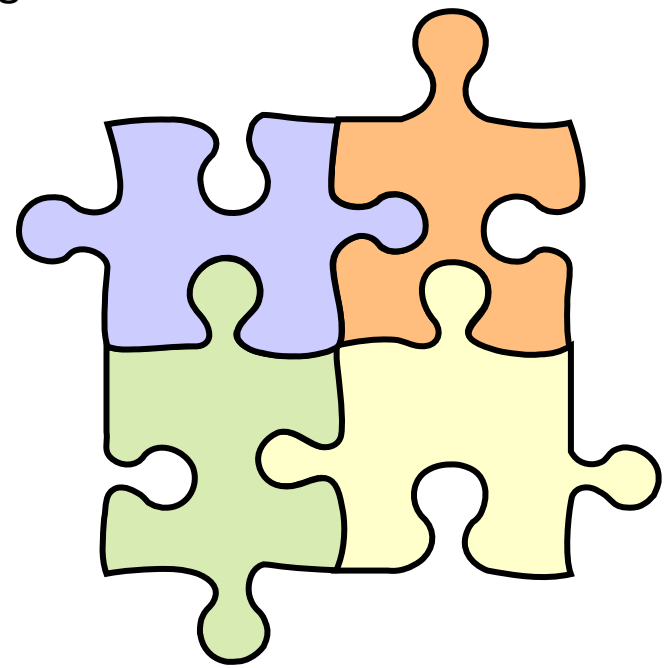
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What makes TPI unique—Putting the pieces together

You may already be using some of the planning, tracking, and quality management practices in the TPI.

What makes the TPI unique is that all these practices are integrated into a simple, operational framework that addresses

- Planning
- Tracking
- Quality
- Measurement
- Tool
- Training
- Team building



And that framework can not only be used at the project level, but at an individual team member level to guide day-to-day work.

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Improving How *YOU* Talk to a Program Manager

Reliable size, effort, cost, schedule, and quality data are required.

You get what you ask for, so know what to ask for and how to use what you get.

Remember—if you try you might just get what you need

Detailed plans that support weekly tracking and reporting of these data are necessary to detect trouble early.

Know how to use the data to identify the real issue, define a realistic course of action, and take it.

Team Process Integration shows promise as means to improve How ***YOU*** Talk to a Program Manager!



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For Further Information . . .
If You Are Interesting in Piloting TPI

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Event Time Analysis in Multi Mission Scenarios with System Simulation Models

Ravi Moorthy

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Topics

- *Abstract*
- *Definitions*
- *Multi Mission Scenarios and Missions*
- *Analysis Methodology*
- *Event Timeline*
- *Simulation Models*
- *Performance Metrics*
- *Sensor Resource Analysis*
- *System Concept Development Derivation*

Abstract

This paper presents an event time line analysis using system simulation models in multi mission scenarios

Radar resource usage is evaluated for the assessment of the multi mission capability of the combat system

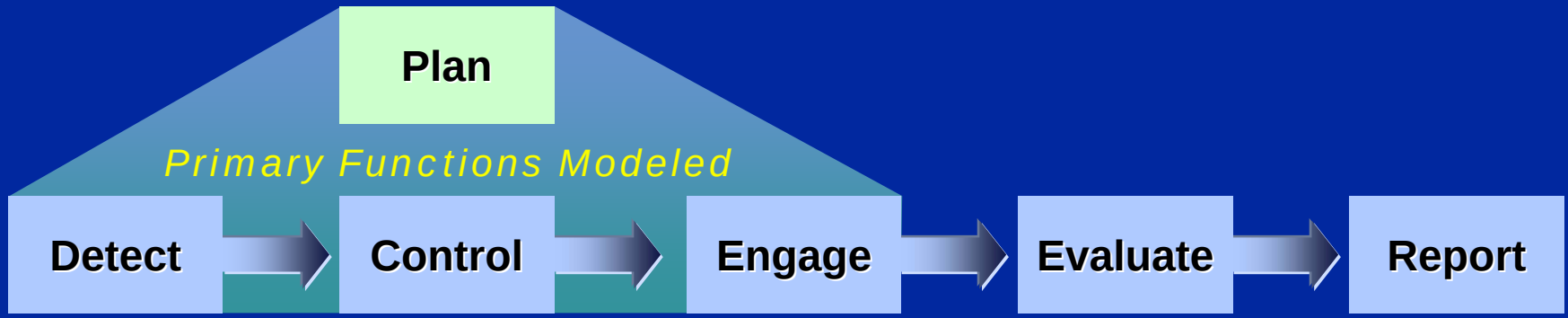
The impact of radar resource availability is evaluated in scheduling the events along the engagement timeline using the system simulation models

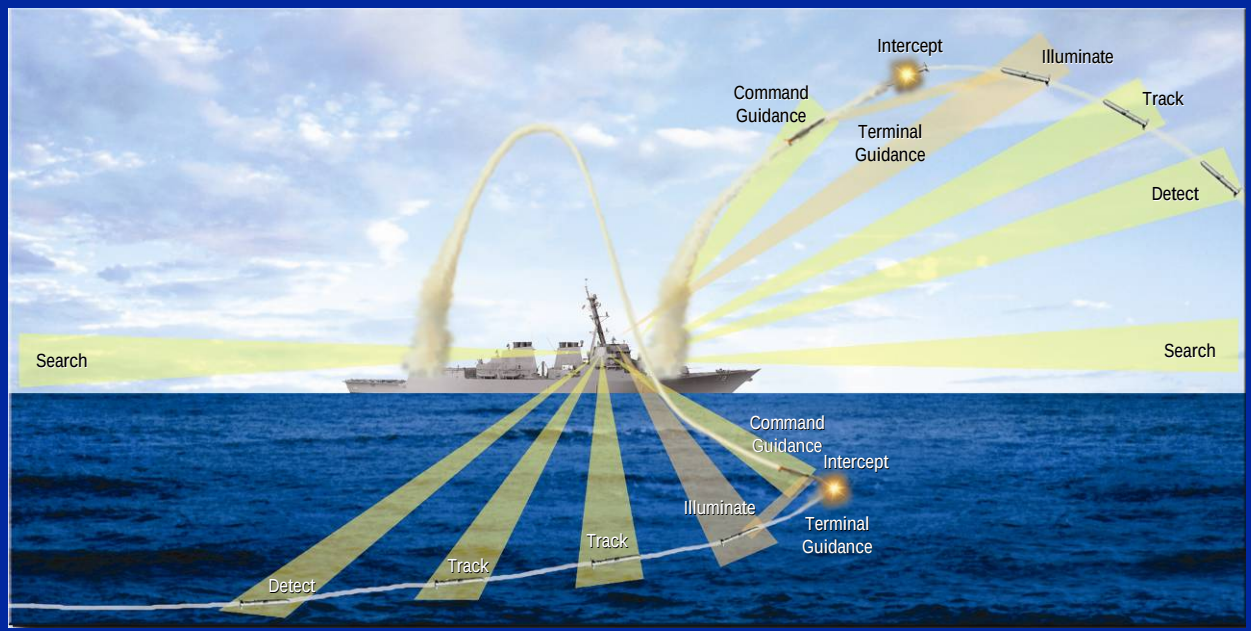
Definitions

- ***AAW – Anti Air Warfare***
- ***Sensors – Scanning and Tracking Radars***
- ***Multi Mission – Combined Missions requiring Simultaneous Tracking and engagements for Ballistic, Air or Surface Targets***
- ***Radar Resource Usage – Radar time required to schedule the beams for search and track***

Scenarios and Mission

General Engagement Timeline Model





Multi-Mission Scenario

- *Goal*
  - *Assess Naval Ship Combat System capability to simultaneously perform multiple Missions*
- *Typical Operational Scenario*
  - *A single ship is tasked with both mission A and a mission B*
  - *The ship will require management of radar resources to achieve both missions*

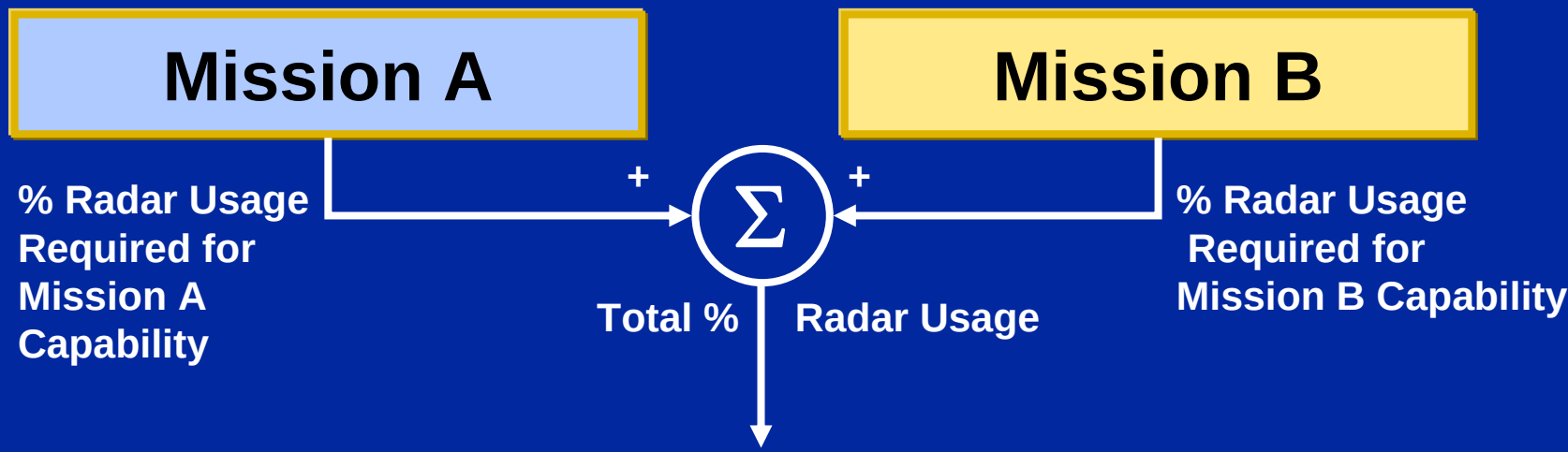
Analysis Methodology

- ***Mission specific system simulation models are used individually to determine individual mission performance***
- ***With post processing the radar resource usage is analyzed for combined event time lines of the missions***
- ***Alternate system concepts can be derived from the analysis***
- ***By managing priorities with some of the events, radar resources can be managed to provide capability for both missions***

Multi-Mission Capability Analysis Methodology

Raid of missiles arriving at a given interval inbound and in the vicinity of the ship while search is performed at a given rate

Raid of missiles arriving at a given interval from a given launch area impacting at a given distance from ownship



Combined analysis results for multi-mission scenario along the event timeline to evaluate whether a single ship system can simultaneously perform A and B missions

Simulation Models

- *System simulation models specific to missions were used*
  - *Event driven simulation models*
  - *High fidelity representation of radar and weapon systems in the models*
- *System simulation models were run individually for mission A and mission B*
- *Output data was combined for event time analysis*
- *Post processing of the data with MATLAB and Excel scripts*

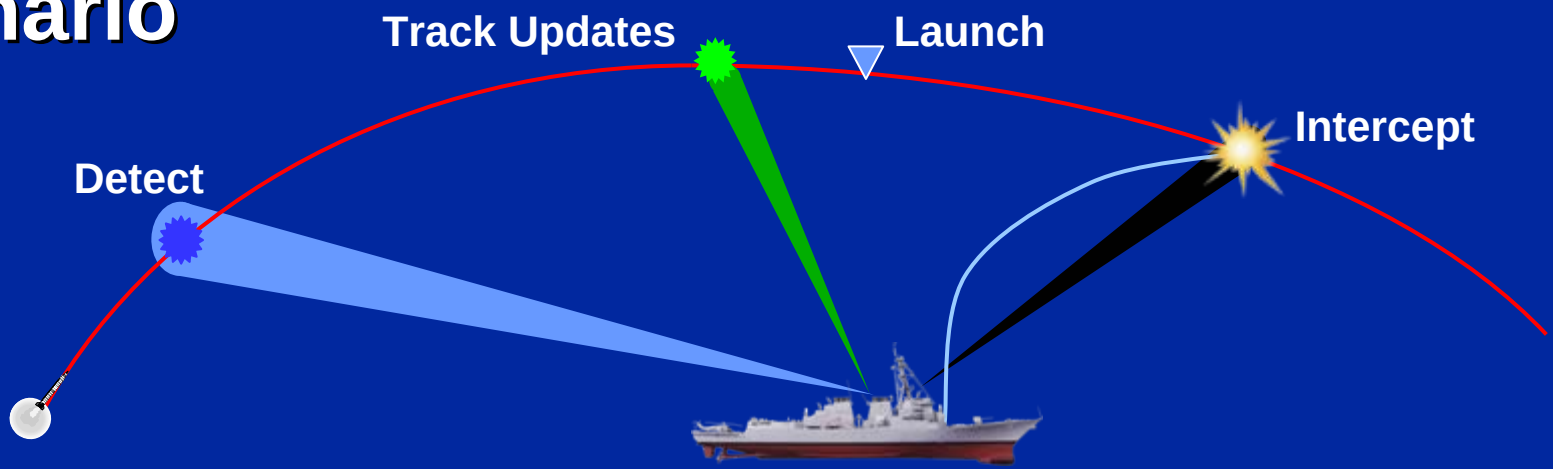
Resource Analysis Methodology

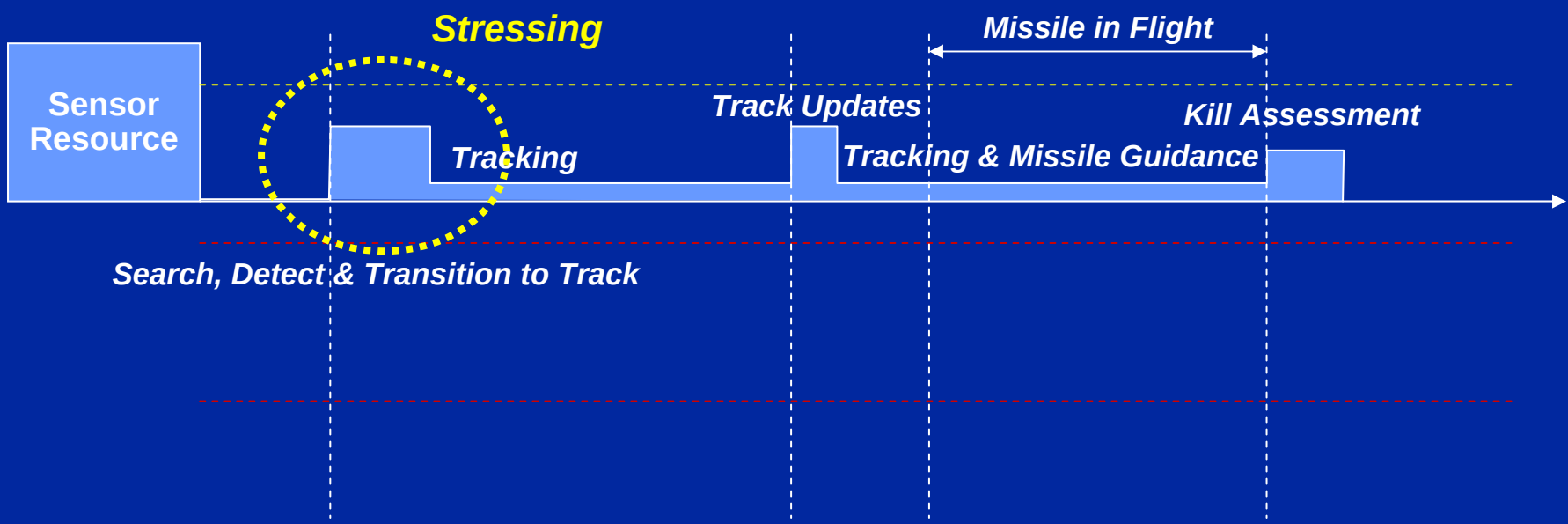
- *Event timeline versus available sensor resources*
- *Intersection of multiple events create stresses on sensor resources*
- *Analyze the initial intersection of events against mission priority to determine unsupportable events*
  - *Event set 1 is higher priority then event set 2*
  - *Event set 1 is given the system resources*
- *Determine baseline measurement of effectiveness*

