11th Annual Systems Engineering Conference

San Diego, CA

20-23 October 2008

Agenda

TUESDAY, 21 OCTOBER 2008

Keynote Addresses:

- HON Charles McQueary, Director, Operational Test & Evaluation;

Plenary Session: Executive Panel
Moderator:
Ms. Kristin Baldwin, Deputy Director, Software Engineering & System Assurance
Panelists:

- Mr. Terry Jaggers, Director, SAF/AQR (Science, Technology & Engineering)
- Mr. Carl Siel, Chief Systems Engineer; ASN(RDA)CHENG
- Mr. Ross Guckert, Assistant Deputy, Acquisition & Systems Integration ASA(ALT)

Luncheon with Speaker in the Regatta Pavilion

- Dr. Ronald Jost, Deputy Assistant Secretary of Defense, C3, Space & Spectrum

BAYVIEW III: SYSTEMS ENGINEERING EFFECTIVENESS
Session 2C1

- 7099- DoD's Systems and Engineering Revitalization Efforts- An Update Mr. Nicholas M. Torelli, OSD/SSE/ED
- 7475 - The Effectiveness of Systems Engineering on Federal (DoD) System Development Programs - Update 2008, Mr. Ken Ptack
- 7153- Systems Engineering Plan (SEP) and Systems Engineering Management Plan (SEMP) Unification Mr. Chet Bracuto, OSD
- Naval Power 21 Integration & Interoperability Improvement, Mr. Kevin Smith
- 7089 - Systems Engineering for Systems of Systems, Dr. Judith Dahmann, The MITRE Corporation

BAYVIEW II: TEST & EVALUATION IN SYSTEMS ENGINEERING
Session 2C2

- 7100- Implementation of the 2007 Developmental Test & Evaluation Defense Science Board Results: Mr. Chris DiPetto, OUSD/SSR/
- 7101 - Test and Evaluation Value Metrics at Acquisition Decision Points: Ms. Darlene Mosser-Kerner, OUSD/SSE/DTE
- 6979 - Integration of Software Intensive Systems: Mr. Tom Wissink, Lockheed Martin
- 6996 - Modeling & Simulation in the Test & Evaluation Master Plan, Mr. Michael Truelove
- 7103 – "New….Improved" Test & Evaluation Master Plan, Ms. Darlene Mosser-Kerner
- 7290 – Mission Based T&E Strategy, Mr. Chris Wilcox

BAYVIEW I: PROGRAM MANAGEMENT
Session 2C3

- 7096 - New Acquisition Policy and Its Impact on Defense Systems Engineering: Ms. Sharon Vannucci, ODUSD/SSE/ED
- 6919- Improving the Quality of DoD Weapon Systems: Ms. Cheryl K. Andrew, U.S. Government Accountability Office
- An Air Force S&T Directorate's View on Applying Systems Engineering Principles to its Programs
- High Confidence Technology Transition Planning Through the Use of Stage-Gates (TD-13), Dr. Claudia Kropas-Hughes, HQ, AFMC
- 7002 - Systems Engineering Re-vitalization at the Defense Contract Management Agency: Mr. Lawrence F. Cianciolo, Defense Contract Management Agency

MISSION I SYSTEM SAFETY- ESOH & HSI
Session 2C4

- 6997 - Human Systems Integration and Model Based Systems Engineering: Dr. Abraham W. Meilich, Lockheed Martin
- 7084 - Human Reliability Analysis and the Advanced Man Portable Air Defense System: A Case Study: Mr. Christopher A. Brown, Naval Surface Warfare Center, Crane
- 7092- Systems Engineering to Ensure Aircraft Airworthiness, Mr. Jim Miller
- 7161 – ESOH In Acquisition OSD Expectations For Implementing DODI 5000.02, Ms. Karen Gill
- ESOH Challenges in Commissioning an Aircraft Carrier, Mr. Doug Parrish, Booz Allen Hamilton

MISSION II MODELING & SIMULATION
Session 2C5

- 7172 - Execution of the Acquisition M&S Master Plan- A Progress Report: Mr. James W.. Hollenbach, Simulation Strategies, Inc.
- Update on Survey on Modeling and Simulation Support for the Systems Engineering of Systems of Systems, Ms. Judith Dahmann, Simulation Strategies, Inc
- 7440 - Synchronizing Modeling and Simulation Plans Across Navy Acquisition: Dr. Ivar Oswalt, VisiTech
- 7085 - Modeling and Simulation Resource Reuse Business Model: Mr. Dennis P. Shea, Center For Naval Analyses
- Joint Rapid Scenario Generation (JRSG) System Engineering, Mr. Ralph O'Connell, US Joint Forces Command, Joint Capability Development (J8)
- Cross-Command Collaboration Effort (3CE)

MISSION III: NET CENTRIC OPERATIONS
Session 2C6

- 7461-Network Centric Engineering use of the NCOIC (Network Centric Operations Industry Consortium) Processes and Tools in a Logistics Example: Mr. Thomas M. Dlugolecki, SenseResponder LLC
- 7128 - Changing the Value Equation in Engineering and Acquisition to Align Systems of Systems with Dynamic Mission Needs: Mr. Philip J. Boxer, Software Engineering Institute
- 7341 - Crucial Factors in the Design of Net-Centric Systems: Dr. David Hernandez, Tactronics Holdings, LLC
- 7330 – Creating a Systems Architecture for an SOA-based IT System as Part of a Systems Engineering Process, Mr. Robert S. Elinger
- A Service-Oriented Architecture (SOA) Business Model for the U.S. Department of Defense (DoD)

PALM I: REQUIREMENTS DEVELOPMENT & MANAGEMENT
Session 2C7

- 7444- Acquisitions Requirements of Capabilities in a Netcentric Enterprise - Creating a Capabilities Engineering Framework: Mr.Jack M. Van Kirk, SFAE-AV-AS
- 7138- Implications of Capability-based Planning on Requirements Engineering: Mr. Leonard Sadauskas, DoD CIO, IT Investment & Commercial Policy
- 7191- System Concept of Operations: Standards, Practices, and Reality: Ms. Nicole Roberts, L-3 Communications
- 7066 - Two-Step Methodology to Reduce Software System Requirements Defects, Mr. Robert J. Kosman
- 7451 - Why Design for Testability Sooner?, Mr. Bruce Bardell, BAE Systems
- 7399 – The Challenges of Requirements Decomposition, Ms. Eliza Siu, Northrop Grumman Corporation

PALM II: SOFTWARE
Session 2C8
Panel

- 7137 - DoD Software Engineering and System Assurance: Moderator: Ms. Kristen J. Baldwin, Systems and Software Engineering
- 7139 - A Framework for Integrating Systems and Software Engineering: Dr. Richard Turner, Stevens Institute of Technology
- 7041 - Software Process Improvement for Acquisition of Naval Software Intensive Systems: Mr. Carl Siel, U.S. Navy, ASN (RDA) CHENG
- 7119 - Architecting Systems to Meet Expectations – Managing Quality Characteristics To Reduce Risk, Mr. Paul R. Croll, CSC
- 7156 – New Concepts and Trends – How Future Trends in Systems and Software Technology Bode Well for Enabling Improved Acquisition and Performance in Defense Systems, Dr. Kenneth E. Nidiffer
- 7239 – Systems and Software Design Principles for Large-Scale Mission-Critical Embedded Products from Aerospace and Financial Problems Domains, Mr. Rick Selby, Northrop Grumman Space Technology

WEDNESDAY, 22 OCTOBER 2008

Luncheon with Speaker in the Regatta Pavilion

- Ms. Shannon Cunniff, Director, Emerging Containments: Office of Under Secretary of Defense (Installations and Environment)

BAYVIEW III: SYSTEMS ENGINEERING EFFECTIVENESS
Session 3A1

- 7405 - Systems Engineering: Application in Complex Organizations: Mr. Kevin Roney, Booz Allen Hamilton
- 7065 - Establishing a Systems Engineering Center of Excellence in PEO Ground Combat Systems: Mr. Michael H. Phillips, Jacobs
- 7423- Systems Engineering Capability Development: Mr. Edward Andres, TARDEC

Session 3B1

- 7436- A Process Decision Table for Integrated Systems and Software Engineering: Dr. Barry Boehm, USC-CSSE
- 7190 - A Tool to Enhance Systems Engineering Planning: Ms. Sue O'Brien, The University of Alabama in Huntsville
- 6945- The Role of Chaos and Complexity in Systems Development: Dr. Robert J. Monson, Lockheed Martin

Session 3C1

- 6878 - Reduction of Total Ownership Costs (R-TOC) and Value Engineering (VE) in Defense System’s Life Cycle: Mr. Chet Bracuto, OSD
- 7007 - Using Performance-Based Earned Value(R) for Measuring Systems Engineering Effectiveness: Dr. Ronald S. Carson, Boeing
- 7017-KBAD- A Cost-Effective Way to Conduct Design and Analysis: Dr. Steven Dam, Systems and Proposal Engineering Company
- 6886 - Air Force Systems Engineering Assessment Model, Mr. Randy Bullard
- 7030 – Defining 100 Best Practices for SE, Mr. Ian Talbot, AAC/EN
- 7204 – Advancing Systems Engineering Practice within the Department of Defense: Overview of DoD’s Newest University Affiliated Research Center (UARC), Ms. Sharon Vannucci, ODUSD
- 7093 – Systems Engineering Performance Measures, Mr. Jim Miller

BAYVIEW II: TEST & EVALUATION IN SYSTEMS ENGINEERING

Session 3A2

- 6937 - Systems Engineering for Testing in a Joint Mission Environment: Mr. Earl Reyes, OSD/JTEM
- 7209- Joint Mission Environment Test Capability (JMETC): Mr. Chip Ferguson, JMETC
- 7351 - End to End System Test Architecture: Dr. Masuma Ahmed, Lockheed Martin

Session 3B2

- 7011 - Implementing a Methodology to Incorporate Operational Realism in CONOPS & Testing: Mr. William R. Lyders, ASSETT, Inc.
- 6928 - The Role of T&E in the Requirements Process for System of Systems: Mr. Walter C. Reel, Naval Surface Warfare Center - Dahlgren
- 7372 - Integrated T&E Process and Tools in the Joint High Speed Vessel Program: Mr. Stephen F. Randolph, Alion Science and Technology

BAYVIEW II: BEST PRACTICES & STANDARDIZATION

Session 3C2

- 6874 - Why CMMI Isn’t Enough: Ms. Anita Carleton, Software Engineering Institute
- 6888 - Value Engineering: Enhance DMSMS Solutions: Dr. Jay Mandelbaum, Institute for Defense Analysis
- 7761- Applying Business Process Modeling to Develop Systems Engineering Guidance for New DoD Acquisition Regulations: Dr. Judith Dahmann, OSD

Session 3D2

- 7003 - How to Specify Applicable Documents: Mr. James R. van Gaasbeek, Northrop Grumman
- 7014 - Systems Engineering in the Science and Technology Environment – Best Practices and other Lessons Learned from the Air Force Research Laboratory: Mr. William P. Doyle, General Dynamics
- 7031-Lessons Learned Doing Systems Engineering Assessments on the Government: Mr. Ian Talbot, AAC/EN

BAYVIEW I: PROGRAM MANAGEMENT

Session 3A3

- 7438 - The Incremental Commitment Model and Competitive Prototyping: Dr. Barry Boehm, USC
- 7070 - An Integrated, Knowledge-based Approach to Developing Weapon System Business Cases could Improve Acquisition Outcomes: Mr. Travis J. Masters, U.S. Government Accountability Office
- 7258 – Joint Service Safety Testing Study Phase II Final Presentation, Ms. Paige V. Ripani, Booz Allen Hamilton

Session 3B3

- 7340 - “Integrated Management Operating Model (iMOM)”, An E-2D Advanced Hawkeye SD&D Program Case Study: Mr. Douglas J. Shaffer, Northrop Grumman
- 7269- Closing the Gap Between Systems Engineering and Project Management: Mr. Robert W. Ferguson, Software Engineering Institute
- 7349- The Death of Rish Management: Mr. Michael P. Gaydar, Naval Air Systems Command

Session 3C3

- 7095 - Evaluating Complex System Development Maturity- The Creation and Implementation of a System Readiness Level for Defense Acquisition Programs: Mr. Eric Forbes, Northrop Grumman
- 7023- Program Management of Concurrently Developed Complex Systems - Lessons Learned: Mr. Alexander Polack, The Aerospace Corporation

Session 3D3

- 7385 - Enabling More Effective Weapons Systems Acquisition and Sustainment through an Enterprise Approach: Mr. John Stewart, Oracle
- 7462 - Applying the Tenets of Military Planning and Execution to Project and Systems Engineering Management: Mr. Philip Lindeman, SAIC
- 7479 - 360 Degree View of the Technology, Strategy and Business: Mr. Min-Gu Lee, Lockheed Martin

MISSION I: SYSTEM SAFETY- ESOH & HSI

Session 3B4

- 7211 - Defining a Generic Hazard Tracking Database for Future Programs: Mr. Jeff Walker, Booz Allen Hamilton
- 7215 - DoD Energy Demand: Addressing the Unintended Consequences: Mr. Thomas Morehouse, Booz Allen Hamilton
- 7258 - Joint Service Safety Testing Study: Ms. Paige Ripani, Booz Allen Hamilton

Session 3C4

- Update on Revisions to MIL-STD 882: Mr. Robert “Bob” Smith, Booz Allen Hamilton

MISSION II: MODELING & SIMULATION

Session 3A5

- 7347 - Deployment of SysML in Tools and Architectures: an Industry Perspective: Mr. Rick Steiner, Raytheon
- 7073 - Standardized Documentation for Verification, Validation, and Accreditation — An Update to the Systems Engineering Community: Mr. Kevin Charlow, Space and Warfare Systems Center-Charleston
- 7052 - Architecture and Model Based Systems Engineering for Lean Results: Mr. Tim Olson, Lean Solutions Institute, Inc.

Session 3B5

- 7026 - Rapid Assessment Approach Using Commander’s Intent to Identify Promising Force Structure Architectures for System Trade Studies: Mr. David A. Blancett, Northrup Grumman
- 7082 - Domain Modeling: A Roadmap to Convergence: Mr. Nathaniel C. Horner, The Johns Hopkins University Applied Physics Laboratory
- 7364 - Predictive Modeling: Principles and Practice: Dr. Rick Hefner, Northrop Grumman

Session 3C5

- 7144 - Systems Engineering Analysis of Threat Reduction Systems using a Collaborative Constructive Simulation Environment: Dr. James E. Coolahan, Johns Hopkins University Applied Physics Laboratory
- 7393 - Systems Engineering Approach to Total Vehicle Design and Integration: Mr. Walter J. Budd, BAE Systems

Session 3D5

- 7228 - Total System Modeling: A System Engineering Application of the Higraph Formalism: Mr. Kevin Fogarty, SAIC
- 7077 - Near-field RCS and Fuze Modeling and Simulation: Mr. David Hall, Survice Engineering Company
- 7174 - Virtual Battlespace Center for Systems Engineering: Mr. James Hollenbach, Simulation Strategies, Inc.

MISSION III: NET CENTRIC OPERATIONS

Session 3A6

- 6954 - SOAs and Net-Centric Warfare-Similarities, Differences and Conflicts: Mr. James A. Mazzei, The Aerospace Corporation
- 7374 - Capitalizing in Migrating Web Service Environments: Mr. Brian Eleazer, South Carolina Research Authority

Session 3B6

- 6972 - A System Engineering Approach to Develop a Service-Oriented Perspective: Mr. Rob Byrd, SI International
- 7413 - Systems Engineering Approach for Assessing a Warfighter’s Cognitive Performance: Mr. James Buxton, U.S. Army

Session 3C6

- 7105 - Building Net-Ready Information Interoperability Performance Indicator Widgets For DoDAF 2.0 Dashboards: Mr. William B. Anderson, Software Engineering Institute
- 7088 - The Benefit of Collaboration: Integration between the DoDAF and Systems Engineering Communities: Mr. Tim Tritsch, Vitech Corporation
- 7337 - Modeling Cognition in the DoD Architecture Framework for Early Concept Development: Dr. John M. Colombi, Air Force Institute of Technology
- 7046 – Survivable Network Design Framework, Mr. Dennis Moen, Lockheed Martin
- 7377 – Joint Surface Warfare Joint Capability Technology Demonstration – Maturing Weapon Data Link Concepts into Operational Capability, Mr. Robert Finlayson, John Hopkins University

PALM I: REQUIREMENTS DEVELOPMENT & MANAGEMENT

Session 3A7

- 7047-Stop the Pain: Take Some Requirements Definition and Management for Project Success: Mr. Scott Derby, AVISTA Incorporated
- 7068-Daily Challenges in Requirements Engineering: Mr. Frank J. Salvatore, High Performance Technologies, Inc.
- 7593- Correlation of Types of Requirements to Verification Methods: Dr. William G. Bail, The MITRE Corporation

Session 3B7

- 7548- Mission Analysis and its Impact on SE Fundamentals: Mr. John T. McDonald, Raytheon
- 7055- How to Write ‘Lean and Mean’ Requirements: Mr. Tim Olson, Lean Solutions Institute, Inc.

PALM I: LOGISTRICS, SUPPORTABILITY & SUSTAINMENT

Session 3C7

- 7180-A Continuous Process View of Systems Engineering for the Sustainment Phase: Mr. Paul d. Ratke, OC - ALC
- 7183- Progress Toward the Development of a Reliability Investment Cost Estimating Relationship: Mr. Andy Long, LMI
- 7235- Future Combat Systems (FCS) Logistics Systems: Ms. Soo R. Yoon, Boeing

Session 3D7

- 7390 - Systems Engineering of Deployed Systems: Mr. Robert K. Finlayson, Johns Hopkins University, Applied Physics Laboratory
- 7383 - Extending Enterprise Systems for an Integrated Logistics Management Environment: Mr. Mike Korzenowski, General Dynamics Land Systems

- 7455- The Seven Affordability Sins of Logistics System Integration: Dr. Thomas E. Herald, Lockheed Martin

PALM II: SOFTWARE
Session 3A8

- 7114- Building the Next Generation of Software Engineers - Benchmarking Graduate Education: Dr. Arthur Pyster, Stevens Institute of Technology
- 7135 - Improving Work Breakdown Structure (WBS) Guidance for Weapons Systems with Substantial Software Content: Mr. Christopher Miller, OUSD/SE/SSA
- 7232 - ASN (RD&A) Initiatives to Improve Integration of Software Engineering into Defense Acquisition Related Systems Engineering: Dr. John F. Miller, The MITRE Corporation

Session 3B8

- 7198- Software Reuse Readiness Levels: A Framework for Decision Making: Mr. Steven Wong, Northrop Grumman
- 7195 - Counting Software Size: Is it as easy as Busying a Gallon of Gas?: Ms. Lori Vaughan. Northrop Grumman

PAM II: ARCHITECTURE
Session 3C8

- 7136- Architecture Trade-off Analysis Method® (ATAM®) for System Architecture Evaluation: Mr. Michael Gagliardi, Software Engineering Institute
- 7243 - Method for Aligning Architecture Frameworks and System Requirements: Mr. Richard L. Eilers, IBM

Session 3D8

- 7428- Adaptable Architecture for System of Systems: Mr. Bruce Schneider, Applied Physics Lab Johns Hopkins University
- 7285 - Universal Architecture Description Framework: Mr. Jeffrey O. Grady, JOG System Engineering
- 7109 - Applying Open Architecture Concepts to Mission and Ship Systems: Mr. John M. Green, Naval Postgraduate School
- 7273 - US Air Force Global Persistent Attack Architecture, Process, & Risk Analysis: Maj Jeffrey D. Havlicek, Air Force Center for Systems Engineering

THURSDAY, 23 OCTOBER 2008

BAYVIEW III: SYSTEMS ENGINEERING EFFECTIVENESS
Session 4A1

- 7697 - Enhancing Systems Engineering in the Department of Defense: Mr. Ceasar Sharper, ODUSD /SSE
- 7186 - Air Force Implementation of NRC “Pre-A SE” Study Committee Recommendations: Mr. Jeff Loren, AF/AQRE
- 7281-A Holistic Approach to System Development: Mr. Douglas T. Wong, NASA Johnson Space Center

Session 4B1

- 7004 - Operational Concepts: Mr. James R. van Gaasbeek, Northrop Grumman
- 7296 - The Dangers of Oversimplifying Availability: Dr. Jeffrey M. Harris, General Dynamics
- 7214-Developing and Maintaining the Technical Baseline: Mr. Michael G. Ucchino, Air Force Institute of Technology

Session 4C1

- 7289 - Process Tailoring Patterns and Frameworks for Accelerating Systems Engineering Processes: Mr. Larry J. Earnest, Northrop Grumman
- 7054 - Using Lean Principles and Process Models to Achieve Measurable Results: Mr. Tim Olson, Lean Solutions Institute, Inc.
- 7265- Rocket Motor Development Cycle Time - Business Process Review: Mr. Jose Gonzalez, OUSD/PSA/LW&M

BAYVIEW II: BEST PRACTICES & STANDARDIZATION
Session 4A2

- 7076 - Systems and Software Life Cycle Process Standards: Foundation for Integrated Systems and Software Engineering: Ms. Teresa Doran, TECHSOFT
- 7111 - Improving Process Utilizations with Tools: Mr. Frank J. Salvatore, High Performance Technologies, Inc.
- 7179 - Integration of Systems and Software Engineering: Implications from Standards and Models Applied to DoDs’ Acquisition Programs: Mr. Donald Gantzer, ODUSD/SSE

Session 4B2

- 7325 - Applying CMMI High Maturity Practices and Leveraging LEAN Six Sigma: Mrs. Ann Hennon, BAE Systems
- 7422 - NDIA CMMI Working Group: Status and Plans: Mr. Geoff Draper, Harris Corporation
- 7441 – Process Enrichment Boot Camp, Mr. Victor Elias, High Performance Technology, Inc
- 7446 – Best Practices Clearinghouse: Making Lessons Learned Come Alive and Be Practical, Mr. Forrest Shull, Fraunhofer Center, Maryland

MISSION II: EDUCATION & TRAINING
Session 4A5

- 6944 - Establishing the Need for Functional Analysis in Systems Development: Dr. Robert J. Monson, Lockheed Martin
- 6946 - Improving Systems Engineering Execution and Knowledge Management: Mr. Steven C. Head, Boeing

Session 4B5

- 7094 - Development and Validation of a Systems Engineering Competency Model: Dr. Don Gelosh, SAIC
- 7098 - Accelerate Performance Improvements: Systems Engineering Skills Competency Analysis and Training Program Development: Mr. Steven A. Diebold, General Dynamics,
- 7130 - Concept Definiti- A Historical Perspective: Dr. David R. Jacques, Air Force Institute of Technology

MISSION III: ENTERPRISE HEALTH MANAGEMENT
Session 4A6

- 7580 - Engineering Solutions for Fleet Readiness Centers utilizing an Avionics Rapid Action Team Innovation Cell: Mr. Bill Birurakis, PIDESO
- 7447 - Prognostics as an Approach to Improve Mission Readiness and Availability: Mr. Sony Mathew, Center for Advance Life Cycle Engineering
- 7613 - Prognostics Based Health Assessment System Approaches: Mr. Ronald D. Newman, VSE Corporation

Session 4B6

- 7520 - NDIA ID Electronic Prognostics (E-Prog) Task Follow-on Study to Quantify Weapon System Benefits: Mr. Paul Howard, Paul L. Howard Enterprises
- 7597 - Enterprise Health Management Emerging Technology Transition Enabling Plan: Mr. Chris H. Reisig, Boeing

LRU Prognostics Demonstration Video MPEG Video RealPlayer

PALM I: LOGISTICS, SUPPORTABILITY & SUSTAINMENT
Session 4A7

- 7481- Defining the Prognostics Health Management Enterprise Architecture: Mr. Ethan Xu, Raytheon
- 7131- Sustaining Systems Engineering - The A-10 Example: Dr. David R. Jacques, Air Force Institute of Technology
- 7188- Reliability Centered Maintenance Applied to the CH-47 Chinook Helicopter–Universal Principles that go beyond Equipment Maintenance: Ms. Nancy Regan, The Force, Inc.

Session 4B7

- 7207- Sustainment Engineering versus Systems Engineering, Is There A Difference?: Ms. Karen B. Bausman, AF Center for Systems Engineering
- 7064- Reliability Growth Analysis of Mobile Gun System during PVT: Dr. Dmitry Tananko, GDLS

PALM II: ARCHITECTURE
Session 4A8

- 7401- Enabling Systems Engineering with an Integrated Approach to Knowledge Discovery and Architecture Framework: Mr. Michael R. Collins, Advantage Development, Inc.
- 7453 - Open Architecture in Electronics Systems: Mr. Bruce R. Bardell, BAE Systems
- 7069 - The Value of Architecture: Mr. Frank J. Salvatore, High Performance Technology, Inc.

Session 4B8

- 7365 - Enabling the Successful Transition from Architecture to Concept Design: Mr. Chris Ryder, Johns Hopkins University Applied Physics Laboratory
- 7079 - The Benefits of Synergizing Naval Open Architecture Practices and Principles with Systems Engineering Processes: Mr. Mike Dettman, PEO C4I - NAVSEA
- 7029 - Concurrent Increment Sequencing and Synchronization with Design Structure Matrices in Software-Intensive System Development: Dr. Peter Hantos, The Aerospace Corporation

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11TH ANNUAL SYSTEMS ENGINEERING CONFERENCE

HYATT REGENCY MISSION BAY ► SAN DIEGO, CA

OCT. 20-23, 2008
WWW.NDIA.ORG/MEETINGS/9870

IN CONJUCTION WITH:

CONFERENCE OBJECTIVES

This conference seeks to create an interactive forum for Program Managers, Systems Engineers, Software Engineers, Chief Scientists, and Engineers and Managers from government, industry, and the academic communities whose interests converge on Defense acquisition, from capabilities analysis through operations and disposal. This conference will provide the opportunity to learn from one's peers on latest techniques and methodologies, and help shape policy and guidance through the exchange of innovative procedures and lessons learned to address the following current issues:

•Effectiveness of Systems Engineering
•Program Management
•Architectures
•Requirements Development & Management
•Interoperability & Systems Integration
•Software & Software-intensive Systems
•Network Centric Operations
•System-of-Systems Engineering
•Modeling & Simulation
•Integrated Risk Management
•Aging Aircraft
•Logistics & Supportability including Performance Based Logistics
•Life Cycle Systems Management
•Improved Cycle Times for Design, Manufacture, & Repair Process
•Sustainment & Upgrade of Legacy Systems
•Application of Government & Industry "Best Practices" Tools, Methodologies, & Technologies
•System Safety – Environment, Safety & Occupational Health & Human Systems Integration
•Improved Mission Readiness & Systems Availability
•Enterprise Health management & Integrated Diagnostics
•Systems Engineering Training & Education
•Capability Maturity Model Integration (CMMI)
•Integrated Systems Engineering, Test, & Supportability Discipline
•Application of DoD Initiatives:
  -Performance Based Business Environment
  -System Safety
  -Open Systems
  -Simulation Based Acquisition
  -COTS Integration

BACKGROUND

The Department of Defense has been undertaking a major transformation of our military capability over the past few years in response to the new world environment and unforeseen, ever-changing threats. The ability to effect this transformation can only be realized if our Defense Systems—space, air, land, sea, and under sea—can effectively satisfy mission area and capability requirements, and achieve and sustain a high degree of interoperability, systems integration, readiness, availability, and systems safety, with affordable cost. We believe that the greatest opportunity to achieve these objectives for new and legacy systems is through strong technical management embodied in systems engineering methodologies and processes, on the part of both industry and the DoD, in not only the technical arms but the management & program management arms. Strong emphasis on systems engineering across the full acquisition life cycle, from concept development & refinement through deployment & sustainment, is a key enabler of improved performance in the overall acquisition process and effectiveness. The Systems Engineering Conference is an annual event targeted at exploring the role of technical planning and execution in Defense programs and systems from a variety of perspectives, academic and pragmatic, by the entire Defense systems engineering community.

GENERAL INFORMATION

CONFERENCE ATTIRE

Appropriate dress for this conference is business casual for civilians and class B uniform for military.

During conference registration and check-in, each participant will be issued an identification badge. Please be prepared to present a picture ID. Badges must be worn at all conference functions.

CONFERENCE PROCEEDINGS

Proceedings will be available on the web through the Defense Technical Information Center (DTIC), and will be available one to two weeks after the conference. You will receive notification via e-mail once proceedings are posted and available on the web.

OTHER INFORMATION

Conference Chair: Mr. Bob Rassa, Raytheon

Conference Technical Program Co-Chairs: Dr. Thomas Christian, USAF, Technical Advisor, Systems Engineering, USAF AFMC/ASC; Mr. Steve Henry, Northrop Grumman

Plenary: Ms. Kristen Baldwin, OSD/SSE

Systems Engineering Effectiveness: Mr. Al Brown, Boeing; Ms. Sharon Vannucci, OSD

Logistics Supportability & Sustainment: Mr. Joel Moorvich, Raytheon

Involving Test & Evaluation in SE: John Lohse, Raytheon; Darlene Mosser-Kerner, OSD

Program Management: Mr. Hal Wilson, Northrop Grumman

Modeling & Simulation: Mr. Jim Hollenbach, SIMSTRAT, Inc.; Mr. Gary Belie, Lockheed Martin

Net Centric Operations: Mr. Jack Zavin, ASD(NII); Dr. Rich Eilers, IBM

Best Practices & Standardization: To be announced

Software: Mr. Paul Croll, CSC

Education & Training in SE: Mr. Mike Ucchino, USAF/AFIT/CSE

Enterprise Health Management: Mr. Dennis Hecht, Boeing; Mr. Howard Savage, Savage Consulting

System Safety, ESOH & HIS: Mr. Sherman Forbes, USAF; Ms. Paige Ripani, Booz Allen Hamilton

Requirements Development & Management: Mr. Bob Scheurer, Boeing

Architecture: Mr. Joe Kuncel, Northrop Grumman; Mr. John Palmer, Boeing

Practical SE Experience: To be Announced

CONFERENCE AGENDA

SUNDAY, OCTOBER 19, 2008

5:00 pm - 7:00 pm	Registration for Tutorials and General Conference (Tutorials are an additional $250.00 registration fee)

MONDAY, OCTOBER 20, 2008

7:00 am - 5:00 pm	Registration
7:00 am - 8:00 am	Continental Breakfast for Tutorial Attendees ONLY (Tutorials are an additional $250.00 registration fee)
8:00 am - 12:00 pm	Tutorial Tracks (Please refer to the following pages 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 Regency Annex (Open to All Participants)

TUESDAY, OCTOBER 21, 2008

7:15 am - 5:00 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*
8:30 am - 9:45 am	Keynote Addresses: HON Charles McQueary, *Director, Operational Test & Evaluation;* Gen Les Lyles, USAF (Ret)
9:45 am - 10:15 am	Break
10:15 am - 12:15 pm	Plenary Session: Executive Panel Moderator: Ms. Kristin Baldwin, *Deputy Director, Software Engineering & System Assurance* Panelists: Mr. Terry Jaggers, *Director, SAF/AQR (Science, Technology & Engineering)* Mr. Carl Siel, *Chief Systems Engineer*; *ASN(RDA)CHENG* Mr. Kelly Miller, *Director, Systems Engineering, NSA* Mr. Ross Guckert, *Assistant Deputy, Acquisition & Systems Integration* *ASA(ALT)*
12:15 pm - 1:30 pm	Luncheon with Speaker in the Regatta Pavilion Dr. Ronald Jost, *Deputy Assistant Secretary of Defense, C3, Space & Spectrum*
1:30 pm - 5:15 pm	Concurrent Sessions (Please refer to the following pages for session schedule)
5:15 pm - 6:30 pm	Reception in the Regatta Pavilion

CONFERENCE AGENDA, CONTINUED

WEDNESDAY, OCTOBER 22, 2008

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 the following pages for session schedule)
12:00 pm - 1:30 pm	Luncheon with Speaker in the Regatta Pavilion Ms. Shannon Cunniff, *Director, Emerging Containments: Office of Under Secretary of Defense (Installations and Environment)*
1:30 pm - 5:15 pm	Concurrent Sessions (Please refer to the following pages for session schedule)

THURSDAY, OCTOBER 23, 2008

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 the following pages for session schedule)
12:00 pm - 1:00 pm	Awards Lunch in the Regatta Pavilion
1:00 pm - 3:00 pm	Concurrent Sessions (Please refer to the following pages for session schedule)
3:00 pm	Conference Adjourns

Tutorial Sessions - Monday, October 20, 2008

Room	8:00 am - 9:45 am	Break	10:15 am - 11:45 am	Buffet Lunch	1:00 pm - 2:45 pm	Break	3:15 pm - 5:00 pm
Bayview III	7025 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) (Part 1) *Dr. Abe Meilich, Lockheed Martin*		7025 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) (Part 2) *Dr. Abe Meilich, Lockheed Martin*		7025 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) (Part 3) *Dr. Abe Meilich, Lockheed Martin*		7025 - Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM) (Part 4) *Dr. Abe Meilich, Lockheed Martin*
Bayview II	7033 - ULCM (Unified Life Cycle Modeling) for Defense Acquisition (Part 1) *Dr. Peter Hantos, The Aerospace Corporation*		7033 - ULCM (Unified Life Cycle Modeling) for Defense Acquisition (Part 2) *Dr. Peter Hantos, The Aerospace Corporation*		7044 - A Model-Based Systems Engineering Roadmap for Developing DoDAF Architectures (Part 1) *Mr. Tim Tritsch, Vitech Corporation*		7044 - A Model-Based Systems Engineering Roadmap for Developing DoDAF Architectures (Part 2) *Mr. Tim Tritsch Vitech Corporation*
Bayview I	6987 - Development and Configuration Mangement of Requirements (Part 1) *Mr. Al Florence, The MITRE Corporation*		6987 - Development and Configuration Mangement of Requirements (Part 2) *Mr. Al Florence, The MITRE Corporation*		7050 - "How to Define Practical Metrics Using NASA JPL as an Example" (Part 1) *Mr. Tim Olson, Lean Solutions Institute, Inc.*		7050 - "How to Define Practical Metrics Using NASA JPL as an Example" (Part 2) *Mr. Tim Olson, Lean Solutions Institute, Inc.*
Mission I	7071 - Introduction to the Capability Test Methodology: Methods and Processes for Testing in a Joint Environment (Part 1) *Lt Col Jay R. Gendron, OSD/JTEM*		7071 - Introduction to the Capability Test Methodology: Methods and Processes for Testing in a Joint Environment *(Part 2)* *Lt Col Jay R. Gendron, OSD/JTEM*				
Mission II	7209 - Joint Mission Environment Test Capability (JMETC), Providing Efficiency and Cost Savings with a Distributed Test Infrastructure (Part 1) *Mr. Ryan Norman, JMETC*		7209 - Joint Mission Environment Test Capability (JMETC), Providing Efficiency and Cost Savings with a Distributed Test Infrastructure (Part 2) *Mr. Ryan Norman, JMETC*		7210- Engineering System of Systems (Part 1) *Mr. Soumya Simanta, Software Engineering Institute*		7210- Engineering System of Systems *(Part 2)* *Mr. Soumya Simanta, Software Engineering Institute*
Mission III	7294 - MFESA: The Method Framework for Engineering System Architectures (Part 1) *Mr. Donald G. Firesmith, Software Engineering Institute*		7294 - FMESA: The Method Framework for Engineering System Architectures (Part 2) *Mr. Donald G. Firesmith, Software Engineering Institute*		7366 - Systems Engineering Applications in Supporting the Joint Capabilities Integration and Development System (JCIDS) *Mr. Chris Ryder, Johns Hopkins University Applied Physics Laboratory*		7366 - Systems Engineering Applications in Supporting the Joint Capabilities Integration and Development System (JCIDS) *Mr. Chris Ryder, Johns Hopkins University Applied Physics Laboratory*
Palm I	6877 - Gap Analysis and Its Conceptual Foundations: Integrating Sound Management Methods with Systems Engineering Best Practices (Part 1) *Mr. Gary Langford, Naval Postgraduate School*		6877 - Gap Analysis and Its Conceptual Foundations: Integrating Sound Management Methods with Systems Engineering Best Practices (Part 2) *Mr. Gary Langford, Naval Postgraduate*		6877 - Gap Analysis and Its Conceptual Foundations: Integrating Sound Management Methods with Systems Engineering Best Practices (Part 3) *Mr. Gary Langford, Naval Postgraduate School*		6877 - Gap Analysis and Its Conceptual Foundations: Integrating Sound Management Methods with Systems Engineering Best Practices (Part 4) *Mr. Gary Langford, Naval Postgraduate School*
Palm II	6975 - Early Verification: The Road to Program Success (Part 1) *Mr. Stephen J. Scukanec, Northrop Grumman*		6975 - Early Verification: The Road to Program Success (Part 2) *Mr. Stephen J. Scukanec, Northrop Grumman*		6970 - Universal Architecture Description Framework (Part 1) *Mr. Jeffrey O. Grady, JOG System Engineering, Inc.*		6970 - Universal Architecture Description Framework (Part 2) *Mr. Jeffrey O. Grady, JOG System Engineering, Inc.*

Tuesday, October 21, 2008

1:30 pm - 3:15 pm

Session			
Bayview III Systems Engineering Effectiveness Session 2C1	7099- DoD's Systems and Engineering Revitalization Efforts- An Update *Mr. Nicholas M. Torelli, OSD/ SSE/ED*	7475 - The Effectiveness of Systems Engineering on Federal (DoD) System Development Programs - Update 2008 *Mr. Ken Ptack*	7153- Systems Engineering Plan (SEP) and Systems Engineering Management Plan (SEMP) Unification *Mr. Chet Bracuto, OSD*
Bayview II Test & Evaluation in Systems Engineering Session 2C2	7100- Implemention of the 2007 Developmental Test & Evaluation Defense Science Board Results *Mr. Chris DiPetto, OUSD/SSR/*	7101 - Test and Evaluation Value Metrics at Acquisition Decision Points *Ms. Darlene Mosser-Kerner, OUSD/SSE/DTE*	6979 - Integration of Software Intensive Systems *Mr. Tom Wissink, Lockheed Martin*
Bayview I Program Management Session 2C3	7096 - New Acquisition Policy and Its Impact on Defense Systems Engineering *Ms. Sharon Vannucci, ODUSD/ SSE/ED*	6919- Improving the Quality of DoD Weapon Systems *Ms. Cheryl K. Andrew, U..S. Government Accountability Office*	7418 - DON Acquisition Reform and its Impact on CANES System Engineering *CDR Phil Turner, USN, APM, PMW 160*
Mission I System Safety-ESOH & HSI Session 2C4	6997 - Human Systems Integration and Model Based Systems Engineering *Dr. Abraham W. Meilich, Lockheed Martin*	7035 - The Special Operational Airworthiness Release (SOAR) Process, A Systems Engineering Approach *Dr. Thomas Christian, ASC/EN*	7084 - Human Reliability Analysis and the Advanced Man Portable Air Defense System: A Case Study *Mr. Christopher A. Brown, Naval Surface Warfare Center, Crane*
Mission II Modeling & Simulation Session 2C5	7172 - Execution of the Acquisition M&S Master Plan- A Progress Report *Mr. James W.. Hollenbach, Simulation Strategies, Inc.*	7440 - Synchronizing Modeling and Simulation Plans Across Navy Acquisition *Dr. Ivar Oswalt, VisiTech*	7085 - Modeling and Simulation Resource Reuse Business Model *Mr. Dennis P. Shea, Center For Naval Analyses*
Mission III Net Centric Operations Session 2C6	7461-Network Centric Engineering use of the NCOIC (Network Centric Operations Industry Consortium) Processes and Tools in a Logistics Example *Mr. Thomas M. Dlugolecki, SenseResponder LLC*	7128 - Changing the Value Equation in Engineering and Acquisition to Align Systems of Systems with Dynamic Mission Needs *Mr. Philip J. Boxer, Software Engineering Institute*	7341 - Crucial Factors in the Design of Net-Centric Systems *Dr. David Hernandez, Tactronics Holdings, LLC*
Palm I Requirements Development & Management Session 2C7	7444- Acquisitions Requirements of Capabilities in a Netcentric Enterprise - Creating a Capabilities Engineering Framework *Mr.Jack M. Van Kirk, SFAE-AV-AS*	7138- Implications of Capability-based Planning on Requirements Engineering *Mr. Leonard Sadauskas, DoD CIO, IT Investment & Commercial Policy*	7191- System Concept of Operations: Standards, Practices, and Reality *Ms. Nicole Roberts, L-3 Communications*
Palm II Software Session 2C8 Panel	7137 - DoD Software Engineering and System Assurance *Moderator: Ms. Kristen J. Baldwin, Systems and Software Engineering*	7139 - A Framework for Integrating Systems and Software Engineering *Dr. Richard Turner, Stevens Institute of Technology*	7041 - Software Process Improvement for Acquisition of Naval Software Intensive Systems *Mr. Carl Siel, U.S. Navy, ASN (RDA) CHENG*

Break in the Regency Annex

3:30 pm - 5:15 pm

Session				
Bayview III Systems Engineering Effectiveness Session 2D1	7042 - Establishing a Departmental-Level Systems-of-Systems Engineering Managment Construct for the Department of Navy *Mr. Carl Siel, Asst. Secretary of the Navy/RDA*	7089 - Systems of Systems: Update on the DoD Systems of Systems SE Guide and Future Direction *Dr. Judith S. Dahmann, The MITRE Corporation*	6986- Technology Readiness Assessments for Systems of Systems *Dr. Jay Mandelbaum, Institute for Defense Analyses*	
Bayview II Test & Evaluation in Systems Engineering Session 2D2	7103- New Test and Evaluation Master Plan Guidance *Ms. Darlene S. Mosser-Kerner, OUSD/SSE/DTE*	6996 - Modeling & Simulation in the Test & Evaluation Master Plan *Mr. Michael R. Truelove, SAIC*	7290- Mission - Based Test and Evaluation Strategy: An Interagency Developed Process to Link Mission Capability with System Functional Requirements *Mr. Christopher M. Wilcox, U.S. Army Test and Evaluation Command*	
Bayview I Program Management Session 2D3	7002 - Systems Engineering Re-vitalization at the Defense Contract Managerment Agency *Mr.Lawrence F. Cianciolo, Defense Contract Management Agency*	7223 - An Air Force S&T Directorate's View on Applying Systems Engineering Principles to its Progrmas *Dr. James C. Malas, Air Force Material Command++*	7320 - Air Force Initiative - High Confidence Technology Transition Planning Through the Use of Stage-Gate *Dr. Claudia V. Kropas-Hughes, Air Force Material Command*	
Mission I System Safety-ESOH & HSI Session 2D4	7092 - Systems Engineering to Ensure Aircraft Airworthiness *Mr. James C. Miller, USAF*	7161 - ESOH in Acquisition - OSD Expectations for Implementing DoD 5000.02 *Ms. Patricia Huheey, ODUSD/I&E*	ESOH Challenges in Pre-commissioning a Naval Aircraft Carrier *Dr. Doug Parrish, Booz Allen Hamilton*	
Mission II Modeling & Simulation Session 2D5	7467- Systems Engineering Across rmy Modeling and Simulation *LTC Favio Lopez,*	7404 - Joint Rapid Scenario Generation Systems Engineering Vision *Mr. Ralph O'Connell, JFCOM*	7175 - LVC Architecture Raodmap - A Path Forward for Distributed Simulation *Mr. James W. Hollenbach, Simulation Strategies, Inc*	
Mission III Net Centric Operations Session 2D6	7414 - An IT Government Solution *Mr. Paul Byrnes, Integrated System Diagnostics, Inc.*	7016 - A Service-Oriented Architecture (SOA) Business Model for DoD *Dr. Steven H. Dam, Systems and Proposal Engineering Company*	7330 - Creating a Systems Architecture for an SOA-based IT System as Part of a Systems Engineering Process *Dr. Robert Ellinger, Northrop Grumman*	
Palm I Requirements Development & Management Session 2D7	7451 - Why Design for Testability Earlier? *Mr. Bruce R. Bardell, BAE Systems*	7066 - Two-Step Methodology to Reduce Software Requirements Defects *Mr. Robert J. Kosman, Naval Undersea Warfare Center Division Newport*	6998 - Quantifying the Impact of System Engineering Changes *Dr. Mark Blckburn, Systems and Software Consortium*	7399- The Challenges in Requirements Decomposition *Mrs. Eliza Siu, Northrop Grumman Corporation*
Palm II Software Session 2D8	7156- How Future Trends in Systems and Software Engineering Bode Well for Enabling Improved Acquisition and Performance of Defense Systems *Dr. Kenneth E. Nidiffer, Software Engineering Institute*	7239 - Systems and Software Design Principles for Large-Scale Mission-Critical Embedded Products from Aerospace and Financial Problem Domains *Dr. Richard W. Selby, Northrop Grumman Space Technology*	7119 - Architecting Systems to Meet Expectations- Managing Quality Characteristics to Reduce Risk *Mr.Paul Croll, Computer Sciences Corporation*	

Wednesday, October 22, 2008

8:00 am - 9:45 am

Bayview III Systems Engineering Effectiveness Session 3A1	7405 - Systems Engineering: Application in Complex Organiztions *Mr. Kevin Roney, Booz Allen Hamilton*	7065 - Establishing a Systems Engineering Center of Excellence in PEO Ground Combat Systems *Mr. Michael H. Phillips, Jacobs*	7423- Systems Engineering Capability Development *Mr. Edward Andres, TARDEC*
Bayview II Test & Evaluation in Systems Engineering Session 3A2	6937 - Systems Engineering for Testing in a Joint Mission Environment *Mr. Earl Reyes, OSD/JTEM*	7209- Joint Mission Environment Test Capability (JMETC) *Mr. Chip Ferguson, JMETC*	7351 - End to End System Test Architecture *Dr. Masuma Ahmed, Lockheed Martin*
Bayview I Program Management Session 3A3	7438 - The Incremental Commitment Model and Competitive Prototyping *Dr. Barry Boehm, USC*	7116 - Exploration of Customer Capability Gaps Through Experi-mentation *Mr. Michael E. Groff, Lockheed Martin*	7070 - An Integrated, Knowledge-based Approach to Developing Weapon System Business Cases could Improve Acquisition Outcomes *Mr. Travis J. Masters, U.S. Government Accountability Office*
Mission I Program Management Session 3A4	7721- Systemic Analysis and Developing System Issues *Mr. Pete Nolte, OSD*	7720- Systemic Root Cause Task Group Results *Mr. Dave Castellano, US Army RDECOM-ARDEC*	System Root Cause Task Group Recommendations Implementation *Mr. Nicholas M. Torelli, OSD/ SSE/ED*
Mission II Modeling & Simulation Session 3A5	7347 - Deployment of SysML in Tools and Architectures: an Industry Perspective *Mr. Rick Steiner, Raytheon*	7073 - Standardized Documentation for Verification, Validation, and Accreditation — An Update to the Systems Engineering Community *Mr. Kevin Charlow, Space and Warfare Systems Center-Charleston*	7052 - Architecture and Model Based Systems Engineering for Lean Results *Mr. Tim Olson, Lean Solutions Institute, Inc.*
Mission III Net Centric Operations Session 3A6	6954 - SOAs and Net-Centric Warfare-Similarities, Differences and Conflicts *Mr. James A. Mazzei, The Aerospace Corporation*	7477 - Service Oriented Architecture - The good, Bad, and Ugly of the Word's Largest SOA Attempt (DoD NECC) *Mr. Allen L. Mink, SRA International*	7374 - Capitalizing in Migrating Web Service Environments *Mr. Brian Eleazer, South Carolina Research Authoirty*
Palm I Requirements Development & Management Session 3A7	7047-Stop the Pain: Take Some Requirements Definition and Management for Project Success *Mr. Scott Derby, AVISTA Incorporated*	7068-Daily Challenges in Requirements Engineering *Mr. Frank J. Salvatore, High Performance Technologies, Inc.*	7593- Correlation of Types of Requirements to Verification Methods *Dr. William G. Bail, The MITRE Corporation*
Palm II Software Session 3A8	7114- Building the Next Generation of Software Engineers - Benchmarking Graduate Education *Dr. Arthur Pyster, Stevens Institute of Technology*	7135 - Improving Work Breakdown Structure (WBS) Guidance for Weapons Systems with Substantial Software Content *Mr. Christopher Miller, OUSD/ SE/SSA*	7232 - ASN (RD&A) Initiatives to Improve Integration of Software Engineering into Defense Acquisition Related Systems Engineering *Dr. John F. Miller, The MITRE Coporation*

Break in the Regency Annex

10:15 am - 12:00 pm

Bayview III Systems Engineering Effectiveness Session 3B1	7436 -A Process Decision Table for Integrated Systems and Software Engineering *Dr. Barry Boehm, USC*	7190 - A Tool to Enhance Systems Engineering Planning *Ms. Sue O'Brien, The University of Alabama in Huntsville*	6945- The Role of Chaos and Complexity in Systems Development *Dr. Robert J. Monson, Lockheed Martin*
Bayview II Test & Evaluation in Systems Engineering Session 3B2	7011 - Implementing a Methodology to Incorporate Operational Realism in CONOPS & Testing *Mr. William R. Lyders, ASSETT, Inc.*	6928 - The Role of T&E in the Requirements Process for System of Systems *Mr. Walter C. Reel, Naval Surface Warfare Center - Dahlgren*	7372 - Integrated T&E Process and Tools in the Joint High Speed Vessel Program *Mr. Stephen F. Randolph, Alion Science and Technology*
Bayview I Program Management Session 3B3	7340 - "Integrated Management Operating Model (iMOM)", An E-2D Advanced Hawkeye SD&D Program Case Study *Mr. Douglas J. Shaffer, Northrop Grumman*	7269- Closing the Gap Between Systems Engineering and Project Management *Mr. Robert W. Ferguson, Software Engineering Institute*	7349- The Death of Rish Management *Mr. Michael P. Gaydar, Naval Air Systems Command*
Mission I System Safety-ESOH & HSI Session 3B4	7211 - Defining a Generic Hazard Tracking Database for Future Programs *Mr. Jeff Walker, Booz Allen Hamilton*	7215 - DoD Energy Demand: Addressing the Unintended Consequences *Mr. Thomas Morehouse, Booz Allen Hamilton*	7258 - Joint Service Safety Testing Study *Ms. Paige Ripani, Booz Allen Hamilton*
Mission II Modeling & Simulation Session 3B5	7026 - Rapid Assessment Approach Using Commander's Intent to Identify Promising Force Structure Architectures for System Trade Studies *Mr. David A. Blancett, Northrup Grumman*	7082 - Domain Modeling: A Roadmap to Convergence *Mr. Nathaniel C. Horner, The Johns Hopkins University Applied Physics Laboratory*	7364 - Predictive Modeling: Principles and Practice *Dr. Rick Hefner, Northrop Grumman*
Mission III Net Centric Operations Session 3B6	6972 - A System Engineering Approach to Develop a Service-Oriented Perspective *Mr. Rob Byrd, SI International*	7122 - Department of Defense Architecture Framework; Delivering Architectures to the World *Mr. Walt Okon, OSD/NII/A&I*	7413 - Systems Engineering Approach for Assessing a Warfighter's Cognitive Performance *Mr. James Buxton, U.S. Army*
Palm I Requirements Development & Management Session 3B7	7548- Mission Analysis and its Impact on SE Fundamentals *Mr. John T. McDonald, Raytheon*	7055- How to Write 'Lean and Mean' Requirements *Mr. Tim Olson, Lean Solutions Institute, Inc.*	
Palm II Software Session 3B8	7198- Software Reuse Readiness Levels: A Framework for Decision Making *Mr. Steven Wong, Northrop Grumman*	7195 - Counting Software Size: Is it as easy as Busying a Gallon of Gas? *Ms. Lori Vaughan. Northrop Grumman*	

Wednesday, October 22, 2008

1:30 pm - 3:00 pm

Session			
Bayview III Systems Engineering Effectiveness Session 3C1	6878 - Reduction of Total Ownership Costs (R-TOC) and Value Engineering (VE) in Defense System's Life Cycle *Mr. Chet Bracuto, OSD*	7007 - Using Performance-Based Earned Value(R) for Measuring Systems Engineering Effectiveness *Dr. Ronald S. Carson, Boeing*	7017-KBAD- A Cost-Effective Way to Conduct Design and Analysis *Dr. Steven Dam, Systems and Proposal Engineering Company*
Bayview II Best Practices & Standardization Session 3C2	6874 - Why CMMI Isn't Enough *Ms. Anita Carleton, Software Engineering Institute*	6888 - Value Engineering: Enhance DMSMS Solutions *Dr. Jay Mandelbaum, Institute for Defense Analysis*	7761- Applying Business Process Modeling to Develop Systems Engineering Guidance for New DoD Acquisition Regulations *Dr. Judith Dahmann, OSD*
Bayview I Program Management Session 3C3	7095 - Evaluating Complex System Development Maturity-The Creation and Implementation of a System Readiness Level for Defense Acquisition Programs *Mr. Eric Forbes, Northrop Grumman*	7023- Program Management of Concurrently Developed Complex Systems - Lessons Learned *Mr. Alexander Polack, The Aerospace Corporation*	7344 - Complex System Development Program Assessments and Support: A Forensics Perspective *Mr. Dinesh Verma, Stevens Institute of Technology*
Mission I System Safety-ESOH & HSI Session 3C4	7378- A Culture Shift–Strengthening the "Jointness" in Weapon Safety Reviews *Ms. Mary Ellen Caro, Naval Ordnance Safety and Security Activity*	Update on Revisions to MIL-STD 882 *Mr. Bob Smith, Booz Allen Hamilton*	Safety Aspects of Weapon Deisng - A Review of Common Sesign Flaws *Dr. Doug Parrish, Booze Allen Hamilton*
Mission II Modeling & Simulation Session 3C5	7144 - Systems Engineering Analysis of Threat Reduction Systems using a Collaborative Constructive Simulation Environment *Dr. James E. Coolahan, JohnsHopkins University Applied Physics Laboratory*	7335 - Model-Based Specification for Legacy Networks *Mr. Robert M. Kane, SAIC*	7393 - Systems Engineering Approach to Total Vehicle Design and Integration *Mr. Walter J. Budd, BAE Systems*
Mission III Net Centric Operations Session 3C6	7105 - Building Net-Ready Information Interoperability Performance Indicator Widgets For DoDAF 2.0 Dashboards *Mr. William B. Anderson, Software Engineering Institute*	7088 - The Benefit of Collaboration: Integration between the DoDAF and Systems Engineering Communities *Mr. Tim Tritsch, Vitech Corporation*	7337 - Modeling Cognition in the DoD Architecture Framework for Early Concept Development *Dr. John M. Colombi, Air Force Institute of Technology*
Palm I Logistics, Supportability & Sustainment Session 3C7	7180-A Continuous Process View of Systems Engineering for the Sustainment Phase *Mr. Paul d. Ratke, OC - ALC*	7183- Progress Toward the Development of a Reliability Investment Cost Estimating Relationship *Mr. Andy Long, LMI*	7235- Future Combat Systems (FCS) Logistics Systems *Ms. Soo R. Yoon, Boeing*
Pam II Architecture Session 3C8	7081 - Littoral Combat Ship (LCS) Mission Modules Integration: An Open Architecture Approach *Mr. Cecil Whitfield, NAVSEA SYSCOM*	7136- Architecture Trade-off Analysis Method® (ATAM®) for System Architecture Evaluation *Mr. Michael Gagliardi, Software Engineering Institute*	7243 - Method for Aligning Architecture Frameworks and System Requirements *Mr. Richard L. Eilers, IBM*

Break in Display Area

3:30 pm - 5:15 pm

Session				
Bayview III Systems Engineering Effectiveness Session 3D1	7030 - Defining 100 Best Practices for Systems Engineering *Mr. Ian Talbot, AAC/EN*	6886 - Air Force Systems Engineer Assessment Model (AF SEAM) *Mr. Randall Bullard, AF Center for Systems Engineering*	7093 - Systems Engineering Performance Measures *Mr. James C. Miller, OC-ALC*	7204 - Advancing Systems Engineering Practice within the Department of Defense: Overview of DoD's Newest University Affiliated Research Center *Ms. Sharon Vannucci, ODUSD/SSE/ED*
Bayview II Best Practices & Standardization Session 3D2	7003 - How to Specify Applicable Documents *Mr. James R. van Gaasbeek, Northrop Grumman*	7014 - Systems Engineering in the Science and Technology Environment – Best Practices and other Lessons Learned from the Air Force Research Laboratory *Mr. William P. Doyle, General Dynamics*	*7031*-Lessons Learned Doing Systems Engineering Assessments on the Governement *Mr. Ian Talbot, AAC/EN*	
Bayview I Program Management Session 3D3	7385 - Enabling More Effective Weapons Systems Acquisition and Sustainment through an Enterprise Approach *Mr. John Stewart, Oracle*	7462 - Applying the Tenets of Military Planning and Execution to Project and Systems Engineering Management *Mr. Philip Lindeman, SAIC*	7479 - 360 Degree View of the Technology, Strategy and Business *Mr. Min-Gu Lee, Lockheed Martin*	
Mission I System Safety - ESOH & HSI Session 3D4	7442 - What Systems Engineers Need to Know About System Environmental Noise *Ms. Lynn Engelman, USAF*	7515 - The Intersection of System Safety, Lean Engineering and Ergonomics *Dr. Lee Ostrom, GDIT*	7216 - Acquisition and Technology Programs Task Force Funded Initiatives *Ms. Lucy Rodriguez, Booz Allen Hamilton*	
Mission II Modeling & Simulation Session 3D5	7228 - Total System Modeling: A System Engineering Application of the Higraph Formalism *Mr. Kevin Fogarty, SAIC*	7077 - Near-field RCS and Fuze Modeling and Simulation *Mr. David Hall, Survice Engineering Company*	7174 - Virtual Battlespace Center for Systems Engineering *Mr. James Hollenbach, Simulation Strategies, Inc.*	
Mission III Net Centric Operations Session 3D6	7046 - Cost-Effective Survivable Network Design Framework *Dr. Dennis M. Moen, Lockheed Martin*	7280- Multiple Information Agents for Real-Time, Dynamic Situational Awareness: Architectures for Real-Time WArfighter Support *Dr. James A. Crowder, Raytheon*	7377 - The Joint Surface Warfare JCTD: Maturing Weapon Data Link Concepts into Operational Capability *Mr. Robert K. Finlayson, Johns Hopkins University, Applied Physics Laboratory*	
Palm I Logistics, Supportability & Sustainment Session 3D7	7390 - Systems Engineering of Deployed Systems *Mr. Robert K. Finlayson, Johns Hopkins University, Applied Physics Laboratory*	7383 - Extending Enterprise Systems for an Integrated Logistics Management Environment *Mr. Mike Korzenowski, General Dynamics Land Systems*	7455- The Seven Affordability Sins of Logistics System Integration *Dr. Thomas E. Herald, Lockheed Martin*	
Palm II Architecture Session 3D8	7273 - US Air Force Global Persistent Attack Architecture, Process, & Risk Analysis *Maj Jeffrey D. Havlicek, Air Force Center for Systems Engineering*	7109 - Applying Open Architecture Concepts to Mission and Ship Systems *Mr. John M. Green, Naval Postgraduate School*	7285 - Universal Architecture Description Framework *Mr. Jeffrey O. Grady, JOG System Engineering*	7428- Adaptable Architecture for System of Systems *Mr. Bruce Schneider, Applied Physics Lab Johns Hopkins University*

Thursday, October 23, 2008

8:00 am - 9:45 am

Bayview III Systems Engineering Effectiveness Session 4A1	7697 - Enahancing Systems Engineering in the Department of Defense *Mr. Ceasar Sharper, ODUSD /SSE*	7186 - Air Force Implementation of NRC "Pre-A SE" Study Committee Recommendations *Mr. Jeff Loren, SAF/AQRE*	7281-A Holistic Approach to System Development *Mr. Douglas T. Wong, NASA Johnson Space Center*
Bayview II Best Practices & Standardization Session 4A2	7076 - Systems and Software Life Cycle Process Standards: Foundation for Integrated Systems and Software Engineering *Ms. Teresa Doran, TECHSOFT*	7111 - Improving Process Utilizations with Tools *Mr. Frank J. Salvatore, High Performance Technologies, Inc.*	7179 - Integration of Systems and Software Engineering: Implications from Standards and Models Applied to DoDs' Acquisition Programs *Mr. Donald Gantzer, ODUSD/SSE*
Bayview I Program Management Session 4A3	7113 - Lessons Learned in EVM Control Account Analysis and Design *Mr. Thomas R. Cowles, Raytheon Space and Airborn Systems*	7158 - Achieving Success for Program Managers: Integrating Work Breakdown Structure, Schedule, and Work Packages *Mr. Philip J. Simpkins, Vitech Corporation*	7010 - Integrating Systems Engineering with Earned Value Management *Mr. Paul Solomon, Performance-Based Earned Value*
Mission I Practical Systems Engineering Experience Session 4A4	6881 - A Systems Engineering Approach For Balancing Powered Trailer Requirements *Mr. Dana F. Peterson, DRS-SSI*	6984 - Evaluation of an Immersive Virtual Collaboration Environment for System Development *Mr. Redge Bartholomew, Rockwell Collins*	7028 - Semi Autonomous Unmanned Aerial Systems with Collaborating Behaviors *MAJ Edward B. Teague, United States Military Academy*
Mission II Education & Training Session 4A5	6944 - Establishing the Need for Functional Analysis in Systems Development *Dr. Robert J. Monson, Lockheed Martin*	6946 - Improving Systems Engineering Execution and Knowledge Management *Mr. Steven C. Head, Boeing*	7034 - Modeling and Simulation Education for the Acquisition/T&E Community *Dr. David Olwell, Naval Postgraduate School*
Mission III Enterprise Health Management Session 4A6	7580 - Engineering Solutions for Fleet Readiness Centers utilizing an Avionics Rapid Action Team Innovation Cell *Mr. Bill Birurakis, PIDESO*	7447 - Prognostics as an Approach to Improve Mission Readiness and Availability *Mr. Sony Mathew, Center for Advance Life Cycle Engineering*	7613 - Prognostics Based Health Assessment System Approaches *Mr. Ronald D. Newman, VSE Corporation*
Palm I Logistics, Supportability & Sustainment Session 4A7	7481- Defining the Prognostics Health Management Enterprise Architecture *Mr. Ethan Xu, Raytheon*	7131- Sustaining Systems Engineering - The A-10 Example *Dr. David R. Jacques, Air Force Institute of Technology*	7188- Reliability Centered Maintenance Applied to the CH-47 Chinook Helicopter–Universal Principles that go beyond Equipment Maintenance *Ms. Nancy Regan, The Force, Inc.*
Palm II Architecture Session 4A8	7401- Enabling Systems Engineering with an Integrated Approach to Knowledge Discovery and Architecture Framework *Mr. Michael R. Collins, Advantage Development, Inc.*	7453 - Open Architecture in Electronics Systems *Mr. Bruce R. Bardell, BAE Systems*	7069 - The Value of Architecture *Mr. Frank J. Salvatore, High Performance Technology, Inc.*

Break in the Regency Annex

10:15 am - 12:00 pm

Bayview III Systems Engineering Effectiveness Session 4B1	7004 - Operational Concepts *Mr. James R. van Gaasbeek, Northrop Grumman*	7296 - The Dangers of Oversimplifying Availability *Dr. Jeffrey M. Harris, General Dynamics*	7214-Developing and Maintaining the Technical Baseline *Mr. Michael G. Ucchino, Air Force Institute of Technology*
Bayview II Best Practices & Standardization Session 4B2	7325 - Applying CMMI High Maturity Practices and Leveraging LEAN Six Sigma *Mrs. Ann Hennon, BAE Systems*	7400 - Systems Engineering Initiative – How do you Implement a New Lessons Learned Process and Tool on a Legacy Program? *Mr. Ray A. Polo, Boeing*	7422 - NDIA CMMI Working Group: Status and Plans *Mr. Geoff Draper, Harris Corporation*
Bayview I Program Management Session 4B3	7363 - Integrated Risk and Opportunity Management *Ms. Audrey Dorofee, Software Engineering Institute*	7459 - Multi-Factor Risk Management *Ms. Laura West, BAE Systems*	7255- Integrated Change Control for the Concurrently Developed Complex Systems – Lessons Learned *Mr. Alexander J. Polack, The Aerospace Corporation*
Mission I Practical Systems Engineering Experience Session 4B4	7063 - Product Platforms in Support of Rapid Response to DOD In-Theatre Force Protection Needs *Dr. Steven B. Shooter, Bucknell University*	7102 - Reengineering Electronic Warefare: Shifting From Platform - To Capability - Centric Engineering *Mr. William B. Anderson, Software Engineering Institute*	7278 - Integrating Metics with Qualitative Temporal Reasoning for Constraint-Based Expert Systems *Dr. James A. Crowder, Raytheon*
Mission II Education & Training Session 4B5	7094 - Development and Validation of a Systems Engineering Competency Model *Dr. Don Gelosh, SAIC*	7098 - Accelerate Performance Improvements: Systems Engineering Skills Competency Analysis and Training Program Development *Mr. Steven A. Diebold, General Dynamics,*	7130 - Concept Definiti- A Historical Perspective *Dr. David R. Jacques, Air Force Institute of Technology*
Mission III Enterprise Health Management Session 4B6	7520 - NDIA ID Electronic Prognostics (E-Prog) Task Follow-on Study to Quantify Weapon System Benefits *Mr. Paul Howard, Paul L. Howard Enterprises*	7597 - Enterprise Health Management Emerging Technology Transition Enabling Plan *Mr. Chris H. Reisig, Boeing*	
Palm I Logistics, Supportability & Sustainment Session 4B7	7207- Sustainment Engineering versus Systems Engineering, Is There A Difference? *Ms. Karen B. Bausman, AF Center for Systems Engineering*	7064- Reliability Growth Analysis of Mobile Gun System during PVT *Dr. Dmitry Tananko, GDLS*	
Palm II Architecture Session 4B8	7365 - Enabling the Successful Transition from Architecture to Concept Design *Mr. Chris Ryder, Johns Hopkins University Applied Physics Laboratory*	7079 - The Benefits of Synergizing Naval Open Architecture Practices and Principles with Systems Engineering Processes *Mr. Mike Dettman, PEO C4I - NAVSEA*	7029 - Concurrent Increment Sequencing and Synchronization with Design Structure Matrices in Software-Intensive System Development *Dr. Peter Hantos, The Aerospace Coporation*

Thursday, October 23, 2008

1:30 pm - 3:00 pm

Bayview III Systems Engineering Effectiveness Session 4C1	7289 - Process Tailoring Patterns and Frameworks for Accelerating Systems Engineering Processes *Mr. Larry J. Earnest, Northrop Grumman*	7054 - Using Lean Principles and Process Models to Achieve Measurable Results *Mr. Tim Olson, Lean Solutions Institute, Inc.*	7265- Rocket Motor Development Cycle Time - Business Process Review *Mr. Jose Gonzalez, OUSD/PSA/LW&M*	
Bayview II Best Practices & Standardization Session 4C2	7441 - Process Enrichment Boot Camp - An Intensive Introduction to a Generic, Enterprise-wide, Strategic Communication and Continuous Improvement Methodology *Mr. Victor Elias, High Performance Technologies Inc.*	7446- Making Lessons Learned Come Alive and be Practical *Mr. Forest Shull, Fraunhofer Center Maryland*		
Bayview I Program Management Session 4C3	7067- Estimating Systems Engineering Level Of Effort *Mr. Frank Salvatore, High Performance Technologies, Inc.*	7189- The Integrated Natural Environment Authoritative Representation Process (INEARP) and Beyond *Maj James Everitt, Air & Space Natural Environment M&S Executive Agent*		
Mission I Practical SE Experience Session 4C4	7417 - VIRGINIA (SSN-774) Class Systems Engineering to Reduce Total Ownership Cost *Mr. Steve Lose, Naval Sea Systems Command*	7463 - The C-17 PIO Team *Mr. David Murray, Boeing*	7497- Accuracy Control Tools, Technology, and Processes used for Addressing Hull Fairness *Mr. Stephan H. Hankins, Northrop Grumman*	
Mission II Education & Training Session 4C5	7308 - PeaceKeeper Intercontinental Ballistic Missile Systems Engineering Case Study *Mr. Charles M. Garland, Air Force Center for Systems Engineering*	7474 - CAPTURE of Critical Engineering Skills and Knowledge *Mrs. Ann Hennon, BAE Systems,*		

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- Space Systems: launch services, satellites, and strategic/defensive missile systems.
- Information Systems & Global Services: Information Systems, Global Services, and Mission Solutions.

Track	Abstract	Paper Title	Author
1A1, 1C1	7025	Introduction to SysML & Object Oriented Systems Engineering Methodology (OOSEM)	Dr. Abe Meilich
1A2	7033	ULCM (Unified Life Cycle Modeling) for Defense Acquisition	Dr. Peter Hantos
1A3	7050	How to Define Practical Metrics Using NASA JPL as an Example	Mr. Tim Olson Dr. Jairus Hihn
1A4	7071	Introduction to the Capability Test Methodology: Methods and Processes for Testing in a Joint Environment Tutorial	Lt Col Jay R. Gendron
1A5	7209	Joint Mission Environment Test Capability (JMETC),Providing efficiency and cost savings with a distributed test infrastructure	Mr. Chip Ferguson
1A6	7294	FMESA: The Method Framework for Engineering System Architectures	Mr. Donald G Firesmith
1A7, 1C7	6877	(TUTORIAL 8 HOURS) Gap Analysis and Its Conceptual Foundations: Integrating Sound Management Methods with Systems Engineering Best Practices	Mr. Gary Langford
1A8	6975	Early Verification: The Road to Program Success - A Tutorial	Mr. Stephen J Scukanec Mr. James R Vangaasbeek
1C2	7044	A Model-Based Systems Engineering Roadmap for Developing DoDAF Architectures	Mr. Tim Tritsch
1C3	6987	Development and Configuration Management of Requirements	Mr. Al Florence Dr. Bill Bail
1C5	7210	Engineering Systems of Systems	Mr. Soumya Simanta Ms. Grace Lewis Mr. Dennis Smith Pat Place Mr. Ed Morris
1C6	7366	Tutorial: Systems Engineering Applications in supporting the Joint Capabilities Integration and Development System (JCIDS)	Mr. Chris Ryder
1C8	6970	Universal Architecture Description Framework Tutorial	Mr. Jeffrey O Grady
2B8	7198	Software Reuse Readiness Levels: A Framework for Decision Making	Mr. Steven Wong Mr. Dean Caccavo
2C1	7099	DoD's Systems and Software Engineering Revitalization Efforts—An Update	Mr. Nicholas (Nic) M. Torelli, Jr.
2C1	7153	Systems Engineering Plan (SEP) and Systems Engineering Management Plan (SEMP) Unification	Mr Chet Bracuto Mr. Robert Scheurer
2C1	7475	The Effectiveness of Systems Engineering: on Federal (DoD) System Development Programs – Update 2008	Mr. Ken Ptack
2C2	7100	Implementation of the 2007 Developmental Test & Evaluation Defense Science Board Results	Mr. Chris DiPetto
2C2	7101	Test and Evaluation Value Metrics at Acquisition Decision Points	Ms. Darlene Mosser-Kerner Mr. William Eischens
2C2	6979	Integration of Software Intensive Systems	Mr. Tom Wissink
2C3	7418	DON Acquisition Reform and its Impact on CANES System Engineering	CDR Philip Turner Mr. Dennis Almazan Mr. Jose Davila
2C3	6919	Improving the Quality of DOD Weapon Systems	Ms. Cheryl K Andrew Mr. Michael J Sullivan
2C3	7096	New Acquisition Policy and Its Impact on Defense Systems Engineering	Ms. Sharon Vannucci

2C4	6997	Human Systems Integration and Model Based Systems Engineering	Dr. Abraham W Meilich
2C4	7035	The Special Operational Airworthiness Release (SOAR) Process, A Systems Engineering Approach	Dr. Thomas F Christian Mr. Gary L. Bailey Mr. Al E Owens
2C4	7084	Human Reliability Analysis and the Advanced Man Portable Air Defense System: A Case Study	Mr. Christopher A Brown
2C5	7172	Execution of the Acquisition M&S Master Plan - A Progress Report	Mr. James W Hollenbach Mr. Michael R Truelove
2C5	7085	Modeling and Simulation Resource Reuse Business Model	Mr. Dennis P Shea
2C5	7440	Synchronizing Modeling and Simulation Plans Across Navy Acquisition	Dr. Ivar Oswalt Dr. Robert R Tyler
2C6	7461	Title of Abstract: Network Centric Engineering use of the NCOIC (Network Centric Operations Industry Consortium) Processes and Tools in a Logistics Example	Mr. Thomas M Dlugolecki Mr. John Yanosy Mr. Hans Polzer
2C6	7341	Crucial Factors In The Design Of Net-Centric Systems	Dr. David Hernandez
2C6	7128	Changing the value equation in engineering and acquisition to align systems of systems with dynamic mission needs	Mr. Philip J Boxer Ms. Suzanne Garcia Mr. William Anderson Mr. Patrick Kirwan
2C7	7444	Acquisition Requirements for Capabilities in a Netcentric Enterprise -- Creating a Capabilities Engineering Framework	Mr. Jack M Van Kirk Mr. Ira A Monarch
2C7	7191	System Concept of Operations: Standards, Practices, and Reality	Ms. Nicole Roberts
2C7	7138	Implications of Capability-based Planning on Requirements Engineering	Mr. Leonard Sadauskas
2C8	7041	Software Process Improvement for Acquisition of Naval Software Intensive Systems	Mr. Carl Siel
2C8	7137	DoD Software Engineering and System Assurance	Ms. Kristen J. Baldwin
2C8	7139	A Framework for Integrating Systems and Software Engineering	Dr. Arthur Pyster Dr. Richard Turner
2D1	6986	Technology Readiness Assessments for Systems of Systems	Dr. Jay Mandelbaum
2D1	7042	Establishing a Departmental-Level Systems-of-Systems Engineering Management Construct for the Department of the Navy	Mr. Carl Siel Mr. John Kevin Smith
2D1	7089	Systems of Systems: Update on the DoD Systems of Systems SE Guide and Future Direction	Dr. Judith s Dahmann
2D2	7290	Mission-Based Test and Evaluation Strategy: An Interagency Developed Process to Link Mission Capability with System Functional Requirements	Mr. Christopher M Wilcox Mr. John W Beilfuss
2D2	6996	Modeling & Simualtion in the Test & Evaluation Master Plan	Mr. Michael R Truelove
2D2	7103	New Test and Evaluation Master Plan Guidance	Ms. Darlene S Mosser-Kerner
2D3	7002	Systems Engineering Re-Vitalization At The Defense Contract Management Agency	Mr. Lawrence F. Cianciolo Mr. Shaun Lanham

2D3	7223	An Air Force S&T Directorate's View on Applying Systems Engineering Principles to its Programs	Dr. James C Malas Mr. Robert L Rapson Capt Ronald Pendleton Mr. Bryan DeHoff Ms. Carol Ventresca
2D3	7320	Air Force Initiative – High Confidence Technology Transition Planning Through the Use of Stage-Gates	Dr. Claudia V Kropas-Hughes Ms. Lynda T Rutledge Mr. George H Sarmiento
2D4	7092	Systems Engineering to Ensure Aircraft Airworthiness	Mr. James C Miller
2D4	7161	ESOH in Acquisition – OSD Expectations for Implementing DoDI 5000.02	Ms. Patricia Huheey Ms. Karen Gill
2D4	7222	What the Systems Engineer Needs to Know About Integrating Environment, Safety, and Occupational Health (ESOH) into Systems Engineering (SE) Using the System Safety Methodology	Mr. Sherman G. Forbes
2D5	7404	Joint Rapid Scenario Generation Systems Engineering Vision	Mr. Ralph O'Connell Mr. Warren Bizub Mr. Ken Goad Mr. Michael Winslow Ms. Leslie Winters
2D5	7467	Systems Engineering Across Army Modeling and Simulation	Mr. Van Sullivan LTC Favio Lopez
2D5	7175	LVC Architecture Roadmap - A Path Forward for Distributed Simulation	Mr. James W Hollenbach
2D6	7016	A Service-Oriented Architecture (SOA) Business Model for DoD	Dr. Steven H Dam
2D6	7330	Creating a Systems Architecture for an SOA-based IT System as Part of a Systems Engineering Process	Dr. Robert S. Ellinger Mr. Gabriel Hoffman
2D6	7414	An IT Governance Solution	Mr. Paul Byrnes
2D7	7451	Why Design for Testability Earlier?	Mr. Bruce R Bardell
2D7	7399	The Challenges in Requirements Decomposition	Mrs. Eliza Siu
2D7	6998	Quantifying the Impact of System Engineering Changes	Dr. Mark R Blackburn
2D7	7066	Two-Step Methodology to Reduce Software Requirement Defects	Mr. Robert J Kosman
2D8	7119	Architecting Systems to Meet Expectations - Managing Quality Characteristics To Reduce Risk	Mr. Paul Croll
2D8	7156	How Future Trends in Systems and Software Engineering Bode Well for Enabling Improved Acquisition and Performance of Defense Systems	Dr. Kenneth E Nidiffer
2D8	7239	Systems and Software Design Principles for Large-Scale Mission-Critical Embedded Products from Aerospace and Financial Problem Domains	Dr. Richard W Selby
3A1	7065	Establishing a Systems Engineering Center of Excellence in PEO Ground Combat Systems	Mr. Michael H Phillips
3A1	7405	Systems Engineering: Application in complex organizations	Mr. Kevin Roney Mr. Robert Parrish

3A1	7423	Systems Engineering Capability Development	Mr. Edward Andres Mr. Troy Peterson Ms. Harsha Desai Mr. Scott Welles
3A2	7351	End to End System Test Architecture	Dr. Masuma Ahmed
3A2	6937	Systems Engineering for Testing in a Joint Mission Environment	Mr. Earl Reyes
3A3	7438	The Incremental Commitment Model and Competitive Prototyping	Dr. Barry Boehm Ms. Jo Ann Lane
3A3	7116	Exploration of Customer Capability Gaps Through Experimentation	Mr. Michael E. Groff
3A3	7070	An integrated, knowledge-based approach to developing weapon system business cases could improve acquisition outcomes	Mr. Travis J Masters Mr. Michael J Sullivan Mr. John E Oppenheim
3A4	7720	Systemic Root Cause Analysis Leads to Acquisition Improvement Recommendations	Ms. Laura M Dwinnell Mr. David R Castellano Mr. Hal Wilson
3A4	7721	Systemic Root Cause Analysis Leads to Acquisition Improvement Recommendations (Part 2)	Mr. Peter Nolte
3A5	7073	Standardized Documentation for Verification, Validation, and Accreditation — An Update to the Systems Engineering Community	Mr. Kevin Charlow Mr. Curtis Blais Mr. David Broyles Ms. Marcy Stutzman
3A5	7052	Presentation: “Architecture and Model Based Systems Engineering for Lean Results”	Mr. Tim Olson
3A5	7347	Deployment of SysML in Tools and Architectures: an Industry Perspective	Mr. Rick Steiner
3A6	6954	SOAs and Net-Centric Warfare-Similarities, Differences and Conflicts	Mr. James A Mazzei Ms. Camille O Keely Mr. James L Ayers
3A6	7477	Service Oriented Architecture - The good, bad, and ugly of the word’s largest SOA attempt (DoD NECC)	Col Allan L Mink, II, USAF (Ret)
3A6	7374	Capitalizing in Migrating Web Service Environments	Mr. Brian Eleazer
3A7	7047	Stop the Pain: Take Some Requirements Definition and Management for Project Success	Mr. Scott Derby
3A7	7593	Correlation of Types of requirements to Verification Methods	Dr. William G Bail
3A7	7068	Daily Challenges in Requirements Engineering	Mr. Frank J Salvatore
3A8	7232	ASN (RD&A) Initiatives to Improve Integration of Software Engineering into Defense Acquisition Related Systems Engineering	Dr. John F Miller Mr. Archibald McKinlay, VI
3A8	7135	Improving Work Breakdown Structure (WBS) Guidance for Weapons Systems with Substantial Software Content	Mr. Christopher Miller
3A8	7714	Building the Next Generation of Software Engineers - Benchmarking Graduate Education	Dr. Arthur Pyster Dr. Richard Turner
3B1	6945	The Role of Chaos and Complexity in Systems Development	Dr. Robert J. Monson
3B1	7190	A Tool to Enhance Systems Engineering Planning	Ms. Sue O’Brien Dr. Dawn Sabados Dr. James Snider, Maj. Gen., ret.

3B1	7436	A Process Decision Table for Integrated Systems and Software Engineering	Dr. Barry Boehm Ms. Jo Ann Lane
3B2	7372	Integrated T&E process and tools in the Joint High Speed Vessel Program	Mr. Stephen F Randolph
3B2	7011	Implementing a Methodology to Incorporate Operational Realism in CONOPS & Testing	Mr. William R Lyders
3B2	6928	The Role of T&E in the Requirements Process for System of Systems	MSG Walter C. Reel, Jr
3B3	7269	Closing the gap between systems engineering and project management	Mr. Robert W Ferguson
3B3	7349	The Death of Risk Management	Mr. Michael P Gaydar
3B3	7340	"Integrated Management Operating Model (iMOM)", An E-2D Advanced Hawkeye SD&D Program Case Study	Mr. Douglas J Shaffer
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3B4	7216	Acquisition and Technology Programs Task Force Funded Initiatives	Ms. Lucy Rodriguez
3B4	7211	Defining a Generic Hazard Tracking Database for Future Programs	Mr. Jeff Walker
3B5	7364	Predictive Modeling: Principles and Practice	Dr. Rick Hefner Mr. Philip Paul Mr. Rasheed Baqui Prem Daniel Arun Durairaj
3B5	7082	Domain Modeling: A Roadmap to Convergence	Mr. Nathaniel C Horner Mr. J. Stephen Topper
3B5	7026	Rapid Assessment Approach Using Commander's Intent to Identify Promising Force Structure Architectures for System Trade Studies	Mr. David A Blancett Mr. Kurt Dittmer
3B6	7048	Requsite EcoSystem alterations for SOA in the DoD/IC domain	Mr. Charles Long
3B6	6972	A System Engineering Approach to Develop a Service-Oriented Perspective	Mr. Rob Byrd
3B6	7122	Department of Defense (DoD) Architecture Framework (DoDAF); Delivering Architectures to the World	Mr. Walt Okon
3B7	7548	Mission Analysis and its Impact on SE Fundamentals	Mr. John T McDonald Mr. David W Rhodes
3B7	7055	Presentation: "How to Write 'Lean and Mean' Requirements"	Mr. Tim Olson
3B8	7195	Counting Software Size: Is it as easy as buying a gallon of gas?	Ms. Lori Vaughan Mr. Dean Caccavo
3C1	7007	Using Performance-Based Earned Value(R) for Measuring Systems Engineering Effectiveness	Dr. Ronald S Carson Mr. Bojan Zlicaric
3C1	7017	KBAD – A Cost-Effective Way to Conduct Design and Analysis	Dr. Steven Dam
3C1	6878	Reduction of Total Ownership Costs (R-TOC)	Mr. Chet Bracuto Dr. Jay Mandelbaum
3C2	6888	Value Engineering: Enhance DMSMS Solutions	Dr. Jay Mandelbaum Dr. Danny L. Reed

3C2	6874	Why CMMI isn't enough	Mr. Timothy A Chick Mrs. Anita D Carleton
3C2	7761	Applying Business Process Modeling to Develop Systems Engineering Guidance for New DoD Acquisition Regulations	Dr. Judith S Dahmann Aumber Bhatti
3C3	7023	Program Management of Concurrently Developed Complex Systems – Lessons Learned	Mr. Alexander Polack
3C3	7095	Evaluating Complex System Development Maturity – The Creation and Implementation of a System Readiness Level for Defense Acquisition Programs	Mr. Eric Forbes Mr. Kenneth Michaud Mr. Peter Gentile
3C3	7344	Complex System Development Program Assessments and Support: A Forensics Perspective	Dr. Dinesh Verma Ms. Laura Dwinnel Mr. Mark Weitekamp Mr. Glynn James Mr. Tom Parry
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3C4	7226	Way Ahead for DoD Acquisition Efforts to Integrate Environment, Safety, and Occupational Health (ESOH) Considerations into Systems Engineering Using the DoD Standard Practice for System Safety	Mr. Sherman G Forbes
3C5	7393	Systems Engineering Approach to Total Vehicle Design and Integration	Mr. Walter J Budd
3C5	7144	Systems Engineering Analysis of Threat Reduction Systems using a Collaborative Constructive Simulation Environment	Dr. James E. Coolahan Dr. Andrew C. K. Wiedlea Dr. Roger L. West Dr. Joseph G. Kovalchik
3C5	7335	Model-Based Specification for Legacy Networks	Mr. Robert M Kane Mr. Martin A Kane
3C6	7105	Building Net-Ready Information Interoperability Performance Indicator Widgets For DODAF 2.0 Dashboards	Mr. William B Anderson Mr. Jayson Durham Dr. David Zubrow
3C6	7337	Modeling Cognition in the DoD Architecture Framework for Early Concept Development	Dr. John M Colombi Dr .Joseph W Carl
3C6	7088	The Benefit of Collaboration: Integration between the DoDAF and Systems Engineering Communities	Mr. Tim Tritsch
3C7	7180	A continuous process view of systems engineering for the sustainment phase	Mr. Paul D Ratke
3C7	7183	Progress Toward the Development of a Reliability Investment Cost Estimating Relationship	Mr. E. Andrew Long Dr. David A. Lee Mr. James Forbes
3C7	7235	Future Combat Systems (FCS) Logistics Systems	Ms. Soo R. Yoon
3C8	7243	Method for Aligning Architecture Frameworks and System Requirements	Mr. Richard L Eilers Mr. Mark Rhaodes Mr. Kevin Hall Dr. Samer Minkara

3C8	7136	Architecture Trade-off Analysis Method® (ATAM®) for System Architecture Evaluation	Mr. Michael Gagliardi Mr. William Wood Mr. John Klein
3C8	7081	Littoral Combat Ship (LCS) Mission Modules Integration: An Open Architecture Approach	Mr. Cecil Whitfield Mr. Jose Casals Mr. Kenneth Montogomery
3D1	6886	Air Force Systems Engineer Assessment Model (AF SEAM)	Mr. Randall Bullard Mr. George Freeman
3D1	7204	Advancing Systems Engineering Practice within the Department of Defense: Overview of DoD's Newest University Affiliated Research Center (UARC)	Ms. Sharon Vannucci Mr. Dennis Barnabe
3D1	7030	Defining 100 Best Practices for Systems Engineering	Mr. Ian Talbot
3D1	7093	Systems Engineering Performance Measures	Mr. James C Miller
3D2	7003	Applicable Documents	Mr. James R van Gaasbeek
3D2	7014	Systems Engineering in the Science and Technology Environment – Best Practices and other Lessons Learned from the Air Force Research Laboratory	Mr. William P Doyle Mr. Michael C Bartmess
3D2	7031	Lessons Learned Doing Systems Engineering Assessments on the Government	Mr. Ian Talbot
3D3	7462	Applying the Tenets of Military Planning and Execution to Project and Systems Engineering Management	Mr. Philip Lindeman
3D3	7479	360 degree view of the technology, strategy and business	Mr. Min-Gu Lee
3D3	7385	Enabling More Effective Weapons Systems Acquisition and Sustainment through an Enterprise Approach	Mr. John Stewart Mr. Pat Morris Mr. John Liss Mr. Rich Fredricks Dr. Iraj Hirmanpour
3D4	7515	The Intersection of System Safety, Lean Engineering, and Ergonomics	Dr. Lee Ostrom Ms. Cathy Rothwell
3D4	7258	Joint Service Safety Testing Study	Ms. Paige Ripani
3D4	7442	What Systems Engineers Need to Know About System Environmental Noise	Ms. Lynn Engelman
3D5	7228	Total System Modeling: A System Engineering Application of the Higraph Formalism	Mr. Kevin Fogarty Dr. Mark Austin
3D5	7174	Virtual Battlespace Center for Systems Engineering	Mr. James W Hollenbach
3D5	7077	Near-field RCS and Fuze Modeling and Simulation	Mr. David Hall Ms. Dorothy L Saitz
3D6	7413	Systems Engineering Approach for Assessing a Warfighter's Cognitive Performance	Mr. James Buxton Mr. Kevin Roney Mr. Albert A Sciarretta
3D6	7280	Multiple Information Agents for Real-Time, Dynamic Situational Awareness: Architectures for Real-Time Warfighter Support	Dr. James A Crowder
3D6	7046	Cost-Effective Survivable Network Design Framework	Dr. Dennis M Moen

3D6	7377	The Joint Surface Warfare JCTD: Maturing Weapon Data Link Concepts into Operational Capability	Mr. Robert K. Finlayson, III
3D7	7383	Extending Enterprise Systems for an Integrated Logistics Management Environment	Mr. Mike Korzenowski Mr. Kurt Hansen Mr. James Garrity
3D7	7390	Systems Engineering of Deployed Systems	Mr. Robert K. Finlayson, III Mr. Bryan E. Herdlick
3D7	7455	The Seven Affordability Sins of Logistics System Integration	Dr. Thomas E Herald, Jr. Mr. Joseph S. Bobinis, PMP
3D8	7428	Adaptable Architecture for System of Systems	Mr. Bruce Schneider Mr. Joe Wolfrom
3D8	7109	Applying Open Architecture Concepts to Mission and Ship Systems	Mr. John M Green Mr. Gregory A. Miller
3D8	7273	US Air Force Global Persistent Attack Architecture, Process, & Risk Analysis	Major Jeffrey D Havlicek Major Brian Hazel Major John Eller Mr. Brendan Rooney
3D8	7285	Universal Architecture Description Framework	Mr. Jeffrey O. Grady, CSEP
4A1	7186	Air Force Implementation of NRC "Pre-A SE" Study Committee Recommendations	Mr. Jeff Loren
4A1	7697	Enhancing Systems Engineering in the Department of Defense	Mr. Ceasar Sharper
4A1	7281	A Holistic Approach to System Development	Mr. Douglas T Wong
4A2	7179	Integration of Systems and Software Engineering: Implications from Standards and Models Applied to DoDs' Acquisition Programs	Mr. Donald J Gantzer Ms. Lisa Reuss
4A2	7076	Systems and Software Life Cycle Process Standards: Foundation for Integrated Systems and Software Engineering	Ms. Teresa Doran
4A2	7111	Improving Process Utilizations with Tools	Mr. Frank J Salvatore Mr. Richard Swanson
4A3	7158	Achieving Success for Program Managers: Integrating Work Breakdown Structure, Schedule, and Work packages	Mr. Philip J Simpkins
4A3	7113	Lessons Learned in EVM Control Account Analysis and Design	Mr. Thomas R Cowles
4A3	7010	Integrating Systems Engineering with Earned Value Management	Mr. Paul Solomon
4A4	6984	Evaluation of an Immersive Virtual Collaboration Environment for System Development	Mr. Redge Bartholomew
4A4	6881	A Systems Engineering Approach For Balancing Powered Trailer Requirements	Mr. Dana F Peterson, CSEP
4A4	7028	Semi Autonomous Unmanned Aerial Systems with Collaborating Behaviors	MAJ Edward B Teague
4A5	6944	Establishing the Need for Functional Analysis in Systems Development	Dr. Robert J. Monson Mr. David Lindstrom
4A5	6946	Improving Systems Engineering Execution and Knowledge Management	Mr. Steven C Head Mr. Bill Virostko

4A5	7034	Modeling and Simulation Education for the Acquisition/T&E Community	Dr. David H. Olwell Ms. Jean M. Johnson
4A6	7613	Prognostics Based Health Assessment System Approaches	Mr. Ronald D Newman Ms. Mary Nolan Mr. Greg DeMare
4A6	7447	Prognostics as an Approach to Improve Mission Readiness and Availability	Mr. Sony Mathew Dr. Michael G Pecht
4A6	7580	Engineering Solutions for Fleet Readiness Centers utilizing an Avionics Rapid Action Team Innovation Cell	Mr. William Birurakis, Jr. Mr. Stu Paul
4A7	7481	Defining the Prognostics Health Management Enterprise Architecture	Mr. Ethan Xu
4A7	7131	Sustaining Systems Engineering - The A-10 Example	Dr. David R Jacques
4A8	7069	The Value of Architecture	Mr. Frank J Salvatore
4A8	7401	Enabling Systems Engineering with an integrated Approach to Knowledge Discovery and Architecture Framework	Mr. Michael R Collins Mr. John M. Green
4A8	7453	Open Architecture in Electronics Systems	Mr. Bruce R Bardell
4B1	7004	Operational Concepts	Mr. James R van Gaasbeek
4B1	7214	Developing and Maintaining the Technical Baseline	Mr. Michael G Ucchino
4B1	7296	The dangers of oversimplifying availability	Dr. Jeffrey M Harris
4B2	7325	Applying CMMI High Maturity Practices and Leveraging LEAN Six Sigma	Mrs. Ann Hennon
4B3	7363	Integrated Risk and Opportunity Management	Ms. Audrey Dorofee Mr. Christopher Alberts
4B3	7459	Multi-Factor Risk Management	Ms. Laura West Ms. Felicia Hong
4B4	7063	Product Platforms in Support of Rapid Response to DOD In-Theatre Force Protection Needs	Dr. Steven B Shooter Mr. Stephen Luckowski Mr. Thomas Kiel
4B4	7102	Reengineering Electronic Warfare: Shifting From Platform- To Capability-Centric Engineering	Mr. William B Anderson Mr. Joseph Elm Lt. Michael Thompson Mr. John Hawrylak Mr. Ray Williams
4B4	7278	Integrating Metrics with Qualitative Temporal Reasoning for Constraint-Based Expert Systems	Dr. James A Crowder
4B5	7094	Development and Validation of a Systems Engineering Competency Model	Dr. Don Gelosh
4B5	7098	Accelerate Performance Improvements: Systems Engineering Skills Competency Analysis and Training Program Development	Mr. Steven A Diebold Mr. Wendell Mullison
4B5	7130	Concept Definiti - A Historical Perspective	Dr. David R Jacques
4B6	7520	NDIA ID Electronic Prognostics (E-Prog) Task Follow-on Study to Quantify Weapon System Benefits.	Mr. Paul L Howard

4B6	7597	Enterprise Health Management Emerging Technology Transition Enabling Plan	Mr. Chris M Reisig Mr. Thomas Dabney Dr. James Dill
4B7	7188	Reliability Centered Maintenance applied to the CH-47 Chinook Helicopter–Universal principles that go beyond Equipment Maintenance	Ms. Nancy Regan
4B7	7207	Sustainment Engineering versus Systems Engineering, Is There A Difference?	Ms. Karen B Bausman
4B7	7064	Reliability Growth Analysis of Mobile Gun System during PVT	Dr. Dmitry Tananko Mr. Sharad Kumar Mr. John Paulson Ms. Jenny Chang
4B8	7079	The Benefits of Synergizing Naval Open Architecture Practices and Principles with Systems Engineering Processes	Mr. Mike Dettman
4B8	7029	Concurrent Increment Sequencing and Synchronization with Design Structure Matrices in Software-Intensive System Development	Dr. Peter Hantos
4B8	7365	Enabling the Successful Transition from Architecture to Concept Design	Mr. Chris Ryder
4C1	7054	Presentation: "Using Lean Principles and Process Models to Achieve Measurable Results"	Mr. Tim Olson
4C1	7265	Rocket Motor Development Cycle Time - Business Process Review	Mr. Jose Gonzalez
4C1	7289	Process Tailoring Patterns and Frameworks for Accelerating Systems Engineering Processes	Mr. Larry J Earnest
4C2	7400	Systems Engineering Initiative – How do you implement a new lessons learned process and tool on a legacy program?	Mr. Ray A Polo Mr. Christian A Stillings Ms. Marybeth Catoline Mr. Dale Retrum
4C2	7422	NDIA CMMI Working Group: Status and Plans	Mr Geoff Draper
4C2	7441	Process Enrichment Boot Camp - An intensive introduction to a generic, enterprise-wide, strategic communication and continuous improvement methodology	Mr. Victor A. Elias
4C2	7446	Making Lessons Learned Come Alive and be Practical	Mr. Forrest Shull Ms. Michele A Shaw Mr. Raimund L Feldmann
4C4	7417	VIRGINIA (SSN-774) Class Systems Engineering to Reduce Total Ownership Cost	Mr. George M. Drakeley, III Mr. Steve Lose Mr. George L Becker
4C4	7497	Accuracy Control Tools, Technology, and Processes used for Addressing Hull Fairness	Mr. Stephan H Hankins Mr. Jimmy R. Sharp
4C4	7463	The C-17 PIO Team	Mr. David Murray
4C5	7308	PeaceKeeper Intercontinental Ballistic Missile Systems Engineering Case Study	Mr. Charles M Garland
4C5	7474	Capture of Critical Engineering Skills and Knowledge	Mrs Ann Hennon

Promotional Partner

LOCKHEED MARTIN

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Crucial Factors in the Design of Net-Centric Systems

Dr. David Hernandez
Director of Advanced Systems Engineering
Tactronics Holdings, LLC

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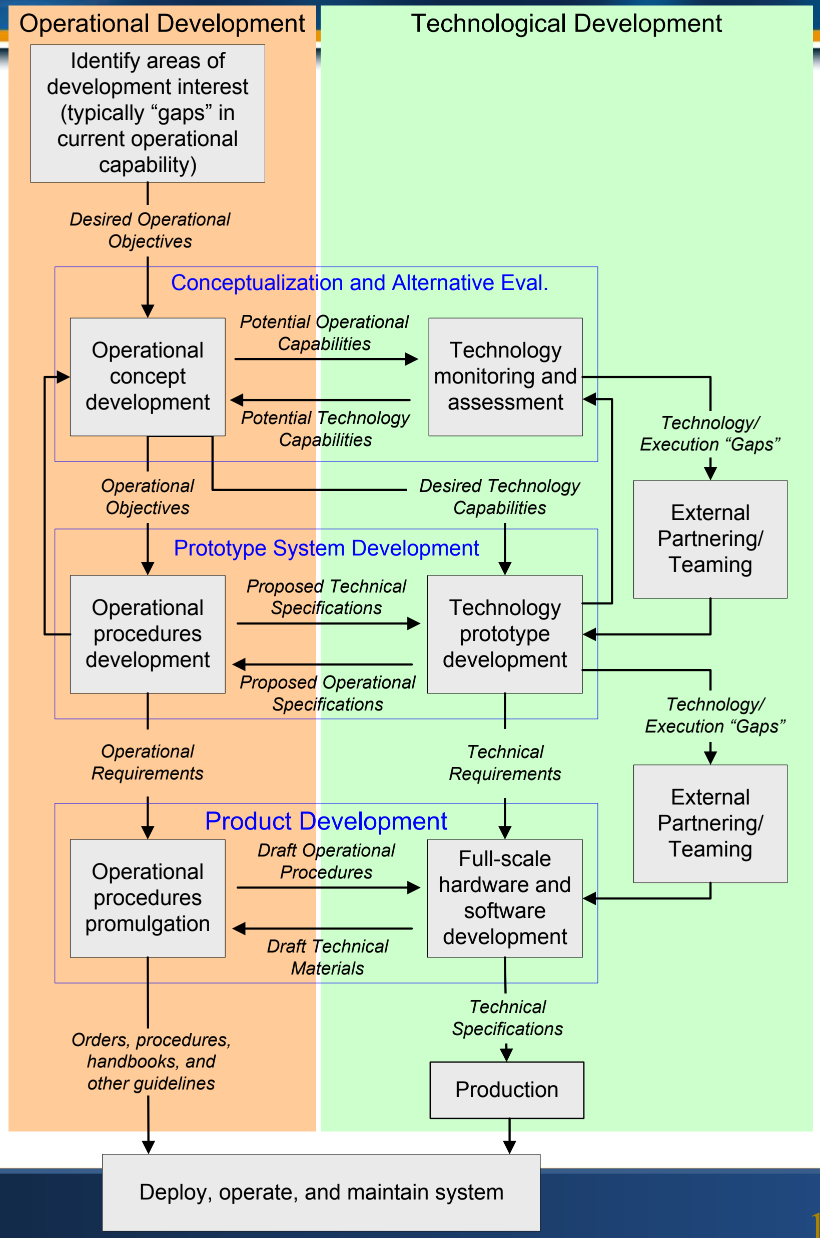
Creating a Tech/Product Pipeline

PRODUCT DEVELOPMENT – ENGINEERING PERSPECTIVE

- Goal: To create a disciplined engineering framework which supports customer focus, sustained innovation, and quick time-to-market

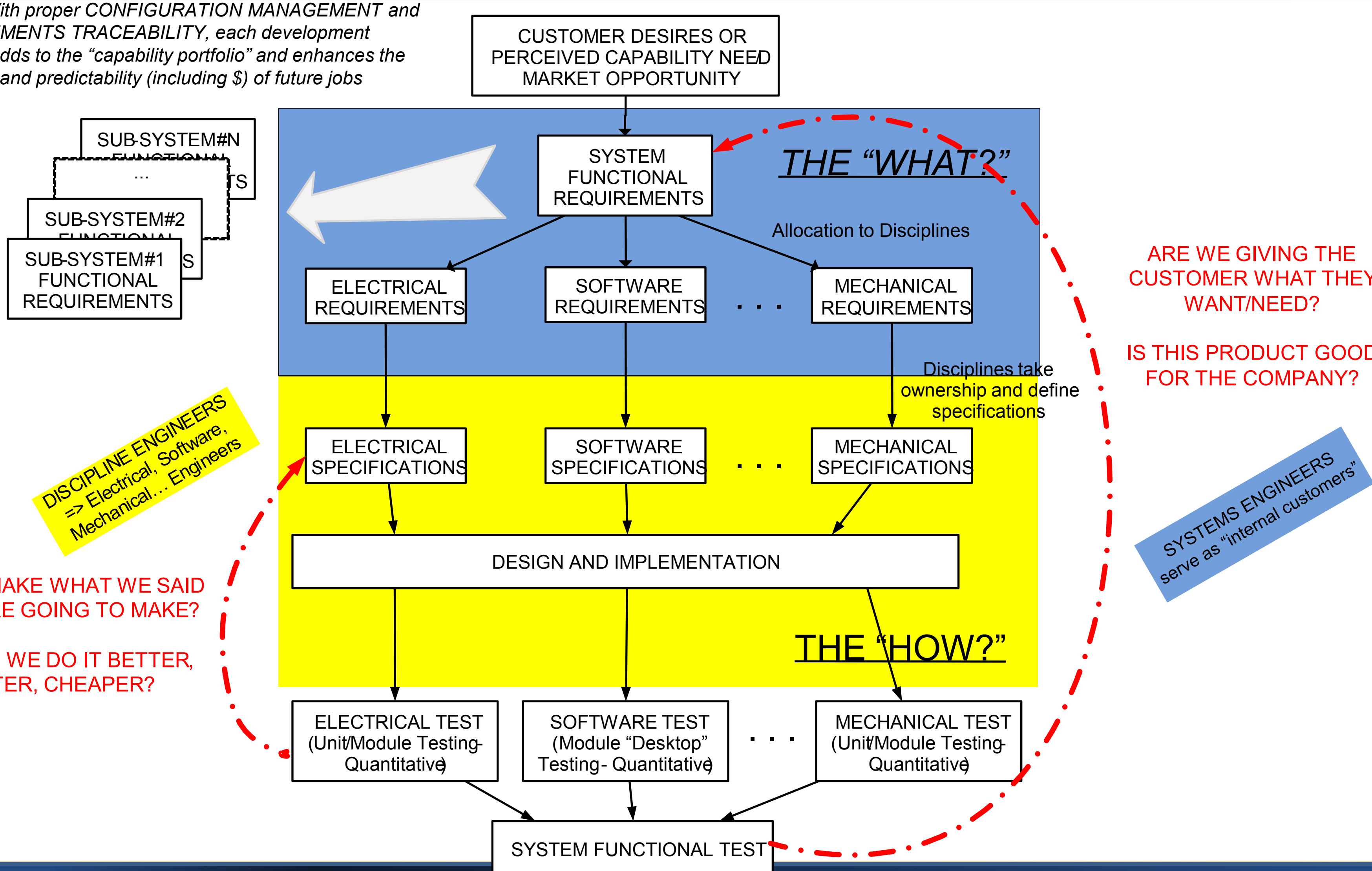


Divide and Conquer

- The Two Components of Success:
  - “Doing the right things” *and* “Doing things right”
  - Focus and Execution

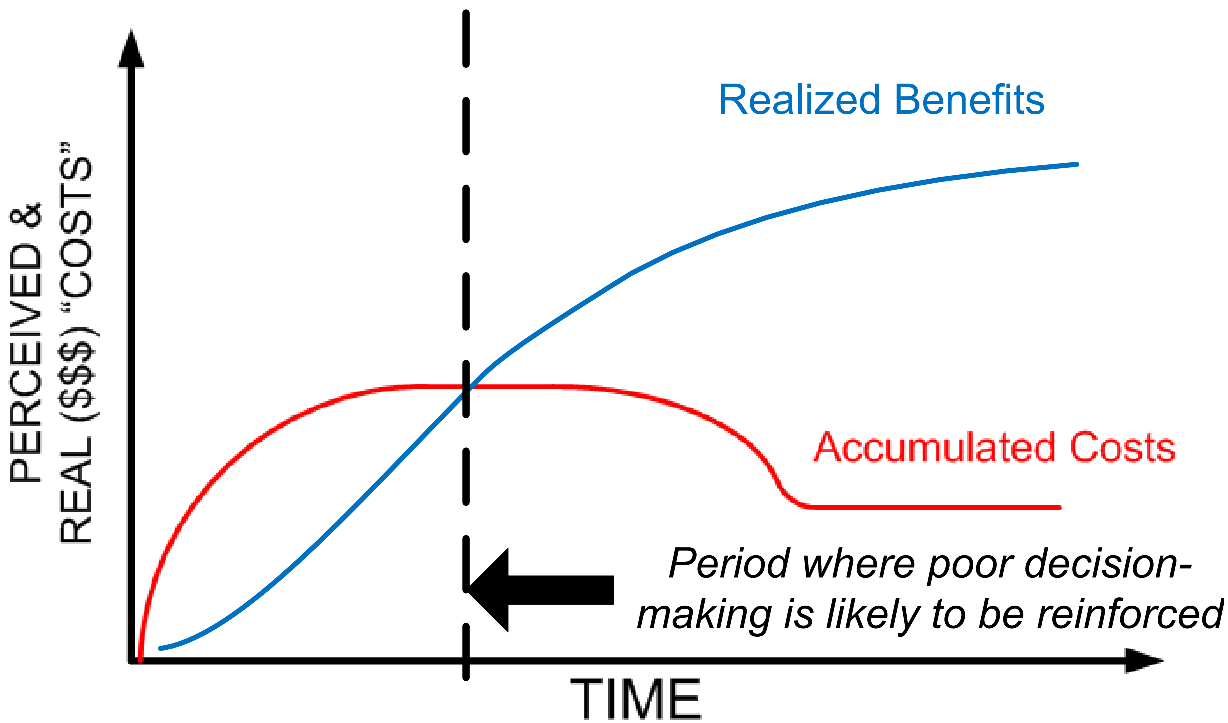
Systems Engineering – Divide and Conquer

NOTE: With proper CONFIGURATION MANAGEMENT and REQUIREMENTS TRACEABILITY, each development program adds to the "capability portfolio" and enhances the execution and predictability (including $) of future jobs



Commitment to Discipline

- Implementing a Disciplined Engineering Framework will initially make things appear qualitatively "slower", "harder", "more bureaucratic", "less responsive"…
- The "startup costs" associated with this approach can often elicit significant resistance from staff and management, however the cumulative effect is a more efficient organization and quicker speed to market



What Makes Engineering "Net-Centric" Different?