Resource Analysis Methodology

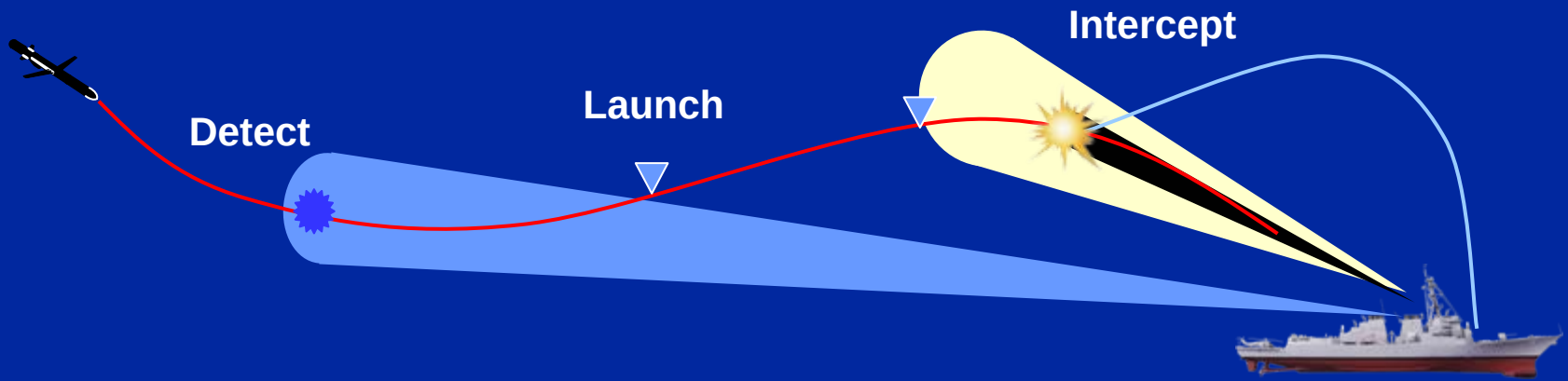
- ***Determine if sufficient time is available to reschedule an unsupportable event.***
  - ***If not reschedule-able, then event timeline is not supportable***
- ***Shift event data (apply system concept) and re-analyze remaining events***
- ***Determine applied system concept measurement of effectiveness***

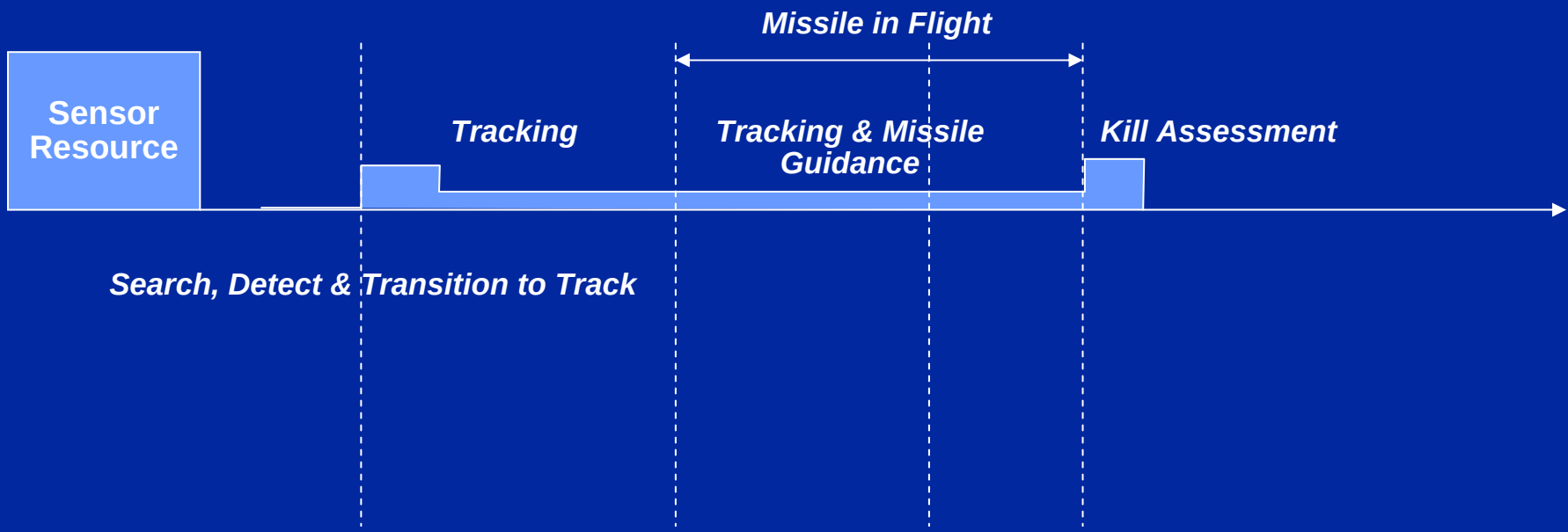
Radar Resource Usage in Mission A Scenario





Radar Resource Usage in a Mission B Scenario





Performance Metrics

- ***Radar resource usage along engagement event timeline***
- ***Number of supportable engagement events along the timeline***
- ***Number of targets not engaged due to resource limitations***

Derived System Concept

- *The engagement event time lines for the mission are built from the output data of the Monte Carlo Simulation runs*
  - *Determine peak supportable events and system resource usage*
  - *Determine total supportable event timelines allowing for rescheduling*
- *Derive observations on system concept functionality required to support a revised total supportable event timeline*

About the Authors

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- ***Lead Systems Performance Analyst in Modeling and Operations Analysis group of System of Systems Engineering of LM-MS2. Current responsibilities include System Performance Assessment and Analysis with System Simulation Models***

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Organizational Leadership and Management Dynamics for Technical Execution in Acquisition Programs

Frank Sisti/Capt. DeWitt Latimer

October 25, 2007

Views expressed in this presentation do not reflect official policy or position of the U.S. Air Force, Department of Defense, or the US Government

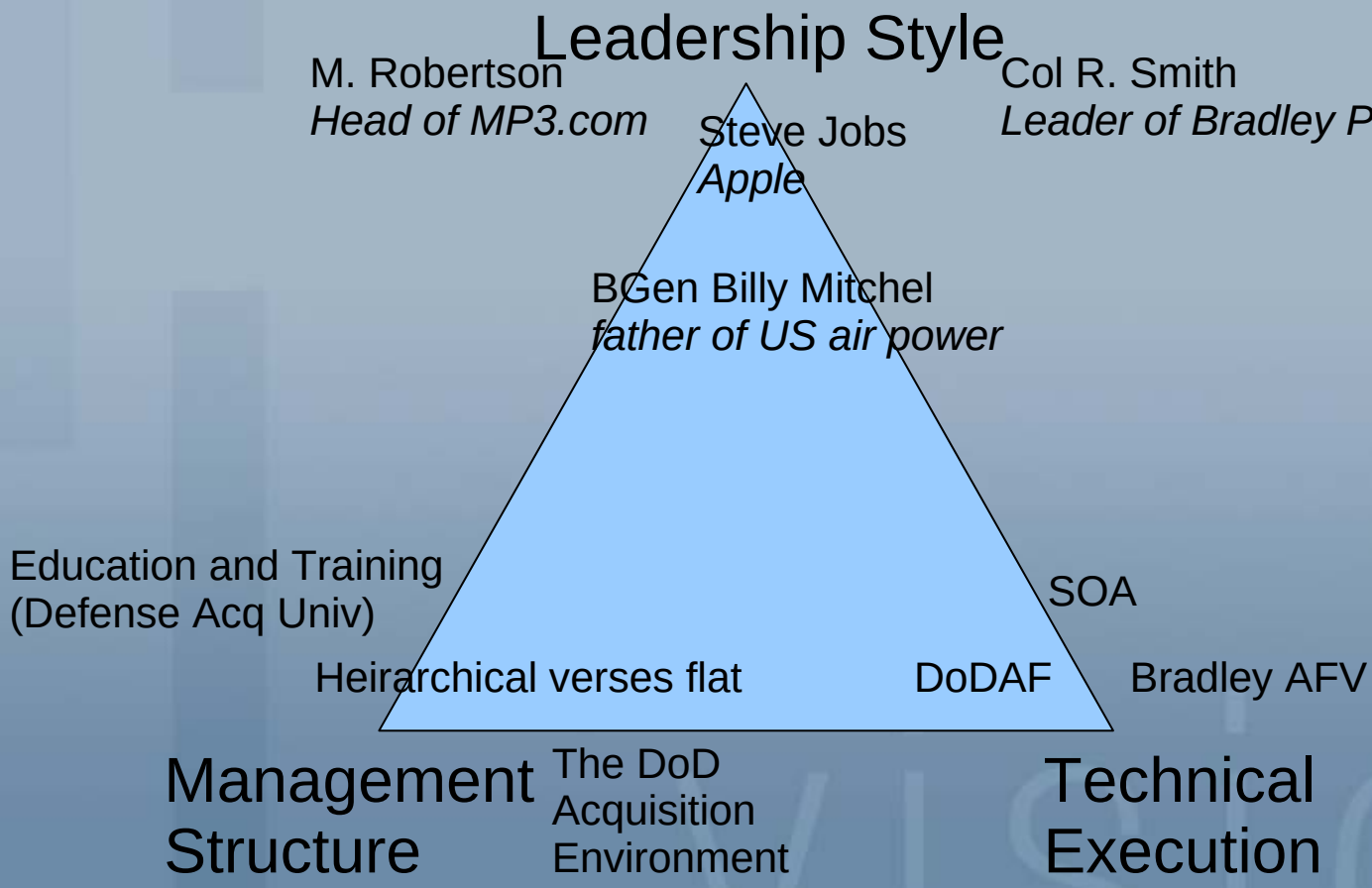
THE AEROSPACE CORPORATION



Overview

- Definitions
  - Leadership/Management/Technical (dis)Harmony
  - Precedented/Unprecedented systems
- Examples
- Methods
  - Leadership evaluation
  - Mapping leadership styles to precedented and unprecedented systems
  - Mitigating style mismatches for individuals
  - Examples of mappings and mitigation

Definition: Leadership/Management/ Technical (Dis)Harmony





Definition: Leadership Styles

- Transactional occurs when
  - "Leader rewards or disciplines the follower depending on the adequacy of the follower's performance
  - Contingent reinforcement, either the positive of contingent-reward or more negative of active or passive forms of management by exception"
- Transformational is seen when
  - "They motivate others to do more than they originally intended and often more than they thought possible
  - Stimulate interest among colleagues and followers to view their work from new perspectives
  - Generate awareness of the mission or vision of the team or organization
  - Develop colleagues and followers to higher level of ability and potential
  - Motivate colleagues and followers to look beyond their own interests toward those that will benefit the group"

- Bass, B. M., Avolio, B. J., Jung, D. I., & Berson, Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. *Journal of Applied Psychology, 88*(2), 207-218. (Reprinted with the permission of Mind Garden, Inc.)



Definition: Stresses the Move to Disharmony

- Budget mandates
- New technology maturations
- Independent reviews
- Performance of peer leaders/managers
- New requirements and requirement combinations that make a system unprecedented



Definition: Precedented and Unprecedented Systems

- Precedented System
  - Technically similar to one that has been built before
  - Schedule and budget constraints (and hence productivity) are similar to previous efforts
- Unprecedented System
  - Technically dissimilar to previous systems
  - Even if technically similar, faster schedules or lower budgets than previous efforts may require sufficient innovation in the delivery/productivity to make the development of the system unprecedented

- Sisti, F. J. & Latimer, D. T. (2007). Linking leadership and technical execution in unprecedented systems-of-systems acquisitions. *Journal of Integrated Design and Process Science,* (In Press).



Example: *Precedented* System with Transactional Leadership

- Demonstrates traction and harmony from leaders and management since they know what to direct the technical folks to do and have reasonable expectations of success of assigned tasks; conversely, technical folks know what management/leadership wants (the *precedented* system using *precedented* methods)
- Example - Armor kits for the HMMVs in Iraq and Afghanistan



Example: Unprecedented System with Transactional Leadership

- MP3.COM
  - Michael Robertson, CEO
  - MP3 Technology/Internet Based
  - Artist and Customer friendly
  - 2000, Universal Music Group - $250 (T)
  - Forced Sales
- Demonstrates stresses that couldn't be handled *transactionally* that eventually led to loss of the company



Example: Unprecedented System with Transformational Leadership

- PMA-271 – E-6B TACAMO Program - combination ABNCP and Longwire VLF antenna onto single Boeing 707-320
  - Two systems never before combined
  - Combined services (Navy and USAF programs) to consolidate C&C of strategic assets across two services
  - Various challenges – Technical & Management
- PM demonstrated the 4I's of Transformational Leadership:
  - Idealize Influence,
  - Inspirational Motivation,
  - Intellectual Stimulation, and
  - Individualized Consideration



A Way Ahead?

Once you understand the system impact, how can you modify your leadership to improve chances of success?



Methods: Leadership Evaluation Mechanisms

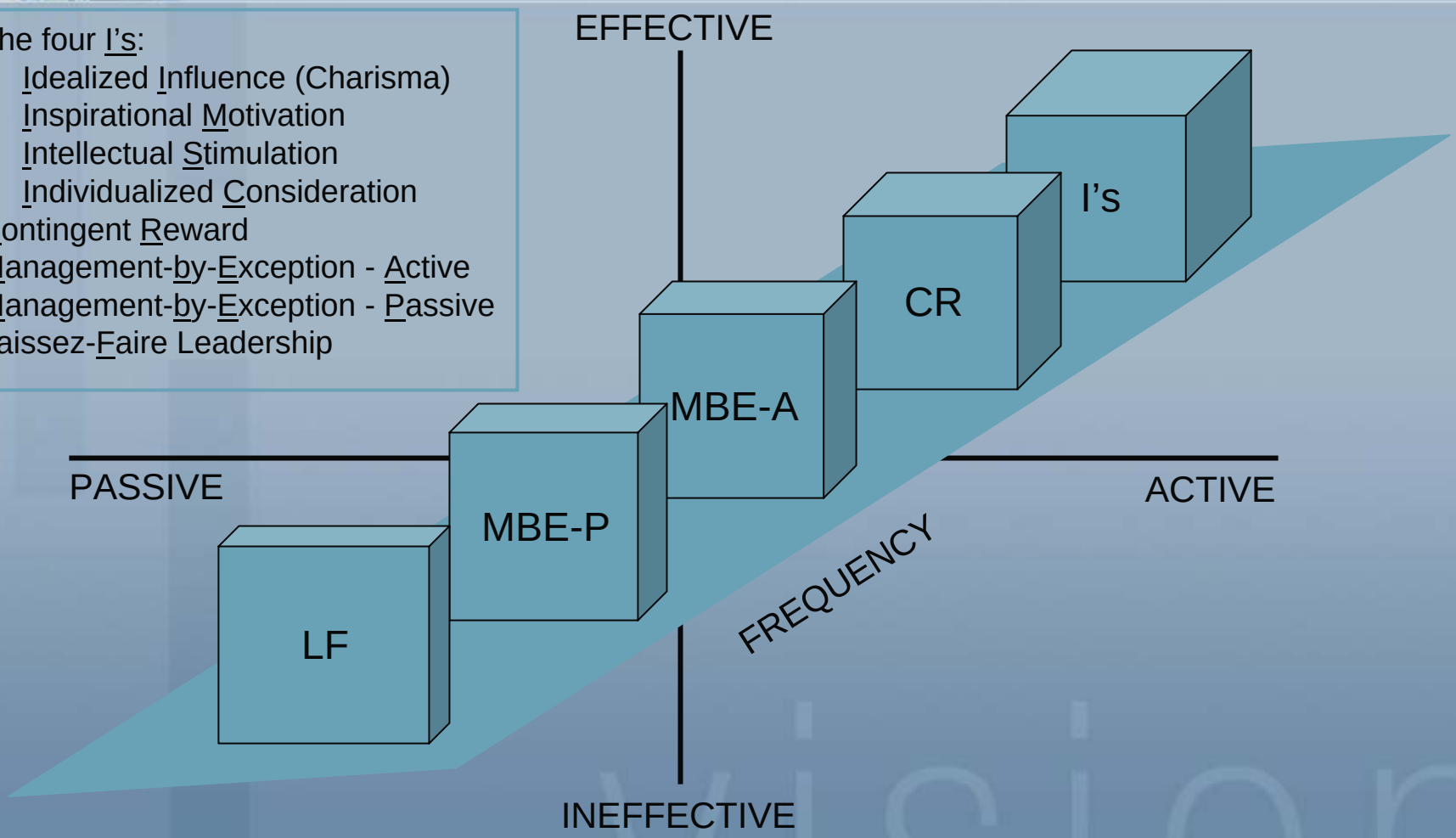
- Multi-Factor Leadership Questionnaire© (MLQ©)
  - Heritage: research in 1978 by Burns extended in 1985 Bass
  - What is measured: 7 component model of leadership
  - How it is measured: 45 questions, 360-degree preferred, reported out across the 7 leadership behaviors
- Full Range of Leadership© (FRL©)
  - Heritage: 1999 Bass/Avolio extended MLQ© to give leaders direction to improve their preferences
  - What is measured: 7 leadership behaviors
  - How is measure used: Augmented MLQ© report provides input to increase specific leadership capabilities

-Avolio, B. J. & Bass, B. M. (2006). *Multifactor leadership questionnaire* (3rd.). Menlo Park, CA: Mind Garden, Inc. (Reprinted with the permission of Mind Garden, Inc.)

The Model of the Full Range of Leadership©

The four I's:
- Idealized Influence (Charisma)
- Inspirational Motivation
- Intellectual Stimulation
- Individualized Consideration

Contingent Reward
Management-by-Exception - Active
Management-by-Exception - Passive
Laissez-Faire Leadership



Bass, B. M., & Riggio, R. E. (2006). *Transformational leadership: Second edition* (Rev. ed.). Mahwah, NJ: Lawrence Erlbaum Associates.
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Comparing the Two Points-of-View

Strength Comparisons

- **Transactional**
  - Maintains subordinate levels & grows individual experience
  - Focuses on "wait for direction" work ethic
  - Encourages linear actions focusing on extending planned schedules
  - Fosters point-to-point solutions
  - Limits perception of value to overall mission success and effectiveness
  - Provides individual with narrow experience profile
  - Does not encourage trust
  - Does not require much training to maintain competency
- **Transformational**
  - Builds subordinate capabilities & potential through experiences
  - Builds understanding, morale, & trust
  - Encourages multi-linear capability focusing on maintaining or reducing schedules
  - Fundamentally net-centric aware
  - Enables perception of value to overall mission success and effectiveness
  - Provides capacity for transfer of knowledge
  - Requires trust
  - Requires appropriate training

System Challenges

- **Precedented**
  - Technically similar to one that has been built before
  - Schedule and budget constraints (and hence productivity) are similar to previous efforts
- **Unprecedented**
  - Technically dissimilar to previous systems
  - Even if technically similar, faster schedules or lower budgets than previous efforts may require sufficient innovation in the delivery/productivity to make the development of the system unprecedented



Method: Individual Development Plans for Leaders/Managers

- Setting goals
  - Approach should be based on system type and FLR© results, style, current environment, personal preferences, and career planning
  - With 360 feedback, you know if you are being successful with your leadership efforts
  - What you desire in the future environment becomes the goal

-Avolio, B. J. & Bass, B. M. (2006). *Multifactor leadership questionnaire* (3rd.). Menlo Park, CA: Mind Garden, Inc. (Reprinted with the permission of Mind Garden, Inc.)



Points-to-Ponder

- This presentation addresses a current examination of the interplay between leadership and effectiveness/success
- Conclusion is that failure to adapt leadership to the circumstances of your project or organization can lead to unexecutable programs



Additional Sources - 1

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Asset-Based PBL for Navy Warships - A case study for LCS Class Ships

NDIA - 10th Annual Systems Engineering Conference
Oct 24, 2007

Mike Mahon

Topics

- ***Definitions/PBL scaling***
- ***LCS Overview***
- ***Asset-Based PBL Key questions***
- ***Asset-Based PBL challenges/Obstacles***
- ***Asset-Based PBL - keys to success***
- ***Path ahead***

Definitions

What is PBL?

- ***any contract where the primary requirement is to provide products & services based on a pre-determined performance metric.***
- ***The performance metric should in some way be a contributing factor to Operational Availability (Ao).***

The Navy today boasts of 150+ PBL contracts; most of these are supply-oriented PBLs issued by NAVICP

- ***Most are lower level component based PBLs***

Definitions (cont.)

What is Asset-based?

Component Level



Tires



System/Eqpt Level







Asset Level











Not all assets are equal in terms of achieving asset-based PBL





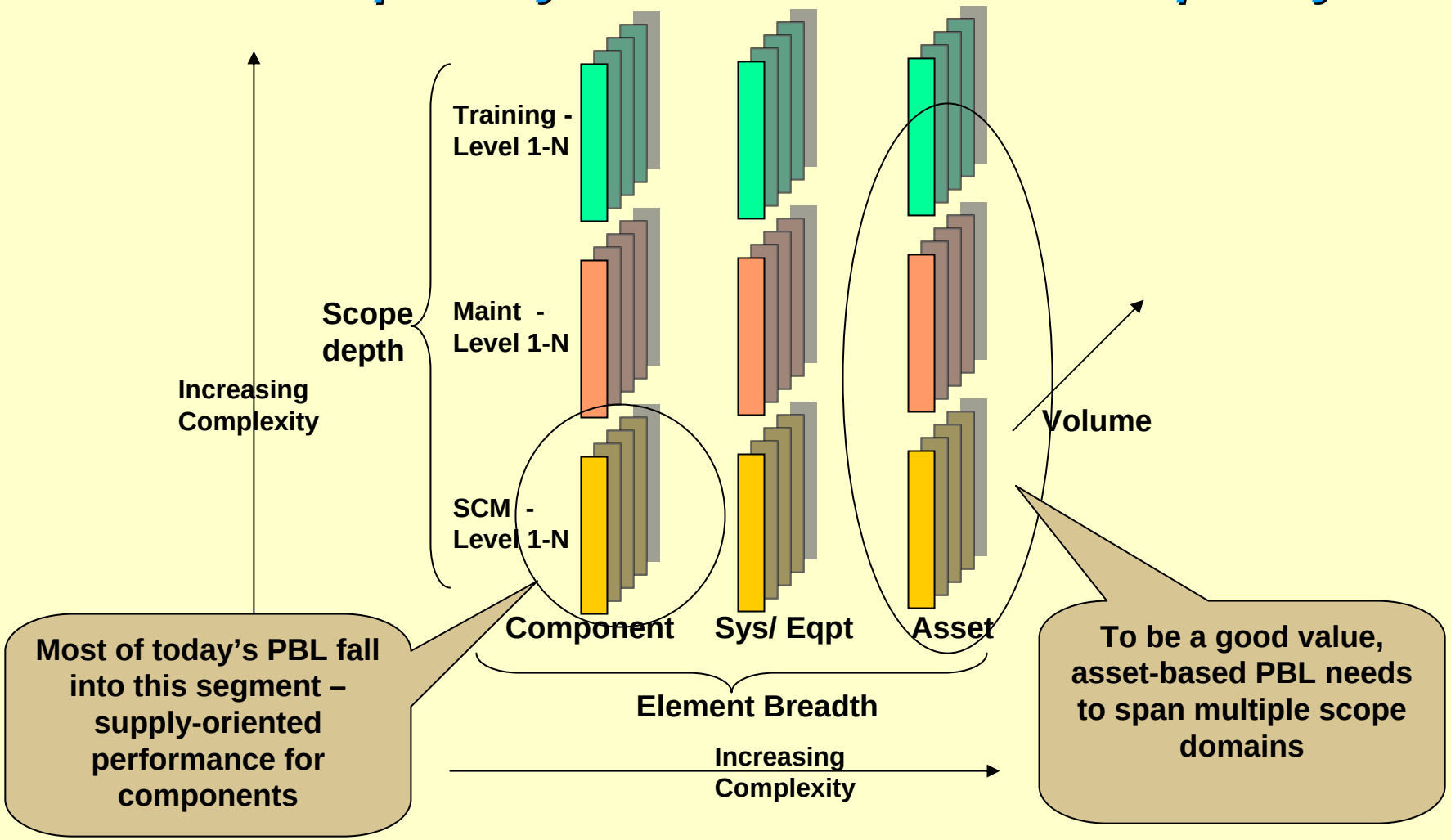


Easier — ***Harder***

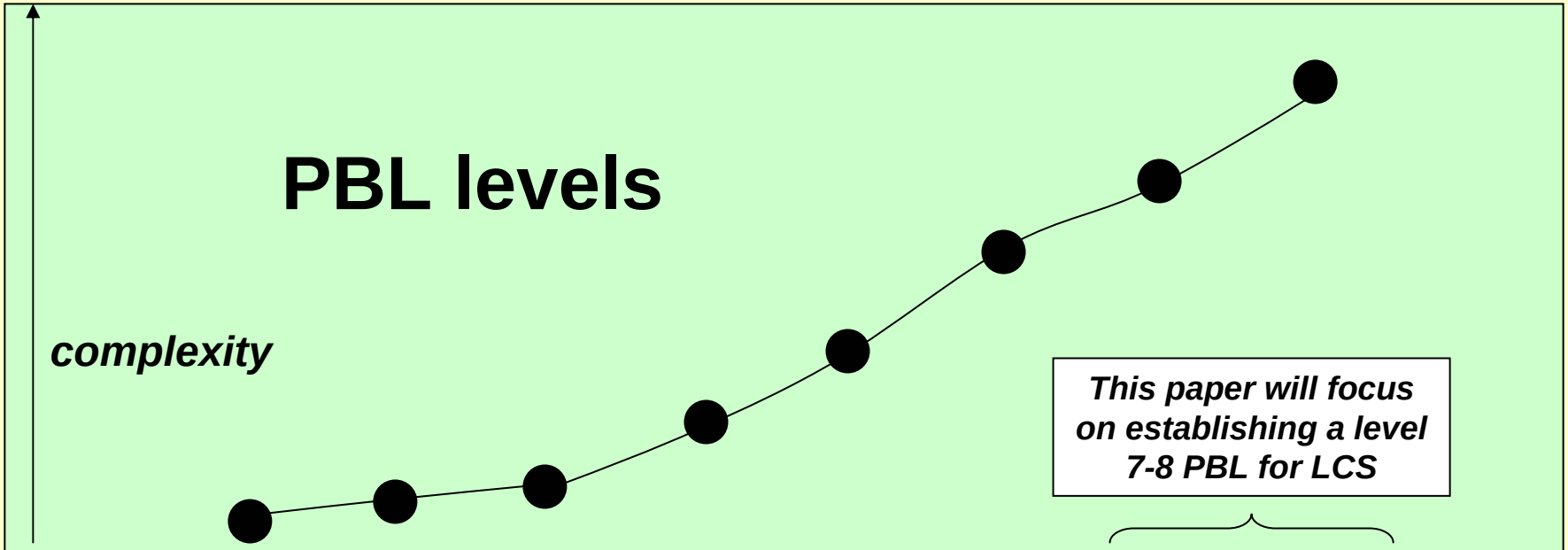
Complexity is based of number of systems within asset

PBL Complexity

There are two primary dimensions to PBL complexity.



PBL Complexity Scaling

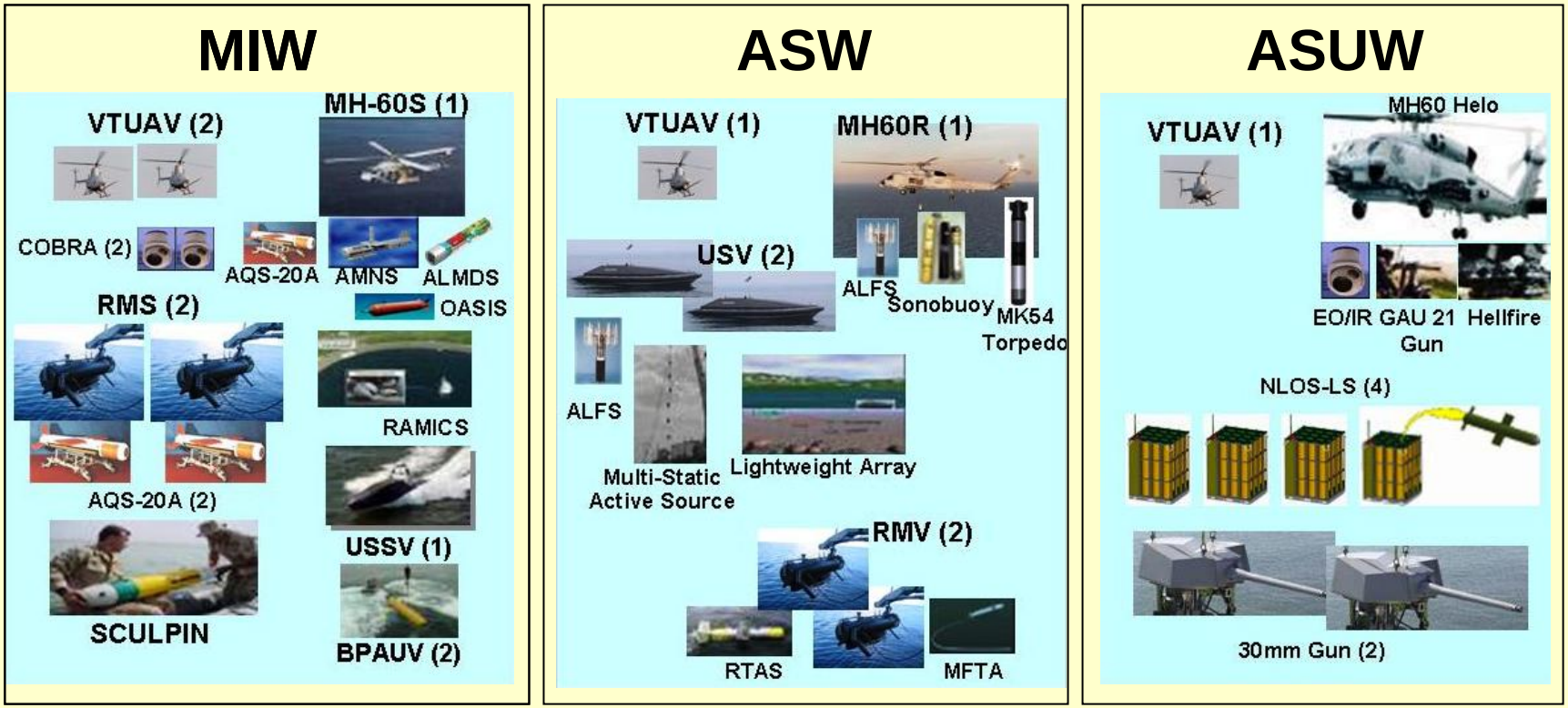


Level	1	2	3	4	5	6	7	8	9
System depth	component	System/ eqpt	component	System/ eqpt	System/ eqpt	Asset-based	Asset-based	Asset-based	Asset based
Domain depth	Supply only	Supply only	Supply only	Supply only	Supply +Maint	Supply only	Supply +Maint	Supply +Maint + Mods	Leased or other special
Element depth	Single element	Single element	Multiple elements	Multiple elements	Multiple elements	Multiple elements	Multiple elements	Multiple elements	

Note: this scale is Mahon developed and not an industry accepted/certified rating system for PBLs

LCS System of Systems

LCS consists of core seaframes designed to host mission packages. Three MP are initially planned.