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- Goal of "Net-Centricity": Get the right information to the right decision-makers at the right time, irrespective of physical/organizational boundaries
- Net-Centric Operations aim to provide:
  – Shared situational awareness across the battlespace, resulting in:
    - Increased ability to self-synchronize & self-task resulting in:
      – Increased agility in executing the mission and carrying out "commander's intent"

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What Makes Engineering "Net-Centric" Different?

- Systems Engineering entails:
  – Defining desired customer/stakeholder capability
  – Defining specific system requirements
  – Allocating those requirements to specific sub-systems/software modules

What Makes Engineering "Net-Centric" Different?

- In the case of Net-Centricity, the "sub-systems" we seek to integrate may already exist
- Consider the much-maligned "stovepipes":
  - Represent investment in developing technologies/platforms to carry out specific tasks effectively, sometimes refined over years of field deployment
  - Represent significant resource expenditure in training personnel to use these tools
  - Net-Centric sub-systems may be separated by great physical distance, but more importantly, "virtual distance"
  - Technologies underlying Net-Centric capabilities – communications/information dissemination – are relatively dynamic compared to other technologies ("internet pace")

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What Makes Engineering "Net-Centric" Different?

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  - Technologies underlying Net-Centric capabilities – communications/information dissemination – are relatively dynamic compared to other technologies ("internet pace")

- Leverage existing capabilities

- Leverage existing personnel familiarity

- Respect differences – adapt to the mission need

- Take advantage of changes in technology as they come, on-the-fly

What Makes Engineering "Net-Centric" Different?

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- Approach:
  - Leverage components that have been developed, deployed, and refined through field testing
  - Maximally leverage knowledge and training that is in place to get capabilities into the field quicker
  - Account for differences across user groups, rather than forcing adaptation, by allowing for tailoring to specific use cases
  - Make systems extensible to incorporate new capabilities

This Approach Applies Across Technology Areas

- Tactronics' Products Areas Where this Approach to Systems Engineering is Being Applied:
  - Fixed Computing/Processing
  - Human-Machine Interfacing and Displays
  - Mobile Computing
  - Navigational/Mapping and Sensor Processing
  - Networking Infrastructure
  - Power Management
  - Radio Management
  - Specialized Data Manipulation/Transport
    - Audio Intercommunications
    - Beyond-Line-of-Sight Communications
    - Data Acquisition/Monitoring (including Platform Telemetry)
    - Radar Processing/Display
    - Video Processing/Manipulation
  - Networked/Fixed Storage Devices

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Example: "Off-the-Shelf" Software

Case Study: Computing/Displays

Case Study: Data Distribution

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Case Study: Radio Management

Case Study: Power Distribution

Case Study: Systems Integration

TAC SINe™
TACTICAL SYSTEMS INTEGRATION NETWORKS

Any or All Components Interchangeable / Upgradeable

Standards-Based Computing & Networking Components

Operation In Multiple Rugged Environments

"Shopping List" For Integrated System Solutions

Platform Immaterial Common Line Replaceable Units For:

- **Man Portable**
- **Vehicular Platforms**
- **Maritime Platforms**
- **Rotary Wing Aircraft**
- **Fixed Wing Aircraft**
- **Forward Staging Bases FSB's**

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ANY QUESTIONS?

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Raytheon
Customer Success Is Our Mission

Deployment of SysML in Tools and Architectures: an Industry Perspective

Rick Steiner
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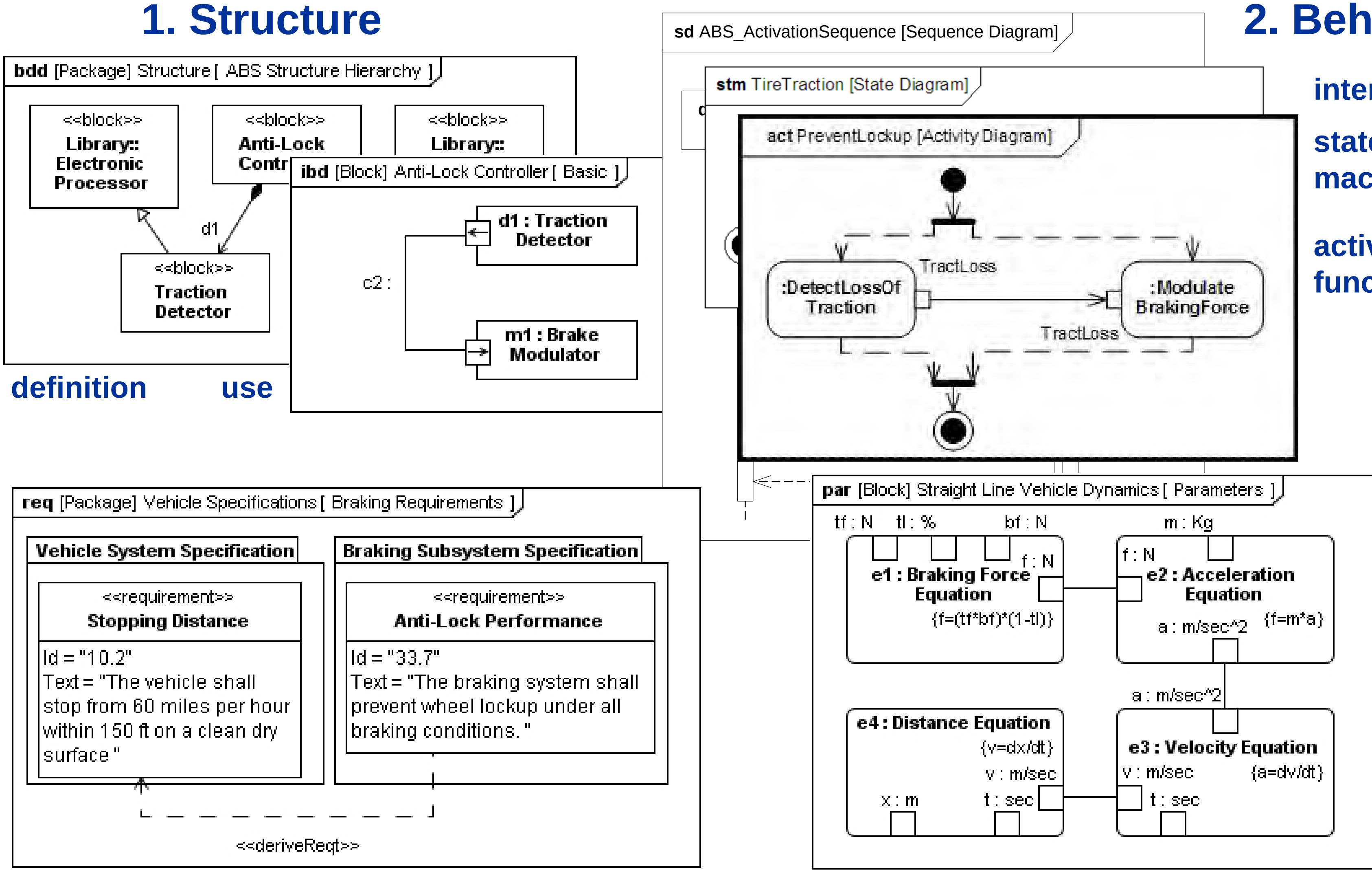
4 Pillars of SysML – ABS Example

1. Structure

2. Behavior



interaction

state machine

activity/ function

3. Requirements

4. Parametrics

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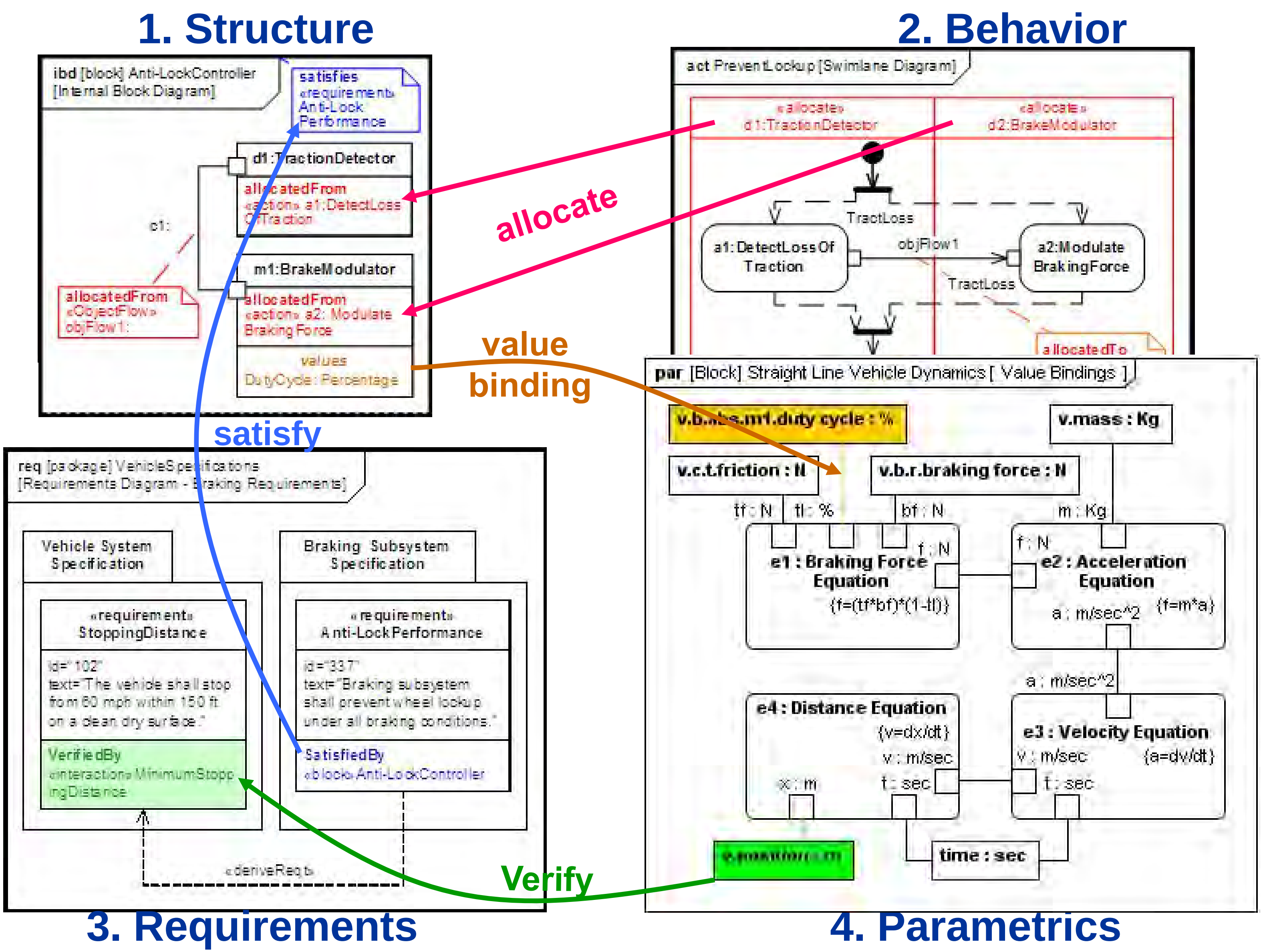
Cross Connecting Model Elements

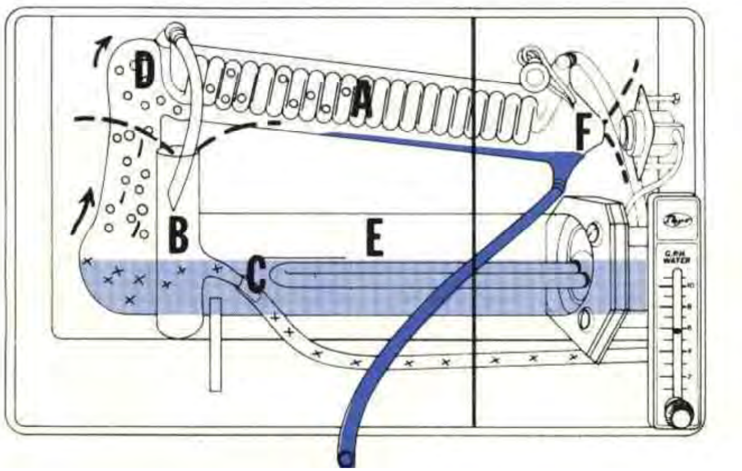


Key Considerations for SysML Tool Selection

- The specific MBSE method employed may leverage specific SysML features, but may not require other features. It is appropriate to ask the following questions to emphasize the features of SysML that a successful tool deployment will need to support.
  - Which behavior representations are most important? Activity diagrams? State machines? Sequence diagrams?
  - Will there be a need for item flow representation?
  - What kind of need will there be for detailed performance analysis and parametric modeling? Expression of mathematical equations relating parameters of system elements may be a very important part of the system development process/method employed.
  - Will there be a need for algorithm specification & development? It may be important to express information processing algorithms explicitly in mathematical form, using constraint blocks and eventually relating them to specific blocks representing software code.
  - Which architecting principles need to be supported by the tool?
  - How will allocation be used? The manner in which allocation is used to guide the development process may dictate a set of constraints & rules associated with allocation relationships. By enforcing or enabling these rules, a toolset can improve the efficiency of the modeling process.

OMG SysML Tutorial (omgsysml.org)
Water Distiller Example

- Functional Analysis based, not OOA
  - Relies heavily on activity diagrams and functional allocation
- Solution to problem focused on activity modeling, flow allocation, item flows & parametrics
  - Heat balance of distiller relies on properties of water flowing through system
- Traditional UML tools just don't do these things



Tool Comparison For Distiller Example

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- No tool "fully" implements SysML
- Clearly, each tool has strengths & weaknesses
  - Make sure tool is compatible with your method
- Other tools exist, but not evaluated
- RS(X) is tool I'm least familiar with

	Enterprise Architect ver 7.1	Magic Draw ver 15.1	Rhapsody ver 7.2	RS(X) ver 7.0.5 E+ SysML ver 2.0.5.1
Activity Modeling	full	full	limited	full
Structural Modeling	full	full	full	full
Item Flows	limited	full	full	limited
Ports/Interfaces	full	limited	full	full
Functional Allocation	yes	yes	yes	yes
Flow Allocation	none	yes	yes	yes
Parametrics	full	full	full	full
Code Gen/Animation	none	none	yes	yes
Requirements	full	full	full	full
Distiller Model Source	Steiner	Steiner	Lussier	Steiner
UML4SysML 2.1	most	all	most	most

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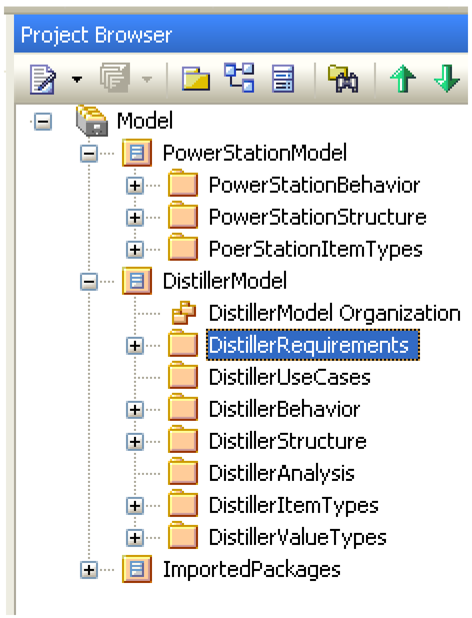
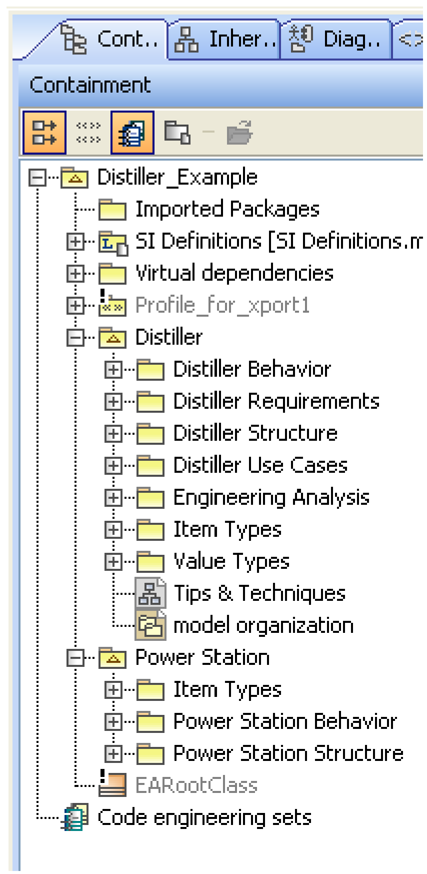
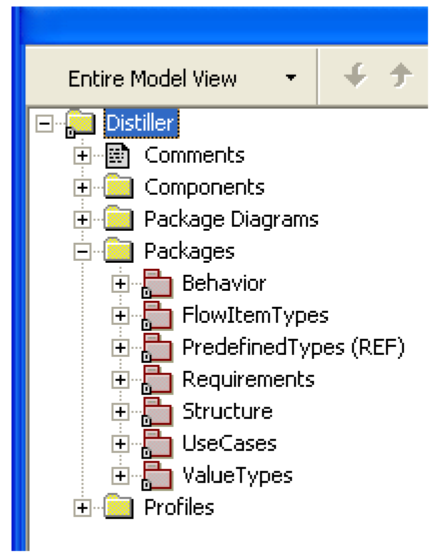
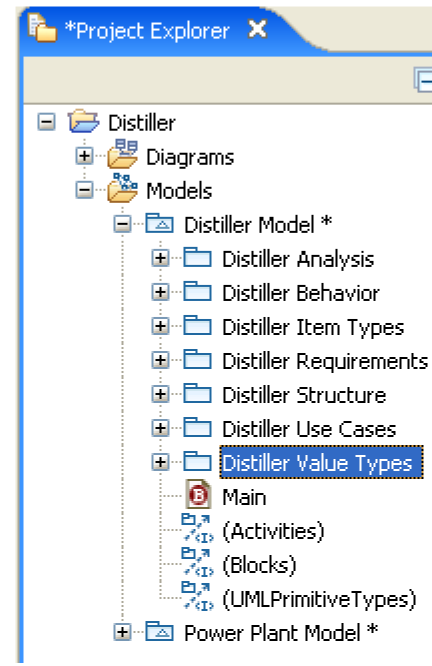
Distiller Model Organization

Enterprise Architect Browser	MagicDraw Browser	Rhapsody Browser	RS(X) Browser

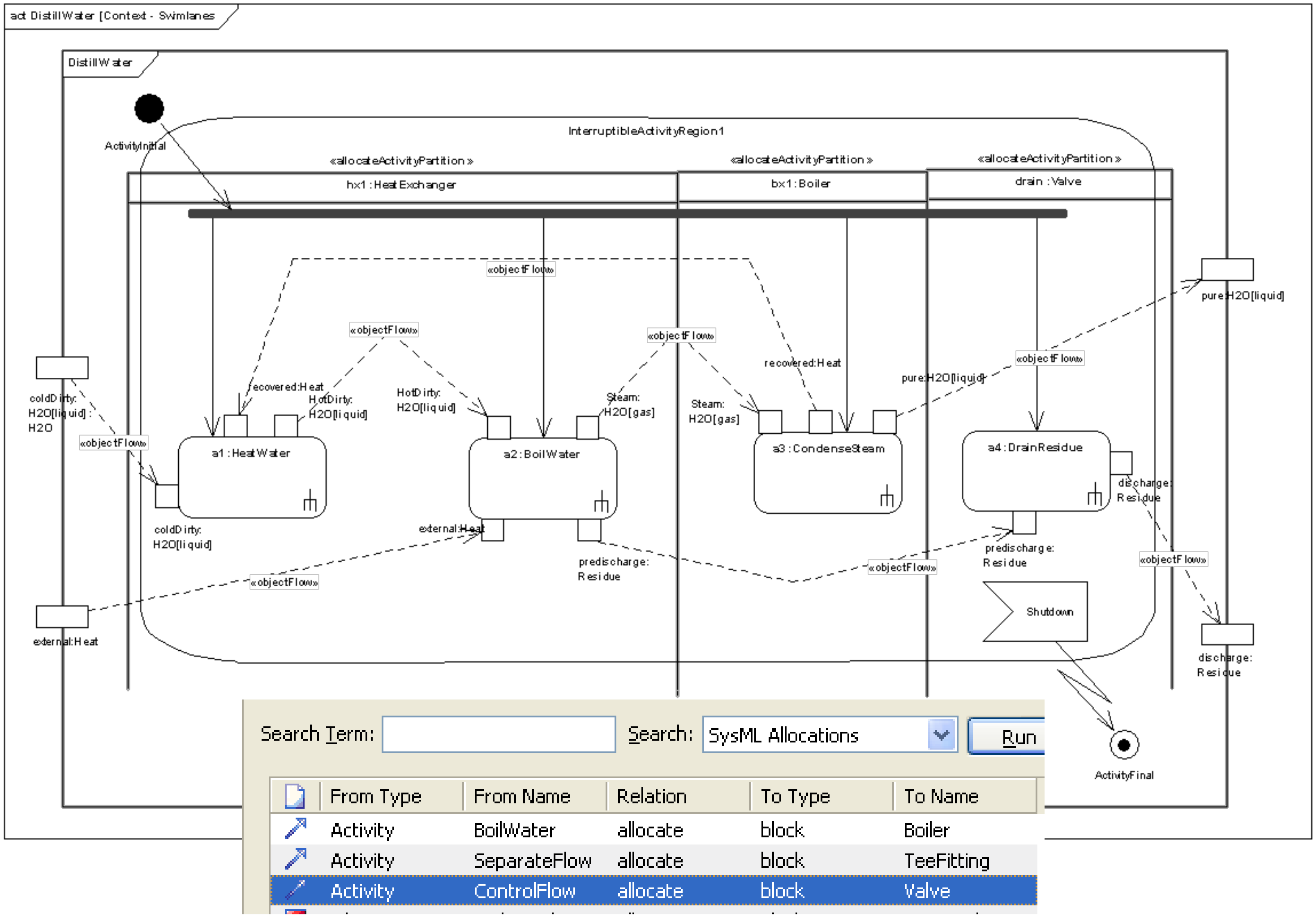






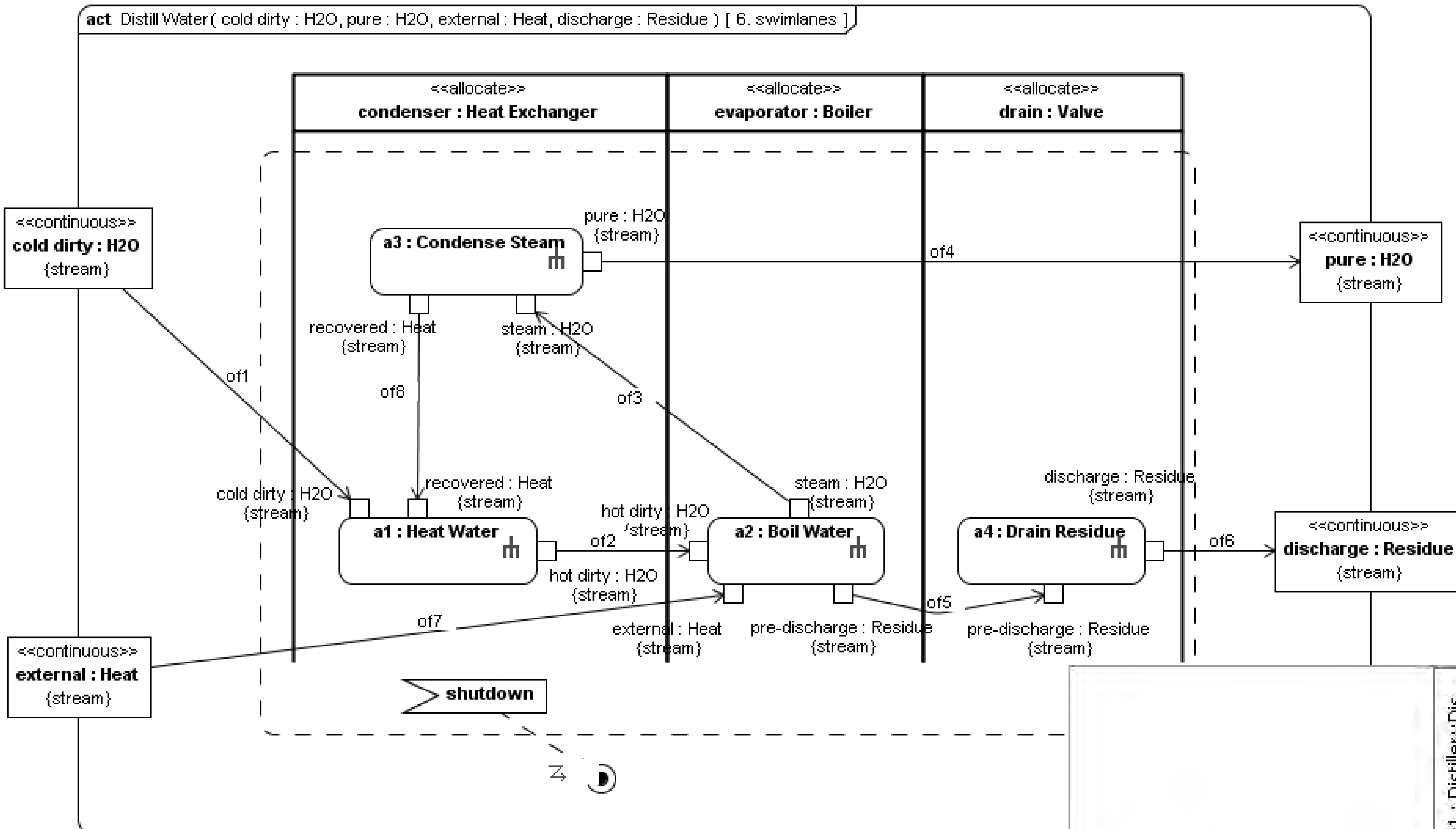


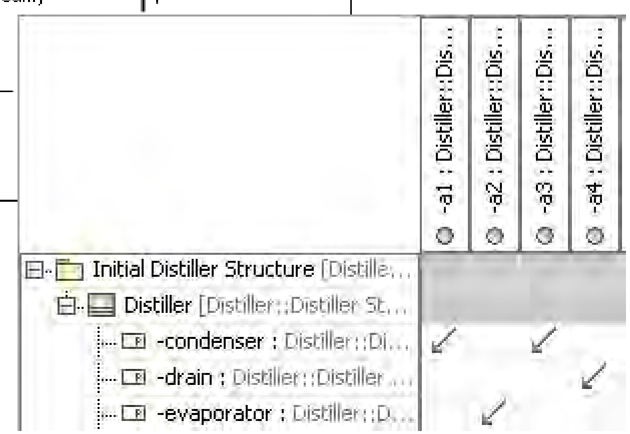
EA Functional Allocation



- Allocate activity partitions work well, allocation tables are fast & easy
- Flow allocation not possible (object flow to item flow)

Magic Draw Functional Allocation





- Allocate activity partitions work
- Flow allocation works
- Flexible tabular view

Rhapsody Functional Allocation

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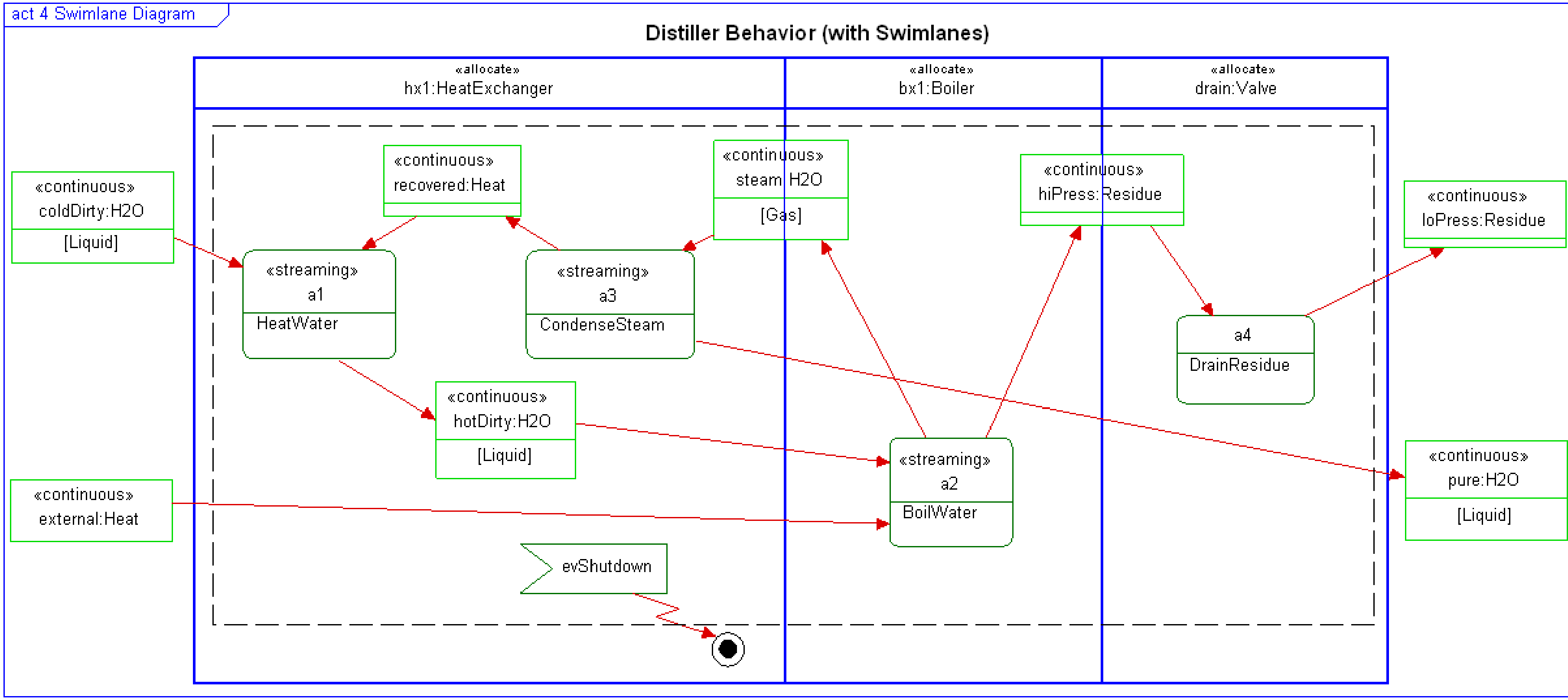

- Action nodes do not invoke activities (no activity hierarchy)
- No activity parameter nodes (on diagram frame, or otherwise)
- Action pin notation is awkward, pins not reused when action referenced
- Can’t distinguish control flow from object flow
- Tabular view & reports of allocation are available

RS(X)/E+ Functional Allocation

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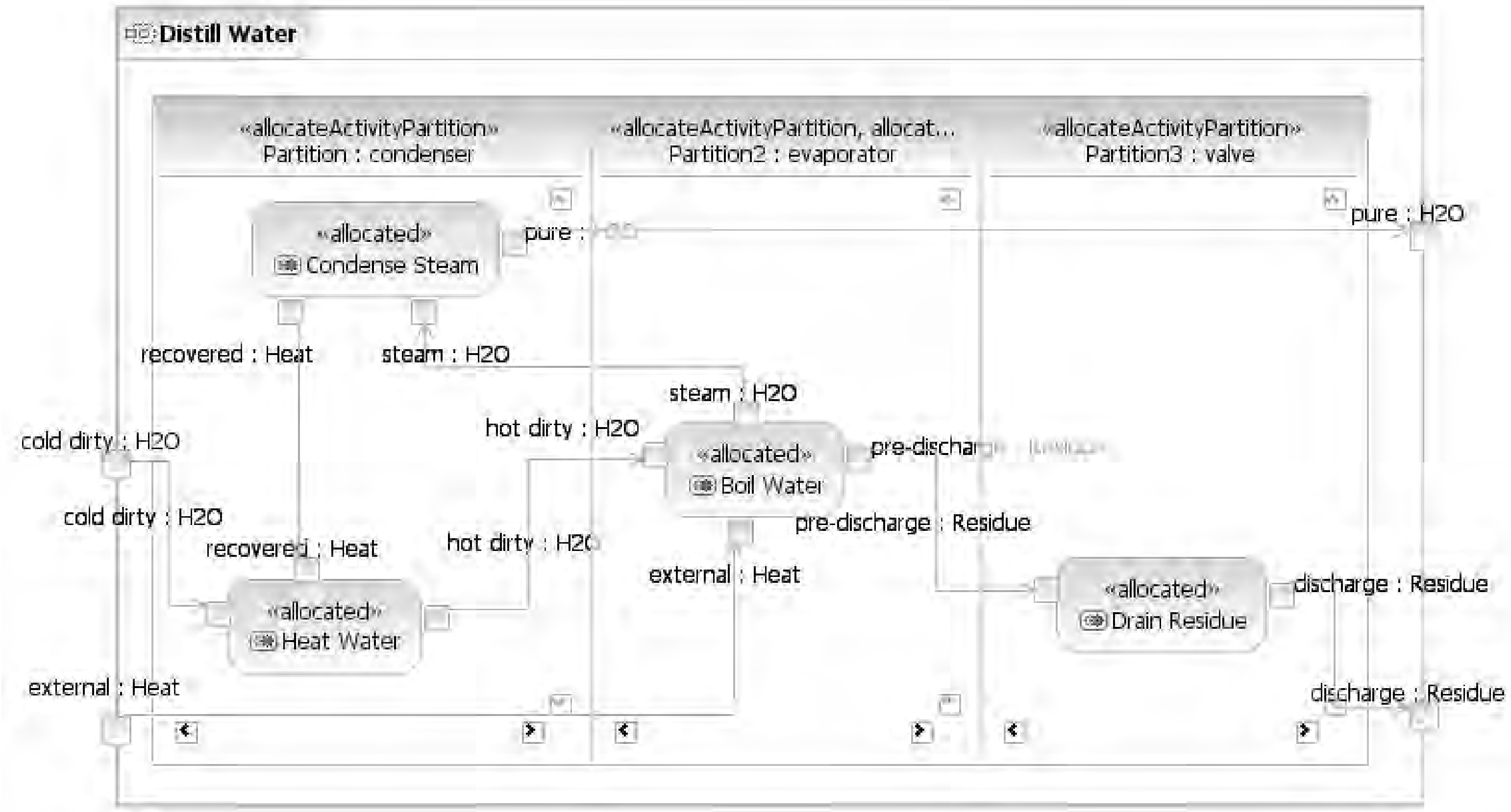

- Non-standard diagram frame/label
- No unique action names (must be same name as activity), but allocation is unique
- Allocation partitions work (automatically create allocation relationships) to blocks or parts.

EA ibd/ItemFlow

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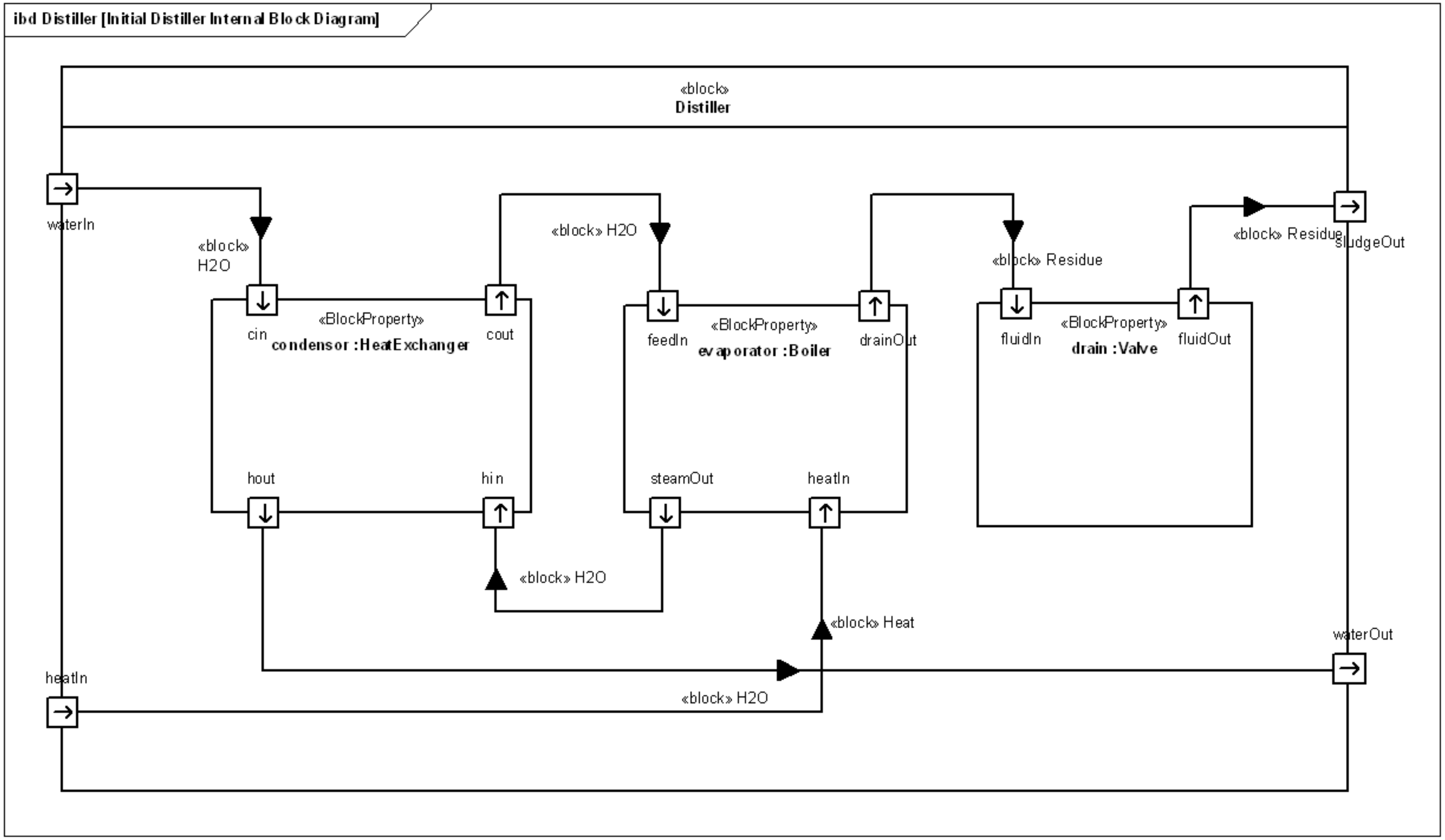
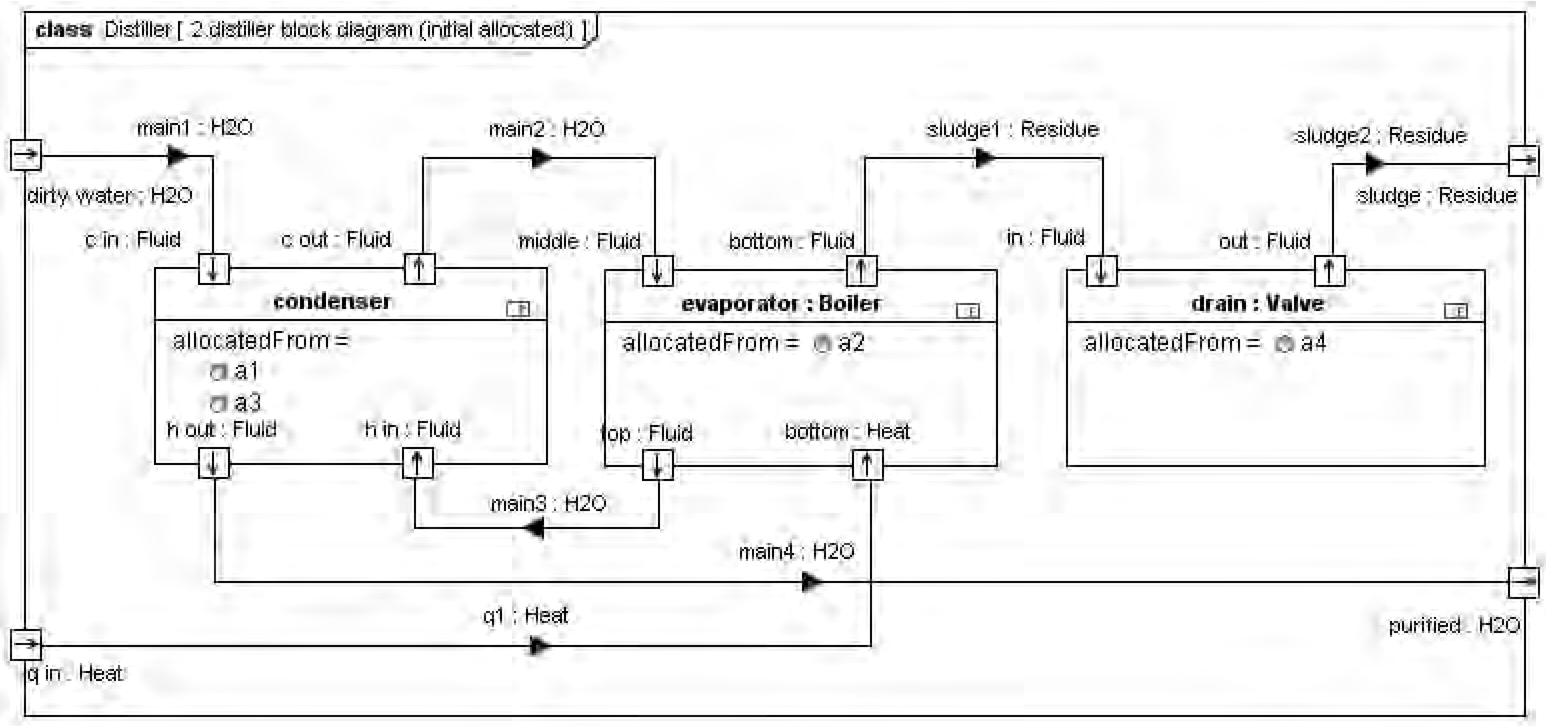


- Allocation works, but compartments not supported
- Can't access value properties of item properties (e.g. temp of water into Heat Exchanger) -> can't do parametric analysis of distiller example.

MD ibd/ItemFlow



- Diagram frame uses incorrect nomenclature
- Allocation compartment incorrect format
- DOES allow full access to item properties

Rhapsody ibd/ItemFlow

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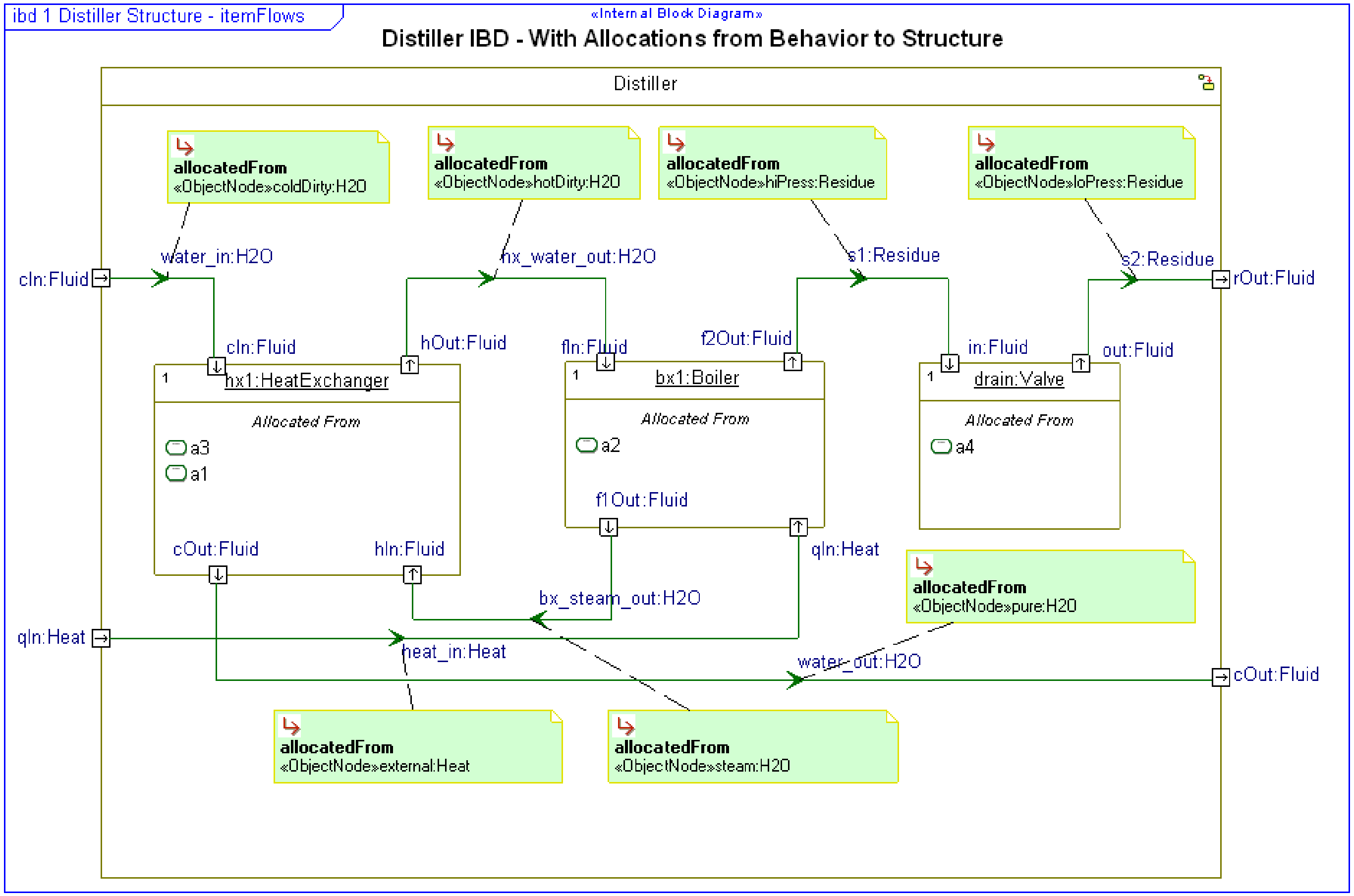

- Item flows and item properties fully allocable
  - Item flows look weird, but work fine
  - ObjectFlows can't be allocated, but ObjectNodes can.
- Full allocation compartments & callouts

RS(X)/E+ ibd/ItemFlow

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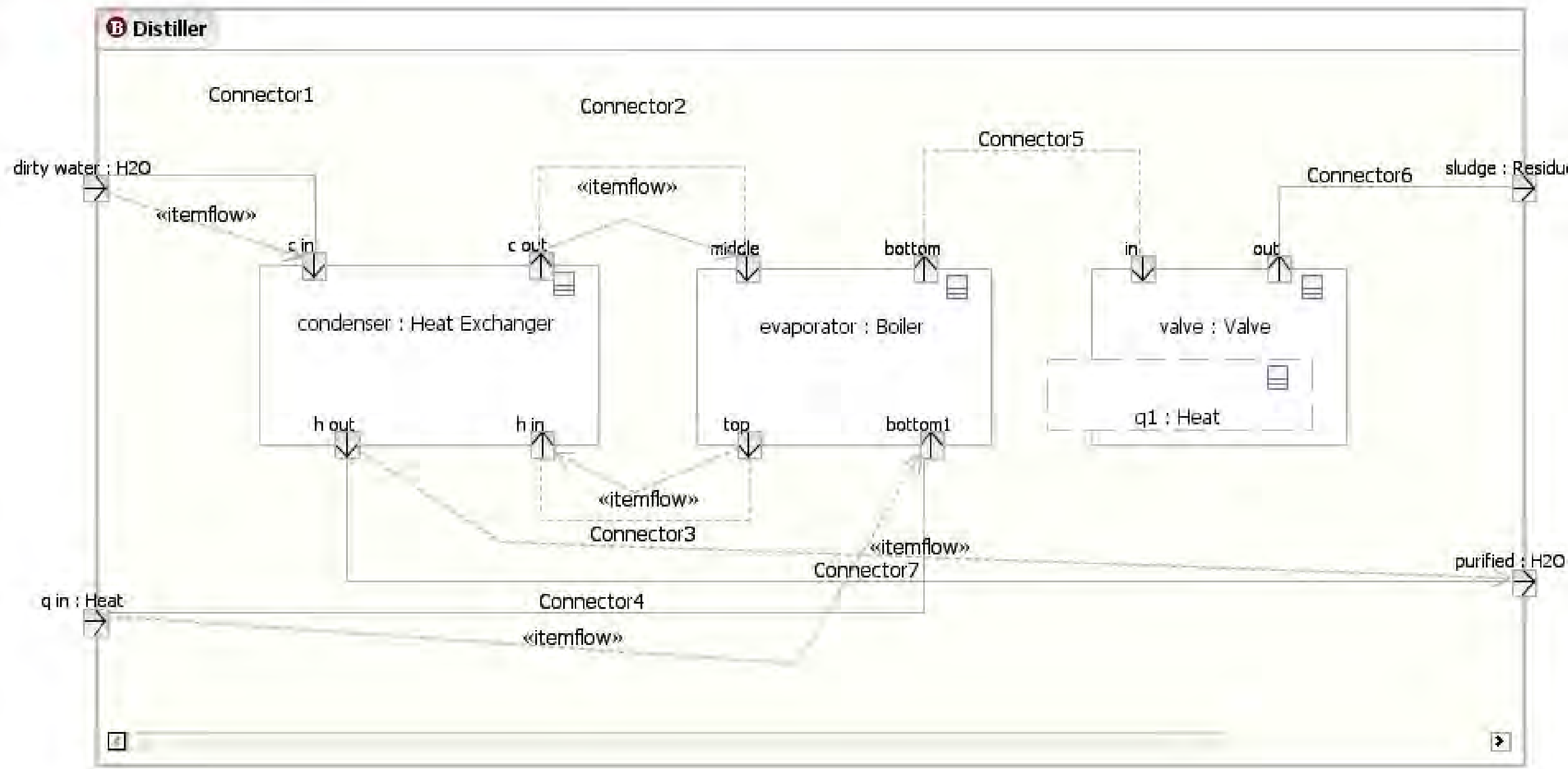
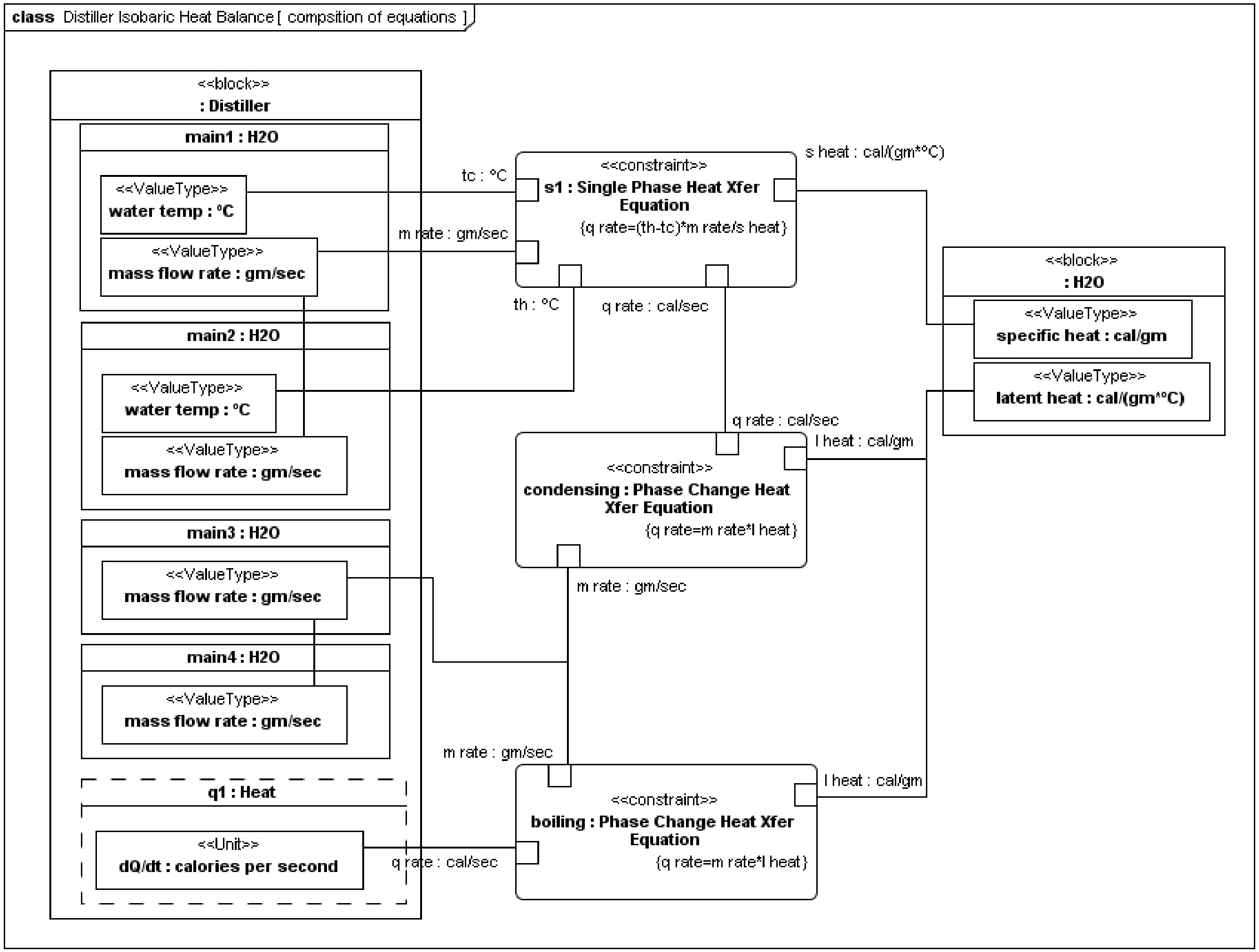


- ItemFlows incorporated in RSD 7.0.5/E+ 2.0.5.1, but
  - no icon or name/ItemProperty on diagram, ItemFlow not associated with Connector
- Non-standard diagram frame/label
- Allows Allocation of ObjectFlow to ItemProperty, but not to ItemFlow
  - no allocation compartment/callouts on parts

MagicDraw Parametric Diagram



- Item properties, value types, units and dimensions fully supported

Rhapsody Parametric Diagram

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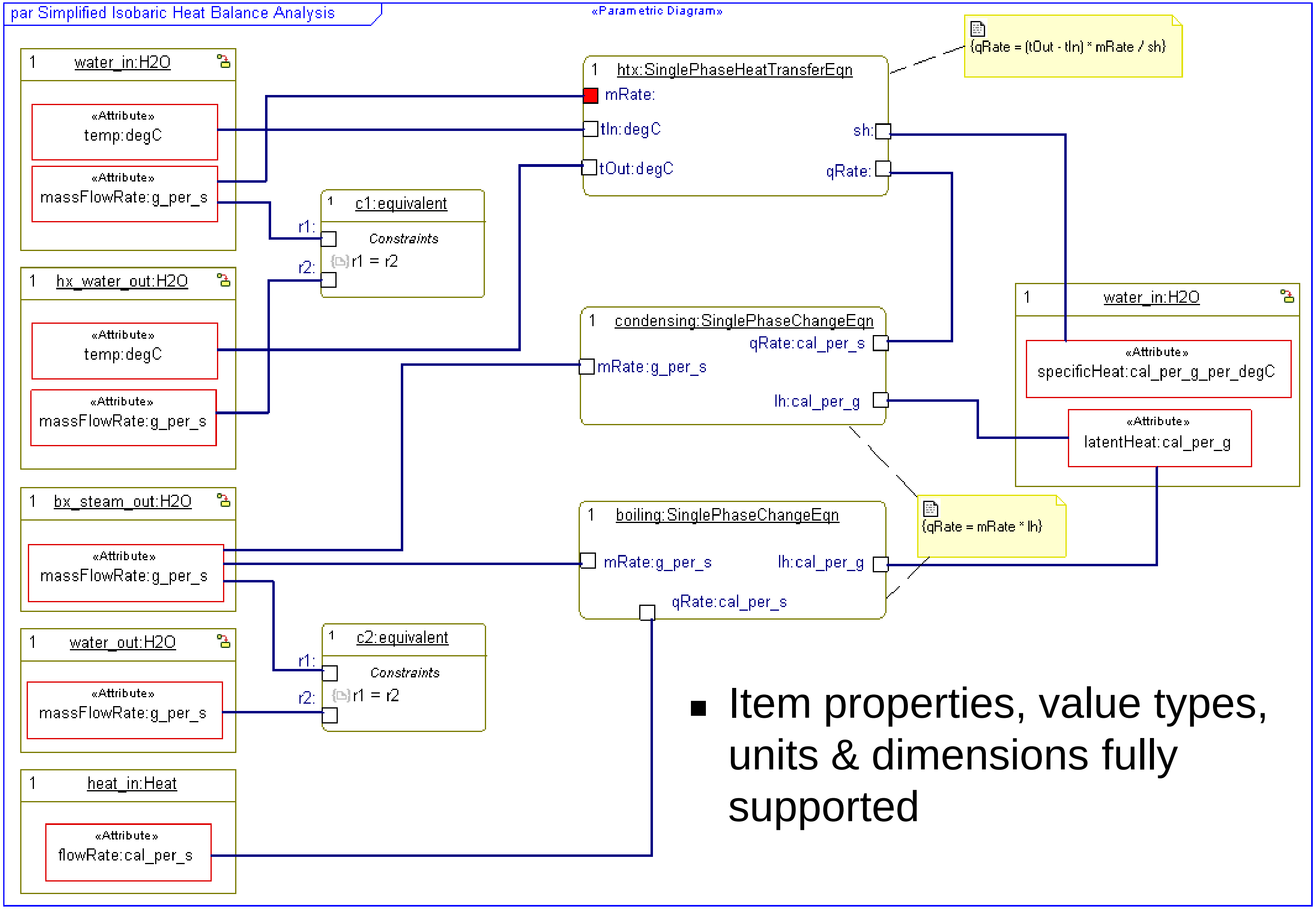

- Item properties, value types, units & dimensions fully supported

EA & RS(X)/E+ Parametrics

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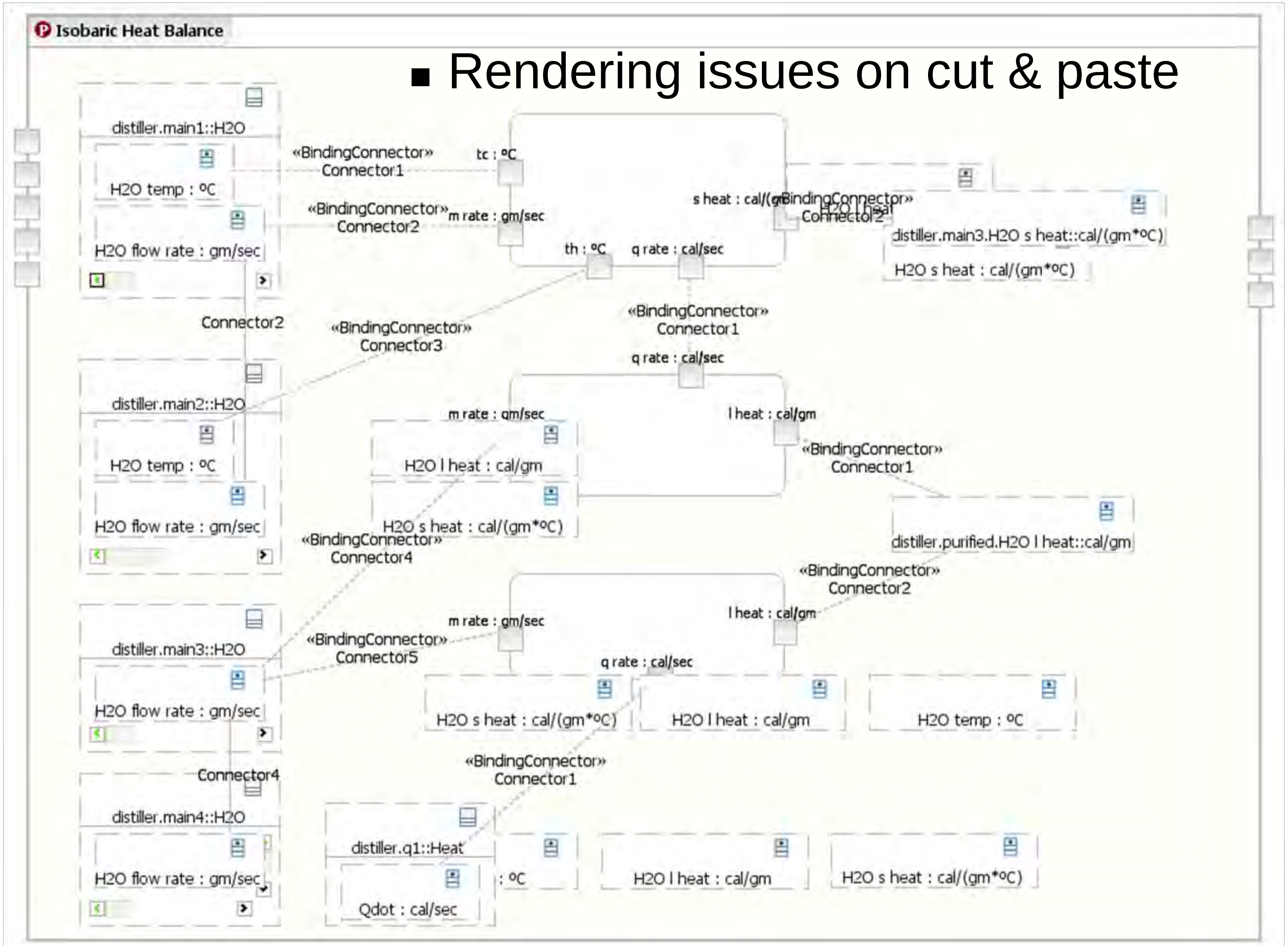
- Rendering issues on cut & paste



EA & RS(X)/E+ Parametrics

- Both support units, dimensions, value types, constraint blocks, and parametric diagrams
- Neither support value properties of item properties on item flows
  – Item Flows incorporated in RSD 7.0.5/E+ 2.0.5.1

SysML Diagrams–
a Method for Model Integration

- 3 separate hierarchies of Structure, Behavior, and Data
  - – Usage (internal connection) is documented with separate diagrams
- These 3 hierarchies maintained at Operational and System level

	Hierarchy	Usage		Cross-Connect
Structure	**bdd**	**ibd**		**act** (swimlane), **seq** (lifeline, op)
Behavior	**bdd**	**act, stm**		**ibd** (itemFlow), **seq** (msgType)
Data	**bdd**	(none)		**act** (objFlow), **seq** (msg,op), **stm**

bdd = Block Definition Diagram (no DoDAF)
ibd = Internal Block Diagram (OV-2, SV-1, SV-2)

act = Activity Diagram (OV-5, SV-4)
seq = Sequence Diagram (OV-6c, SV-10c)
stm = State Machine Diagram (OV-6b, SV-10b)

DoDAF Views Horizontally Cross-Connecting a Complex SoS Model

I. Operational

Command, OpNode

II. System

IIA. Conceptual

Multi-Node System

IIB. Logical

Generic Systems (C2, Sensor…)

IIC. As-Is

POR 1

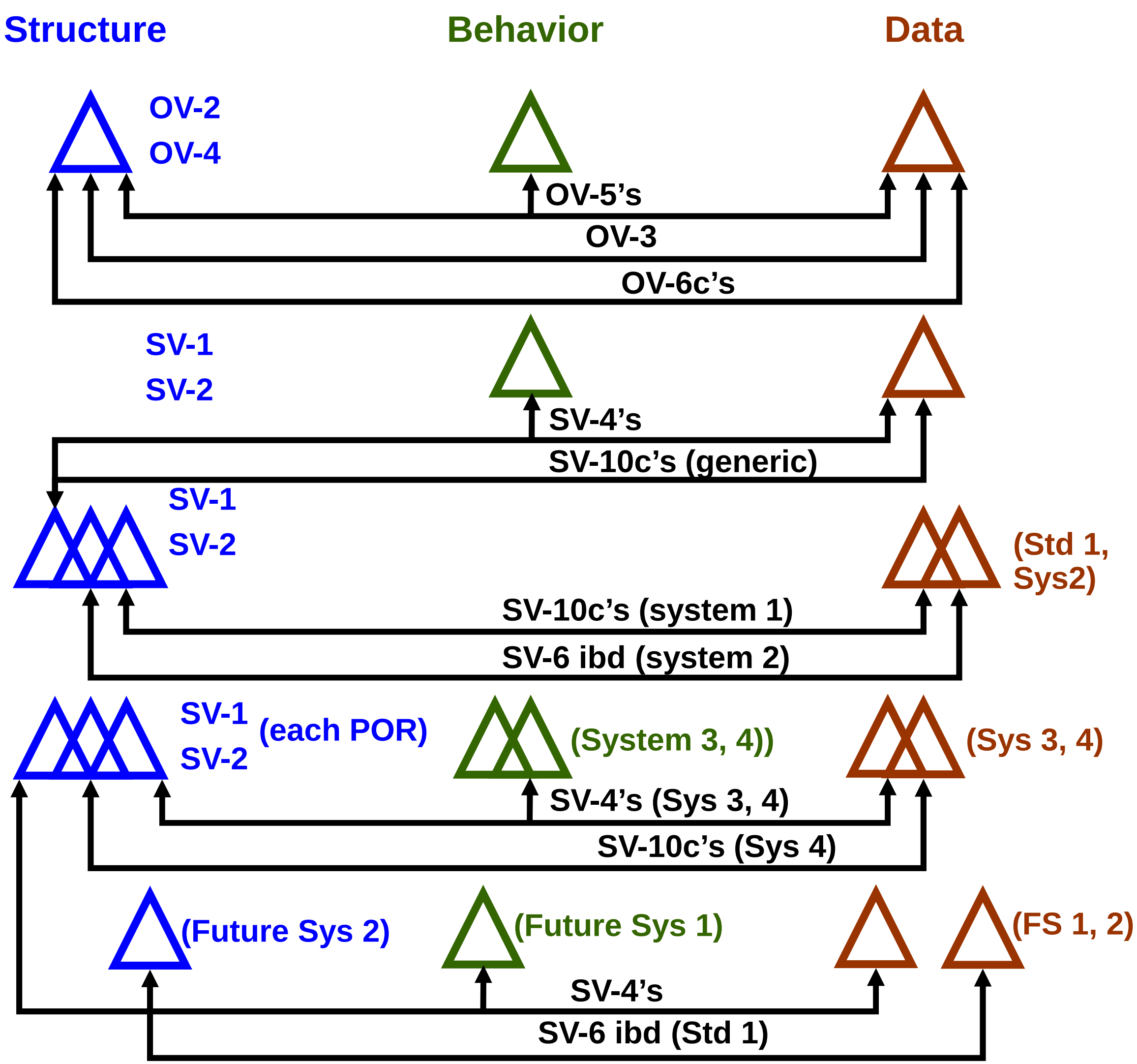
POR 2

POR 3

IID. To-Be

Future System/Standard 1

Future System/Standard 2



Triangles represent hierarchy diagrams (no DoDAF equivalent)

Allocation Vertically Cross-Connecting a Complex SoS Model

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I. Operational

Command, OpNode

II. System

IIA. Conceptual

Multi-Node System

IIB. Logical

Generic Systems (C2, Sensor…)

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POR 1

POR 2

POR 3

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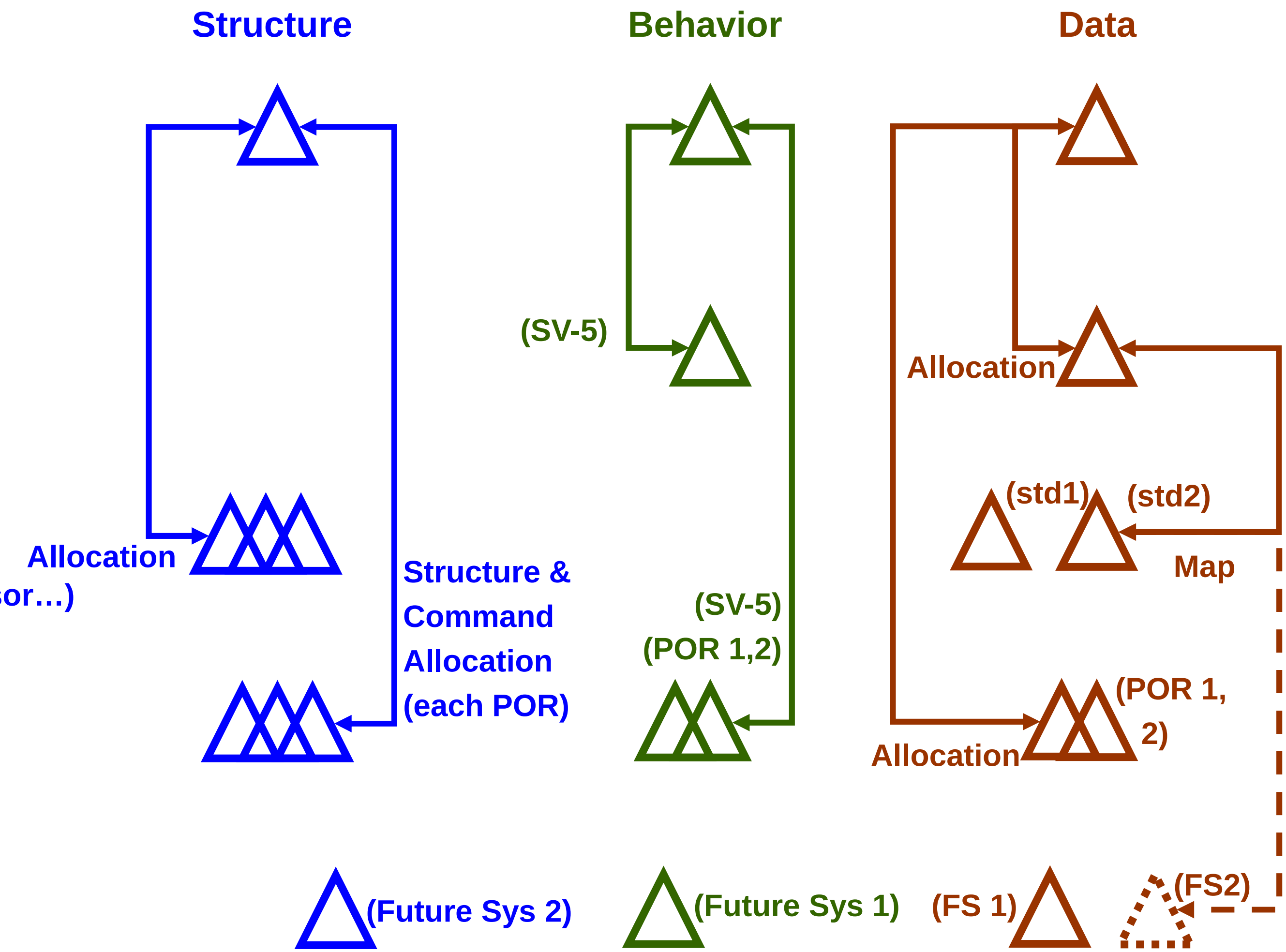


Triangles represent hierarchy diagrams (no DoDAF equivalent)

The Death of Risk Management

Michael Gaydar
Chief Systems Engineer, NAVAIR

Self Destruction

Risk Identification And Mitigation Is Required On All Programs.

However, Poor Implementation And Understanding Of Risk Management Has Resulted In Unacceptable Level Of Risk Assumption.

A common misconception, and program office practice, concerning risk management is to identify and track issues (vice risks), and then manage the consequences (vice the root causes). This practice tends to mask true risks, and it serves to track rather than resolve or mitigate risks.

DOD Risk Management Guide

"Risk is a measure of future uncertainties in achieving program performance goals and objectives within defined cost, schedule and performance constraints."

RISK IS NOT:
Lack of Oversight, Failure to Plan, or Unrealistic Performance Goals

Risk Management

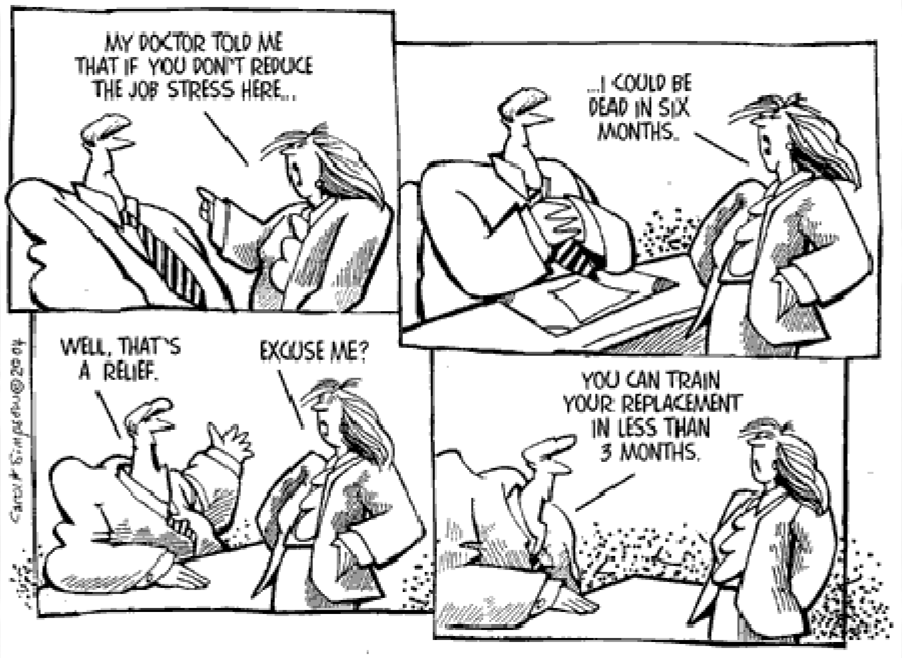
- Risk Management Is Only A Subset Of Project Management
- Risk Identification
  - – Poorly Understood
  - – Incorrectly Implemented
- Risk Mitigation Plans
  - – Inadequate
  - – Outside Daily Program Management
- Risk Realization Totally Ignored

Risk Management Programs Require Risky Programs

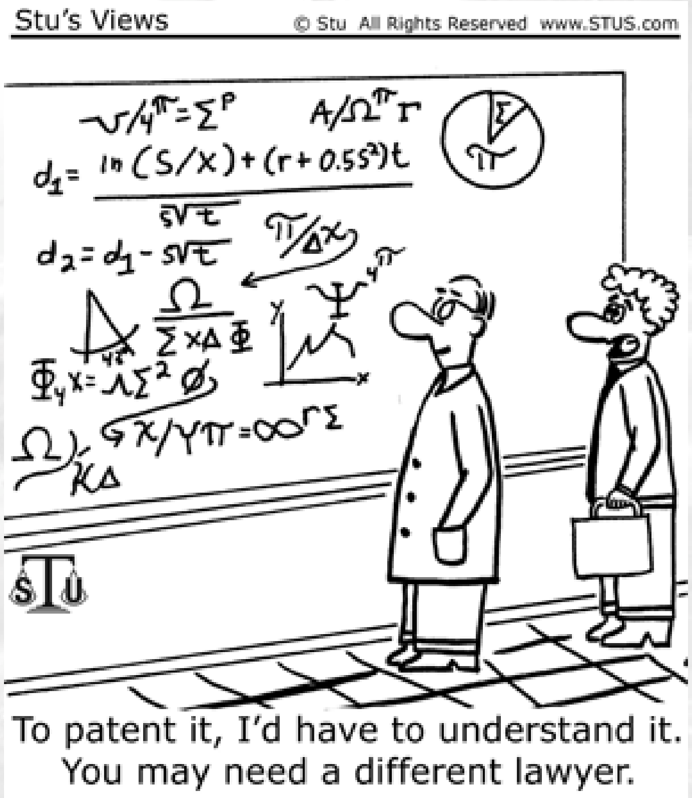
Program Management By The Book

- Requirements Must Be Achievable And Documented
- Historically Derived Basis Of Estimate
- Integrated Master Schedule
  - All Tasks Are Planned And Linked
  - Well Constructed IAW ANSI 748
  - Critical Path Understood And Managed
  - Fully Integrated Supplier And Government Schedule Dependencies
- Integrated Data Environment
  - Deliverables Identified In Contractual Language
  - Deliverables Integrated Into Master Schedule
- Configuration Management Established & Active
- Timely Problem Resolution Across Contractual Lines
- Alternate Design Paths For Critical Technologies

Properly Planned And Executed Programs Inherently Eliminate And Avoid Risk



Trading Cost-Schedule-Performance Is A Ponzi Scheme



Michael Gaydar, AIR-4.1, 301-757-5549

DOD Handbook RM Objective

The objective of a well-managed risk management program is to provide a repeatable process for balancing cost, schedule, and performance goals within program funding, especially on programs with designs that approach or exceed the state-of-the-art or have tightly constrained or optimistic cost, schedule, and performance goals…

…Successful risk management depends on the knowledge gleaned from assessments of all aspects of the program…

Categories Of Risk

Risk	
Technical	Critical Design Elements Depend On Technology That Is Just Not Achievable. Caused By Overreaching Performance Requirements Embedded In KPPs.
Programmatic	Resource Estimates (Budget & Schedule) Too Low. Caused By Insufficient BOE Or Optimism.

- Technical Risk Against KPPs & Thresholds Yields No Trade Space
- Result: No Resource Increases Will Eliminate Technical Risk. True Technical Risk Will Always Result In A Requirements Disconnect When Realized.
- True Technical Risk Requires Alternate Design Paths That Deliver Lower, But Acceptable, Levels Of Performance
- Minimum Acceptable Performance, And Design, Must Be Achievable Within Current State Of Technology.

There Must Be Trade Space

Congressional Domain

Program of Record

Risk Contingency (CAIG)

Design Cost Estimate (Proposals)

Contractor & Program Office Domain

Current EAC Threshold Requirements

User Domain

CDD

Requirements Flexibility

Threshold Requirements Do Not Support CAIV Margin

Hope springs eternal

…until the spring dries up.

Ineffective Mitigation Paths

- Technical
  - Balance Design Against Unproven Technology
  - Pursue Single Design Path Hoping Testing Will Show Compliance
  - Carry Significant (RED) Risk Beyond Design Closure (Roughly PDR)
- Execution
  - Hope For Optimistic Performance Through Management Challenges
  - Shift Risk To Suppliers In Firm Fixed Price Contracts
  - Fail To Include All Aspect Of Rebaseline In New EAC

Effective Risk Mitigation Plan

- Risk Realization MUST Be Part Of Risk Mitigation Strategy
- Risk Mitigation Steps Must Address Root Cause Uncertainty
  - Technical: Demonstrate Improved Performance Predictions Or Alternate Design Path
  - Execution: Improve Resource Estimates
- Technical Performance Measures (TPM) Are Essential To Mitigating Technical Risk
- Task Identification Is Essential to Mitigating Execution Risk

Risk Mitigation Steps Should Not Be A Way To Buy Time In The Hope The Risk Will Be Eliminated

Fourth Law Of Risk Management

You Get What You Pay For…

First Corollary:

You Pay For Nothing-You Get Nothing

Michael Gaydar, AIR-4.1, 301-757-5549

Risk Mitigation Costs

- Risk Mitigation Plans Are Unplanned Work
- Unplanned Work Requires MR To Execute
- Risk Mitigation Creates It Own Cost & Schedule Risk
- Unfunded Risk Mitigation Is Unresolved Risk

Risk Mitigation Is A "Pay Me Now Or Pay Me Later" Decision

Summary

- Risks Are Rooted In Uncertainty
- Disciplined Use Of PM Tools Is Required To Identify Areas Of Uncertainty (True Risks)
- Historical Execution And Standard Design Practices Normalize Optimism
- Money And Time Doesn’t Mitigate All Technical Risk-Requirement Relief Only Solution
- Trade Space Has To Exist
- Mitigation Plans Must Attack Root Cause Of Risk-Which Is Uncertainty


QUESTIONS?