LCS Original Requirements

Requirements	THRESHOLD	OBJECTIVE
Sprint Speed (kts)	40	50
Mission Package Payload (mt)	180	210
Range @ Transit Speed (nm)	3500	4300
Navigational Draft (ft)	20	10
Core Crew manning	50	15

Two Years **$220M**

Any Mission Package / Any Ship / Any Time

- Non-traditional hull forms
- Non-traditional materials
- Non-traditional Propulsion
  - CODAG + Waterjet drive (x4)
- Non-traditional construction practices
- Non-traditional system suppliers
- Modular Open Systems Approach
- Open Computing Architecture
- Automation

LCS Breaks thru many Traditional Paradigms

LCS Flight 0 Acquisition Strategy

6 Industry Concepts
(06 Feb 03)



3 Preliminary Designs
(19 Jul 03)



2 Final Designs
(Contracts Awarded 27 May 04)





FLT 0 Lockheed Martin
(15 Dec 04)



FLT 0 General Dynamics
(14 Oct 05)

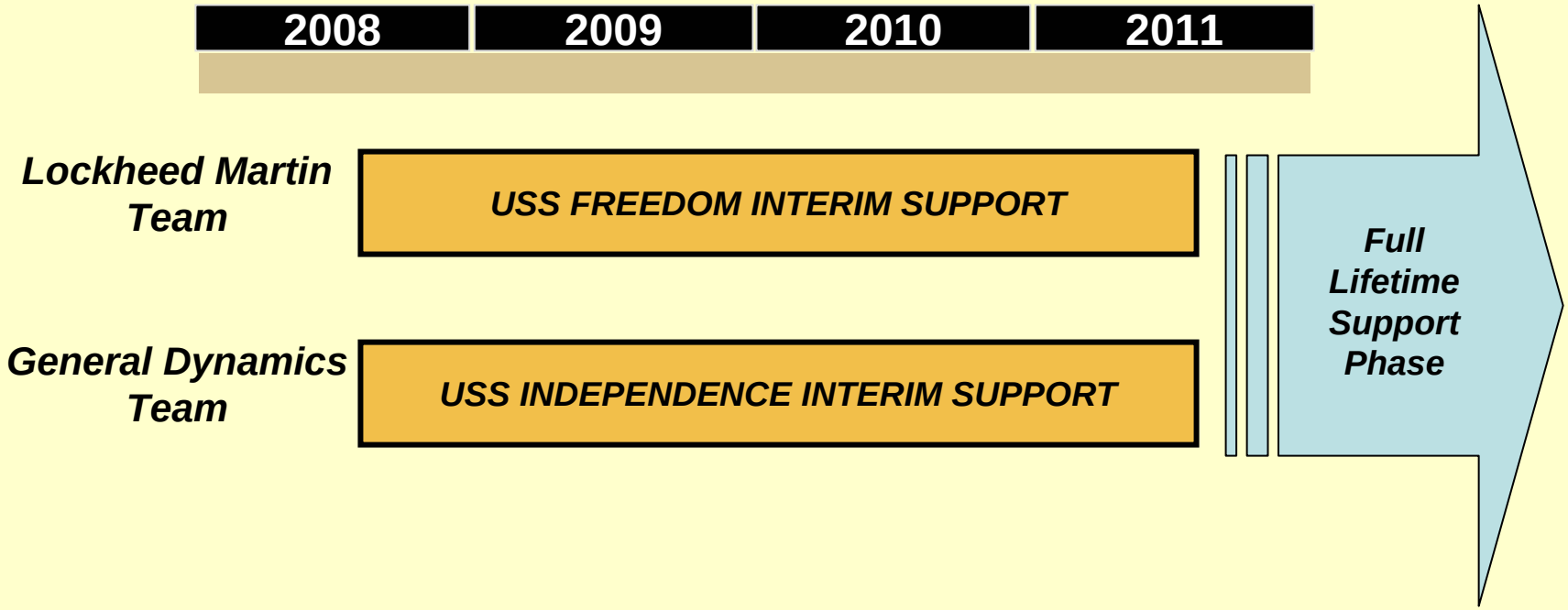
February 2003	July 2003	May 2004	December 2004	October 2005

First Ships Delivers in Summer 2008

LCS Flight 0 Sustainment Strategy

The US Navy approach for LCS sustainment is to establish the lead shipbuilding teams as lead for sustainment for an interim 36-month period.

- ***Concept is to leverage knowledge for design/construction for risk mitigation in initial sustainment phase***



Asset-based PBL – Key Questions

1. ***Will it work? Just because it works at lower levels doesn't mean it's a good thing at a higher level?***

2. ***Will it save money and if so, how much?***

3. ***Can we really put such heavy responsibility for our nations defense in the hands of Industry?***

4. ***What is the fallback if it doesn't work?***

5. ***What will happen to the existing infrastructure that is still required for other ship classes?***

Asset-based PBL – Challenges/Obstacles

1. ***Jobs/responsibilities – see attached***
2. ***Risk – all dimensions of risk must be identified and mitigation plans established and funded***
3. ***Colors-of-money (RDT&E, SCN, O&M, etc.)***
   - ***it is difficult securing an extra SCN dollar to save two dollars of OM&N***
4. ***Cost/Business case analyses (BCA)***
   - ***Most transformational concepts require a BCA, yet establishing a baseline for today's warships is difficult at best***
5. ***Interaction with other existing PBLs***
   - ***Need to ensure that upper level, asset-based PBLs can work in harmony with existing, established PBLs***
6. ***Patience (or lack of it)***
   - ***Initial performance will be bumpy/full of glitches – all parties need to be prepared for this and work through it.***

Asset-based PBL – Keys to Success

1. ***Support from DoD/Customer community***
2. ***A Good approach that manages Risk***
   - ***'stair-step' approach that progresses to full asset-based PBL incrementally***
   - ***Initially costs more to have parallel paths in case of failure***
   - ***Integrated industry-Govt processes***
3. ***Solid team Structure***
   - ***Embraces/uses competition for optimal value***
4. ***Good performance metrics***

Path Ahead

1. ***Build the team and the processes for the three year Interim Sustainment timeframe.***
2. ***Establish initial metric set***
3. ***Do NOT accept PBL from initial suppliers - risk/cost will be too high. Instead use the 3yr period to understand the ship and operational caps and lims – measure everything!***
4. ***Build alternate suppliers – keep competitive environment***
5. ***Establish transition plan for full life-time support***

   (Also build plan to fallback to traditional approach if reqd)

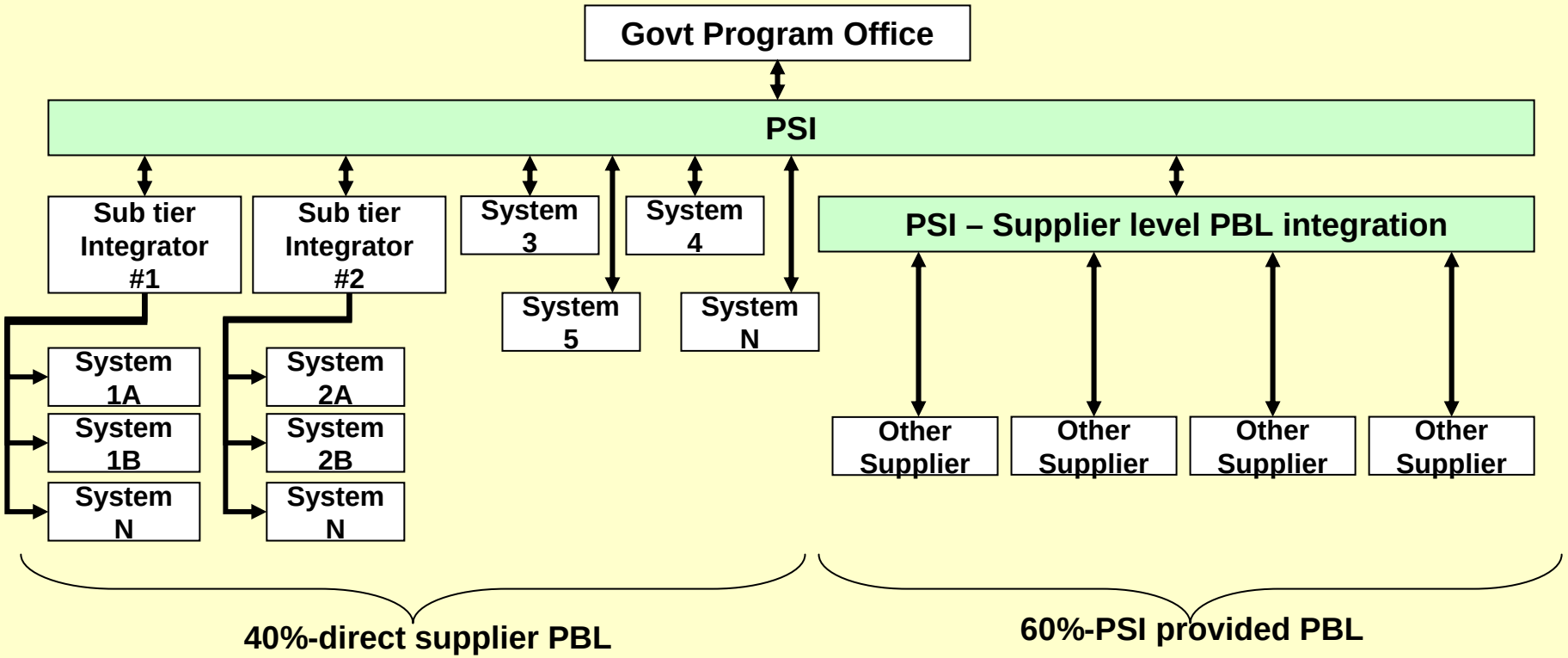
Back-ups

Job/Responsibilities

- ***The biggest obstacle to asset-based PBL (or FSC or CLS) will be from the organic support infrastructure who's very livelihood is threatened by this initiative***
- ***Unlike component based PBL (which never shifted who did the work but how it was contracted), asset-based PBL transitions organic responsibility to industry***
- ***And yet, industry must work with these very same organic activities to develop and operate the Asset-based PBL***
- ***Many people/organizations will be very happy to see asset-based PBL fail and may even work to help it fail.***

Asset-Based PBL - Org structure

- *The business structure of an asset-based PBL for a warship can be very complex. It consists of many suppliers and varying levels*

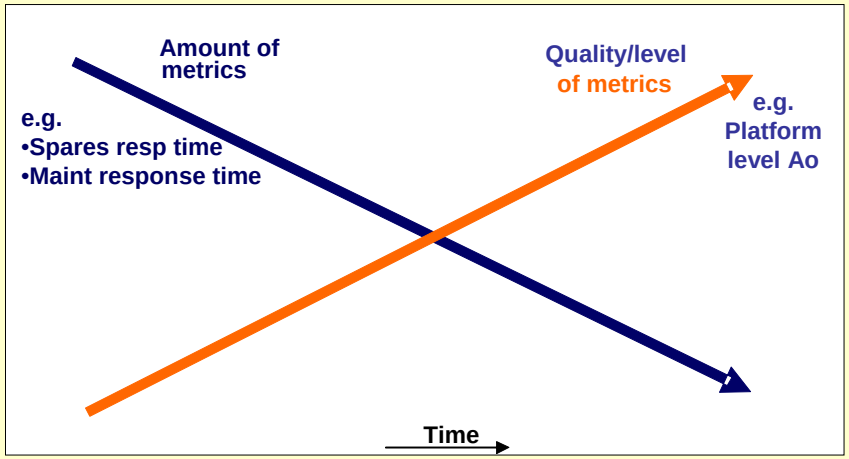


Performance Metrics

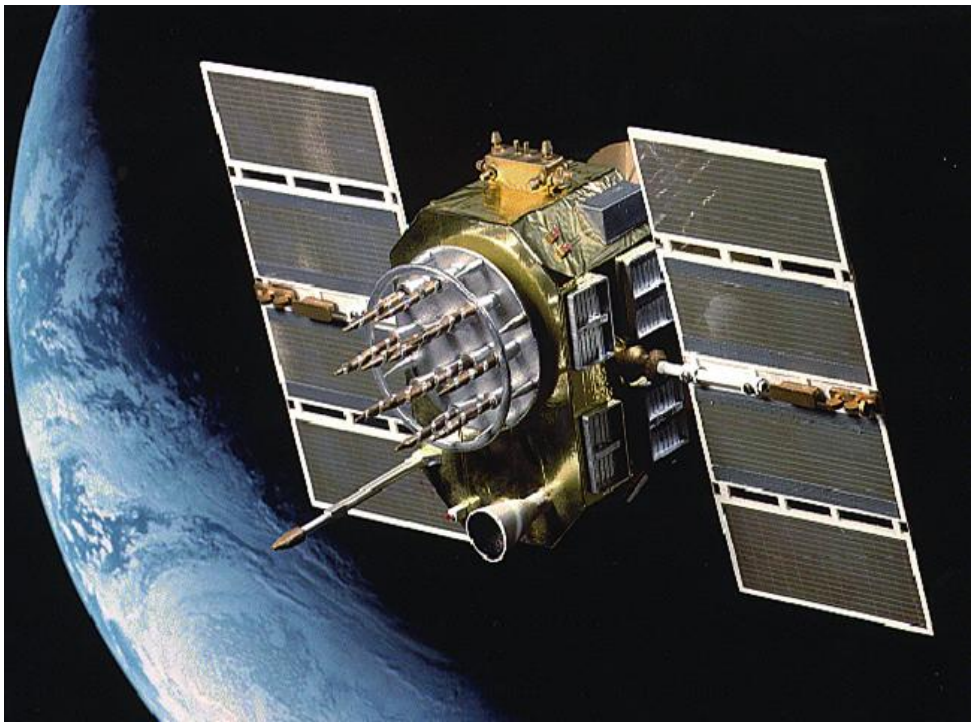
- *Measuring performance is critical*
- *Samples metrics include:*

SCM	Maintenance	Training
•Inventory management	•Casualty response time	•Train-to-qualify (T2Q)
•Demand forecasting	•Remote monitoring	•Embedded training
•Transportation	•Condition-based Maint.	•Initial& replenishment crew training
•Requisition processing	•Distance support	•Computer based training & sim
•Parts Repair	•'O' level maint. PM/CM	•Trainer site ops
•Parts replenishment	•'I' level Maint. PM/CM	•Team training
•SCM management	•'D' level Maint	•Training management
	•Maintenance Mgt	

- *To achieve asset-based PBL – in time metric quantity lessens but the metric 'quality' grows*



Global Positioning System (GPS) Systems Engineering (SE) Case Study



Randy Bullard
AFIT/SYA
25 Oct 2007

Agenda



- Why SE Case Studies Are Important
- Example – GPS
  - Method of Analysis
  - Results
  - Benefits (Education & Practice)
- Foundational SE Learning Principles
- Summary

Why We Do Case Studies

AF CSE

- AF Center for SE tasked to develop case studies
  - Focus on application of SE principles in various programs



- Additional case studies
  - Completed:
    - C-5
    - F-111
    - Hubble Telescope
    - Theatre Battle Management Core System (TBMCS)
    - B-2
    - Joint Air to Surface Standoff Missile (JASSM)
  - In work: A-10 & Peacekeeper
  - More on contract in FY08

Case Study Construct

- Support teaching & practicing of SE principles
  - Facilitate learning by emphasizing long-term consequences of SE & programmatic decisions on program success
  - Provide real-world, detailed examples of how SE process attempts to balance cost, schedule, & performance
- Used Friedman-Sage framework & matrix for analysis
- Identify learning principles
  - Discuss factors that significantly influenced successful outcome and failures of the program

SE processes used in today's complex system and system-of-systems were matured and founded on principles developed in the past.

Friedman-Sage Framework

- Developed by:
  - Dr George Friedman: University of Southern California
  - Dr Andy Sage: George Mason University
- Comprised of 9 concept domains (rows) & 3 responsibility domains (columns)
  - Rows represent phases in SE life cycle & necessary process and systems management support
  - Columns depict responsibilities from both sides of the program (industry and government)
- Derived into matrix
  - Identifies learning principles
- Used as analysis baseline

Friedman-Sage Matrix

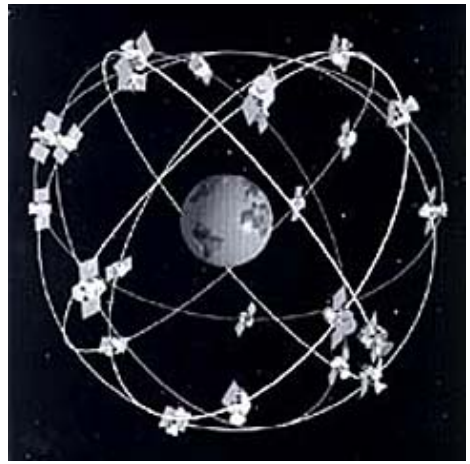
	Concept Domain	Responsibility Domain		
		1. Contractor Responsibility	2. Shared Responsibility	3. Government Responsibility
A.	Requirements Definition and Management			LP 3
B.	Systems Architecture and Conceptual Design			
C	System and Subsystem Detailed Design and Implementation			
D.	Systems Integration and Interface			LP 2
E.	Validation and Verification			
F.	Deployment and Post Deployment			
G.	Life Cycle Support			
H.	Risk Assessment and Management		LP 4	
I.	System and Program Management		LP 1	

GPS Program Background

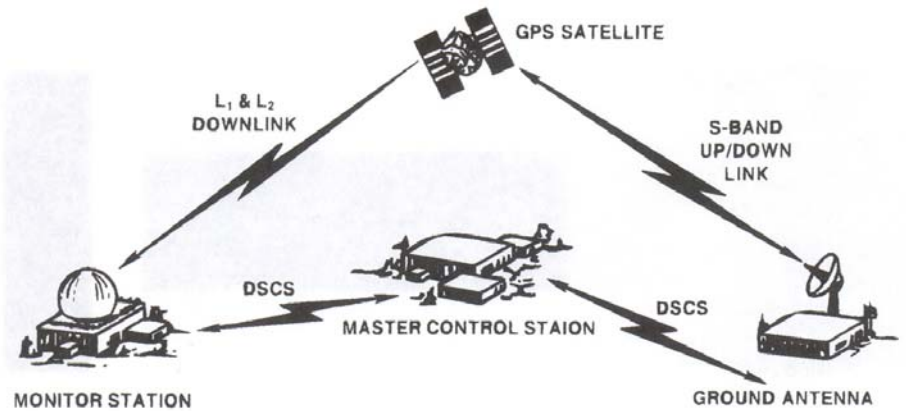
- Russians launched Sputnik, 1957
  - Satellite circled earth broadcasting its tone
  - US engineer postulated using Doppler Effect
    - Orbiting satellite could compute location on Earth
  - Air Force & Navy established separate programs
    - They demonstrated many key technologies
- DoD established Joint Program Office (JPO), 1972
  - Purpose was to replace land-based navigation aids
  - Air Force was assigned to lead JPO
    - Joint effort included Army, Navy, & Coast Guard
  - JPO tasked to develop space-based navigation system

GPS System

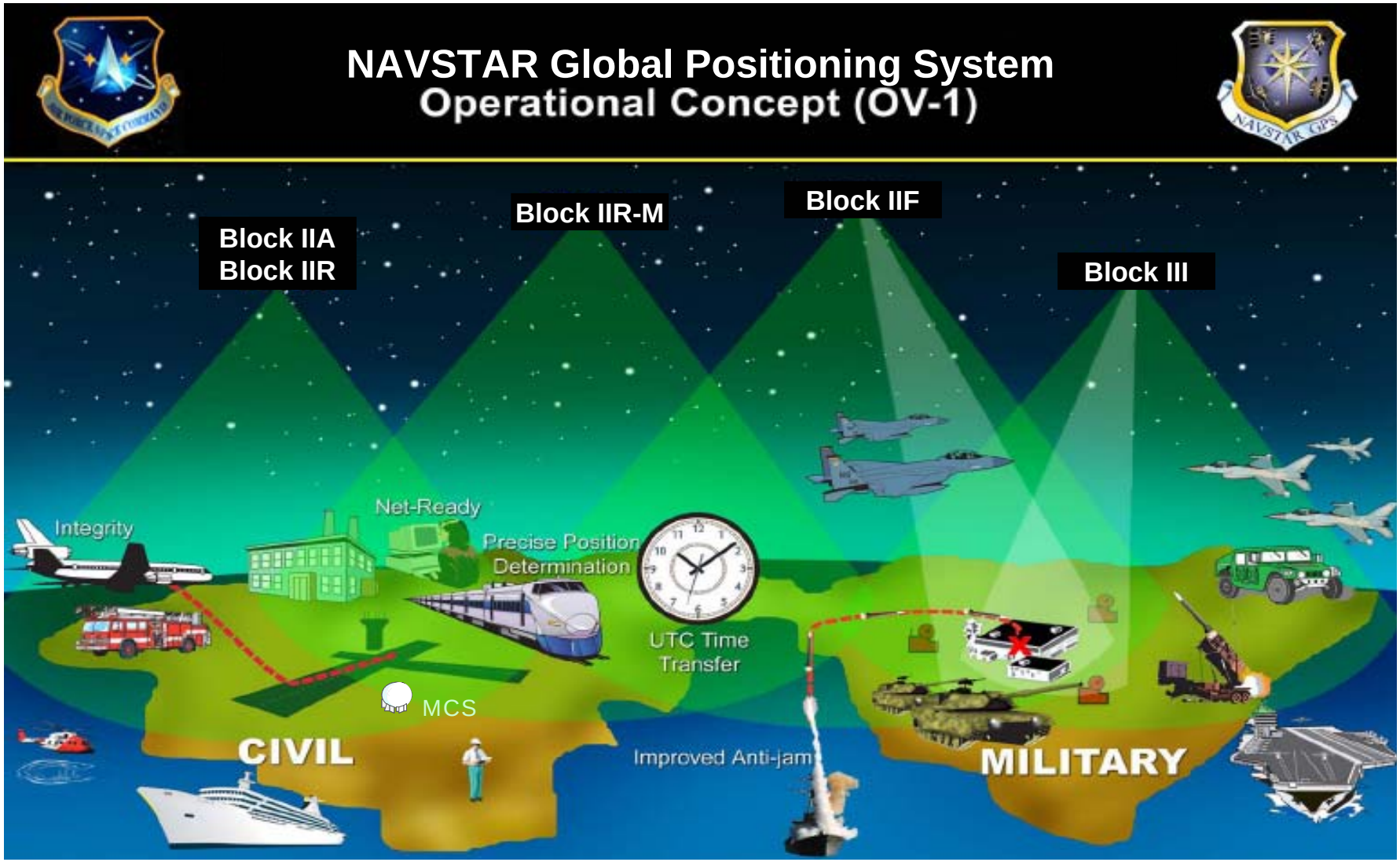
- System requirements
  - Accurate
  - Global
  - Real-time
  - Continuous
  - Additional characteristics



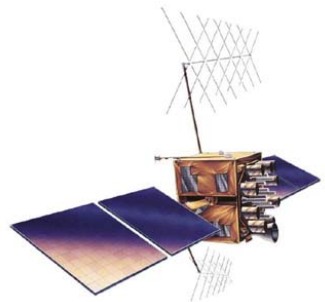
- System design
  - Space Vehicle (SV)
  - User Equipment (UE)
  - Control Station (CS)



GPS OV-1


NAVSTAR Global Positioning System
Operational Concept (OV-1)
Block IIA
Block IIR
Block IIR-M
Block IIF
Block III
Integrity
Net-Ready
Precise Position
Determination
UTC Time
Transfer
MCS
CIVIL
Improved Anti-jam
MILITARY

GPS SE Approach



- JPO constructed system specification
  - It became the functional baseline
  - Strategy was to manage:
    - Requirements at the performance level
    - Interfaces between space vehicles, control stations, & users
  - Process highlighted cost, schedule, & performance risks
    - Impacted team derived alternatives
    - Decisions made quickly by management
- Program placed emphasis on staffing key positions
  - JPO staffed with technical officers & civilians
  - Aerospace augmented with engineering & scientific staff

Learning Principles

1. Programs must strive to staff key positions with domain experts
2. The systems integrator must rigorously maintain program baselines
3. Achieving consistent and continuous high-level support and advocacy helps funding stability, which impacts SE stability
4. Disciplined and appropriate risk management must be applied throughout the lifecycle

Learning Principle 1

Programs must strive to staff key positions with domain experts

- Program personnel were well-versed in their disciplines
  - All possessed a systems view of the program
  - Entire team understood implications of their work at all system levels
- They used a knowledge-based approach for decision making
  - Information was understood and the base and alternative solutions were accurately presented.
  - This shortened the decision cycle
- Additional benefits were realized
  - Communications were better
  - Working relationships were improved

Learning Principle 2

The systems integrator must rigorously maintain program baselines

- JPO retained the role of managing and controlling the systems specification
  - This allowed control of functional baseline
- They derived and constructed an “agreed-to” set of systems requirements that became the program baseline
  - Performance/Risk/Cost trade studies against functional baseline used to control both risk and cost
  - Interface Control Working Group process managed the functional requirements on the allocated baseline
  - Processes gave JPO first-hand knowledge and insight into risks at lowest level

Learning Principle 3

Achieving consistent and continuous high-level support and advocacy helps funding stability, which impacts SE stability

- OSD support provided requirements and funding stability
  - They provided advocacy and sourced funding at critical times
  - They catalyzed coordination among the various services
  - They reviewed & approved GPS JPO system requirements
- OSD played the central role in the establishment and survivability of the program
  - They had support from Deputy Secretary of Defense
- Military services were primary users & eventual customers
  - Each service initially advocated their individual programs
  - SECAF supplied manpower & facilities

Learning Principle 4

Disciplined and appropriate risk management must be applied throughout the lifecycle

- GPS program structured to address risk throughout the multiphase program
- Key risks were known up front
  - Contractor and/or government utilized a classic risk approach to identify & analyze risk
  - They developed and tracked mitigation actions
  - Various risks (design, manufacturing, launch) were managed by office who owned those risks
- Technical risks tracked by Technical Performance Measures (TPMs)
  - Satellite weight & SLOC were tracked
  - TPMs addressed at weekly chief engineer's meetings

SE Outcomes



- SE played major role in GPS success
  - Identifying system requirements
  - Integrating new technologies
  - Taking system of systems approach
  - Interfacing with many government & industry agencies
  - Dealing with lack of an operational user early in program formation

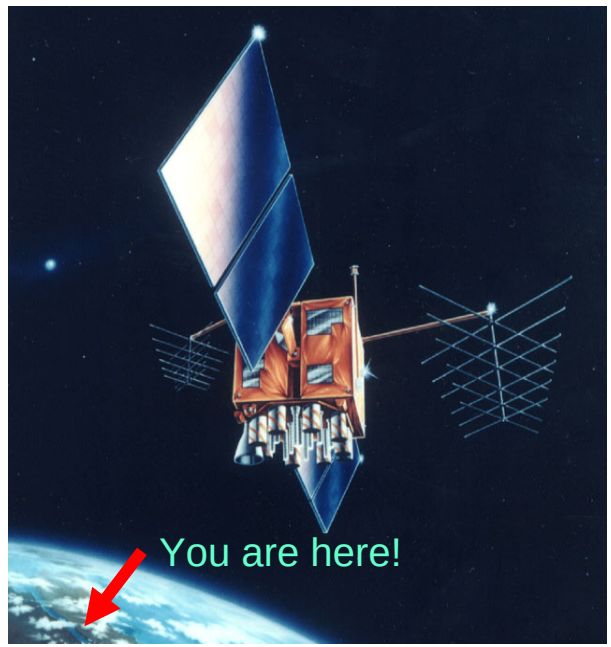
- Key learning principles identify SE processes
  - Application of SE processes is required throughout life cycle
  - Experienced people applying sound SE principles, practices, processes, & tools are necessary at each phase

GPS Program Success

- JPO overcame numerous challenges:
  - Technology, customers, organization, cost, & schedule
  - Integrating new technologies

- Program achieved great success
  - Military relied upon extensively
  - Civilian applications growing
  - Unique uses invented

Imagine current technology without GPS!



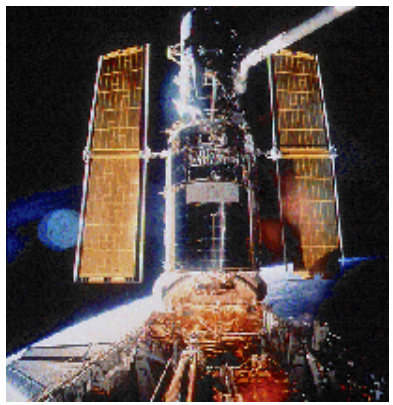
CSE Case Studies

Case studies on our website:

http://www.afit.edu/cse/cases.cfm



B-2



Hubble



F-111



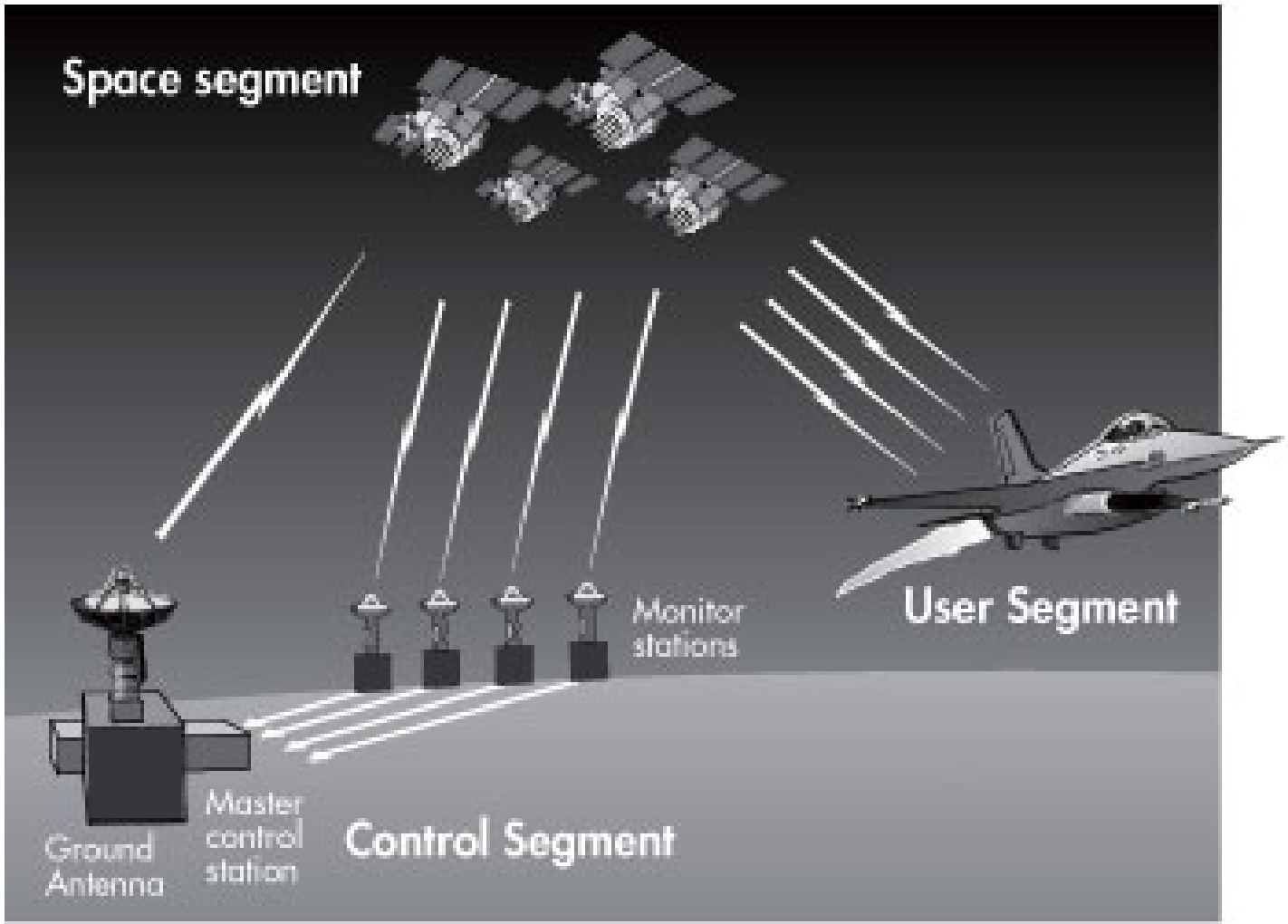
C-5



TBMCS

Questions ?

AF CSE



U.S. Department of Defense (DoD) Approach to Best Practices: *Building Evidence for Practice Selection Based on Real Experiences*









Forrest Shull,
Fraunhofer Center Maryland

NDIA Systems Engineering Conference
October 25, 2007

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Topics

- **Why** do we need a Clearinghouse?
- **What** to expect in the Best Practices Clearinghouse (BPCh)?
- **How** does the BPCh work?
- **When** can I get involved?
- **Who** to contact?

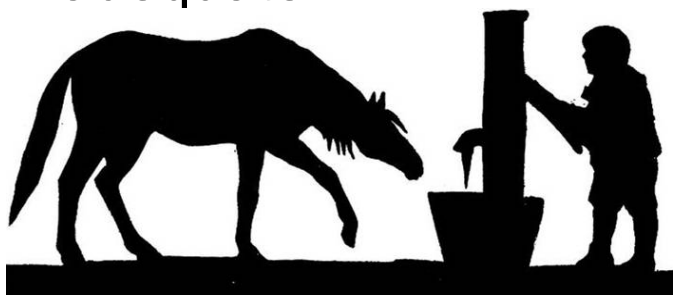


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Why a Clearinghouse?

"Best" practices are recommended, but…

- Too many lists to choose from
- No basis for selecting specific practices
- Proof of effectiveness is not generally available
- Not easy to see connection between practices and specific program risks or issues
- Practice's success factors not well understood
- Resources are limited and the return on practice investment is unknown (costs/benefits)
- Implementation guidance is inadequate



Contents

- **Why** do we need a BPCh?
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What are the main requirements?