End-to-End System Test Architecture

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Net-Centric Mission Operations Features

Fully Synchronized Interoperable, Network of Networked Systems and Mission Capabilities

- Networked Battle Command To The Warfighter
- Networked Multi-Spectral Air, Ground, Space Sensors & Shooters
- Rapidly Reconfigurable Networked Real Time C4ISR Capabilities
- Adaptable Information Formats for Command/Mission
  - Simultaneous Real-time, Near-real Time, Non-real Time, Applications
  - Network-Centric Collaborative SOA / Infrastructure
  - Seamless Information Sharing Across Forces, Multinational and Interagency Partners
- Built-in Redundancy with Operations Continuity

Network of Networked C4ISR Capabilities

Net-Enabled Capabilities

- ***Shortens Chain of Attack***
- ***Provides***
  - ***Decision Superiority***
  - ***Greater Speed***
  - ***Greater Precision***
- ***Capabilities Supported***
  - ***Global Network Connectivity***
  - ***Network Enabled Platforms/Weapons***
  - ***Fused Intelligence***
  - ***Real Time Command / Control & Situational Awareness***

***Key:* Net-Centric Operations**
IP-based Routing, Shared Data, Assured Service

Masuma Ahmed

Air Force Vision - One Network

- **Space Layer**
  - **Transformational Communications – Satellite Constellations, Operations & Management Systems**
- **Near Earth Orbit & Airborne Layer**
  - **JTRS, Laser Optics, BMC2, NATO AGS, E-2C Hawkeye, J-UCAS, UAVs**
- **Maneuver Layer (upper echelon)**
  - **Future Combat Systems, Blue Force Tracking**
- **Maneuver Layer (lower echelon)**
  - **Sensors, Weapon Systems, Munitions Data link**
- **Terrestrial Layer**
  - **GIG-BE, Teleport, CAOC**
- **Characteristics**
  - **Robust Self-Forming, Self-Healing Network of Mobile War Fighters**
  - **IP Routing Platform For Information Flow Between Ground, Air and Space Networks**

Merged Defense and Space Infrastructure

TEST & INTEGRATION CHALLENGES

- Netcentric Scope Encompasses Integration of Diverse Systems, Technologies, Applications, and Protocols Across Forces, Multinational and Interagency Partners. This Requires
  - Understanding, Test, and Verification of Transparent Interoperability of Protocols and Systems Across Network of Diverse Networks
  - Simulating Communications Systems, Sensors, Weapons, and War Fighters in an End-to-End Test Environment
  - Data Consistency End-to-End
  - Multi-step Processing End-to-End
  - Assured Service Interoperability End-to-End

Seamless Integration of Net-Centric Capabilities Requires Robust Test & Verification Environments

TECHNOLOGY & PROTOCOL ISSUES

- Technology and Protocol Standards Are Not Perfect
  - Diverse Systems Implementing the Same Standards May Support Different Requirements – Protocol Interoperability
  - Testing and Verifying Interoperability Across Network of Networks - Challenging
- OSI Protocol Layers Can Span Across a Single or Many Interfaces Across Network of Networks
  - Non-transparency of Protocol Layers - Costly Mission Failure
  - Isolating and Mitigating Issues with E2E Protocol Layers - Difficult, Time Consuming and Costly
  - Simulating, Testing, and Verifying Real-time, Near-real Time and Non-real Time Protocols E2E in Multi-vendor Environment – Complex and Time Consuming

Test & Verifications of Network of Networked Systems Logistically Complex

E2E TEST CONSIDERATIONS

- Any Net-centric Mission Systems Must Be
  - Tested in True Battlefield Network Conditions Prior to Deployment
    - End to End Protocol Interoperability Fundamental To Success of Netcentric Mission Operations
    - Network of Networked Systems Use Multi-layered Protocol Architecture to Communicate Transparently Across Networked Systems
  - Tested in a Distributed E2E Test Architecture Emulating Real-time, Near-real Time, and Non-real Time Protocols, Interfaces, and Technologies across Networked Systems
    - Designed with Hierarchical Protocol Architecture in Mind
    - Emulated All Segments
    - Supporting Virtual Test Systems For Multiple Test Scenarios

Net-Centric, Distributed, E2E System Test Architecture

Test Architecture Considerations

- Mesh vs Hub/Spoke Architecture
  - Cost, Schedule, & Protocol Considerations
  - Management, Control and Data Planes
  - Distributed vs Centralized Control
  - Overlay Protocol Architectures
  - Security Architecture, Protocols & Boundaries
    - Security at Physical and Higher Protocol Layers
  - Hardware, Software, Simulators, & Emulators Integration
  - Complex Protocol Interactions
- Architectural Requirements
  - Adaptability to Changes
  - Reconfigurable
  - Remote Configurability
  - Multi- Protocol Support
  - Protocol Fidelity

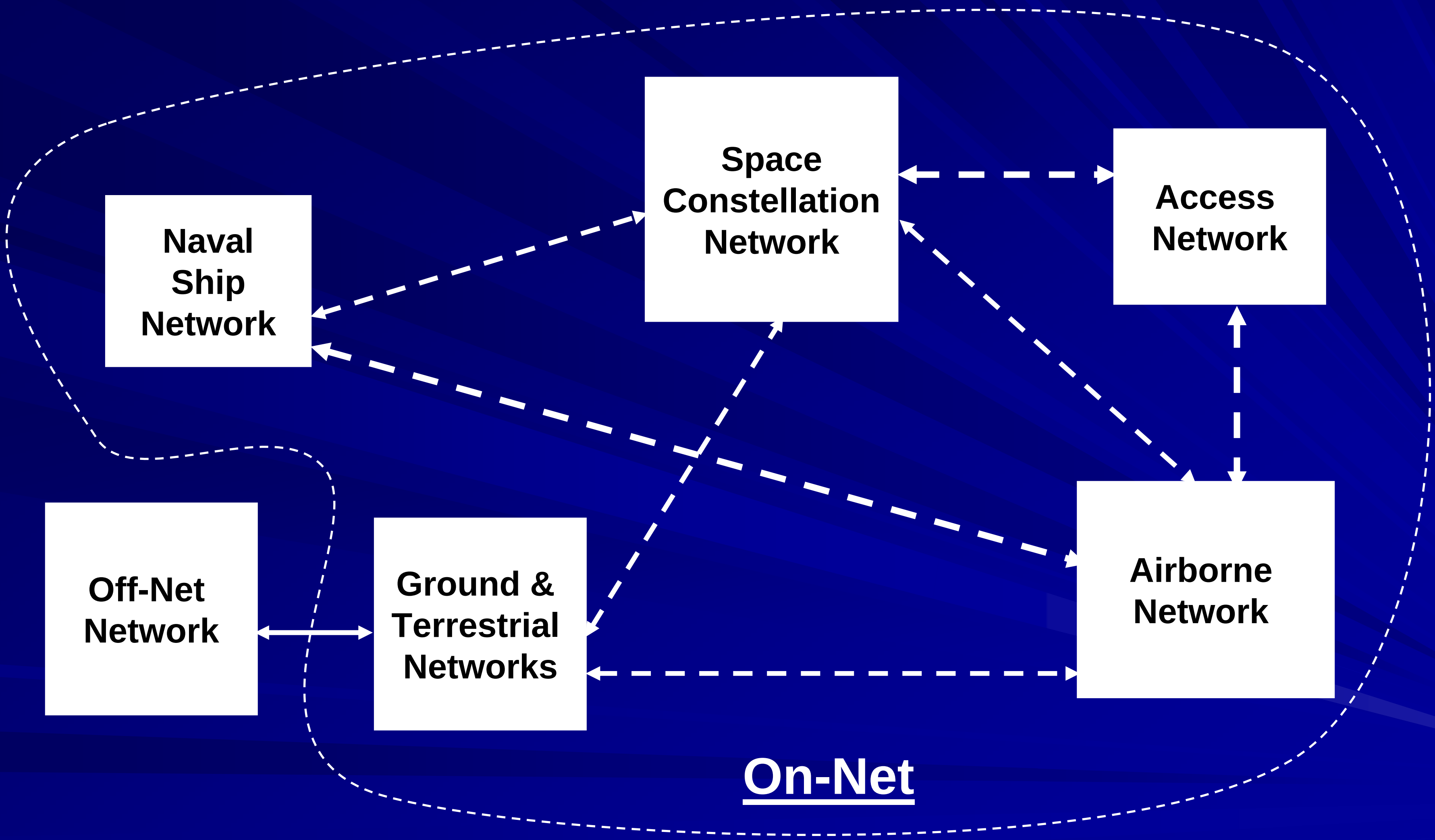
Adaptable & Reconfigurable Secured System Test Architecture

Distributed System Test Architecture Issues

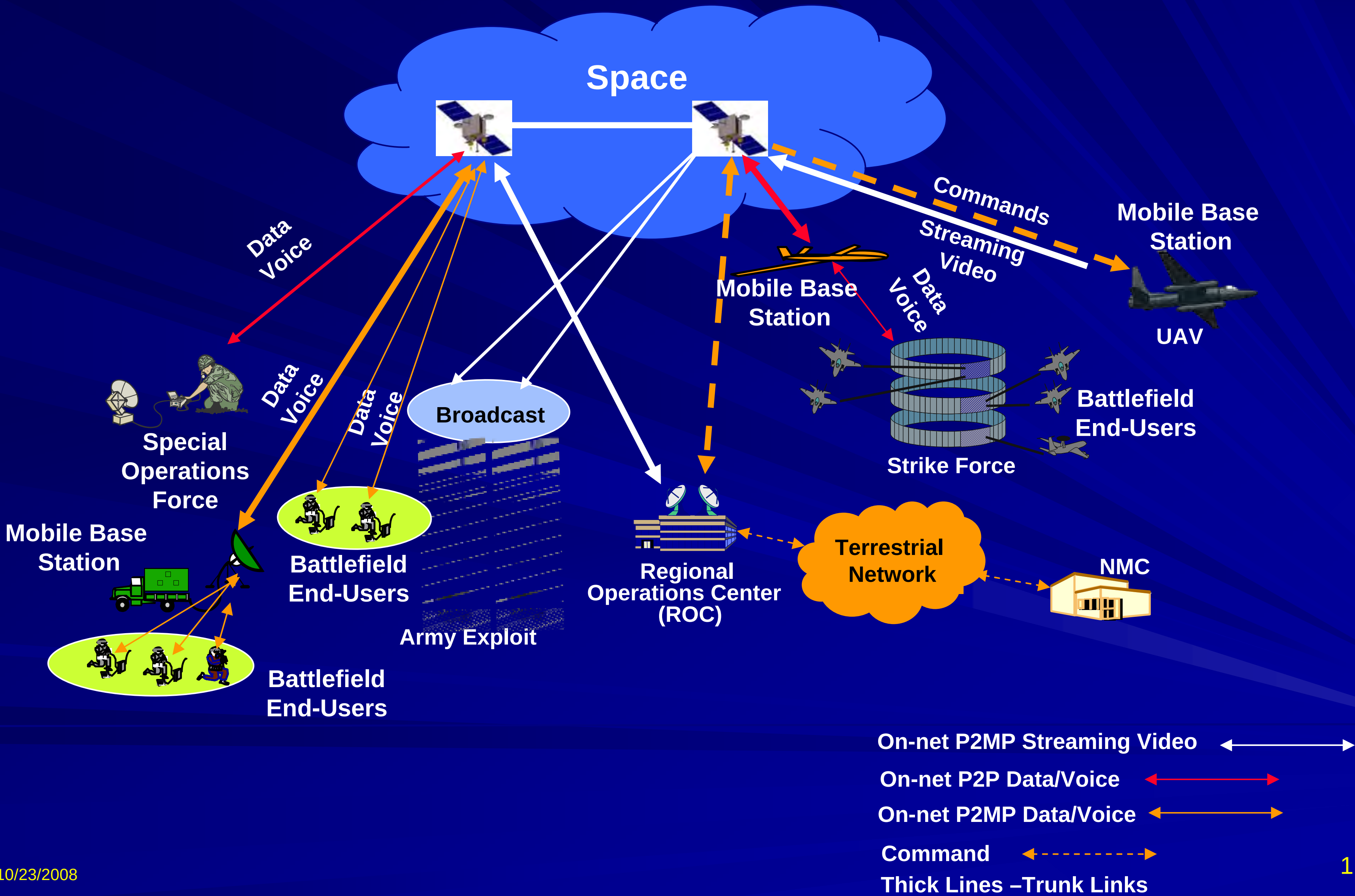
- Latency
- Security
- Timing
- Data Integrity
- Service Availability
- Race Conditions
- Priorities

Early Planning and Detail Requirements Specifications Essential

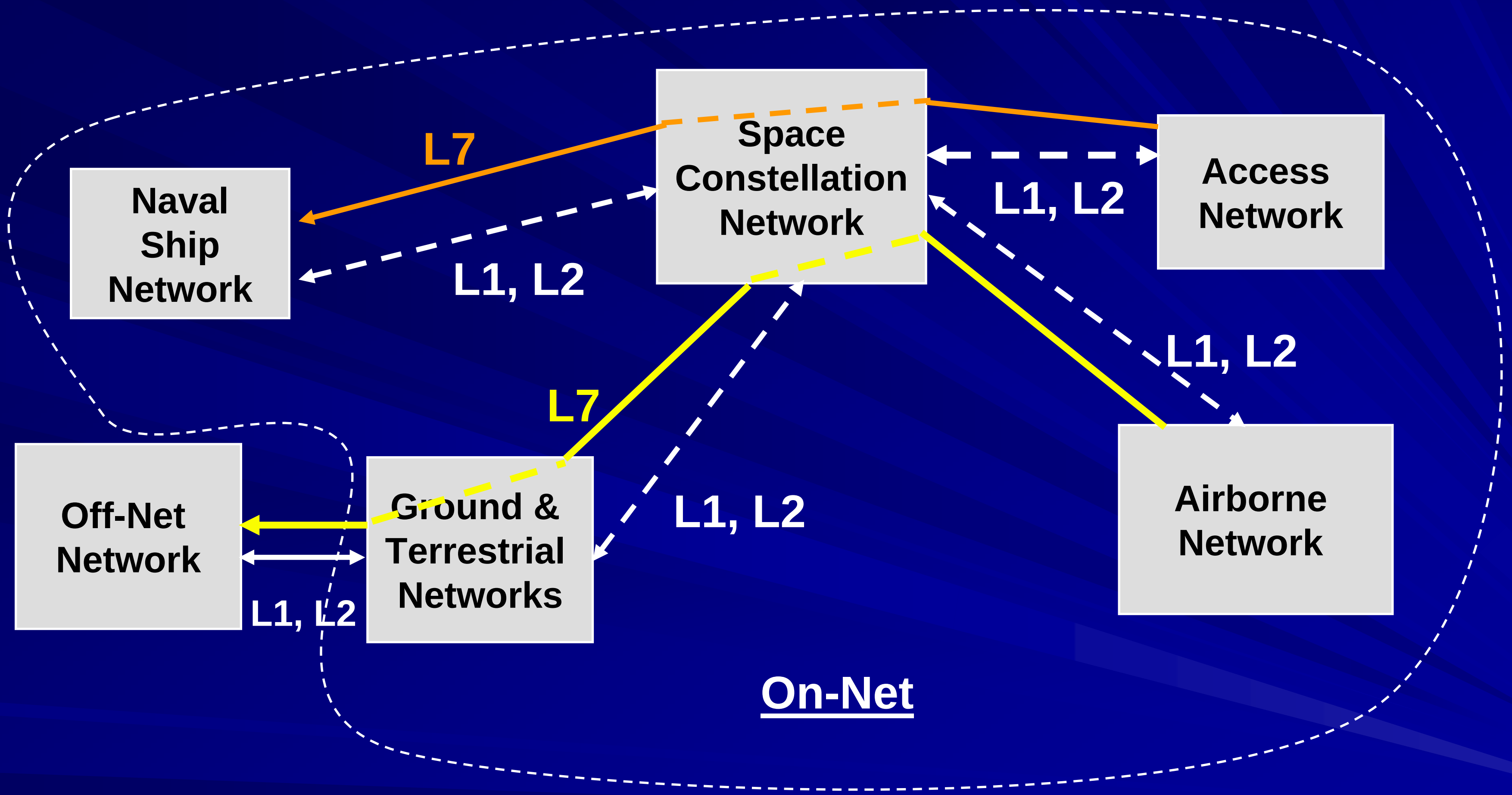
Network of Networks - A Simplified Example



Networked Satcom Service Example



Networked Protocol Layers (L1, L2, L7) - Example



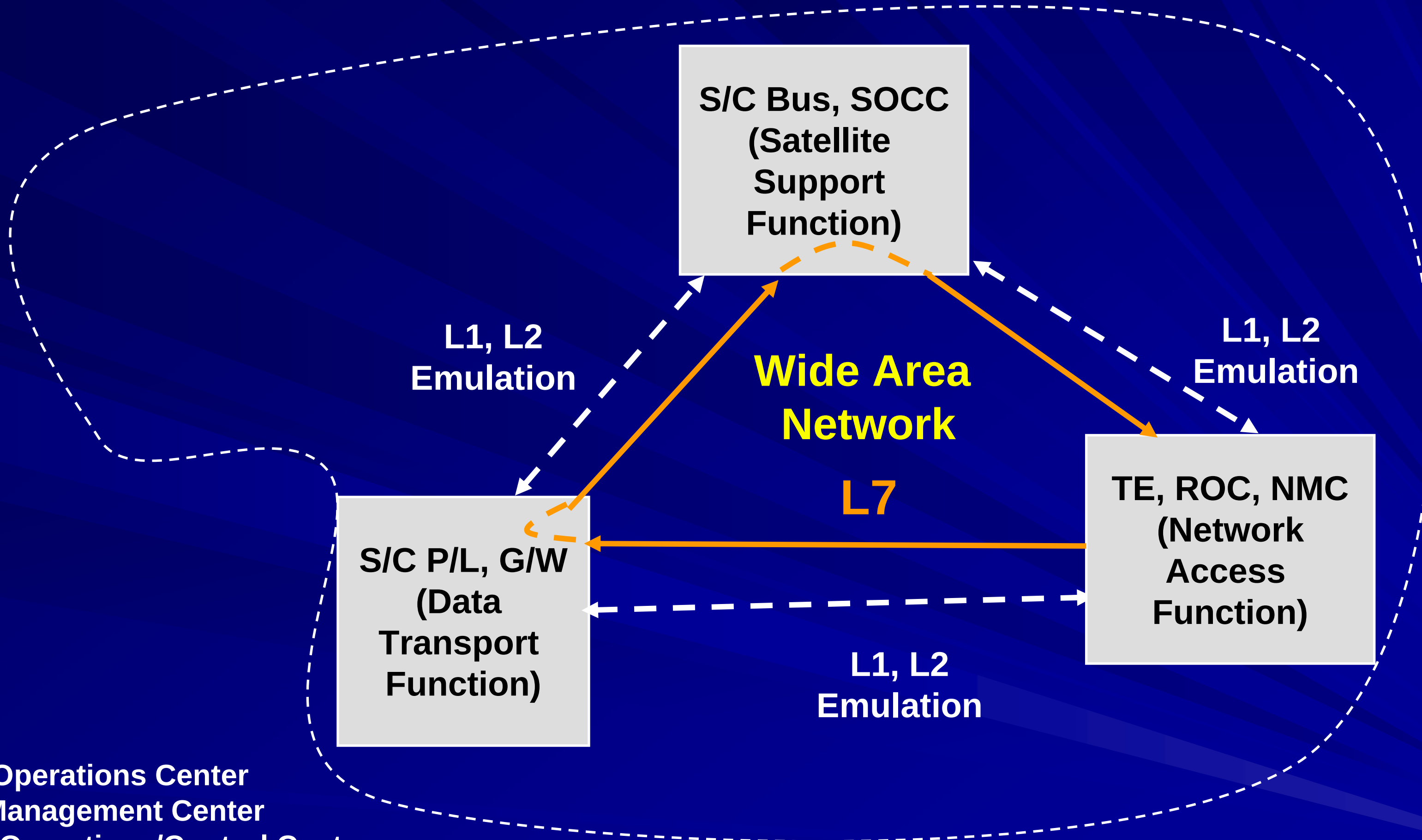
Testing L7 Performance Over Diverse L1 / L2 – Complex & Challenging

Protocol Performance

- Physical and Data Link Layers (L1, L2)
  - Terminate Between Adjacent Systems In The Same or Adjacent Networks
  - Data Link Layer Performance Depends on Physical Layer Performance
  - Application Layer Transparent to Physical and Data Link Layers
  - Example: Physical Layer - RF, SONET; Data Link Layer – Link 16, Ethernet MAC
- Application Layer (L7)
  - Traverses Multiple Networks & Terminates End to End
  - Rides On Diverse & Multiple Physical & Data Link Layers (L1, L2)
  - Uses Services of Lower Protocol Layers
  - L7 Performance and Data Integrity Depend on Lower Protocol Layer Performance (e.g. Timing)
  - Example: Email, Streaming Video, Audio, File Transfer, Web Browsing

L7 Performance Depends on L1 / L2 Performance

Distributed System Test Architecture - Example



S/C: Spacecraft
P/L: Payload
G/W: Gateway
ROC: Regional Operations Center
NOC: Network Management Center
SOCC: Satellite Operations/Control Center
TE: Terminal

Supports Virtual Test Systems for Multiple Test Scenarios

Distributed System Test Architecture Features

- Emulates Multi-Segments – Space, Air, Terrestrial Systems, Elements, Interfaces, & Protocols
- Consists of Geographically Distributed, Multiple
  - System Integration Labs (SILs)
  - Test Beds
  - Simulators
  - Emulators
  - Control Centers

  Interconnected by Wide Area Networks (WAN)
- Supports
  - Multi-Element and Flight Element Integration, Test and Verification
  - Multiple Software and Database Integration and Integrated SW Load Testing
  - Prototyping Hierarchical Protocol Layers and Interfaces
    - Simultaneous Test and Verification of Command / Control, Application, Network, and Lower Protocol Layers and Interfaces
      - Functions
      - Performance
      - Load
    - Prove Out C4ISR Interoperability End to End

Supports Simultaneous Test and Verification

Summary

- Distributed Networked E2E System Test Architecture is Essential
  - To Ensure Interoperability of Networked C4ISR Capabilities Across Network of Diverse Networks Before Deployment
    - Test and Verify Transparency of All Networked Protocol Layers
    - Emulate and Test True Battlefield Conditions by Simulating Networked Elements, Protocols, Interfaces, and Systems
    - Support Test-Like-You-Operate
    - Facilitate Early Risk Reduction

Verify Power of Networked War Fighting Before Deployment

LOCKHEED MARTIN

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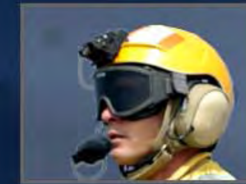

Predictive Modeling: Principles and Practices

Rick Hefner, Dean Caccavo
Northrop Grumman Corporation

Philip Paul, Rasheed Baqai
Unlimited Innovation, Inc.

NDIA Systems Engineering Conference
20-23 October 2008

Background

- **Predictive modeling relies on historical program performance data (predictive analytics) in conjunction with a forecasting algorithm model to predict future outcomes**
  - Ranges from simple extrapolation techniques to sophisticated Neural Network based models
- **This presentation will discuss the principles of predictive modeling, outline the fundamental methods and tools, and present typical results from applying these techniques to project performance**

Agenda

- ✓ **What is Predictive Analysis?**
- Recent Trends
- Application to Program Performance
- Pilot Results and Feedback
- Summary

What is Predictive Analysis?

- ***Could this network packet be from a virus attack?***
  - Predict likelihood of the network packet pattern
  - ➔ **Anomaly detection (outlier detection)**
  - Similar questions:
    - Are the hospital lab results normal (Adverse drug effect detection)
    - Is this credit transaction fraudulent? (fraud detection)
- ***Will this student go to college?***
  - Based on Gender, ParentIncome, ParentEncouragement, IQ, etc.
  - E.g., if ParentEncouragement=Yes and IQ>100, College=Yes
  - ➔ **Classification (prediction)**
  - Similar questions:
    - Is this a spam email? (spam filtering)
    - Recognition of hand-written letters (pen recognition)
- ***What is the person's age?***
  - Based on Hobby, MaritalStatus, NumberOfChildren, Income, HouseOwnership, NumberOfCars, …
  - E.g., If MaritalStatus=Yes, Age = 20+4*NumberOfChildren+0.0001*Income+…
  - ➔ **Regression (prediction)**

Agenda

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- ✓ **Recent Trends**
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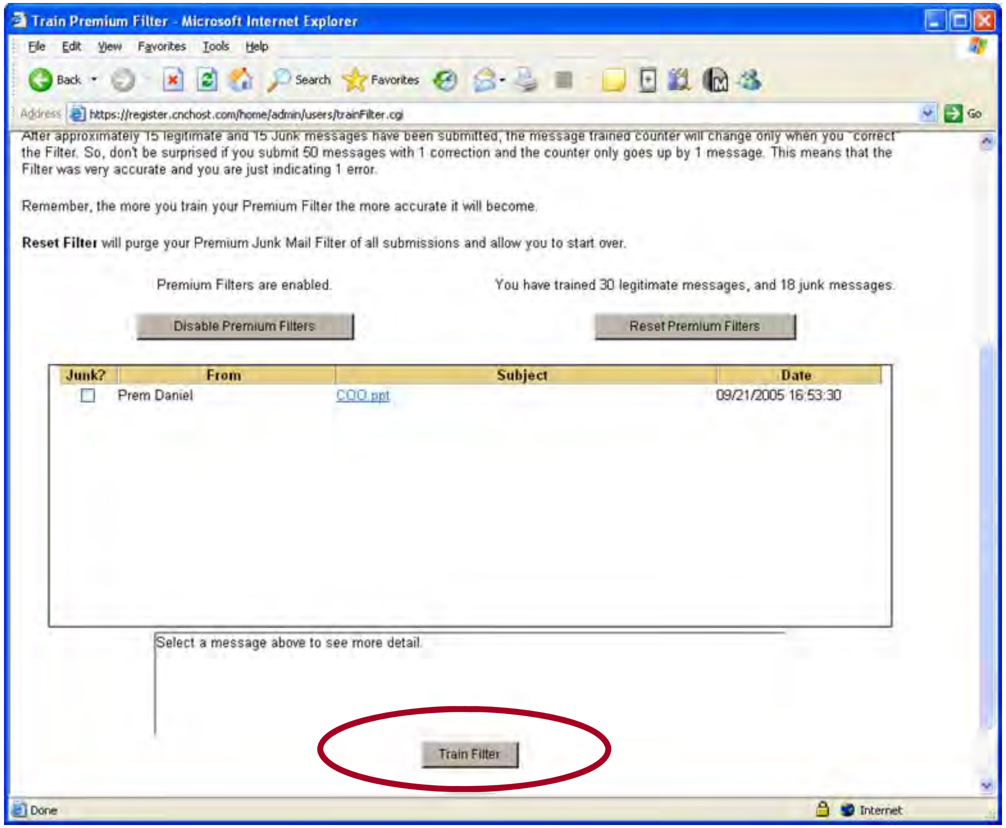
Predictive Analysis Trends – Adoption is on the rise

- Predictive Analysis is becoming more prevalent and integrated in business applications
  - o *Example: Disease management and evidence based care, based on historical diagnosis and procedure codes of patients*
  - o *Example: E-Mail filtering using predictive analysis*

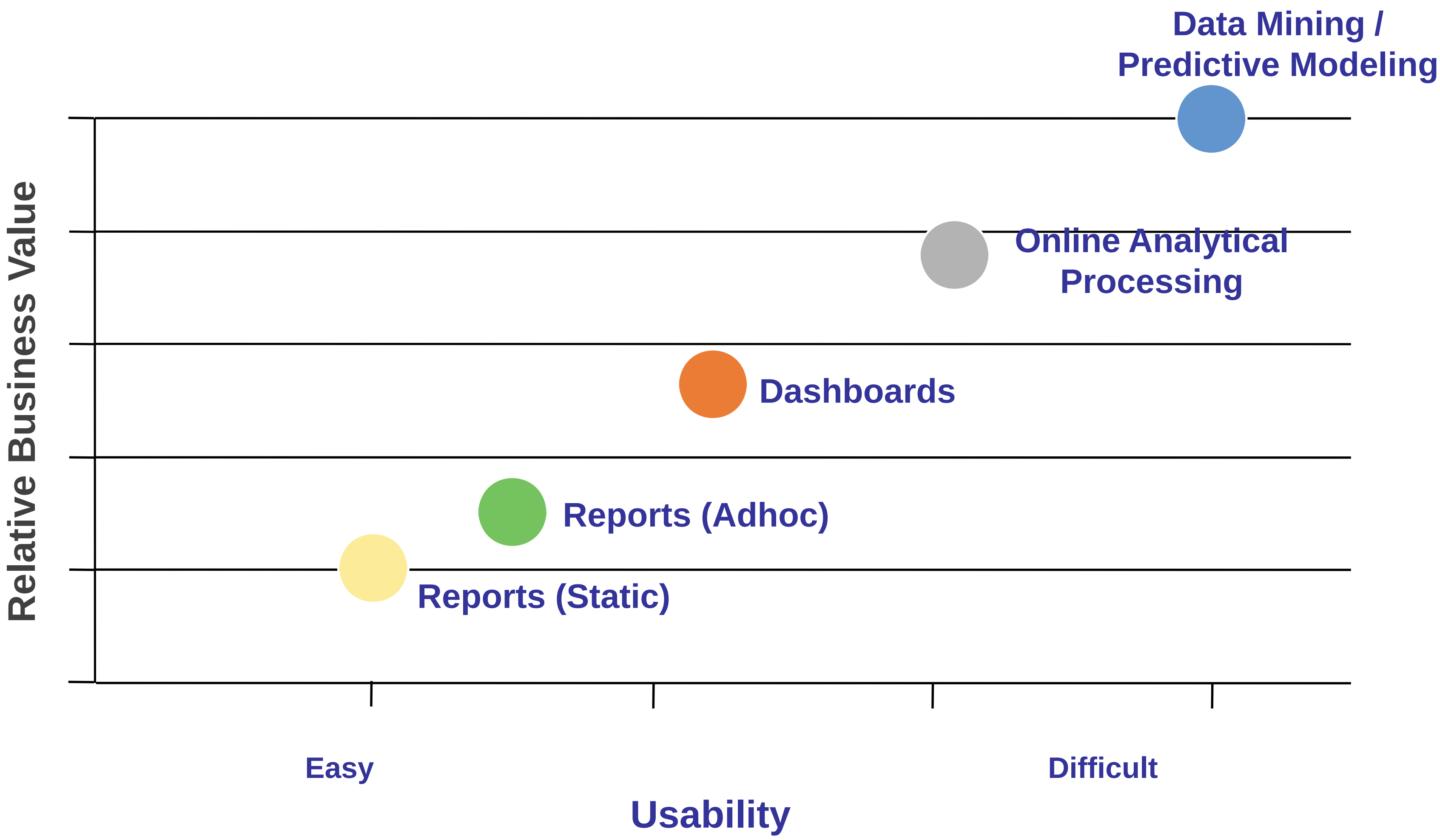
- Predictive Analysis algorithms are being integrated into existing databases, data mining tools
  - o *Example: Microsoft SQL Server 2005 has predictive analysis algorithms*

Example:

Premium predictive analysis based filtering on e-mail, available to any e-mail user



Predictive Analysis Trends – Tools are becoming easier to use



Predictive Analysis Trends – Model development is more structured

Define a Model

Train the Model

Training Data

Test the Model

Test Data

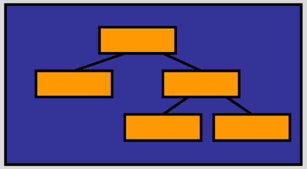
Prediction using the Model

Prediction Input Data

Off-the-shelf or Proprietary Predictive Analysis Engine

Third Party Predictive Analysis tools

Off-the-shelf or proprietary Predictive Analysis Model



- Executive understanding of the creation, training and testing of the model is critical to success
- The Model gets more powerful and accurate as the volume of data fed into the model increases

Predictive Analysis Trends – Algorithms are available for use

	Decision Trees	Naïve Bayesian	Clustering	Sequential Clustering	Time Series	Association rules	Neural Network
Classification	1	2	2	2		2	1
Regression	1	2	2	2			1
Segmentation			1	1			2
Association Analysis	1	1	2	2		1	1
Anomaly Detect.			1	1			2
Sequential Analysis				1			
Time series					1		

1 - First Choice 2 - Second Choice

Data Mining Vendors & Tools

- SAS (Enterprise Miner)
- IBM (DB2 Intelligent Miner)
- Oracle (ODM option to Oracle 10g)
- SPSS (Clementine)
- Insightful (Insightful Miner)
- KXEN (Analytic Framework)
- Prudsys (Discoverer and its family)
- Microsoft (SQL Server 2005)
- Angoss (KnowledgeServer and its family)
- DBMiner (DBMiner)
- Many others

Agenda

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- Recent Trends
- ✓ **Application to Program Performance**
- Pilot Results and Feedback
- Summary

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Mission Assurance Continuum

Program Performance Oversight	Program Analysis Reporting	Predictive Program Health
Industry Minimum	**Industry Best Practice**	**Industry Innovators**
Proactive Program Management Program Portfolio Management	**Reports based on current and passed performance data of portfolio programs, programs, and subcontract reports**	**Predictive Analysis based on Program Performance Modeling**
Approach and Scope		
• Self reported Program Portfolio includes critical and high visibility programs • Standard Program Management Metrics collected on a periodic basis	• Self Reported Program metrics collected periodically and at specific program milestones • Reporting analysis performed as needed	• Self reported program metrics, organizational data, personnel data and customer reported metrics collected at regular intervals • Predictive models developed using historical data (leading indicators rationalized) • Models validated against historical data
Infrastructure and Breadth		
• Program data maintained by individual programs • Summary information provided to enterprise repository	• Program data collected periodically into an enterprise-wide program management repository • Program, Enterprise and Subcontracts performance reports available	• Holistic enterprise wide approach to program execution • Models continually refined using current program performance data • Sophisticated predictive measures provided to programs and enterprise
Data Requirements		
• Very few metrics collected from programs • Key program metrics (cost performance, schedule performance, technical performance, CPI, SPI etc.) • Standardized program taxonomy information like customer, contract type	• 25 – 100 metrics collected from programs • Key program metrics collected at all specified Program Milestones.	• 50 – 75 metrics collected from programs and refined to include only the few relevant metrics • Adaptive approach to qualitative and quantitative performance indicators • Direct and Indirect metrics collected for the programs; qualitative information is mined • Proactive responses based on predictive analysis of ongoing and historical performance

Overarching Objectives for Predictive Modeling

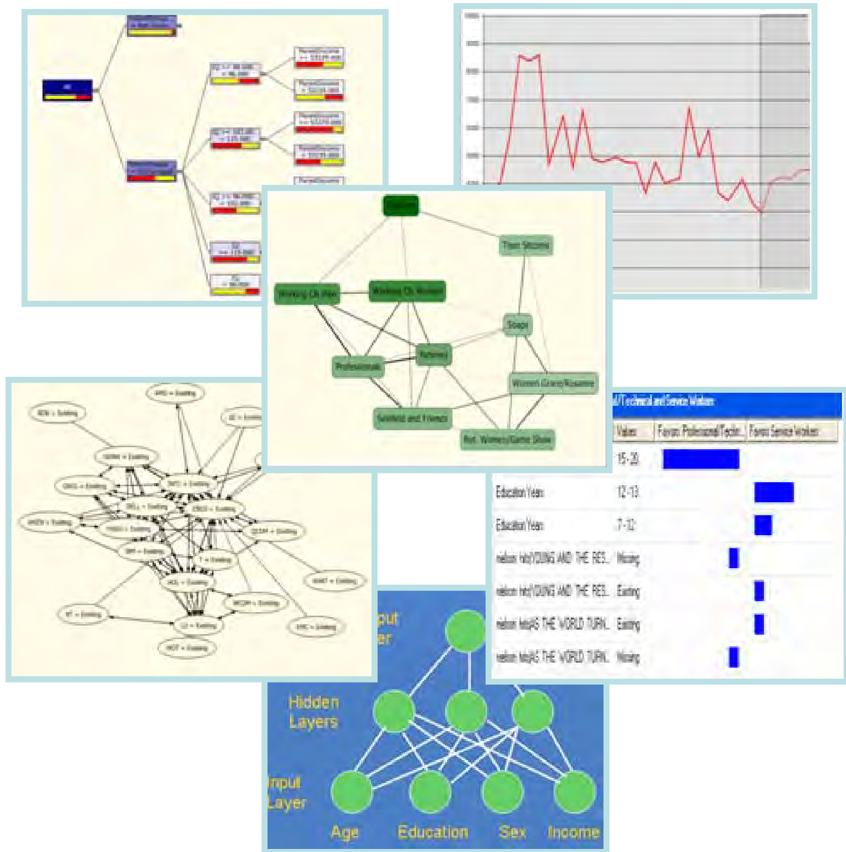
- **Provide program management staff with Predictive Models to "test-their-gut" against enterprise experience data before making strategic program decisions**
- **Develop Predictive Models that provide insight into identifying "headlight metrics" that influence Schedule and Cost realism during program execution**
- **Leverage existing enterprise information to develop Predictive Models for programs**
- **Ensure that models are extensible and automatically calibrated with additional data from the program and enterprise**

13

Potential Areas for Predictive Analysis

Potential Predictive Analysis Models for Program Management and Subcontractor Management

- Schedule Risk at WBS level based on past performance
- Cost Risk at WBS level based on past performance
- Technical Risk at WBS level based on past performance
- Spending and staffing profile for the program life cycle
- Subcontractor risk profile based on past performance
- Sub-tier quality at subcontract and WBS level
- Defect/Aberrations for the program life cycle
- Mission Assurance models based on program category



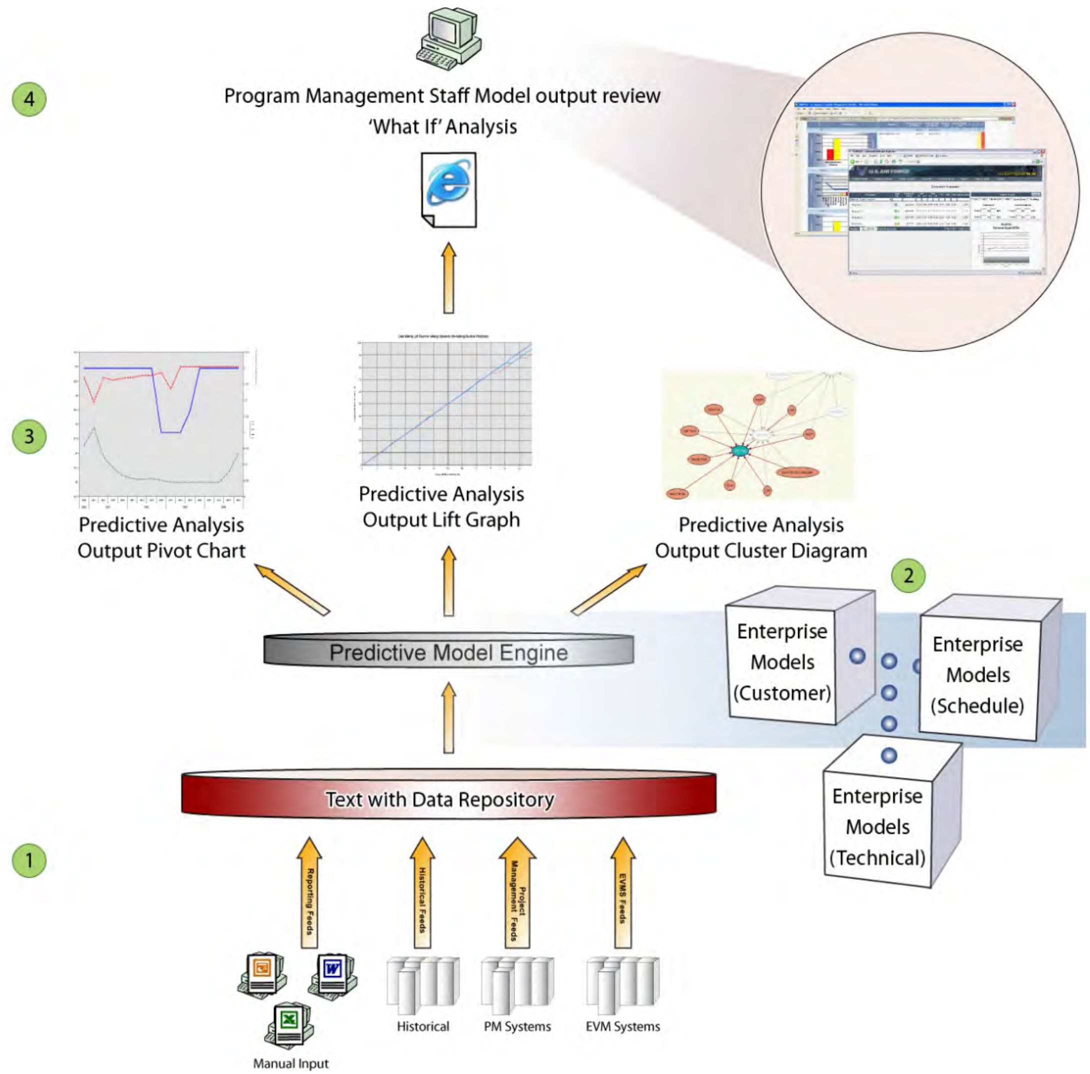
Predictive Analysis Algorithms

- Decision Trees
- Naïve Bayesian
- Clustering
- Sequence Clustering
- Association Rules
- Neural Network
- Time Series
- Custom Model

Predictive Analysis High Level CONOPS

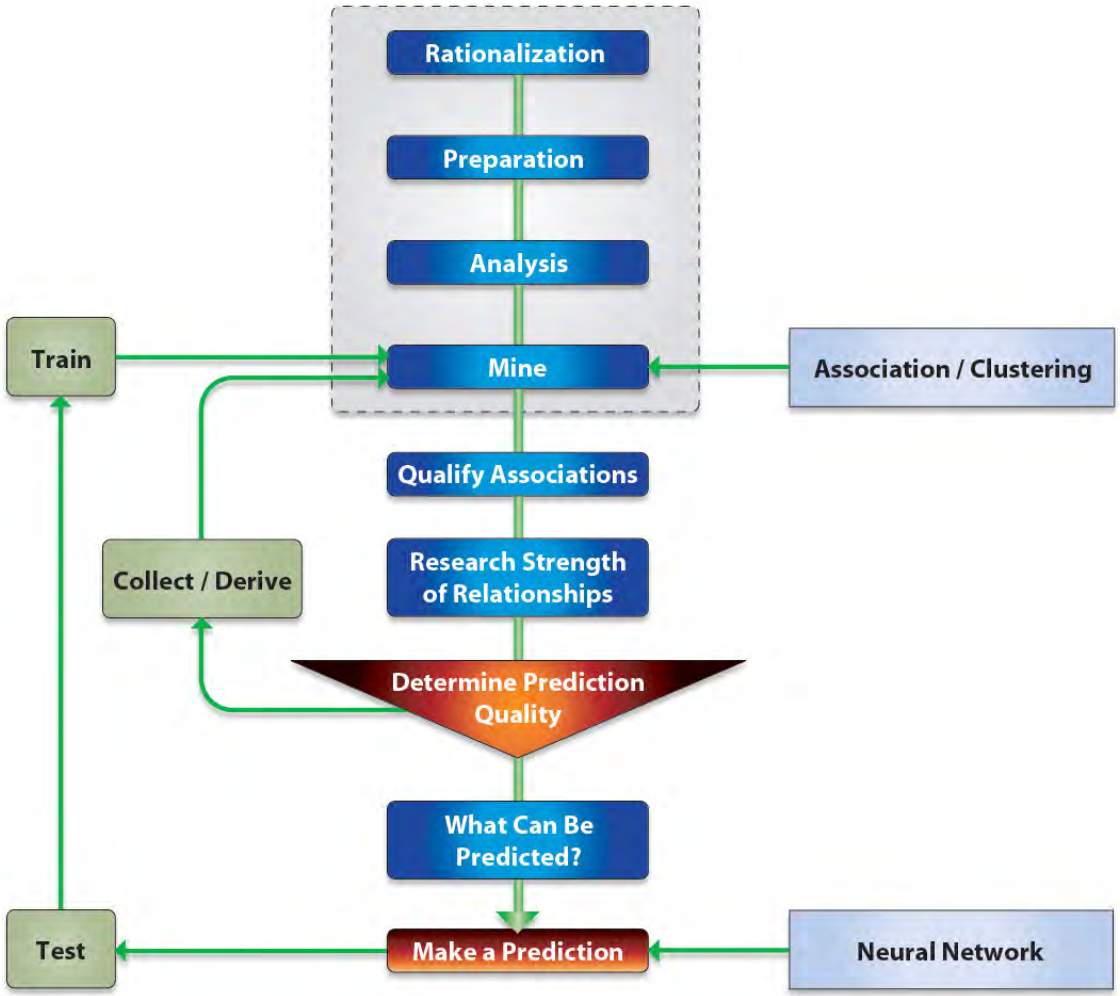
1) Enterprise data is mined and analyzed
2) Enterprise models are defined by Analysts
3) Enterprise model outputs are defined by Analysts and customized by PM staff
4) PM staff use models interactively

Key Benefit:
Leverages enterprise experience data and sophisticated algorithms into predictive models for cost and schedule realism checks during program execution



The Predictive Modeling Process

- Explore the Data
- Understand Data Relationships
- Derive/Enhance the Data
- Use the Data to Predict
- Train the Model



What can be Predicted with Reasonable Accuracy?

Program Lifecycle Stage	Limited Number of Programs	Enterprise Experience
Large volume of historical data	▪ Likelihood or return to acceptable performance ▪ Predictive Program Performance **1**	▪ Quadrant 2 predictions ▪ Quadrant 3 predictions ▪ Early warning "headlight indicators" ▪ Higher accuracy based on enterprise experience **3**
Limited Historical data		▪ Cost, schedule realism ▪ Phase realism ▪ WBS Accuracy **2**
	Low	High

Volume of "Like" Programs

Agenda

- Background
- Industry Trends
- Application to Program Performance
- ✓ Pilot Results and Feedback
- Summary

Predictive Modeling Pilot Objectives

- **Provide program management staff with Predictive Models to "test-their-gut" against enterprise experience data before making strategic program decisions**
- **Develop Predictive Models that provide insight into identifying "headlight metrics" that influence Schedule and Cost realism during program execution**
- **Leverage existing enterprise information to develop Predictive Models for programs**
- **Ensure that models are extensible and automatically calibrated with additional data from the program and enterprise**

Pilot Approach

- Analyze and rationalize the available enterprise data
  - Enterprise Level Office of Cost Estimation and Risk Assessment (OCERA) data
  - Division Level Stoplight Program data
  - Program Level Program Review Authority (PRA) data for relevant programs
- Develop predictive modeling approach to provide schedule and cost measures during program execution phase
- Develop preliminary predictive models using appropriate algorithms and mining existing enterprise data
  - Mining – Clustering, Decision Trees and Naïve Bayesian Algorithms
  - Predictions – Neural Network, Bayesian Algorithms and Clustering
- Get Pilot participation from three representative program types:
  - Large Scale System Integration Low Rate Initial Production program
  - Medium Sized Software program
  - Small IT System (Software and Hardware) program

Key Benefit: Leverages enterprise experience data and sophisticated algorithms into predictive models for use during program execution

Data analyzed for developing preliminary models

Data	Stoplight	OCERA	PRA
Data Period	2.5 years	5 – 6 years	Past 4 months
Frequency	Quarterly/Some older data is monthly	Major milestones or annually	Monthly
Breadth and depth of data	Monthly snapshot of key metrics	Very deep, very broad, with significant contextual information	Very deep, mostly snapshot without significant contextual information
Approximate number of data elements	~ 20	~ 70 key attributes	~40 key attributes

Analyzed enterprise level (OCERA), division level (Stoplight) and program level (PRA) data

Some Actual Data Types Used to Develop Predictive Model Relationships

Program Data

- Contract Type
  - CPAF, FFP, CPFF
- Type of Program
- Period of Performance
- Number of Milestones
- Number of sub-contractors
  - Subcontract value
  - Subcontract performance
- Total Value
- Annual Sales
- Number of incremental deliveries
- Average staff count
- SPI, CPI
- EAC, BAC
- Number of EAC changes
- Number of ECR/ECP
- Defects
  - Injection by phase
  - Occurrence by phase
- Skills Data
- Program Review Data
- Project Initiation Review Data

Program Self Assessment

- Monthly Ratings
  - Schedule
  - Technical
  - Cost
  - Mission Assurance
  - Management
  - Process

External Data

- CPARS
- Customer satisfaction data
- Award Fees

Milestone Data

- Milestones
  - Proposal
  - Contract Startup
  - SRR
  - SDR
  - Software Specification Review
  - PDR
  - CDR
  - Test Readiness Review
  - Completion

Other Data

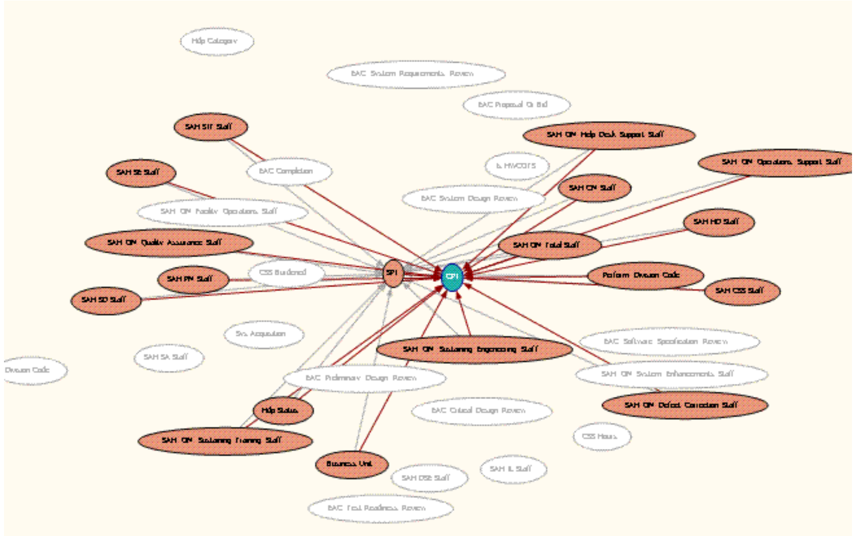
- Action Item Data
- Organization benchmark data
- SLOC, ESLOC
- Productivity
- Language, Component type, complexity,
- Reuse ratios
- Platform, environment

Contains Enterprise, Division and Program Data

Data Mining Results

Column Name	Score	Input
PRA	0.295	x
Tech	0.275	x
CustSatis	0.266	x
ContractType	0.203	x
Customer	0.154	x
Cost	0.121	x
ContractTypeID	0.113	x
MA	0.101	x
MonthAndYear	0.093	x
TypeOfWork	0.084	x
EVM	0.078	x
Organization	0.075	x
EVMReq	0.073	x
Supl	0.068	x
WorkTypeID	0.062	x
UnconPrecon	0.058	x
T2N	0.034	
Proc1	0.030	
CashFlowDSR	0.023	
POPBegins	0.000	

Prediction Measures
- Schedule
- Cost



- **The mining showed that out of the over 125 metrics and measures some are leading indicators and are more important than others in influencing cost and schedule**
- **While it cannot be proved to be conclusive with the limited data that was used, the trends were definite**

Derivation of Data & Data Relationships

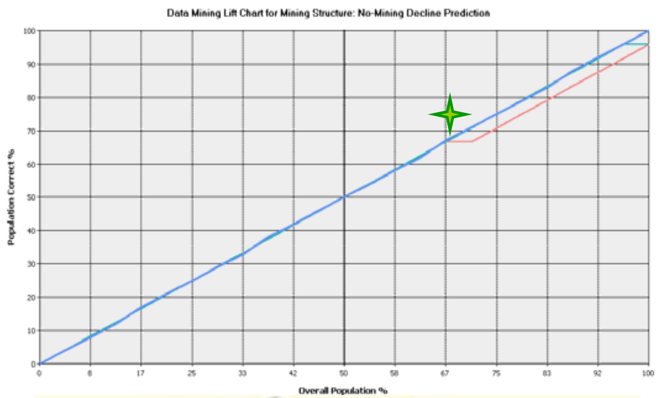
- **Examples of Derived Data**
  - Number of Outstanding Program Issues (with and without recovery dates)
  - Variance in program Cost/Schedule/Technical health from month-to-month
  - Program Cost/Schedule/Technical health trend from month-to-month
  - Variance in VAC from month-to-month taken as a percentage of the current EAC

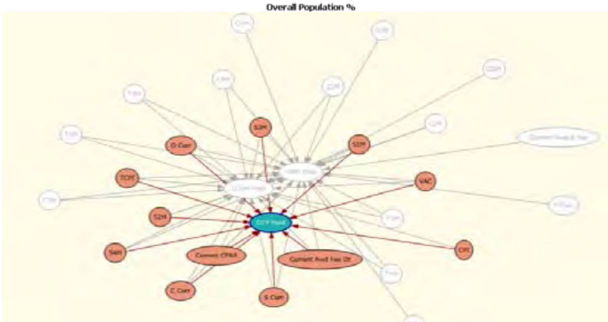
- **Examples of Discovered Relationships**
  - Schedule Health is a good indicator of program Overall Health recovery
  - Cost and Technical Health are good indicators of program Overall Health decline

Better understanding of the data allows for organization and enhancement of the dataset

Model Development & Calibration

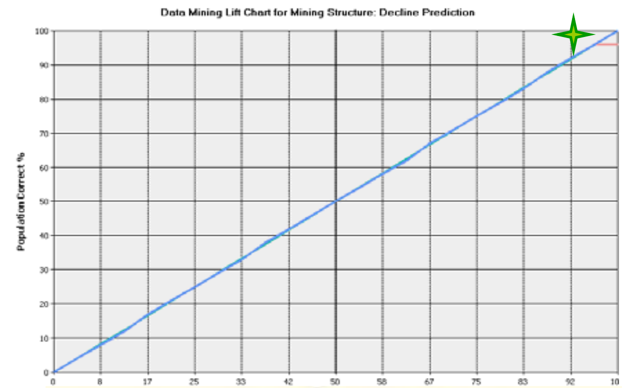
Model





- Modeling without applied domain knowledge or calibration resulted in lower accuracy
- Association models able to determine relevant data attributes

Calibrated Model

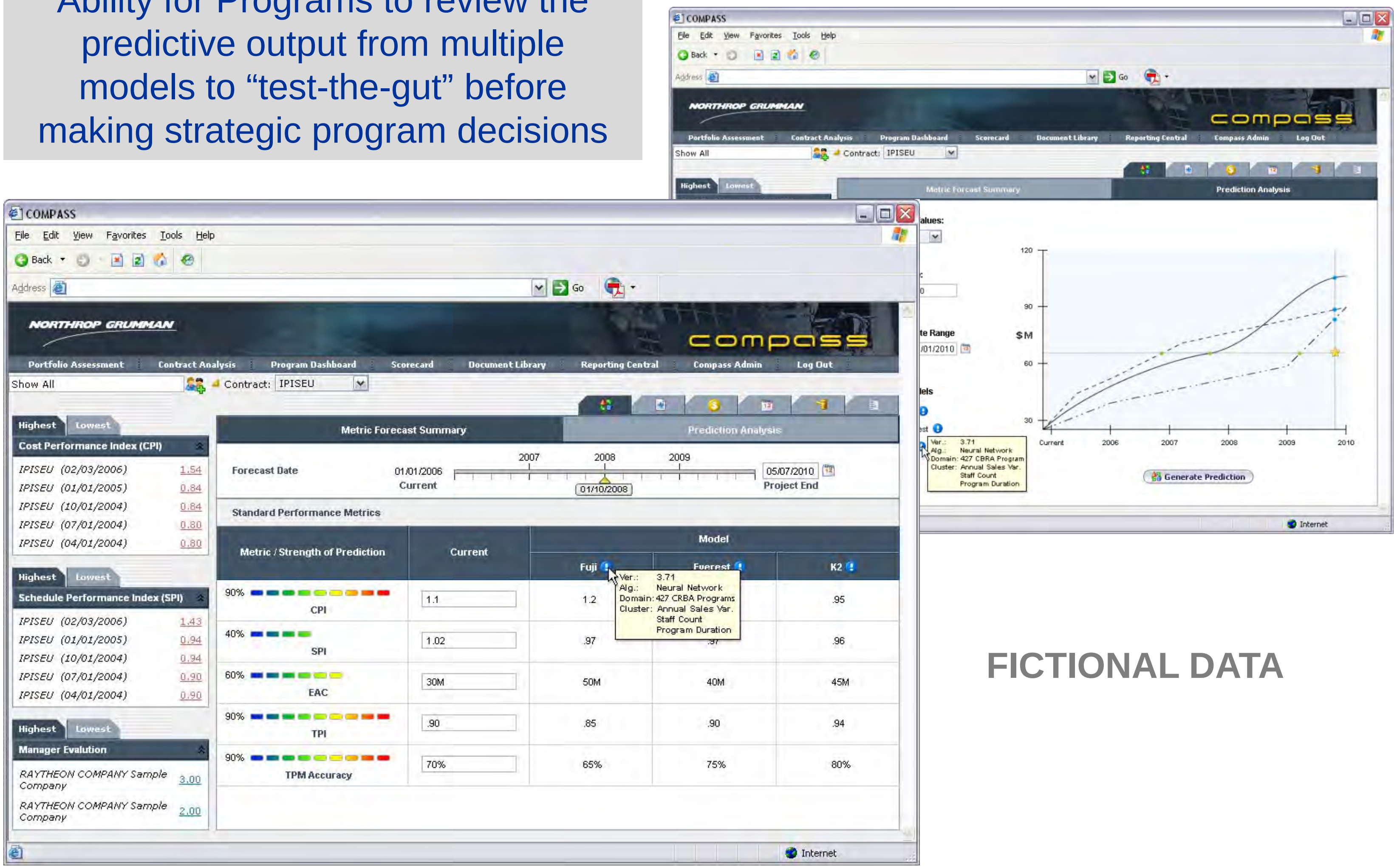


- Incorporating domain knowledge and calibration into data mining resulted in higher accuracy
- Data relationships are more clearly defined

Domain knowledge & calibration applied to data mining can enhance the predictive model

Typical Results from the Models

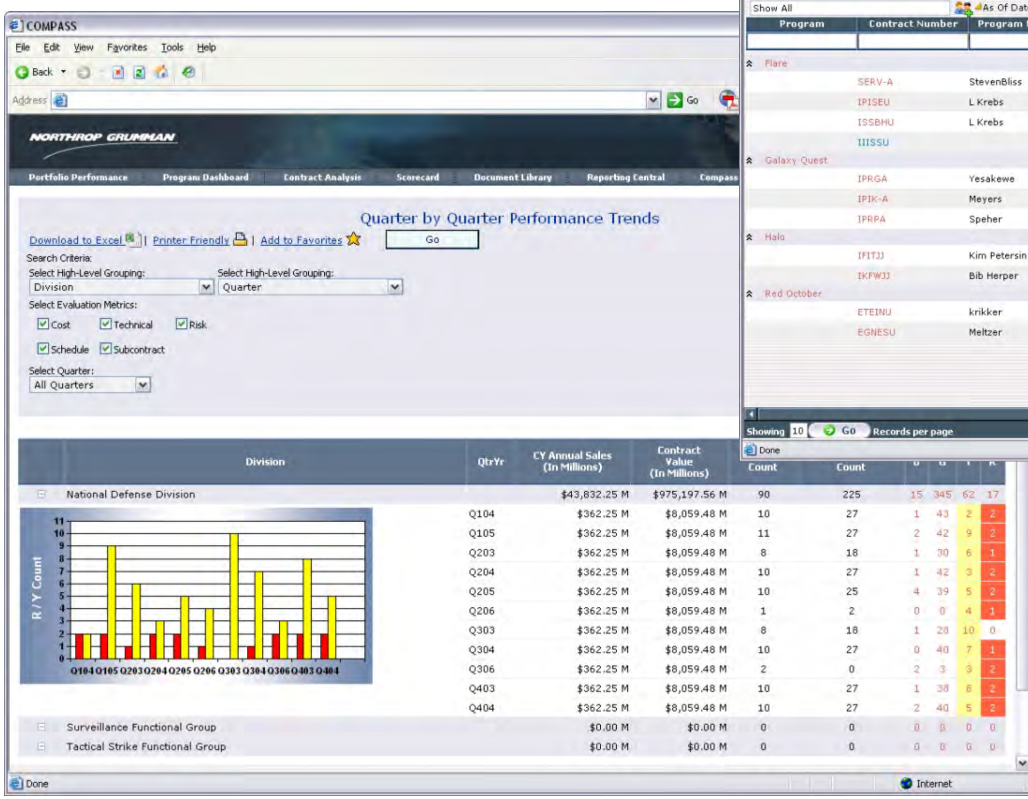
Ability for Programs to review the predictive output from multiple models to “test-the-gut” before making strategic program decisions

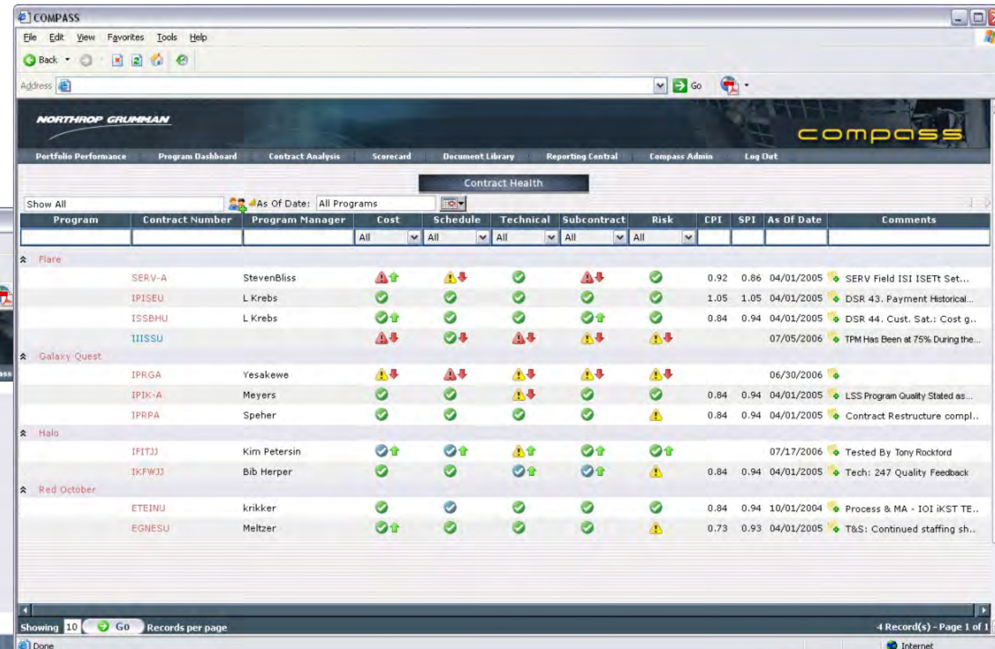


FICTIONAL DATA

Typical Results from the Models

Ability for staff to review status and trends across the portfolio of programs, across a variety of categories





FICTIONAL DATA

Agenda

- What is Predictive Analysis?
- Recent Trends
- Application to Program Performance
- ✓ **Summary**

Summary – Critical success factors

- Executive and Enterprise support and understanding of long-term strategic benefits
- Understanding of the types of data and the correlation between the data
- Understanding of the various constituents in the value chain and the tools/processes for each constituent
- Prototypes or mockups that depict the results of the model
- Sound and robust technical architecture
- Delivery mechanism that shields the complexity of the model from the end users

More Information

- OLE DB for DM specification
  - http://www.microsoft.com/downloads/details.aspx?FamilyID=01005f92-dba1-4fa4-8ba0-af6a19d30217&DisplayLang=en
- Plug-in
  - http://www.msnusers.com/AnalysisServicesDataMining/Documents/Files%2FSQL%20Server%20Data%20Mining%20Plug%2DIn%20Algorithms%20%28Beta%202%20%2B%2B%29.zip
  - A white paper, tutorial, and complete sample code for Pair-wise Linear Regression
- SQL Server 2005:
  - www.microsoft.com/sql/2005
- Community:
  - Microsoft.public.sqlserver.datamining
  - Microsoft.private.sqlserver2005.analysisservices.datamining
  - Groups.msn.com/AnalysisServicesDataMining
- msdn.microsoft.com (search "data mining")
- Decision trees (classification/regression):
  - ftp://ftp.research.microsoft.com/users/surajitc/icde99.pdf
  - http://www.research.microsoft.com/research/pubs/view.aspx?tr_id=81
  - http://research.microsoft.com/~dmax/publications/dmart-final.pdf
- Association rules:
  - Apriori algorithm (see Data Mining concepts and techniques)
- Clustering
  - EM:http://www.research.microsoft.com/scripts/pubs/view.asp?TR_ID=MSR-TR-98-35
  - K-means (see Data Mining concepts and techniques)
- Sequence clustering
  - ftp://ftp.research.microsoft.com/pub/tr/tr-2000-18.pdf
- Time series:
  - http://research.microsoft.com/~dmax/publications/dmart-final.pdf
- Neural network
  - Conjugate gradient method (see Data Mining concepts and techniques)
- Naïve Bayesian
  - See Data Mining concepts and techniques

Contact Information

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Effecting the Transition to Concept Design

Chris Ryder
Johns Hopkins University
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NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

APL
The Johns Hopkins University
APPLIED PHYSICS LABORATORY

The Basic Question?

- What is the Systems Engineering community doing to enhance the development of systems our Warriors need to execute their missions?
- Without:
  - Being late to need
  - Costing too much
  - Failing at the wrong time and the wrong place
  - Being too hard to:
    - Operate
    - Sustain
- Does our Defense Acquisition system maintain a long-term focus on development and acquisition of our warfighting systems?

Observations (by some smart people)

- NDIA Systems Engineering Committee
- Undersecretary of Defense for Acquisition, Technology and Logistics
- Department of the Air Force Directorate for Science and Technology

NDIA Systems Engineering Committee

- **Issue Number ONE:**

Key Systems Engineering practices and procedures known to be effective are not consistently applied across all phases of the program life cycle!

Why?

- "Inconsistent SE practices for program planning and execution"
  - Training and Development of career Systems Engineers
  - Retirement of the "gray beards"
  - Too busy doing the "day job" to take the necessary time to deal with the basics
- Short-term focus
  - Programs working toward the next big event
  - Public law on appropriations and contracting
  - "Will this get me promoted?"
- Bureaucracy
  - Well-intentioned policies hinder vice help
  - Non-technical bureaucrats in key positions

Undersecretary of Defense (AT&L)

- **The Honorable James Finley – Keynote address to the NDIA Systems Engineering Conference (10/23/07)**

Programs usually fail because they are not properly initiated

Why?

- Requirements not well defined
  - Requirements Creep
- Inadequate early technical planning
- Inadequate funding and schedule realism
- Lack of technical maturity
- Insufficient focus on support and sustainment
  - Reliability the most critical current problem
    - The services must pay this bill every year
  - Support and sustainment as critical elements of Total System Effectiveness
- Need for a skilled, clearable workforce

Air Force Office of Science, Technology and Engineering

- **Mr. Terry Jaggers – address to the NDIA SE Conference (10/23/07)**

DoD needs to improve its ability to perform Concept SE!

Why?

- What is Concept SE?
  - Translate needs into a set of requirements describing a concept solution
- How does Concept SE relate to the "traditional life cycle SE definition"?
  - Architecture
  - Engineering Design
  - Test and Evaluation
  - Production and Deployment
- Concept SE leads to better military utility assessments to evaluate concept alternatives

Personal Observations

- Misapplication of DoDAF
  - Fundamental misunderstanding of "The A-Word"
  - Emphasis of Product over Process
  - Architecture views over Architecture model
- Viewing JCIDS as a bureaucratic control mechanism as opposed to an engineering opportunity
  - Emphasis of the artifact over the analysis

DoDAF Contributions to SE

Good Architecture → Effective Design

- A good architecture model IS NECESSARY for good systems design
  - Model traces back to Requirements; traces forward to design
  - Architecture views ARE NOT limited to those prescribed by DoDAF
    - DoDAF presents the C^4ISR Viewpoint, but is this sufficient?
    - What are the other relevant viewpoints?
  - Architecture model is fundamental for Concept SE

JCIDS Contributions to SE

Good SE → Effective JCIDS

- IF the engineering is done right and the analysis is thorough, THEN the JCIDS will be effective
  - JCIDS Functional (Area, Needs, Solutions) Analyses are critical SE activities.
    - Artifacts will reflect the analysis
- This is MATERIAL SOLUTIONS ANALYSIS
  - New DoD 5000 Pre-MS A

Consider the Fundamentals of SE

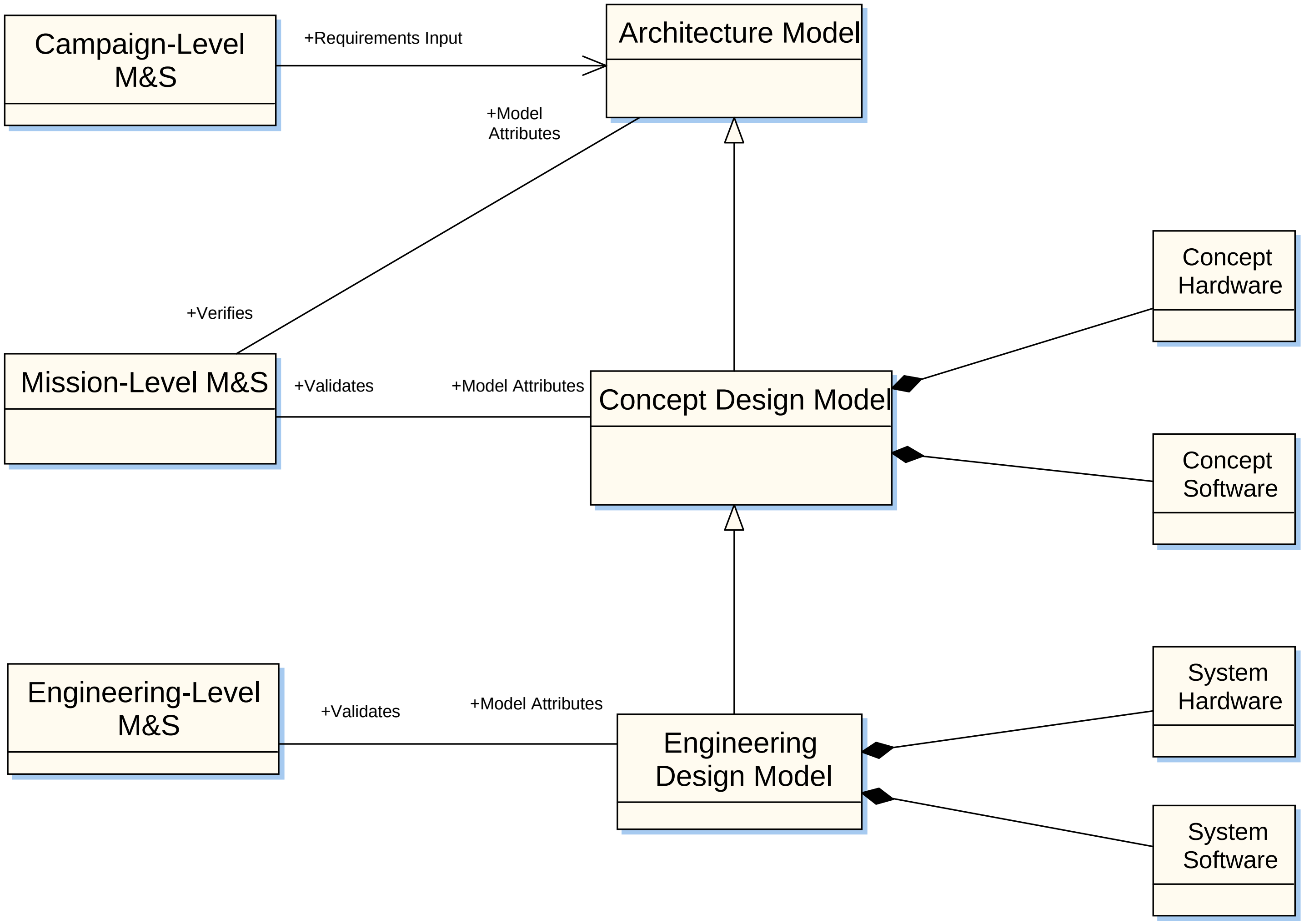
- Applying the "Key Systems Engineering Practices known to be effective"
  - Needs Analysis
  - Concept definition and development
    - Analyses of alternatives
  - Engineering and Development
    - Advanced development, system design and integration
  - Production and Post-deployment Support

Concept SE forms the foundation for system development AND deployment

Model-Based SE

- Modeling is fundamental to Concept SE
  - Captures operational and system requirements
  - Foundation for operational and system architecture
  - Details conceptual and engineering design
  - Facilitates Software development
  - Basis for M&S environment
  - Details information exchanges and data elements
- Text artifacts (i.e. specs) don't go away
  - Included in the model as parameters, constraints

Model Evolution and Relationships



What is a Model?

- A simplified representation of reality
  - Used to mimic the appearance or behavior of a system or part (Kossiakoff & Sweet)
  - Abstracts features of situations relative to the problem being analyzed (Blanchard and Fabriky)
  - Promote understanding of the real system (Underhill)

If you don't model it, you won't understand it!

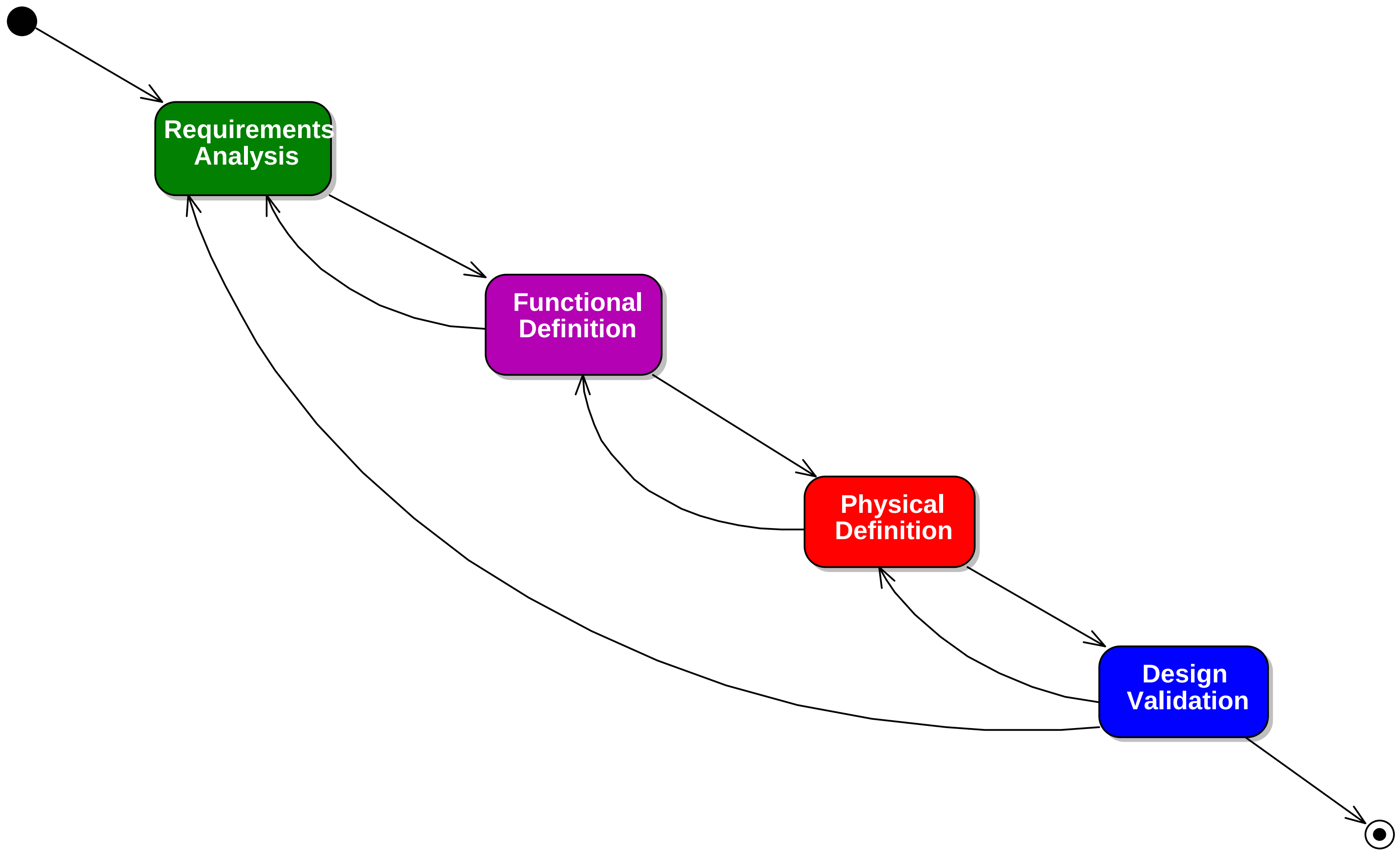
Jacobson

Systems Engineering Method

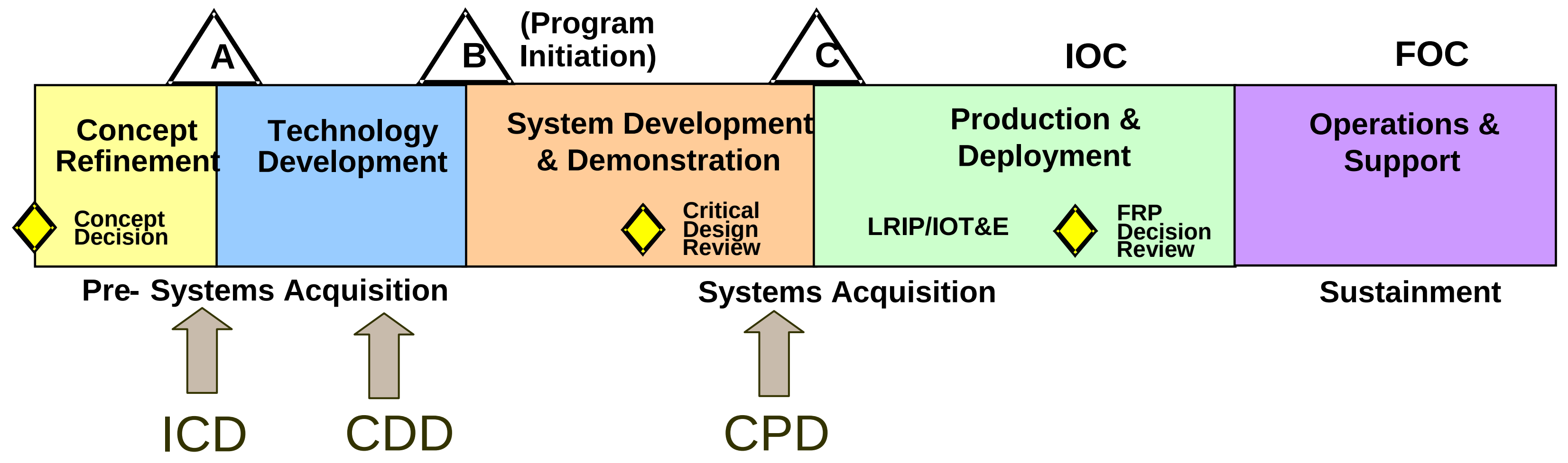
- Every phase of the System life cycle has some form of:
  - Requirements Analysis
  - Functional Definition
  - Physical Definition
  - Design Validation
- A more fundamental form of the SE “VEE”, but a little more iterative
  - Particularly within a given life cycle phase

Source: Kossiakoff & Sweet

SE Method

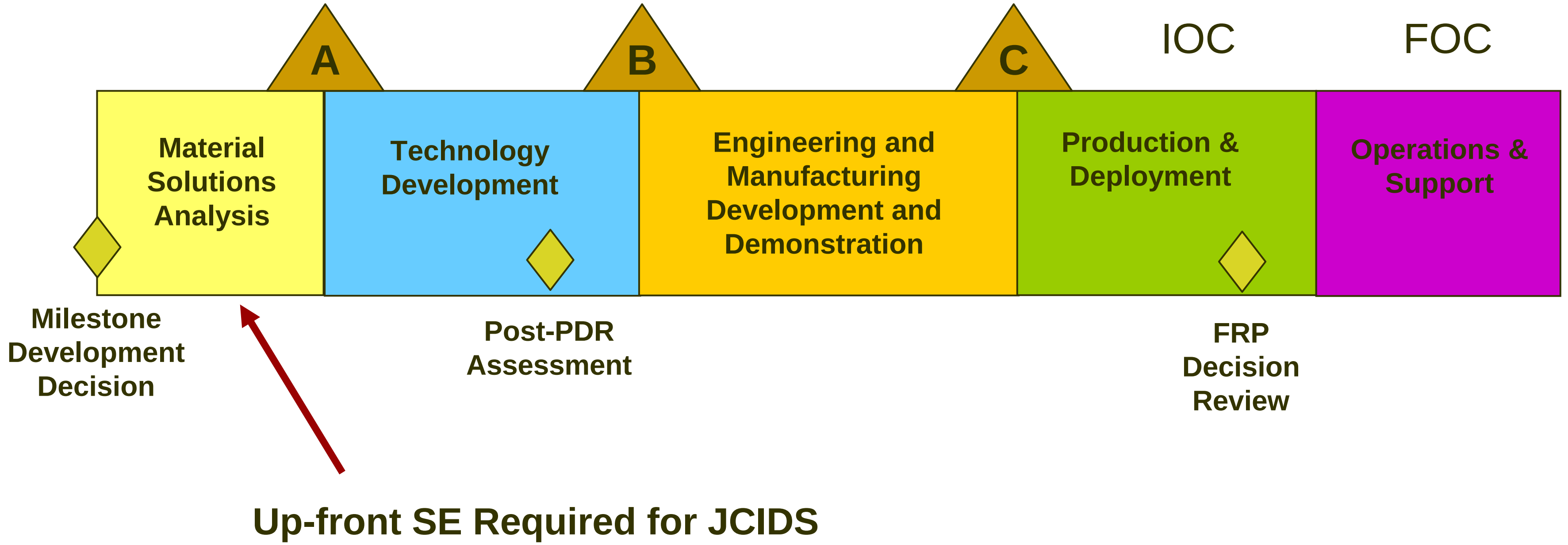

Requirements Analysis
Functional Definition
Physical Definition
Design Validation

DoD Product Life Cycle (Simplified)

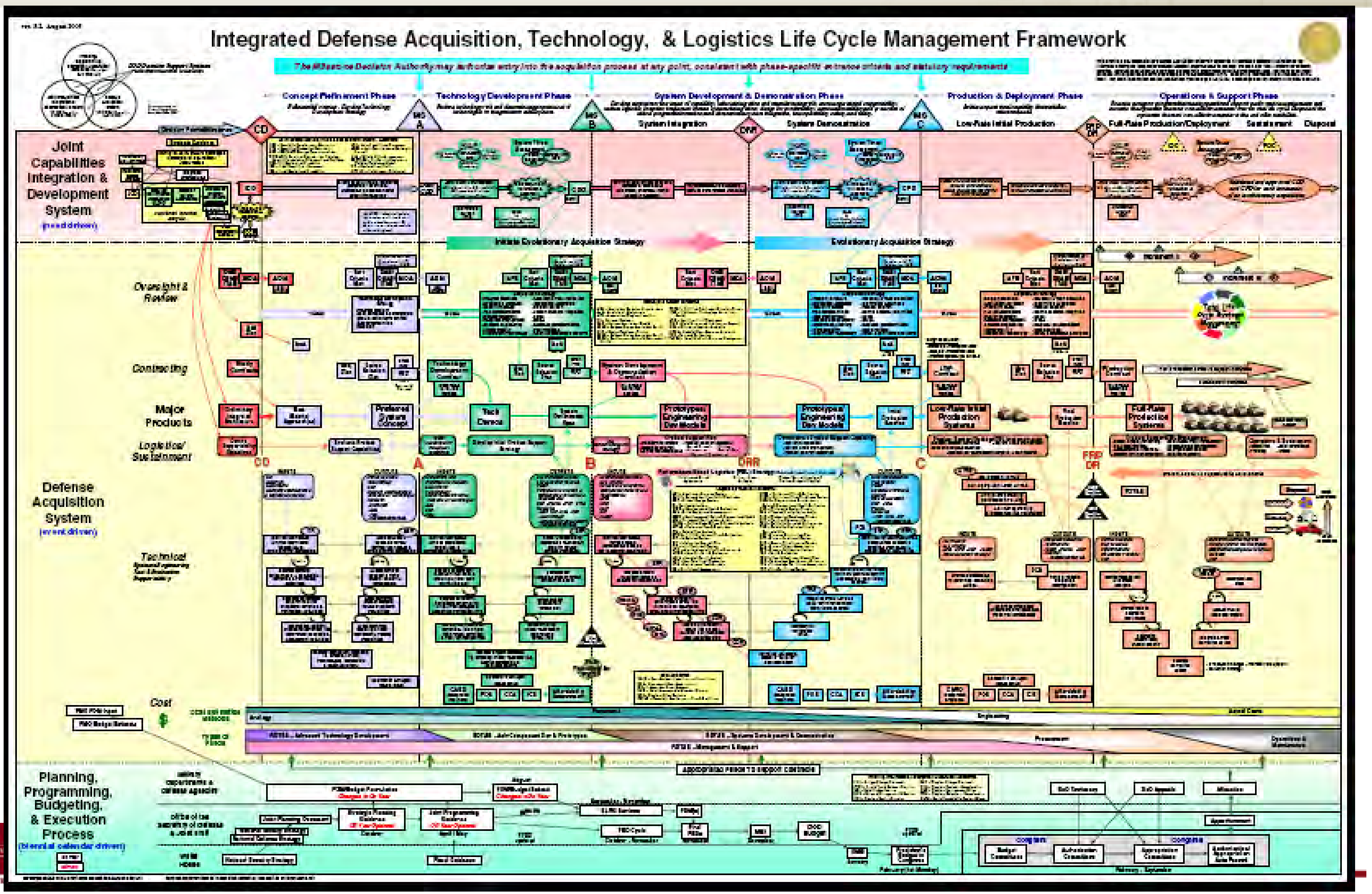


ICD = Initial Capability Document
CDD = Capability Development Document
CPD = Capability Production Document
IOC = Initial Operational Capability
FOC = Full Operational Capability

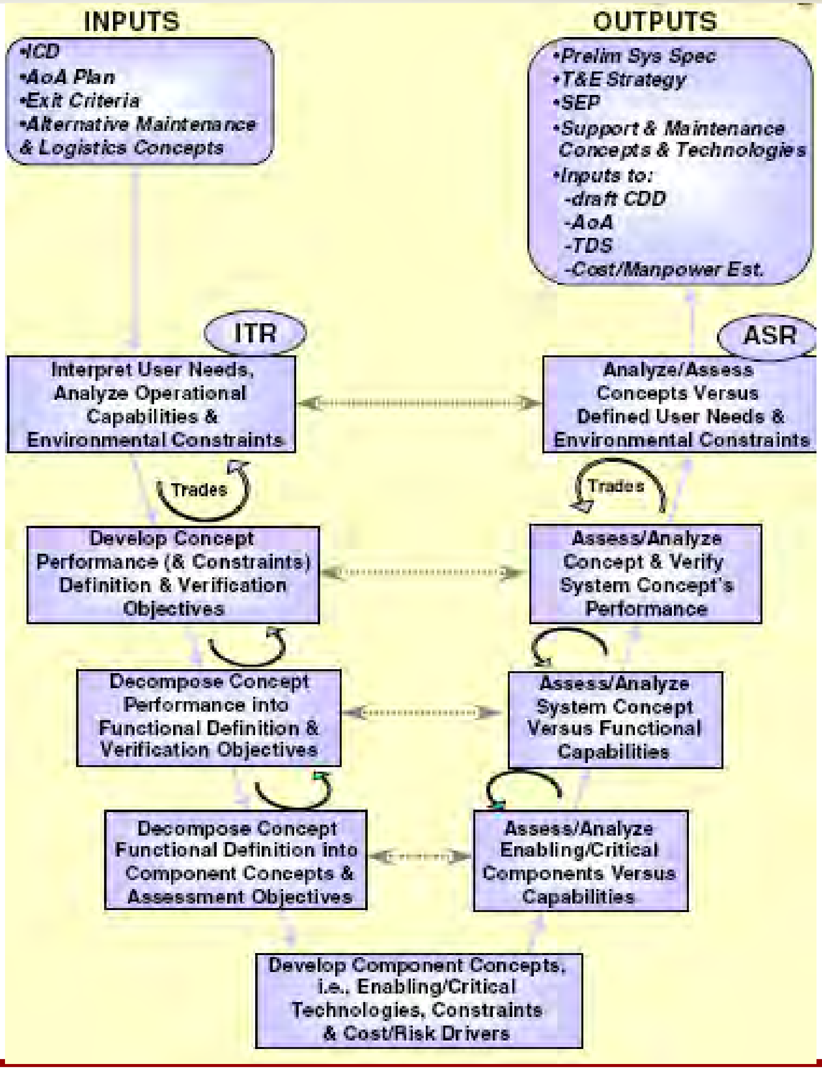
Proposed DoD Life-Cycle



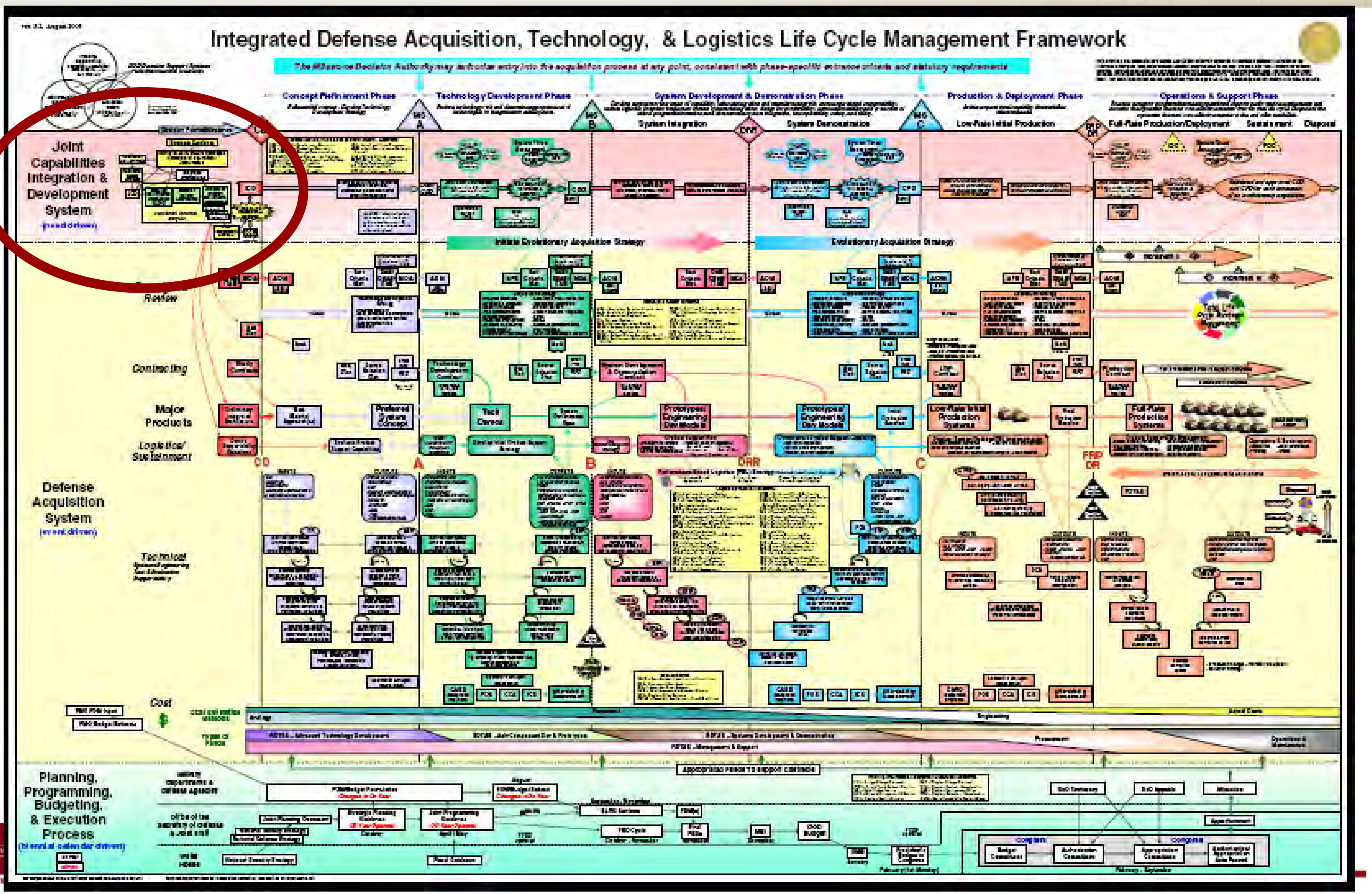
DoD Product Life Cycle (Not Simplified)



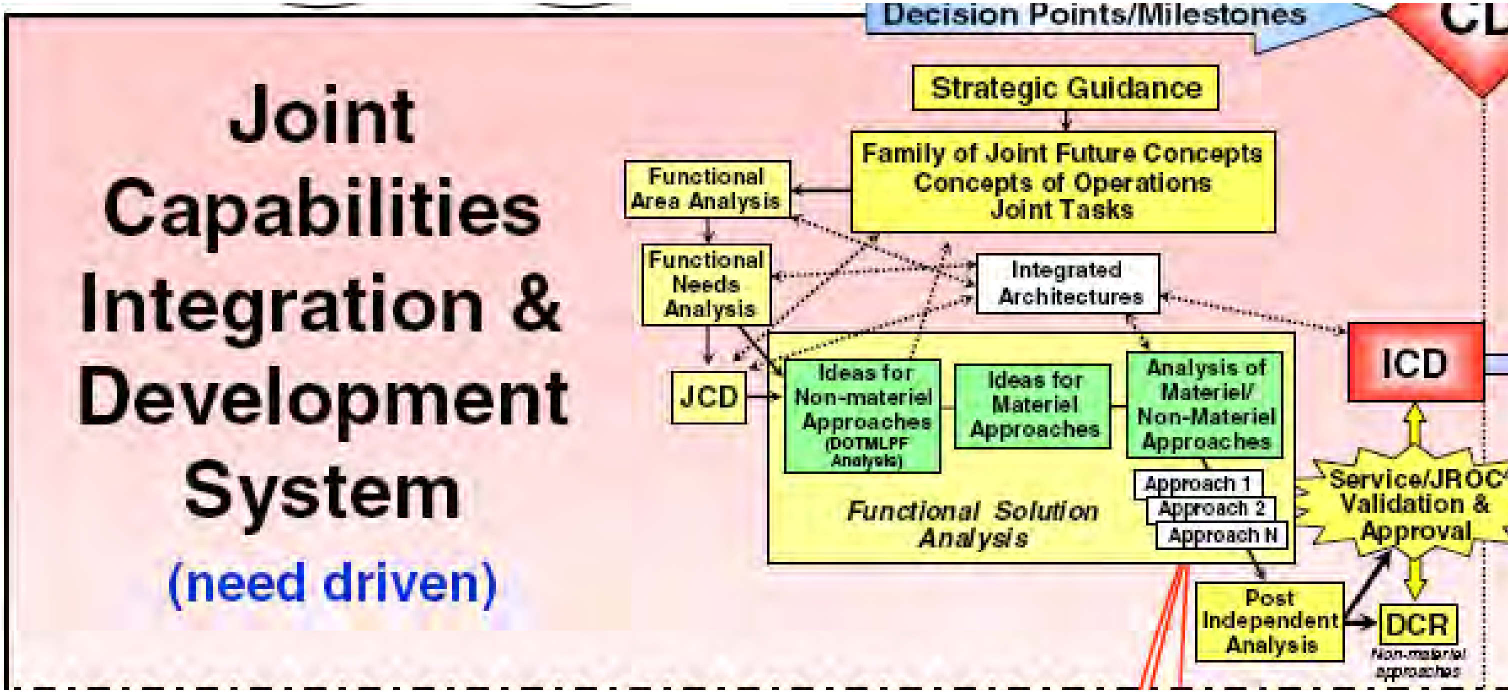
SE VEE (Concept Refinement)



The DoD Product Life Cycle



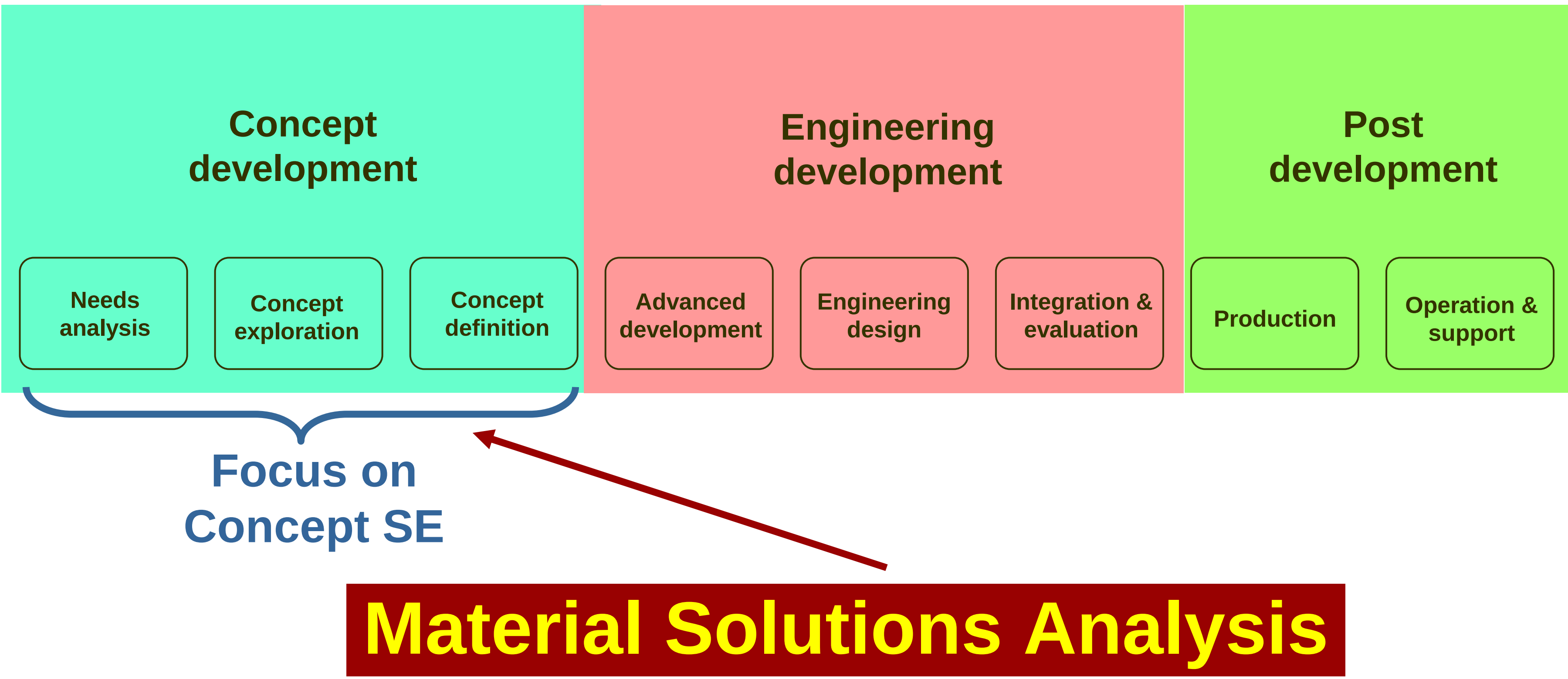
Pre-MS A JCIDS Functional Analyses



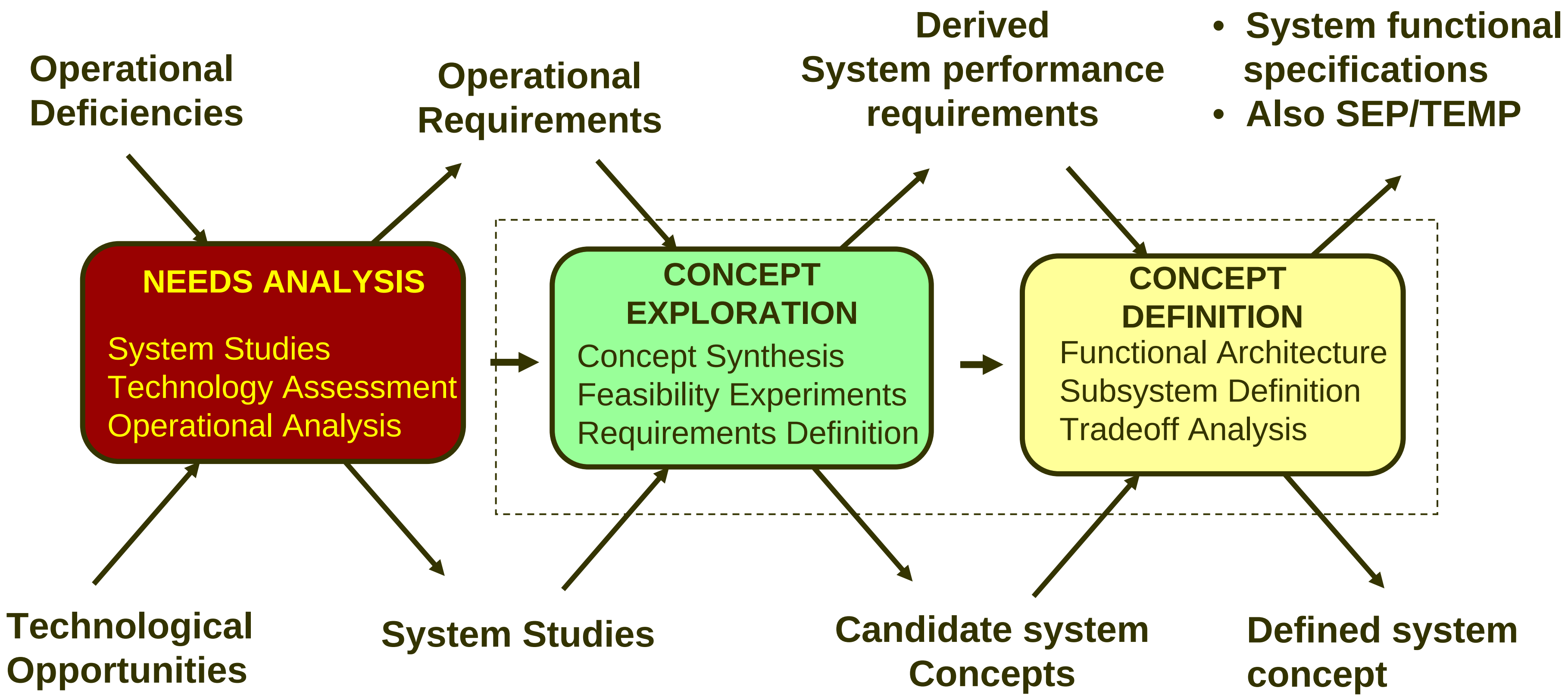
There is no "VEE" during this CRITICAL SE Phase

System Life Cycle Model

(Kossiakoff & Sweet)



Concept Development

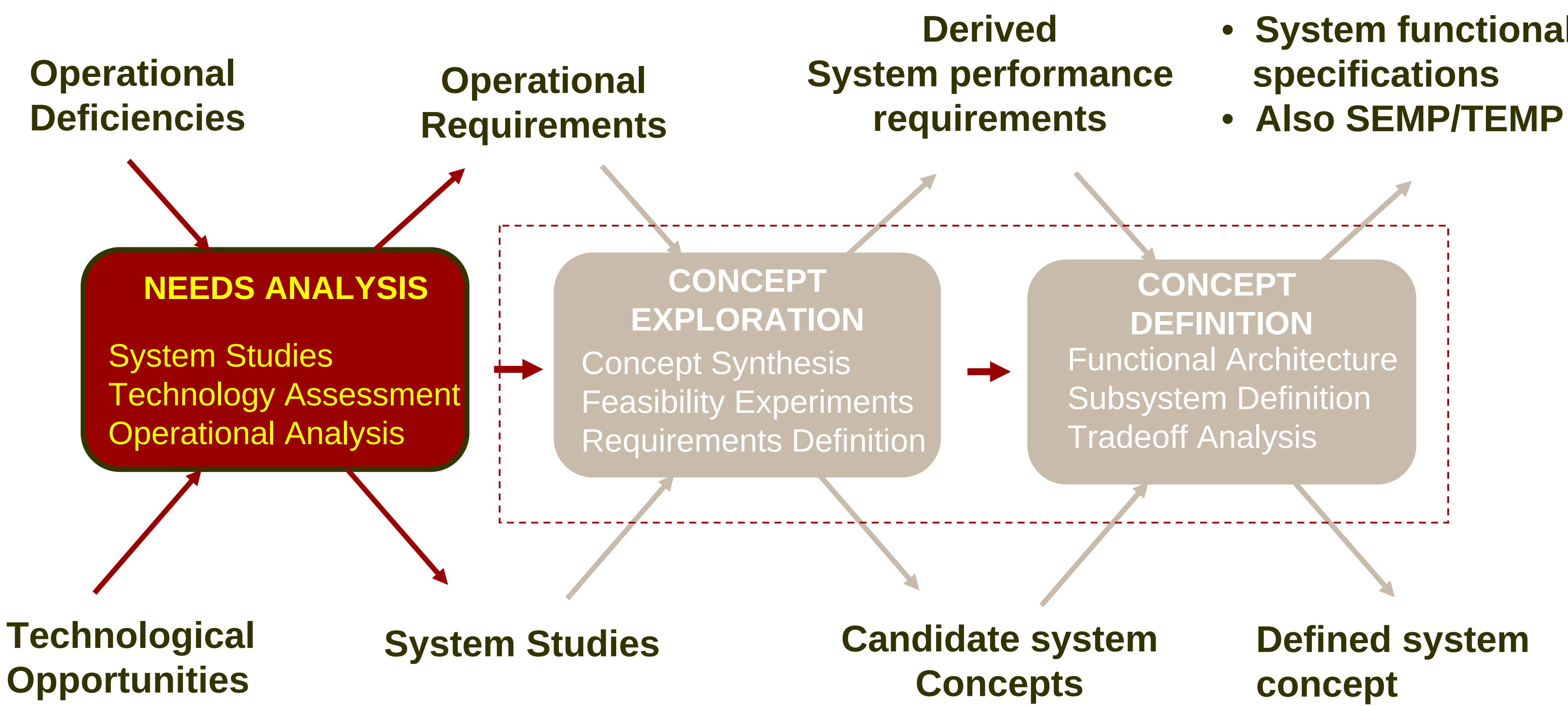


Source: Kossiakoff & Sweet

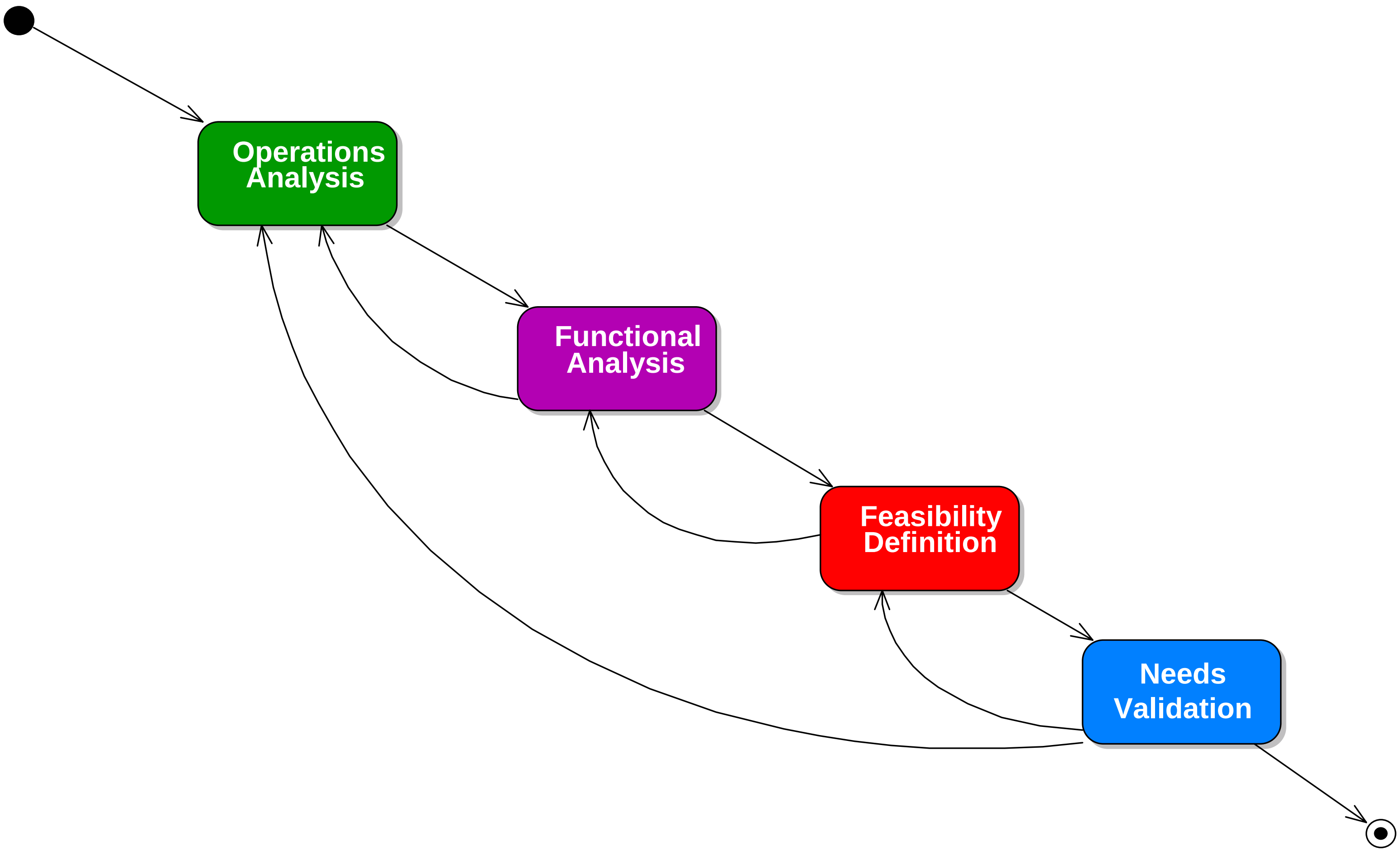
Needs Analysis

(Kossiakoff & Sweet)

Requirements Analysis *Defining the System*



Needs Analysis



Needs Analysis

- Operations Analysis – Clearly state OBJECTIVES
  - Several iterations of analysis before objectives transform to REQUIREMENTS
- Functional Analysis/ Feasibility Definition
  - Objectives → Functions → "Things"
    - "Physical" objects are initially logical abstractions
  - Assessing technological opportunities
    - Including production and support

Architecture Model originates in Needs Analysis

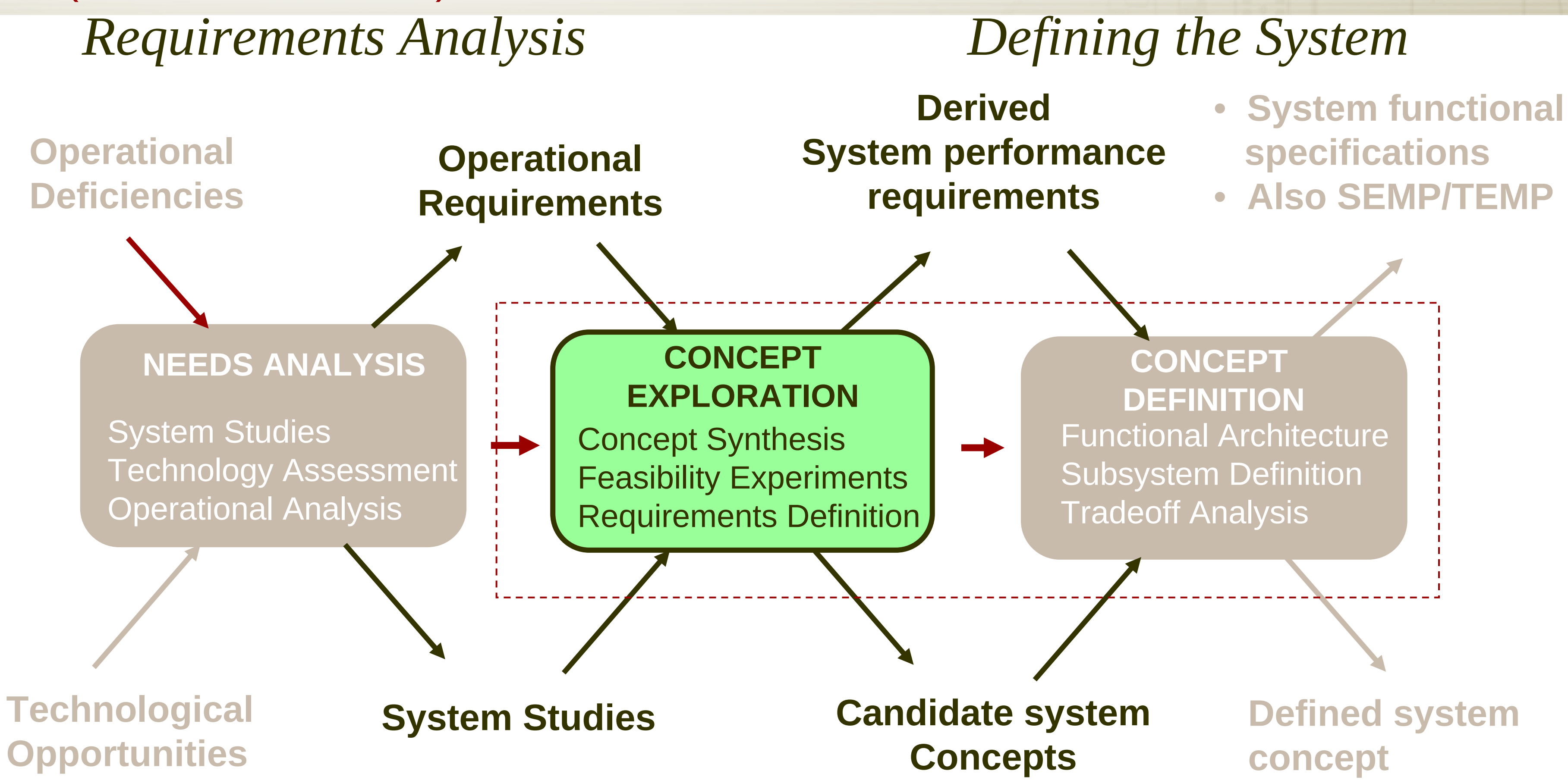
Needs Validation

- Model-based operational effectiveness analysis
  - Quantify the operational environment in both normal and "stressing" conditions
- System performance parameters and constraints critical to the model
- How does the "new" system compare with the legacy system?
  - Is the need based on overcoming a deficiency or leveraging technology
- Outcome – Fully validated Operational Architecture Model

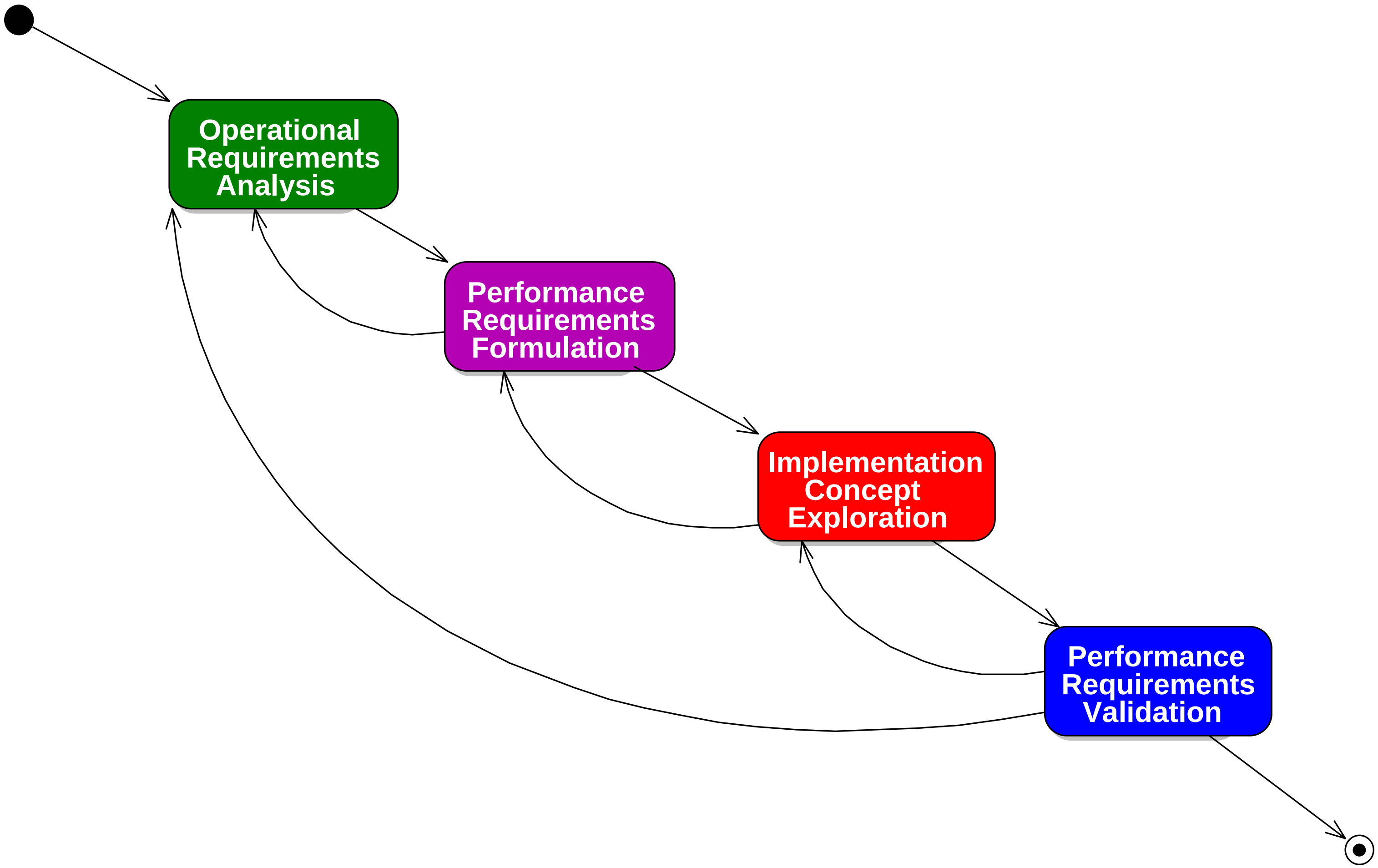
Does the Functional Needs Analysis result from sound Concept SE practices?

Concept Exploration

(Kossiakoff & Sweet)



Concept Exploration



Transform Operational to System Focus

- **What does the SYSTEM have to do**
- **Convert the Operationally oriented view of the system to an Engineering oriented view**
  - **Baseline for subsequent phases of development**
- **Significant "exploratory research and development"** **(Kossiakoff & Sweet)**
  - **This must be completed BEFORE system performance requirements are quantified**

Discover and analyze critical issues and gain insight into the design task

(Kroll et al)

Operations Requirements Analysis

- Ensure operational objectives are clear and the requirements meet the engineering standards of "goodness"
- Understanding compatibility with related Systems of Systems and/or Families of Systems
  - Data and information exchanges
- CONOPS is essential for this phase
  - If the new system is technology driven, how does the new technology factor into the CONOPS?

Performance Requirements Formulation

- Achieving operational functionality with system functions
  - Measurable Results of Value (RoV)
- Conceptual allocation of system functions to abstract "Functional Building Blocks"
- Setting bounds of system performance requirements
  - Design team must set the "limits of behavior" (Rechtin)
  - If the RoV exceeds the acceptable constraints, a "design trap" can result

Physical Implementation Exploration

- "Involves the examination of different technological approaches, generally offering a more diverse source of alternatives." (Kossiakoff & Sweet)
- Evaluating concept alternatives
  - Setting parametric boundaries and constraints
- Iterating with functional stage
  - "Bad or incorrect functional analysis adversely affects physical implementation" (Kroll et al)
  - Complexity of physical elements driven by functionality
  - Physical interfaces correspond to functional interfaces

The Architecture Model begins transformation to the Concept Design

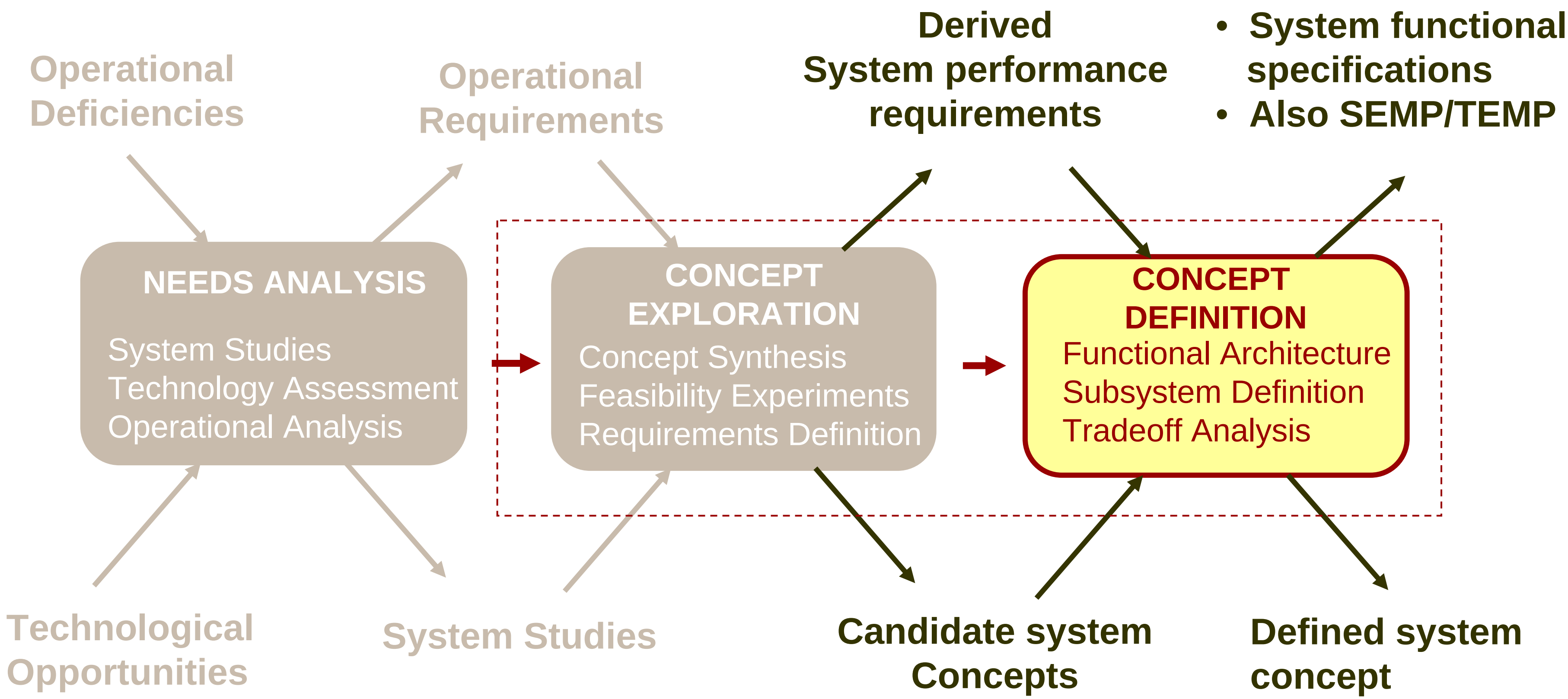
Performance Requirements Validation

- Performance Requirements Validation process is a "closed loop" process that results in "system performance characteristics"
  - Define WHAT the system must do
  - Define characteristics in engineering terms that is verified by analytical means or experimental tests
  - Completely and accurately reflects the system operational requirements and constraints including external interfaces and interactions

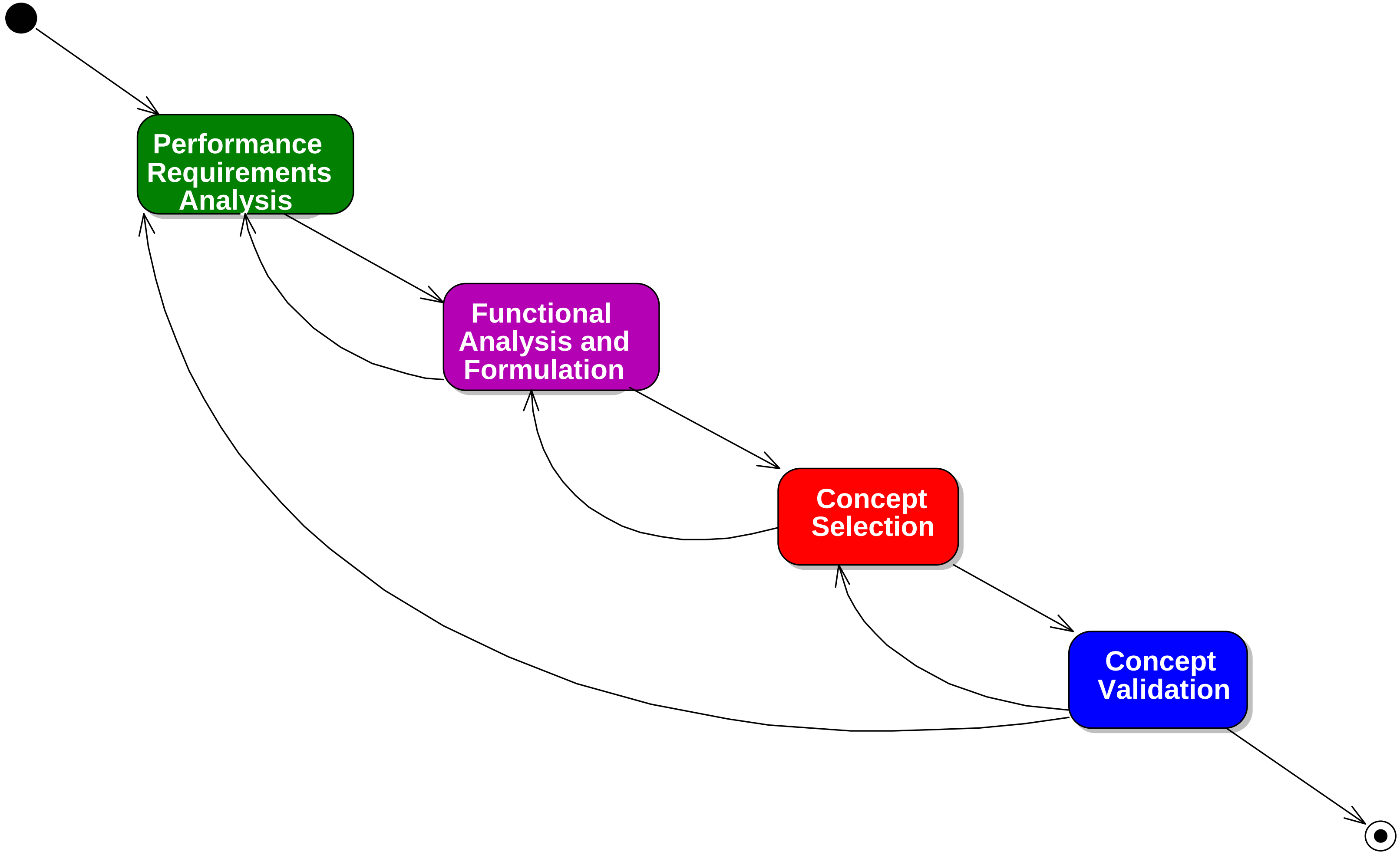
Concept Definition Stage

(Kossiakoff & Sweet)

Requirements Analysis *Defining the System*



Concept Definition



Conceptual Design

- Concept transforms into a preferred solution
  - Concept still involves sufficient alternatives, but among the choices, a final decision is made
- The design results from a fully validated conceptual design model with some preliminary drawings
- Consistent with system performance, cost and schedule goals
  - With acceptable risk
- Fully considers support and sustainment – Total System Effectiveness

Cautions during Concept Development

- Extreme Requirements
  - Meeting the requirements exceed the state of the technology
  - Meeting these extremes significantly add to cost and schedule
- Scope Creep
  - Taking on too many operational tasks
    - Adding scope during development
    - Tightly coupled with Extreme Requirements
- Production
  - The production line is usually just as complex as the system it builds
    - Software and test laboratories
- Not paying attention to Supportability and Sustainment

Transition to TD and SDD

- Industry should be a part of an integrated process during Concept SE
  - Each competitor will base own concept model on from a single architecture
  - Government SE IPT verify that developer's concept traces to the architecture
- During TD & SDD, the Developer's engineering design should evolve from the concept design
  - If it doesn't, traceability to requirements will be difficult to prove

Transition to TD & SDD is a major step, but a good architectural and conceptual models will enhance this transition

Conclusion

- "Best practices" for Concept SE involves a model-based design approach that begins at Needs Analysis/ Requirements Definition and results in the conceptual design model
- Architecture is the basis for design
  - Architecture is more than just DoDAF views
- JCIDS is a critical ENGINEERING task where sponsors, requirements officers and project engineers work together to instantiate the model
  - The artifacts are natural outputs of Good Systems Engineering

References

- Ambler, Scott W.; *Process Patterns*; Cambridge, UK; Cambridge University Press; 1998
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- Kroll, Ehud; Condoor, Sradhar and Jansson, David; *Innovative Conceptual Design*; Cambridge, UK; Cambridge University Press; 2001
- Richtin, Eberhardt; *Systems Architecting*, Englewood Cliffs, NJ; Prentice Hall; 1991
- Underhill, David; Lecture on Modeling and Simulation presented to Johns Hopkins University Introduction to Systems Engineering; 3 March 2008

Biography

- **Chris Ryder is a member of the Johns Hopkins University Applied Physics Laboratory's Principal Professional Staff. He is a supervisory systems engineer in the Aviation Systems Analysis Group where he works primarily on strike weapons systems. Chris is also an Adjunct Lecturer in the JHU Whiting School of Engineering Systems Engineering and Technical Management department. He has a BS degree from Miami University, an MBA from Old Dominion University and an MS from George Mason University.**

Backup

Constructing the Model

- Four basic steps
  - Translating requirements into ideas into understanding
  - Embedding the ideas into the model to reflect the requirements
  - Continuous iteration until the model is sufficient for advancement
  - Verifying and validating the model for further action
- Continue the basic steps in each stage of the system's life cycle

Ref: Rechtin and Jacobs

MBSE – Initiating the Model

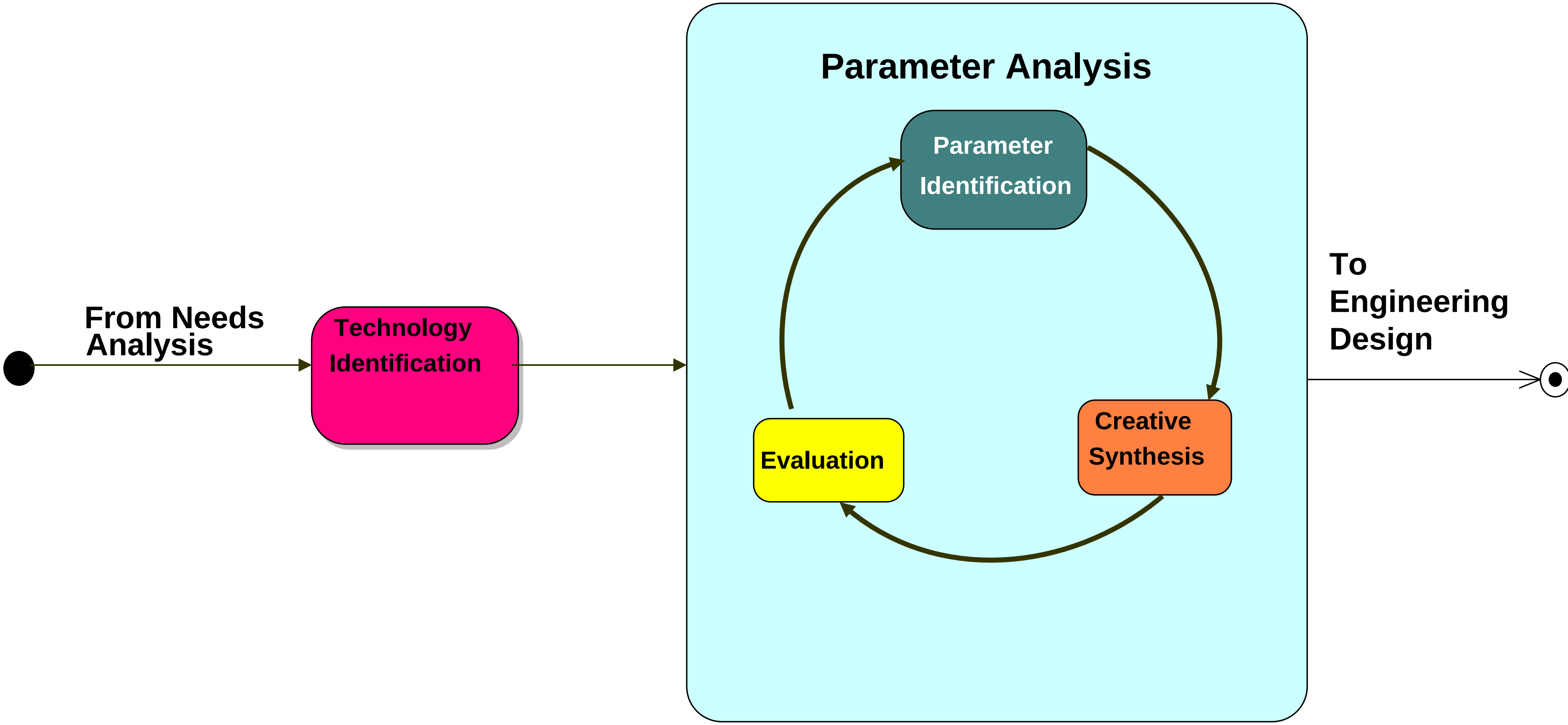
- MBSE assumes the existence of a well-structured set of requirements
  - The designer does not have to know the specific “end”
    - Only a prioritized understanding of variables that can produce a “Result of Value”
  - Modeling can assist the designer discover requirements that are missed, misunderstood or overlooked
- The initial model is “rough” and often abstract
  - But the model facilitates a logical analysis of what will become a complex system
  - Facilitates stakeholder discussions on future trade-offs

Source: Rechtin

Advantages of MBSE

- Model documents the evolution of the system from requirements definition through architecture development and into conceptual design
- Available modeling tools match detailed graphics with powerful data-bases
- Evolution of SysML as a standardized family of graphical presentations that contain necessary data including:
  - Requirements, parametrics and constraints
- Evolution of AP-233 standard for data portability across models and data bases
- Models LIVE!
  - Today's "As Is" is the baseline for tomorrow's "To-Be"

Another View of Concept Design



Source: Kroll et al

Parameter Analysis

- Parameter Identification
  - Examine all information about the design task, the alternative configurations that lead to "best and final"
  - Parameters influence the outcome and the optimal outcome may differ from "current solution paradigms"
- Creative Synthesis
  - Craft a resulting concept that "solves, satisfies and embodies conceptual parameters."
- Evaluation
  - Quantifying strengths and identifying weaknesses
  - Does this system meet the requirements
  - Is this the right configuration?

Source: Kroll et al

SE for Concept Development

- Methodical analysis from identification of the initial operational objectives to a validated concept design
- System elements trace to operational elements
- Technology is feasible for advanced development and engineering design
- JCIDS Functional Analyses is accomplished within the scope of Concept SE
- SE Model originated in Needs Analysis matures into Concept model that traces back to the architecture and requirements models and forward to the design model

Aren’t We Doing This Already?

- Yes, but
  - Is Concept SE an integrated ENGINEERING activity that includes requirements analysis, architecture formation and conceptual design?
  - Are the artifacts we develop during concept development used throughout the process?
    - And are they a suitable baseline for Engineering Design
  - Is the Concept SE team employing MBSE?
    - If not, there is likely a fundamental misunderstanding of the problem which correlates to an incorrect solution

Aligned with your needs.

Integrated T&E Process and Tools in a Joint Services Acquisition Program

NDIA 11th Annual Systems Engineering Conference
San Diego, CA
October 22, 2008

Steve Randolph, PMP, CSEP-Acq
Alion Science and Technology

ALION SCIENCE AND TECHNOLOGY

Integrated T&E in a Joint Program

- Integrated Test & Evaluation (T&E) provides an integral part of the Systems Engineering Process, identifying levels of performance, assisting developers in identifying and correcting deficiencies, and validating to the system owner that performance requirements are met in a cost efficient manner. Historically, developmental T&E activities conducted by the Program Office have been fire-walled from the operational T&E activities and organizations.
- Joint Naval Platform acquisition programs have the additional constraints of supporting the needs and requirements of potentially three varied customer groups, such as the U.S. Army, The U.S. Marines, and the U.S. Navy. As the lead Program Office, NAVSEA has led the development of processes and tools that meet the various programmatic needs and potentially provide a cost savings by the use of an Integrated T&E environment.
- This presentation will discuss some of the lessons learned and an oversight into the methodology and tools used in a program that is a model for future joint programs to provide a cost-effective interface between the Requirements Engineering, and the Developmental T&E and Operation T&E communities.

Joint Acquisition for Naval Platforms

- While many know of the U.S. Navy combatant and non-combatant fleet and of the Coast Guard fleet, most do not know the U.S. Army maintains it's own fleet of littoral non-combatant vessels.

Joint High Speed Vessel Prototypes

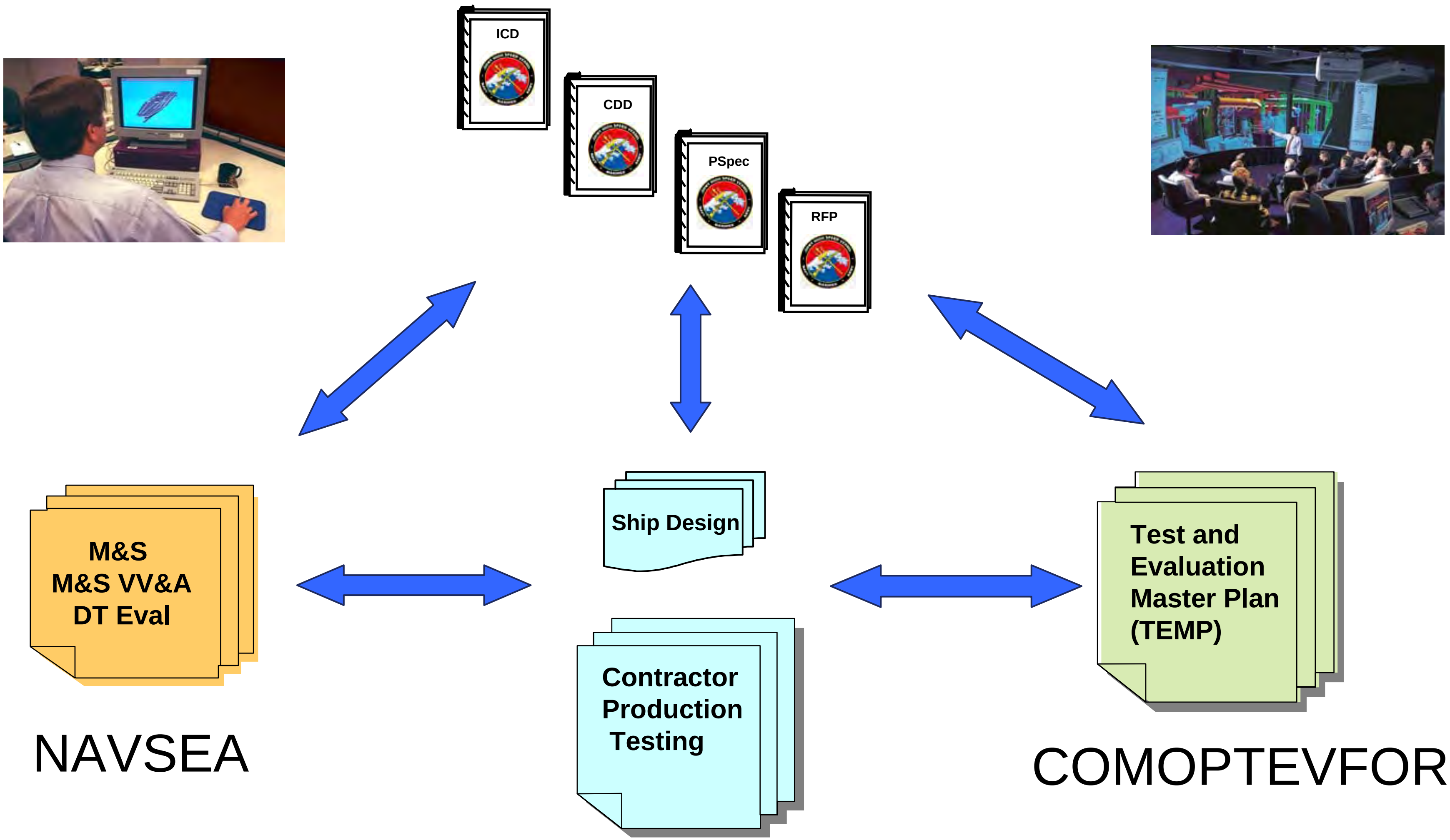
- The U.S. Army and U.S. Navy have been very successful testing converted high speed ferries as non-combatant vessels.

- Currently the Navy, Army, and Marines are jointly acquiring a production Joint High Speed Vessel.
- NAVSEA is the lead acquisition organization.

Joint Requirements

- The three organizations formed an IPT to develop the Analysis of Alternatives (AoA), Initial Capabilities Document (ICD), and Capability Development Document (CDD) IAW Joint Capabilities Integration and development System (CJCSI 3710.01).
- NAVSEA coordinated the development and adjudication of the AoA, ICS, and CDD, including the Key Performance Parameters (KPP).
- With it's background of deepwater non-combatant ship design, NAVSEA took the lead in the development of the platform Performance Specification (PSpec) and coordinated adjudication through the Joint IPT.

Verification & Validation Traceability



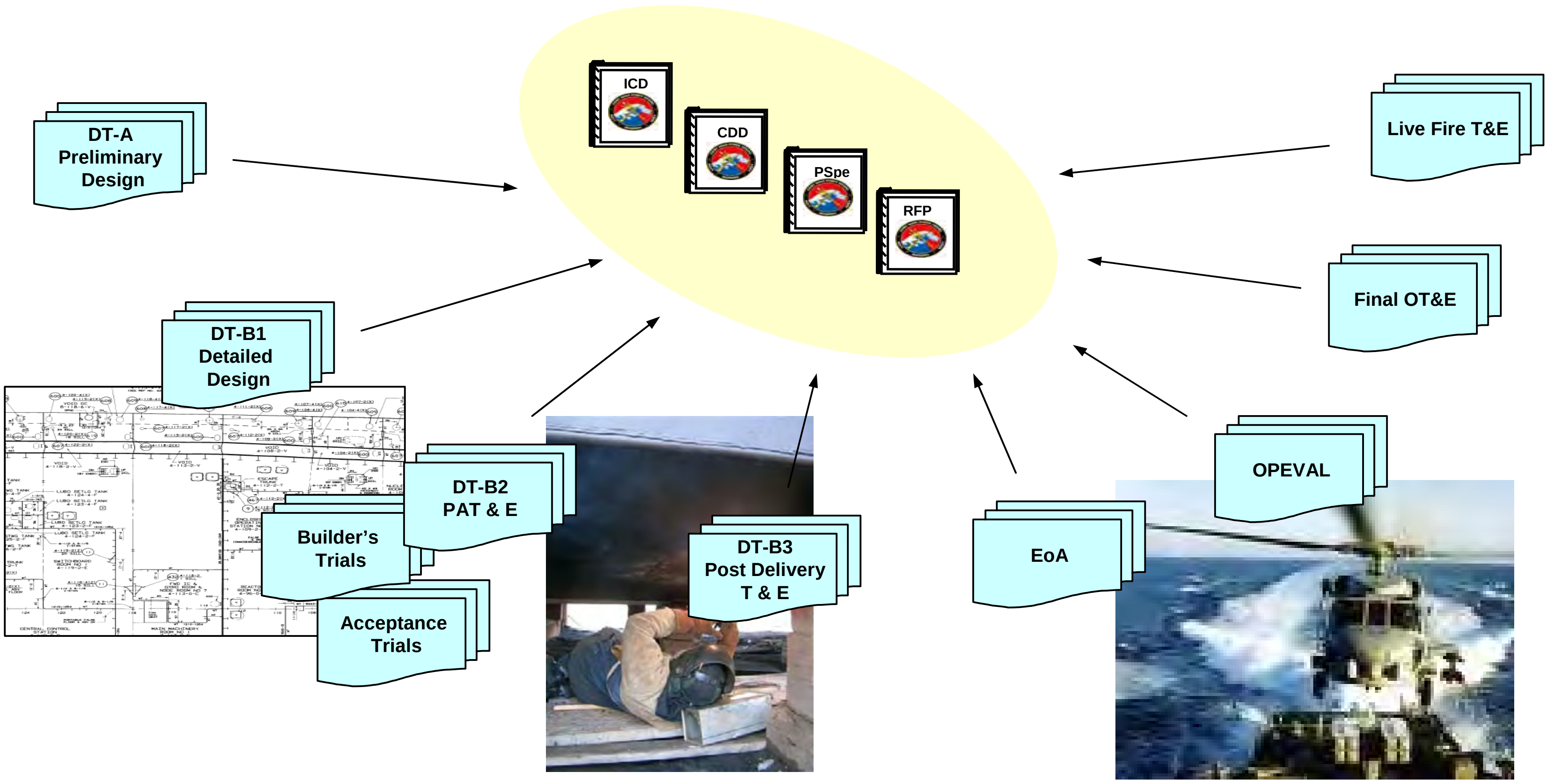
MOE/MOSs, CTPs and COIs

- Requirements module and T&E modules linked by various categories of measures.
- Developmental T&E test events linked to PSpec via Critical Technical Parameters (CTP).
- Operational T&E test events linked to CDD via Measures of Effectiveness and Suitability (MOE/MOS).
- Additional concerns in regards to survivability features and Live Fire Test &Evaluation Issues

Joint Test & Evaluation Master Plan

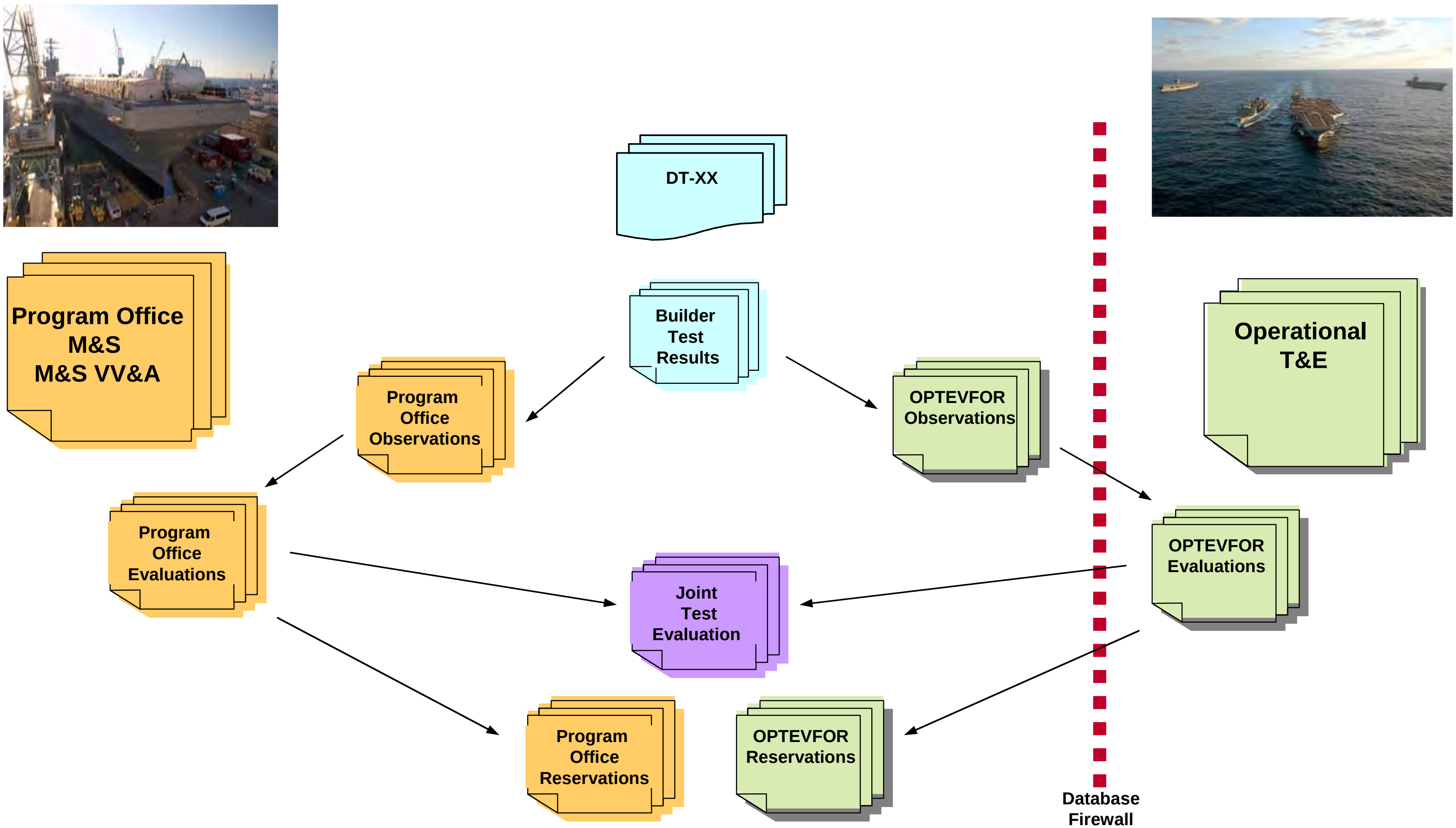
- The T&E W-IPT developed to represent all the major stakeholders.
- Stakeholders include:
  - Program Executive Office, Ships (PEO SHIPS)
  - NAVSEA Ship Design Manager (SEA 05D3)
  - Commander, Operational Test and Evaluation Force (COMOPTEVFOR)
  - Army Test and Evaluation Command (ATEC)
  - Marine Corps Test and Evaluation Activity (MCOTEA)
  - Chief of Naval Operations, Expeditionary Warfare (OPNAV N85)
  - Chief of Naval Operations, Navy Test and Evaluation Division (OPNAV N912)
  - Deputy Assistant Secretary of the Navy (DASN(Ships))
  - Army Test & Evaluation Executive
  - U.S. Army Test and Evaluation Management Agency (TEMA)
  - Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) (OASA(ALT))
  - Office of the Secretary of Defense, Director, Operational Test and Evaluation (OSD/DOT&E)
  - Office of the Under Secretary of Defense (Acquisition, Technology and Logistics), System and Software Engineering/Assessments & Support (OUSD(AT&L)/SSES/AS)

Integrated Test Database



Supports Staged T&E Approach through Acquisition Lifecycle

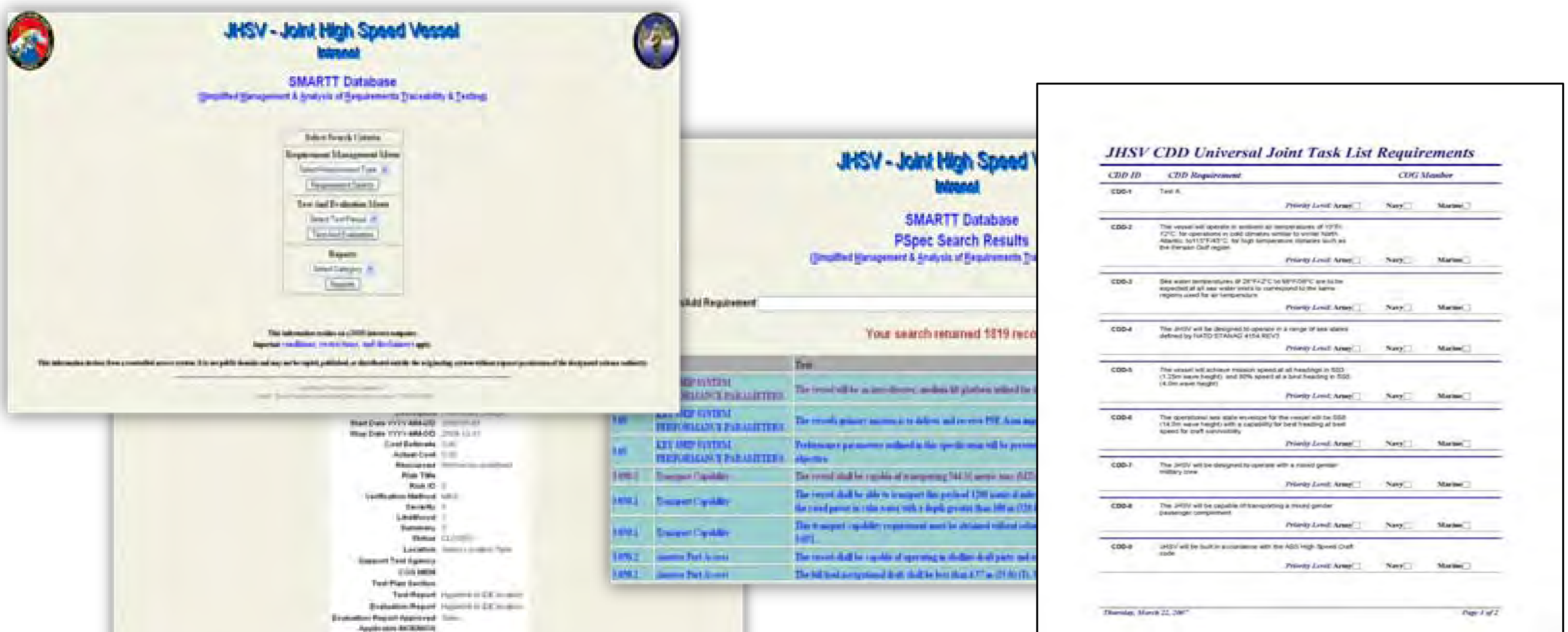
Web-Enabled Integrated Test Evaluation Tool



Provides for Independent Evaluation

SMARTT ® Alion's Web-enabled Integrated Requirements Management and T&E Database

- Integrated program developed by Alion and currently used in a variety of internal and external naval acquisition programs.



Provides Virtual Team Direct Editing and Management of Data

Questions or comments can be forwarded to:

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Capitalizing in Migrating Web-Service Environments

11TH ANNUAL NDIA SYSTEM ENGINEERING CONFERENCE, 20-23 OCTOBER 2008

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CHALLENGES

Capitalizing in migrating web service environments requires focused diligence in tactical and strategic considerations in achieving Net-Centric efficiencies and operational utility.

Net-Centric strategies present challenges and not **easily *integrated*** into engineering, acquisition, testing, management, and funding disciplines.

Applying

'Adopt or Buy' (adapt and use) strategies to existing web-services to meet acquisition criteria may ignore or delay essential 'business rules' and use; thereby not exploiting technologies for ***greater net-centric capability end-goals*** in the field.

Evaluating

a single or group of web-services in a ***transitioning*** environment may well ***stovepipe*** web-services as system/system function replacement and ***focus testing*** on program; which yield less than optimum net-centric operational efficiencies.

Deploying

web-services without exploitation of the web-service in a given mission-to-task consideration may ***hinder*** product operational usage and ***foster*** miss-use or non-use.

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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 urgent operational need -- solution stakeholders must forge a single 'integrated' enterprise to reduce risk in satisfaction of that need.

Changing the Business Model Requires:

(1) Willingness to empower teams working together to achieve more than organizations working alone

(2) Focus on Operator or Warfighter as central driver – solution need originator and evaluator

(3) Commitment to providing meaningful services rather than inflexible "products"

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POINT 1

CAPITALIZING REQUIRES KNOWING THE CENTER OF GRAVITY (COG) OF THE PROBLEM THAT YOU ARE TRYING TO SOLVE

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POINT 2

CAPITALIZING REQUIRES MEETING MUTUAL INCLUSIVE PERSPECTIVES – PROGRAM MANAGERS, DEVELOPER, TESTER, AND END USER

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CAPITALIZING AND PROVIDING A NET-CENTRIC MISSION/TASK CAPABILITY REQUIRES INTEGRATING THREE INSTRUMENTS: TECHNOLOGY, PROCESS, AND PEOPLE

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"Coevolved MCP (Mission Capability Packages) response to the problems that can arise when new technologies… are introduced but are not accompanied by changes in other areas, such as training or doctrine." For years, the belief has been that "computer technology was not cost-effectives because there was a lack of empirical evidence to show improvement in productivity."

David Alberts and Richard Hayes, 2007

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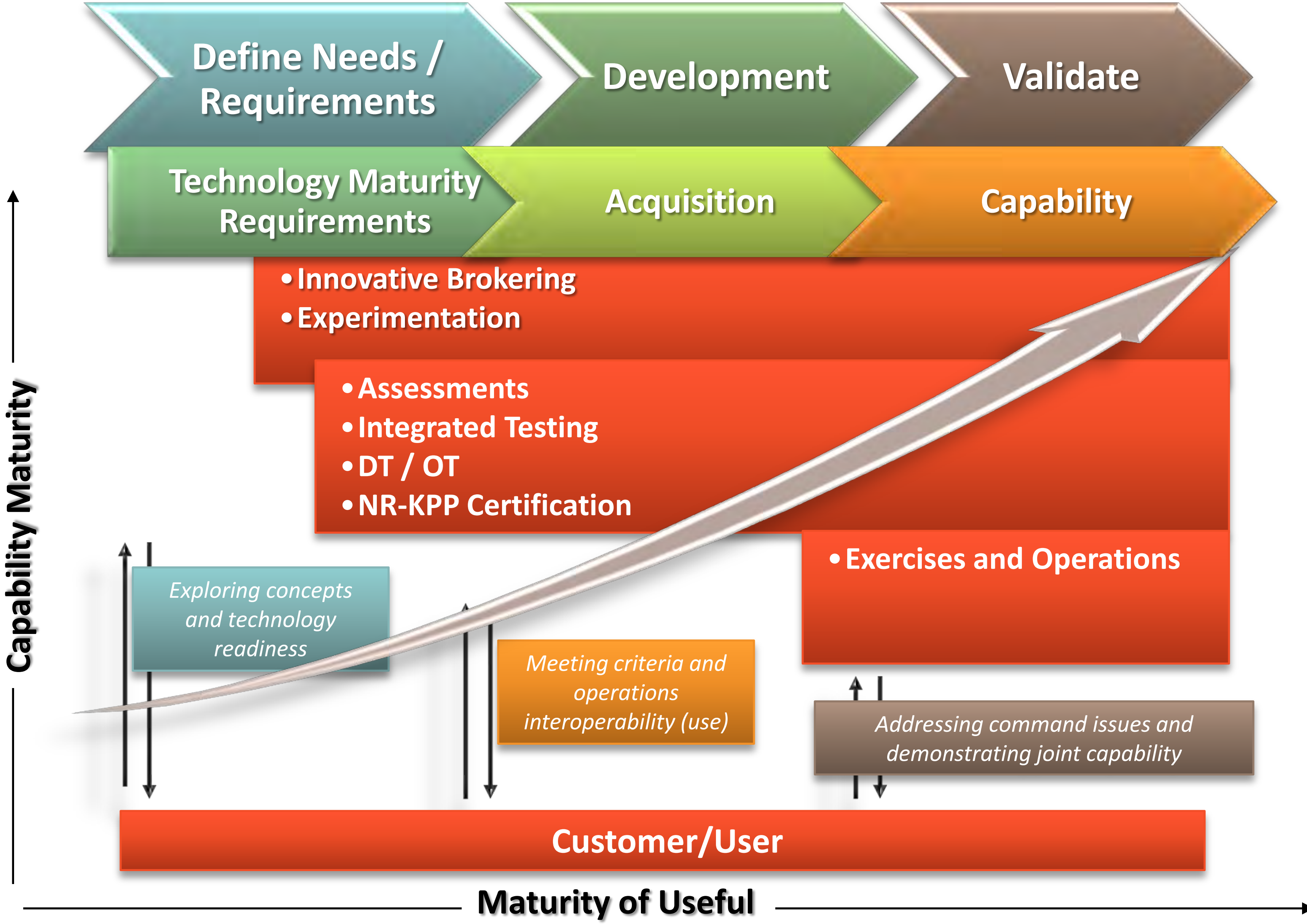
INTEGRATED CAPABILITY MATURITY MODEL

Meeting the challenges require integrating view point and instruments through life cycle progression of experimentation, integrated testing, and exercises & operations.



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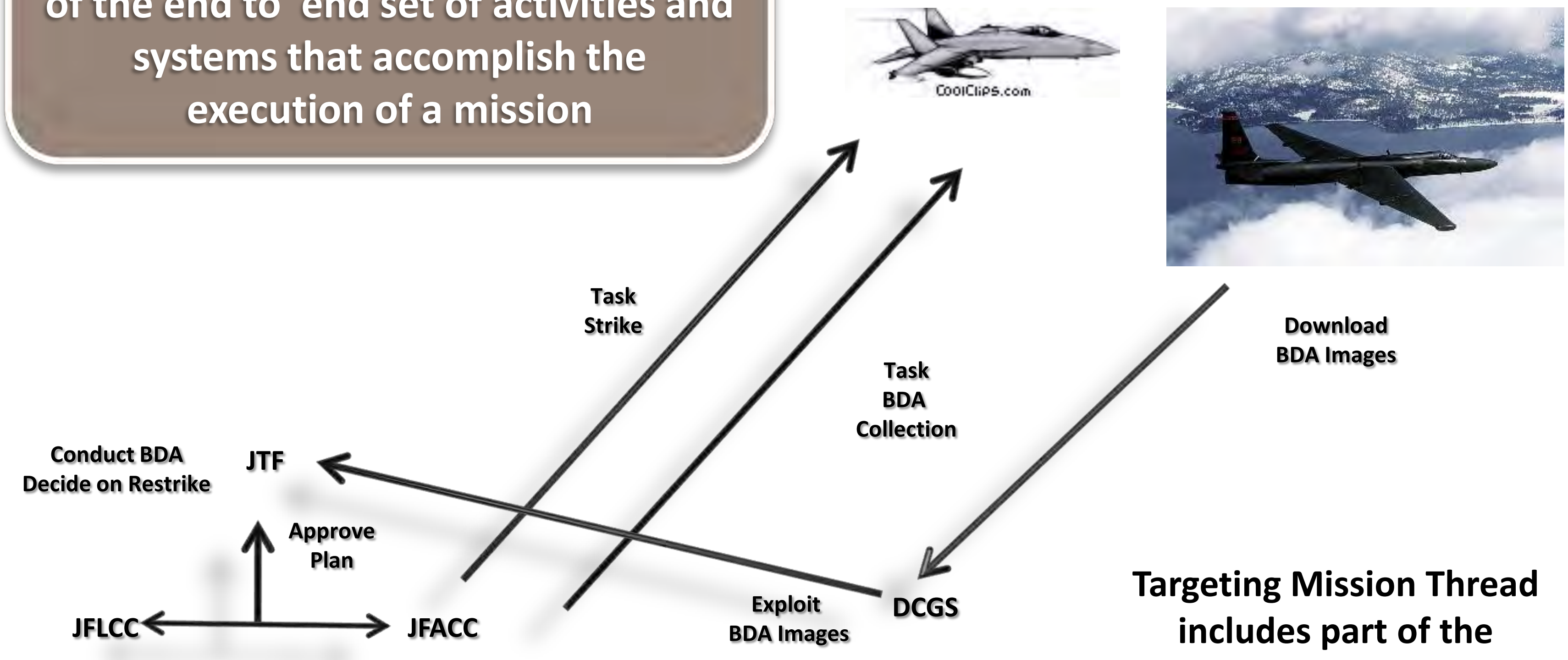
An Operational Mission Thread is an operational and technical description of the end to end set of activities and systems that accomplish the execution of a mission



Targeting Mission Thread includes part of the Collection Management Mission Thread to provide the set of *end to end activities*

Both operational and technical products are used to document a mission thread

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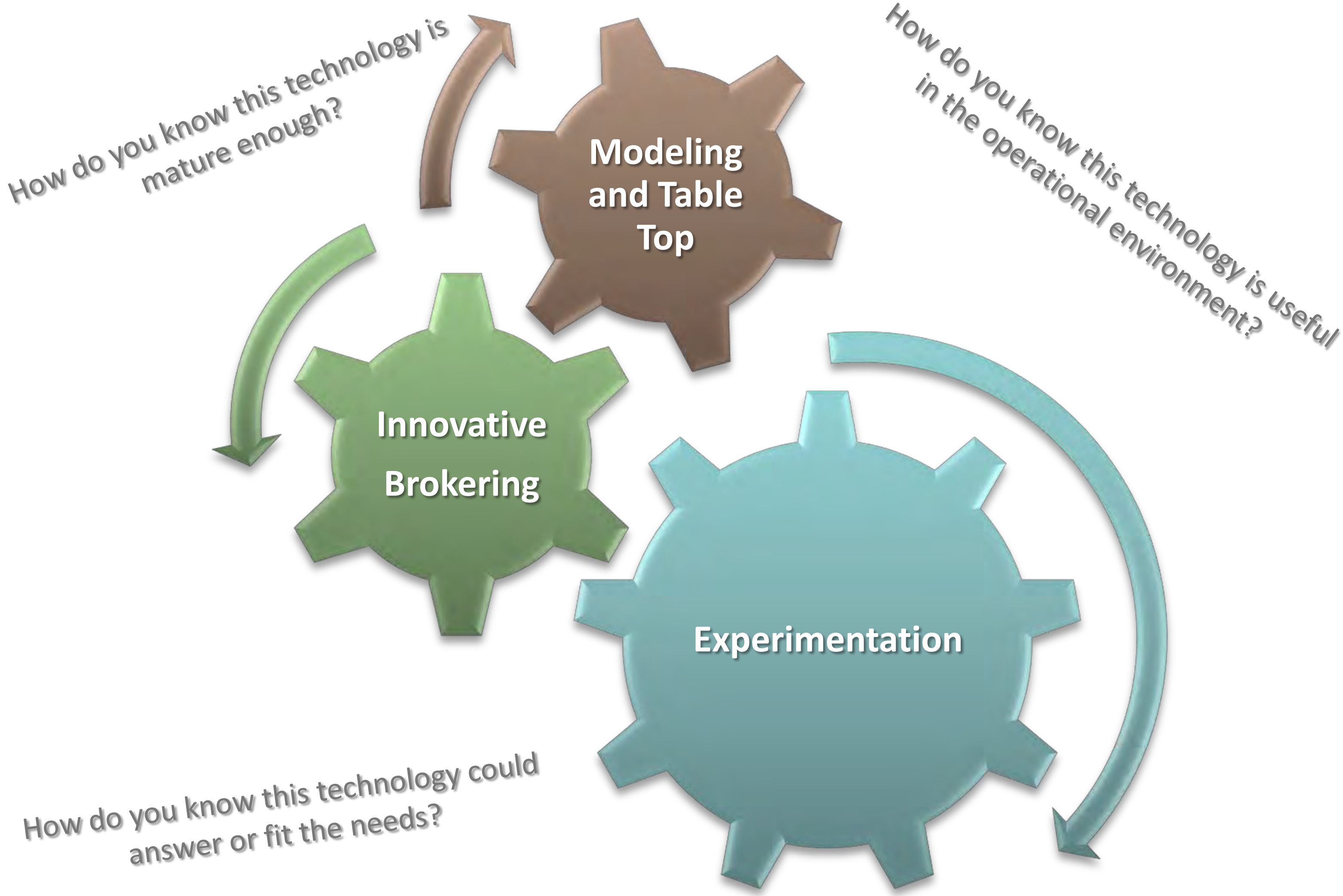

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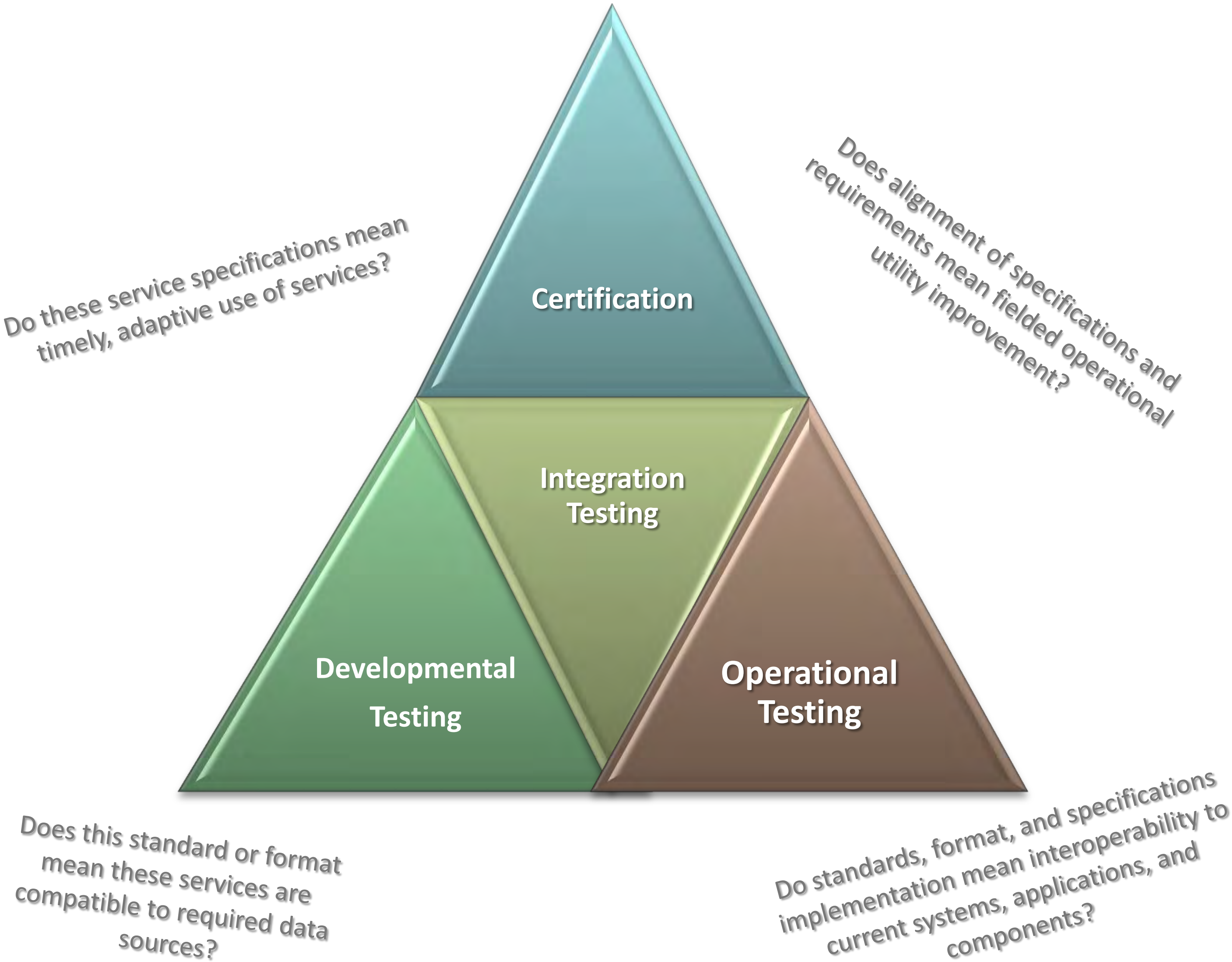
Engagement Opportunities – What does this mean?



SCRA Collaborating To Advance Technology

Engagement Opportunities – Can You Show Me?

Can you show the operational efficiencies of services implemented with adapted doctrine in operational scenario?

Can you show that this command priority issue has been successfully addressed?

Level of Enabling Questions: Testing and Exercise

Testing & Assessment → Exercise

Critical Questions	Measures/ Metrics	Focus	Traditional Approach
Do services provide html/xhtml display of Blue Force friendly forces location?	Information Display	Individual solution/services (technical specification)	Developmental Testing
Does information exchange between services (solutions) comply with message format and standards (i.e., XML, NR-KPP, security)?	Response time, Transition load, and Web-service availability	Between solution/services : Technical interface level (technical specification)	Developmental and Technical Interoperability
Do services (solution) meet information exchange specifications?	Message Format Standards and data/Taxonomy standards	Individual solution/services (technical specification)	Developmental and Technical Interoperability
Do services provide access to and display friendly force location from automated track feeds?	Requirement Statement	Individual solution/services meet requirements	Operational Testing
Do services provide access, generate, and display overlay information?	Requirement Statement	Individual solution/services meet requirements	Operational Testing
Do group of services improve Common Picture Overlay interoperability?	Priority C2 Related Issue	Group of material solutions, C2 environment, and business rules	Operational Testing, Assessments
Does group of services increase Common Picture Track Management Capability?	Priority C2 Related Issue	Group of material solutions, C2 environment, and business rules	Operational Testing, Assessments
Do solutions address C2 System Interoperability for DoD, Coalition, Multi-national, Agencies, and NGOs	Command or Theater Operations Issue	Group of MCP solutions, C2 environment, and business rules	Assessments, Exercises
Do solutions increase Joint net-centric operations with interagency, multinational, and operational forces	Command or Theater Operations Issue	Group of MCP solutions, C2 environment, and business rules	Assessments, Exercises

SCRA
Collaborating To Advance Technology

SUMMARY

- ***Capitalizing requires knowing the Center of Gravity (CoG) of the problem you are trying to solve***

- ***Capitalizing requires meeting mutual inclusive perspectives – program manager, developer, tester, and end-user***

- ***Capitalizing and providing a net-centric mission/task capability requires integrating three instruments: Technology, Process, and People***

- ***Drive capitalization with appropriately timed 'engagement' questions***

SCRA
Collaborating To Advance Technology

Joint Surface Warfare
Joint Capability Technology Demonstration –

Maturing Weapon Data Link Concepts into Operational Capability

Robert Finlayson
Senior Systems Engineer

The Johns Hopkins University
APPLIED PHYSICS LABORATORY

NAVAIR Public Release SPR-08-924

Demonstration Description

- Developing a capability, not a system
  - System of systems approach
- Leverages maturing weapon data link network technologies
  - Demonstrate the integration of multiple Intelligence, Surveillance, and Reconnaissance (ISR) and launch platforms with existing stand-off weapons
  - Allows interchangeable ISR assets to provide initial targeting data and in-flight target updates for multiple weapons
  - Provides multiple, comprehensive joint kill chain threads to the Combatant Commander
  - Significantly increases operational agility
  - Increases probability of target kill in adverse weather conditions and at extended ranges
  - Minimizes launch platform threat exposure
- Conscious decision to organize, plan and execute demonstration as if it were a program
  - Programmatic and system engineering discipline

JSuW Background

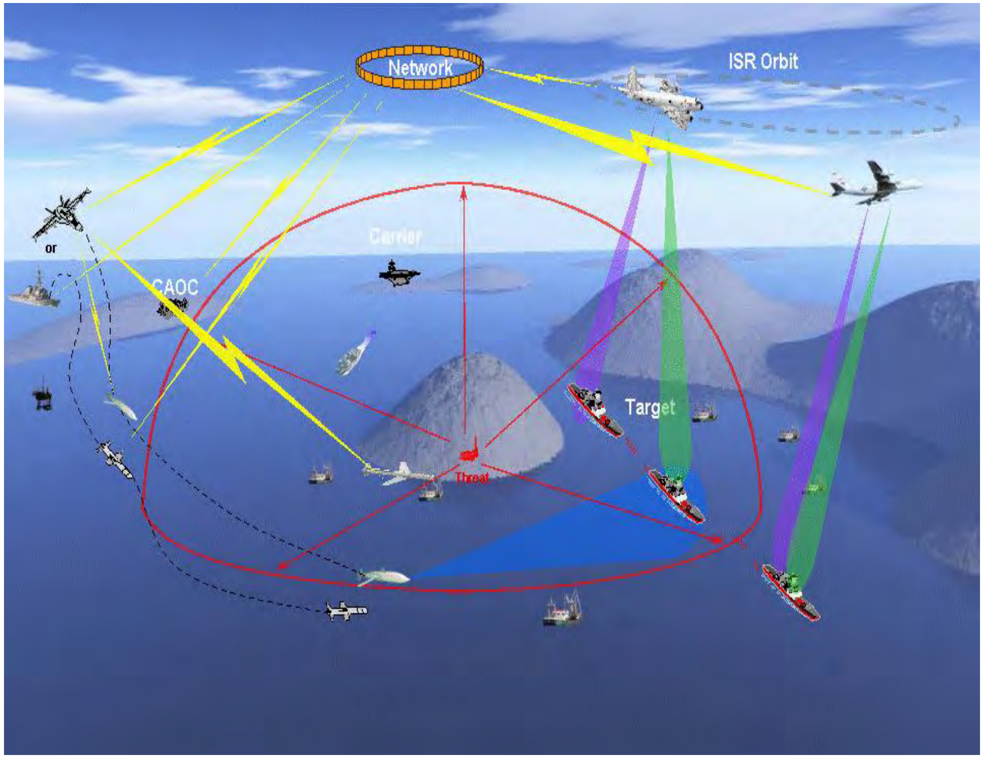
- In FY07 Advanced Concept Technology Demonstrations (ACTD) were re-designated to JCTD
- Managed out of PMA 201 – Precision Strike Weapons
- JSuW approved for FY07 start
  - Kickoff in June 2007
- Approximately three year period of performance and $40M effort
- Follow-on to the Weapons Data link Network ACTD
- JSuW involves five programs of record (PoR)
  - Joint Standoff Weapon (JSOW-C-1), Harpoon Block III and F/A-18E/F are funded for J11 message integration as part of their PoR
  - Joint Surveillance and Target Attack Radar System (JSTARS) and P-3C Littoral Surveillance Radar System (LSRS) will incorporate J11 for demo purposes only

Technical Implementation

- Incorporate the J11 message software into existing Link-16 terminals
- Interim Change Proposal to Link-16 (MIL-STD-6016C)
  - J11.1 Directive messages
    - Sent to the weapon
  - J11.0 Status Response messages
    - Sent from the weapon
  - J11.2 Weapon Coordination messages
    - Coordination of NEW control
    - Sent and received by weapon controllers and In-Flight Target Update (IFTU) Third Party Sources (3PS's)
- Weapons are receiving the Strike Common Weapon Data Link radio
  - Rockwell Collins

APL

Operational View

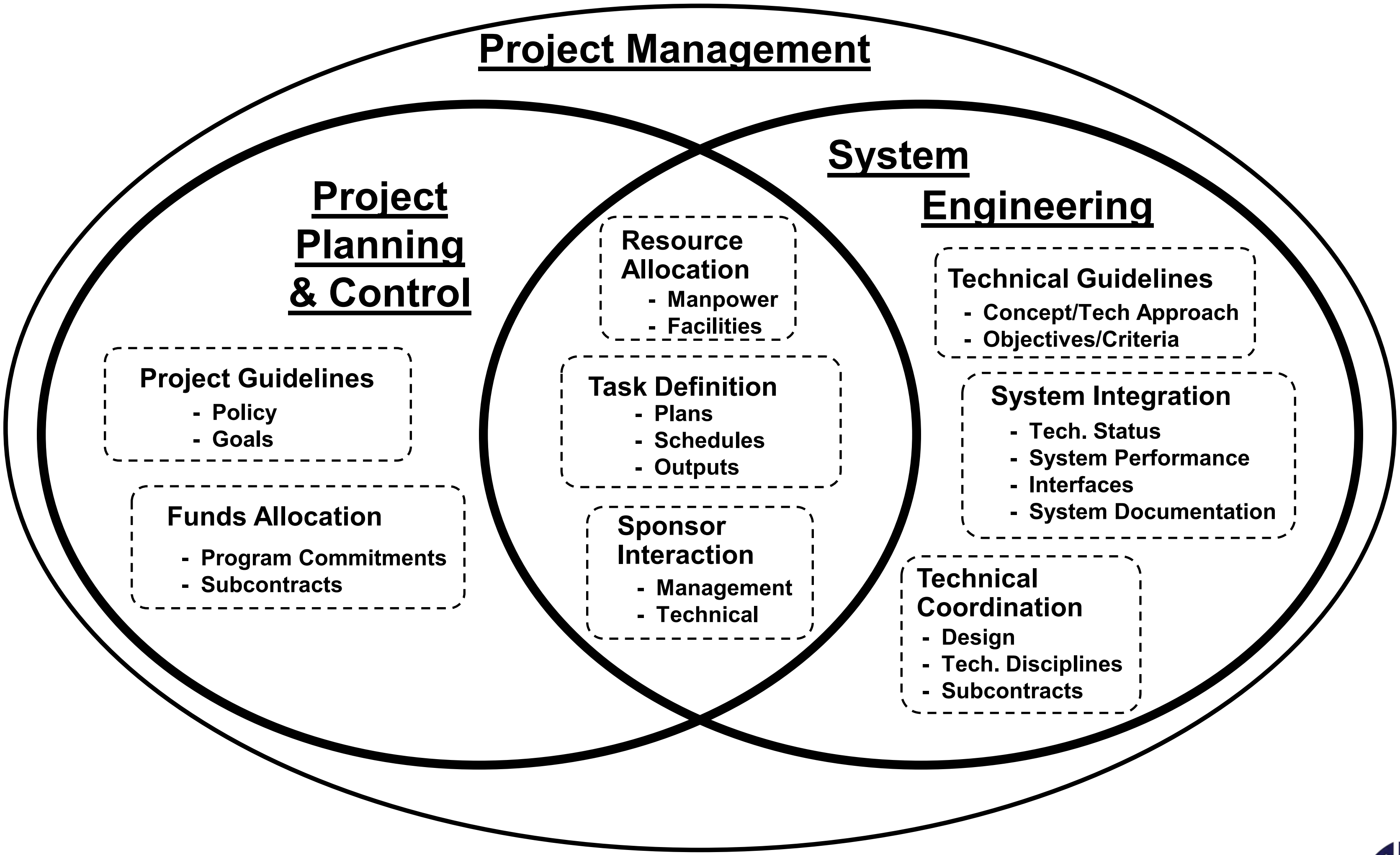


- **Integrate the Link-16 J11 Message Set into existing software architectures for the JSTARS and LSRS platforms**
- **Ensure interoperability with the JSOW-C-1, Harpoon Block III, and F/A-18E/F programs of record (incorporating J11 message set)**
- **Develop the associated CONOPS/TTPs**

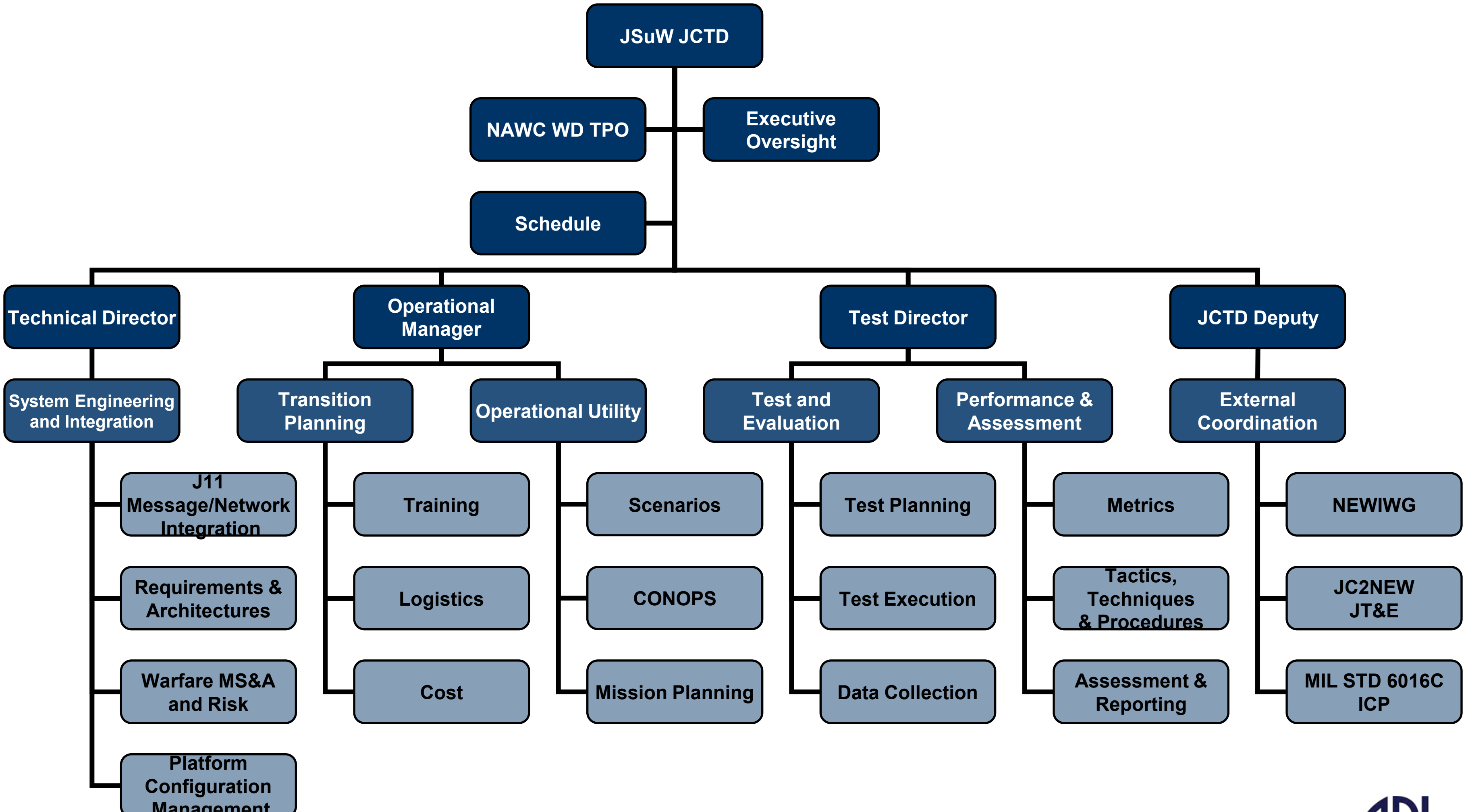
Concept of Operations

- F/A-18E/F, third party targeting source (3PS; i.e., second F/A-18E/F, JSTARS, LSRS) or other ISR platform detect enemy combatants
- J11.2 messages passed between controller / shooter (F/A-18E/F) and 3PS for coordination
- Weapon released by shooter (F/A-18E/F)
- 3PS provides In-Flight Target Updates (IFTUs) to weapon via J11.1 messages
- Weapon replies with Weapon In-Flight Track (WIFT), Ack/Nack and Bomb Hit Indication via J11.0 message

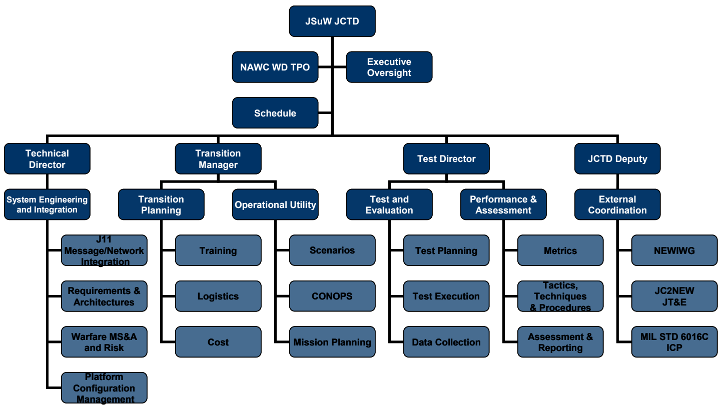
PM-SE Interaction



Organizational Breakdown Structure



Setting Constraints

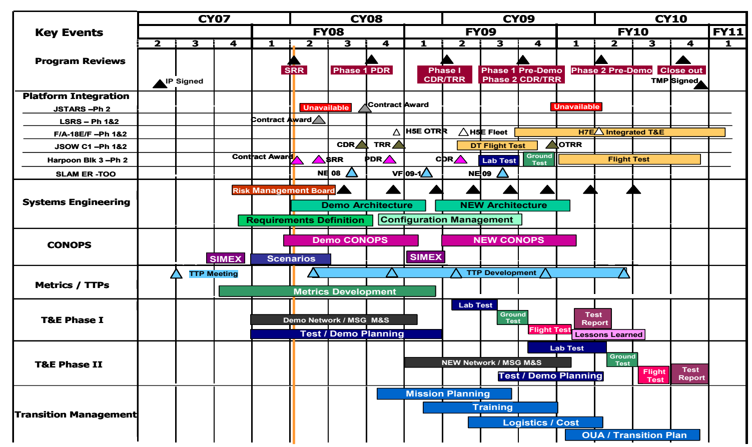


Organizational Breakdown

IMP Event	IMP Sub-Event	IMP Accomplishment	IMP Criteria	IMS Task	Deliverable Name (s) - if applicable	Responsibility
Program Manager's Review 2 (PDR/CDR June 08)						
	LSRS / JSOW PDR / CDR					
		LSRS JCTD Integration Plans Complete				
			Preliminary Design Review (Critical Design Review for JSOW) Complete	Conduct a Net Enabled Weapons PDR	PDR/CDR Summary Briefing	PM
			SW Development Plan Complete	Build J11 Message SW Development Plan	SW Development Plan (PPT Briefing)	PM
			Platform Integration Plan Complete	Write, Assemble and integrate code into OFP	Platform Integration Plan (PPT Briefing)	PM
			Platform Risk Assessment Complete	Conduct an end-to-end risk assessment	Risk Assessment Briefing and risk element integration into the JCTD risk database for management and mitigation	PM
	JSTARS Contract Award					
		Contract Award				
			Negotiated contract with the appropriate contractor	Conduct the necessary steps for contract award	Signed Contract	PM

Integrated Master Plan

Work Breakdown Structure



Integrated Master Schedule

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APL

Capability Statement

Challenge: Cost effective, simultaneous, multi-axis strike in the littorals, against a mutually supported, state-of-the-art surface action group (SAG); at the time and place of our choosing

Defining Scenarios

- Understand the environmental conditions
  - Use a guide to ensure all potential impacts have been addressed
- Look at a range of scenarios
  - Address each mission
  - Across the spectrum of “easy to hard”
- Understand the requirements and/or desired capabilities for each scenario
  - How does this affect system design and performance?
- Distribute demonstration resources to address the scenario spectrum
  - Engineering level analysis, modeling and simulation, flight test, etc.

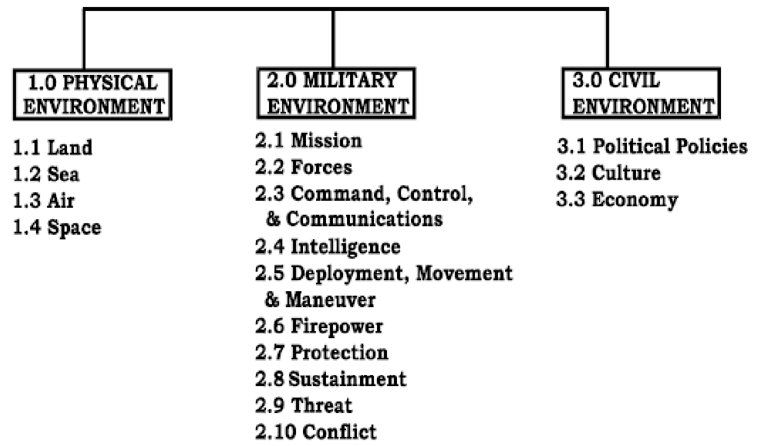


Figure C-1. Organization of Conditions for Joint Tasks

CJCSM 3500.04D, Universal Joint Task List, 1 August 2005

Capability Decomposition

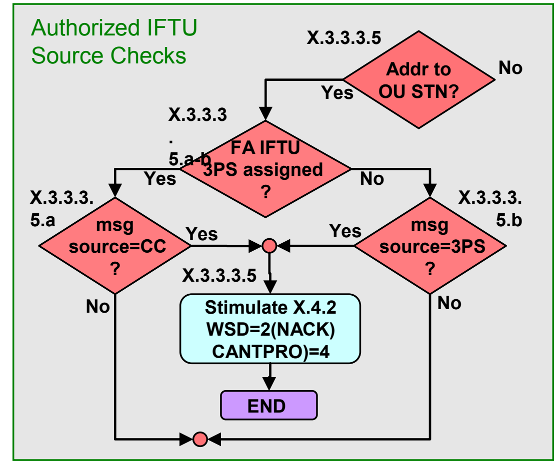
Capability	Attribute / Requirement	Sensor	Shooter	Controller	Weapon	External Sources	Network / Message
Cost Effective	Efficient use of assets	Minimize standoff sensors	Increase survivability	Co-locate with shooter/sensor	Level of effort weapons	Low cost intel. collection platforms	Use existing network
Simultaneous	Coordinated (timing, position)	Synchronized with shooter and weapon	Synchronized, positioned	Auto-logic; advanced USI	Predictable / programmable flight profile	Multiple, dispersed collection	Number of users
Multi-Axis	Pre-planned	Position wrt shooter/weapon	360 LAR wrt target	Controller positioning	Maneuver in flight	Multiple, dispersed collection	Range
Strike	Kinetic attack	Targeting wrt weapon	Loadout, weapon support	ROE feed; combat ID assurance	Lethality vs target set	Multi-role platforms; collect and strike	Detailed message set
Littorals	Clutter, neutral shipping	Resolution, accuracy, fusion	Range from base, CVN	Advanced SA	Selectivity, AI, scan volume	Deployable; survivable	Spectrum management
SAG – Mutual Support	Integrated air defense system	Standoff, fusion	Standoff	Standoff	Survivability	Survivable	Range
SAG - SOTA	Stealth, CCD, decoys, firepower	Accuracy, fusion, jam resistant	Situational awareness	Advanced decision tools – superior SA	Selectivity, CCM, AI, Jam resistant	Embedded artificial intelligence	Resilient
Time and Place of our Choosing	Independent of environment	All Weather (vis, sea state, etc.)	Endurance	Endurance; comm links	Detect target in all weather	Persistent	Reliable

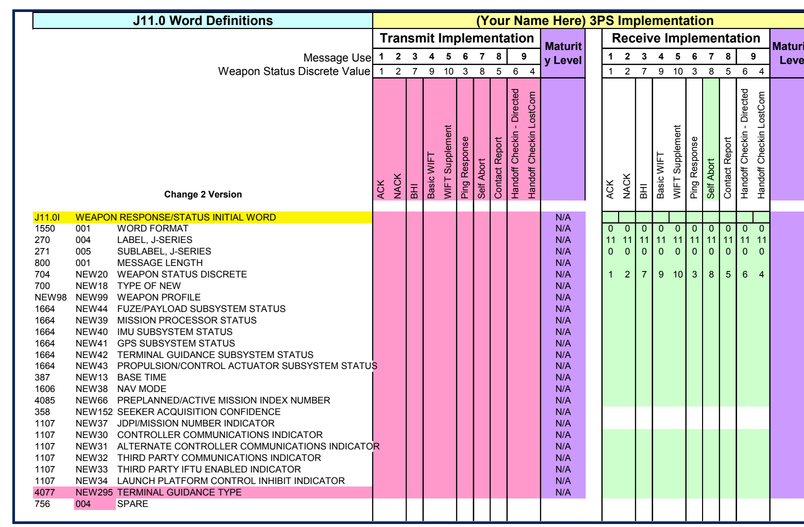
System Performance Measures

Metrics / Entities	Extent	Accuracy	Timeliness	Reliability	Robustness
Sensor	# targets Range	TLE Update rate Resolution	Internal latency IFTU rate	MTBF ETOS Turn time	Survivability Discrimination Jam effects
Shooter	# weapons Sensor range Launch envelope	Msg processing HSI	Platform speed	MTBF ETOS Sys. Architecture	Survivability Launch envelope
Weapon	Range Flight profile	Seeker res. Control logic Aero perf.	IFTU processing Speed Loiter ability	MTBF WIFT trans.	Env. Effects Survivability Discrimination
Network	Range # JUs Bandwidth	Msg. transfer Mission planning	Latency Aircraft interface	Packet loss MTBF Protocols	Jam effects Encryption
Controller	# weapons # targets	IFTU rate Data fusion HSI	Internal latency	MTBF	Location Tgt. Processing Jam effects
External Sources	# available	Gateway	Network-network latency	Data security Intel fusion	Network access Msg. format

Interoperability Challenge

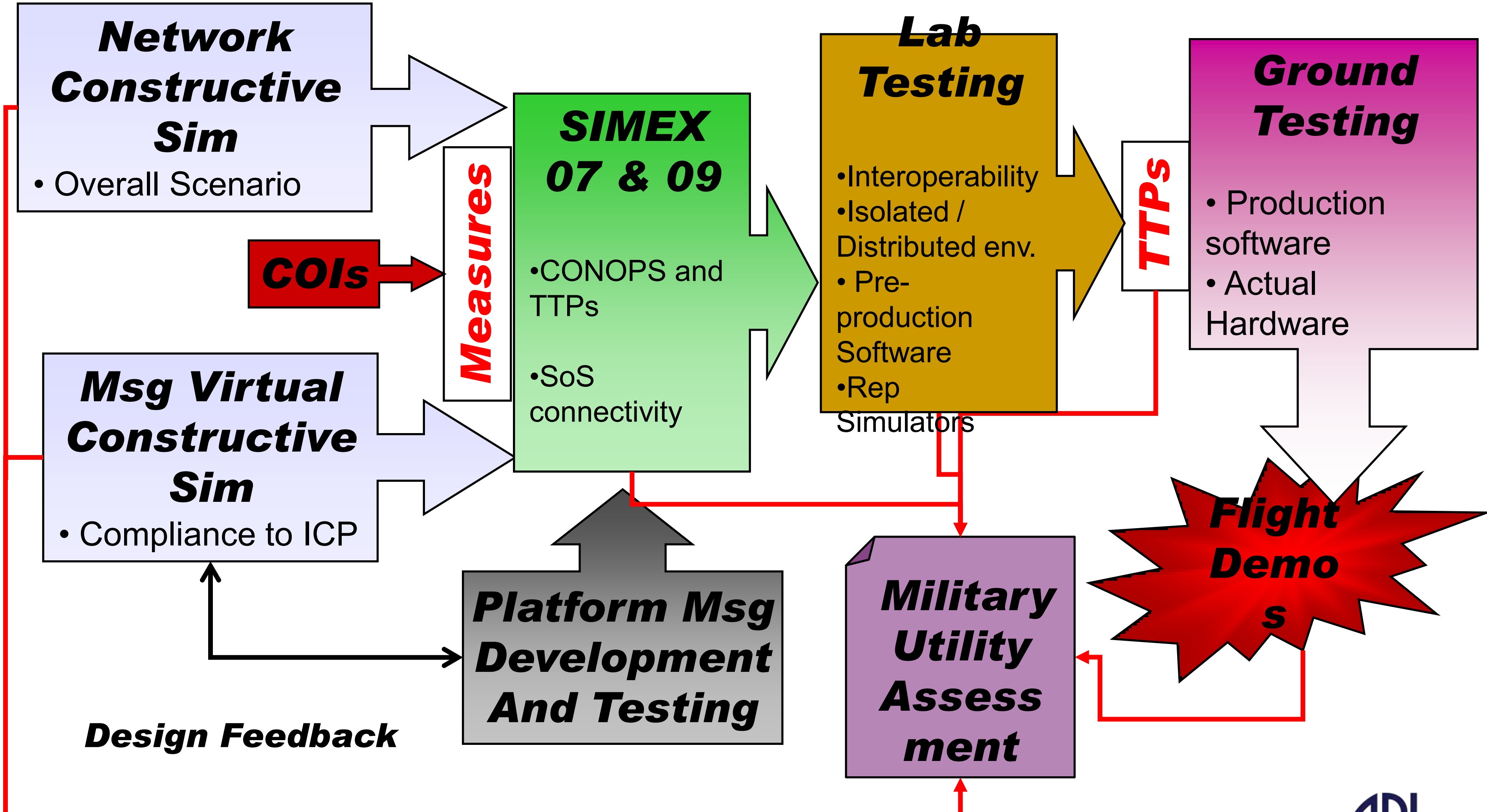
- Link-16 (MIL-STD-6016C, Interim Change Proposal TM06-093Ch2)
  - Approved by the Joint Multi-TADIL Configuration Control Board (JMTCCB) on 02 May 2008
  - Staffing underway for NATO review
  - Message standard is still in “interim state”
- Using Excel spreadsheets for interoperability assessment and configuration management
  - Awaiting Interoperable Systems Management and Requirements Transformation (iSMART) configuration change to the ICP
  - Compare each platform’s implementation by software version
  - Identify interoperability gaps and work with platform’s to eliminate discontinuities
- Migrate eventually to iSMART as well as MS&A tools currently under development





J11.0 Word Definitions			(Your Name Here) 3PS Implementation: Transmit Implementation											Receive Implementation										
		Message Use	1	2	3	4	5	6	7	8	9		Maturity Level	1	2	3	4	5	6	7	8	9		Maturity Level
		Weapon Status Discrete Value	1	2	7	9	10	3	8	5	6	4		1	2	7	9	10	3	8	5	6	4	
		Change 2 Version	ACK	NACK	BHI	Basic WIFT	WIFT Supplement	Ping Response	Self Abort	Contact Report	Handoff Checkin - Directed	Handoff Checkin LostCom		ACK	NACK	BHI	Basic WIFT	WIFT Supplement	Ping Response	Self Abort	Contact Report	Handoff Checkin - Directed	Handoff Checkin LostCom	
J11.0I	WEAPON RESPONSE/STATUS INITIAL WORD												N/A											
1550	001	WORD FORMAT											N/A	0	0	0	0	0	0	0	0	0	0	
270	004	LABEL, J-SERIES											N/A	11	11	11	11	11	11	11	11	11	11	
271	005	SUBLABEL, J-SERIES											N/A	0	0	0	0	0	0	0	0	0	0	
800	001	MESSAGE LENGTH											N/A											
704	NEW20	WEAPON STATUS DISCRETE											N/A	1	2	7	9	10	3	8	5	6	4	
700	NEW18	TYPE OF NEW											N/A											
NEW98	NEW99	WEAPON PROFILE											N/A											
1664	NEW44	FUZE/PAYLOAD SUBSYSTEM STATUS											N/A											
1664	NEW39	MISSION PROCESSOR STATUS											N/A											
1664	NEW40	IMU SUBSYSTEM STATUS											N/A											
1664	NEW41	GPS SUBSYSTEM STATUS											N/A											
1664	NEW42	TERMINAL GUIDANCE SUBSYSTEM STATUS											N/A											
1664	NEW43	PROPULSION/CONTROL ACTUATOR SUBSYSTEM STATUS											N/A											
387	NEW13	BASE TIME											N/A											
1606	NEW38	NAV MODE											N/A											
4085	NEW66	PREPLANNED/ACTIVE MISSION INDEX NUMBER											N/A											
358	NEW152	SEEKER ACQUISITION CONFIDENCE											N/A											
1107	NEW37	JDPI/MISSION NUMBER INDICATOR											N/A											
1107	NEW30	CONTROLLER COMMUNICATIONS INDICATOR											N/A											
1107	NEW31	ALTERNATE CONTROLLER COMMUNICATIONS INDICATOR											N/A											
1107	NEW32	THIRD PARTY COMMUNICATIONS INDICATOR											N/A											
1107	NEW33	THIRD PARTY IFTU ENABLED INDICATOR											N/A											
1107	NEW34	LAUNCH PLATFORM CONTROL INHIBIT INDICATOR											N/A											
4077	NEW295	TERMINAL GUIDANCE TYPE											N/A											
756	004	SPARE																						

JSuW T&E Strategy



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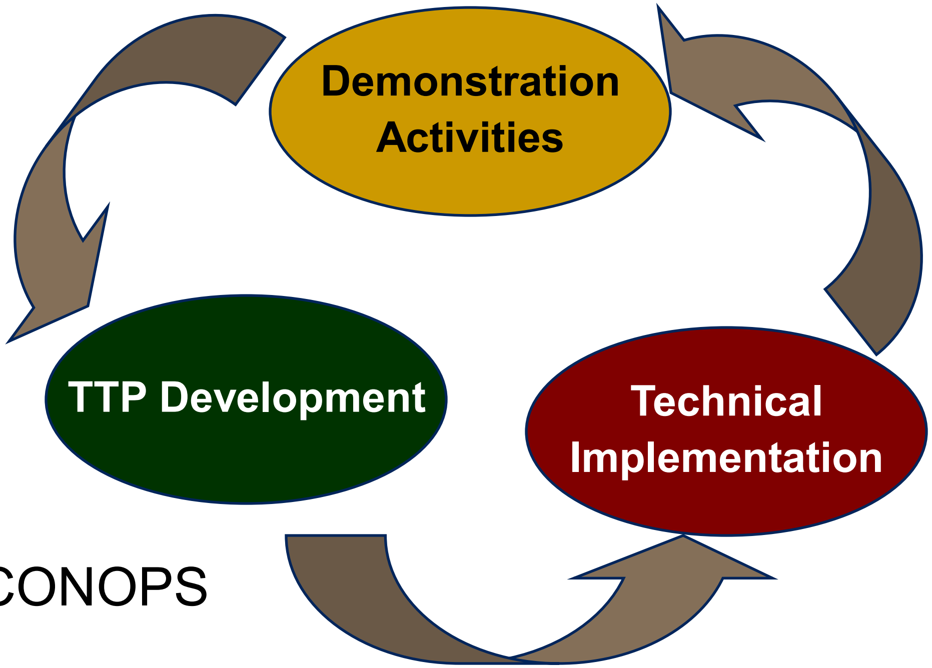
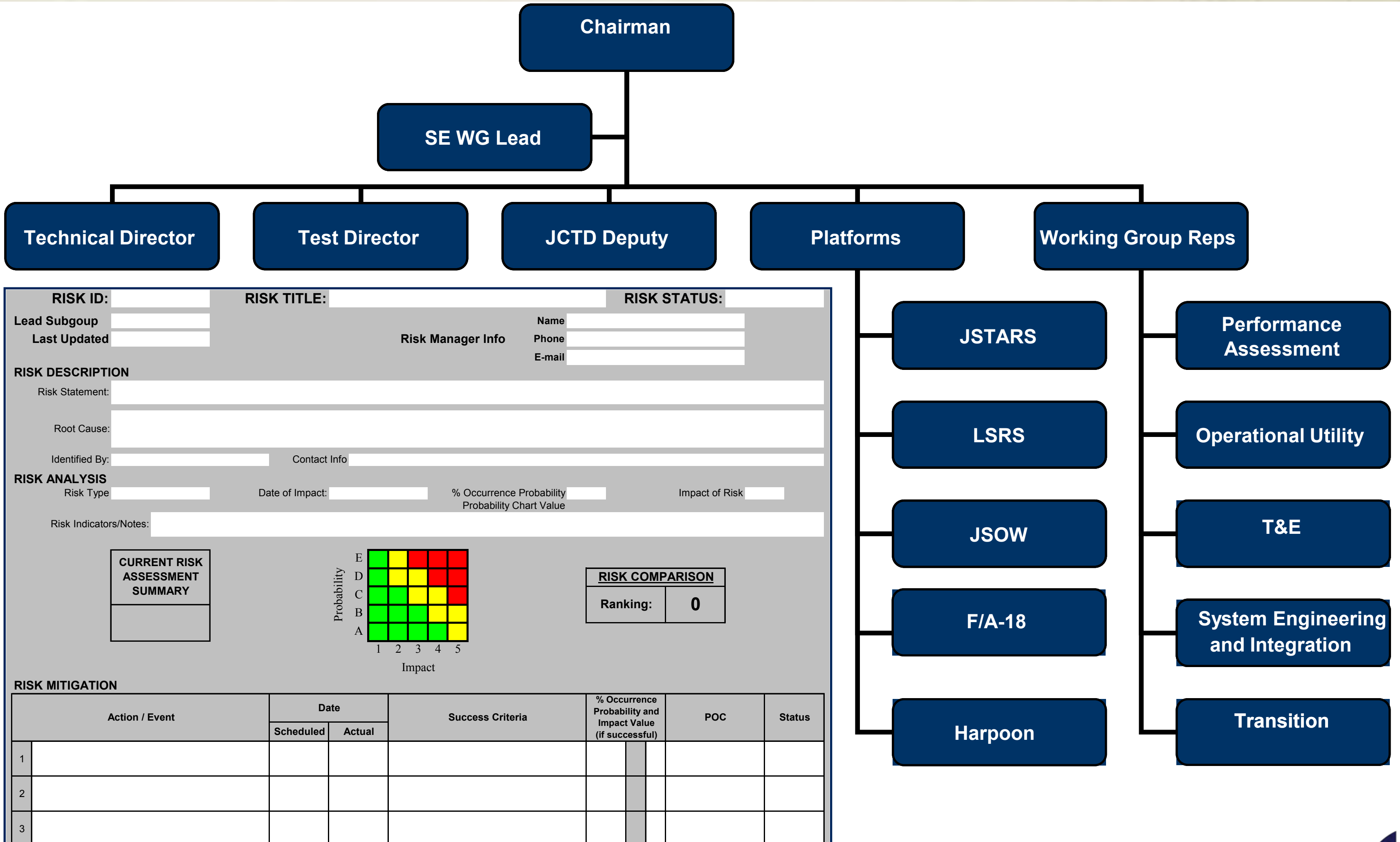
Tactics, Techniques and Procedures Development

- Maturing TTPs through:
  - Engagement Simulation
  - Table top role play
  - Simulation Exercise
    - Constructive, virtual
  - Ground demo
  - Flight demo
- Balance demo ops with real world CONOPS development
  - Scenario dependent, design to succeed
- Continual trade-off and maturation of TTPS in parallel with message set implementation
- Validation and modification with demo (T&E) activities



APL

Risk Management Board



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Interoperability Certification Proposal

- Can JSOW-C-1 and Harpoon Block III use the JSuW demonstration events to obtain certification?
  - Save $$
  - Improve understanding of NEW certification process
  - Streamline test planning and execution
  - Develop a process for certifying future Net Enabled Weapons

JITC Certification

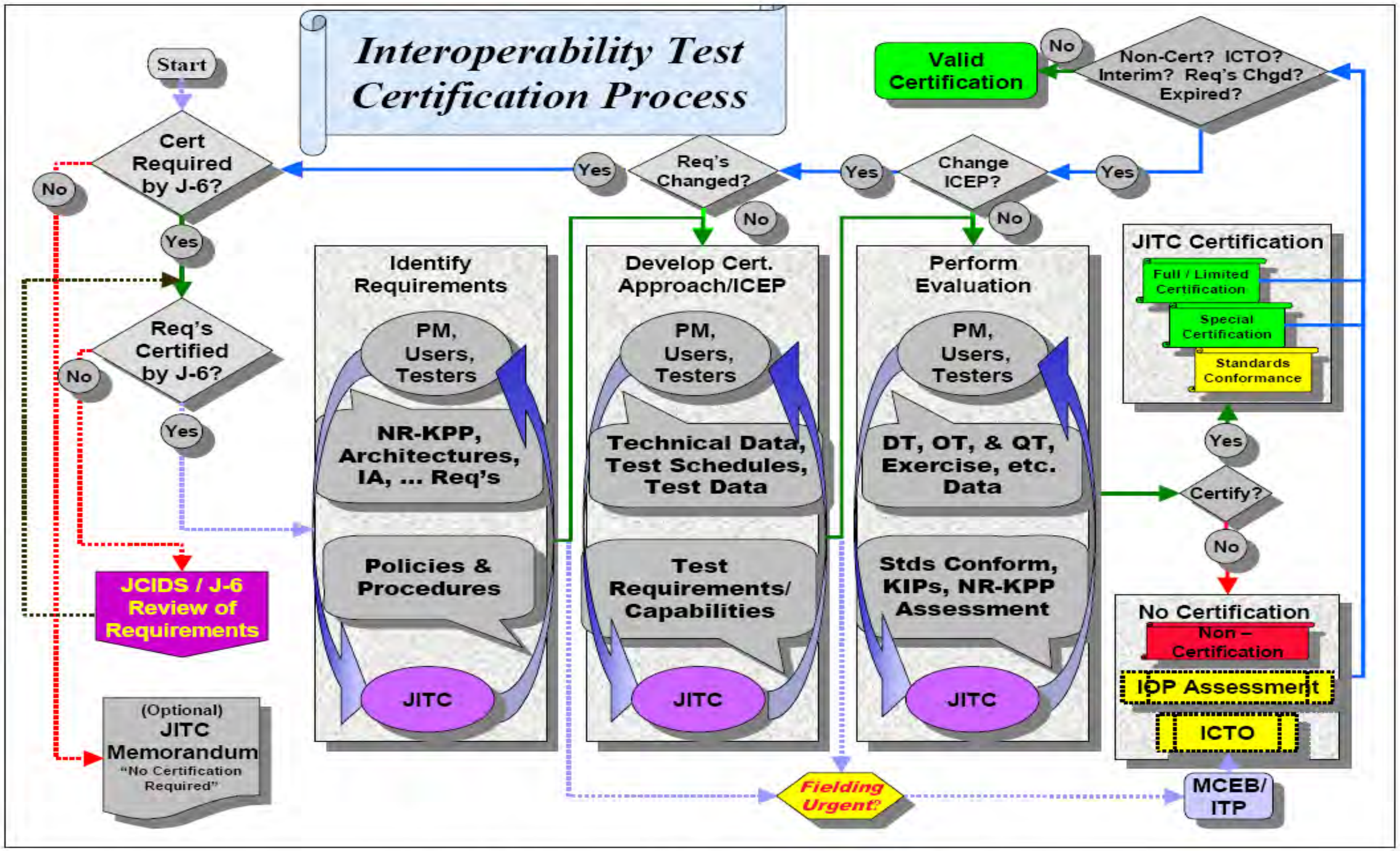


Figure E-1. Interoperability Test Certification Process

CJCSM 6212.01D, Interoperability and Supportability of IT and NSS, 14 March 2007

Summary

- Joint Surface Warfare JCTD has provided a challenging systems engineering environment
  - Engineering a capability more than a system
  - Team dispersion
  - Requirements allocation
  - Interoperability assurance
- Programmatic and SE discipline, practices and procedures still apply
  - Demonstrations don't give you a "free pass" when it comes to project management and engineering
- Expect more of the same in the coming decades
  - Unmanned system expansion
  - Weapon maturity and migration
  - Adaptation of CONOPS and TTPs to optimize NEW capability

GENERAL DYNAMICS
Land Systems

EXTENDING ENTERPRISE SYSTEMS FOR AN INTEGRATED LOGITICS MANAGEMENT ENVIRONMENT

11th Annual Systems Engineering Conference

Presenter: Mike Korzenowski

Oct 20th, 2008

Authors: GLSN Team – Kurt Hansen, Jim Garrity

Introduction

- A System Engineering approach wrapped with a Design For Six Sigma (DFSS) blanket of methodology to provide a means of designing and delivering an Integrated Logistics Management Environment for the collaboration and delivery of logistics information over a military support network.