Process Components

IT components



Communities

Roles

Contents

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Central Repository for AT&L Policy & Reference Materials

Also serves as the home for knowledge gateways like:
- Defense Acquisition Guidebook
- AT&L Integrated Framework Chart (IFC)
- Ask A Professor



DoD & Industry Best Practices

- Will stand alone as a best practices resource
- Will also provide content for CoPs to allow for additional collaboration/input on best practices
- Will be included in the enterprise search index/results



Enterprise Search System

- Stand-alone search and discovery for AT&L workforce
- Integrated search for AKSS
- Searches open areas of ACC
- Integrated search for DAU Homepage
- Integrated search for DAU Intranet





Collaborative Tool for the AT&L Community Where the Workforce Contributes Knowledge and Interacts to Share "Know-How"

Provides a nest of collaborative tools:
- Communities of Practice/Interest
- Special Interest Areas
- Limited Access Workspaces
- DAU Course Spaces
- Workflow Learning Tools
- IFC Templates

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How do we define a practice?

Contents

- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
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Operational definition:

- A *documented* activity that is described in an *actionable, repeatable* way
- A description of *how* to do something, not a general goal of *what* to do
- Usable by targeted acquisition end users
- About which we can collect empirical data or experiences.

→ may be a process, method, or tool

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What is a practice?

Distinguished from:

- A *best practice area*
  - …a type of activity the user can't neglect, without specific advice on *how* to do it. E.g., risk management
- A *lesson learned*
  - …good advice, drawn from experience, without enough detail to be clearly repeatable. E.g., don't overestimate cost savings from using COTS components.

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What is a practice?

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For example:

- System Engineering Plan:
  - **Risk Management Strategy**
    Options to consider:
    - COTS Usage Risk Evaluation (CURE)
    - Willoughby templates
    - SEI's Taxonomy-based Risk Identification
    - Probability Consequence Software

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What makes BPCh unique?

- Not all best practices are “best” for everybody
  - Descriptions of past results in context, not just what to do
- Context-sensitive search
- Levels of vetting of content
- Subject Matter Experts as practice owners
- Pointers to existing sites, resources, examples

Contents

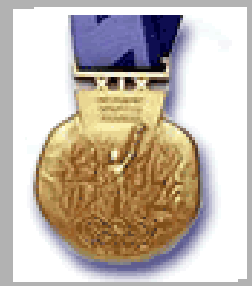
- **Why** do we need a BPCh?
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What are the main process steps?

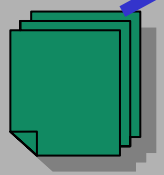
Name: **Practice *X***

Practice Maturity



(Bronze)

- Practice X has been successfully applied …
- Use It to …
- For more information click on the following links:
  - …



Evidence 1

Source
Context
Results



Evidence 2

Source
Context
Results



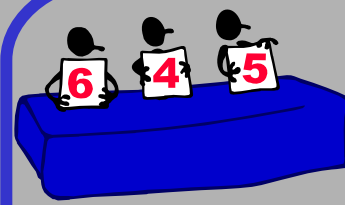
Evidence 3

Source
Context
Results



Evidence 4

Source
Context
Results



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What are examples of content sources?

- **Systems Engineering**
  - OUSD / SEP Review Team
  - OUSD / PSR Teams and Systemic Analysis
  - Experience reports from NDIA-SE & similar
- **Software engineering**
  - ARDEC's Software Enterprise / Picatinny Arsenal
- **Acquisition**
  - NDIA
- ***Other ideas?***
  - Existing DOD guidebooks / standards
  - Existing best practice / lessons learned sites
  - Expert interviews
  - Conference presentations, experience reports

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What are some example practices?

- Requirements analysis
  - Govt-only review of RFP
  - Distribute requirements database for bidders
- Reporting / stakeholder communication
  - Establish a battle rhythm for meetings in SEP – what gets done daily, weekly, semi-annually.
- Interfaces
  - PEO-level coordination
- General…
  - Independent technical reviews
  - Integrated data environment

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What is the BPCh content pedigree?

- Pedigree comes from information that is available on each piece of evidence:
  - **Target role** (acquirer, developer)
  - **Domain** (warfighter, business, intelligence, enterprise integration environment)
  - **Criticality level** (normal, mission, safety, security)
  - **Integration level** (software application, standalone subsystem, platforms, major system, system of systems)
  - **Environment** (military, other govt., industry, academia)
  - **ACAT level** (I, IA, II, III)
  - **Lifecycle phases** where practice used: (Concept refinement, Technology development, System development & demonstration, etc.)
  - **Organizational scope** (individual, project, program, organization, enterprise)

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- **When** can I get involved?
- **Who** to contact?

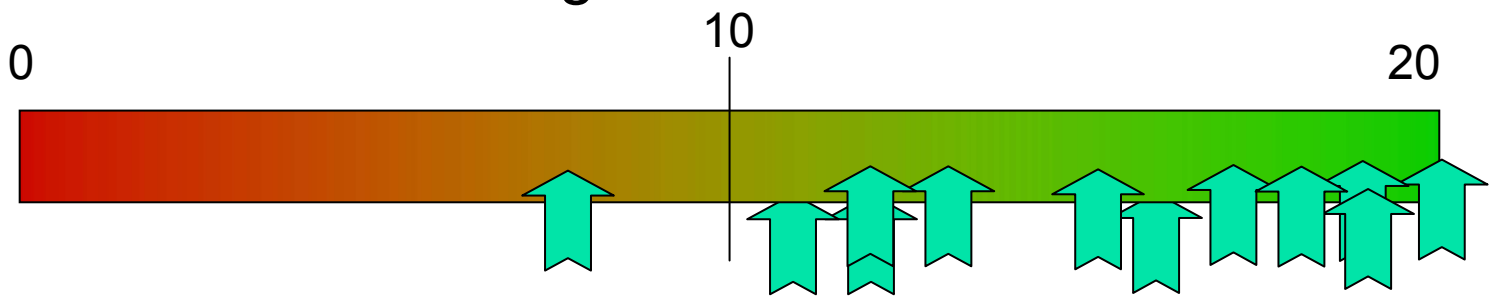
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How do we classify “trustability”?

- Evidence is scored based on objective measures:

Total =	How practice applied	How results measured	How reported	Who reported
[0..20]	[0..7]	[0..5]	[0..5]	[0..3]

- Practices are described as a sum of evidences with different ratings:



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- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** does the BPCh work?
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How does it work for a particular example?

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- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** BPC
- **Wh** get i
- **Wh** cont

Practice detail

Practice Name:	Inspections
Description:	Formal inspection is a well-defined review process for finding and fixing defects in work products from all phases of development.
Practice Status:	Summarized - waiting for vetting

Resources:	**Description:**
DAU's Tech Review Course	

Summary

Primary Benefit:

The majority of sources show that inspections have a measurable impact on the number of defects taken out of software documents.

Inspections have a better ROI for the effort spent performing them, than other common means of defect reduction like testing.

All sources agree that inspections are useful within the system development phase. Multiple authors discuss that inspections are usable in all phases of software development, although more benefits accrue when they are used earlier in the lifecycle.

Organizational Scope:

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Summary

Primary Benefit:

The most often-mentioned impact is on quality: The majority of sources show that inspections have a measurable impact on the number of defects taken out of software documents. As a side-effect, some sources also argue that they lead to fewer defects being generated in the future, through skill development of the personnel involved.
A secondary benefit is on cost: Inspections have a better ROI for the effort spent performing them, than other common means of defect reduction like testing.

Life Cycle Phases:

All sources agree that inspections are useful within the system development phase. Multiple authors discuss that inspections are usable in all phases of software development, although more benefits accrue when they are used earlier in the lifecycle.

Organizational Scope:

While there are numerous benefits that can be achieved within a project, authors also described an overall advantage to the entire organization or a given program that can result from implementation of inspections across projects.

Primary Target:

Almost all sources focus on the use of inspection within the development organization (to minimize their test and rework effort). However, the technical review process at NavAir can be considered a variant. It has been used across many projects by acquirers to help monitor the developers they are overseeing.

Barriers:

The primary inhibitors seem to be in the realm of developer motivation:
- Inspections are perceived as being labor intensive in nature
- Payback is delayed (i.e. benefits are not seen until long after the effort is spent)

than the team to coordinate the process, and personnel who provide support for measurement and interpretation.
Inspections may not be put into common use if there is no way to allow some customization to the division/group.

Madachy argues that, since there is some overhead cost involved in inspections, projects that already have extremely low defect rates (e.g. development using the Cleanroom paradigm) may not see a cost-benefit.

Enablers:

There is a need for local champions and management support. Development teams who implement inspections need trained moderators and support materials. Providing explicit training helps improve effectiveness.

Inspections work best if management is not present at inspections, to remove the threat that defect information could be used to evaluate workers.

Net Impact on Cost:

Is there any evidence that inspections will actually save us time and money?

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List of evidences for this practice

Rating	Status	Evidence Name	Created on
20	Included in summary	Advances in Software Inspections	2/16/2005
19	Included in summary	An Analysis of Defect Densities Found During Software Inspections	1/13/2005
19	Included in summary	Measuring Inspections at Litton	1/12/2005
18	Included in summary	Experience with Inspection in Ultralarge-Scale Developments	1/13/2005
17	Included in summary	Key Lessons in Achieving Widespread Inspection Use	1/13/2005
17	Included in summary	Space Shuttle Primary Onboard Software Development: Process Control and Defect Cause Analysis	2/16/2005
15	Included in summary	Comparing the Effectiveness of Software Testing Strategies	2/16/2005
13	Included in summary	Report on the Loss of the Mars Climate Orbiter Mission	2/17/2005
13	Included in summary	The Empirical Investigation of Perspective-Based Reading	2/16/2005
12	Included in summary	Applying Program Comprehension Techniques to Improve Software Inspections	1/13/2005
12	Included in summary	NavAir technical reviews	2/17/2005
8	Included in summary	What We Have Learned about Fighting Defects	1/13/2005

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Is there any evidence that inspections will actually save us time and money?

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Sources:
Madachy, Ray

Affiliations:
Litton

Name:
Criticality Level
Integration Lev
Domain:
Environment:
Applied how:
Total System co
ACAT Level:
Team Size
Team Environm
Life Cycle Phase
Organizational
Target Role:

Project detail

Domain:	Business
Environment:	Industry
Applied how:	Multiple production projects
Total System cost:	
ACAT Level:	
Team Size	
Team Environment:	
Life Cycle Phases:	System Development & Demonstration
Organizational scope:	Organization
Target Role:	Developer

Resulting recommendations

Primary Benefit:	Improve Quality

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Net Impact on Cost:	Reduced cost

p6: "Our project director set goals to save at least 50% of integration effort..." which are being met using inspections.

p9: "The net return per inspection... range from 64 to 200 person-hours saved per inspection..."

Cost involves extra effort in addition to meeting time. p9: "Our results concur with [Grady92] and other references that suggest a large proportion of preparation time to meeting time..."

Resulting recommendations

Primary Benefit:	Improve Quality
Barriers:	

p13: "We have also found that the use of an SEPG peer review coordinator goes a long way to keep the process intact." That is, sustaining requires someone at a higher level responsible for coordinating the practice.

p13: "While inspection and preparation effort stay fairly constant, the rework and test error fixing effort vary with the defect rates... [...]

Net Impact on Cost:

- **During design and coding, about 3% of the total project effort was used for inspection**
- **The net return per inspection range from 64 to 200 person-hours saved per inspection**

p7: "An overall inspection efficiency of 30%..." That is, inspections removed approximately 30% of defects in the inspected products, improving quality.

p6: "...achieved significant results in terms of defect reduction and return on investment"

p9: "Besides the detection of errors during inspection, less errors are originally generated due to authors being more careful as inspection metrics are publicized."

p9: "When comparing trouble report data before and after inspections were introduced, there is about a 2/3 reduction in trouble report density during integration..."

Is there any evidence that inspections will actually save us time and money?

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Is there any evidence that inspections will actually save us time and money?

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Resulting recommendations

Primary Benefit:	Improve Quality
Barriers:	

Lack of training can be a barrier: p. 748: "Some organizations have started inspections without proper education and have achieved some success, but less than others who prepared their participants fully. This has caused some amount of start-over, which was frust

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Net Impact on Cost:
Inspections have the effect of slightly front-end loading the commitment of resources, adding to requirements and design

In each instance, the new uses of inspection were found to improve product quality and to be cost effective, i.e., it saved more than it cost.

Net Impact on Quality:	Increased quality

p. 744: "In each instance, the new uses of inspection were found to improve product quality and to be cost effective, i.e., it saved more than it cost."

p. 744: Fagan quotes an IBM director saying: "Since we introduced the inspection process in 1974, we have achieved significant improvements in quality. IBM has nearly doubled the number of lines of code shipped... since 1976, while the number of defects per

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What is the status of BPCh?

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- **Why** do we need a BPCh?
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- **Who** to contact?

- Run by **Defense Acquisition University** (DAU)
  - An OUSD(AT&L) training institution
- **IT Components:**
  - BPCh v1.0 developed, undergoing usability training
- **Processes:**
  - Piloted for submitting practices and evidence, e.g.
    - Integration with DAU traditional and e-classrooms
    - Solicited via the tool
- **Roles / Communities:**
  - SMEs from DAU, Services, Agencies and Industry are being engaged
  - Practice Provider Network being forged to create a list of trusted content sources

→ Public debut of BPCh v1.0 planned for Spring 2008

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How are practices prioritized?

Contents

- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** does the BPCh work?
- **When** can I get involved?
- **Who** to contact?

- Priorities are set by Content Advisory Group
  - Periodic meetings to review content, recommend areas of interest
    - Low-hanging fruit or areas of high concern
  - Also to review opportunities to share content with other best practice / lessons learned initiatives
    - *Looking for speakers!*
  - Chaired by David Castellano, OUSD (AT&L)
  - Recommendations executed by Content Manager, Forrest Shull
  - Current hot topics include: Risk management, Earned Value Management, Requirements engineering

→ Priorities constantly reviewed and updated

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Can I suggest content?

Contents

- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** does the BPCh work?
- **When** can I get involved?
- **Who** to contact?

- YES!
  - We are looking for practice suggestions to ensure the usefulness of the BPCh to the user community
  - We are looking for evidence to add to an existing practice
  - Everyone can suggest practices
    → simply e-mail us

→ please fill in the survey that we circulate

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How can I participate next year?

- Visit: https://acc.dau.mil/bpch
- Built-in feedback forms in the application
  - …To give us a lead
  - …To suggest a practice we should have
  - …To tell us your experience with a practice
  - …To give us a detailed experience report
- Ability to integrate BPCh with in-house best practice / lessons learned systems
- Elicitation workshops
  - *Send us your suggestions*

Contents

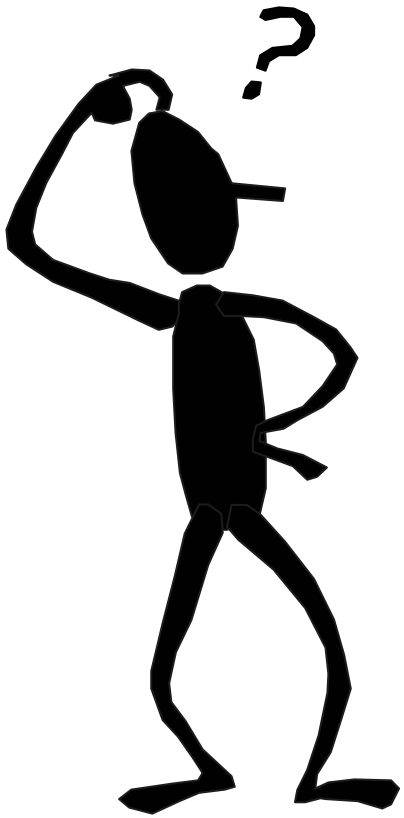
- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** does the BPCh work?
- **When** can I get involved?
- **Who** to contact?

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Questions?

Contents

- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** does the BPCh work?
- **When** can I get involved?
- **Who** to contact?



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301-403-8970

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Michael.Lambert@dau.mil
703-805-4555

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List of used abbreviations

Contents

- **Why** do we need a BPCh?
- **What** to expect in the BPCh?
- **How** does the BPCh work?
- **When** can I get involved?
- **Who** to contact?