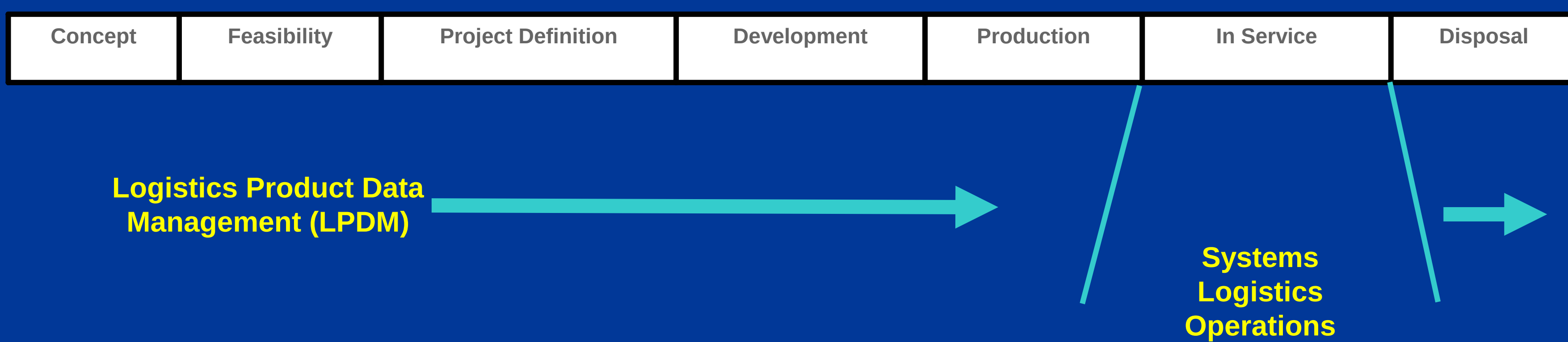
Large Scale, Sprawling Systems

- Stove pipes for product source and delivery
- Security, Limited access
- Funding Problems
- Heavy Payloads, Quick Access Demands
- Heavy, Traditional Process Driven methods
- Old, New Mil Standards
- Large Complex Legacy Systems
- New Technologies waiting to be exploited

Transitions to Deal With

- Old Technology, Legacy Processes
- Logistics maintainability models
- Today's technology without changing the development processes
- Streamlined delivery over Global Support Networks
- Containment to Military Networks with limited access
- Low time, cost
- High Demand, The Right Data at the Right Time

The Typical Full Product Life Cycle



(ILS) Has not changed
1388-2B MIL-Standard (circ 1973)

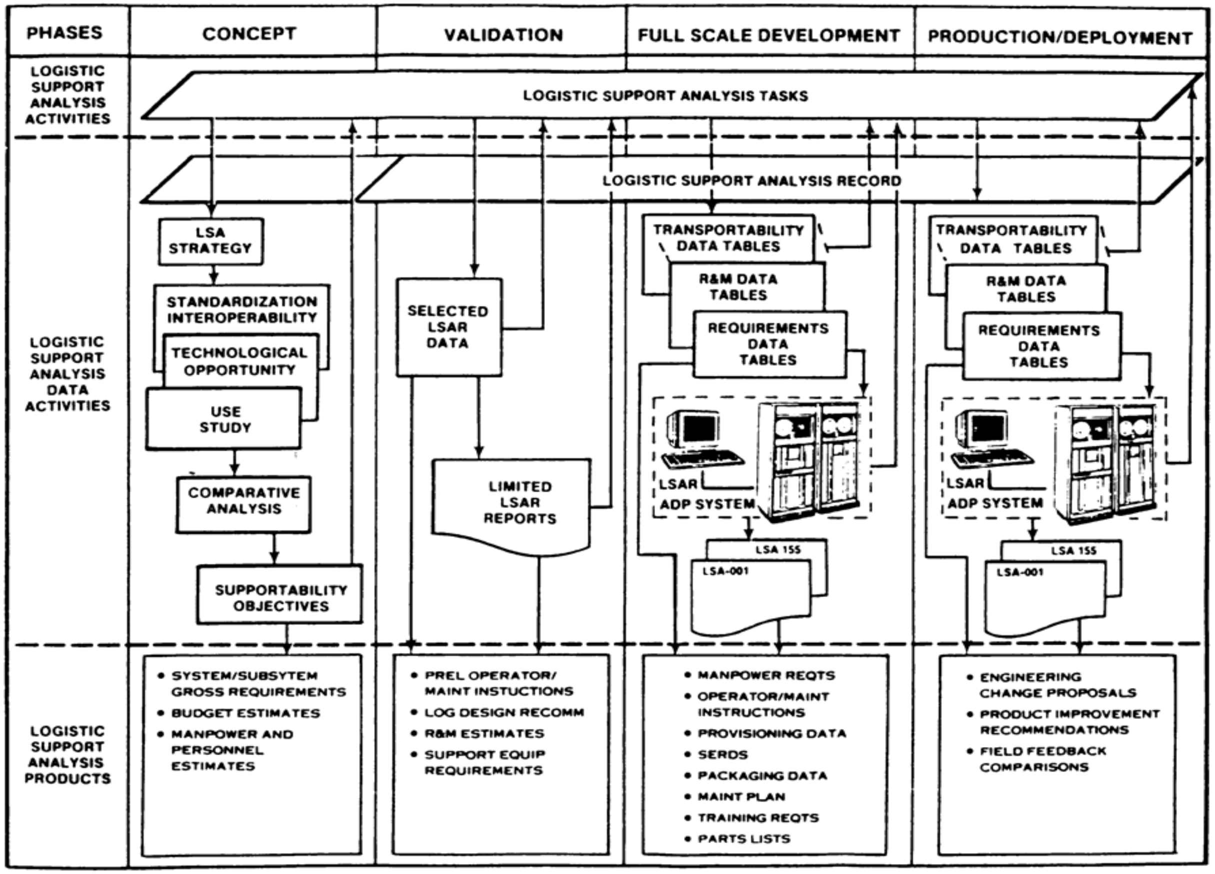
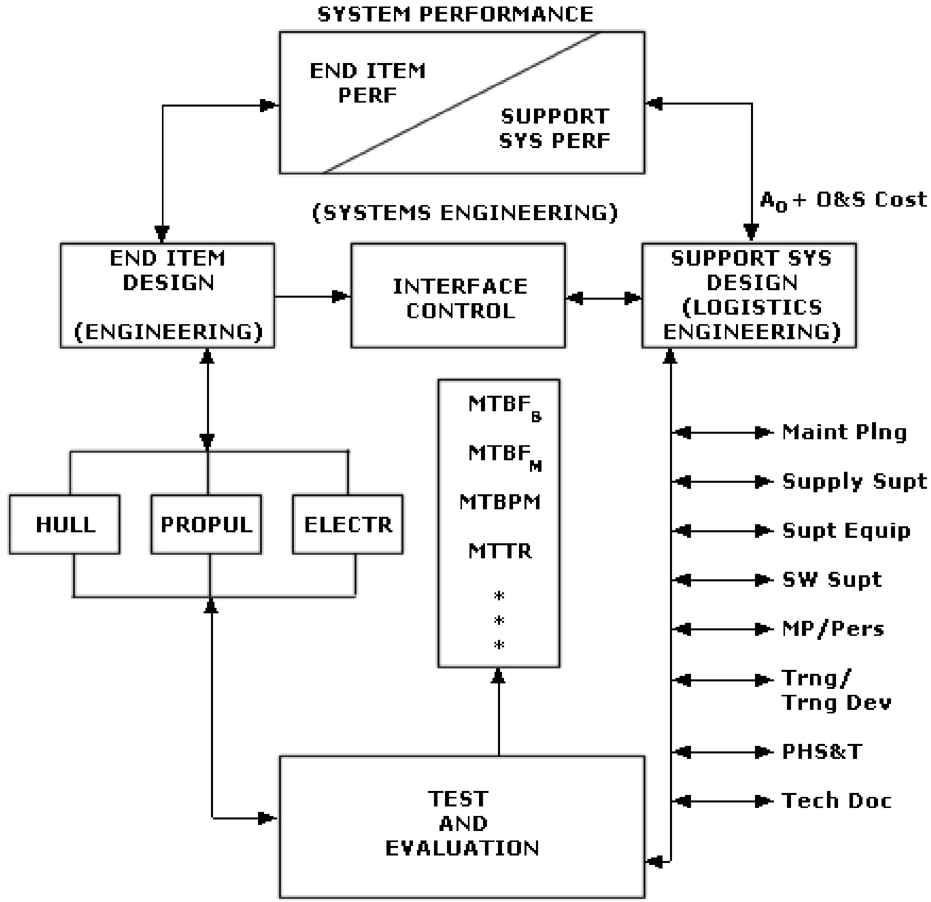


FIGURE 1. LSA data documentation process.

ILS – Integrated Logistics Support

- The ILS management process which facilitates development and integration of the 10 individual logistic support elements to specify, design, develop, acquire, test, field, and support systems. There are 10 ILS elements:
  - Maintenance planning
  - Supply support
  - Support and Test Equipment/Equipment support
  - Manpower and personnel
  - Training and training support
  - Technical data
  - Computer Resources support
  - Facilities
  - Packaging, Handling, Storage, and Transportation (PHS&T)
  - Design interface

Source Data Model and Outputs For Supportability (ILS Program)



Products Delivered

- Technical manuals.
- Technical and supply bulletins.
- Transportability guidance technical manuals.
- Maintenance expenditure limits and calibration procedures.
- Repair parts and tools lists.
- Maintenance allocation charts.
- Preventive maintenance instructions.
- Drawings/specifications/technical data packages.
- Software documentation.
- Provisioning documentation.
- Depot maintenance work requirements.
- Identification lists.
- Component lists.
- Product support data.
- Safety critical parts list.
- Lifting and tie down pamphlet/references.
- Hazardous Material documentation.

Typical Tools – Program to support ILS

ANALYSIS

- SLIC/SLICwave
- PRO-E/UG
- ProductView
- COMPASS/Lite
- IDE
- ECARDS
- ESCHER
- CMWebstat
- eXpress (Testability Modeling Tool)

CONTENT CREATION & CAPTURE

- Arbortext Epic Editor
- MsWord
- Content@ XML/SGML Management & Multi-Channel Publishing
- SLIC/SLICwave
- IBM Mainframe (LS3Q)
- TIPS-PC (MsWord/VBA/ VB/Access)
- Autotrol Technical Illustration
- ProductView
- PRO-E
- Adobe Illustrator
- Adobe Photoshop
- Authorware
- QuickSilver (Packaging)

STORAGE AND MANAGEMENT

- Content@
- Documentum
- Access
- IBM Mainframe (LS3Q)
- SLIC/SLICwave

ASSEMBLY/ DATA TRANSFORM

- Omnimark
- Perl
- VB/VBA
- Sed/Awk/Nawk
- Unix Shell
- Xychange
- EMS2 RPSTL Editing Tool (ERET)

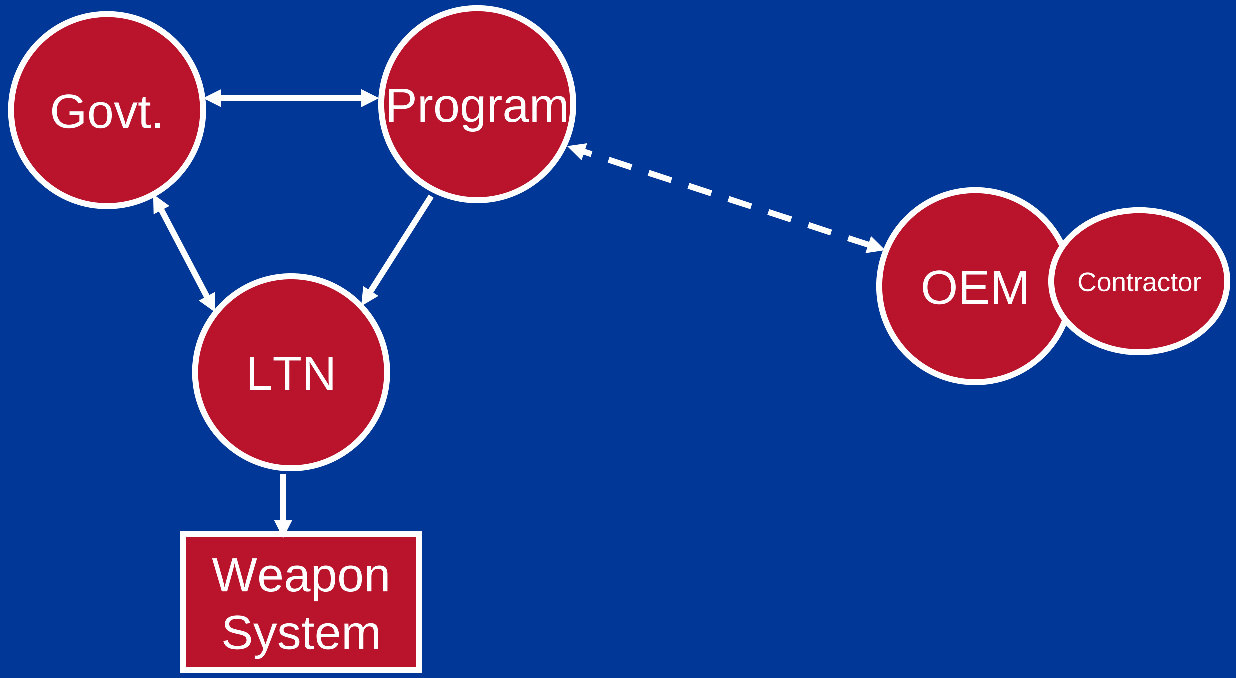
PRODUCTION

- Content@
- XPP (XML Publishing)
- Epic
- EMS2 Reformatter /Linker/Compiler
- InfoLinker
- Adobe Acrobat
- IBM Mainframe (LS3Q) –LSA36 Delivery
- MRP (Pricing)
- WebFLIS (Prov NSN)

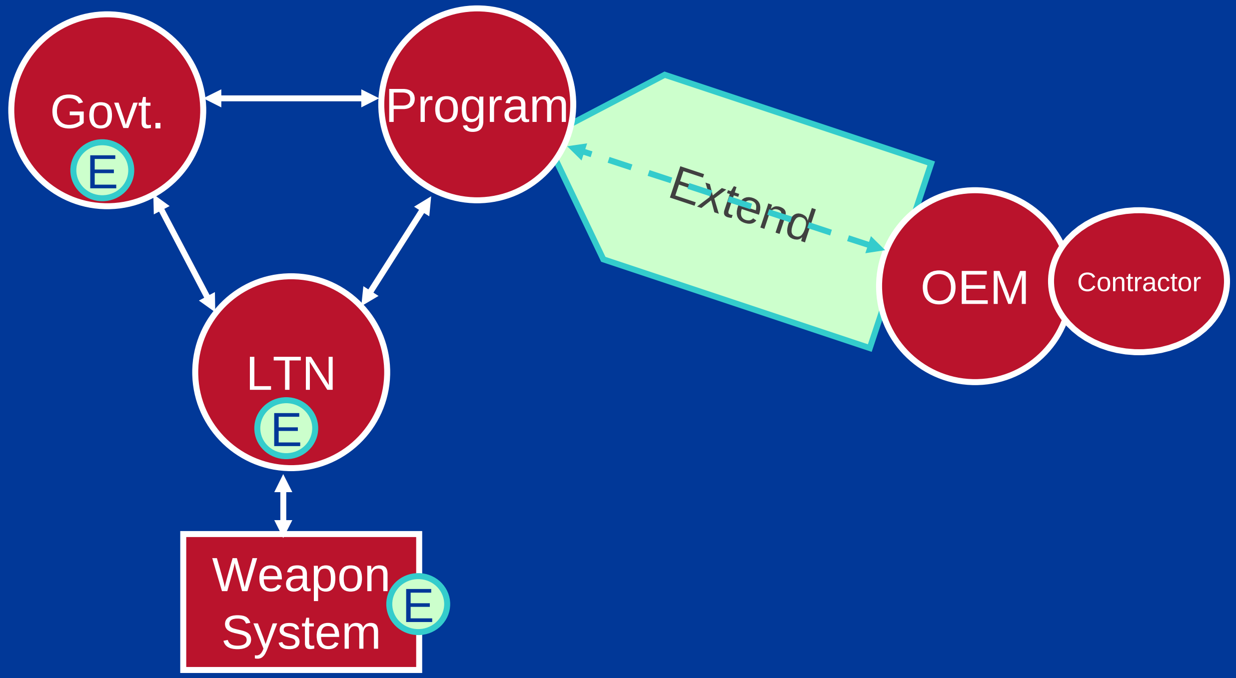
DEPLOYMENT

- Adobe PDF
- EMS2 Runtime
- InstallShield
- Internet Explorer
- Powerarchiver/ Winzip

The Enterprise, High-Level Military



The Enterprise, High-Level Military



Why? Products Delivered over Network

- Data is now capable of streaming and is considered developed in native format for delivery over a network. (serialization)
- Near-time access is required, updates as well.
- Publish-Subscribe methods is desired, only when I need it mentality
- Authentification, Security maintained easily
- Information Assurance can be applied
- Feedback to OEM

Attempts to Solve

- Replacing legacy systems with integrated COTS packages (like Baan, PeopleSoft, and SAP)
- Developing data and information warehouses
- Establishing central operational data stores or data clearinghouses
- Implementing Enterprise Portals
- Using Middleware
- Using XML
- Reengineering all applications to a single architecture
- All of these approaches have value and some will even provide at least temporary benefit. However, unless they are business-driven and model-based they are more likely to further compound the problems than provide a solution.

Design for Six Sigma (DFSS)

- The goal of DFSS is to create designs that are development efficient, capable of exceptionally high yields and are robust to process variations.

Design for Six Sigma (DFSS)

- *Capture Voice of Customer & Define Eng. Requirements*
  - Wants & needs tools
  - Customer use observations
  - Kano Analysis
  - Quality Function Deployment (QFD)
- *Develop Concepts and Select*
  - Pugh Matrix
  - Axiomatic Design
  - TRIZ
  - Failure Mode & Effects Analysis (FMEA)
- *Develop Detailed Design*
  - Systems Engineering
  - Function Models & FMEAs
  - Transfer Functions
- *Statistical Design*
  - Monte Carlo Analysis
- *Design for Robust Performance*
  - Design of Experiments
  - Robust Design
  - Design for Reliability
- *Design for Manufacturability*
  - Process Capability Databases
  - Statistical Tolerancing
- *Predict Quality*
  - DFSS Scorecards

Axiomatic Design

- Axiomatic design is <u>systems design methodology</u> using matrix methods to systematically analyze the transformation of customer needs into functional requirements, design parameters, and process variables.

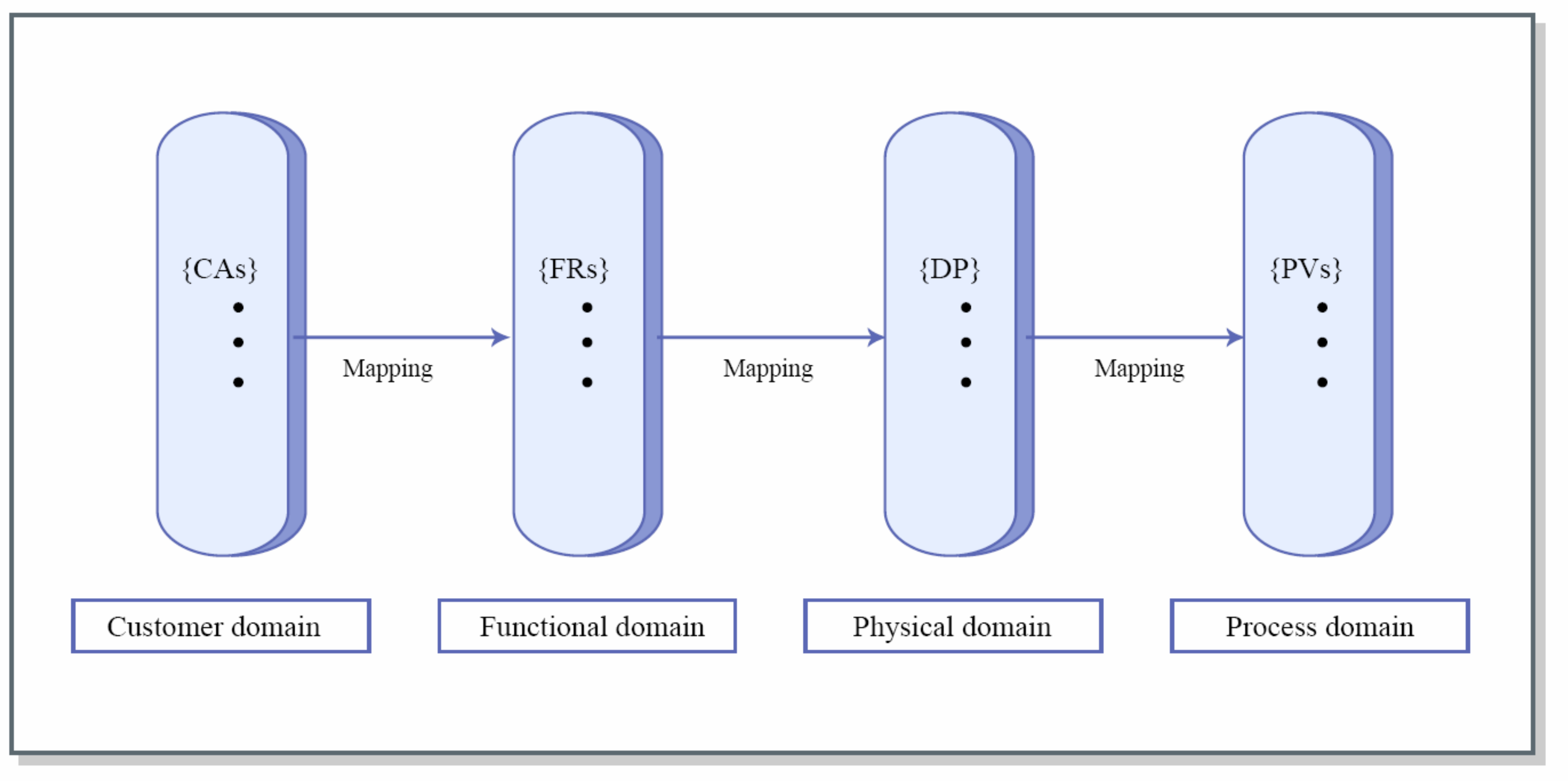
2 Principles of Axiomatic Design

- Axiom 1:The Independence Axiom
  - *Maintain the independence of the functional requirements (FRs)*
- Axiom 2:The Information Axiom
  - *Minimize the information content of the design*

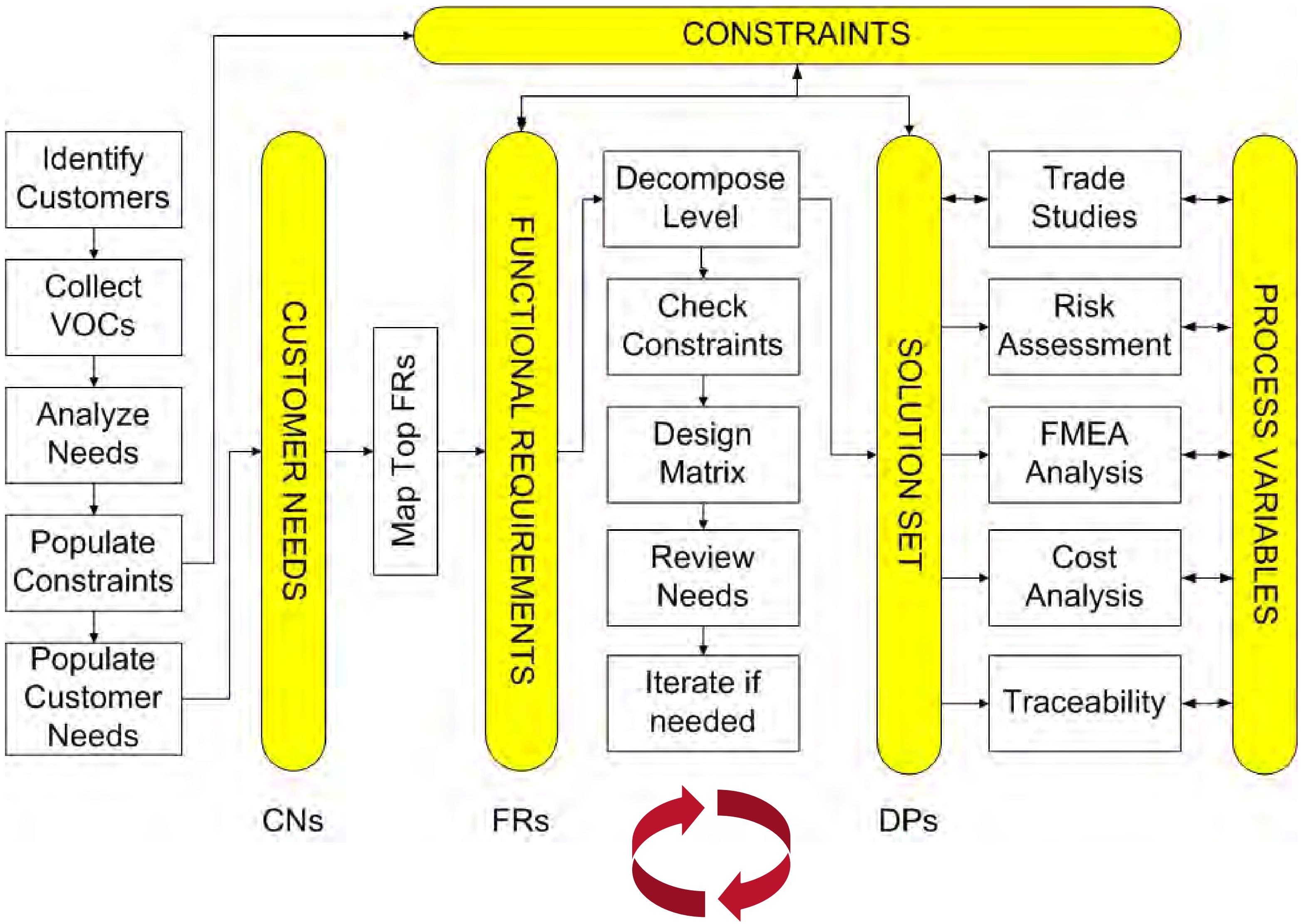
Key Axiomatic Design Definitions

- *Customer Needs (CN)*
  - Collection of statements expressed in the "voice of the customer" that express the customers' perceptions of the design task
- *Functional Requirement (FR)*
  - Minimum set of independent requirements that completely characterize the functional needs of the product (or software, organizations, systems, etc.) in the functional domain
- *Constraint (C)*
  - Bounds on acceptable solutions
  - There are two kinds of constraints:
    - Input constraints
      - Imposed as part of the design specifications
    - System constraints
      - Imposed by the system in which the design solution must function
- *Design parameter (DP)*
  - Key physical (or other equivalent terms in the case of software design, etc.) variables in the physical domain that characterize the design that satisfies the specified FRs.

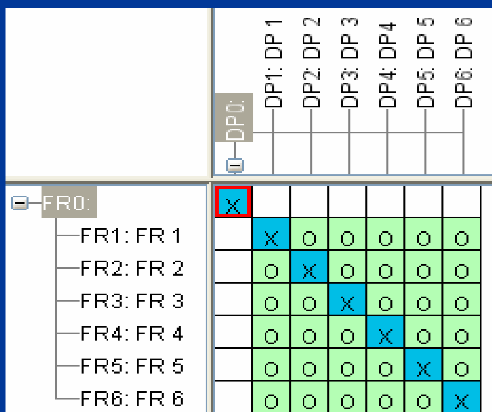
Four Axiomatic Domains



Overall Axiomatic Process



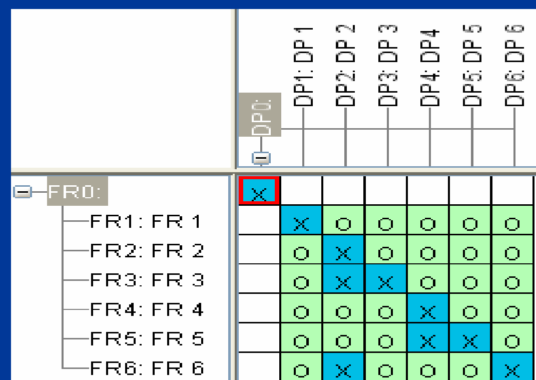
Three States of Functional Coupling



Uncoupled

Each DP uniquely satisfies a single FR

Order of Development and Function not important

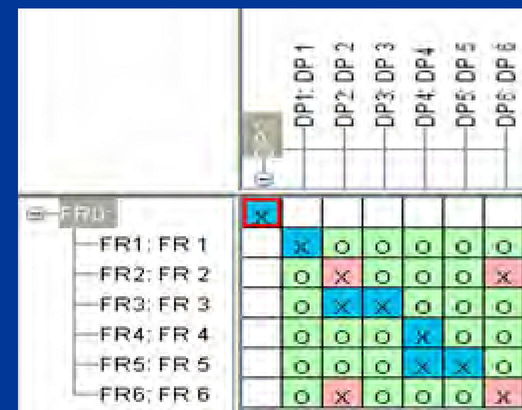


Decoupled

Some DP's impact more than one FR.

A Progressive Solution is possible

Order of Development and Function are important



Coupled

Some DP's impact more than one FR.

A Simultaneous Solution is required

Order of Development and Function are important and will require iterations

Axiomatic design:
Evaluate options using the independence axiom

The Independence Axiom:
Maintain independence between functional requirements

Coupled - *Unacceptable*

	DP.1	DP.2	DP.3
FR.1	X	X	X
FR.2	X	X	X
FR.3	X	X	X

Decoupled - *Acceptable*

FR.1	X	O	O
FR.2	X	X	O
FR.3	X	X	X

Uncoupled - *Desired*

	DP.1	DP.2	DP.3
FR.1	X	O	O
FR.2	O	X	O
FR.3	O	O	X

Analysis

- Analysis from DFSS axiomatic design methods indicate the need for a point-point solution, (eliminate design coupling) specifically to meet the critical component requirements, however a technology which will expand (Design Parameter).

- A methodology of delivering just the interface to and from the components, streamed line for global access, performance in near-time and system delivered in less than a year time (Critical Key Parameters).

- A unique approach is required, which resulted in a new way for successful Application Integration and Deployment of Data with the demands specified.

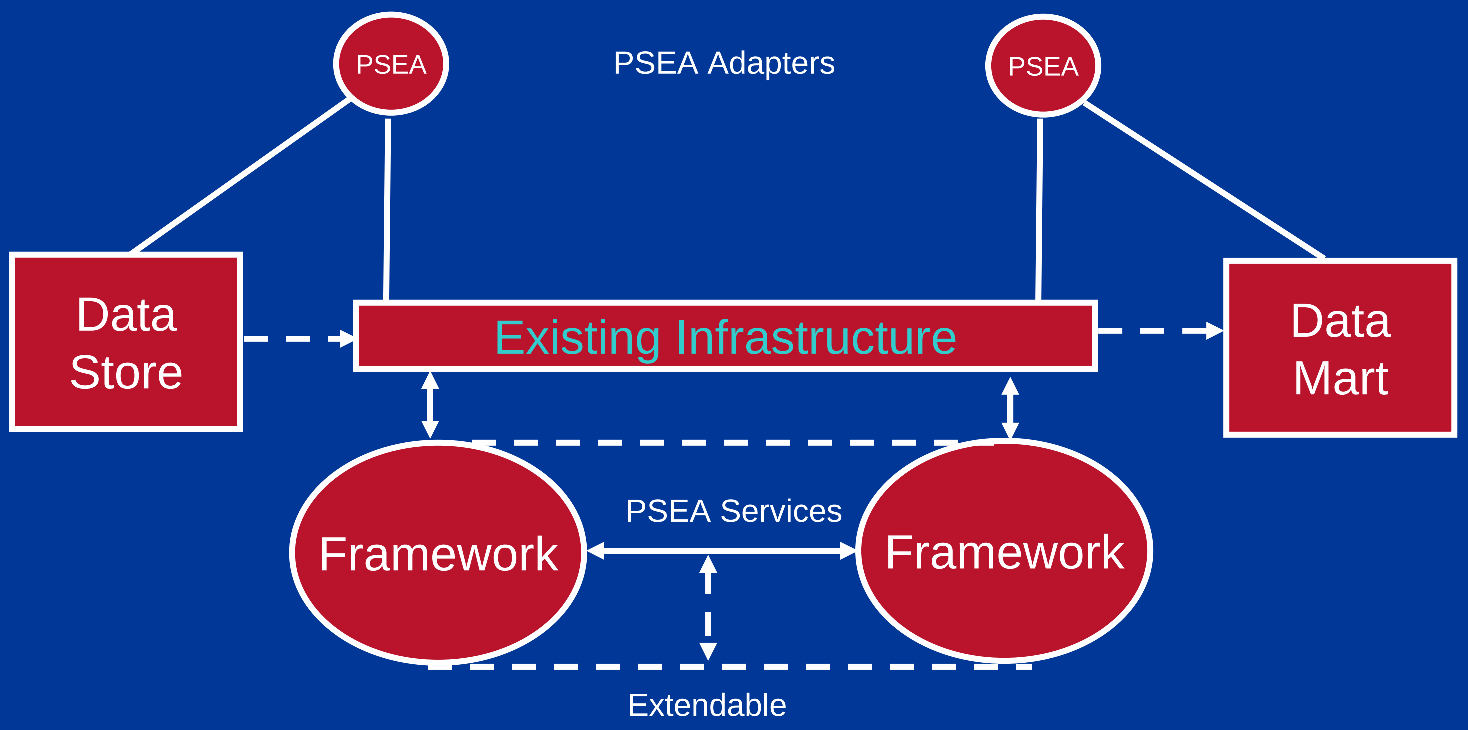
- It is being called Point Service Enterprise Architecture (PSEA).
- Where a Point Service Enterprise Architecture links an enterprise's business architecture with its existing enterprise systems and applications utilizing existing software component frameworks that can be applied specifically to meet a business practice. Point-to-Point Application Services.

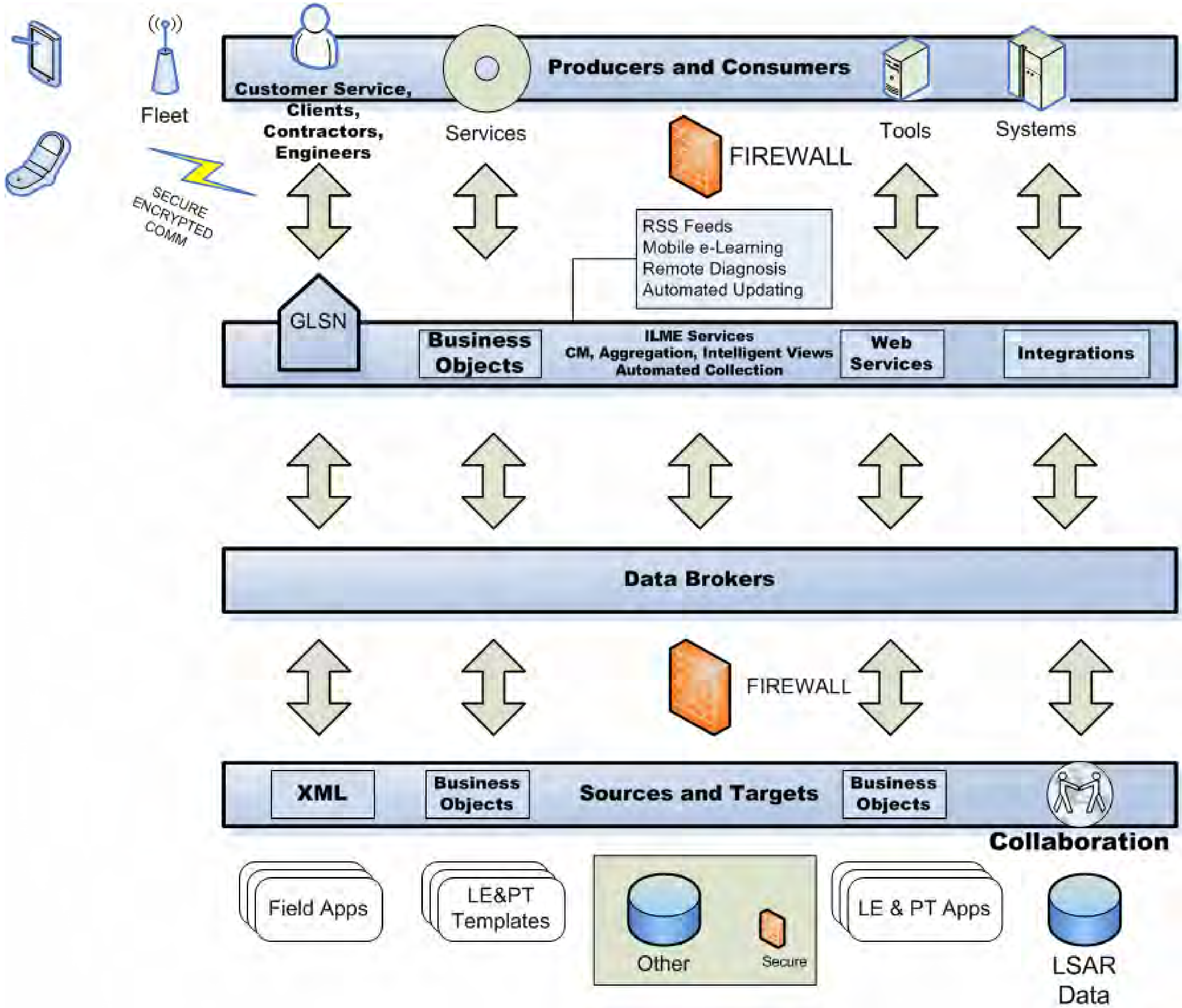
- .NET, J2EE, SOA Architectures, ect all are enabling technologies, it's the arrangement of the frameworks interfaced to existing systems with interlacing services over a business process.

PSEA

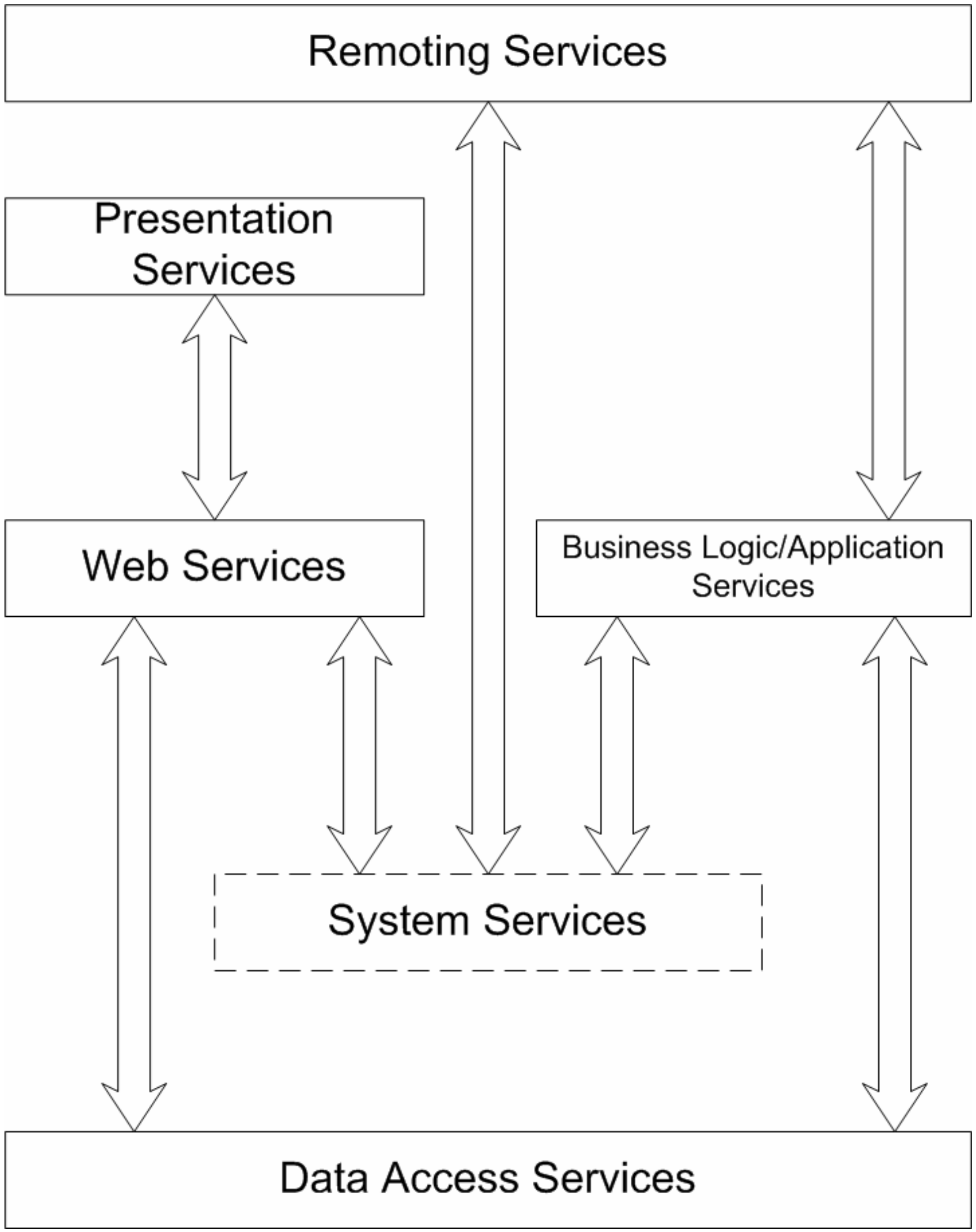
- A well-documented process architecture is critical, with a precise logical organization of information pertaining to the following elements:
  - Strategic goals, objectives, and strategies
  - Business rules and measures
  - Information requirements
  - Processes, systems and applications
  - Relationships between architecture elements
  - Technology infrastructure

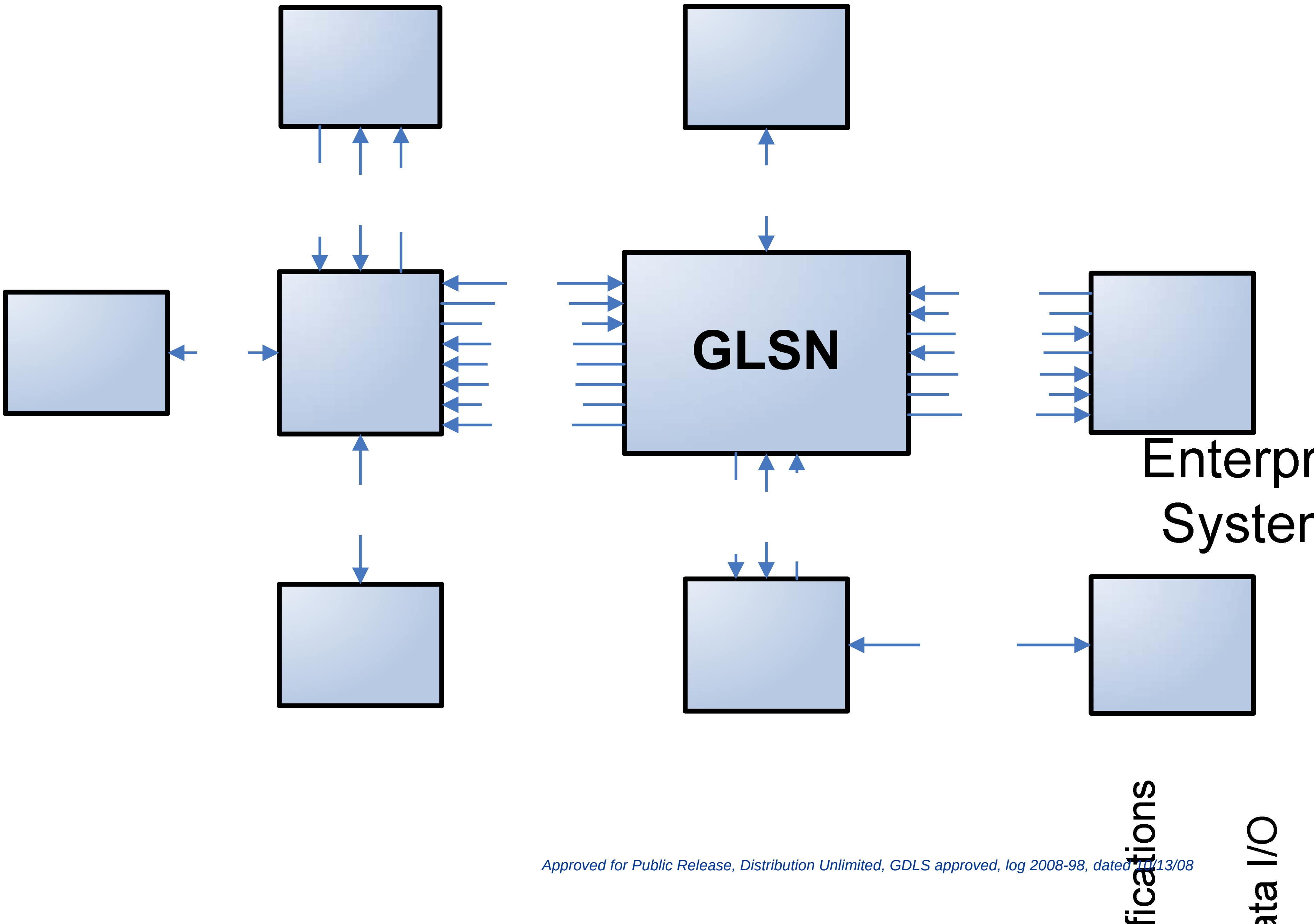
PSEA High-Level





Approved for Public Release, Distribution Unlimited, GDLS approved, log 2008-98, dated 10/13/08


Remoting Services
Presentation Services
Web Services
Business Logic/Application Services
System Services
Data Access Services



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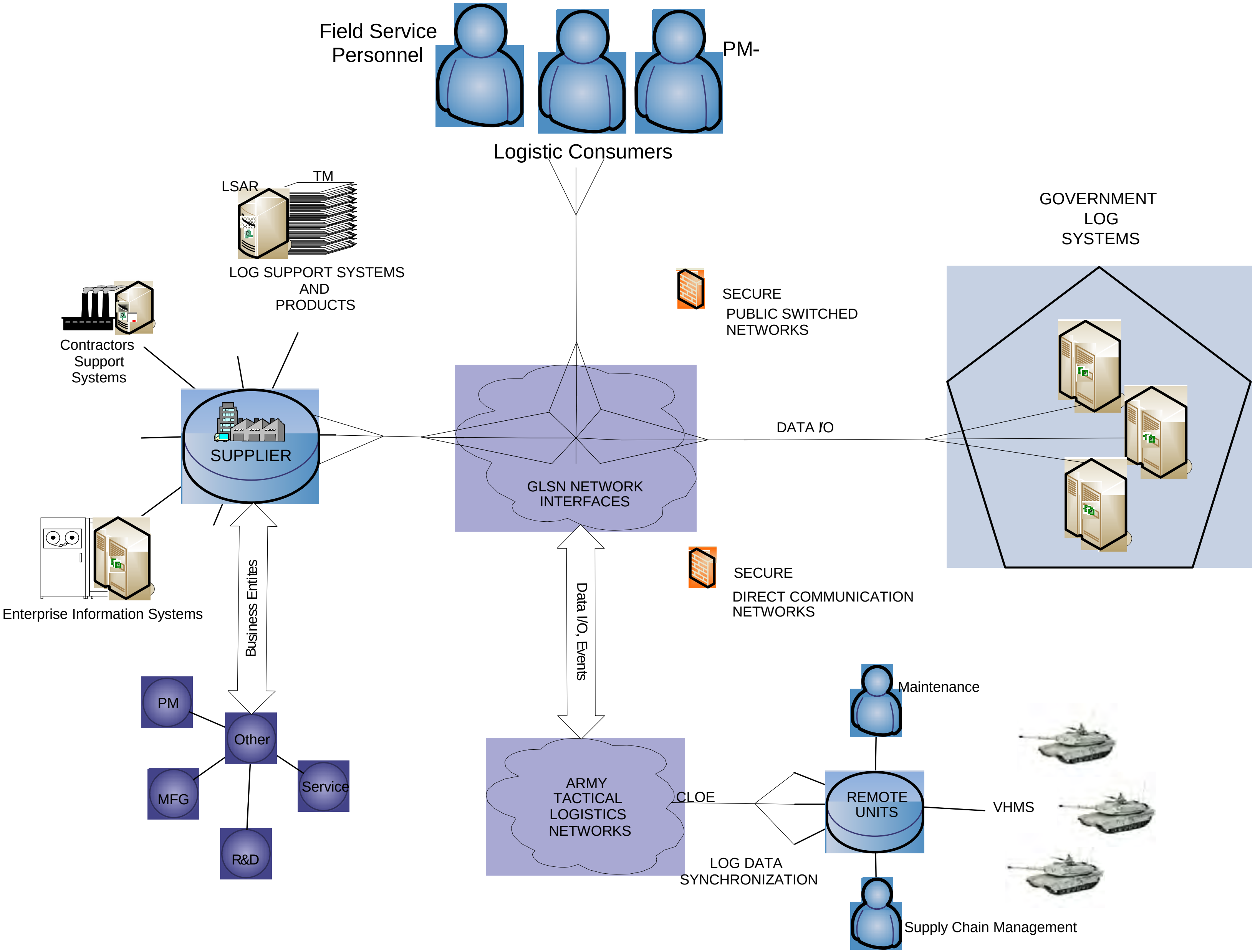
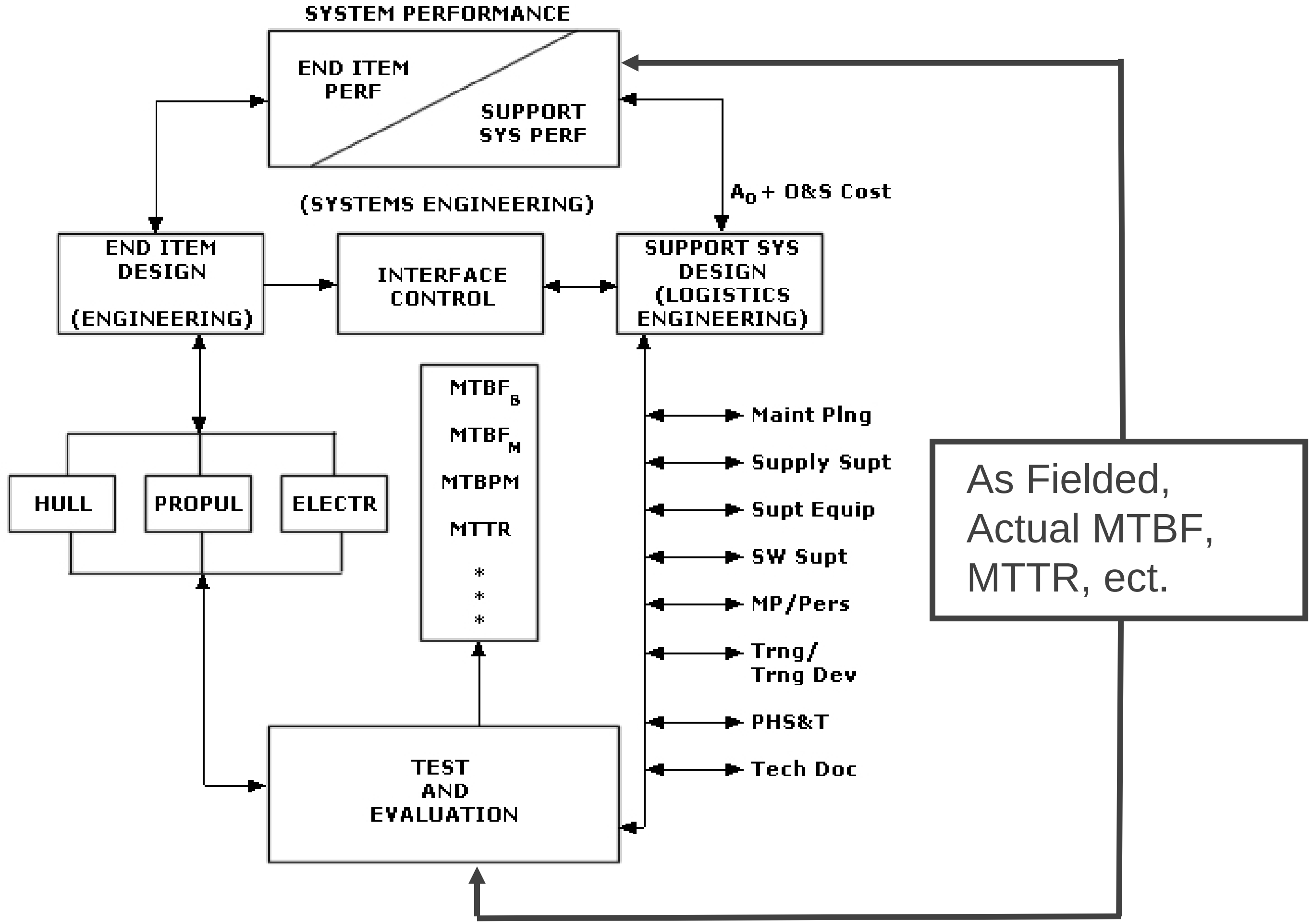

Field Service Personnel
PM-
Logistic Consumers
LSAR
TM
LOG SUPPORT SYSTEMS AND PRODUCTS
Contractors Support Systems
GOVERNMENT LOG SYSTEMS
SECURE PUBLIC SWITCHED NETWORKS
SUPPLIER
DATA I/O
GLSN NETWORK INTERFACES
Enterprise Information Systems
Business Entites
Data I/O, Events
SECURE DIRECT COMMUNICATION NETWORKS
PM
Other
MFG
Service
R&D
Maintenance
ARMY TACTICAL LOGISTICS NETWORKS
CLOE
REMOTE UNITS
VHMS
LOG DATA SYNCHRONIZATION
Supply Chain Management


SYSTEM PERFORMANCE
END ITEM PERF
SUPPORT SYS PERF
(SYSTEMS ENGINEERING)
A_O + O&S Cost
END ITEM DESIGN
(ENGINEERING)
INTERFACE CONTROL
SUPPORT SYS DESIGN (LOGISTICS ENGINEERING)
HULL
PROPUL
ELECTR
$MTBF_B$
$MTBF_M$
MTBPM
MTTR
*
*
*
Maint Plng
Supply Supt
Supt Equip
SW Supt
MP/Pers
Trng/
Trng Dev
PHS&T
Tech Doc
TEST AND EVALUATION
As Fielded, Actual MTBF, MTTR, ect.

Conclusion

- (PSEA) Point services allow enterprises to develop applications on globally distributed computing platform effectively.

- Modernization Efforts, bridging Contractor to Government:
- GLSN (Global Logistics Support Network)
- CLOE (Common Logistics Operating Environment)
- VHMS (Vehicle Health Management Systems

Questions, Other Information

- Whitepaper on PSEA is available
- Proven – GD Enterprise and Army

GENERAL DYNAMICS

ORACLE®

Enterprise Approach to Knowledge Management

October 22, 2008

Institutionalize Best Practices

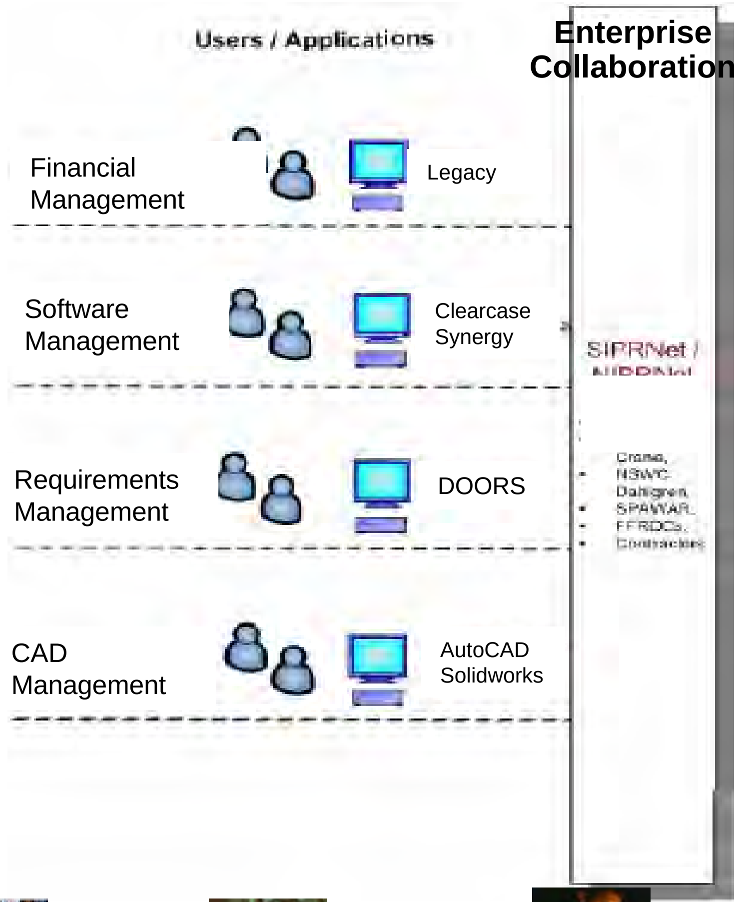
HARRIS

- Scorecarding yielded 75% improvement by a key supplier
- Detected and replaced 8 discontinued parts before design started on major program
- Alternate sources of supply were identified on 27% of parts on a new design

ViaSat

- Decreased time to market by 10%
- Improved operational efficiency by 30%
- Reduced new product introduction time by 44%

Enterprise Knowledge



Customers

Contractors/ Suppliers

Program Team

Enterprise Integrated Data Environment (IDE)

Portfolio Management

- Earned Value Management
- Performance Metrics
- Ad-Hoc Reports

Program Management

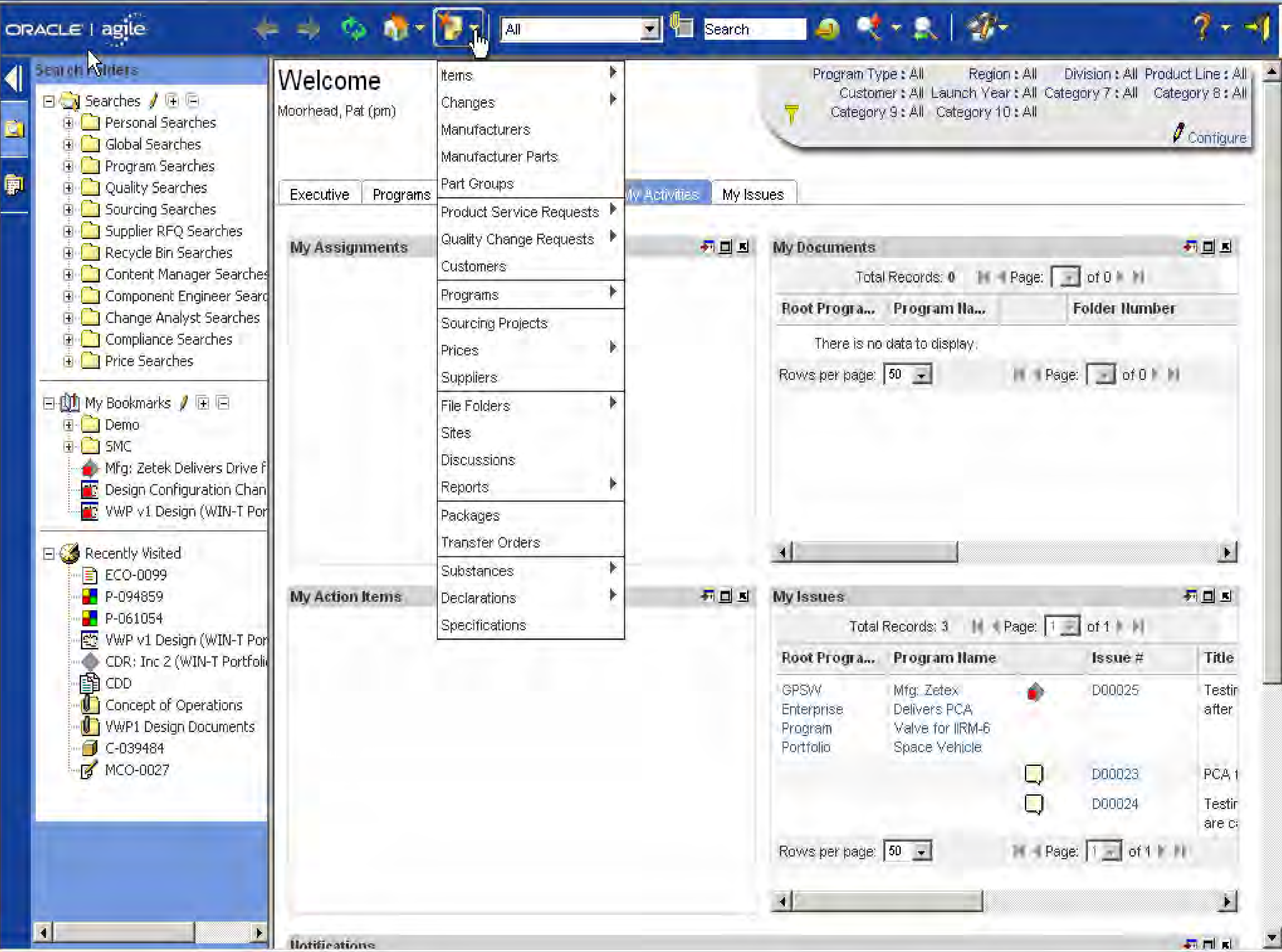
- Master Schedule
- Program Mgmt
- Milestone Tracking
- CDRL Documents

Systems Engineering

- Capabilities
- Requirements Mgmt
- Systems (SoS) Design
- Design/Operations Testing

Toolset

Workflow	Content Mgmt	Web Conference
Business Rules	Roles & Privileges	Calendar


ORACLE | agile
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Global Searches
Program Searches
Quality Searches
Sourcing Searches
Supplier RFQ Searches
Recycle Bin Searches
Content Manager Searches
Component Engineer Searc
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Compliance Searches
Price Searches
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Mfg: Zetek Delivers Drive f
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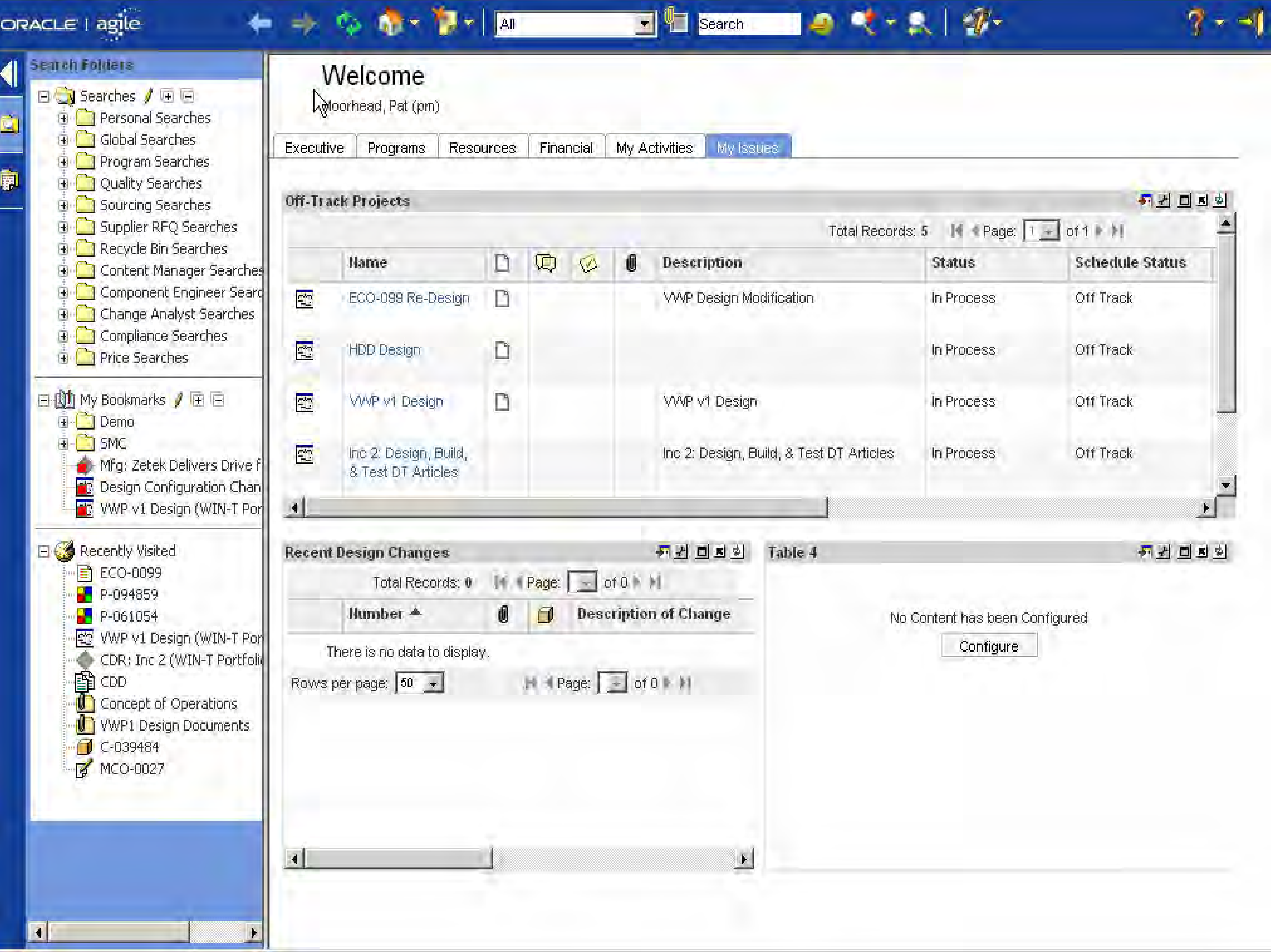
VWP v1 Design (WIN-T Por
Recently Visited
ECO-0099
P-094859
P-061054
VWP v1 Design (WIN-T Por
CDR: Inc 2 (WIN-T Portfoli
CDD
Concept of Operations
VWP1 Design Documents
C-039484
MCO-0027
Welcome
Moorhead, Pat (pm)
Items
Changes
Manufacturers
Manufacturer Parts
Part Groups
Product Service Requests
Quality Change Requests
Customers
Programs
Sourcing Projects
Prices
Suppliers
File Folders
Sites
Discussions
Reports
Packages
Transfer Orders
Substances
Declarations
Specifications
Program Type : All Region : All Division : All Product Line : All
Customer : All Launch Year : All Category 7 : All Category 8 : All
Category 9 : All Category 10 : All
Configure
Executive
Programs
My Activities
My Issues
My Assignments
My Documents
Total Records: 0 Page: of 0
Root Progra... Program Na... Folder Number
There is no data to display.
Rows per page: 50 Page: of 0
My Action Items
My Issues
Total Records: 3 Page: 1 of 1
Root Progra... Program Name Issue # Title
GPSW Enterprise Program Portfolio
Mfg: Zetex Delivers PCA Valve for IIRM-6 Space Vehicle
D00025
D00023
D00024
Rows per page: 50 Page: 1 of 1
Notifications


ORACLE | agile
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Personal Searches
Global Searches
Program Searches
Quality Searches
Sourcing Searches
Supplier RFQ Searches
Recycle Bin Searches
Content Manager Searches
Component Engineer Searc
Change Analyst Searches
Compliance Searches
Price Searches
My Bookmarks
Demo
SMC
Mfg: Zetek Delivers Drive f
Design Configuration Chan
VWP v1 Design (WIN-T Por
Recently Visited
ECO-0099
P-094859
P-061054
VWP v1 Design (WIN-T Por
CDR: Inc 2 (WIN-T Portfoli
CDD
Concept of Operations
VWP1 Design Documents
C-039484
MCO-0027
Welcome
Moorhead, Pat (pm)
Executive
Programs
Resources
Financial
My Activities
My Issues
Off-Track Projects
Total Records: 5
Page: 1 of 1
Name
Description
Status
Schedule Status
ECO-099 Re-Design
VWP Design Modification
In Process
Off Track
HDD Design
In Process
Off Track
VWP v1 Design
VWP v1 Design
In Process
Off Track
Inc 2: Design, Build, & Test DT Articles
Inc 2: Design, Build, & Test DT Articles
In Process
Off Track
Recent Design Changes
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Number
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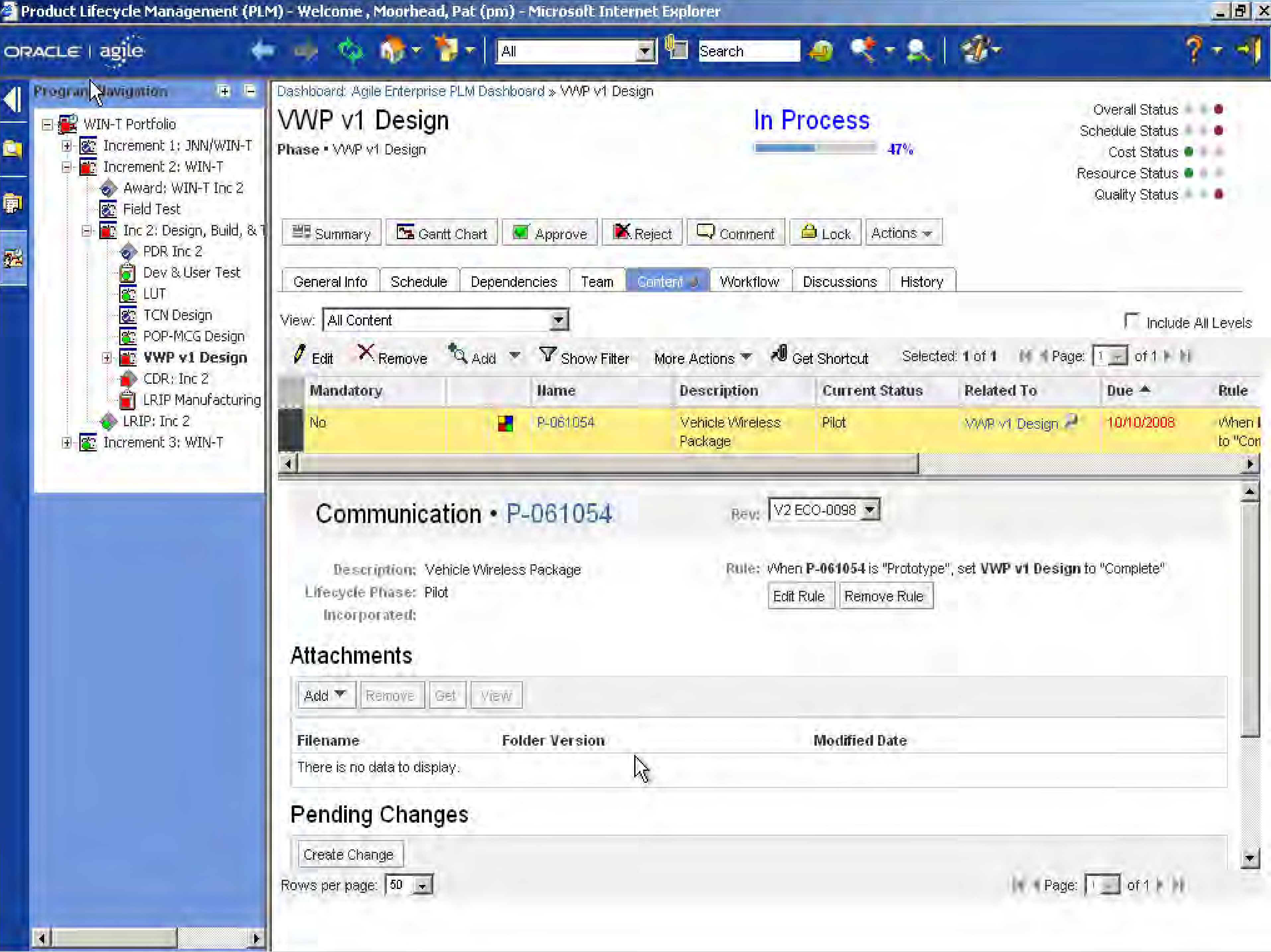
Product Lifecycle Management (PLM) - Welcome , Moorhead, Pat (pm) - Microsoft Internet Explorer
ORACLE | agile
All
Search
Program Navigation
WIN-T Portfolio
Increment 1: JNN/WIN-T
Increment 2: WIN-T
Award: WIN-T Inc 2
Field Test
Inc 2: Design, Build, &
PDR Inc 2
Dev & User Test
LUT
TCN Design
POP-MCG Design
VWP v1 Design
CDR: Inc 2
LRIP Manufacturing
LRIP: Inc 2
Increment 3: WIN-T
Dashboard: Agile Enterprise PLM Dashboard » VWP v1 Design
VWP v1 Design
Phase • VWP v1 Design
In Process
47%
Overall Status
Schedule Status
Cost Status
Resource Status
Quality Status
Summary
Gantt Chart
Approve
Reject
Comment
Lock
Actions
General Info
Schedule
Dependencies
Team
Content
Workflow
Discussions
History
View: All Content
Include All Levels
Edit
Remove
Add
Show Filter
More Actions
Get Shortcut
Selected: 1 of 1
Page: 1 of 1
Mandatory
Name
Description
Current Status
Related To
Due
Rule
No
P-061054
Vehicle Wireless Package
Pilot
VWP v1 Design
10/10/2008
When
to "Con
Communication • P-061054
Rev: V2 ECO-0098
Description: Vehicle Wireless Package
Lifecycle Phase: Pilot
Incorporated:
Rule: When P-061054 is "Prototype", set VWP v1 Design to "Complete"
Edit Rule
Remove Rule
Attachments
Add
Remove
Get
View
Filename
Folder Version
Modified Date
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Pending Changes
Create Change
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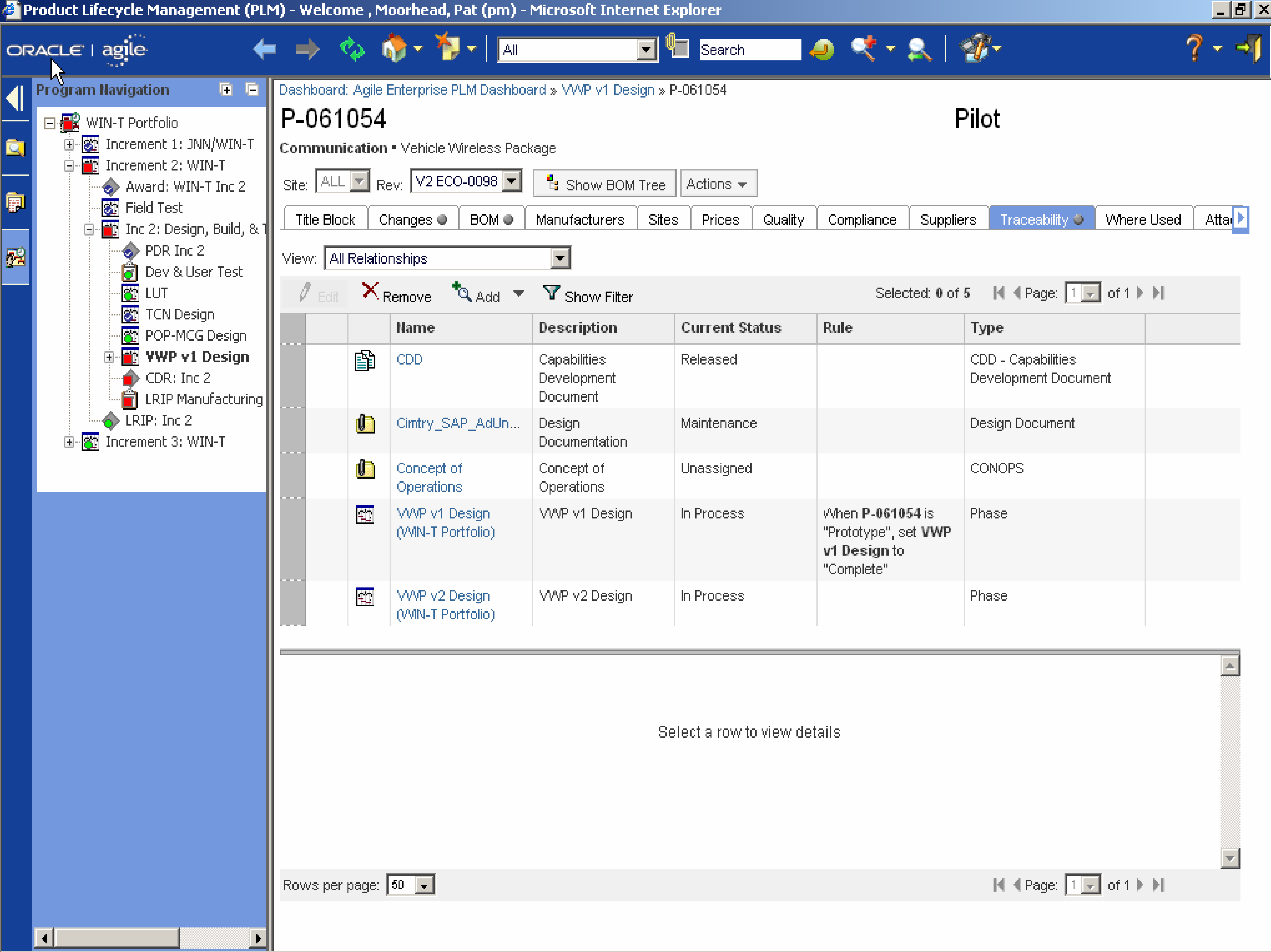
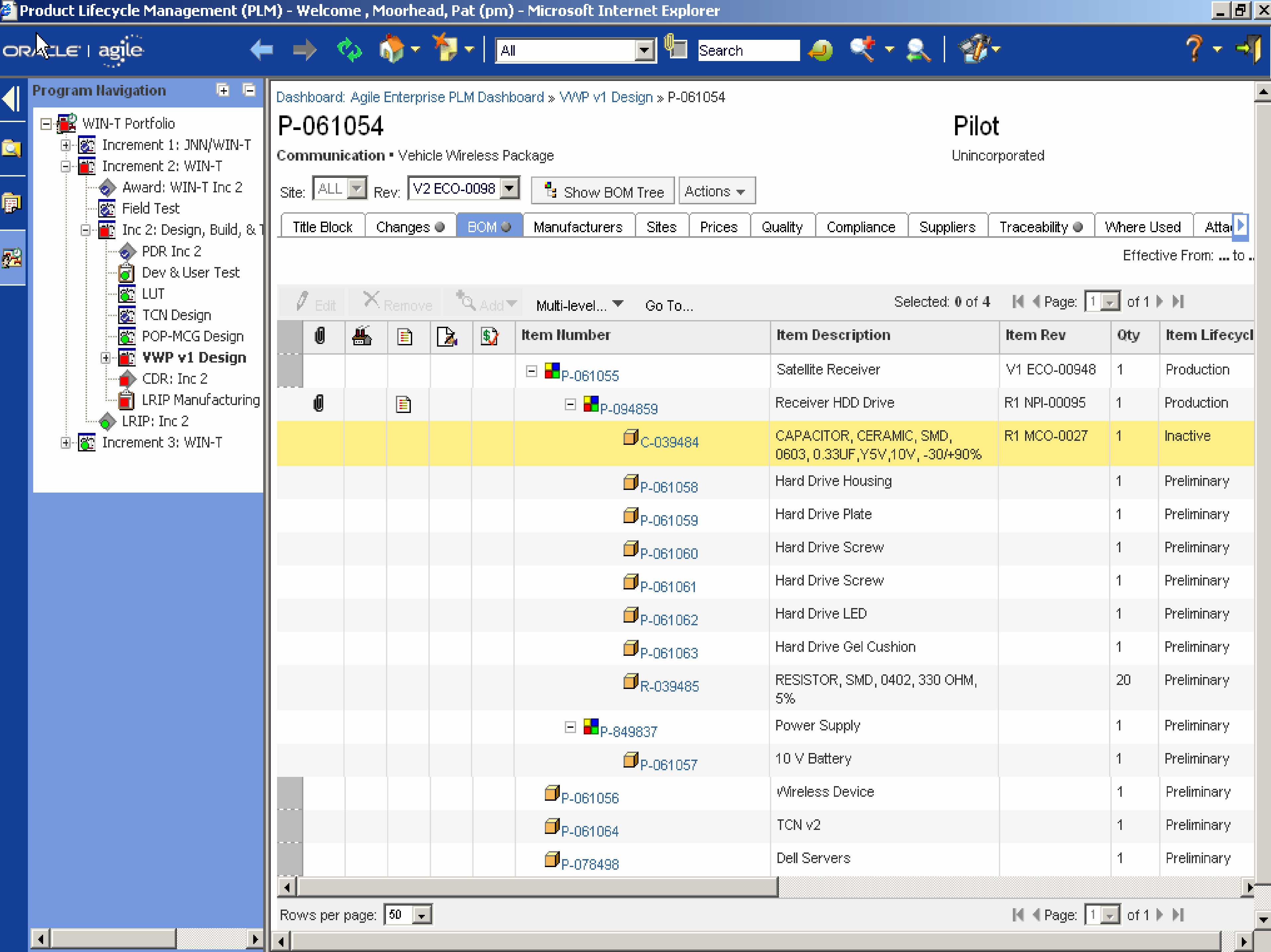
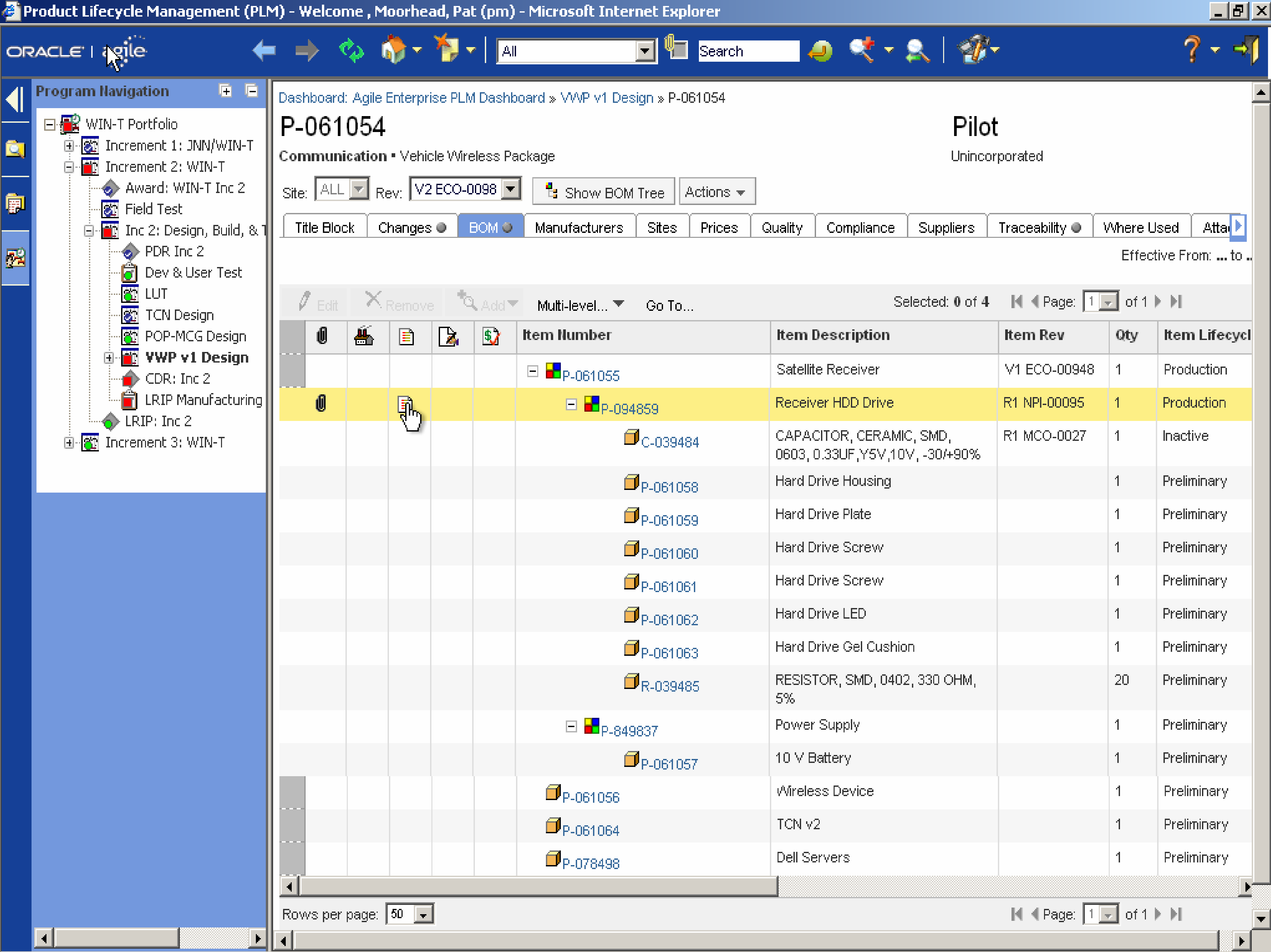
Page: 1 of 1


Product Lifecycle Management (PLM) - Welcome , Moorhead, Pat (pm) - Microsoft Internet Explorer
ORACLE | agile
All
Search
Program Navigation
WIN-T Portfolio
Increment 1: JNN/WIN-T
Increment 2: WIN-T
Award: WIN-T Inc 2
Field Test
Inc 2: Design, Build, & T
PDR Inc 2
Dev & User Test
LUT
TCN Design
POP-MCG Design
VWP v1 Design
CDR: Inc 2
LRIP Manufacturing
LRIP: Inc 2
Increment 3: WIN-T
Dashboard: Agile Enterprise PLM Dashboard » VWP v1 Design » P-061054
P-061054
Pilot
Communication • Vehicle Wireless Package
Site: ALL
Rev: V2 ECO-0098
Show BOM Tree
Actions
Title Block
Changes
BOM
Manufacturers
Sites
Prices
Quality
Compliance
Suppliers
Traceability
Where Used
Atta
View: All Relationships
Edit
Remove
Add
Show Filter
Selected: 0 of 5
Page: 1 of 1
Name
Description
Current Status
Rule
Type
CDD
Capabilities Development Document
Released
CDD - Capabilities Development Document
Cimtry_SAP_AdUn...
Design Documentation
Maintenance
Design Document
Concept of Operations
Concept of Operations
Unassigned
CONOPS
VWP v1 Design (WIN-T Portfolio)
VWP v1 Design
In Process
When P-061054 is "Prototype", set VWP v1 Design to "Complete"
Phase
VWP v2 Design (WIN-T Portfolio)
VWP v2 Design
In Process
Phase
Select a row to view details
Rows per page: 50
Page: 1 of 1



Item Number	Item Description	Item Rev	Qty	Item Lifecycl
P-061055	Satellite Receiver	V1 ECO-00948	1	Production
P-094859	Receiver HDD Drive	R1 NPI-00095	1	Production
C-039484	CAPACITOR, CERAMIC, SMD, 0603, 0.33UF,Y5V,10V, -30/+90%	R1 MCO-0027	1	Inactive
P-061058	Hard Drive Housing		1	Preliminary
P-061059	Hard Drive Plate		1	Preliminary
P-061060	Hard Drive Screw		1	Preliminary
P-061061	Hard Drive Screw		1	Preliminary
P-061062	Hard Drive LED		1	Preliminary
P-061063	Hard Drive Gel Cushion		1	Preliminary
R-039485	RESISTOR, SMD, 0402, 330 OHM, 5%		20	Preliminary
P-849837	Power Supply		1	Preliminary
P-061057	10 V Battery		1	Preliminary
P-061056	Wireless Device		1	Preliminary
P-061064	TCN v2		1	Preliminary
P-078498	Dell Servers		1	Preliminary


Product Lifecycle Management (PLM) - Welcome , Moorhead, Pat (pm) - Microsoft Internet Explorer
ORACLE | agile
All
Search
Program Navigation
WIN-T Portfolio
Increment 1: JNN/WIN-T
Increment 2: WIN-T
Award: WIN-T Inc 2
Field Test
Inc 2: Design, Build, & T
PDR Inc 2
Dev & User Test
LUT
TCN Design
POP-MCG Design
VWP v1 Design
CDR: Inc 2
LRIP Manufacturing
LRIP: Inc 2
Increment 3: WIN-T
Dashboard: Agile Enterprise PLM Dashboard » VWP v1 Design » P-061054
P-061054
Pilot
Communication • Vehicle Wireless Package
Unincorporated
Site: ALL
Rev: V2 ECO-0098
Show BOM Tree
Actions
Title Block
Changes
BOM
Manufacturers
Sites
Prices
Quality
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Edit
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Selected: 0 of 4
Page: 1 of 1
Item Number
Item Description
Item Rev
Qty
Item Lifecycl
P-061055 Satellite Receiver V1 ECO-00948 1 Production
P-094859 Receiver HDD Drive R1 NPI-00095 1 Production
C-039484 CAPACITOR, CERAMIC, SMD, 0603, 0.33UF,Y5V,10V, -30/+90% R1 MCO-0027 1 Inactive
P-061058 Hard Drive Housing 1 Preliminary
P-061059 Hard Drive Plate 1 Preliminary
P-061060 Hard Drive Screw 1 Preliminary
P-061061 Hard Drive Screw 1 Preliminary
P-061062 Hard Drive LED 1 Preliminary
P-061063 Hard Drive Gel Cushion 1 Preliminary
R-039485 RESISTOR, SMD, 0402, 330 OHM, 5% 20 Preliminary
P-849837 Power Supply 1 Preliminary
P-061057 10 V Battery 1 Preliminary
P-061056 Wireless Device 1 Preliminary
P-061064 TCN v2 1 Preliminary
P-078498 Dell Servers 1 Preliminary
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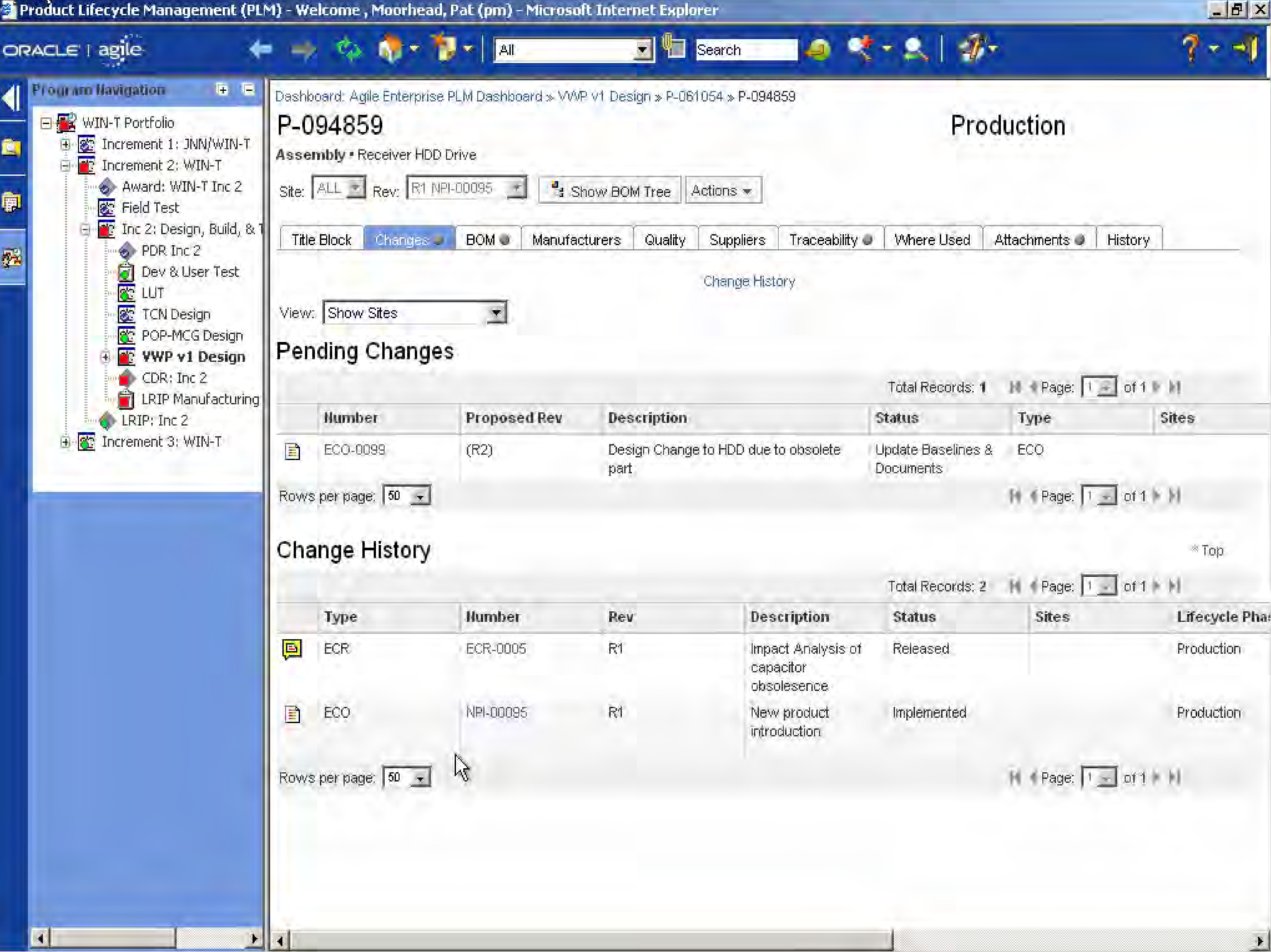
Page: 1 of 1


Product Lifecycle Management (PLM) - Welcome , Moorhead, Pat (pm) - Microsoft Internet Explorer
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WIN-T Portfolio
Increment 1: JNN/WIN-T
Increment 2: WIN-T
Award: WIN-T Inc 2
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PDR Inc 2
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POP-MCG Design
VWP v1 Design
CDR: Inc 2
LRIP Manufacturing
LRIP: Inc 2
Increment 3: WIN-T
Dashboard: Agile Enterprise PLM Dashboard » VWP v1 Design » P-061054 » P-094859
P-094859
Production
Assembly • Receiver HDD Drive
Site: ALL
Rev: R1 NPI-00095
Show BOM Tree
Actions
Title Block
Changes
BOM
Manufacturers
Quality
Suppliers
Traceability
Where Used
Attachments
History
Change History
View: Show Sites
Pending Changes
Total Records: 1 Page: 1 of 1
Number
Proposed Rev
Description
Status
Type
Sites
ECO-0099
(R2)
Design Change to HDD due to obsolete part
Update Baselines & Documents
ECO
Rows per page: 50
Page: 1 of 1
Change History
Top
Total Records: 2 Page: 1 of 1
Type
Number
Rev
Description
Status
Sites
Lifecycle Pha
ECR
ECR-0005
R1
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Released
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NPI-00095
R1
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Implemented
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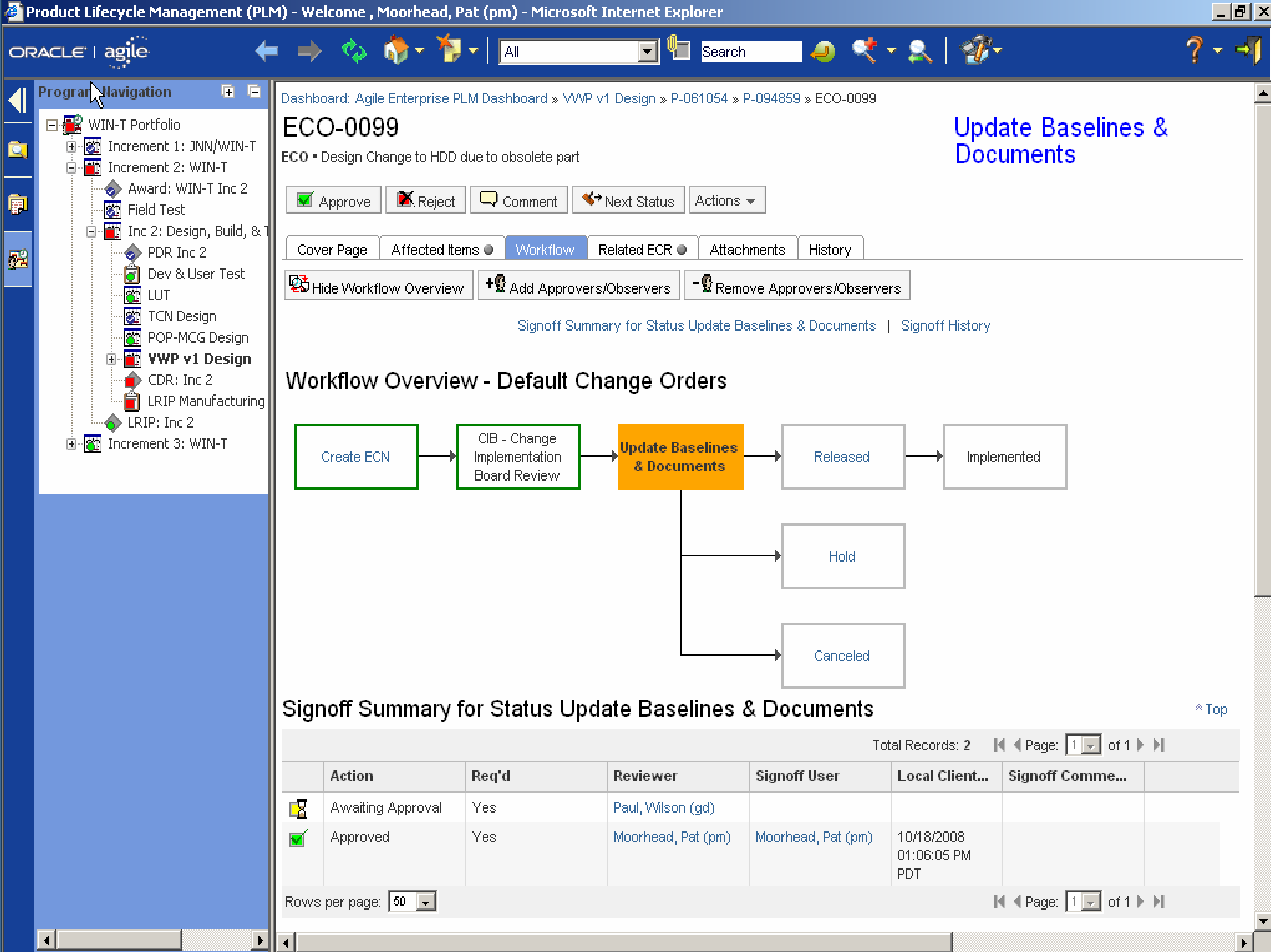
Product Lifecycle Management (PLM) - Welcome , Moorhead, Pat (pm) - Microsoft Internet Explorer
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Program Navigation
WIN-T Portfolio
Increment 1: JNN/WIN-T
Increment 2: WIN-T
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Inc 2: Design, Build, & T
PDR Inc 2
Dev & User Test
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POP-MCG Design
VWP v1 Design
CDR: Inc 2
LRIP Manufacturing
LRIP: Inc 2
Increment 3: WIN-T
Dashboard: Agile Enterprise PLM Dashboard » VWP v1 Design » P-061054 » P-094859 » ECO-0099
ECO-0099
ECO • Design Change to HDD due to obsolete part
Update Baselines & Documents
Approve
Reject
Comment
Next Status
Actions
Cover Page
Affected Items
Workflow
Related ECR
Attachments
History
Hide Workflow Overview
Add Approvers/Observers
Remove Approvers/Observers
Signoff Summary for Status Update Baselines & Documents | Signoff History
Workflow Overview - Default Change Orders
Create ECN
CIB - Change Implementation Board Review
Update Baselines & Documents
Released
Implemented
Hold
Canceled
Signoff Summary for Status Update Baselines & Documents
Top
Total Records: 2
Page: 1 of 1
Action
Req'd
Reviewer
Signoff User
Local Client...
Signoff Comme...
Awaiting Approval
Yes
Paul, Wilson (gd)
Approved
Yes
Moorhead, Pat (pm)
Moorhead, Pat (pm)
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Rows per page: 50
Page: 1 of 1

Dashboard: Agile Enterprise PLM Dashboard » VWP v1 Design » P-061054 » P-094859 » ECO-0099

ECO-0099

ECO • Design Change to HDD due to obsolete part

Update Baselines & Documents

Approve | Reject | Comment | Next Status | Actions

Cover Page | Affected Items | Workflow | Related ECR | Attachments | History

View: All Relationships

Remove | Add | Show Filter — Selected: 0 of 3 — Page: 1 of 1

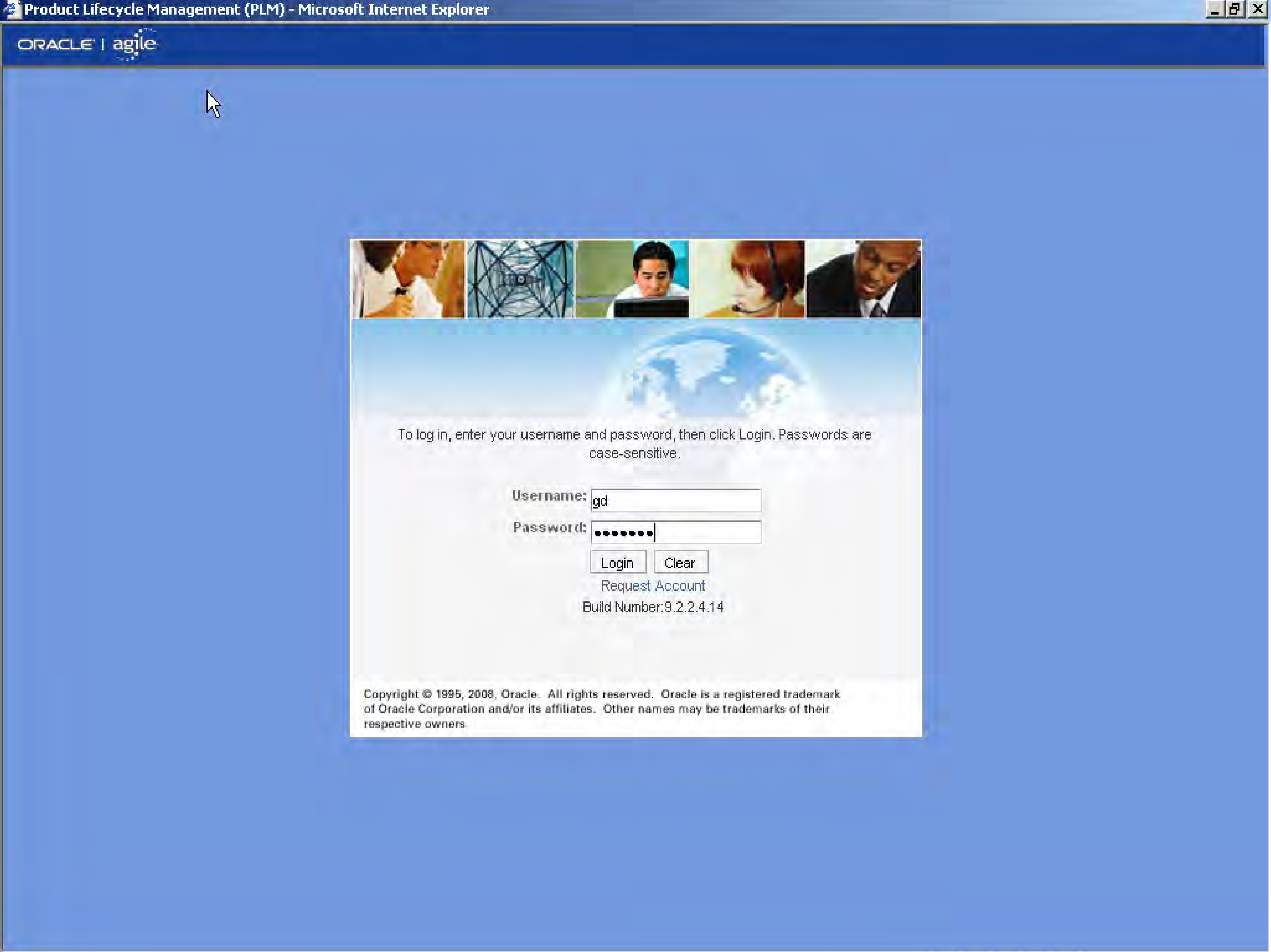
Name	Description	Current Status	Rule	Type
ECO-099 Re-Design (WIN-T Portfolio)	VWP Design Modification	In Process	When **ECO-0099** is "Released", set **ECO-099 Re-Design** to "Complete"	Phase
ECR-0006	Impact Analysis of HDD Design Change due to obsolesence of certain components	CCB		ECR
MCO-0027	Mfg dis-continuing capacitor part in March 2009	Released		MCO

Select a row to view details

Rows per page: 50 — Page: 1 of 1

Program Navigation

- WIN-T Portfolio
  - Increment 1: JNN/WIN-T
  - Increment 2: WIN-T
    - Award: WIN-T Inc 2
    - Field Test
    - Inc 2: Design, Build, & T
      - PDR Inc 2
      - Dev & User Test
      - LUT
      - TCN Design
      - POP-MCG Design
      - **VWP v1 Design**
      - CDR: Inc 2
      - LRIP Manufacturing
    - LRIP: Inc 2
  - Increment 3: WIN-T


Product Lifecycle Management (PLM) - Microsoft Internet Explorer
ORACLE | agile
To log in, enter your username and password, then click Login. Passwords are case-sensitive.
Username:
gd
Password:
Login
Clear
Request Account
Build Number:9.2.2.4.14
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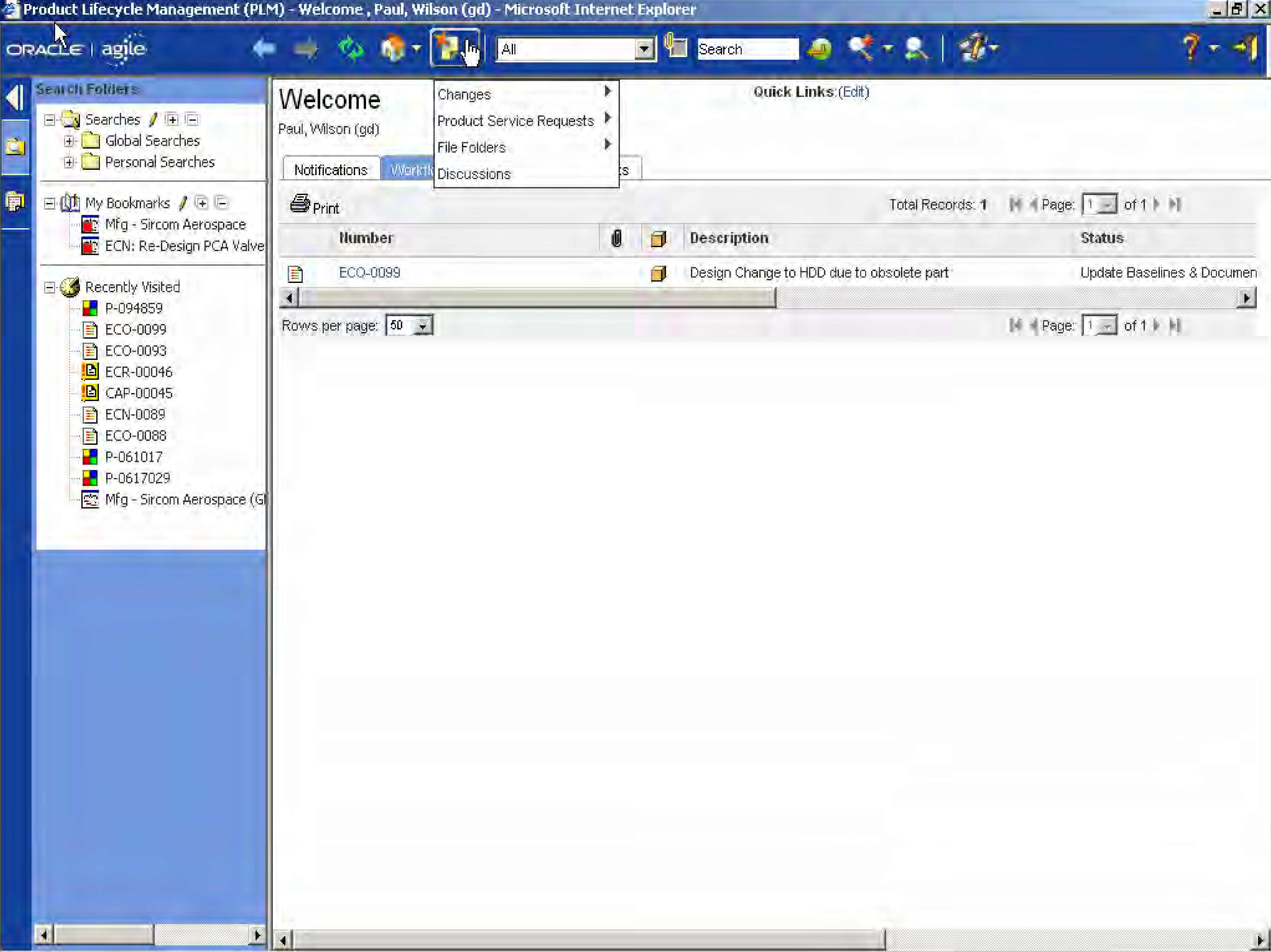
Product Lifecycle Management (PLM) - Welcome , Paul, Wilson (gd) - Microsoft Internet Explorer
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All
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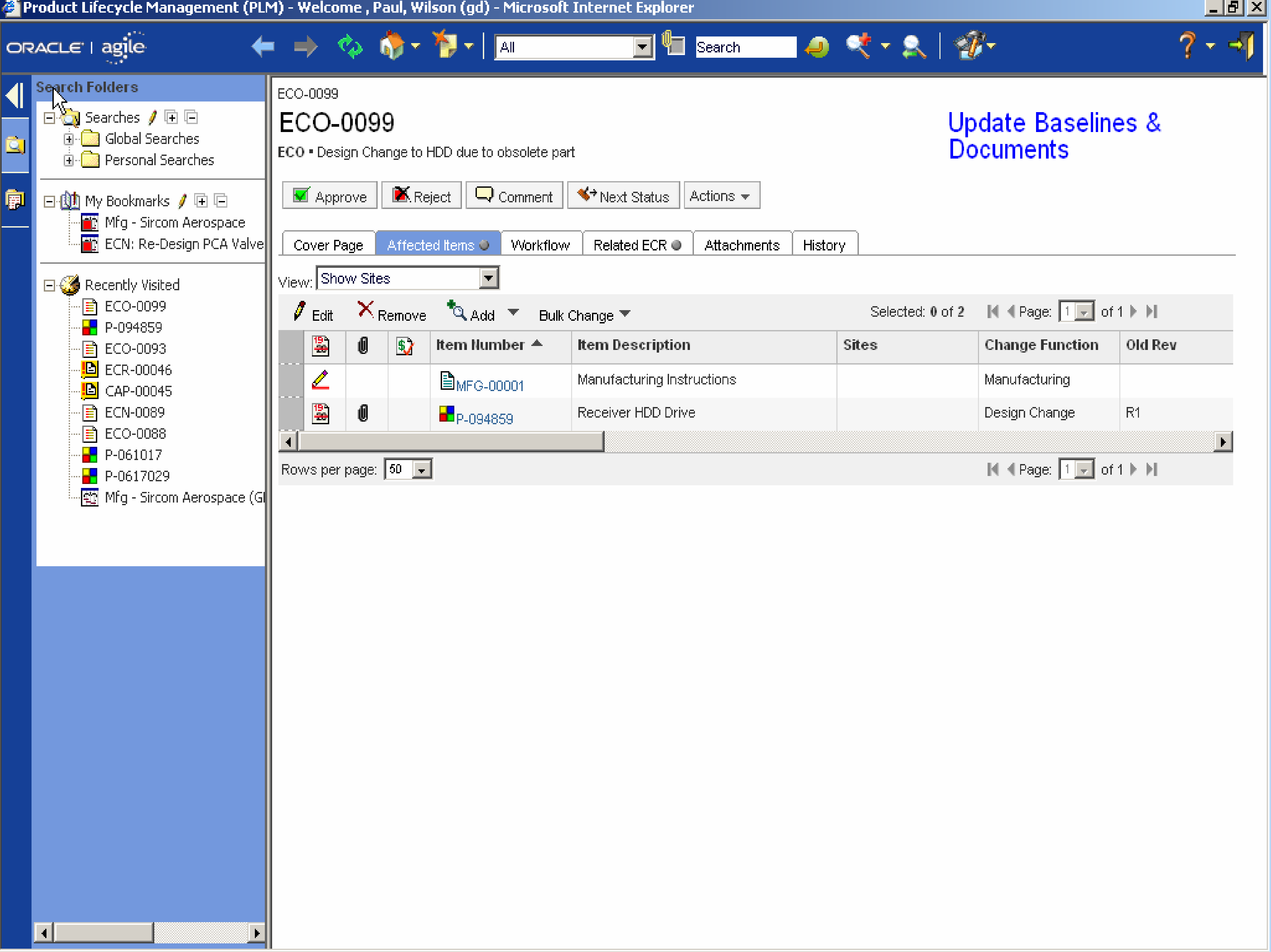
Search Folders
Searches
Global Searches
Personal Searches
My Bookmarks
Mfg - Sircom Aerospace
ECN: Re-Design PCA Valve
Recently Visited
P-094859
ECO-0099
ECO-0093
ECR-00046
CAP-00045
ECN-0089
ECO-0088
P-061017
P-0617029
Mfg - Sircom Aerospace (G
Welcome
Paul, Wilson (gd)
Changes
Product Service Requests
File Folders
Discussions
Quick Links:(Edit)
Notifications
Print
Total Records: 1
Page: 1 of 1
Number
Description
Status
ECO-0099
Design Change to HDD due to obsolete part
Update Baselines & Documen
Rows per page: 50
Page: 1 of 1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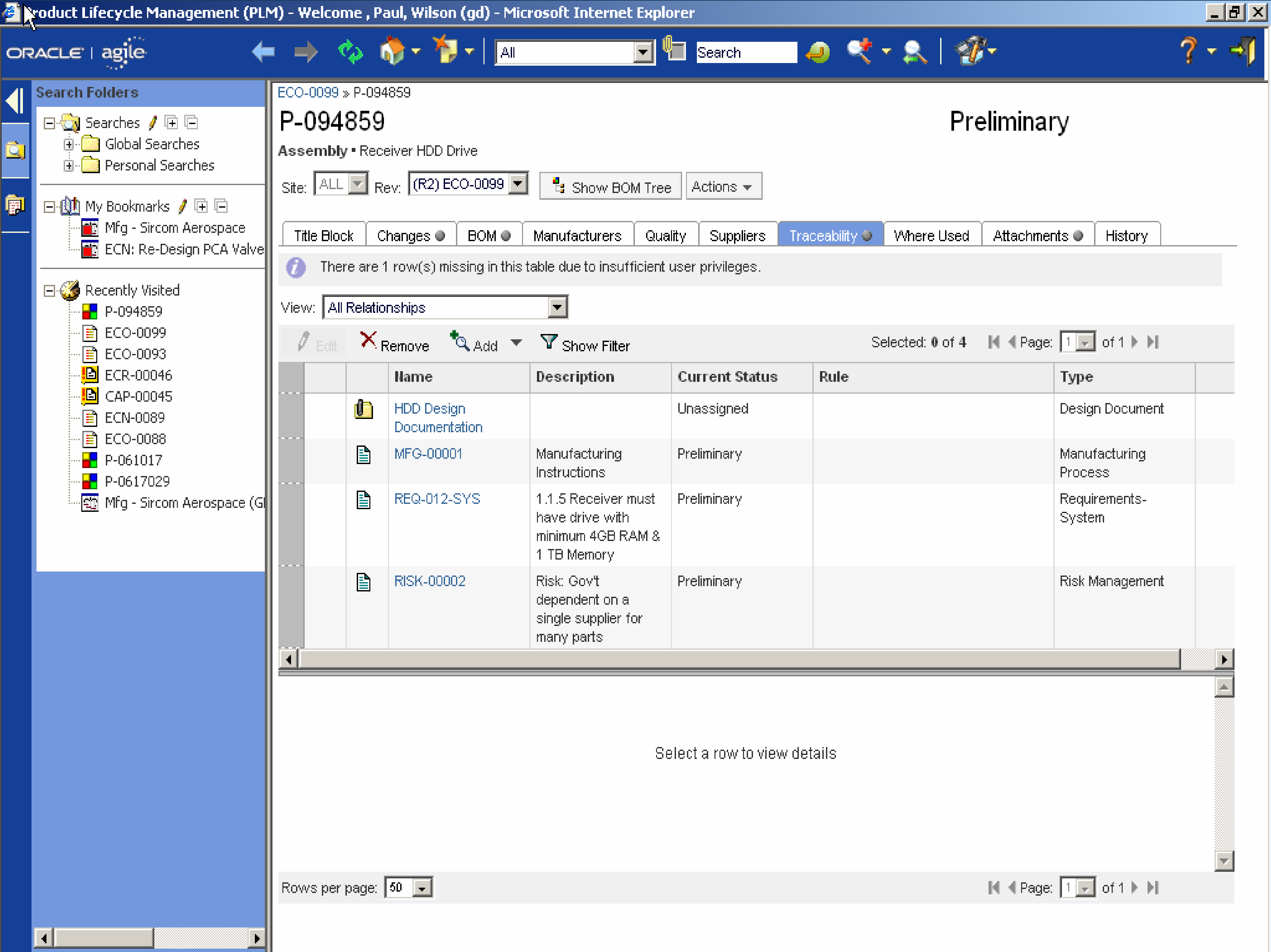
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REQ-012-SYS | 1.1.5 Receiver must have drive with minimum 4GB RAM & 1 TB Memory | Preliminary | | Requirements-System
RISK-00002 | Risk: Gov't dependent on a single supplier for many parts | Preliminary | | Risk Management
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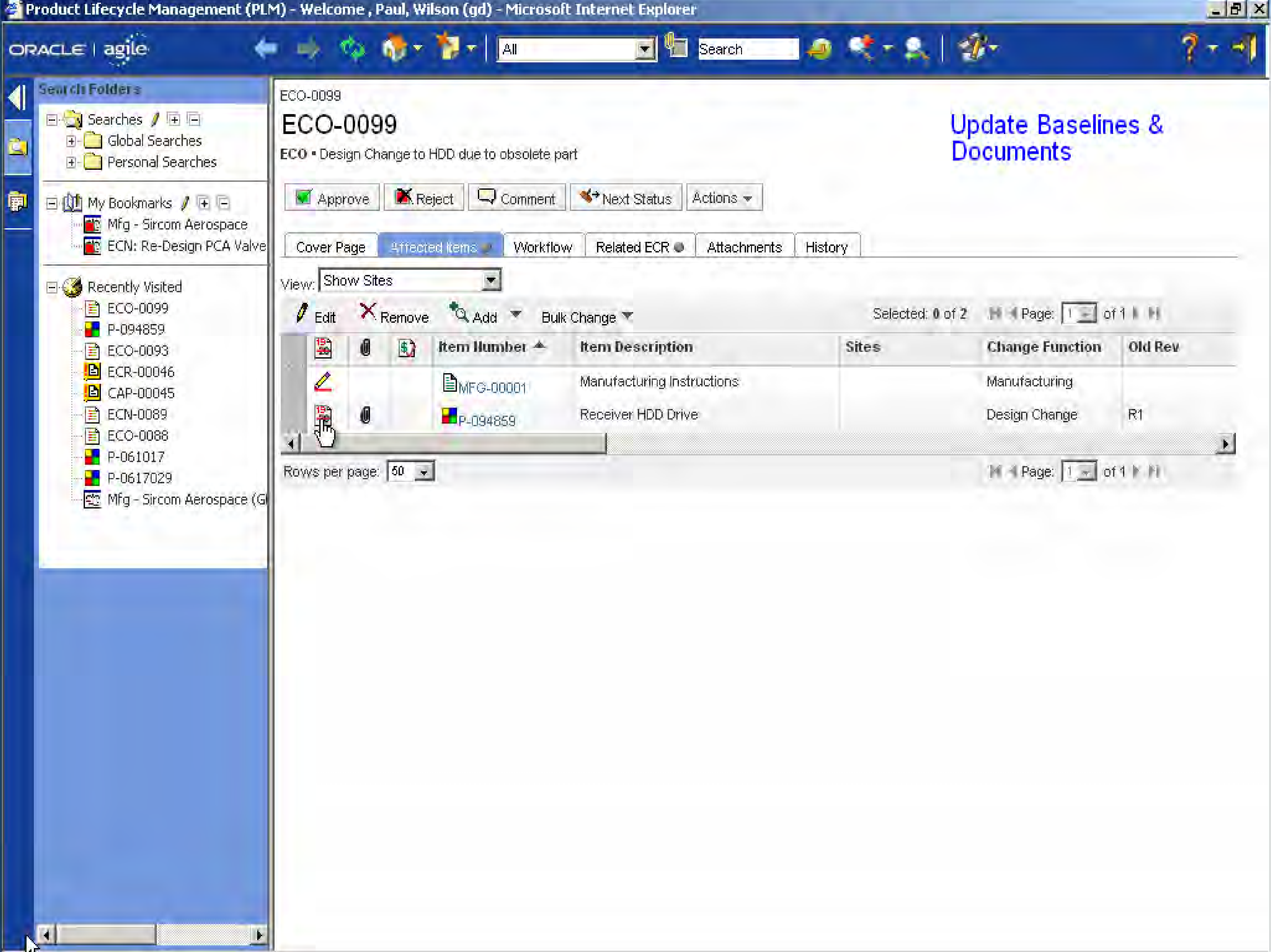
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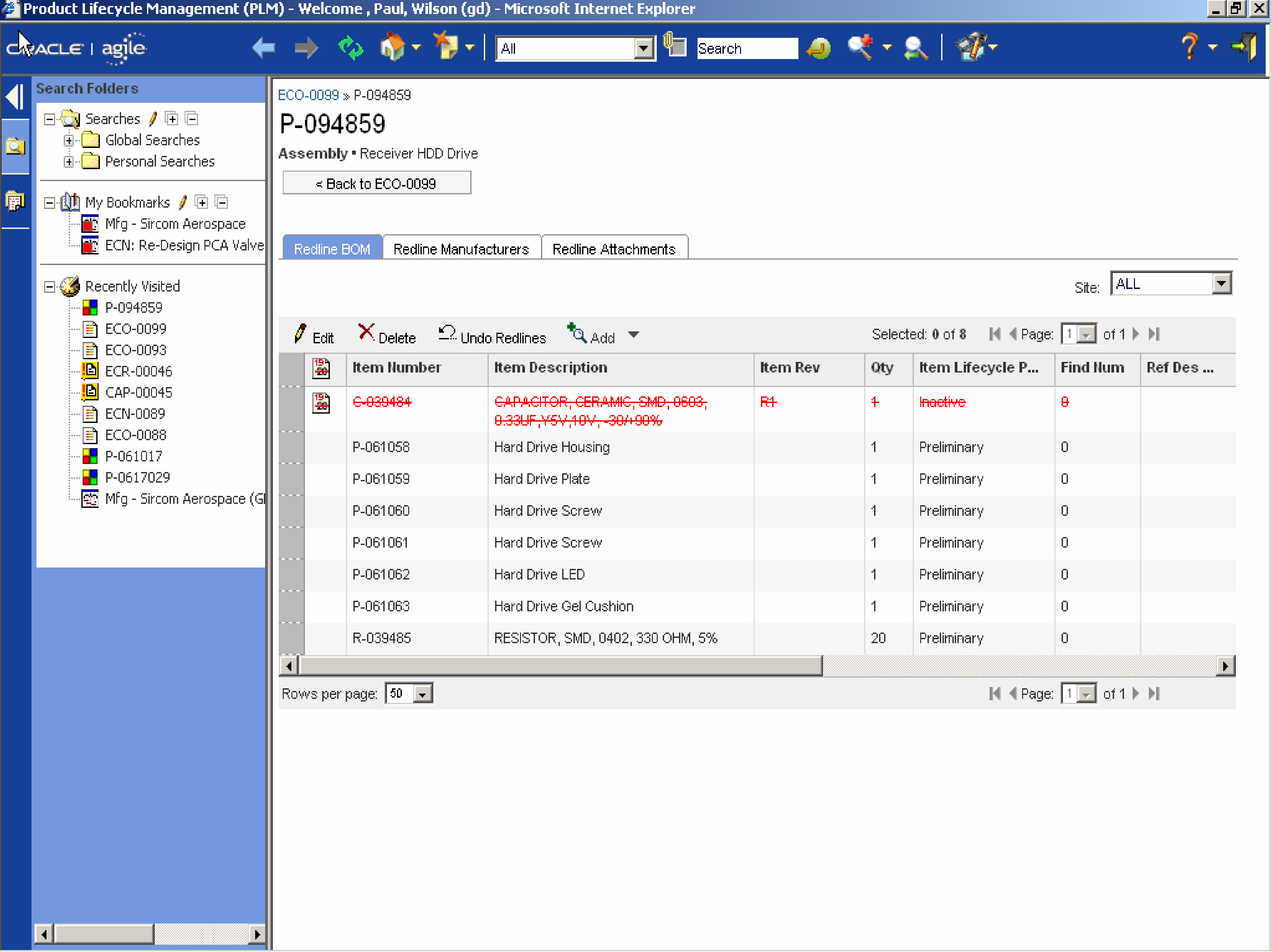
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P-061059 | Hard Drive Plate | | 1 | Preliminary | 0
P-061060 | Hard Drive Screw | | 1 | Preliminary | 0
P-061061 | Hard Drive Screw | | 1 | Preliminary | 0
P-061062 | Hard Drive LED | | 1 | Preliminary | 0
P-061063 | Hard Drive Gel Cushion | | 1 | Preliminary | 0
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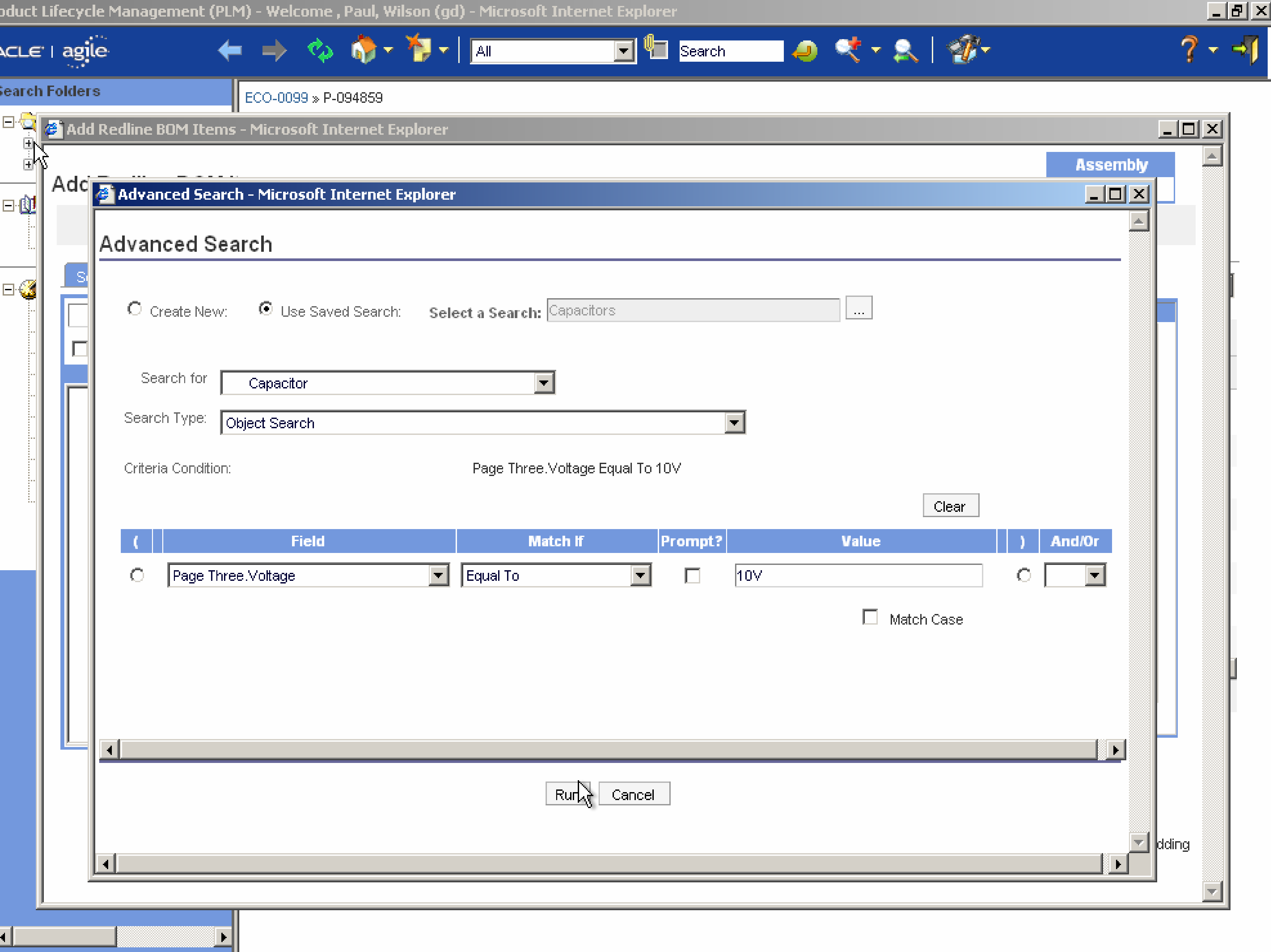

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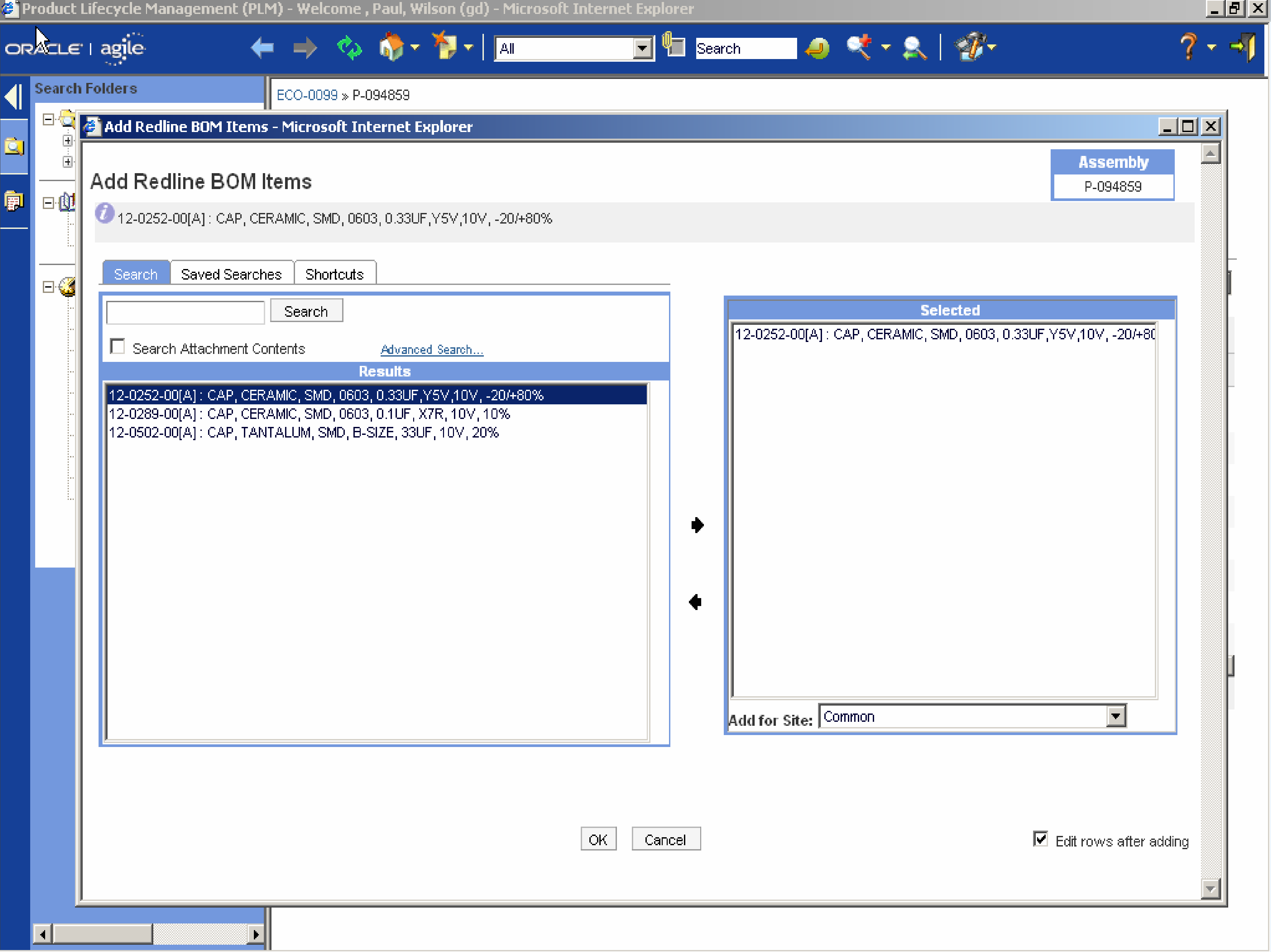
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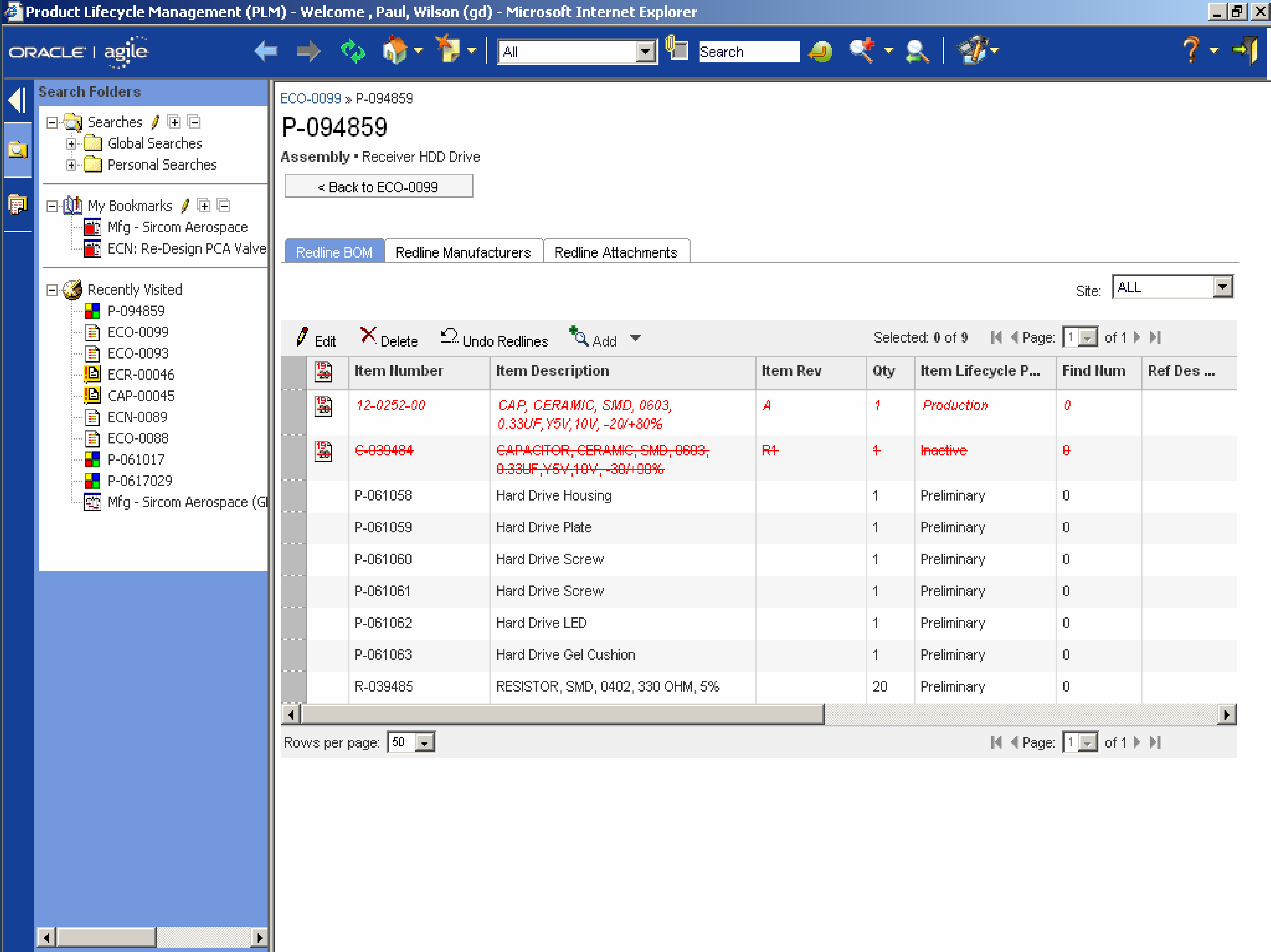

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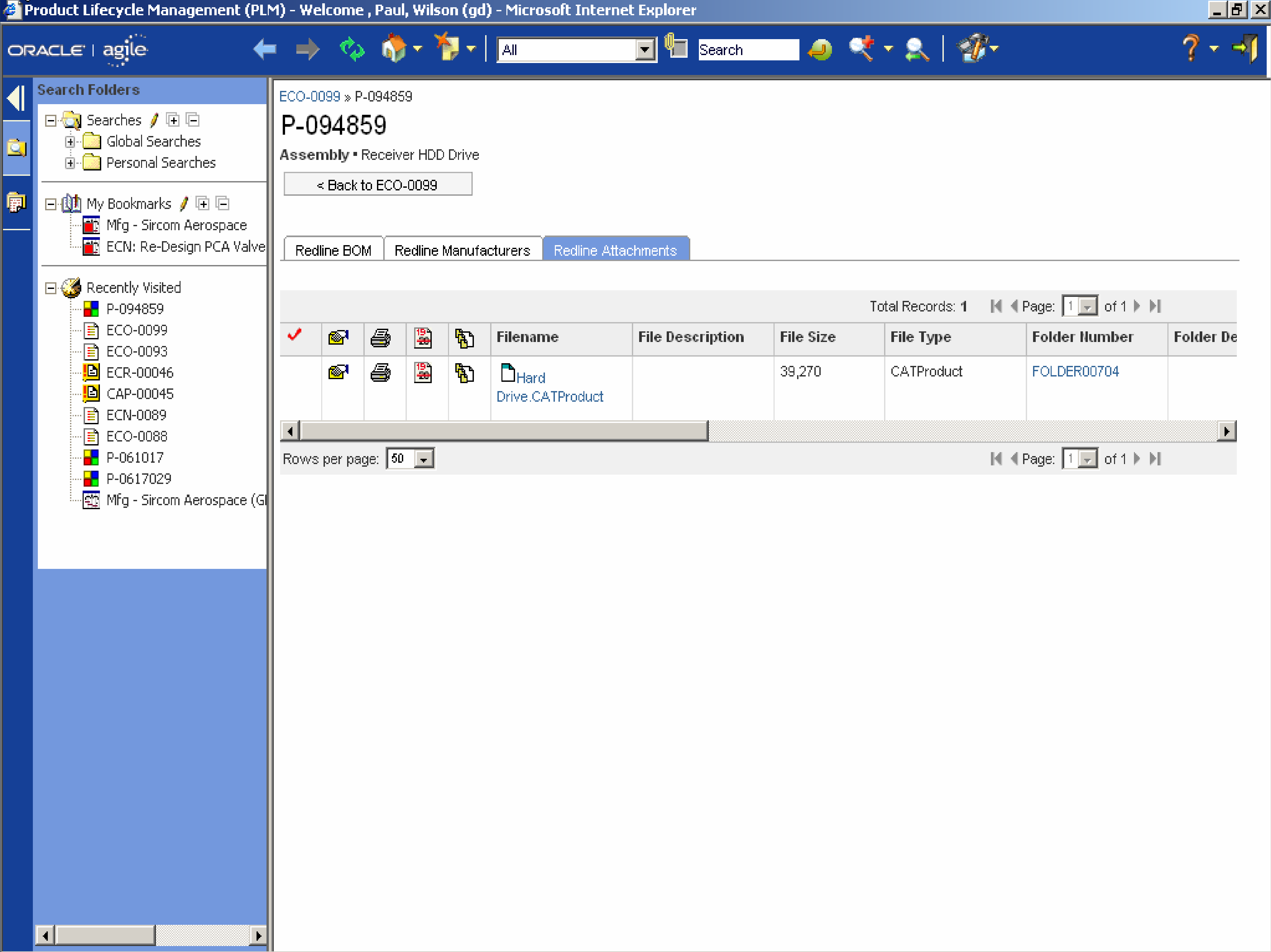
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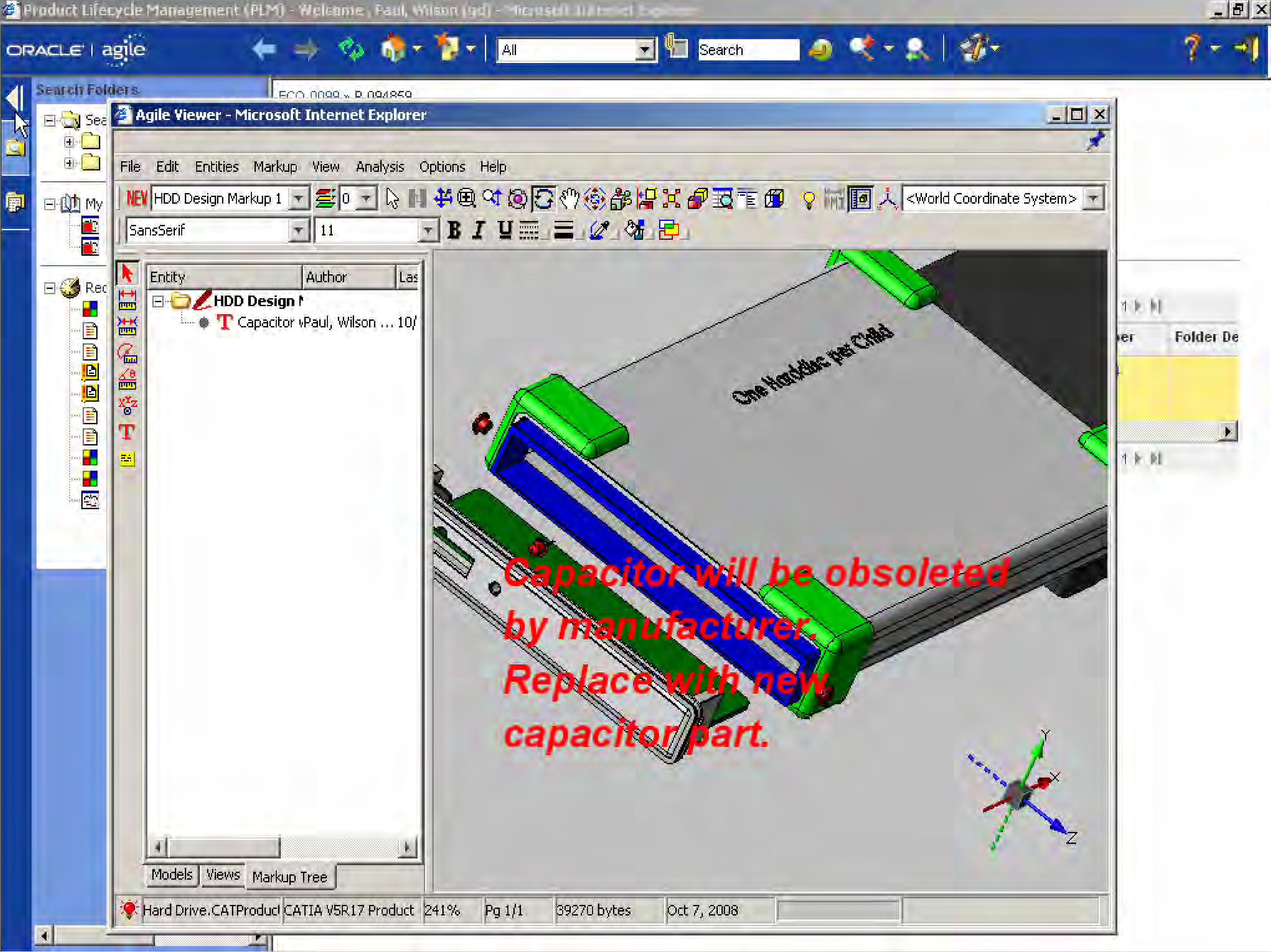

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Summary

- Institutionalize Best Practices
- Improve Program Oversight
- Integrate
- Collaborate

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Systems Engineering of Deployed Systems

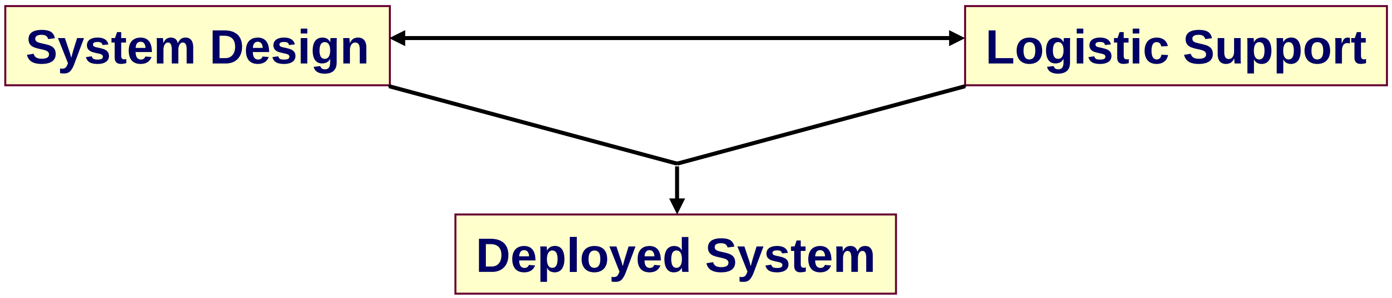
Bob Finlayson

Bryan Herdlick

The Johns Hopkins University, Whiting School of Engineering

Purpose

- Understand the role and function of the system engineer during the operations and support phase of a system
  - Understand logistic support considerations and how they influence design, manufacturing, production and operations decisions
  - Identify system supportability challenges and the means to address them
  - Develop deployed support resource requirements for system life
  - Master the ability to address system modifications in a dynamic environment



Challenge

- *“The operations and support phase of the system life cycle is the time during which the products of the system development and production phases perform the operational functions for which they were designed. In theory, the tasks of systems engineering have been completed. In practice, however, the operation of modern complex systems is never without incident.”*

Kossiakoff, A., Sweet, W., *Systems Engineering Principles and Practice*

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Course Focus

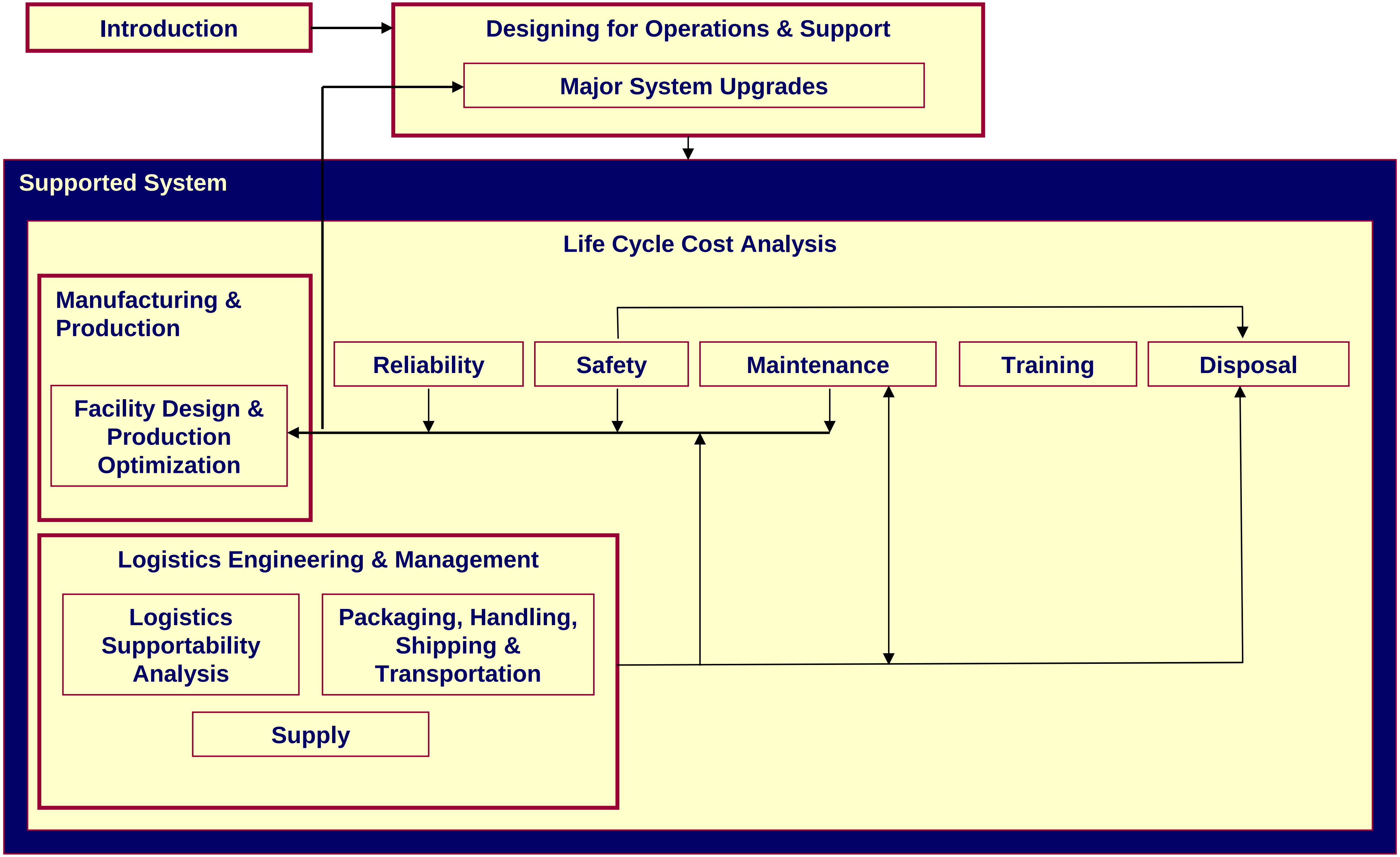
- What is peculiar about this aspect of the lifecycle & related SE topics in the context of mature / deployed / legacy systems?
- What lessons learned, best practices, tools should the systems engineer be familiar with?
- What are the risks that the SE should watch out for?
- Are there rules to live by?
- What is the role of the systems engineer in context of deployed / mature / legacy systems?

This is not a course in logistics management, but the systems engineer must have a thorough understanding of the logistics discipline if he or she hopes to address the engineering challenges of deployed systems

Scope

- System under design – usually in the early stages of initial design or during the design of deployed system upgrades
- Operating environment
- System developer and manufacturer
- Manufacturer's supply chain
- Logistics elements and their impact on systems

Course Flow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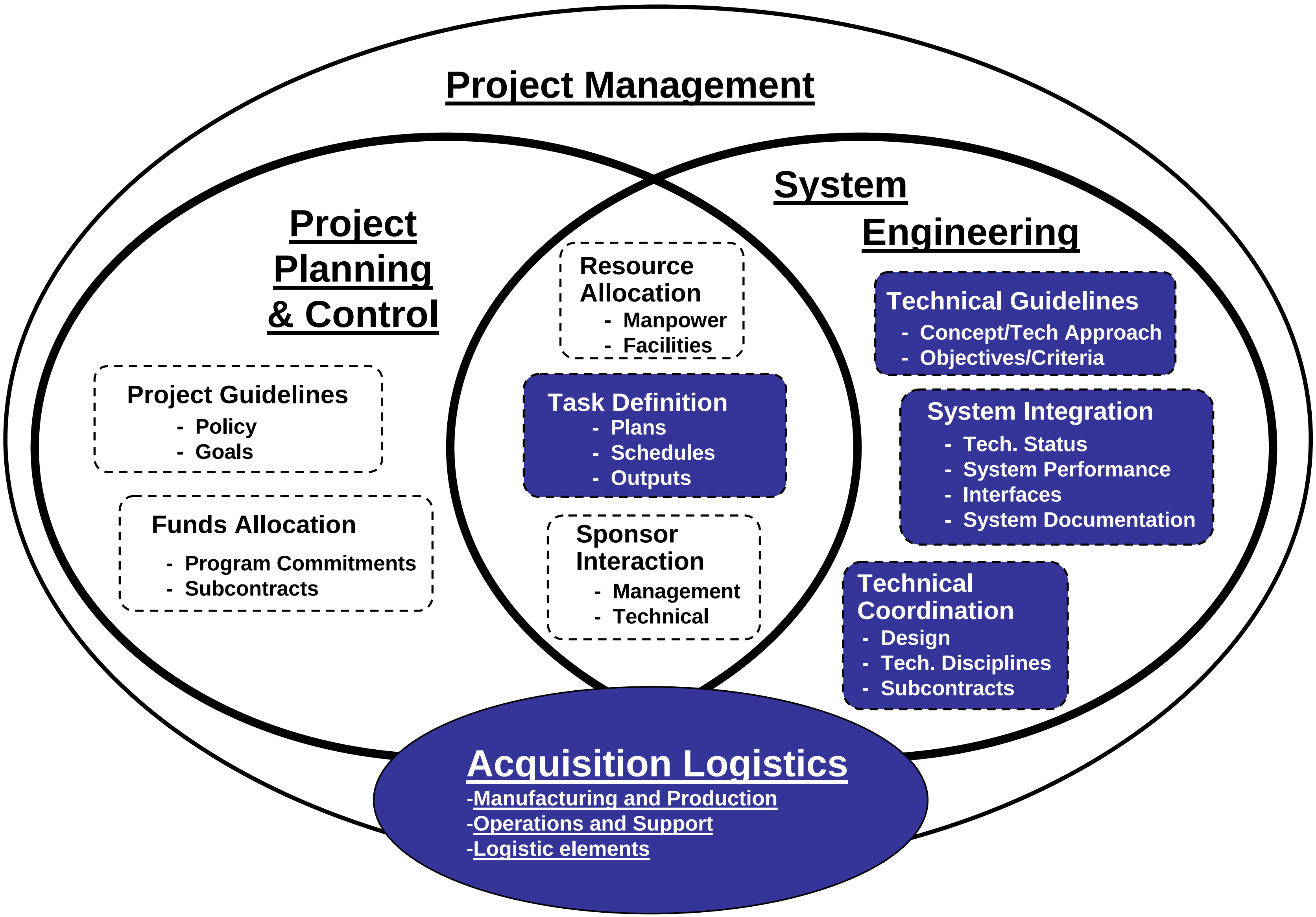
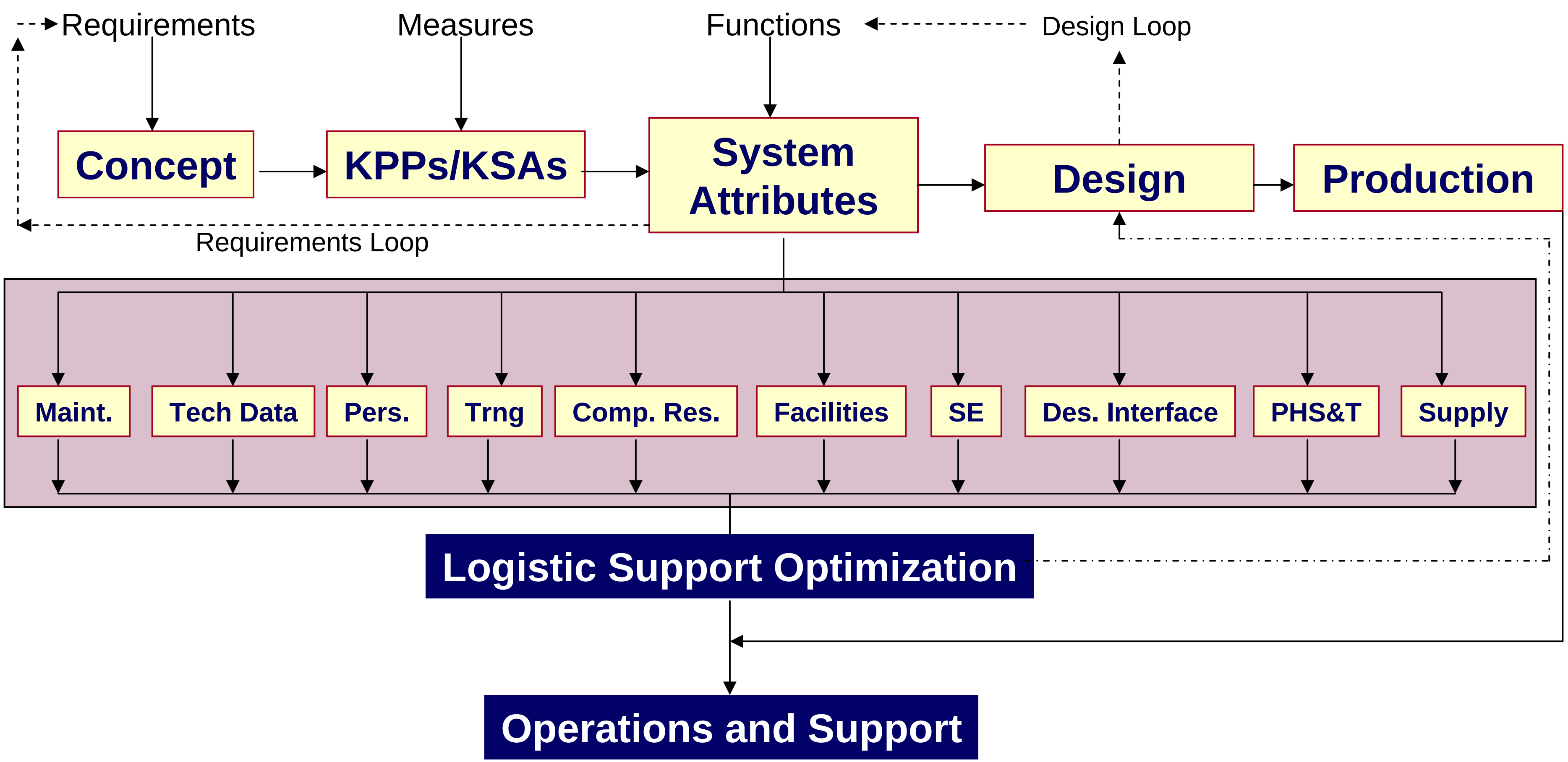
Designing for Operations & Support
Major System Upgrades
Supported System
Life Cycle Cost Analysis
Manufacturing & Production
Facility Design & Production Optimization
Reliability
Safety
Maintenance
Training
Disposal
Logistics Engineering & Management
Logistics Supportability Analysis
Packaging, Handling, Shipping & Transportation
Supply

System Engineering is Part of Project Management



Logistics Management:
A systems approach



KPP – Key Performance Parameter
KSA – Key System Attribute
SE – Support Equipment

Deployed System Design

- What aspects or attributes of deployed systems do we typically worry about?
  - Reliability
  - Maintainability
  - Training
  - Supply support
  - Health and status
  - Safety (Operational Risk)
  - Adaptability
  - Upgradeable
  - Disposability
  - Cost

How do we account for these in the design phases, during production and then again, once the system is deployed?

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Limitations/Constraints

- Analyses limitations
  - Availability of data to conduct
  - Time to complete
  - Resources
- Funding
  - Deployed phase often relegated to second tier status
    - “Worry about it later” mentality
    - Change in funding source
    - Lack of R&D funds in deployed phase
- System design
  - May be “frozen”
- Concept of operations (CONOPS) and the associated tempo are already established
  - Reluctance to alter CONOPS based on new capability

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Manufacturing & Production

Lecture Topics

- **Production as a system**
- **Producibility**
- **Designing for Manufacture**
- **Analysis & Metrics**
  - **Facility / Utility**
  - **Operational Equipment Effectiveness**
  - **FMECA**
- **Depot Maintenance & Warranty Repair**
- **Test**
- **Upgrades**
- **Foreign Military Sales**
- **Engineering Disciplines and the Systems Engineer**

Admin

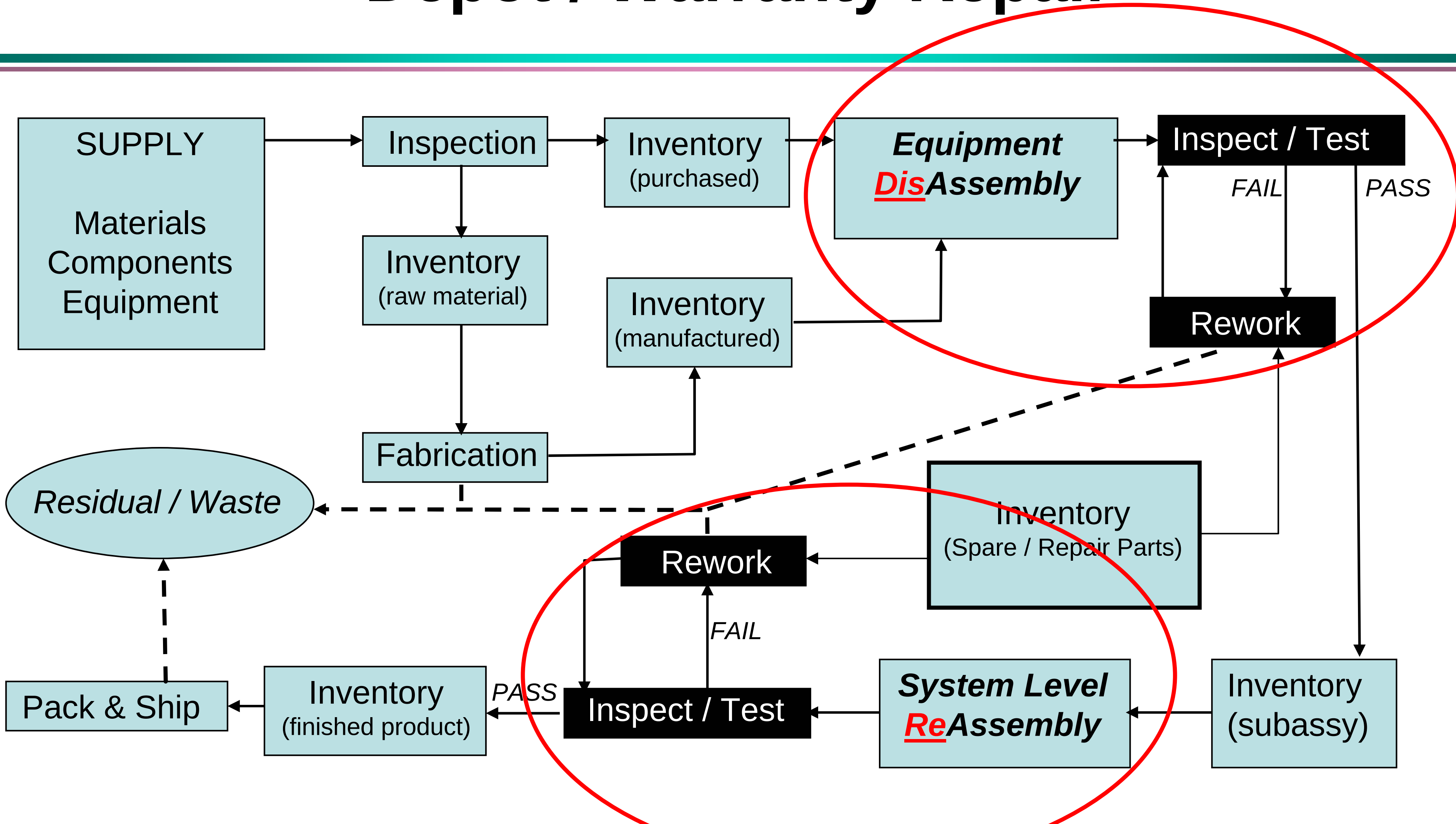
- **Instructor** – Bryan Herdlick
- **Learning Objectives**
  - Establish an understanding of fundamental manufacturing & production processes
  - Identify SE principles and activities that influence effectiveness of manufacturing and production
  - Understand the responsibility of the systems engineer relative to manufacturing & production
- **Preparation**
  - 3.1, 4.4(c), 5.2.2, 6.2.4 / Chapter 7 / TBD
- **Homework Problems**
  - 3.1, 3.4, TBD

Take Aways

- A stable process, with quantifiable & meaningful metrics, active monitoring and control programs, and characteristic workforce ‘ownership’ is a prerequisite for any successful improvement efforts.
- TBD
- TBD

- **Example :** JSF Airframe Affordability Demonstration

Depot / Warranty Repair



Maintenance concept & contractual stipulations for warranty repair may direct return of entire system or sub-assemblies for depot level repair

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Facility Design & Production Optimization

Lecture Topics

- **Goals & Benefits**
- **Cost of Quality**
- **Tools**
  - **FMECA**
  - **Six Sigma**
  - **Lean Manufacturing**
- **Industrial Engineering**
  - **Facility design**
  - **Manufacturing process**
- **Role of SE and the systems engineer**

Admin

- **Instructor** – Bryan Herdlick
- **Learning Objectives**
  - Identify aspects of facility design and the production process that can influence efficiency
  - Establish a basic understanding of the tools available to monitor and optimize production activities
  - Understand the responsibility of the systems engineer relative to improving manufacturing & production efficiency
- **Preparation**
  - 5.2.2, 6.2.4, Chapter 7
- **Homework Problems**
  - 6.10(a&c), 6.18, Chapter 7: 1, 3, 5, 8, 11, 12, 27, 30, 32

Take Aways

- The production process, including the associated facilities, is a system unto itself and is well suited to the application of basic systems engineering principles.
- Each production “batch” or “lot” is an iteration in the collection of reliability data and insight into opportunities for enhanced efficiency, with recommendations for improvement becoming more accurate and actionable
- The systems engineer serves a vital role in the planning and conduct of successful production activities by bridging multiple engineering disciplines and facilitating cooperative process & design improvement efforts

Production Optimization
(CONTINUOUS PROCESS)

- Achieving peak effectiveness through continuous efficiency enhancement
  - ***Production line <u>reliability</u> is key***
  - Minimize down-time
    - Preventative Maintenance (PM)
      - Reliability Centered Maintenance (RCM) approach
        - » PM only when justified (***reliability data***, physics-of-failure, etc.)
    - Continuous production (i.e. no "breaks" in production runs)
    - Maintainability features
  - ***Involve operators in ongoing process analysis and improvement***
    - *Responsibility* for process "escapes"
    - *Responsibility* for initial troubleshooting
    - Understanding of cause-effect relationships = *"ownership"*

Each production "batch" or "lot" is an iteration in the collection of reliability data and insight into opportunities for enhanced efficiency, with recommendations for improvement becoming more accurate and actionable as each cycle is completed.

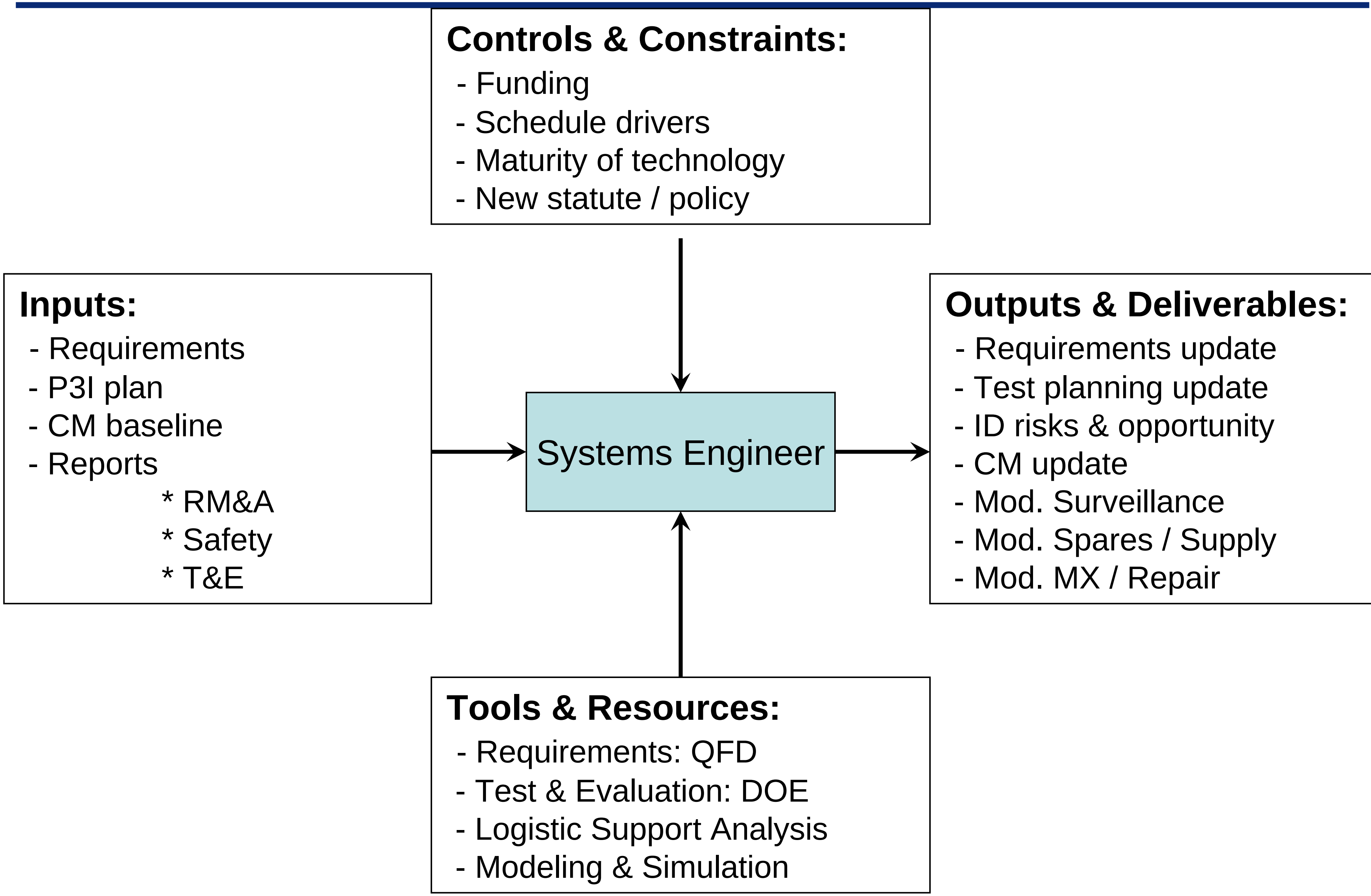
Major System Upgrade Challenges

- Upgrades are often pursued without due diligence in one or more of the following areas:
  - Requirements refinement & validation
  - Supportability Analysis
  - Configuration Management
  - Accurate assessment of
    - Design / integration challenges
    - Technology maturity

In addition to ensuring that a system upgrade satisfies *requirements* for corrective action or performance enhancement, the systems engineer is also responsible for maintaining or improving the suitability of the fielded system – including both supportability and lifecycle affordability

The Systems Engineer

(In the context of system upgrades)



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Conducting a Logistics Supportability Analysis

- An LSA can aid in:
  - Initial establishment of supportability requirements during conceptual design
  - Early establishment of supportability design-to criteria
    - Definition of system operational requirements
    - Maintenance and support concept
    - Identification and prioritization of technical performance measures
    - Performance of functional analysis
    - Allocation of requirements
  - Synthesis, analysis and design optimization effort through trade studies
    - Alternative repair policies
    - Reliability and maintainability characteristics
    - Commercial-off-the-shelf implementation
  - Evaluation of a given design configuration
  - Assessment of an operating system's effectiveness and supportability in its intended environment

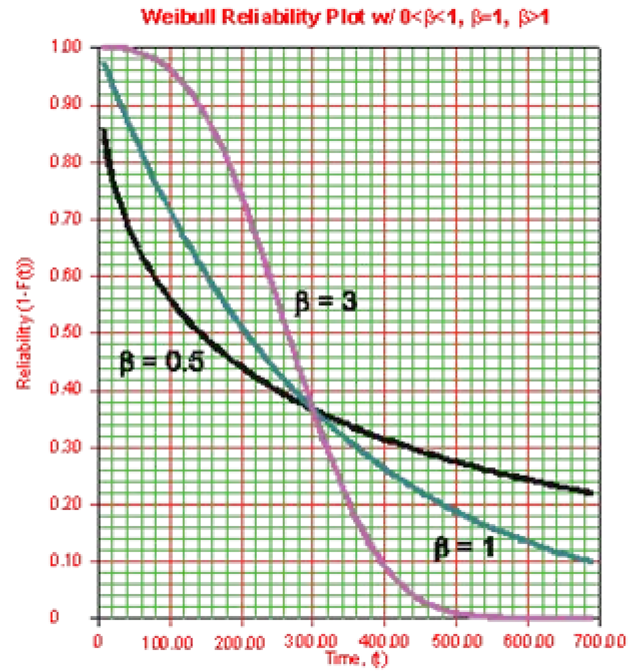
LSA Tools

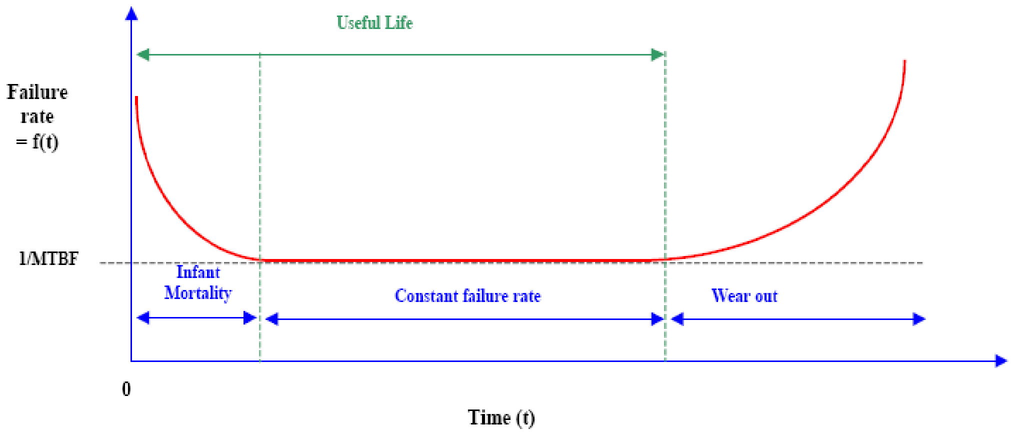
- Life Cycle Cost Analysis (LCCA) (Session 13)
  - Total cost of the system and its supporting activities throughout the life of the system
- Failure Mode, Effects and Criticality Analysis (FMECA) (Session 6)
  - Identification of potential system and/or process failures, the expected mode of failure and causes, failure effects and mechanisms, anticipated frequency, criticality and the steps required for compensation
- Fault Tree Analysis (FTA)
  - Deductive approach involving graphical enumeration of different ways a failure can occur and its probability of occurrence
- Maintenance Task Analysis (MTA) (Session 7)
  - Maintenance functions to be allocated to a human
- Reliability Centered Maintenance (RCM) (Session 3)
  - Best overall approach for preventative maintenance
- Level-of-Repair Analysis (LORA) (Session 7)
  - Maintenance policies in terms of level of repair
- Evaluation of Design Alternatives (Analysis of Alternatives (AoA))
  - Assess design configurations using multiple criteria

Addressing Reliability

- It's one thing to teach reliability theory, it is another to apply it in the proper manner

- Do you truly understand the problem at hand?
  - Environment, requirements, CONOPS
- Have you set the boundary conditions?
  - Assumptions, limitations
- Have you correctly assumed equilibrium?
  - Modeling
- Can you solve for the unknowns?
  - Design and verification





This is a typical behavioral model for an organic and inorganic system – looks fairly benign, but there is much more to the curve than depicted here – randomness, environmental effects, catastrophic events, etc.

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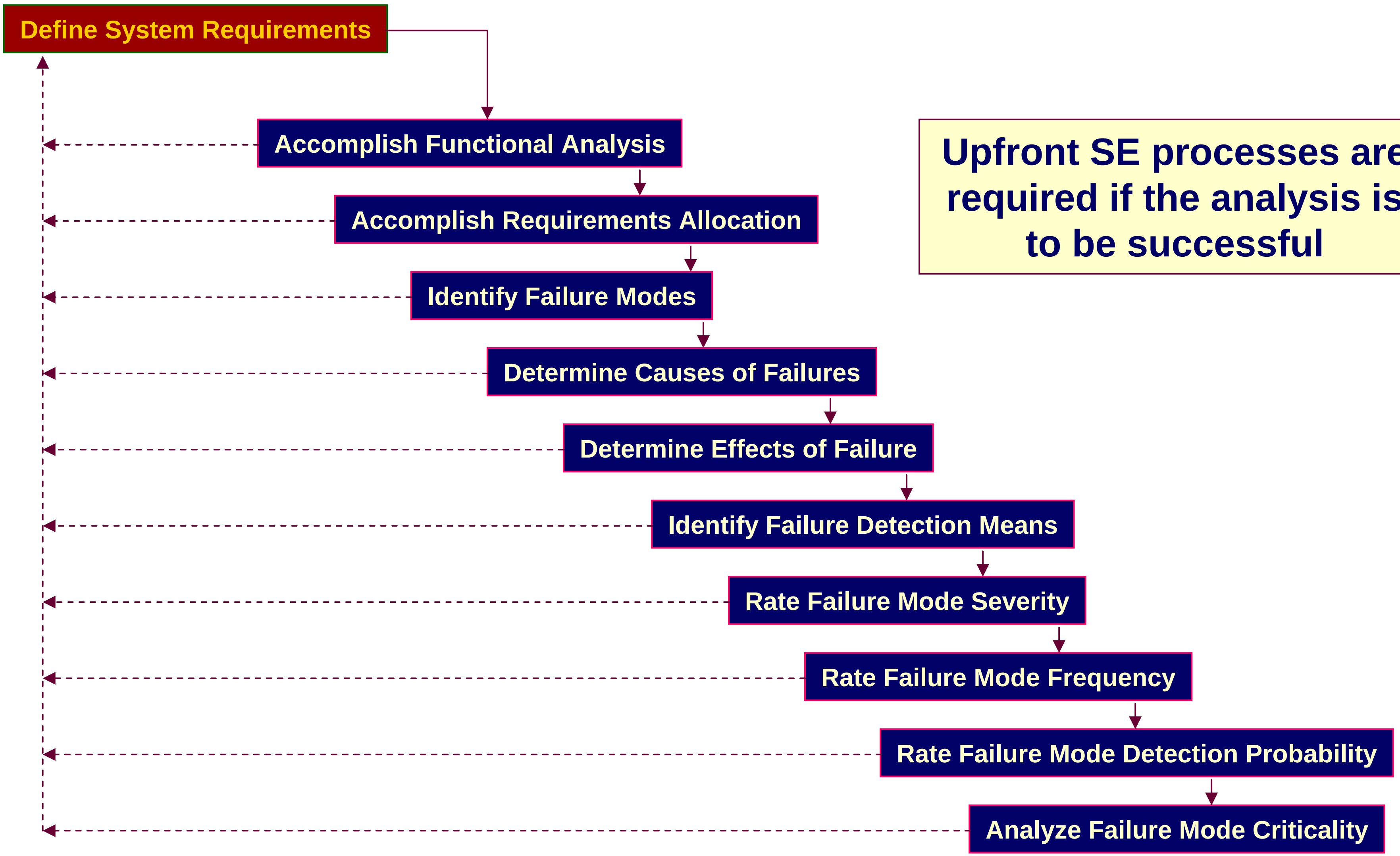
FMECA Approach



Upfront SE processes are required if the analysis is to be successful

Overall Maintenance Conceptualization

- Why – reusable or disposable
- Who – personnel requirements and limitations
- What – type of maintenance to be performed (electronic, software, structural, mechanical)
- Where – field environment or designated repair facility
- When – Planned versus unscheduled
- How – appropriate level of maintenance

Maintenance Planning: Environmental

- Location
  - Constraints
    - Space, accessibility to the system
  - External factors
    - Weather, contaminants
- Supply chain
  - Provide the necessary support infrastructure to conduct maintenance actions
- Number of personnel available
  - Limited detachment
  - Provisioning
- Support equipment
  - Weight, volume, fragility

Spares Hypothesis Testing

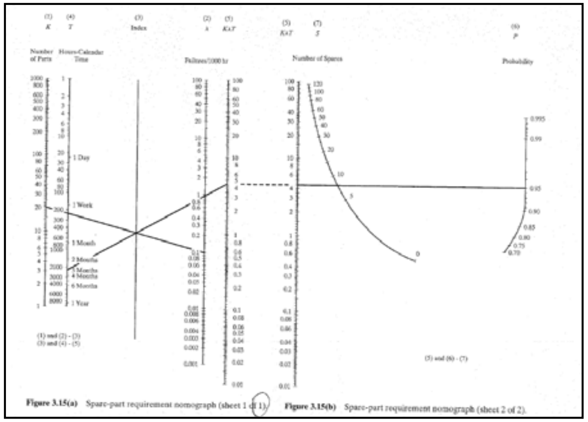
- *Following deployment of a system (and throughout the lifecycle) the requirements for spares and parts must be reevaluated based on…*
  - *Actual system performance / reliability / availability*
  - *Changes in the operating and programmatic environments*
  - *Changes in the maintenance concept or production*

Planning for adequate spares and repair parts (including subassemblies) is based upon assumptions and predictions that must be continuously reviewed in light of post-deployment system performance and maintenance / repair activities

Spares Calculation

- What goes into predicting spares requirements?
  - Failure rates
    - Individual parts
    - Subassemblies
    - Composite system
  - Spares procurement & stock intervals
    - Predicated on one-for-one replacement maintenance concept
  - Mission duration
  - Number of systems in service (available to satisfy mission)

- K λT = Translation factor
  - K = Number of Parts (per assembly under consideration)
  - λ = Part failure rate
  - T = Interval for procurement of stock / spares



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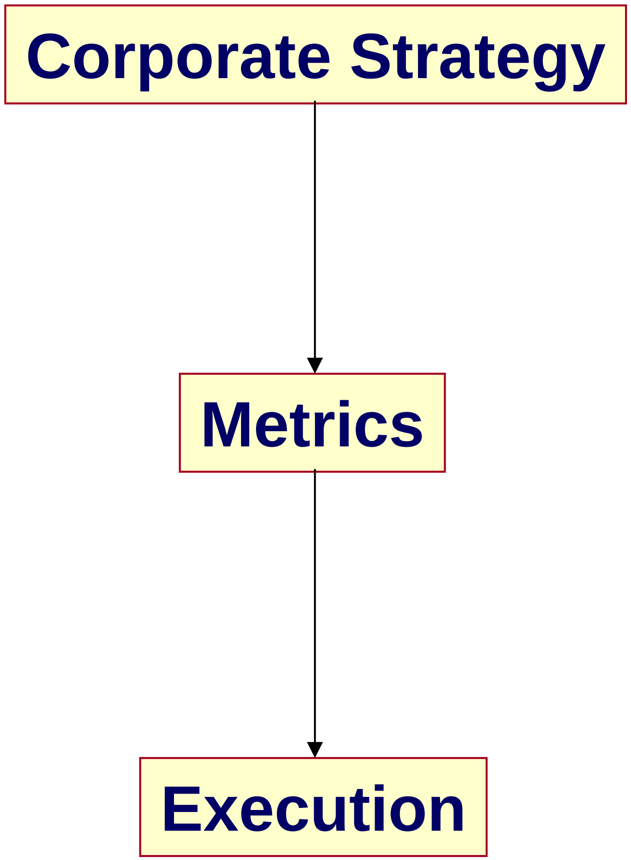
PHS&T: Implementing a Supply Chain



- What are the strategic objectives with regard to logistics?
  - In-house transportation management
  - Investment in automated systems
  - Customer liaison policy
  - Warehousing and inventory management
  - Corporate reach (global?)
- Are adequate measures in place to assess progress?
  - Requirements articulated
  - Supply chain modeling
  - Design in place
  - Functional flows understood
  - Trades analyses identified
- Is the infrastructure in place to execute, monitor and control the process?
  - Personnel
  - Tools
  - Visibility
  - Quality Management
  - Risk forecasting

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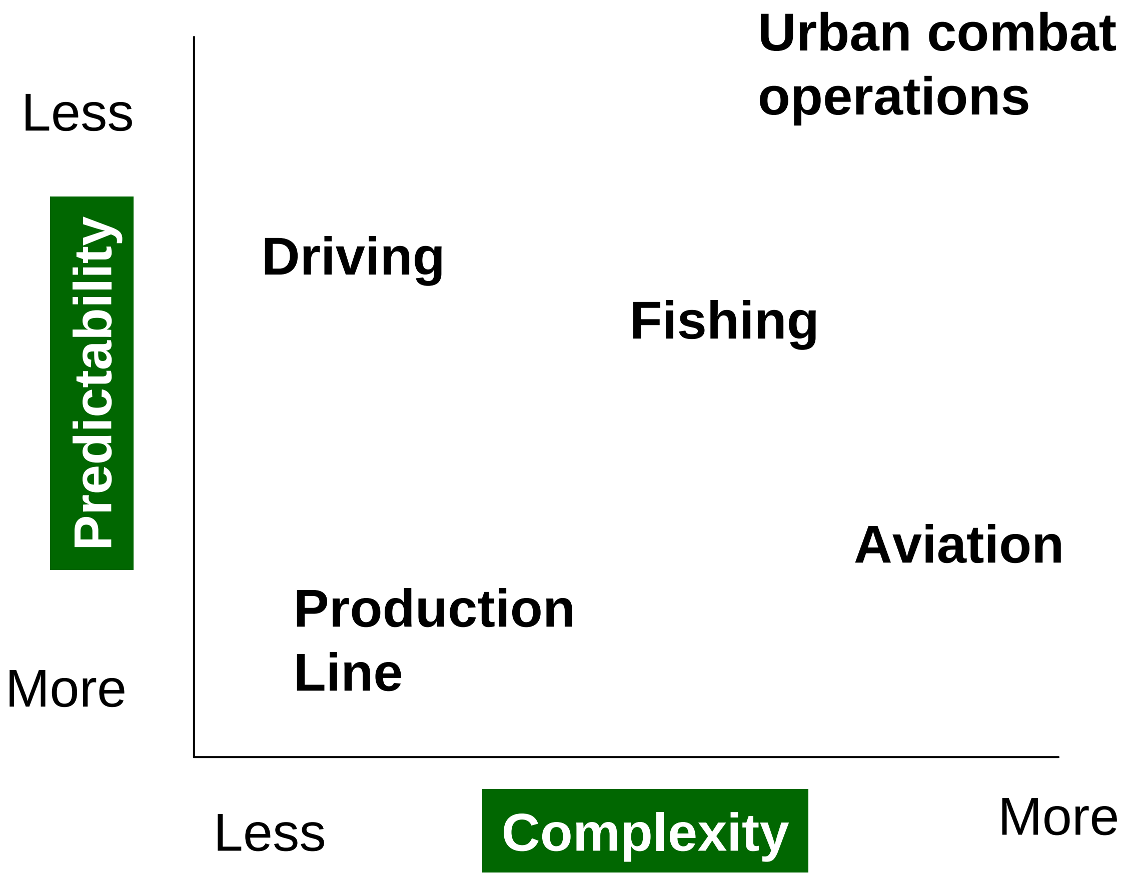
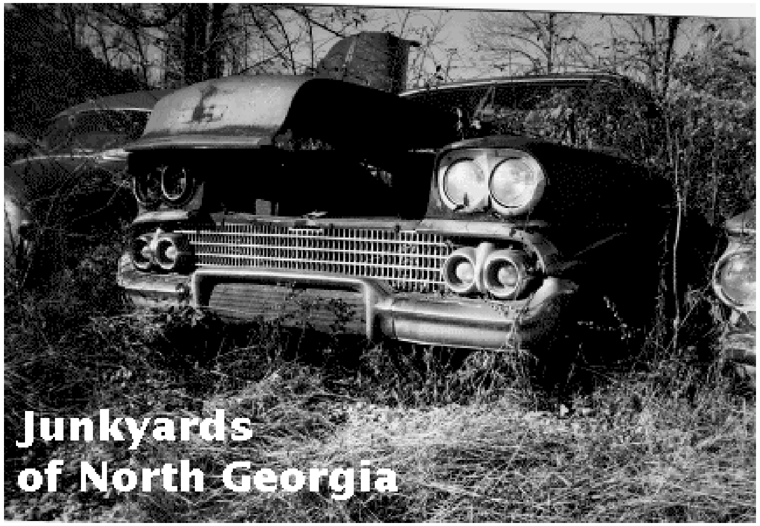
Typical Training Requirements

- System design
  - Human system interface, operational environment
- Training facilities
  - Location, size
- Throughput
  - Number of training events per day
- Data capture and recording – feedback
- Task Complexity
- SS environmental predictability
  - Numerically controlled machine maintenance
  - Driver’s education

Training System Interaction



Disposal



Lecture Topics

- Disposal at retirement
- Disposal during the lifecycle
- Environmental considerations / impact statements
- Designing for disposal
  - Disposal considerations during mod / upgrades
  - Ties to maintenance plan decision tree
- The "Zero Waste" ideal
  - Reuse / reclaim options
  - Salvage operations
  - Cost, benefits and examples

Admin

- **Instructor** – Bryan Herdlick
- **Learning Objectives**
  - Discuss disposal considerations associated with each phase of a system's lifecycle
  - Identify SE principles and activities that can assist in avoiding or managing disposal risks and cost
  - Understand the role and responsibilities of the systems engineer relative to system disposal
- **Preparation**
  - See text reference list
- **Homework Problems**
  - Problems: 8.23, 8.27, 8.28, 8.29, 8.30, 8.31

Take-Aways

- Disposal, as an activity, is not relegated to system retirement and the end of the lifecycle
- Disposal, as commonly defined (e.g. dumping, discarding, throwing away), should be considered the least efficient and least desirable alternative for the processing of residual / waste materials
- A system successfully "designed for disposal" would incorporate extensive use of alternatives to disposal such as salvage, recycling, reuse
- Exceptionally high quality products / systems evidence longevity that can reduce retirement waste (but mid-life maintenance waste still exists)

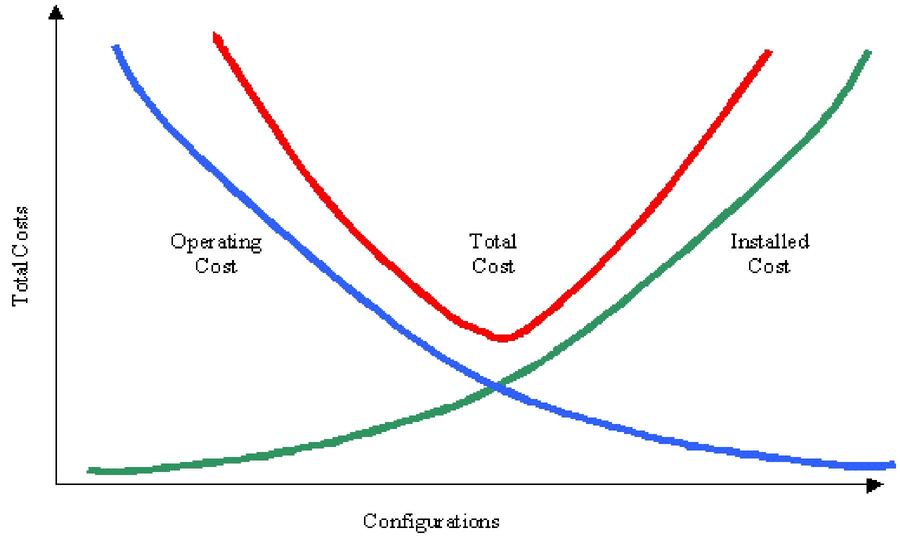
“Disposal” in the Design Checklist

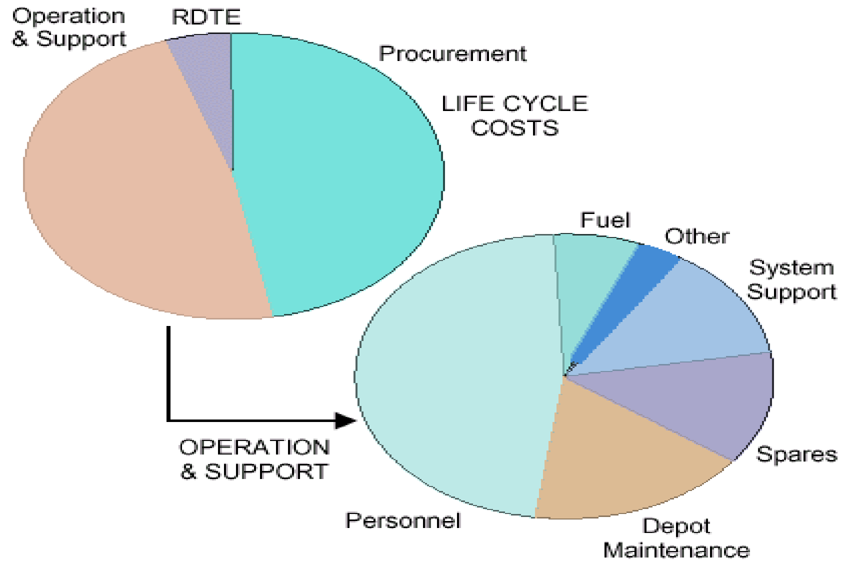
- Has disposability been evaluated during design?
  - Is recycling or re-use of components an alternative?
  - Is decomposition / disassembly an alternative (requirement)?
  - Are additional logistic support resources required?