ACC:	Acquisition Community Connection
ACAT:	Acquisition CATegory
AKSS:	AT&L Knowledge Sharing System
AT&L:	Acquisition, Technology and Logistics
BPCh:	(Acquisition) Best Practices Clearinghouse
CoP:	Communities of Practice
COTS:	Components Off The Shelf
DAU:	Defense Acquisition University
DoD:	U.S. Department of Defense
IFC:	Integrated Framework Chart
MOSS:	Microsoft Office SharePoint Server
OSD:	Office of the Under Secretary of Defense
ROI:	Return On Investment
SAM:	Software Acquisition Management
SE:	Systems Engineering
SEI:	Software Engineering Institute
SMEs:	Subject Matter Experts

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Understanding Social Networks- A Key Requirement for System Engineers

Mr. Karl Selke
Systems Engineering Analyst

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Vienna VA 22182 (703)-893-6800
selke@ebrinc.com

Agenda

- Introduction
- Wicked Problems
- Understanding Social Networks
- Social Network Analysis Process
- Concluding Thoughts

Introduction

- My motivation: Preliminary research for an Army Small Business Innovative Research Solicitation
  - *Social Networks and Organizations* (2003) by Martin Kilduff and Wenpin Tsai
  - *Social Network Analysis: Methods and Applications* (1994) by Wasserman and Faust
- My question: Is quantification and visualization of the maze of social interactions important for project success?
- My underlying assertion: Technical success, enabled by good systems engineering, should be accompanied by successful engineering of the social network in which the project exists.
- My underlying mission: Utilize computational social sciences' approaches for anticipating and managing the complexity, inherent in diverse, potentially conflicting stakeholders, project teams, and project managers.

The social network matters and the following is merely a simple articulation of the problem and a potential solution.

The Importance of “Wicked Problem” on Systems Engineering

Every textbook of system engineering starts with an enumeration of these phases: “understand the problems or the mission,” “gather information,” “work out solution,” or the like. For wicked problems, however, this type of Schema will not work.[1]

- Rittel and Webber’s paper introduced the concept of “wicked” problems to explain why scientific approaches and methods for solving societal problems are inherently flawed.
- As systems engineers have turned proper prior planning into a science, this raises the question as to the distribution of “wickedness” faced by systems engineers and if so, whether the field of systems engineering has adequately prepared system engineers to address them.

[1] Rittel and Weber, *Dilemmas in a General Theory of Planning* (1973)

The social network matters and the following is merely a simple articulation of the problem and a potential solution.

Properties of Wicked Problems

The ten properties are as follows:

1. There is no definitive formulation of a wicked problem.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem’s resolution.
10. The Planner has no right to be wrong.[1]

[1] For further articulation of these properties, one can refer to Rittle and Webber, *Dilemmas in a General Theory of Planning* (1973).

One can define “wickedness” as the extent to which one or more of these properties are dominant.

“Wicked” System Engineering Problems

Establish good relationships and open communications between systems engineers and stakeholders. This is helpful when negotiations begin to refine and clarify the set of requirements.[1]

- In general, project managers and systems engineers work to meet project performance requirements within planned schedule and cost.
- There are a set of observable reasons that are asserted to be the most common rationales for why project objectives are not met.
  - Inadequate articulation of requirements
  - Poor planning
  - Inadequate technical skills and continuity
  - Lack of teamwork
  - Poor communications and coordination
  - Insufficient monitoring of progress
  - Inferior corporate support[2]

[1] INCOSE Systems Engineering Handbook

[2] Howard Eisner, *Essentials of Project and Systems Engineering Management* (2002) page 9

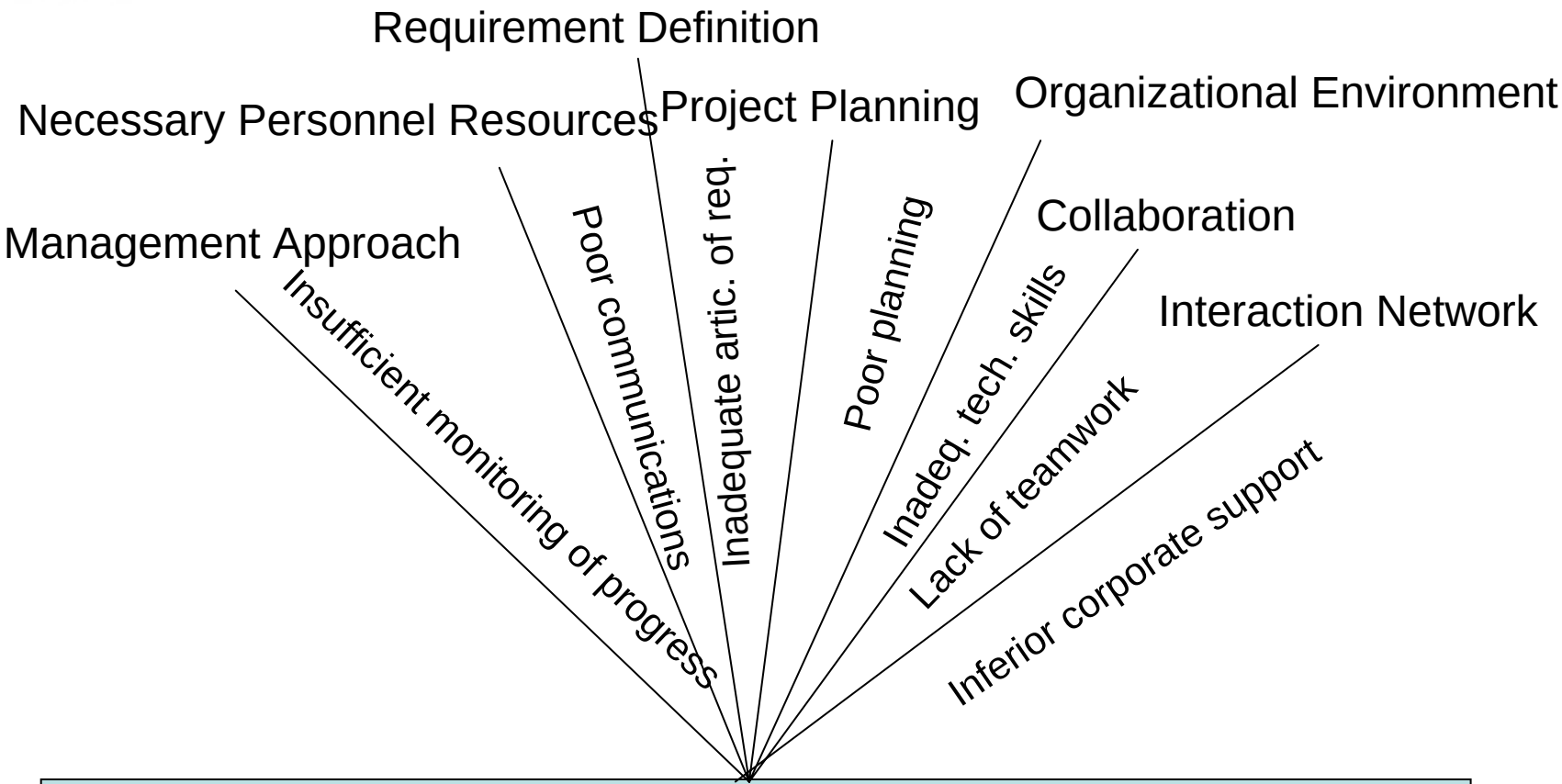
It is more useful to view these rationales as problem areas.

Problem Areas

- Requirement Definition- customer defined requirements for the system.
- Project Planning- initial project plan, personnel plans, and subsequent updates over time.
- Necessary Personnel Resources- required technical staff
- Collaboration- ability for personnel to function as a “team”
- Interaction Network- propagation and instantiation of guidance or orders
- Management Approach- leadership’s guiding principles of interaction with personnel
- Organizational Environments- external (to the project team) networks containing all the external factors that are relevant to the project.

Underlying each of these problem areas are complex interactions amongst the internal project personnel, external project personnel, customers, and stakeholders.

“Wicked” Engineering Management Problems- continued



Given that the problems are heavily correlated to the outcomes of social interactions, it suggests that these problems may have “wicked” aspects.

Properties of Wicked Problems

The ten properties are as follows:

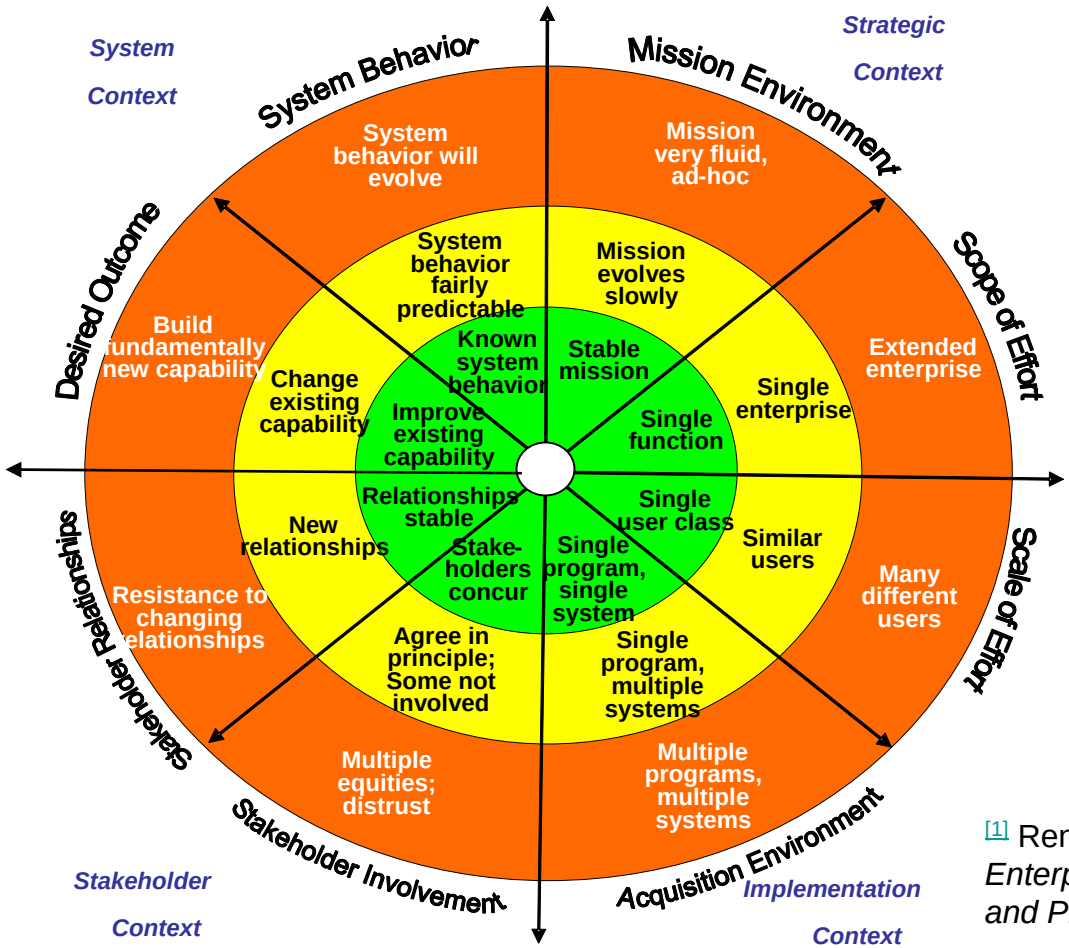
1. **There is no definitive formulation of a wicked problem.**
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. **Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.**
6. **Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.**
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8. **Every wicked problem can be considered to be a symptom of another problem.**
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10. The Planner has no right to be wrong.[1]

[1] For further articulation of these properties, one can refer to Rittle and Webber, *Dilemmas in a General Theory of Planning* (1973).

Property 7 can dominant the interaction of customers and systems developers

Growing Complexity of Social Interactions

Enterprise Systems Engineering Profiler[1]



[1] Renee Stevens, *Engineering Enterprise Systems: Challenges and Prospects*

Unfortunately for systems engineering, understanding the situation (or the social complexity) is the wicked problem.

Understanding Social Networks

System Thinking

- "The systems engineering perspective is based on systems thinking. Systems thinking occurs through discovery, learning, diagnosis, and dialog that lead to sensing, modeling, and talking about the real-world to better understand, define, and work with systems."[1]
- *Systems Thinking* is an important component of systems engineering—it may actually be the defining characteristic that separate great engineers from good engineers.

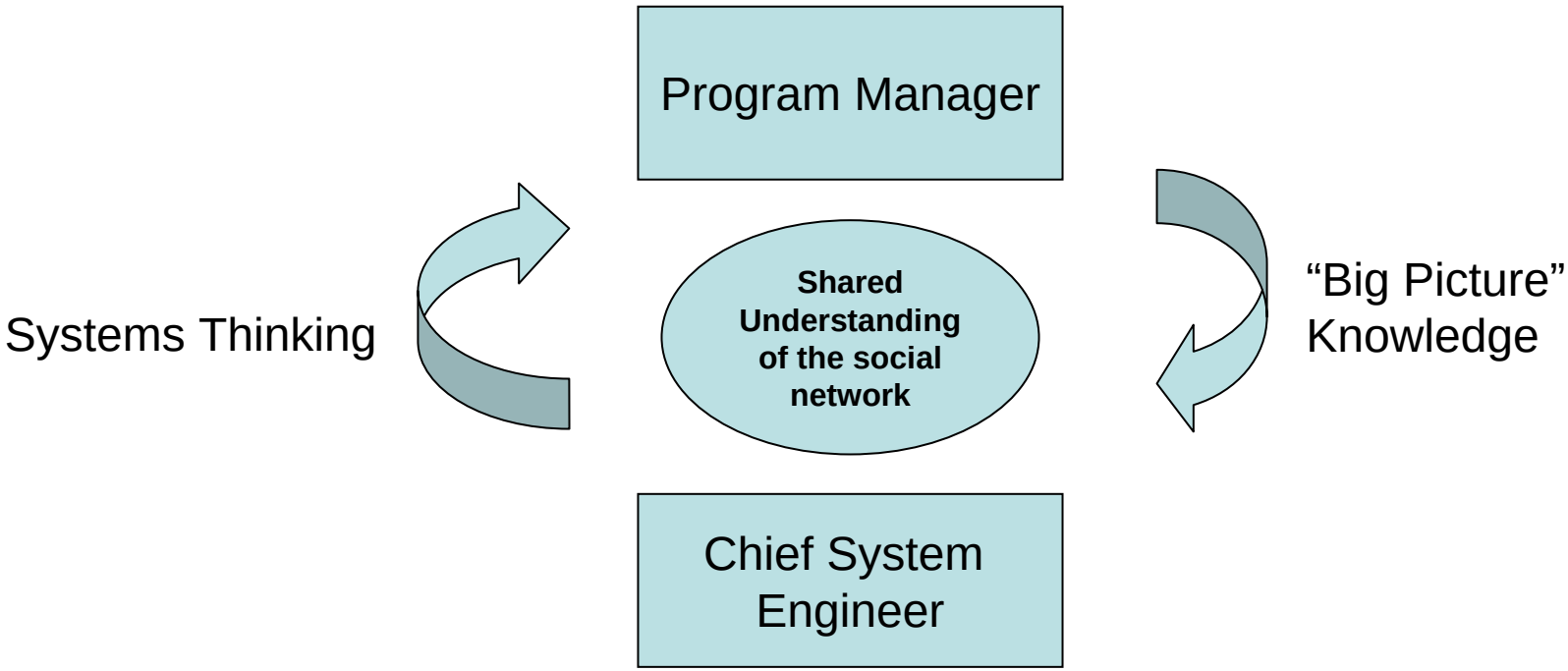
"Big Picture"Knowledge

- "Big Picture" Knowledge is simply the knowledge of the internal and external environment including communities of interest, processes, and specific players.
- Big Picture Knowledge is a necessary component of effective program management.