- Have disposal procedures been identified / prepared?
  - Are methods & results consistent with environmental, safety, political and social requirements
  - Are the methods economically feasible?

Life Cycle Cost Analysis

- LCCA is presented at the end of the course
  - Necessary to understand the other elements in order to conduct a LCCA
  - Serves as a review of the material
- Can only address certain aspects of the LCCA
  - Too encompassing to cover it completely
  - SE contributes, but typically does not conduct the LCCA itself
- However, a primary driver not only for decision making, but for keeping O&S activities under control





Deployed Systems Engineering Risks

- Confusing performance requirements with supportability requirements
  - Can’t have one without the other, but there is a tension between them in many cases
- Incomplete understanding of requirements and their allocation to system functions
- Assigning the wrong measures (and the respective values) to the system evaluation process
- Addressing 3 or 4 of the primary logistic elements (e.g., maintenance, personnel), while ignoring the rest
- Designing for O&S at the component level without regard for the system and its internal and external interactions

Deployed Systems Opportunities

- Good systems engineering is necessary in the O&S phases
  - Success is not in deploying a system, but in the system performing its intended role effectively and efficiently for its entire duration
- A good SE approach will reveal risks and challenges that often go unseen until a system is too far along in the design process
  - Costly upgrades
  - Performance degradation
  - Excessive schedule delays
- Understanding and applying a disciplined technical approach is necessary for all phases of the life cycle
  - Computers can crunch numbers, but they cannot build a credible model
    - Intuition, discipline, accurate assumptions
  - Technical leadership that encompasses many disciplines

BAE SYSTEMS

Welcome to BAE Systems

Mobility & Protection Systems, Sterling Heights, MI – October 2008

Systems Engineering in New Vehicle Development

FTTS (Future Tactical Truck Systems)

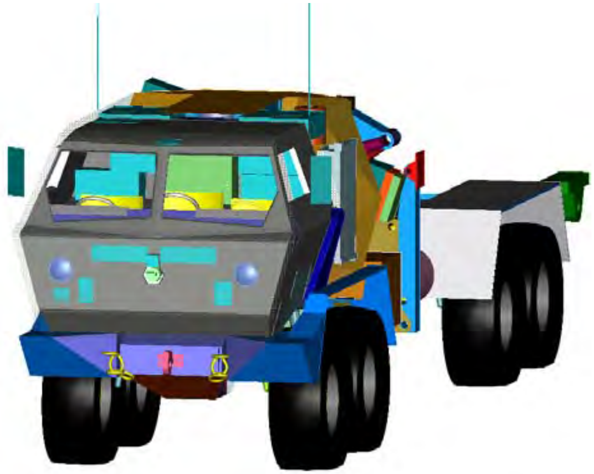
Customer: US TACOM National Automotive Center (NAC), Warren Mi

Walter J. Budd
Chief Engineer
BAE M&PS
October 2008

BAE SYSTEMS

MSV - Maneuver Sustainment Vehicle

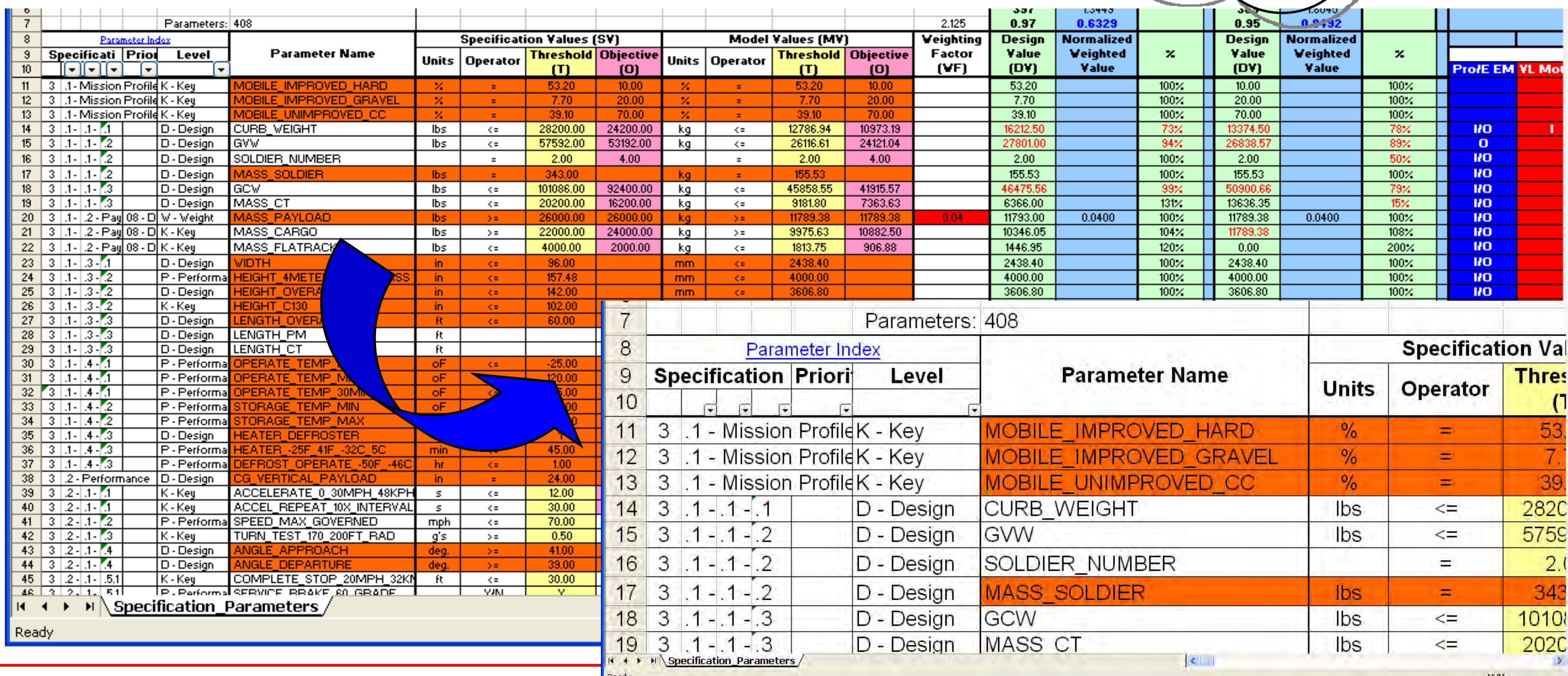
- 18 Month Project, Design, Build, Qualify New Vehicle
- Systems Engineering Approach
- Requirements Analysis
- Performance Parameters Linked Into Models



BAE SYSTEMS

- **Process Began With Customer Supplied 92 Page Performance Requirement Document**
- **Our Engineers Developed and Tracked 408 Given and Derived Requirements**

Simple Spreadsheet Based Tracking



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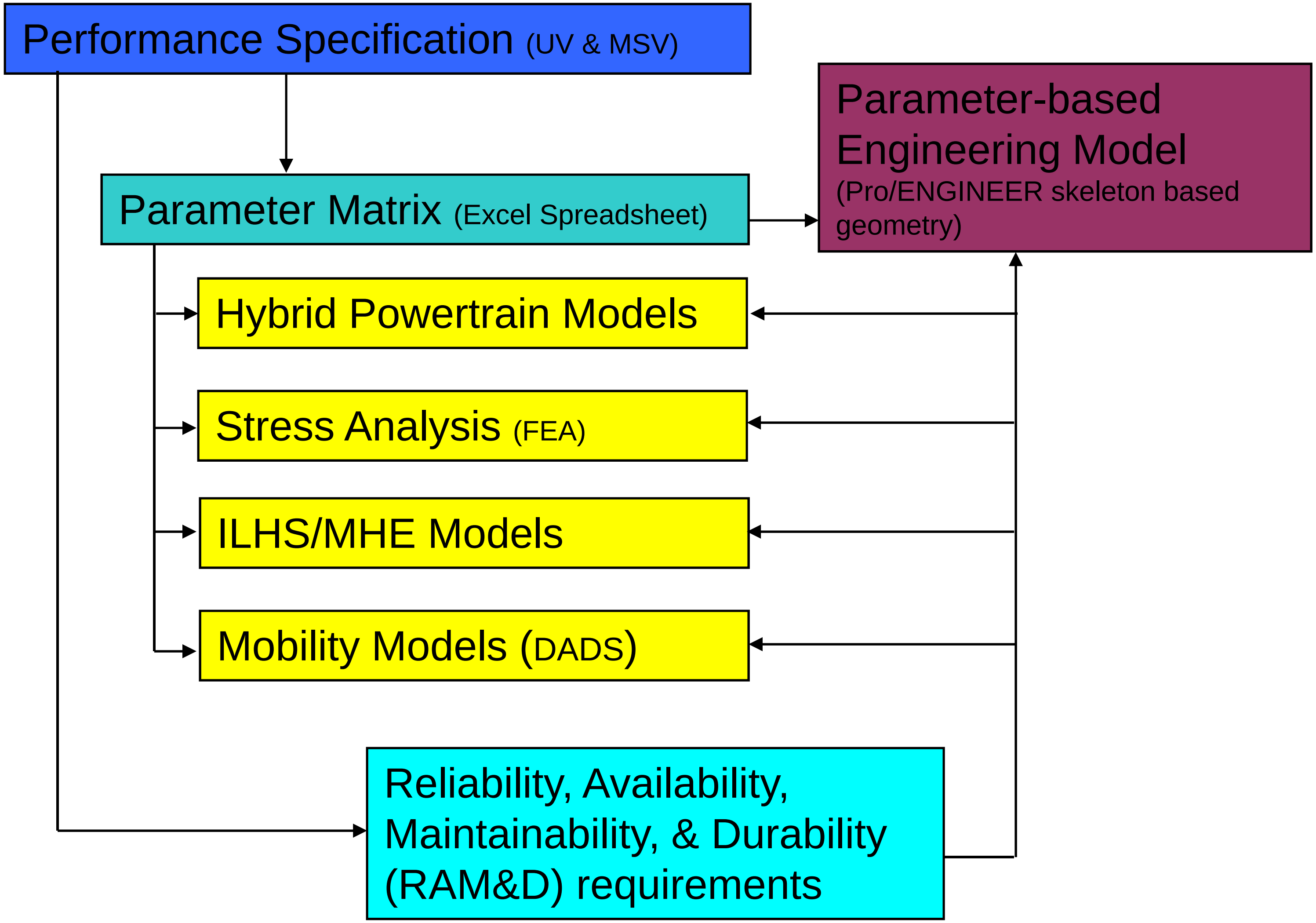
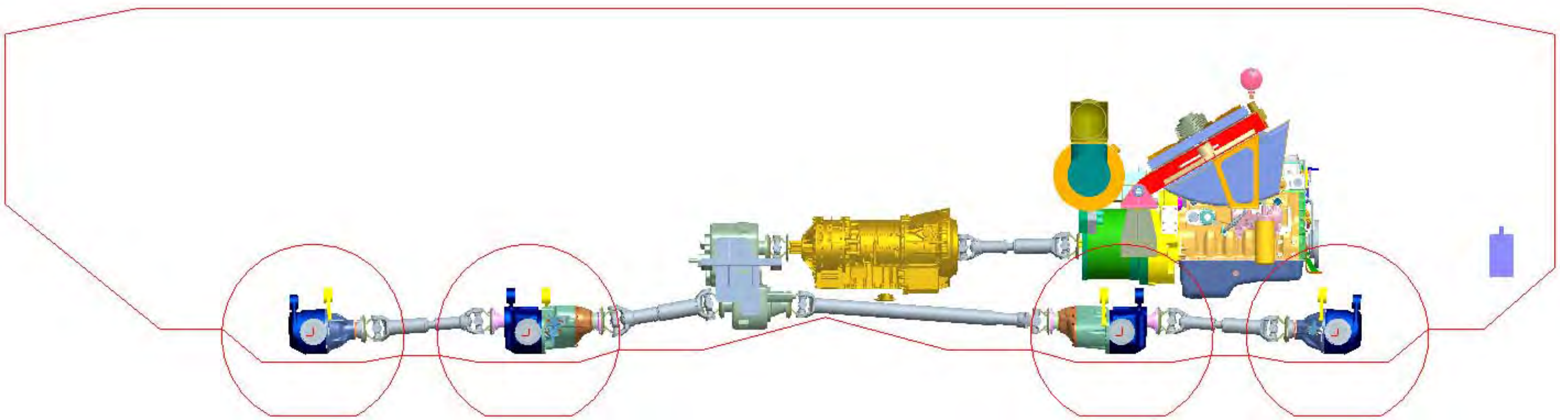

Performance Specification (UV & MSV)
Parameter Matrix (Excel Spreadsheet)
Parameter-based Engineering Model (Pro/ENGINEER skeleton based geometry)
Hybrid Powertrain Models
Stress Analysis (FEA)
ILHS/MHE Models
Mobility Models (DADS)
Reliability, Availability, Maintainability, & Durability (RAM&D) requirements

Propulsion Modules

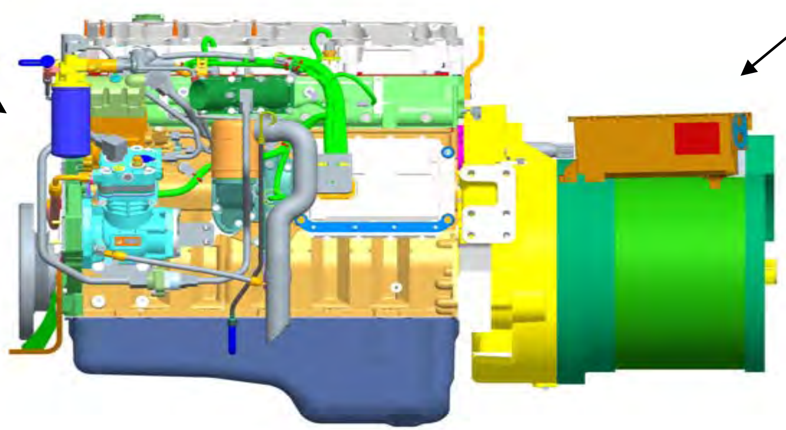


BAE SYSTEMS

Power Generation

Hybrid System

CAT C9
1600 RPM
1850 N.m
450 Hp



UQM
1900 RPM
600 N.m
160 Hp

Combined Peak Torque

2446 N-m (1804 ft-lbf) @ 1600 RPM

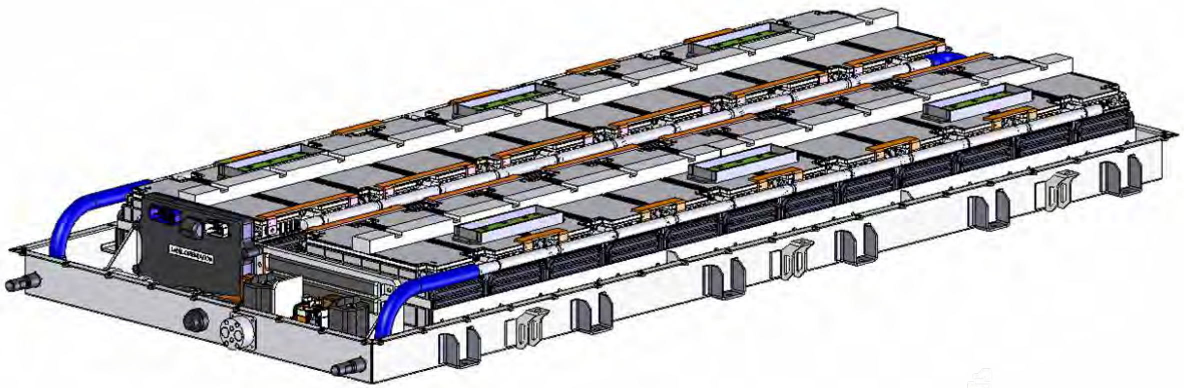
Combined Peak Power

610 HP (455 kW) @ 2300 RPM

BAE SYSTEMS

Battery Pack

Four, 45A*h NiMH Batteries Used To Support The Hybrid Power Requirements



MANUFACTURER		COBASYS
TYPE		NiMH
MODEL		4500 SERIES
VOLTAGE	V	336
CAPACITY	Ah	45
COOLING		LIQUID, INTEGRATED
DRY WEIGHT	Kg	330
No. of BATTERIES		28
DIMENSIONS: L x W x H	MM	1900 x 600 x 310

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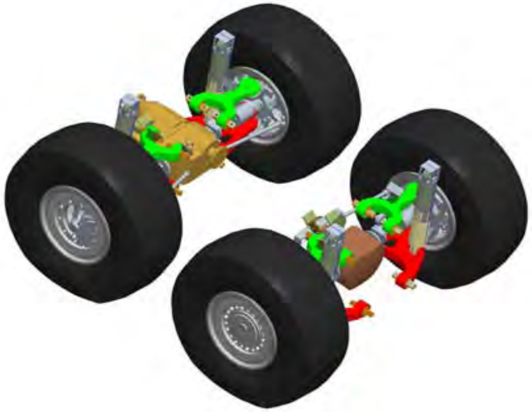
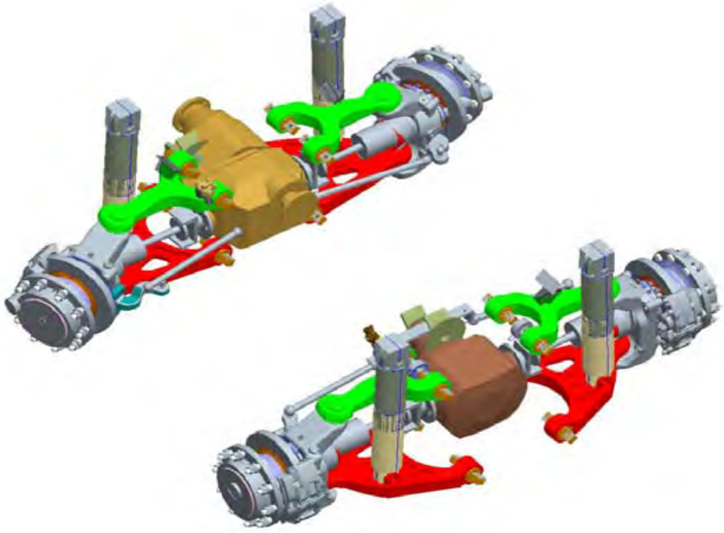
Custom Designed Independent Suspension Axles





- Independent Suspension SLA
- Axel Differential Ratio: 2.077
- Wheel Hub Planetary Ratio: 3.55
- Hydraulic Disc Brakes - ABS

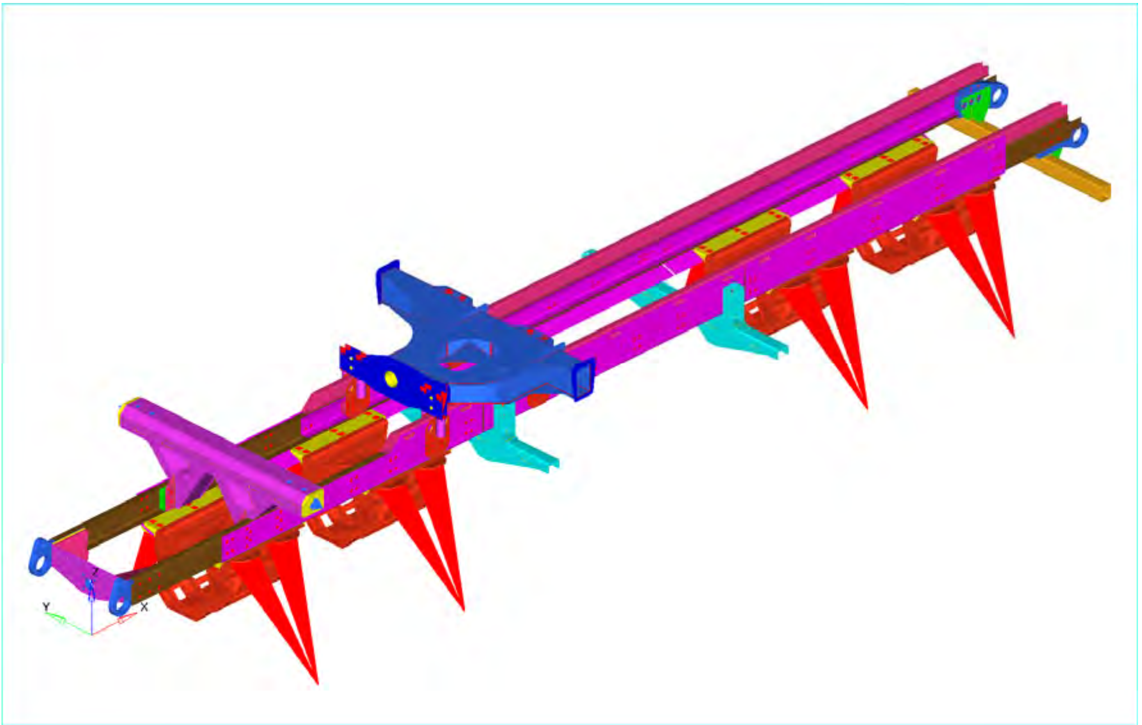
BAE SYSTEMS

All-New Frame

Was Required

Inputs from:

- **Automotive Loads**
- **13 Ton Load Carry**
- **Lift/Unload 13 Ton Cargo**



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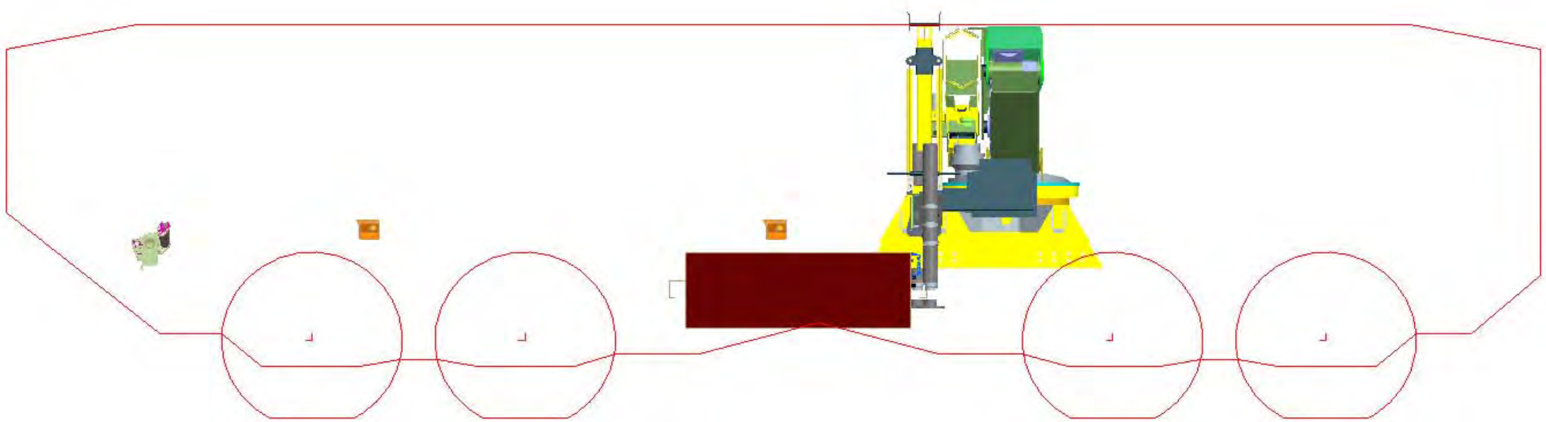
Material Handling Equipment



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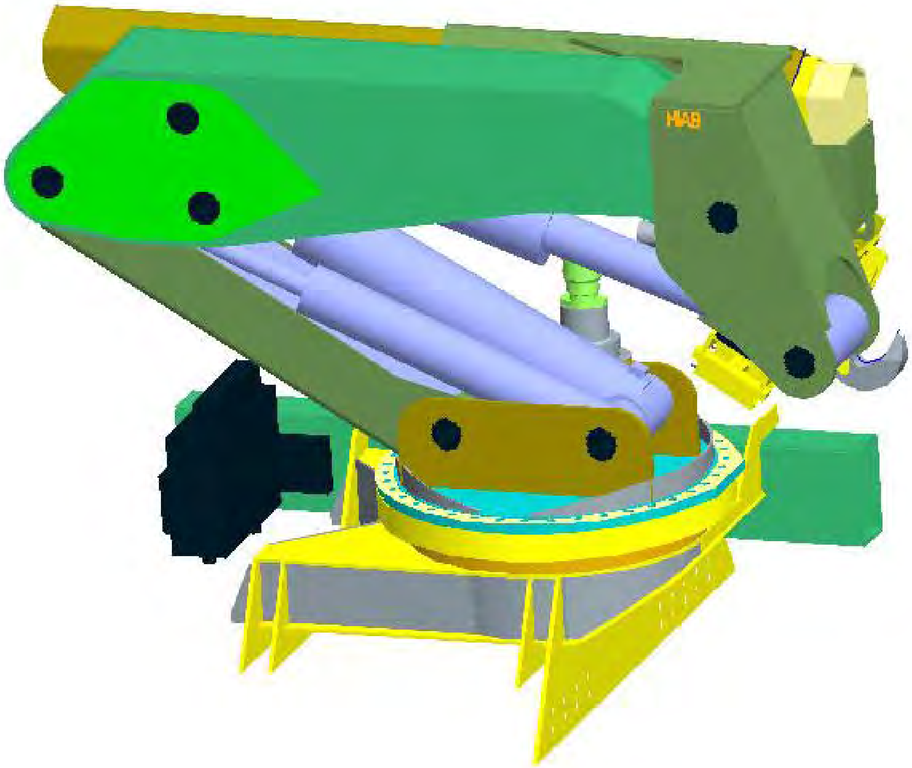
Material Handling Equipment



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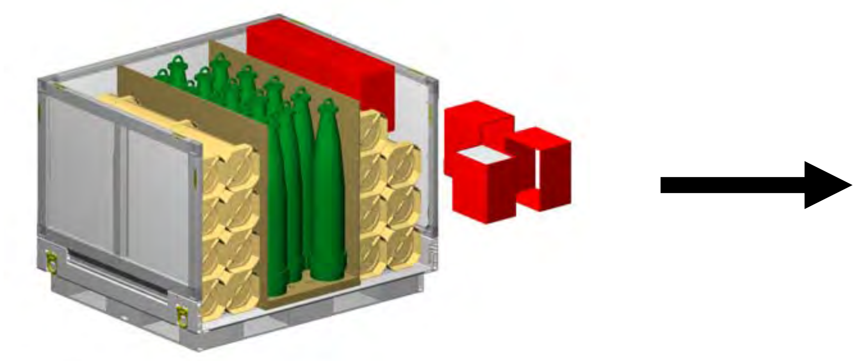
Get supplies to the soldiers as quickly and as safely as possible



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- **Load/Unload Cargo**

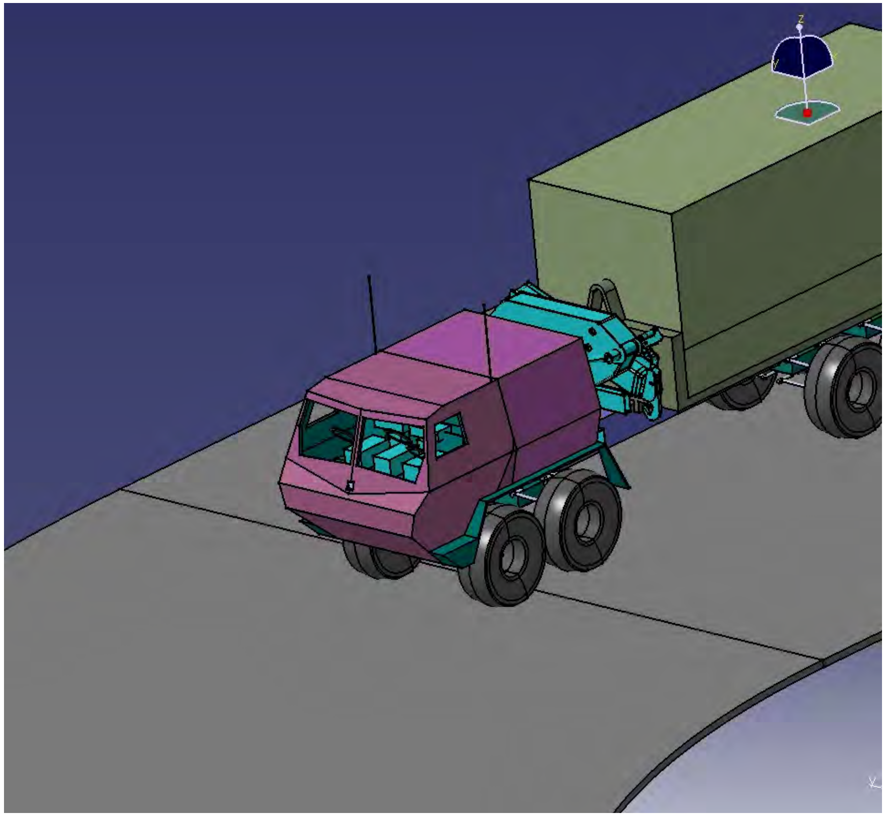
- **Load/Unload Trailer**

- **Load/Unload ISO Containers**

BAE SYSTEMS

Challenge

- *Create* multibody simulation that represents several truck and suspension variants
- *Different* suspension designs (not just parameter values)
- Make it *easy* to run different trucks on all possible roads and obstacles



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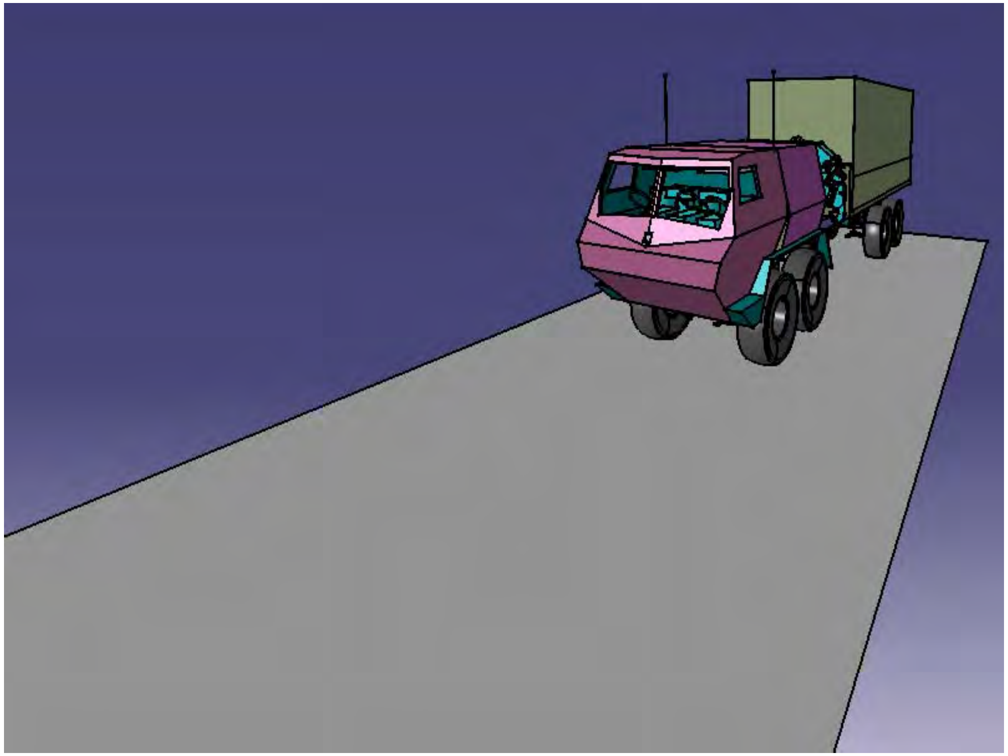
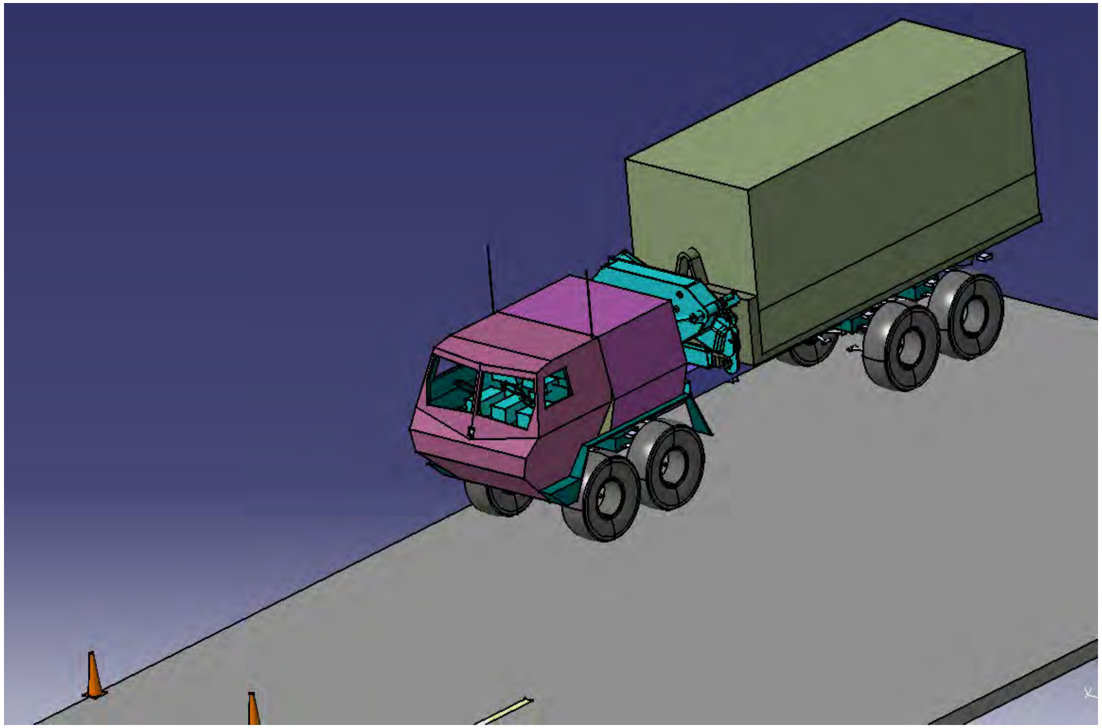
- Model as a series of rigid bodies with joints and force elements
- Tire forces modeled for both hard and soft surfaces
- Driving scenarios to test limit handling in loaded condition

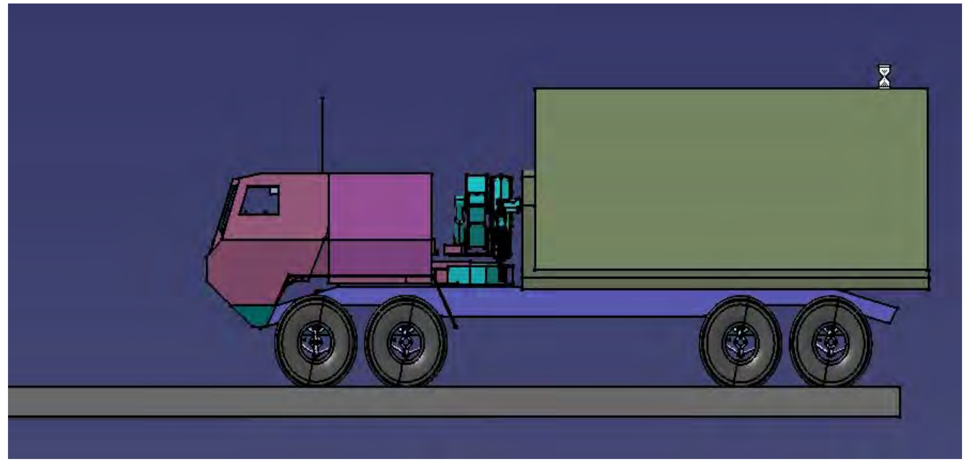


BAE SYSTEMS

- Lane change stability test
- Predict handling stability and peak roll and lateral accelerations



- Predict roll, sliding and dynamic loads
- Verify safe operating limit for field tests
- Avoid dangerous tests that could endanger drivers and prototype equipment



Results

BAE SYSTEMS

MSV: Measured and tested to the limits

Results

BAE SYSTEMS

MSV

Core Team

BAE SYSTEMS

- Lessons Learned
  - Value Of The Systems Engineering Process
  - Importance Of Model Validation
  - Benefits To BAE Systems
  - Benefits To The Customer

Conclusion

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DEFINING THE FUTURE

The Challenges of Requirements Decomposition

October 21, 2008

Eliza Siu
Northrop Grumman Corporation

Agenda

1. Introduction – Requirement Composition
2. Challenge 1 – Timing
3. Challenge 2 – High Level of Accuracy
4. Challenge 3 – Non-normal Data
5. Challenge 4 – Simulated Data
6. Recommendations
7. Conclusion
8. Questions and Answers

Introduction – Requirements Decomposition

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- What is typically done when requirements are decomposed or flowed down?
  - Split up one function into smaller ones and allocate them to various components, so that when each component performs its function, the entire function will be completed.
  - Performance requirements on timeline/speed/ accuracy, etc. are divided up similarly.
- Requirements must be verifiable or testable
  - Otherwise, one cannot tell if requirements are implemented correctly.
- Requirements need to be sold off

Challenge 1 – Timing (1 of 5)

- Example 1 – “classic” decomposition
  - The system shall complete the task within 10 sec
    - A shall complete its task within 3 sec.
    - B shall complete its task within 4 sec.
    - C shall complete its task within 2 sec.
    - Margin – 1 sec
- At a minimum
  - The start & end points at each component must be measurable
  - Need a well-defined boundary between the 2 components
    - Won’t work if B is an embedded library
    - Architecture & design are important
      - If components are not divided up logically, there will be issues with verifying requirements

Challenge 1 – Timing (2 of 5)

- The classic decomposition works just fine if the 10 seconds is a generous number, and each component's worst case timing is within the allocation.

Component	Allocation	Typical	Worst case
A	3	2	2.5
B	4	2	3
C	2	1	1.5
Total	9	5	7

Challenge 1 – Timing (3 of 5)

- When the timing is tight

Component	Allocation	Typical	Worst case
A	3	2.5	4
B	4	4	5
C	2	1.9	3
Total	9	8.4	12

Challenge 1 – Timing (4 of 5)

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- In the case when the time allowed is very tight, requiring each component to individually satisfy the timing allocation may be a problem.

- By measuring the time for the whole system, there is a much better chance of passing the requirement.

- May need customer agreement to bypass the tests for individual components and test the system.

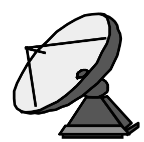
Challenge 1 – Timing (5 of 5)

X varies with
- **Atmospheric absorption**
- **Background**
- **Position w.r.t. scan pattern or starer step pattern**

Y varies with
- **Photon → exceedance (background/clutter)**

Z varies with
- **State of OS**
- **Load of server**

A Real Example



Time = X + Y + Z

Challenge 2 – High Level of Accuracy (1 of 4)

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- Example 2A
  a) The system shall do something 99% of the time.
  b) The system shall do something 99.99% of the time.

- Mathematical distinction
  a) To be able to distinguish 99% from 98%, at least 100 test cases must be run
  b) To be able to distinguish 99.99% from 99.98%, at least 10,000 test cases must be run

Challenge 2 – High Level of Accuracy (2 of 4)

- In order to obtain results that are statistically meaningful, larger samples are needed, so the no. of test cases needed will be even bigger
- Cost for running a test can be expensive
- Therefore, the consequence of higher accuracy must be understood

Challenge 2 – High Level of Accuracy (3 of 4)

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- Example 2B
  How does the higher accuracy creep in at decomposition?
  - The system shall do something 0.99 of the time
    - The accuracy is divided up as follows:
      - A shall do its task 0.9995 of the time
      - B shall do its task 0.9905 of the time
    - So that 0.9995 X 0.9905 > 0.99

Challenge 2 – High Level of Accuracy (4 of 4)

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- Therefore, the consequence & trade-off of decomposing requirements this way must be understood
  - Is the higher accuracy for each component needed?
  - With the much larger number of test runs for each component, is the system gaining a higher accuracy as a result?

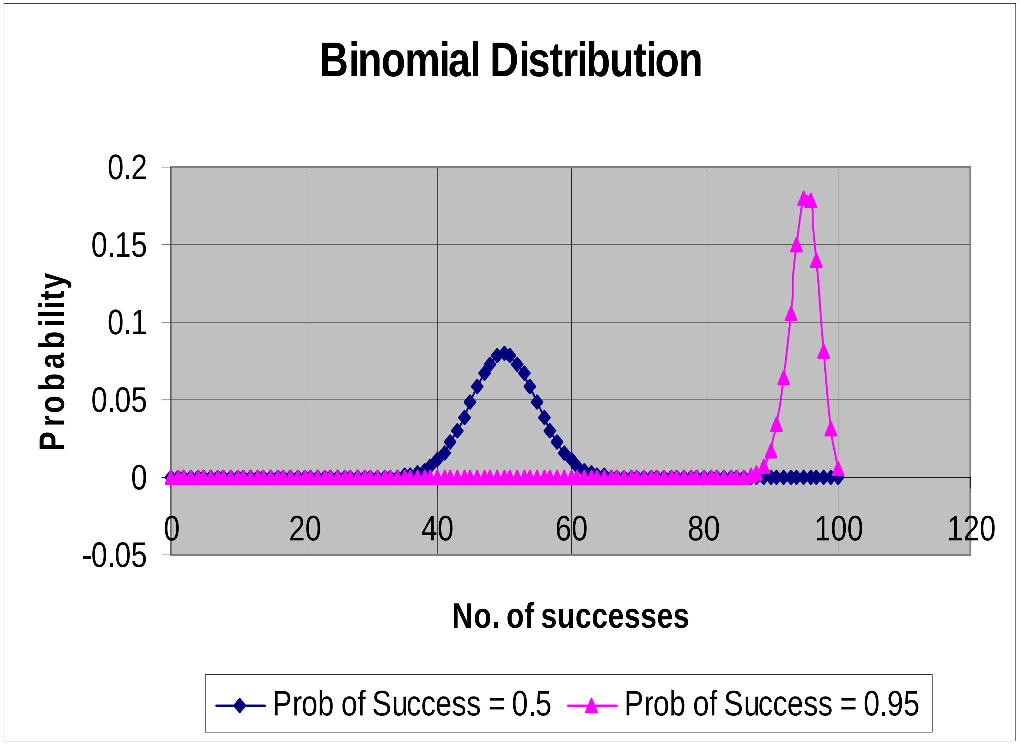
Challenge 3 – Non-normal Data (1 of 5)

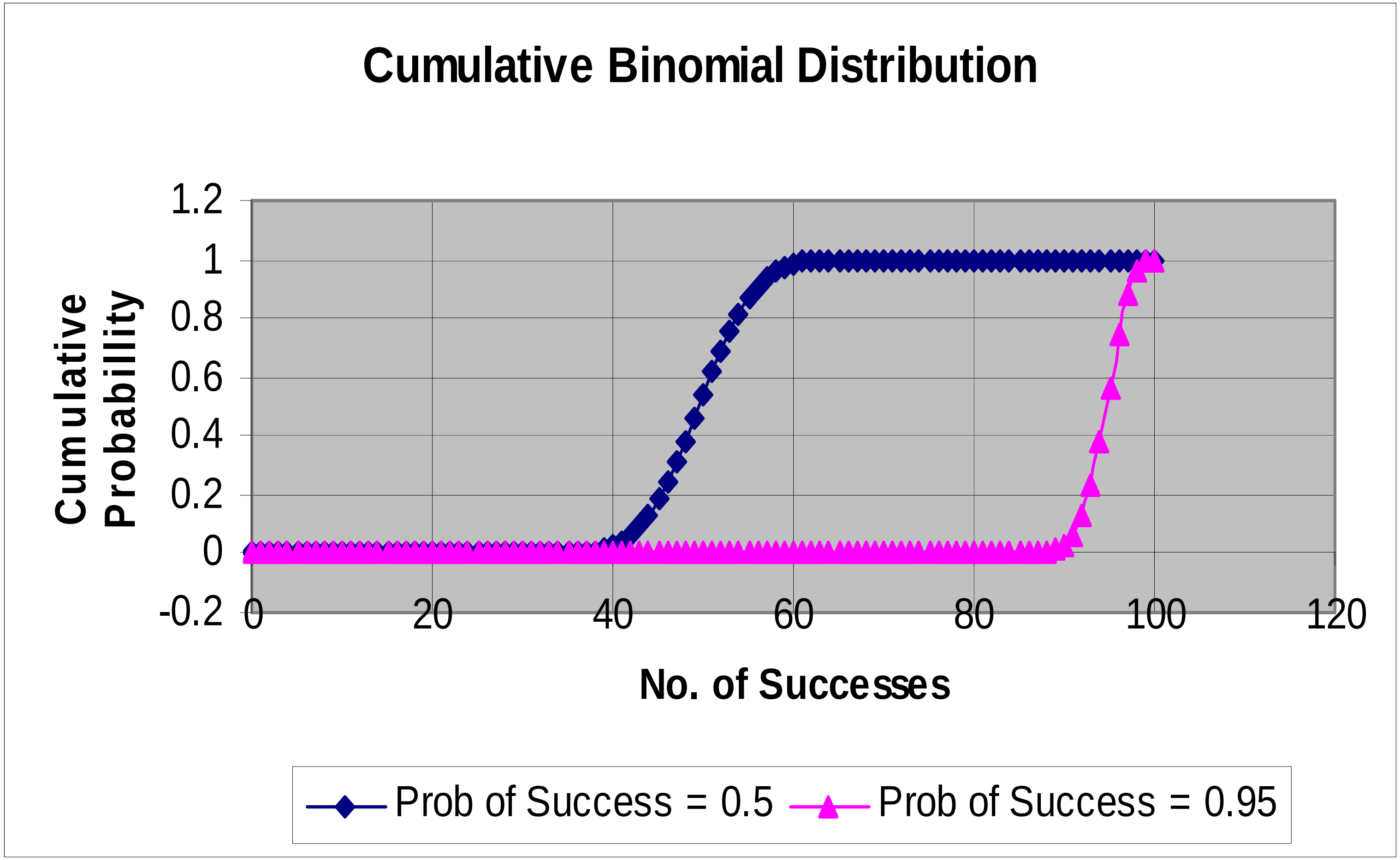
- Statistical distinction
  - In order to obtain results that are statistically meaningful, larger samples are needed. Furthermore, the more the data does not follow the normal distribution, the bigger the sample size should be.

The distribution of the data measured is usually not well understood.

Challenge 3 – Non-normal Data (2 of 5)

- An example of binomial distribution
  - Probability of success of each trial is 0.5 or 0.95
  - Total no. of trial is 100




Cumulative Binomial Distribution
Cumulative Probabillity
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
20
40
60
80
100
120
No. of Successes
Prob of Success = 0.5
Prob of Success = 0.95

Challenge 3 – Non-normal Data (4 of 5)

- Example 3
  - The system shall do something 1/month

- In both Examples 2 & 3, the probability of success is close to zero or one, i.e. the data is far from a normal distribution.
  Assuming a minimum of 10 samples are needed
  - 99.99% => need to run test case (10,000 X 10) = 100,000 times
  - 1/month => need to run test for 10 months

➡ If the requirement is on the order of 1/year, will the program ever have enough time to test the requirement?

Challenge 3 – Non-normal Data (5 of 5)

- If there are not sufficient resources to run the large no. of tests needed
  - If the requirement says >= 0.95
    - If values measured are
      0.945, 0.955 & 0.951,
      is it conclusive that the system meets the requirement?

- Several possible solutions to this situation
  - Build a better system
  - Run more test cases
  - Buyer is willing to accept the risk
    - The smaller the no. of samples,
      the higher the risk

Challenge 4 – Simulated Data (1 of 2)

- Limitation of Simulated Data
  - In order to verify requirements, simulated data will often be needed. However, the limitations of simulated data (or the models from which the data is created) must be understood
    - The physical system that needs to be modeled/simulated is often not well understood to the level of precision required.

      E.g.
      How well do we think we can simulate the weather data for the next 10 days?
      How well can we simulate a coin toss & to what level of fidelity?
    - In Example 2, the simulated data for testing 99.99% needs to be many times more accurate than the data for testing 99%. Therefore, the models also need to be much more accurate.

Challenge 4 – Simulated Data (2 of 2)

- Program Decision
  - The program needs to decide how much resources should be spent on modeling and simulation
    - Is it worth spending a lot of resources to improve the simulated data?
    - An alternative to spending resources on simulation is to conduct verification after the system is fielded. This is also a decision that the program needs to make.

Recommendations (1 of 2)

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- Never write requirements that are impossible to test or cost a lot to test
- Get involved as early as possible
  - Try to influence upper level requirements as early as possible, so that you won't have bad parent or grandparent requirements
  - Participate in other systems engineering activities, such as architecture development, and look out for potential problems
  - The earlier a problem is discovered, the less expensive it is to fix the problem

Recommendations (2 of 2)

- If you are stuck with them, need to work with customer to find a way out, e.g.
  - Help customer to understand the
    - Problem
    - Alternatives
    - Cost vs benefit of each alternative
  - Get customer agreement on testing the system without testing individual components
    - Example 1 & 2B
  - Get customer agreement on a lower level of accuracy
    - Example 2A
  - Convince customer to accept higher risk
    - Example 3
  - Get customer agreement on testing the system after it is fielded
    - Example 4

Conclusion

- Systems/Requirements engineers need to
  - Know how to write/develop/decompose requirements, and also understand the impact of requirements written in various manners
  - Understand how the system works
  - Be proactive and get involved as early as possible
    - Be involved in higher level requirements, architecture, etc.
    - Include the effort in the BOE
  - Work with customers

- Contact Info
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  - 626-812-1013

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DEFINING THE FUTURE

Enabling Systems Engineering with an Integrated Approach to Knowledge Discovery and Architecture Framework

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October, 2008

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Architecting and Engineering Different Sides of the Same Coin

- **Engineering employs <u>analysis of function</u> to iteratively decompose and separate a primarily functional representation of a whole into representations of economically producible components that can be assembled to construct the functional whole.**
  - **Big implication here! Engineering requires an "initial point" - a representation of the whole — to be successful!**

<u>Engineering does not work without an initial point!!</u>

- **We refer to this "initial point" as:**

<u>Engineerible Requirements</u>

The set of *engineering requirements* necessary and sufficient to <u>initiate</u> the successful engineering and production of a system

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Architecting and Engineering
Different Sides of the Same Coin

- **Architecting employs <u>synthesis of form</u> to iteratively compose separate elements to form a coherent whole, or a representation of a coherent whole, that can serve as an "initial point" for system development.**

- **Architecting synthesizes this "initial point" from the collective vision, goals, constraints, and other needs of the stakeholders in the to-be-developed system — converting conflicting stakeholder demands into a conceptualized whole that maximizes the satisfaction of each stakeholder.**

- **From the point of view of architecting, we refer to this "engineering initial point" as an:**

> ***<u>Architecture Specification</u>***
>
> **An architecture description to which all system implementations must adhere; and a set of principles, practices, and constraints guiding implementation, operation, and evolution of the developed system**

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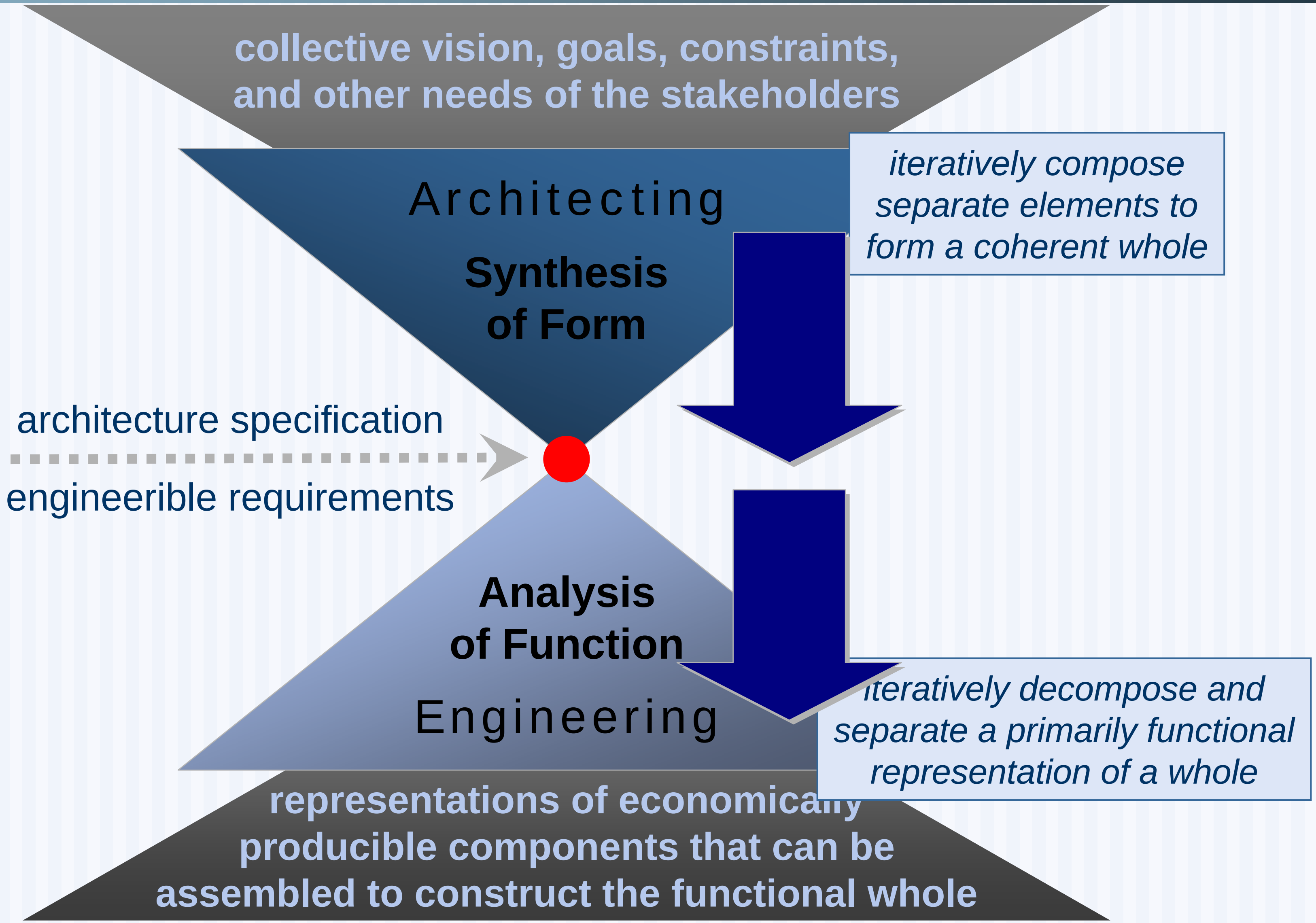
Architecting and Engineering
Different Sides of the Same Coin



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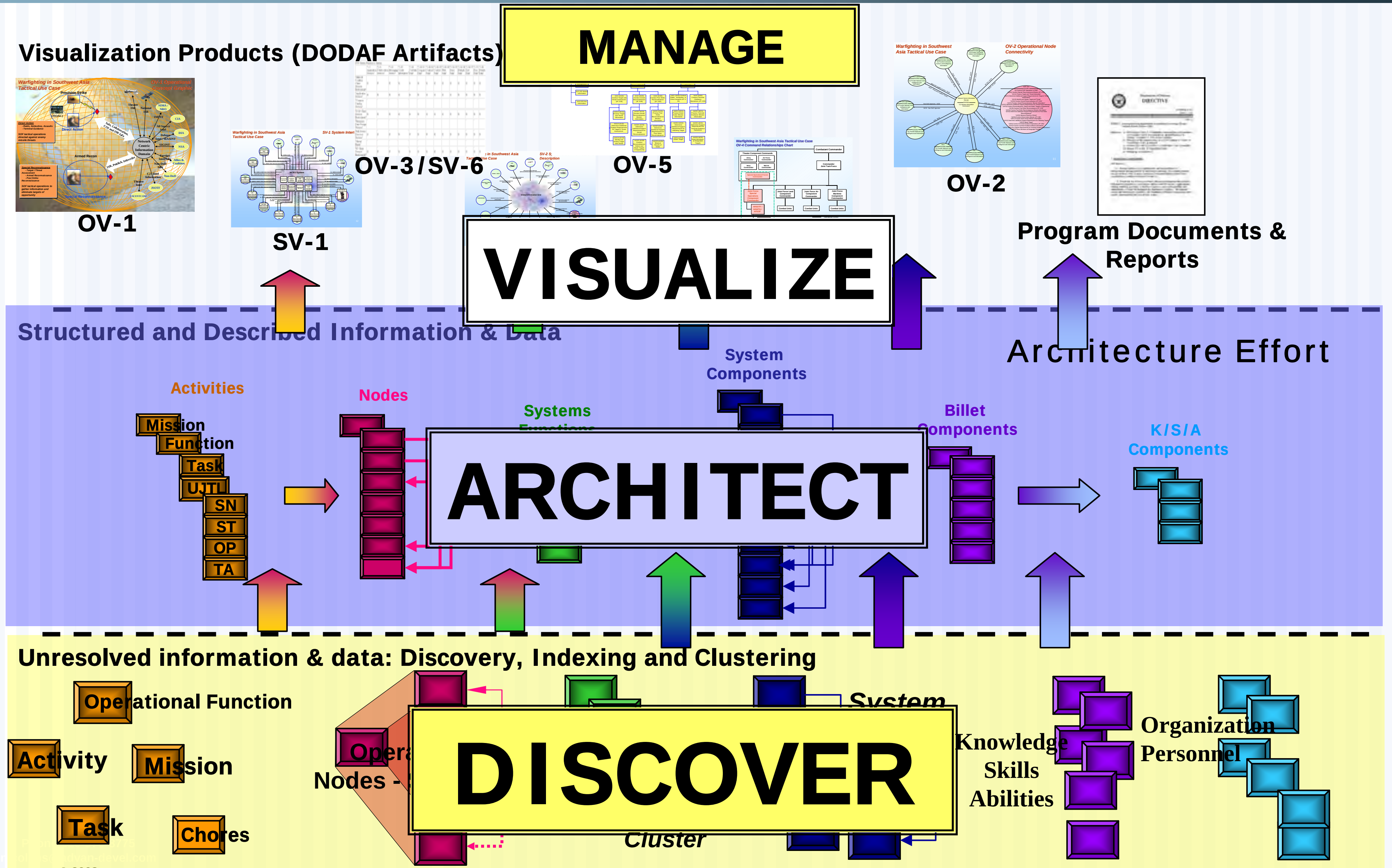
DISCOVER, ARCHITECT, VISUALIZE, MANAGE™



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Root Process Problem

- **Complexity of data elements is overwhelming**
- **Difficult to support the book-keeping management of all of the data elements and their relationships across all the echelons of the Enterprise**
  - ♦ **‘Structuring’ complexity**
  - ♦ **‘Echelon integration and enterprise description’– everything is a part of a larger system**
  - ♦ **Persistent, iterative, and evolutionary incorporation in a knowledge and reuse environment**

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Discovery

- ***Every object, relationship and aggregation of objects in the knowledge metamodel*** **is in documents, the universe of textual models**
- ***Discovery*** **is about finding the objects, relationships, aggregations and descriptions of each of these in the authoritative and original data sources**
- ***Integration*** **is about using Discovery to build and describe the Architecture using an architecture meta-model**

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Concept, Themes, and Description

- A concept, or theme, is the encapsulation of a pattern that is identified as a gestalt: a persistent and unique ‘signature’
- Documents are textual patterns
- Models are labeled, structured patterns
- Labels are knowledge anchors to concepts and themes
- Knowledge is pattern recognition, association and application in integrated textual and model gestalts

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DISCOVERING CONCEPTS / THEMES

- **‘Information' can be treated as quantifiable symbols in communications**
- **Natural language has a high degree of unessential content, the less frequently a unit of communication occurs, the more information it conveys**
- **Information objects extracted from Natural Language text form a *index unique to that concept***
- **The architecture metamodel is the syntactic of the knowledge pattern and is semantically rigorous**
- **Information objects cluster based upon an inference relationship measuring semantic completeness**

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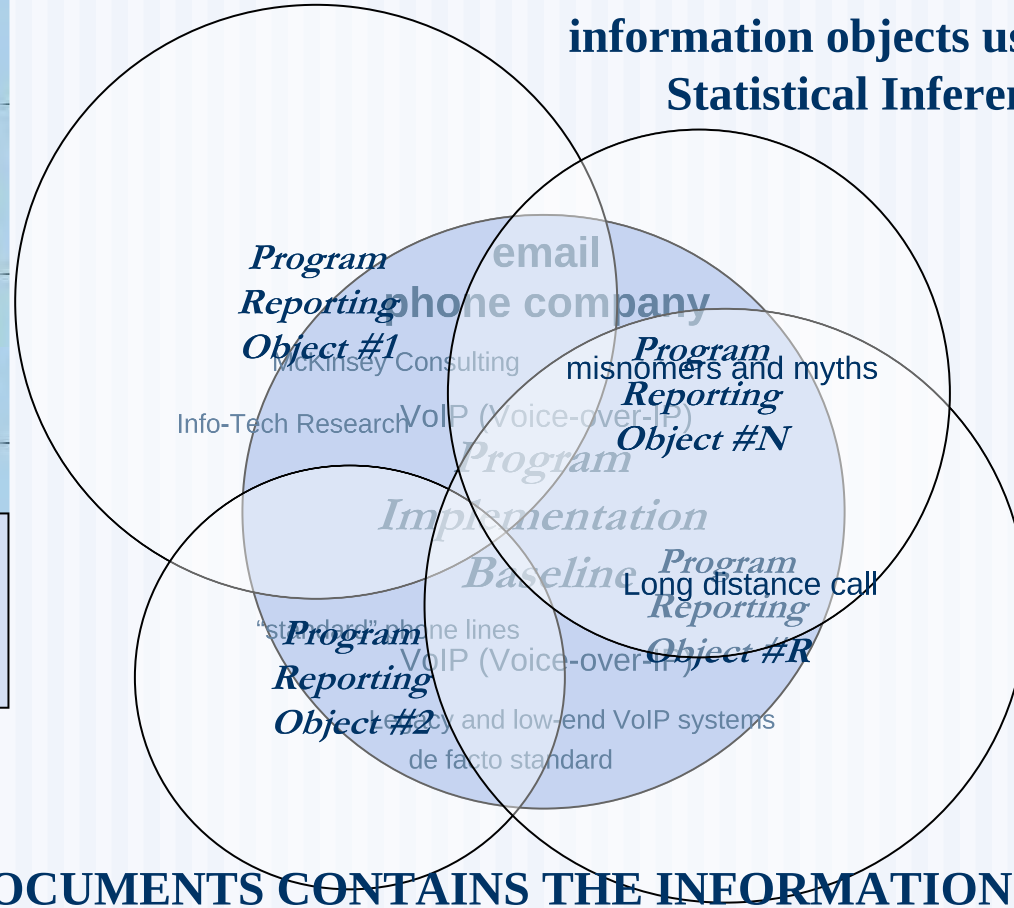
Mapping and Demonstrating Impactful Relationships

Example Cluster Picture from the Cartia: ThemeScape Web Site

Define the information objects and index them

Cluster the indexes of the information objects using Statistical Inference!



THE UNIVERSE OF DOCUMENTS CONTAINS THE INFORMATION OBJECTS THAT DESCRIBE THE IMPLEMENTATION BASELINE

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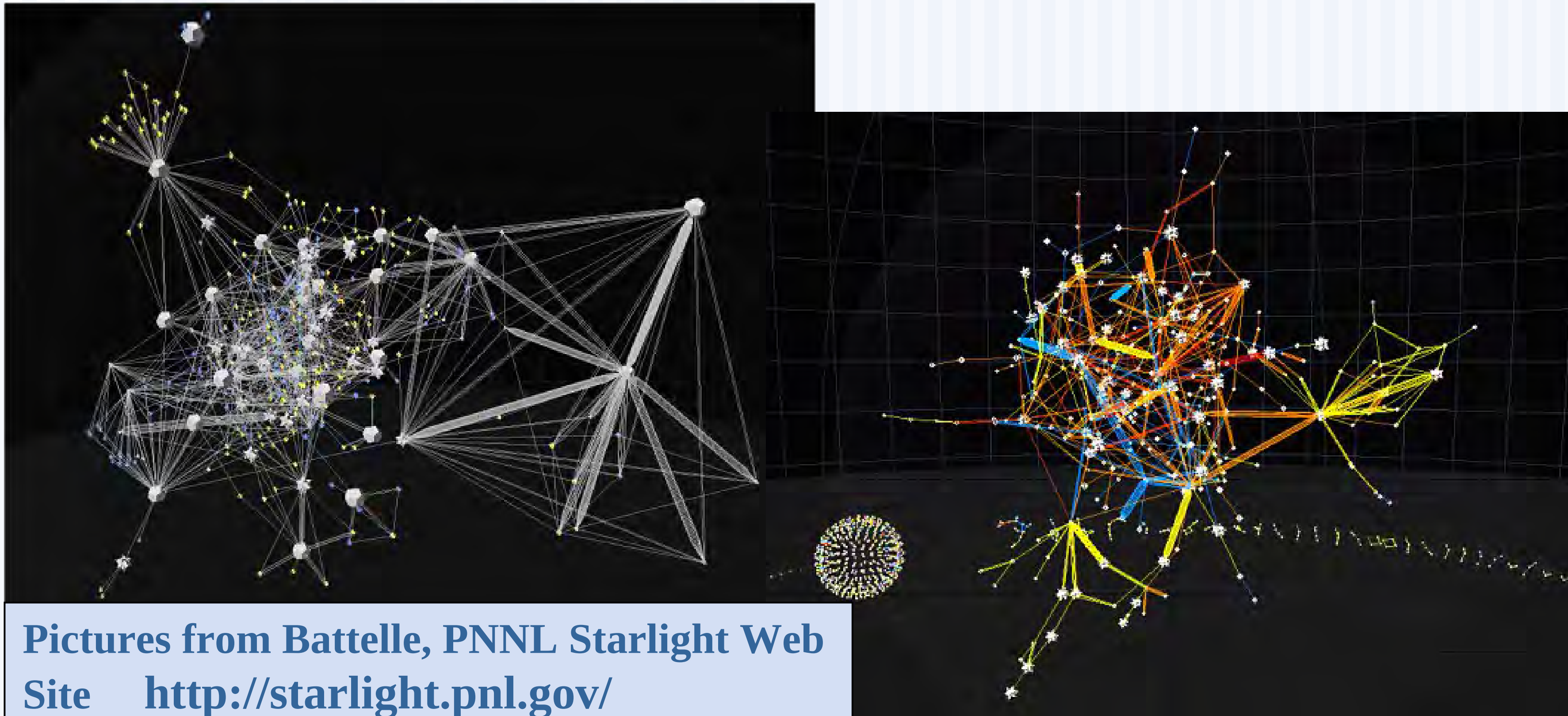
Cluster and Relationship Visualizations



Pictures from Battelle, PNNL Starlight Web Site http://starlight.pnl.gov/

Cluster and integrate using the architecture meta model
Visualization can take many forms presenting many perspectives.
Tracing of the models back to the authoritative and original data sources.

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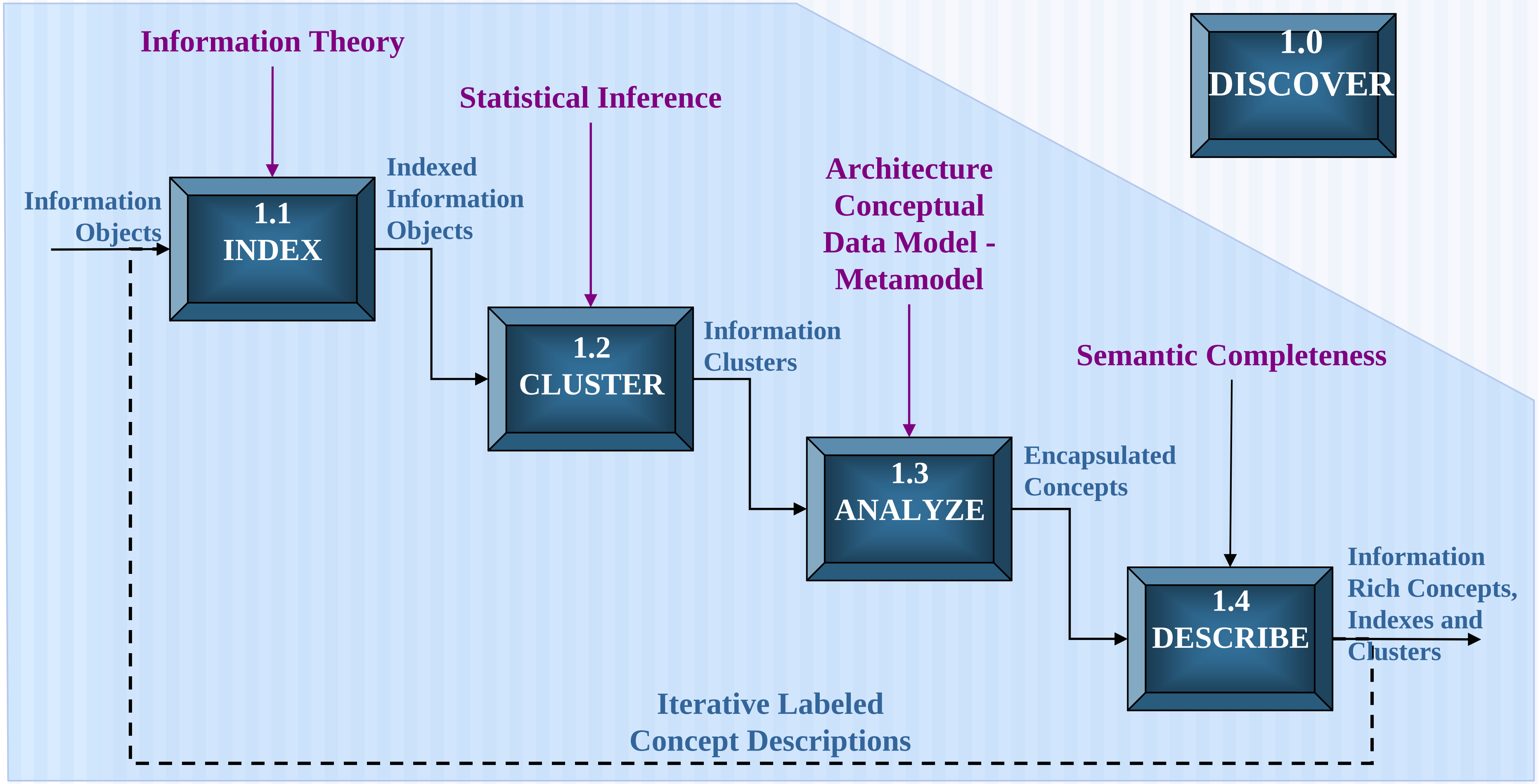
DISCOVERY PROCESS



Discovery works best when it has a pre-existent form upon which it can operate.

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ARCHITECTURE & DISCOVERY

- **Architecture is the *description* of the *intrinsic* relationships, characteristics and behaviors of the system under study**
  - **All systems have an architecture — intentionally architected or not — and that architecture is a primary determinant of the system's behavior. Brad Mercer, MITRE Principal Architect**
  - **Architecture *is* the model in Modeling and Simulation and a rigorous and well-constructed model can be executed**
- **Discovery: the process for identifying the conceptual syntactic of architecture and the rich semantics**
- **Present architecture efforts are neither semantically complete nor rich: they contain a series of model artifacts (products) built and limited to "*labeled*" components and relationships; it has no processes, only product templates**

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Taxonomies of Primitives

- Indexing and clustering builds initial identification and organization of labeled themes and concepts
- Clusters are labeled taxonomical elements
- Rich taxonomies can be developed from clusters
  - Structured and organized categorization of information
  - Syntactic and semantic descriptions
  - Parent – child relationships
- Labeled themes and concepts are the architecture primitives

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Topologies in Domains (information, behavioral, functional)

- Topology in architectures relates to the connectedness of child – child with order of precedence and importance
- Information object references contain topological reference information useful in describing and identifying the syntactic and semantic elements
- The taxonomical and topological elements provide the structure and precedence of concepts and their references provide the content for specification

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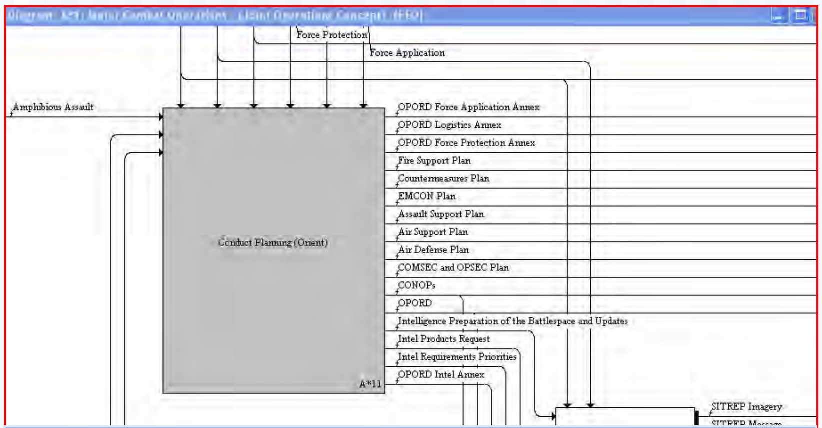
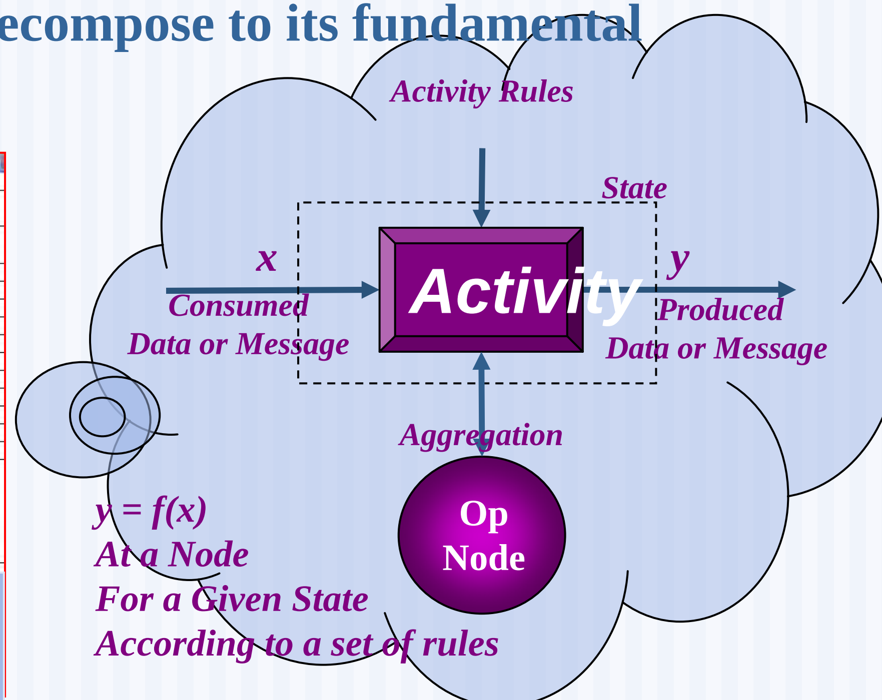
Persistence (Primitives) and Re-use (Encapsulations)

To be Persistent, the model must decompose to its fundamental components, its primitives.



IDEF0 MODELS mix component information and concerns and are *<u>a visualization standard, not a data standard</u>*.



To be Re-useable, the model must encapsulate its fundamental components, or primitives into re-useable Objects.

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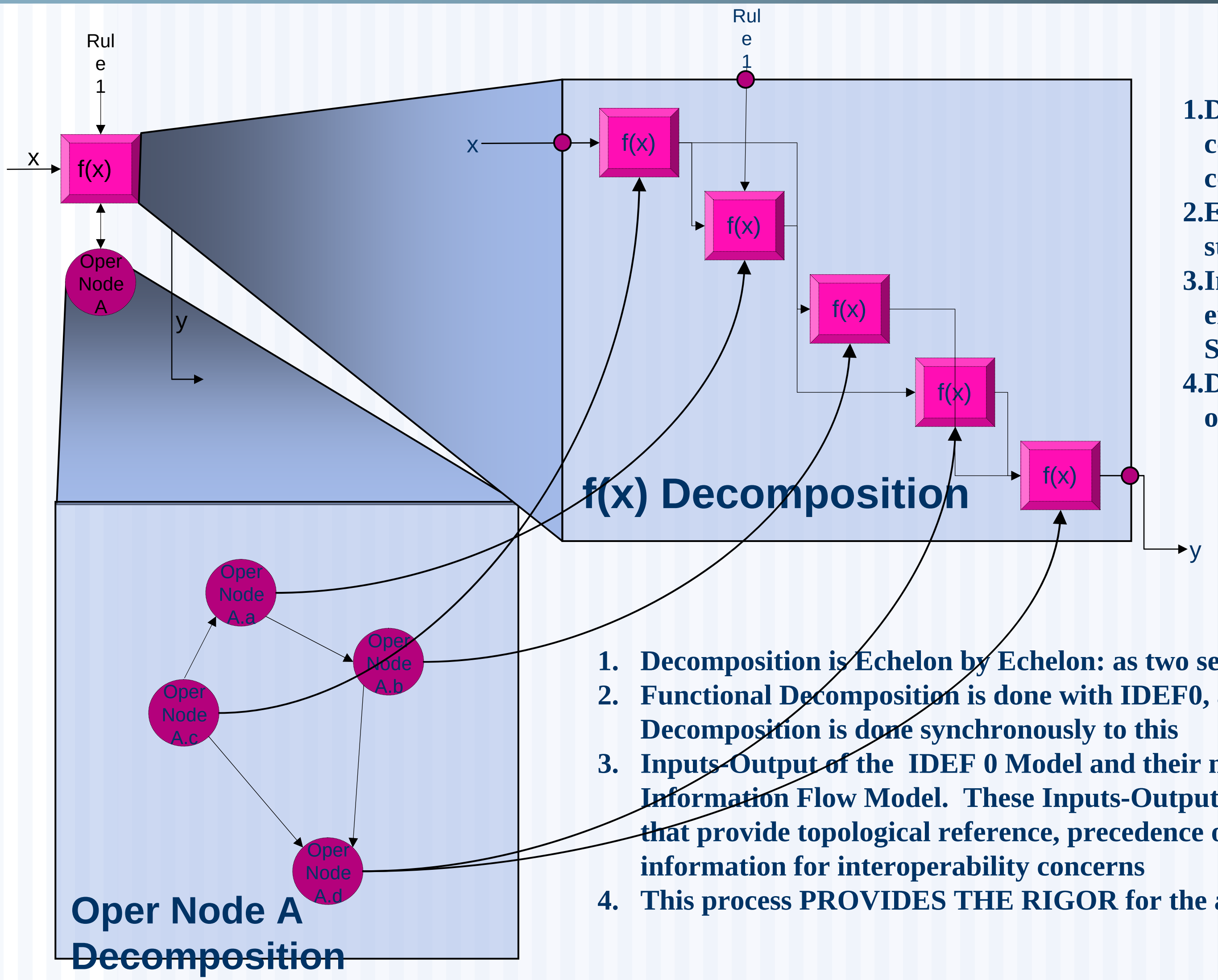
Enterprise Decomposition by Echelon



1. De-confliction of meta-model components to remove mixing of concerns
2. Encapsulation represents the statement of a gestalt.
3. Incremental instances of encapsulation represent Rules and States.
4. Decomposition is a basic principle of Architecting and Engineering

1. Decomposition is Echelon by Echelon: as two separate 'synchronous' taxonomies
2. Functional Decomposition is done with IDEF0, and the Operational Node Decomposition is done synchronously to this
3. Inputs-Output of the IDEF 0 Model and their mapping to the Node Model are the Information Flow Model. These Inputs-Outputs are the Information Elements that provide topological reference, precedence of function and critical exchange information for interoperability concerns
4. This process PROVIDES THE RIGOR for the architecture primitives.

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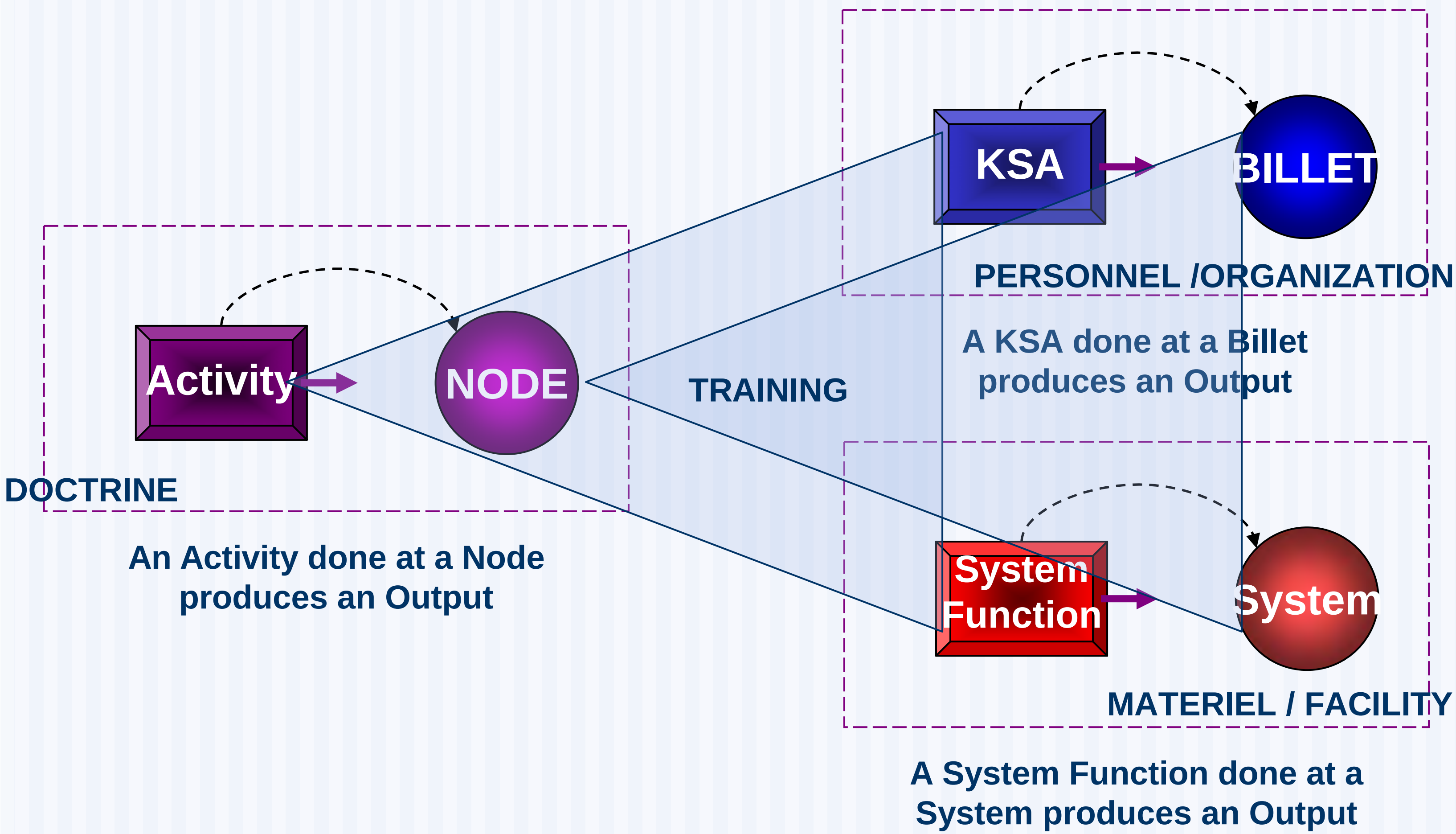
View Relationships: Simplified Calculus



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DISCOVERY ENABLED ARCHITECTURE SPECIFICATION

- **Document information objects describe the taxonomy and topology of architecture primitives and relationships**
- **Integration is accomplished using the principles and practices of a tightly coupled discovery-based architecting process**
  - ♦ **Indexing and Clustering provide navigation to the authoritative and original sources for descriptions of the information objects**
  - ♦ **Clustering, using these descriptions, iteratively refines and extracts more relevant information objects**

This enables the Synthesis of Form

- **Discovery described Architectures enables the development of Rigorous, Semantically complete Architecture Specifications, i.e., engineerible requirements**

This enables the Analysis of Function

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QUESTIONS

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Systems Engineering: Application in complex organizations

Robert Parrish – PEO Simulation, Training, Instrumentation

Kevin Roney – Booz Allen Hamilton

October 22, 2008

Outline

- Introduction
- Complexity
  - Complexity – effects on systems
  - Complex Systems
- Enterprise (Complex) Systems Engineering (ESE)
  - Systems Engineering
  - SoS Engineering
  - Enterprise Systems Engineering
- Use Case Example
  - Systems Engineering in a Complex Organization
  - PEO Simulation, Training, and Instrumentation
  - Complexity Space
- ESE Approach
  - LVC I2 – ESE Approach
  - Applying ESE
- Summary
- References

Introduction

- Systems Engineering evolved because of the complexity in large scale engineering problems, which is a reality of today's projects
- Transformation to Network Centric Operations is another perturbation to the increase in complexity
- Program Executive Office (PEO) is the foundation of DoD material development that produces complex systems and system of systems
- Additionally, the PEO tends to be a complex organization
  - They tend to be large, heterogeneous, exercise control over strategic objectives, and consist of portfolio of projects
  - A PEO is often composed of several Project Managers with their own complex set of systems engineering challenges
- Intuitively, we understand that systems engineering at the Project Manager (PM) level benefits producing complicated systems
- What form should systems engineering look like in a complex organization such as a PEO?