[1] INCOSE Systems Engineering Handbook

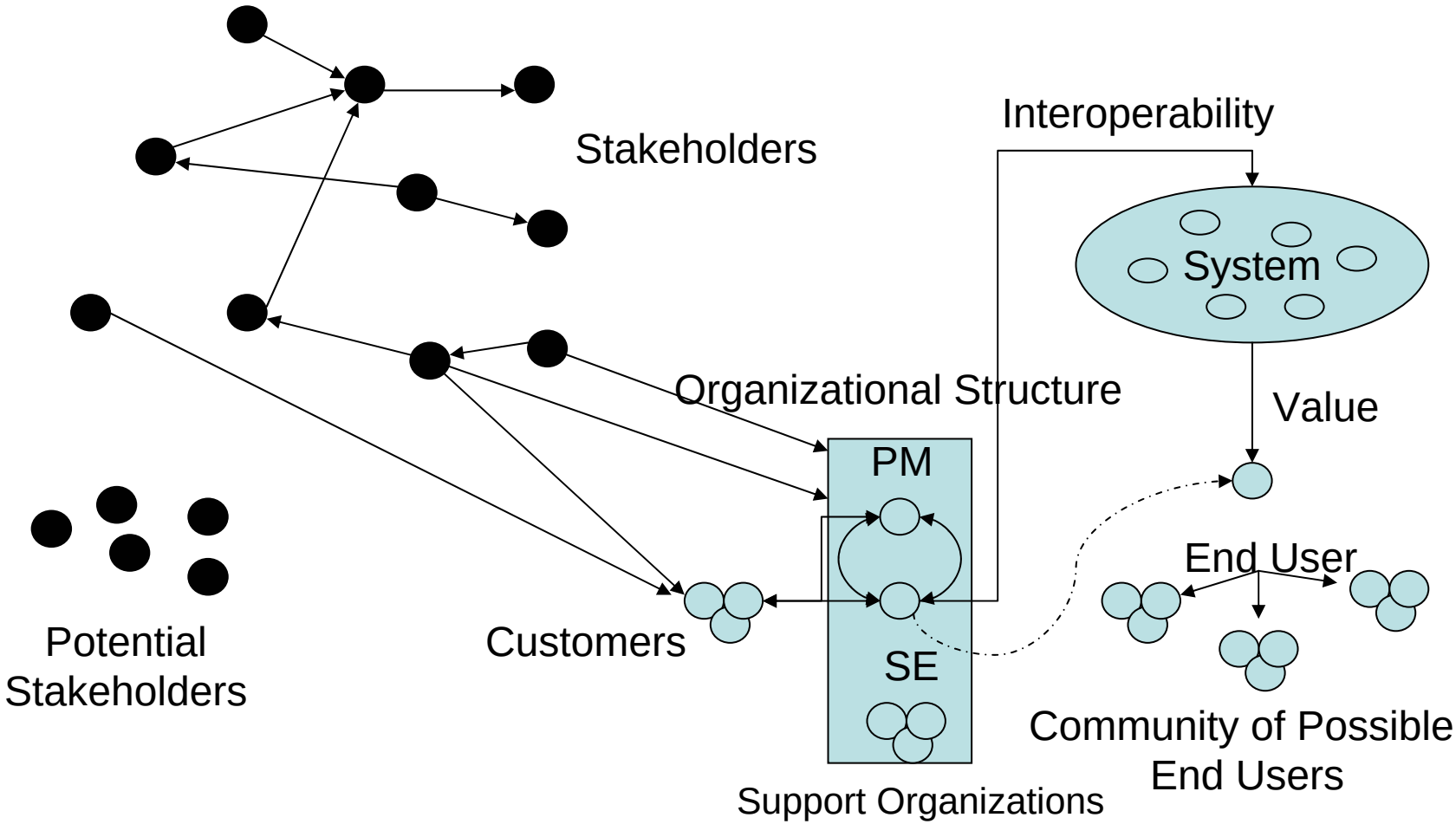
Is there a collaboration mechanism that combines "gray beard" knowledge of the big picture with the systems thinking capability of systems engineers?

Collaboration Mechanism



This interaction between the suave business knowledge program manager and the experienced systems thinker as the chief systems engineer may mitigate "wickedness."

Players Comprising the Social Network



Is it possible to institutionalize knowledge of the social network?

Brief Description of Social Network Analysis

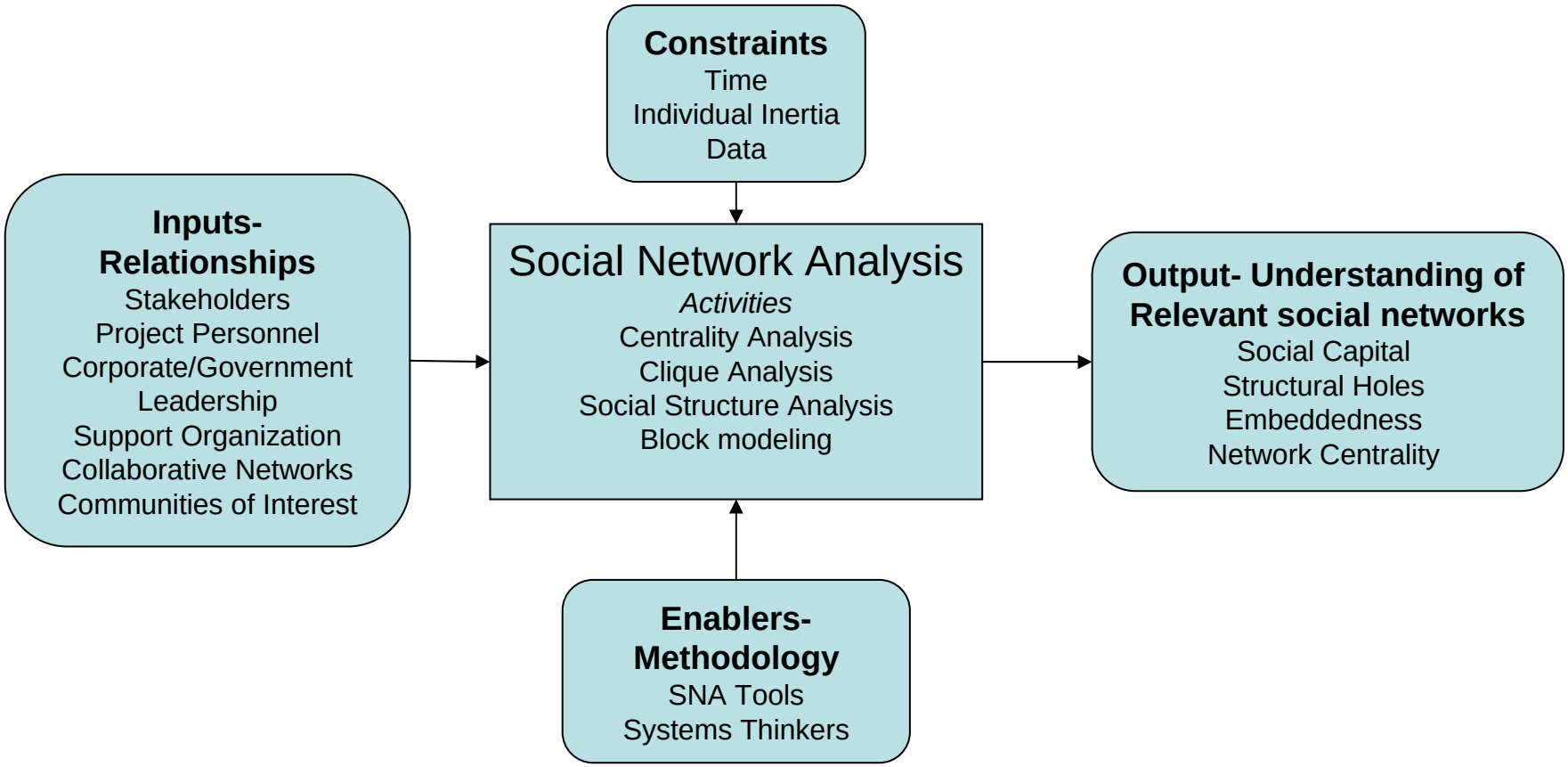
- "Social network analysis is based on an assumption of the importance of relationships among interacting units. The social network perspective encompasses theories, models, and applications that are expressed in terms of relational concepts or processes."[1]
- Social network analysis should not be outside the capability of a systems engineer, but rather its benefits would fold nicely into mission engineering—a core component of systems engineering.
  - Mission engineering is that often overlooked aspect in which the system developers ask the 'big picture' question: "why is this system being developed?"[2]
  - Social network analysis makes the question more fundamental: "Why is this system being developed and who is important to its sustained success?"
- "The purpose of social network analysis is to provide insightful information and inferences on the organization and structural properties of a network, given its nodes and relations."[3]

[1] Wasserman and Faust, Social Network Analysis: Methods and Applications (1994) page 10

[2] *Howard Eisner, Essentials of Project and Systems Engineering Management (2002) page 195*

[3] Dr. Cioffi-Revilla and Dr. Sean Obrien, Computational Analysis in US Foreign and Defense Policy (2007)

Social Network Analysis Process



Continuous process where individuals, organizations, and relationships should be systematically identified, processed, and refined into actionable information

Social Network Analysis Process- Inputs

- The inputs for this process are the data and information describing the individuals, organizations, and relationships comprising both the internal and external system engineering and management environment.
  - The nature of the data can include everything from friendship ties and organization memberships to personality.
  - This data often resides with numerous individuals; however, the project manager will likely have a solid foundation.
  - The data can be collected in several ways including roster type surveys, egocentric data from interviewing available people, archival data such as employee records based on the barriers of access.[1]
- Depending on the scope of the project, the following entities may be relevant:
  - Stakeholders including customers
  - Project Personnel
  - Corporate/Government Leadership
  - Support Organizations
  - Collaborative Networks (fellow systems engineers, project managers, etc)
  - Communities of Interest (similar projects, cutting-edge technical expertise)[1]

[1] Howard Eisner, *Essentials of Project and Systems Engineering Management* (2002) page 9-30
[1] Wasserman and Faust, *Social Network Analysis: Methods and Applications* (1994) page 28-66

Social Network Analysis Process- Constraints

- There is a strong argument that advocates progress over process which would stringently reject additional action items for systems engineers to accomplish.
  - The time pressure for project managers and system engineers is often overwhelming.
  - There may also be reluctance amongst system engineers to capture and codify individual and relationship data as part of the system engineering process, but rather let the data reside in their own mental models.
  - Thus, both time pressure and individual inertia will constrain this process.
- Data collection and a systematic examination into the social network to prevent the eschewing of project success by key stakeholders present several challenges such as personally sensitive information.

Social Network Analysis Process- Enablers

- Social network analysis as a component of the broader field of computational social science has spawned a great deal of research in the past ten years.
  - This has yielded social network software packages such as UCINET and visualization software such as KrackPlot and Netdraw (there are a good many more tools).[1]
- The automation of certain types of analysis such as deducing centrality of an individual greatly empowers social network appliers rather than only academics.
- There are current initiatives in the Department of Defense seeking to utilize social network analysis related to modeling the performance of joint, interagency, multi-organizational, and multinational organizations.
- Another enabler is the systems thinkers, particularly the graybeard contractors, who have spent forty years in the business and have deep understandings of the social networks.

[1] See Wasserman and Faust or Kilduff and Tsai for more information concerning tools.

Social Network Analysis Process- Analysis

The network of relationships within which we are embedded may have important consequences for the success or failure of our projects. Evidence suggests that the types of networks we form around ourselves affect everything from our health, to our career success, to our very identities.[1]

- There are numerous activities that can be done within the field of social network analysis that could be useful for systems engineers.
  - Centrality Analysis: Analyzes the data based on several indices to determine the degree to which the network is centered around a few key individuals.
  - Clique Analysis: Determines how many, what kind, and other clique related information that may be useful to the analyst.
  - Social Structure Analysis: Provides a delineation of structural features not observable by inspection.
  - Blockmodeling: Aims to discover groups in which there are no or limited connections.[2]
- The traditional approach for performing this type of analysis is to trust the insights of the retiring graybeards in whom past experience has grown wisdom and connections.

[1] Kilduff and Tsai, *Social Networks and Organizations* (2003) page 2.
[2] Kilduff and Tsai, *Social Networks and Organizations* (2003)

The potential knowledge gleaned from these activities can provide actionable information to project managers and systems engineers to provide assurance for project success given technical success.

Social Network Analysis Process- Output

- The analysis provides an increasing understanding of the social network in which the project exists.
- Social network analysis yields actionable information vital for decision-making.
- Four useful features of social network analysis:
  - Social Capital
  - Embeddedness
  - Network Centrality
  - Structural Holes.

Output- Understanding Social Networks: Social Capital

All leadership is influence – John C. Maxwell, Injoy, Inc.

- Social capital can be defined as “the benefits that accrue to the collectivity as a result of the maintenance of positive relations between different groups, organizational units, or hierarchical levels. At the individual level, this concept can be defined as the potential resources inherent in an actor’s set of social ties.”[1]
- Echoing this concept, Clark Aldrich in *Simulations and the Future of Learning* writes that “there is a currency that all people earn and spend called personal influence.”[2]
- Unfortunately, not all program managers and systems engineers have strong social networks that yield large amounts of influence.
- Social network analysis can be combined into the project’s personnel plan to intelligently spend your team’s social capital and your own personal influence paying special attention to the dynamics which could lead to unintended consequences.

[1] Kilduff and Tsai, *Social Networks and Organizations* (2003) page 28

[2] (2004) page 161

Output-Understanding Social Networks: Network Centrality

Richard knew that if the quality program was going to get anyplace in the organization he would have to place on the support of the princes and to dance past the kings – David T. Kearns[1]

- Network centrality is certainly implicit when discussing social capital, embeddedness, and structural holes.
- Actors can be central in the network from a variety of different perspectives such as popularity, go-between ties, or proximity to popular individuals.
  - Ascertaining this can be very informative because an actor with a high centrality level is in "direct contact or is adjacent to many other actors."
  - "This actor should then begin to be recognized by others as a major channel of relational information, indeed, a crucial cog in the network, occupying a central location."[2]

[1] *Prophets in the Dark: How Xerox Reinvented Itself and Beat Back the Japanese* page 278.

[2] Wasserman and Faust, *Social Network Analysis: Methods and Applications* (1994) page 178-179

Output- Understanding Social Networks: Embeddedness

In Washington, as elsewhere, power does not always follow organizational charts; a person's title does not necessarily reflect the power that he or she has.[1]

- The concept of embeddedness purports the notion that work-related transactions tend to overlap with patterns of social relations.
  - This is very similar to the "Good Old Boy System"
  - This has broad consequences in information flow and collaboration in the professional environment.
- Discovering individuals' or groups' past interactions early can often mitigate issues.
  - For example, there is a clear benefit to knowing that a scientist on your project has had very unfavorable interactions with a potential emergent stakeholder who could toss a wrench in the next phase of the project.
  - This prior knowledge empowers you to stave off potentially damaging issues. Carefully examining the stakeholders for friendship-enabled work transactions can guide the crafting of marketing proposals and requirements.[2]

[1] Hedrick Smith, *The Power Game: How Washington Works* page xxii

[2] Kilduff and Tsai, *Social Networks and Organizations* (2003) page 26-34

Output- Understanding Social Networks: Structural Holes

Sometimes those who refuse to cooperate actually have valuable knowledge or abilities; they may even be indispensable to your success.[1]

- The concept of structural holes is simply explained as the absence or severe shortage of ties between groups in a network.
- This is also the area in which systems engineers can leverage when doing requirement analysis and definition with the stakeholders, including customers.
- Identifying structural holes yields the benefits of increasing collaboration by furthering information sharing and dissemination.
- It may be that by connecting two otherwise stovepiped groups, the systems engineer can create more stable requirements as groups converge to a shared situational awareness (of course the opposite could easily be the case).[2]

[1] Eliza G.C. Collins and Mary Anne Devanna, *The New Portable MBA* page 33

[2] Kilduff and Tsai, *Social Networks and Organizations* (2003) page 26-34

Conclusion

If I had eight hours to chop down a tree, I'd spend six sharpening my ax. – Abraham Lincoln

- The current systems engineering practices are not sufficient in situations where the social context dominates the environment.
- Unfortunately, the trend in systems engineering is driving towards the need to anticipate and manage issues arising from diverse and competing constituencies in a complex environment.
- An important element for successful systems engineering is the incorporation of social network analysis into the systems engineering process and in effect, using this information to engineer social success in addition to technical success.

It is time to formalize what successful systems engineers have been doing guided by their intuition and in an ad hoc manner.

Additional Slides

Requirement Definition

- As previously mentioned by only simple inspection, the seven problem areas seem to have a strong social focus. These reasons are a product of the social interaction of the individuals involved. Hence, it is possible to correlate the problem areas in systems engineering with the properties of wicked problems.
- Relevant correlations: Requirement articulation
  - Property 1: There is no definitive formulation of a wicked problem.
  - Property 7: Every wicked problem is essentially unique
  - Property 6: Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan
  - Property 8: Every wicked problem can be considered to be a symptom of another problem
  - Property 5: Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly

A problem area may actually indicate the presence of a “wicked” or social aspect of system development and implementation.