Complexity – effects on systems

- Systems become open
- Systems behaviors aren't reducible to the sum of their parts
- Systems parts interact nonlinearly
- More difficult to completely comprehend systems
- Is a fundamental reason for failure in large scale engineering projects[3]

Complex Systems

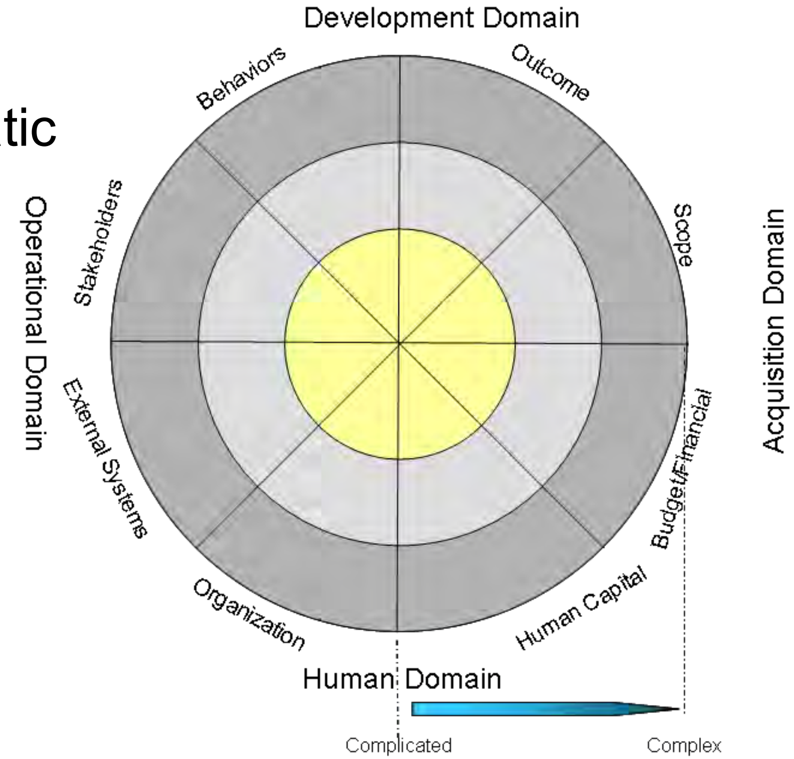
- Focus is on the overall coherence of the whole complex system – without direct, immediate attention to the details while typical engineering tends to focus on the functional description
- Emphasis is on how decisions are made and not what those decision should be
  - The order and complexity of the solution rather than a pre-specified solution
  - What parts of the whole solution should addressed
- Relationship and interaction of the population associated with the complex system development is key

Complex Systems (cont)

- Development characteristics- Shapes the environment and not the actual development
  - Variety of autonomous agents. Ability to add and remove agents without halting the system
  - Enable autonomous agents interaction
  - Resources flow throughout the development without any prescribed means, based on cooperation and competition
- Operational characteristics
  - Because complex systems evolve – direct interaction is needed between development and operational
  - Only non complex systems can be treated in a way of isolating development from operation
- Enterprise is a complex system

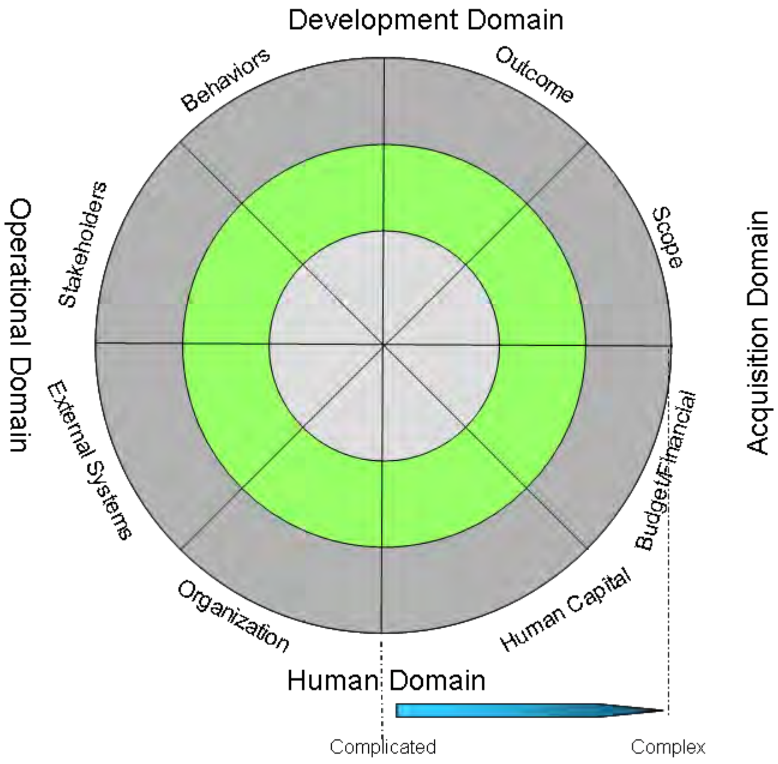
Systems Engineering

- Development Domain
  - Behaviors- definable
  - Outcome/Reward – predictable/static
- Acquisition Domain
  - Scope – linear/closed boundary
  - Budget/Financial –systems owned
- Human Domain
  - Human Capital - skills are understood (classical)
  - Organization-defined & structured
- Operational Domain
  - External Systems- single interface
  - Stakeholders- single user class



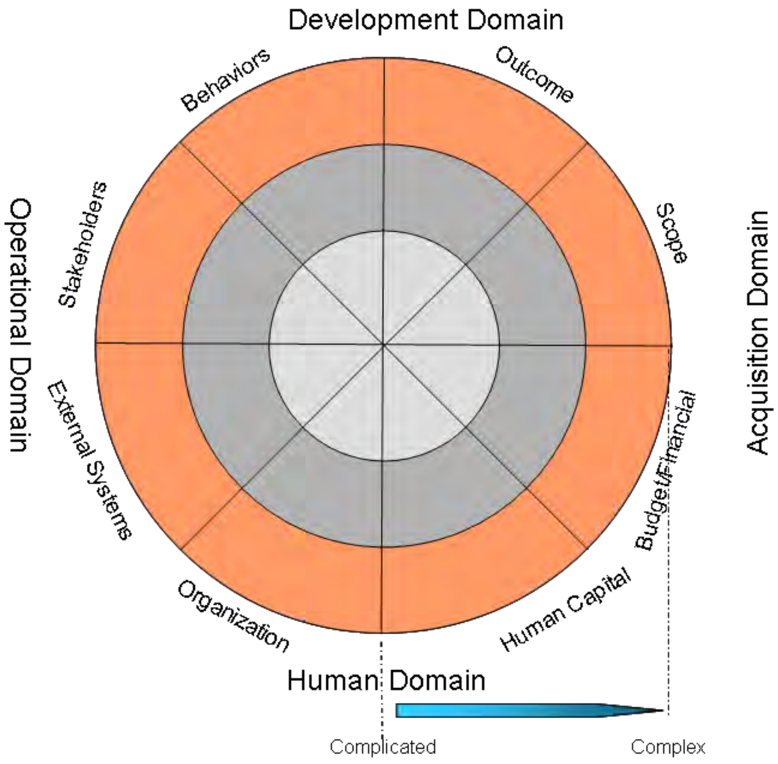
System of Systems Engineering

- Development Domain
  - Behaviors- identifiable
  - Outcome/Reward – predictable/dynamic
- Acquisition Domain
  - Scope – linear/complicated boundaries
  - Budget/Financial – systems shared
- Human Domain
  - Human Capital - skills are diverse
  - Organization- complicated & relational
- Operational Domain
  - External Systems- multiply systems – similar interfaces
  - Stakeholders- similar users



Enterprise Systems Engineering (ESE)

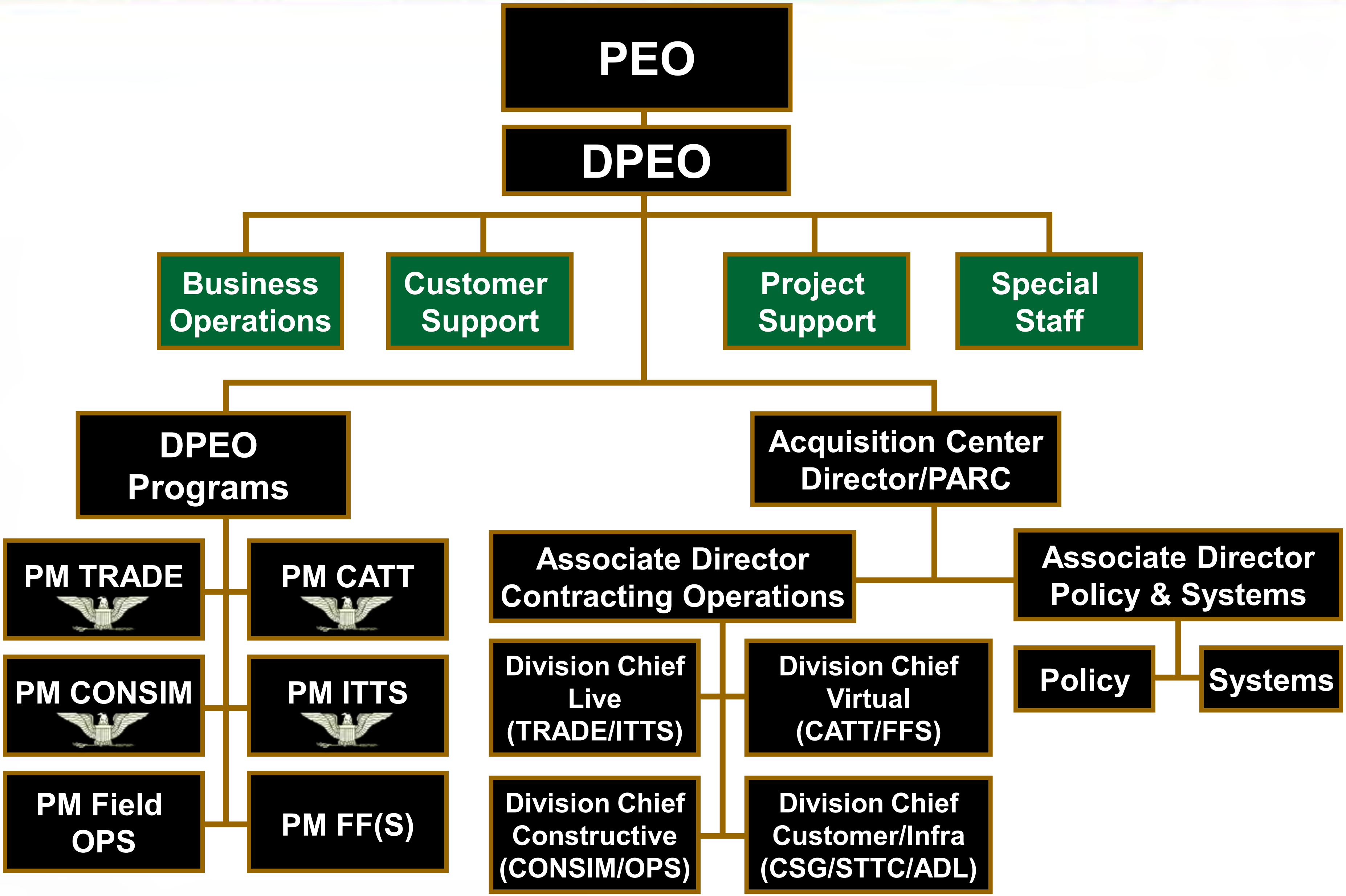
- Development Domain
  - Behaviors- self organizing/open
  - Outcome – adaptable/flexible
- Acquisition Domain
  - Scope –nonlinear/open boundary
  - Budget/Financial – systems advocacy
- Human Domain
  - Human Capital - skills are diverse
  - Organization- distributed & cooperative
- Operational Domain
  - External Systems- multiple systems – multiple interfaces
  - Stakeholders- multiple users



Systems Engineering in Complex Organization – Use Case Example

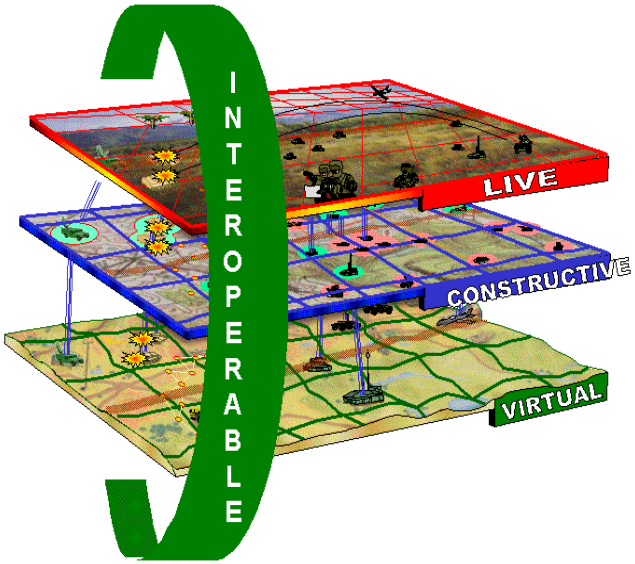
- Program Executive Office – Simulation, Training, and Instrumentation (PEO STRI)
  - Complex Organization
  - Complex Systems and System of Systems
- Conceptual application of “enterprise-level” Systems Engineering best practices to support the PEO’s SoS problem space of integrating the Live Virtual Constructive (LVC) domains.
  - Utilized SE technical management processes such as technical planning, requirements management and interface management

PEO STRI Organization

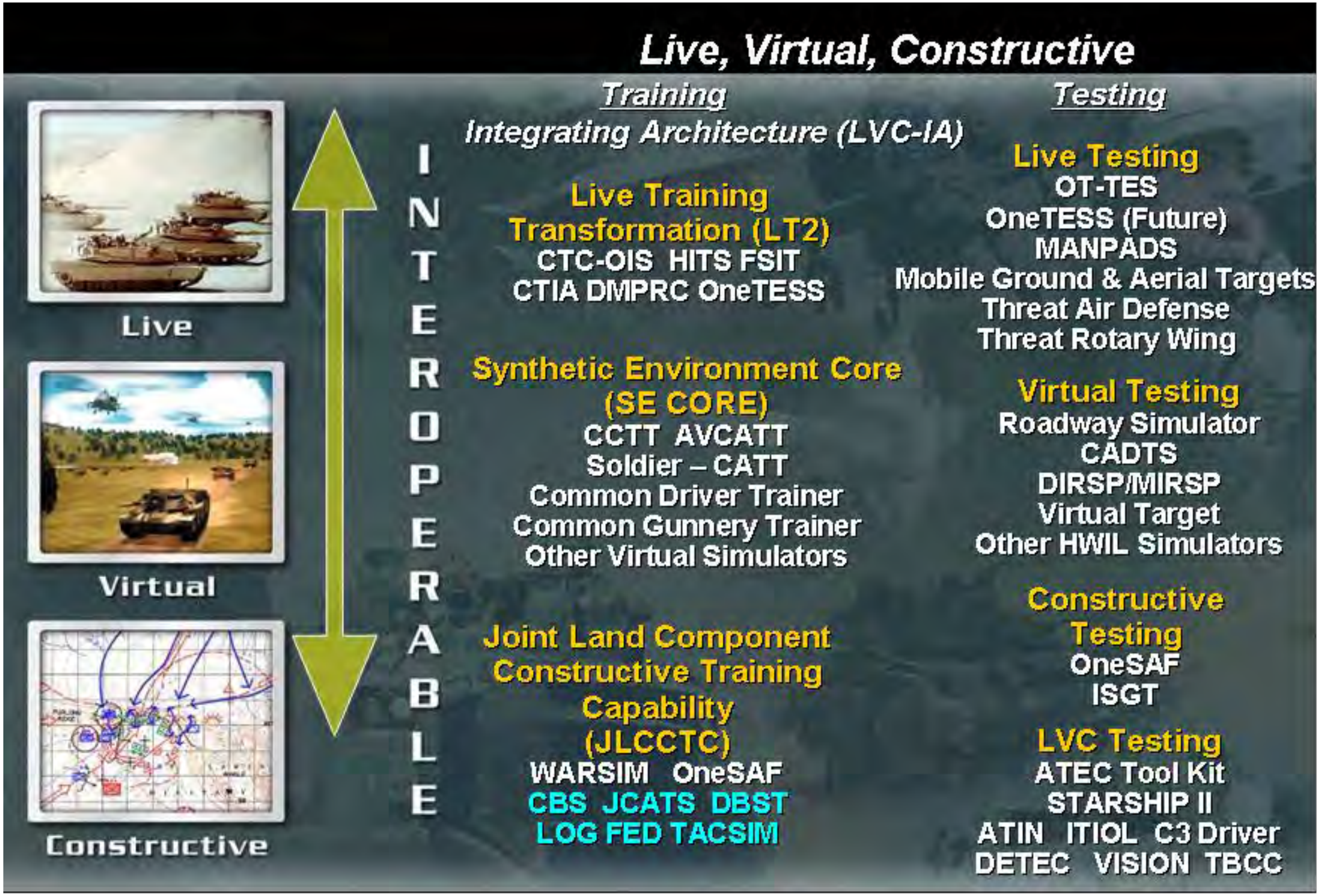


PEO STRI Mission-Complexity Space

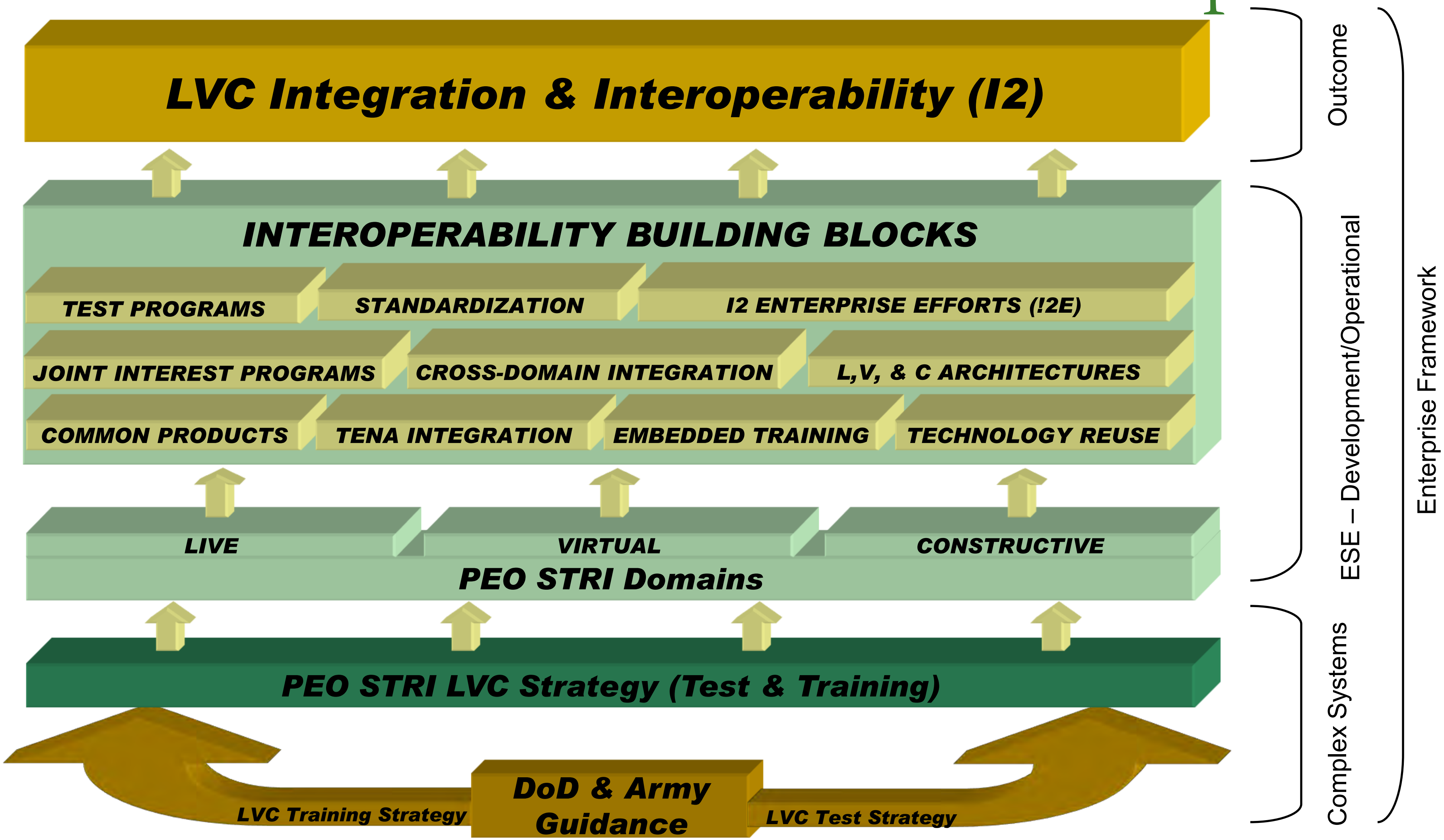
- Provide a modular, agile, simulation, training, testing, and instrumentation environment to enable Warfighter success for any threat
- We must capitalize on the Army's investment through integration and interoperability (I2)
- Achieved through leveraging and reuse of capabilities across the PEO's Enterprise (i.e.: Standards, Common Products, etc.)
- Provide effective and efficient lifecycle managements of simulations solutions to support the Warfighter



A Complex System – LVC Interoperability



LVC I2 – ESE Framework Example



Applying ESE – Developmental Environment

- Single most basic activity underpinning engineering enterprise systems
- Create environment of continuous innovation to address complexity
- PEO STRI established a group called the Integration/Interoperability Advisory Board (I2AB) to provide governance to technical and PM processes
  - I2AB provided the forum for team organization and open communications across the PEO domains
  - Comprised of technical and programmatic leaders from each of the L/V/C domains
- I2AB creates coherence
  - Requirements Management
  - Interface Management

I2 Advisory Board (I2AB) Characteristics

- **Responsible to provide management oversight, direction, and guidance of I2 mission.**
- **Comprised of both PEO technical and program senior leadership and reports to the PEO Board of Directors (BOD).**
- **Provides technical and program recommendations to the DPEO/ BOD to facilitate I2 across the PEOs program portfolio.**
- **Manage the PEO portfolio Dependency Matrix.**
- **Establishes I2 standards, guidelines, and processes for use and compliance in coordination with PMs.**
- **Defines I2 policies for PEO implementation.**
- **Educates community on I2.**

Requirements Management

- I2AB understood basic complexity principal to cope with SoS complexities requires increased flexibility
- SoSE requires adaptation to changing requirements
- Utilize DODAF to develop “enterprise” architecture artifacts to support interoperability and information exchange requirements for LVC
  - Methods and information
  - Functions, processes, activities, data elements
  - Standards

Interface Management

- I2AB understood the importance of "standards-compliance" as an asset to support interoperability
- I2AB developed and enforced the use of the PEO's Common Standards, Products, Architectures and Repository (CSPAR)
- Initiated the Live, Virtual, Constructive Integration Cell (LVCIC) effort to begin integration of key systems/interfaces for the LVC Integrated Training Environment (ITE).

ESE LVC Outcome Challenges

- Data Model Strategy that supports efficient LVC Training and Testing – modeling across systems
  - Fair fight
- Consensus on what is “good enough” – defining the “right” MOE/TPMs that apply to the SoS
  - Use LVC Interoperability Model as “measuring stick”
  - Ensure fidelity and density of data and signals meets needs of both test and training communities
  - Address security of data issues across all communities
- Defining clear LVC use cases
- Resources that specifically address LVC requirements
- Common Test / Training Solutions
- Scalability of LVC products – Different requirements for each domain

Summary

- Complexity – Impact on Systems
  - Complex organization are complex systems
  - Complex System are open
  - Complexity makes it more difficult to completely comprehend a system
- Why Enterprise Systems Engineering?
  - Complex systems don't decompose well and tend to be nonlinear
  - Complex systems behaviors are not predictable
  - Therefore, classical systems engineering approaches need modification
- Keystone concepts to ESE approach
  - Configure for the context and local interaction and not detailed design
  - Incorporate processes to handle unforeseen changes in behavior
  - Include multiple methods for achieving the same end
- Potential Benefits to PEOs
  - Complex systems that are flexible and adaptable
  - Ability to evolve systems through introduction of new technology with out disrupting the systems
  - Ultimately, reduces risks caused by unanticipated effects that lead to failures of systems

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NDIA

11th Annual Systems Engineering Conference

Systems Engineering Approach for Assessing a Warfighter's Cognitive Performance

22 October 2008

James Buxton

U.S. Army Aberdeen Test Center

Kevin Roney

Booz Allen Hamilton

Albert Sciarretta

CNS Technologies, Inc.

The Situation

- Historically for warfighting systems….

  System and SoS performance = f {warfighter performance}

- Future for warfighting systems….

  Complexity ↑ Dependence on Netcentric Environment ↑ Dependence on & Criticality of Warfighter Performance ↑

- Future Warfighter's performance = f {situational awareness (SA)}

- Future Warfighter's SA will be highly dependent on:
  – Sensor Input
  – Information from Other Humans
  – Information Systems Output
  – Education and Training
  – Combat Experience
  – Cognitive Capabilities
  – Others…..

The Problem

- DOD lacks capability to measure human performance
  - In an objective, quantifiable manner
  - In an operational environment – near real time
  - With statistical quality
- Significant shortcomings in measuring a warfighter's cognitive SA.
  - Much progress in measuring technical SA
    - Tracking information displayed on screens or available in a network
  - Limited success in measuring cognitive SA
    - In a laboratory environment
- **Limited technical means** for collecting **objective data** in support of **assessing cognitive SA** in an **operational environment**

As the complexity of systems and level of information flow increases, this assessment deficiency grows proportionately larger

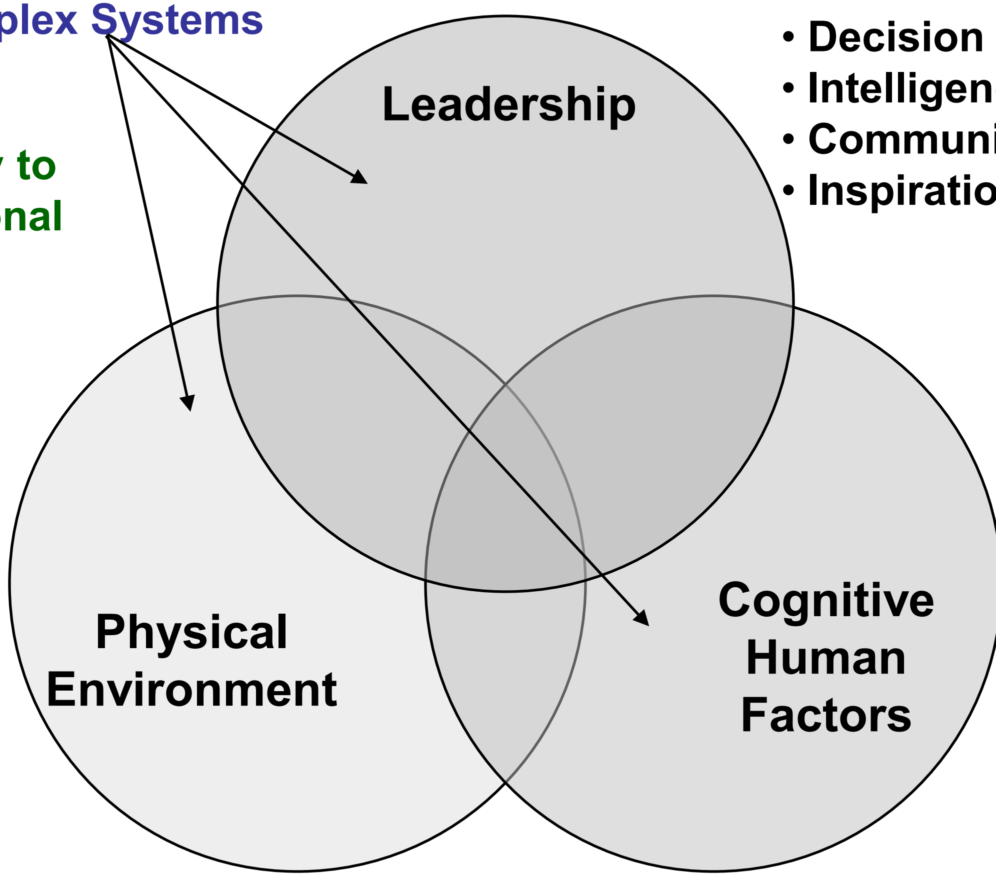
The Problem

(Continued)

Complex Systems

Acceptable ability to test in an operational environment

- **Weapons**
- **Sensors**
- **Platforms**
- **Munitions**
- **Terrain**
- **Weather**



- **Decision Making**
- **Intelligence**
- **Communication**
- **Inspiration**

Inadequate ability to test in an operational environment

- **Morale**
- **Training**
- **Confidence**
- **Fatigue**
- **Fear**
- **Risk Aversion**

Limited ability to test all aspects of a Warfighter's combat environment

The Program

Joint Warfighter Test and Training Capability (JWTTC)

- A major US Army major instrumentation program
- Focused on measuring
  - Cognitive human performance
  - Cognitive SA
  - Physiological status
  - In an operational environment
- Will address test and evaluation (T&E) shortfalls in terms of
  - Instrumentation
  - Measurement and analysis of Warfighter performance
  - Impact of physiological and neurological stress
  - The collection and analysis of Warfighter performance data in terms of
    - SA of an individual
    - Shared SA (SSA) of teams, crews, or combined teams and crews
    - The total system performance of a single manned system or a combination of Warfighters, manned systems, and unmanned systems.

Systems Engineering (SE)

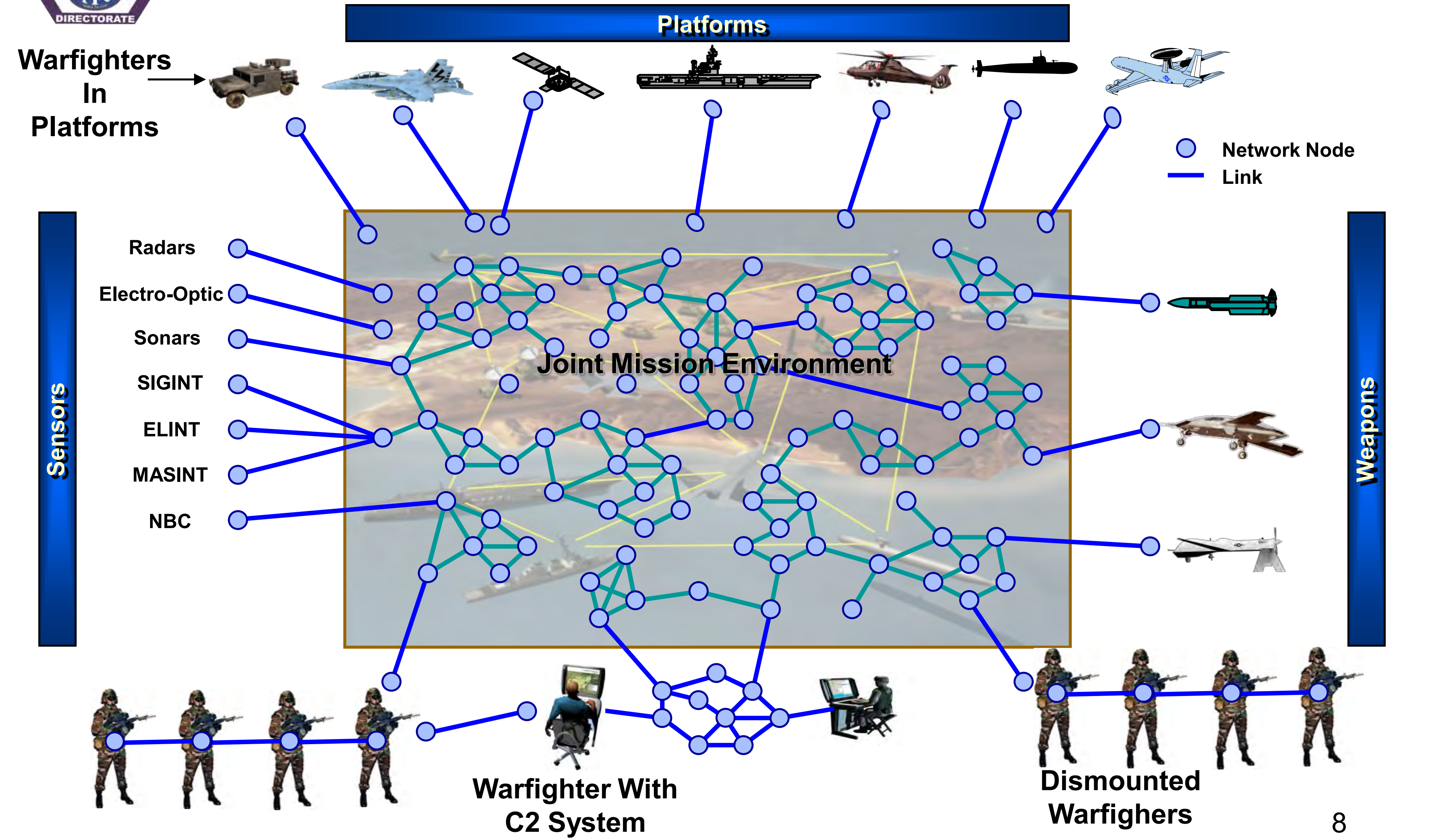
Need for JWTTC

- DOD 5000.2 requires systems engineering in a program's acquisition life cycle
- The SE describes the overall technical approach to development of an effective JWTTC product that is sustainable at an affordable cost
- Identifies how the program is structured and conducted to effectively achieve program goals and objectives
- It an instance of the technical baseline defining the architecture and design components
  - Decomposes the capabilities into logical and physical components
  - Includes technical performance measures
- Provides the road map for acquiring and integrating technologies to address the JWTTC capabilities
  - Includes a comprehensive program schedule outlining component acquisition activities, integration, test, and delivery
- A tool in managing the technical development of JWTTC System

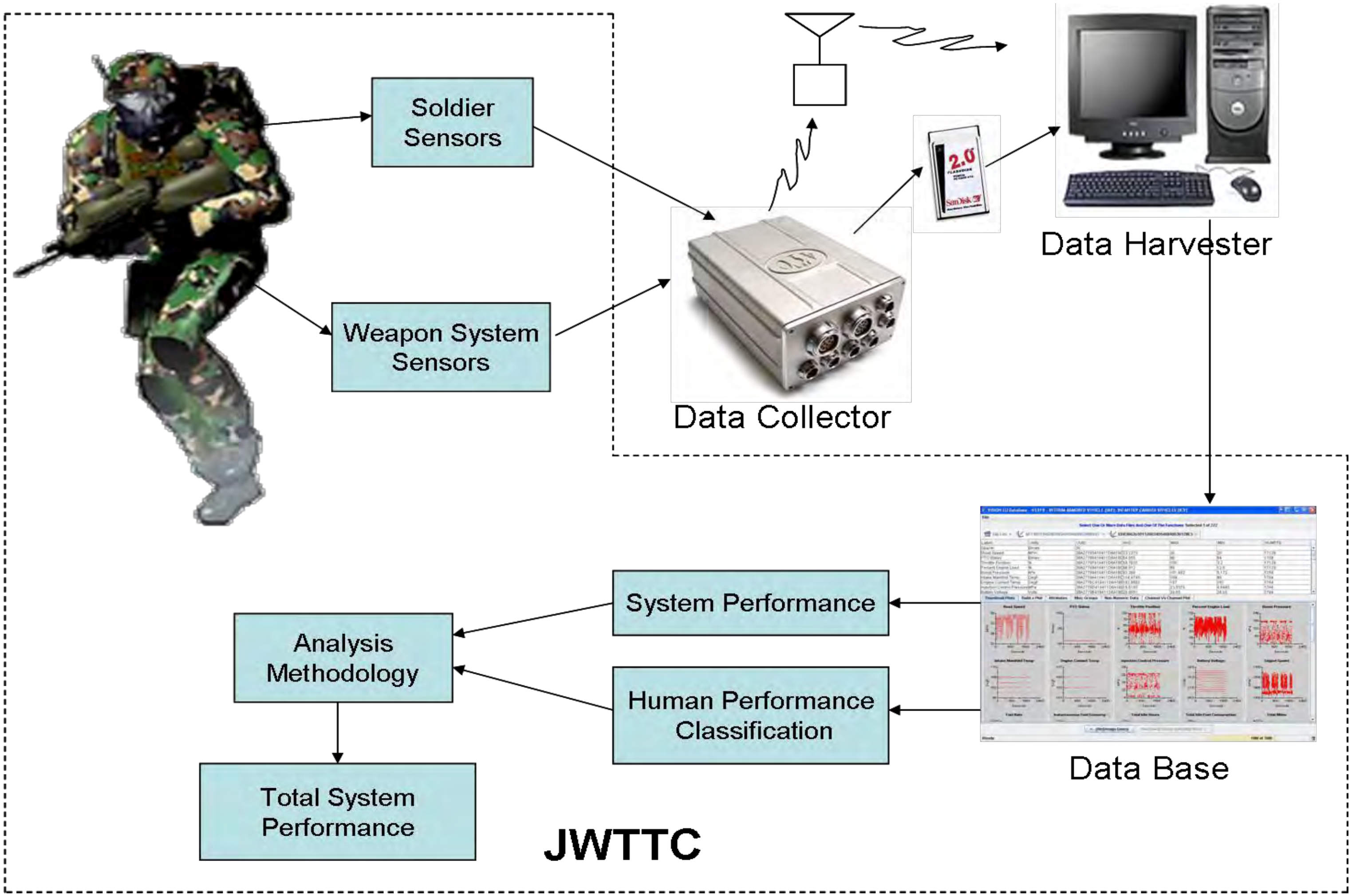
Engineering Approach for JWTTC

- Consideration in developing the JWTTC program
  - Warfighter is a system in JWTTC
  - JWTTC is a system-of-systems
- Use proven SE approaches to evaluate the systems

Warfighter as a Node in an SoS Environment



The JWTTC SoS

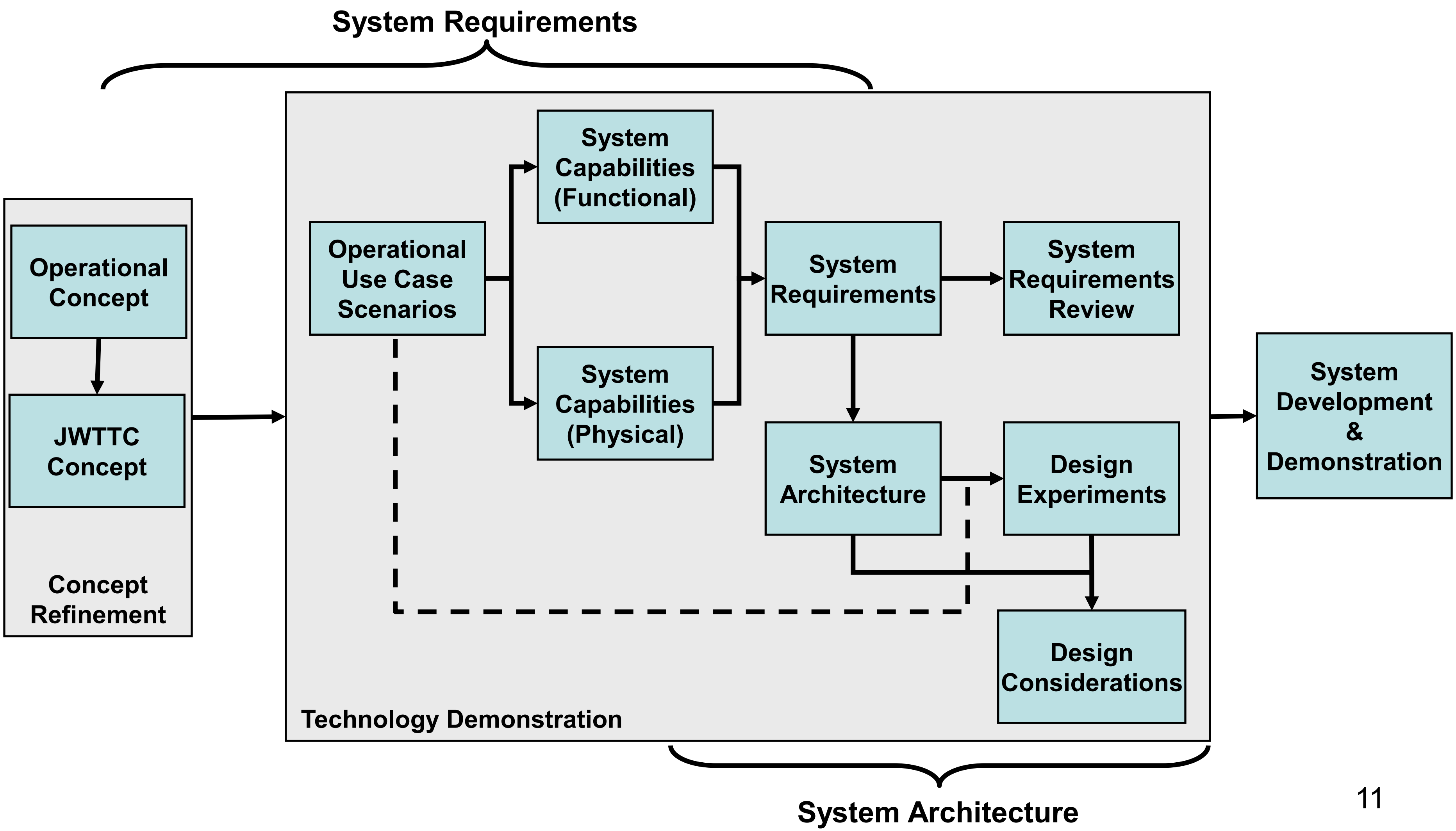


Use Proven SE Approaches

- Support the development of JWTTC
  - Use a systems approach to develop the program
  - Conduct a systems engineering analysis effort
    - To identify system requirements
      - Through Use Cases
      - Through decomposition of evaluation metrics
    - To develop a system architecture
  - Develop a Systems Engineering Plan (SEP)
  - Implementing the SE process
  - Integrate SE effort with the overall program management control efforts

The SE Effort

Systems Approach for Developing JWTTC



The SE Effort

Identifying System Requirements (Approach #1)

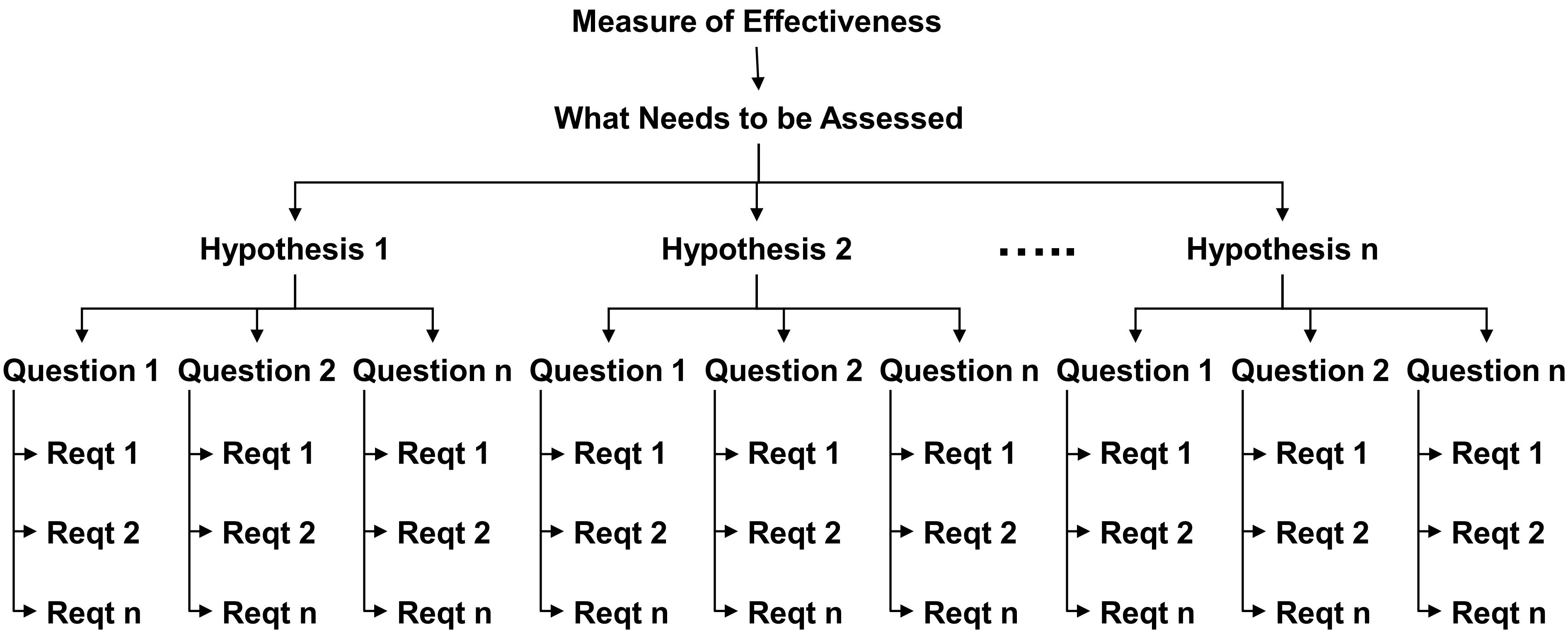
- Develop Use Cases
  - Narrative descriptions of a sequence of activities a T&E effort would undertake
  - Use cases do not identify capability needs, but rather imply them in the story it tells
  - An analyst then identifies capability needs
- Derive requirements from the capability needs

- Top Level
  - Actors
    - IT Systems
    - Warfigther
    - Test Control
    - Test Environment
  - Cases
    - Pre test
    - Test
    - Post test data collection (e.g., AAR)
    - Data Transfer
    - Post Test Analysis
    - Failure Warning

The SE Effort

Identifying System Requirements (Approach #2)

- Decompose evaluation metrics (e.g., measures of effectiveness)



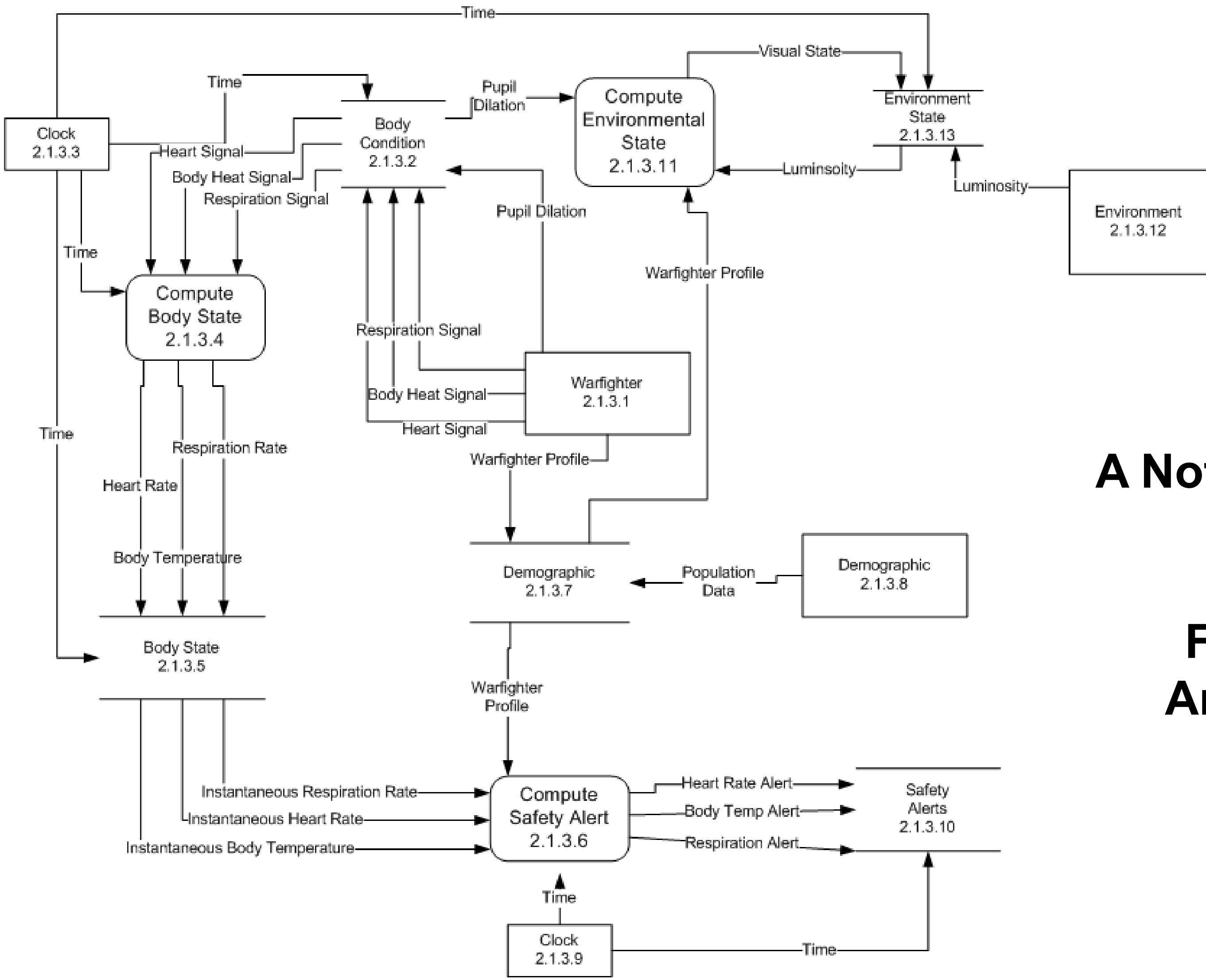
The SE Effort

Defining the System Architecture

- Once requirements are identified, design an architecture that satisfies the requirements
- Conduct experiments of the architecture design using functioning systems, prototypes, and surrogates
- Adjust the architecture as needed
- Identify areas of risk and potential mitigation efforts

The SE Effort

Defining the Functional Architecture



A Notional Design Of A JWTTC Functional Architecture

The SE Effort

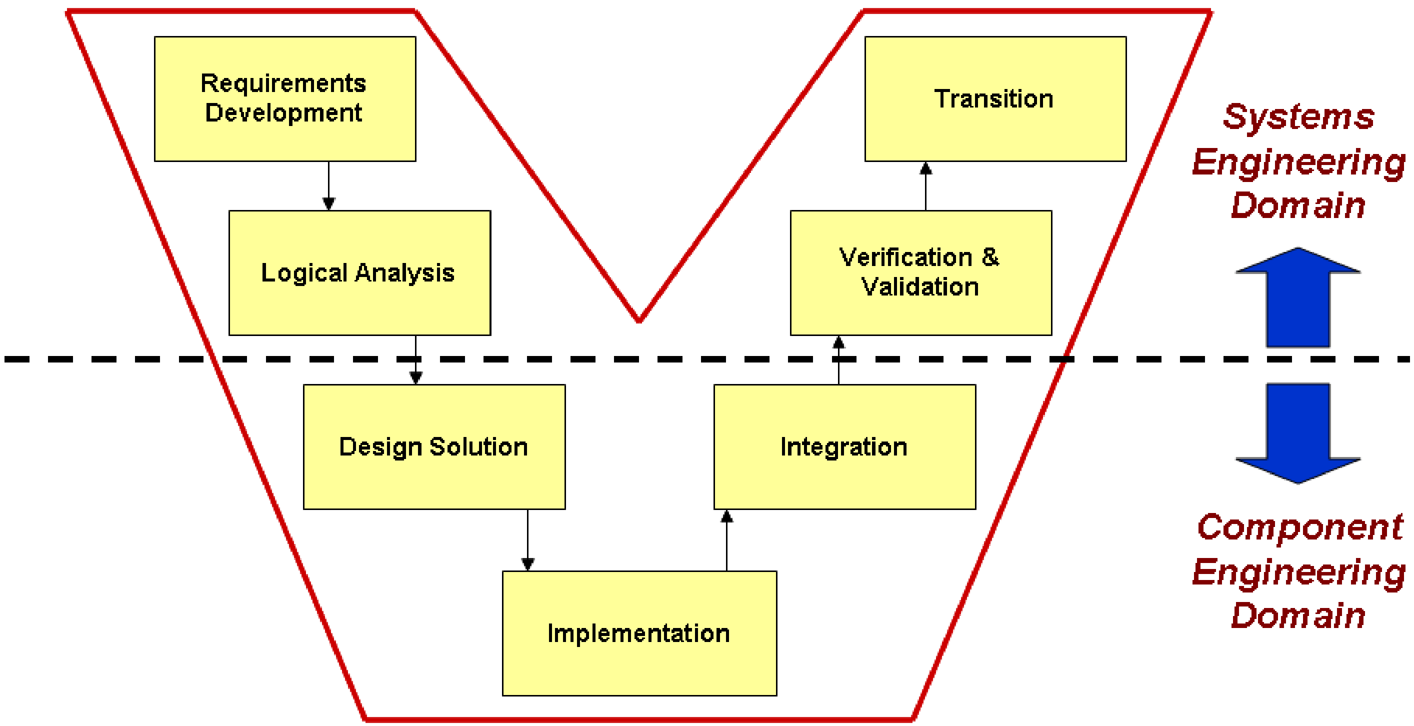
System Engineering Plan (SEP)

- The JWTTC SE methodology is tailored from the ISO/ECI 15228 four systems engineering process groups (Technical, Project, Enterprise, Agreement)
- The tailored JWTTC SE methodology includes
  - Technical processes
    - Requirements development, logical analysis, design solution, implementation, and integration
  - Parts of the project processes
    - Decision making
    - Risk, configuration, and information management
  - Enterprise environment management process groups

The SE Effort

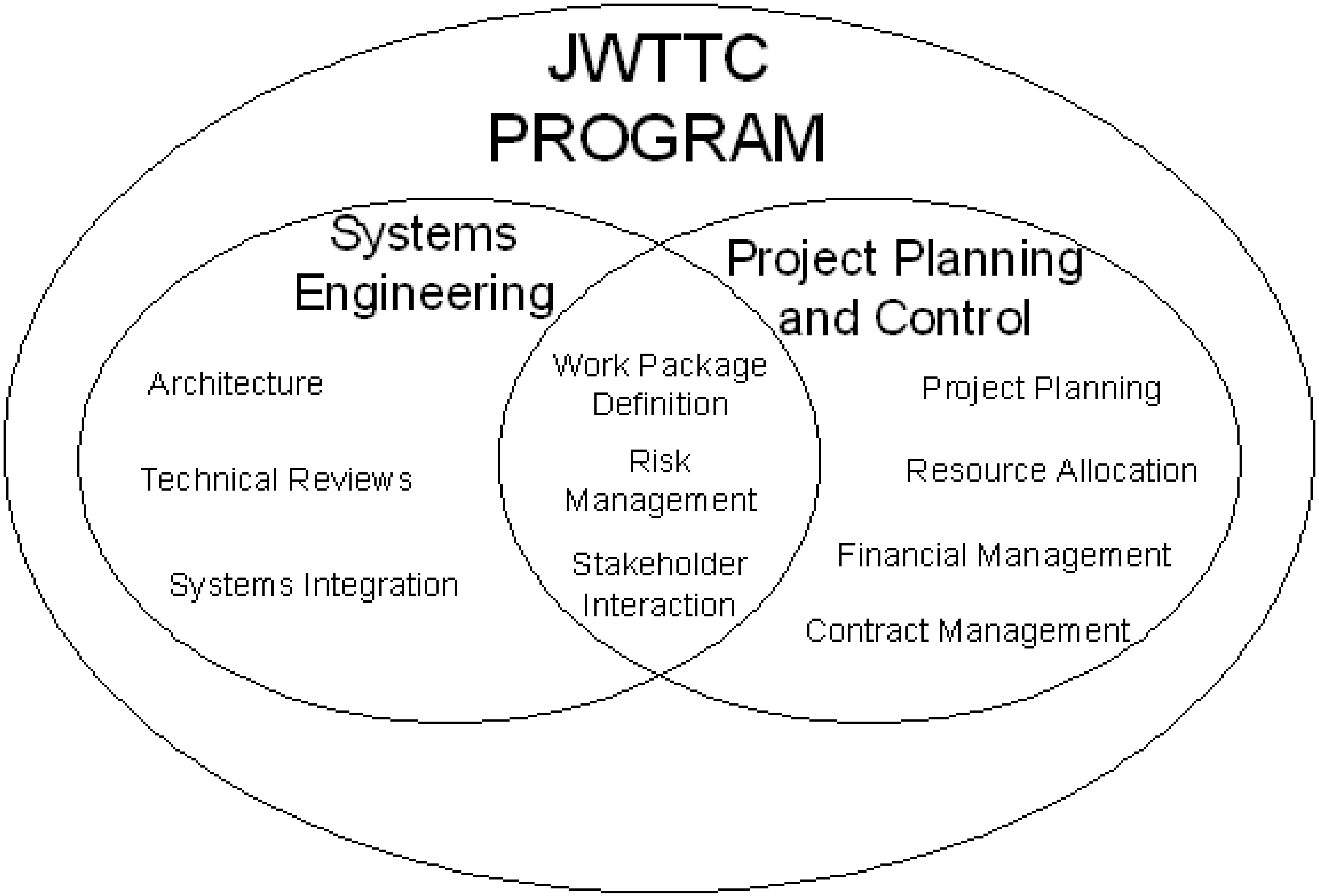
Implementing SE Processes

- As described in the SEP, the plan is to implement JWTTC SE processes using the Vee systems engineering method



The SE Effort

Integrate SE Effort with Overall Program Management Control Efforts



In Closing….

- Much of the JWTTC Systems Engineering effort is being refined
- The approach so far has been beneficial in enhancing the JWTTC program
- The effort should prove to be an effective method for reducing JWTTC program life cycle risks due to
  - Complexity of the technology
  - Unforeseen changes

CMMI® Interactive!

NDIA Systems Engineering Division

CMMI Working Group

October 23, 2008

NDIA CMMI® Working Group

Charter

- Collect and provide a broad-based, representative viewpoint on issues relating to CMMI-based process improvement within NDIA member companies
- Advise NDIA SE Division and CMMI Steering Group on CMMI Product Suite content, issues, and strategies for implementation, appraisal, and training with recommendations to optimize the leverage of CMMI investments in government and industry

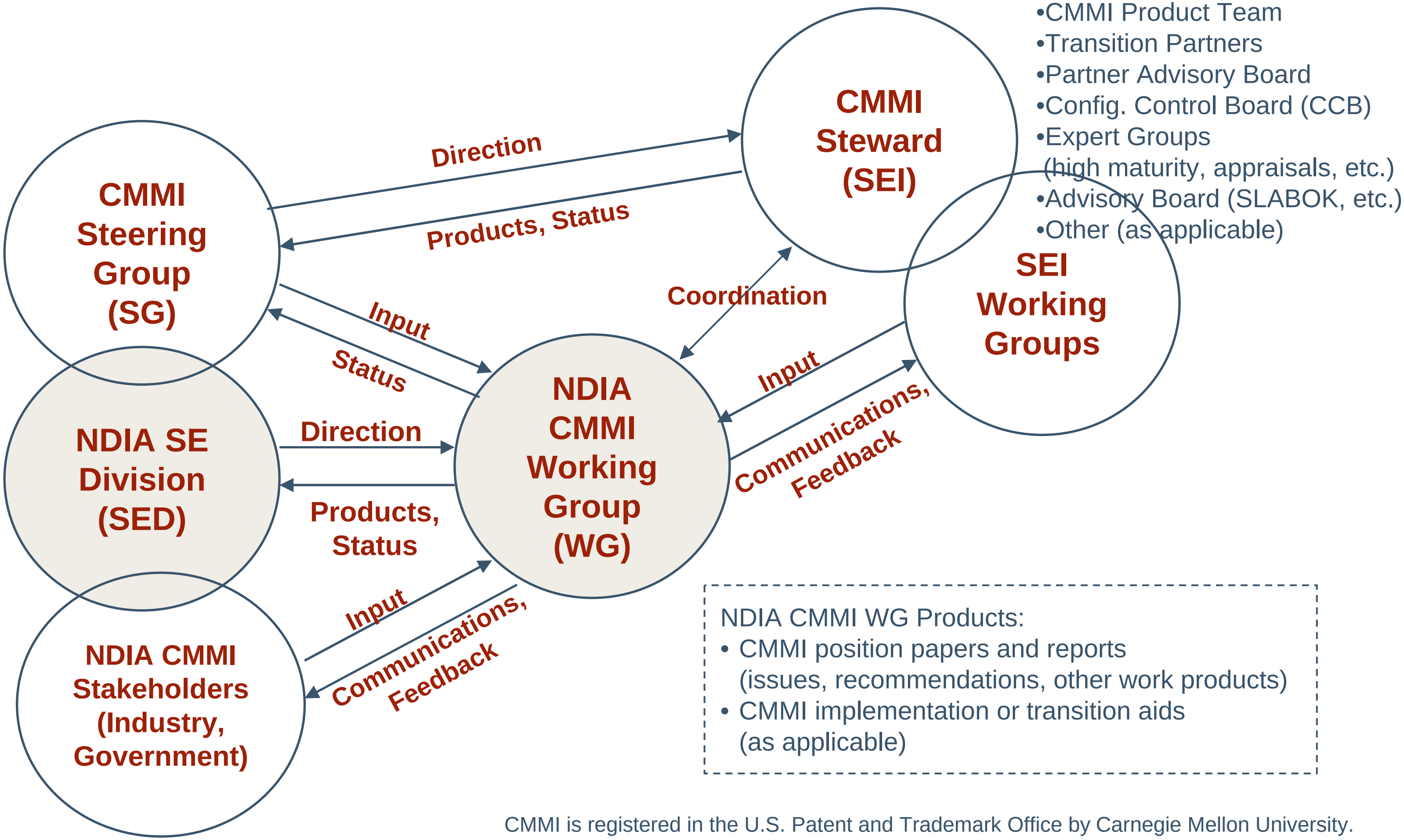
Membership

- Representatives from industry, government, academia, and SEI (see membership list)

Tasking

- Respond to requests for input from CMMI Steering Group (product reviews, position papers, recommendations, feedback)
- Provide bi-directional communications and feedback from CMMI community

NDIA CMMI® Working Group Interfaces and Work Flows



NDIA CMMI WG Products:

- CMMI position papers and reports (issues, recommendations, other work products)
- CMMI implementation or transition aids (as applicable)

CMMI WG Membership

Name	Organization
Jim Armstrong	Stevens Institute
Karen Bausman	USAF AFIT
Dan Blazer	SAIC
Geoff Draper (lead)	Harris Corporation, Govt Communications Systems Division
Jeff Dutton	Jacobs Technology Inc.
Ray Kile	Lockheed Martin, Systems and SW Resource Center (SSRC)
Dawn Littrell	L-3 Communications
Wendell Mullison	General Dynamics, Land Systems
Randy Walters	Northrop Grumman Mission Systems, C2 Systems Division
Jon Gross	Software Engineering Institute (SEI)
Mike Phillips	Software Engineering Institute (SEI)
Karen Richter	Institute for Defense Analyses (IDA)

CMMI WG Organization

Subteam	Summary Objectives	Membership
High Maturity (HiMat) Subteam	•Respond to SG priority direction on HiMat issues •Provide industry input on CMMI L4-L5 model issues and process improvement benefits	Randy Walters (lead - NG) Wendell Mullison (GD) Jim Armstrong (Stevens) Ray Kile (LM) Dan Blazer (SAIC) Dawn Littrell (L-3 Com) (Karen Richter: OSD liaison)
CMMI Survey Subteam	•Collect broad-based industry feedback on CMMI via conference sessions	Geoff Draper (lead - Harris) Jeff Dutton (Jacobs) Karen Bausman (USAF)
CMMI Performance Subteam	•Quantify CMMI performance improvements •Linkage between CMMI MLs and program performance	Jeff Dutton (lead – Jacobs) Karen Bausman (USAF) Wendell Mullison (NG) Randy Walters (NG)

Task descriptions validated with CMMI Steering Group

CMMI® Interactive!

Did you ever want a voice on what works, and what doesn't, with the implementation of CMMI in industry?

Objective:

- Collect and provide real-time, interactive feedback on how well your organization's implementation of CMMI supports the business objectives within your organization

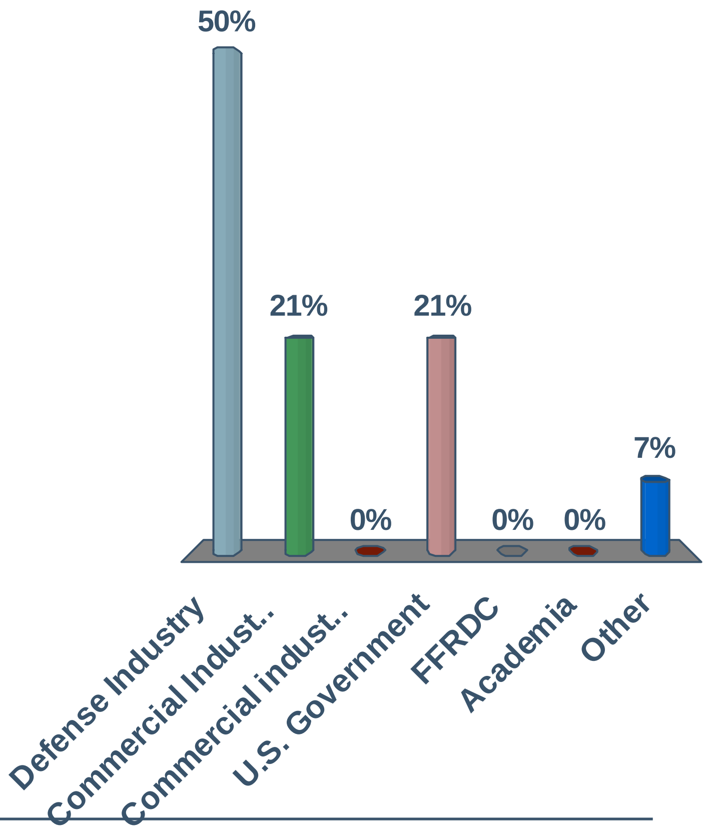
Approach:

- Live anonymous electronic voting and results analysis
- Results will be provided to CMMI Steering Group and SEI to help establish future directions for the CMMI Product Suite
- No areas are off limits!
  - Model, appraisals, training, business impact, ….
- Open discussion for additional feedback (as time permits)

Appreciation to Harris Corporation for use of interactive voting devices.

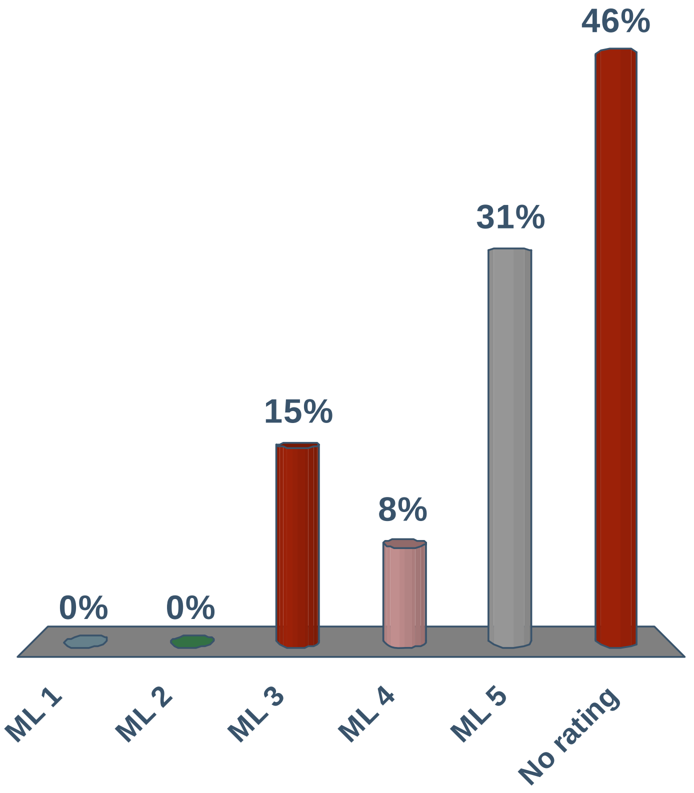
What type of organization are you representing?

1. Defense Industry
2. Commercial Industry (U.S.)
3. Commercial industry (Non-U.S.)
4. U.S. Government
5. FFRDC
6. Academia
7. Other



Does your organization have a CMMI maturity level rating?

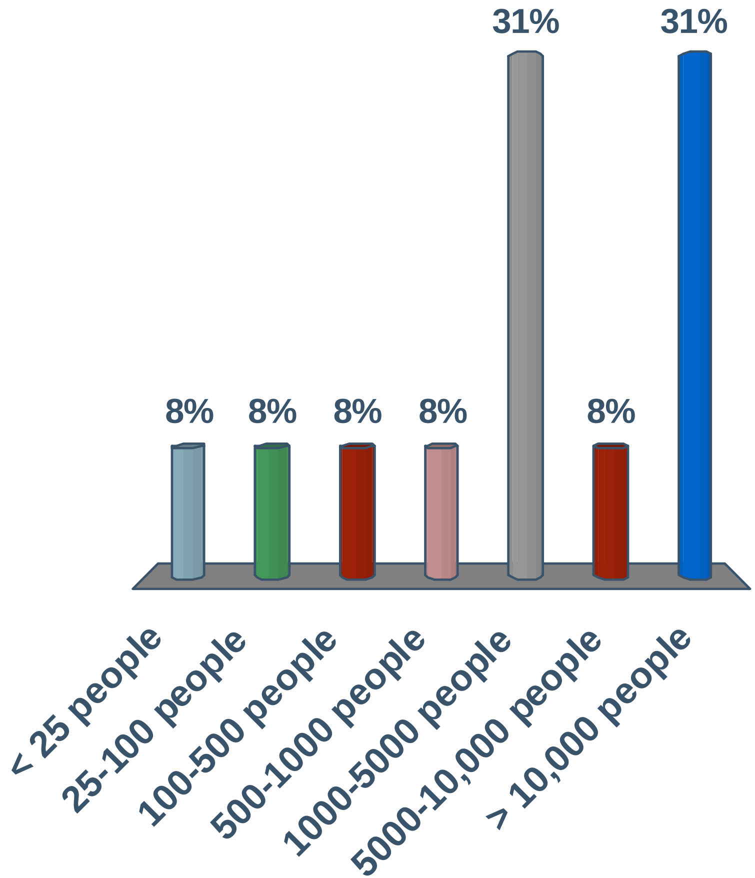
1. ML 1
2. ML 2
3. ML 3
4. ML 4
5. ML 5
6. No rating



How large is your organization (staff size)?

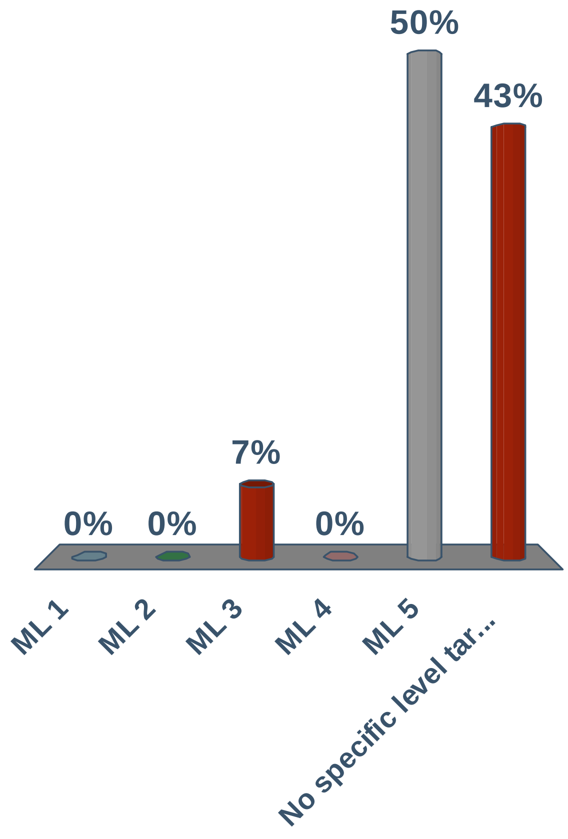
(for the organizational unit with the CMMI maturity level rating indicated previously)

1. < 25 people
2. 25-100 people
3. 100-500 people
4. 500-1000 people
5. 1000-5000 people
6. 5000-10,000 people
7. > 10,000 people



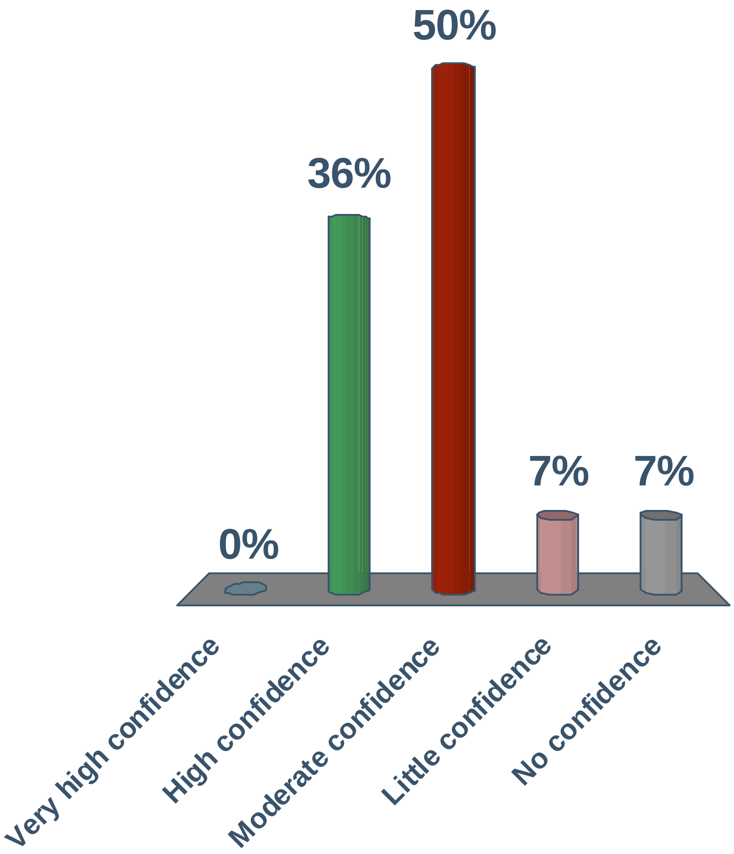
Does your organization have defined goals for achieving a CMMI maturity level rating?

1. ML 1
2. ML 2
3. ML 3
4. ML 4
5. ML 5
6. No specific level targeted



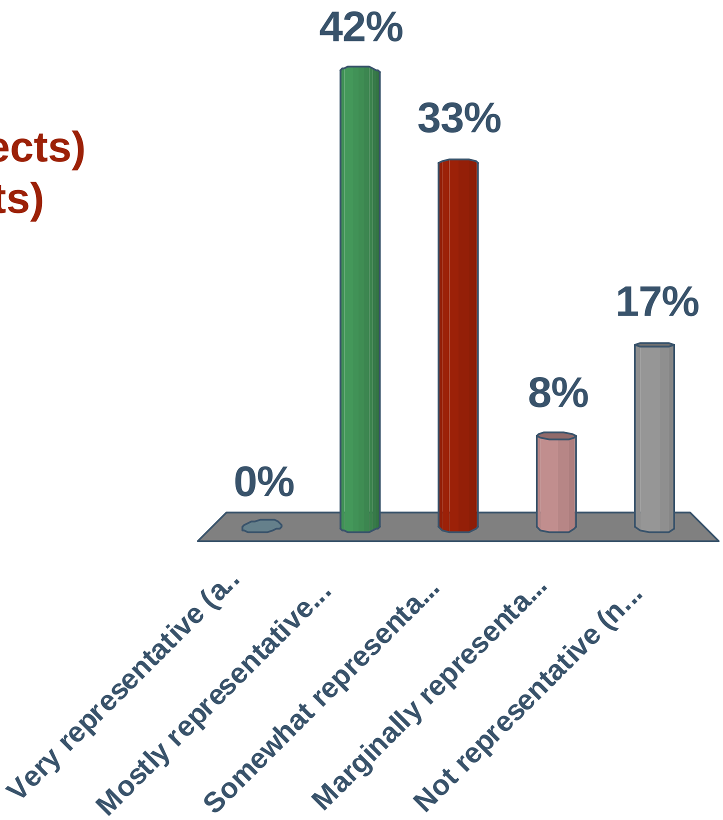
How much confidence do you have in CMMI maturity level ratings as benchmarks?

1. Very high confidence
2. High confidence
3. Moderate confidence
4. Little confidence
5. No confidence



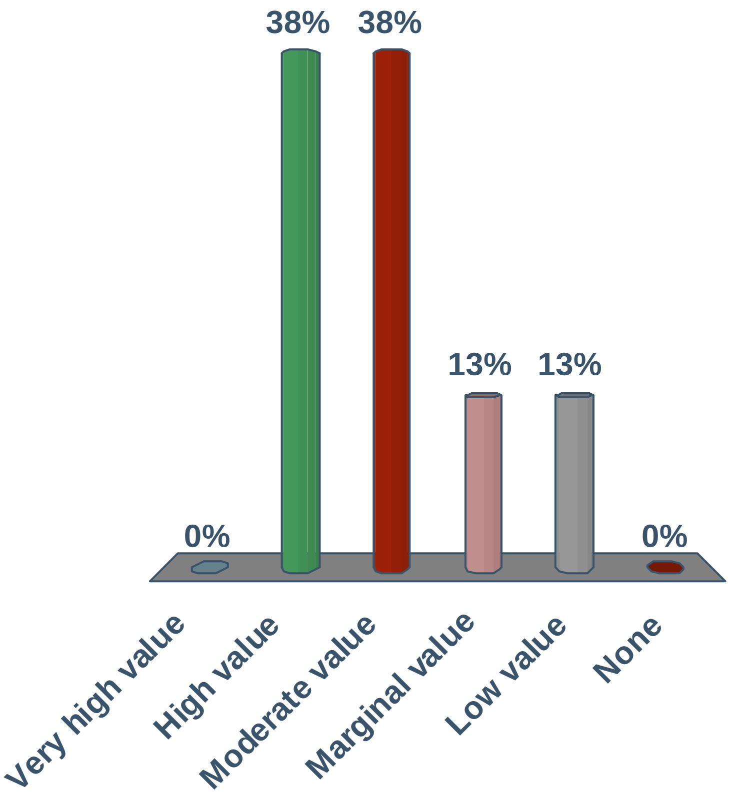
How representative is your maturity level rating of how projects really execute in your organization?

1. Very representative (all projects)
2. Mostly representative (most projects)
3. Somewhat representative (some projects)
4. Marginally representative (few projects)
5. Not representative (no projects)



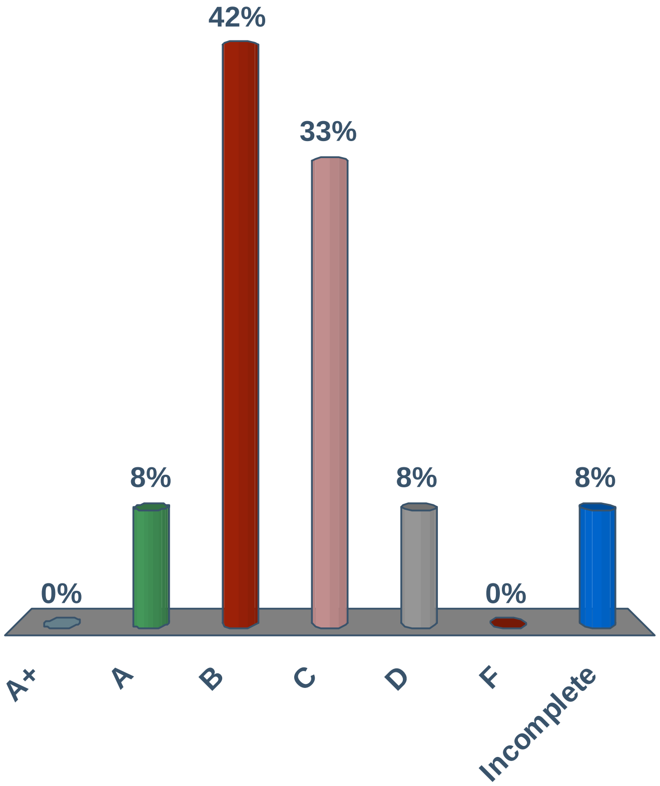
How much business value has your organization obtained through deployment of CMMI?

1. Very high value
2. High value
3. Moderate value
4. Marginal value
5. Low value
6. None



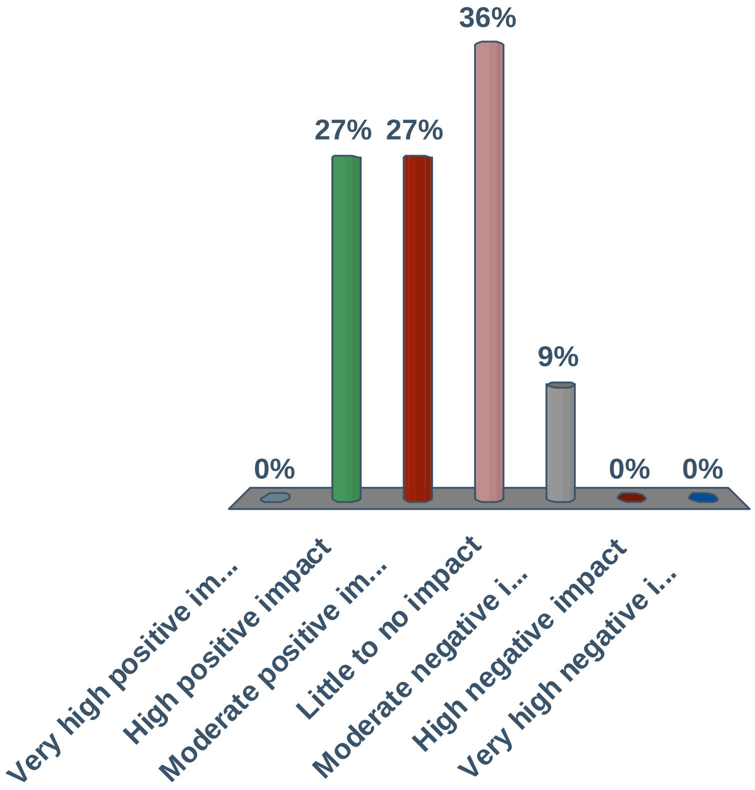
What grade would you give the CMMI Product Suite overall in meeting the needs of your business?

1. A+
2. A
3. B
4. C
5. D
6. F
7. Incomplete



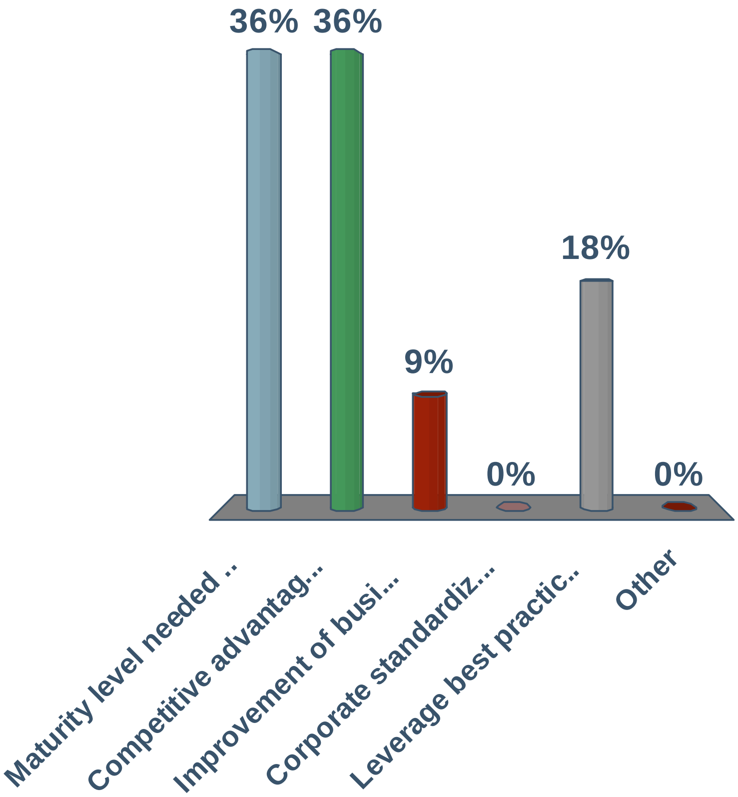
What relationship has improvement in CMMI maturity levels had on performance of projects in your organization?

1. Very high positive impact
2. High positive impact
3. Moderate positive impact
4. Little to no impact
5. Moderate negative impact
6. High negative impact
7. Very high negative impact



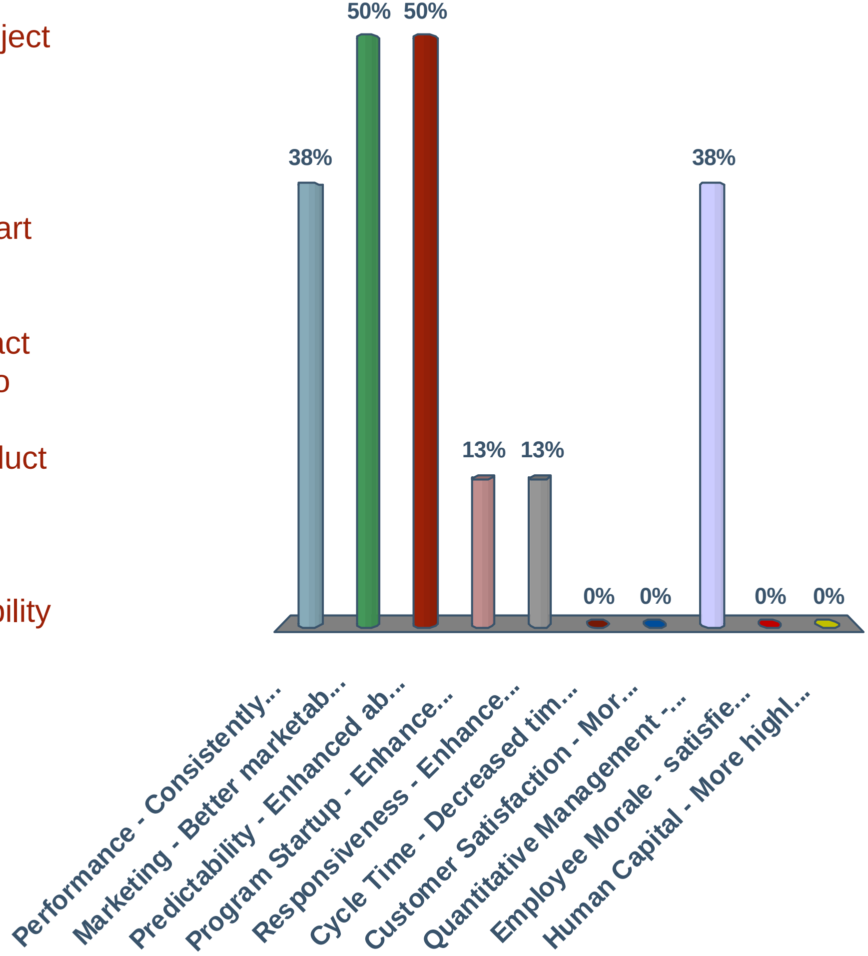
What is the primary reason your organization uses CMMI?

1. Maturity level needed to bid on contracts
2. Competitive advantage from maturity level ratings
3. Improvement of business processes
4. Corporate standardization initiative
5. Leverage best practices proven successful in industry
6. Other



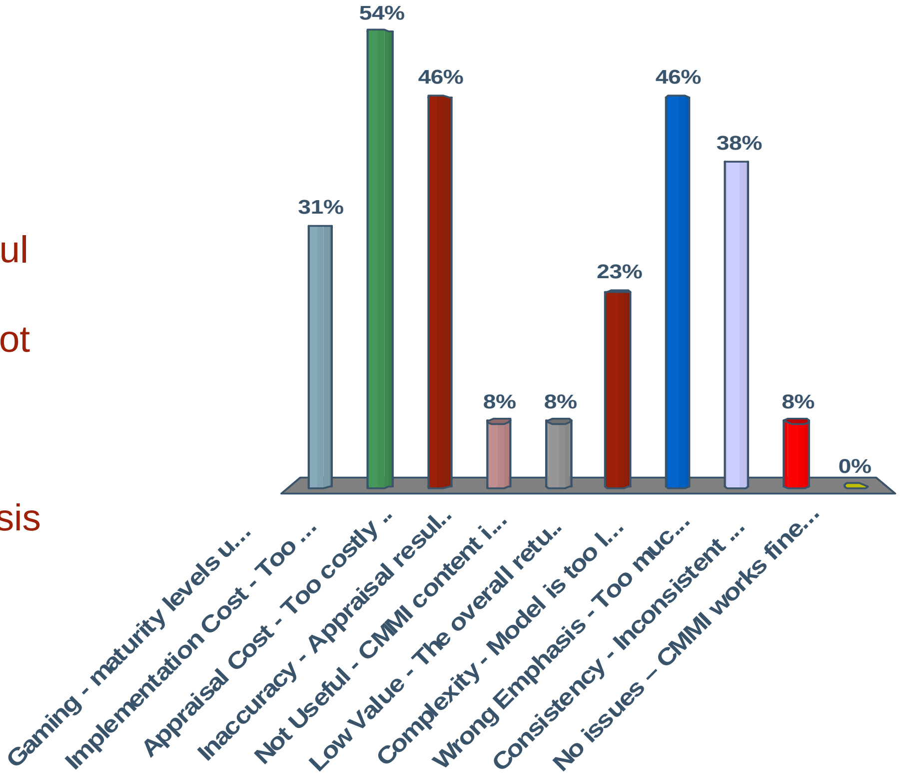
What are the top benefits your organization has realized from implementation of the CMMI? (Pick up to 3 choices in priority order)

1. **Performance** - Consistently enhanced project performance
2. **Marketing** - Better marketability/win rate
3. **Predictability** - Enhanced ability to accurately predict project performance
4. **Program Startup** - Enhanced ability to "start up" a new project/program in a repeatable and predictable manner
5. **Responsiveness** - Enhanced ability to react to customer risks with processes tailored to the customer's needs
6. **Cycle Time** - Decreased timelines for product development life cycles
7. **Customer Satisfaction** - More satisfied customers and more repeat business
8. **Quantitative Management** - Enhanced ability to "tell our story" in a defined, quantitative manner
9. **Employee Morale** - satisfied employees, reduced turnover
10. **Human Capital** - More highly skilled and knowledgeable employees



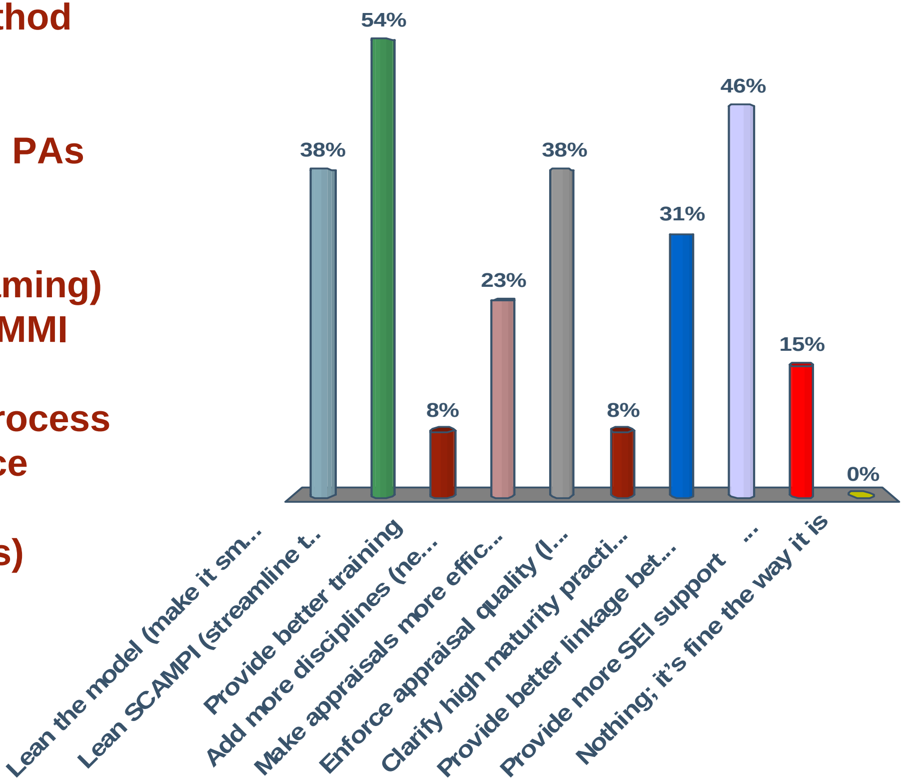
What are the top issues related to the effectiveness of CMMI? (Pick up to 3 choices in priority order)

1. **Gaming** - maturity levels undeserved
2. **Implementation Cost** - Too costly to implement CMMI
3. **Appraisal Cost** - Too costly to do appraisals
4. **Inaccuracy** - Appraisal results are not accurate
5. **Not Useful** - CMMI content is not useful for my type of business
6. **Low Value** - The overall return does not justify the investment (low ROI)
7. **Complexity** - Model is too large (too many process areas and practices)
8. **Wrong Emphasis** - Too much emphasis on compliance, not enough on improvement
9. **Consistency** - Inconsistent model interpretations
10. **No issues** – CMMI works fine in my organization



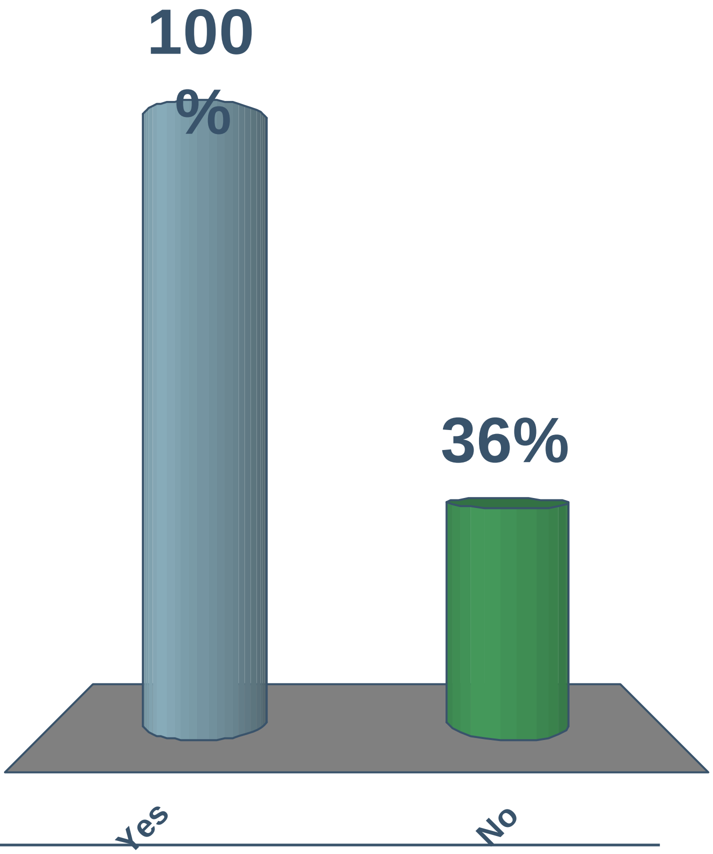
What should be the top priorities for improving the CMMI Product Suite? (Pick up to 3 choices in priority order)

1. Lean the model (make it smaller)
2. Lean SCAMPI (streamline the method and evidence rules)
3. Provide better training
4. Add more disciplines (new model PAs or constellations)
5. Make appraisals more efficient
6. Enforce appraisal quality (less gaming)
7. Clarify high maturity practices (CMMI ML4-ML5 PAs)
8. Provide better linkage between process capability and project performance
9. Provide more SEI support (e.g., resources, examples, assets)
10. Nothing; it's fine the way it is



Are you representing an organization that actually develops products?

1. Yes
2. No



CMMI – Open Discussion/Feedback

What Works?	What Doesn't?
	•CMMI does not include business results •ISO/Baldrige is more objective – appraisals must be completely objective and independent (not people appraising their own work) •CMMI-SVC: draft appears more ITIL/SW/IT oriented; does not well support government services organizations, SETA •Model should focus more on measurable results; must be important to the organization, show positive trends

Thank you for your participation!

Watch for more communications feedback.

Want to learn more or get involved?

Contact your CMMI Working Group representative, or:

Geoff Draper
Harris Corporation
gdraper@harris.com

Please return the interactive voting devices!

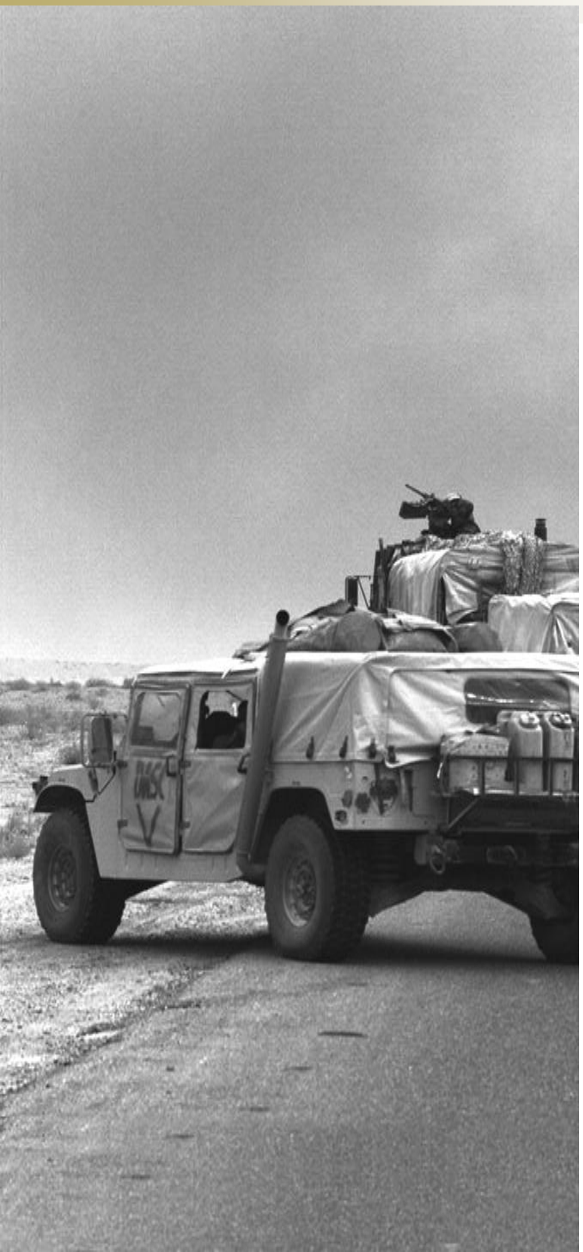
RDECOM

TARDEC

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Systems Engineering Capability Development

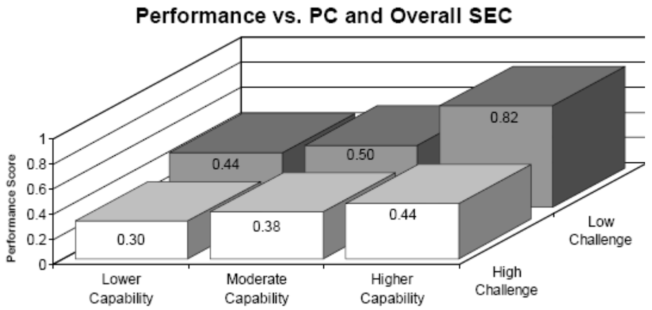
Mr. Edward Andres – TARDEC Systems Engineering
Mr. Troy Peterson – Booz Allen Hamilton



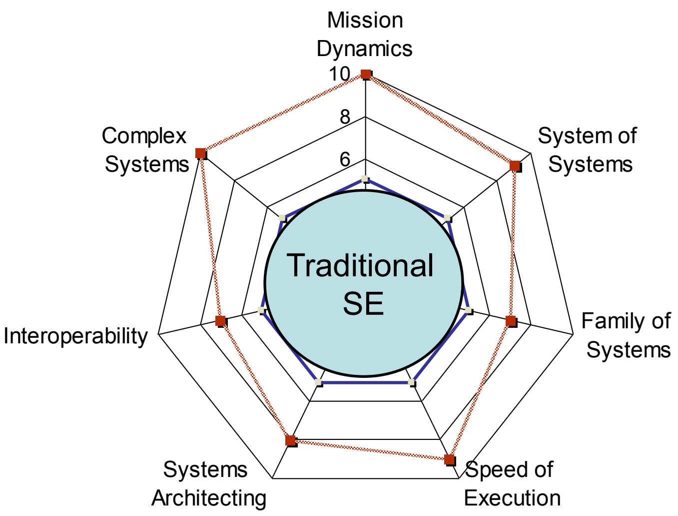
Overview

- The application of disciplined Systems Engineering has been proven to significantly improve program performance especially on complex systems.
- This fact is particularly important for Department of Defense programs which are often large scale and complex.
- The quickest way to realize systems engineering benefits is to prioritize work efforts based on the highest return on investment.
- One key step to success is for an organization to benchmark their own Systems Engineering capability, identify gaps, and plan to improve.
- This session will discuss an analytical approach for rapidly maturing Systems Engineering capability within institutions as applied across multiple programs and lifecycle phases.

Increased Complexity Demands Increased SE Capability



Source: Software Engineering Institute and NDIA - Elm, Joseph P., et al. A Survey of Systems Engineering Effectiveness—Initial Results, November 2007



Complexity of Current and Future Systems

- Traditional SE Approaches are not sufficient to tackle increasingly large-scale complex systems
- The SE community is paying increasing attention to issues of Systems of Systems, complex systems, and enterprise systems
- Increased system complexity warrants increased systems engineering capabilities. Considerations include:
  - Agile Constructs and Lean Processes for rapid execution
  - Integrating technologies across multiple Families of Systems
  - Increased demands requiring optimal trades/balancing
  - System of Systems Analysis, Interoperability, constrained integration

Ground Domain Complexity

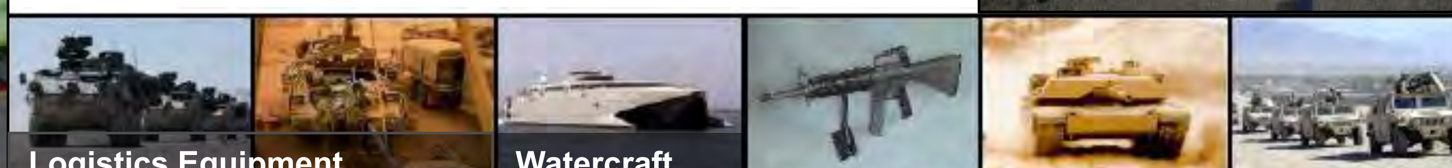
- TARDEC SE Applications
  - Science and Technology Programs
  - Mine Resistant Ambush Protected (MRAP)
    - – Required speed of execution & trades for survivability
  - Condition Based Maintenance
    - Technology Integration across multiple families of systems
  - Joint Lightweight Tactical Vehicle
    - Large new program seeking to balance Payload – Protection – Performance

RDECOM

TARDEC MISSION AND VISION

MISSION: TARDEC develops, integrates, and sustains the right technology solutions for all manned and unmanned DOD Ground Systems and Combat Support Systems to improve Current Force effectiveness and provide superior capabilities for the Future Force

VISION: The recognized DOD lead for Ground Systems & Combat Support Systems Technology Integration and Systems of Systems Engineering across the Life Cycle

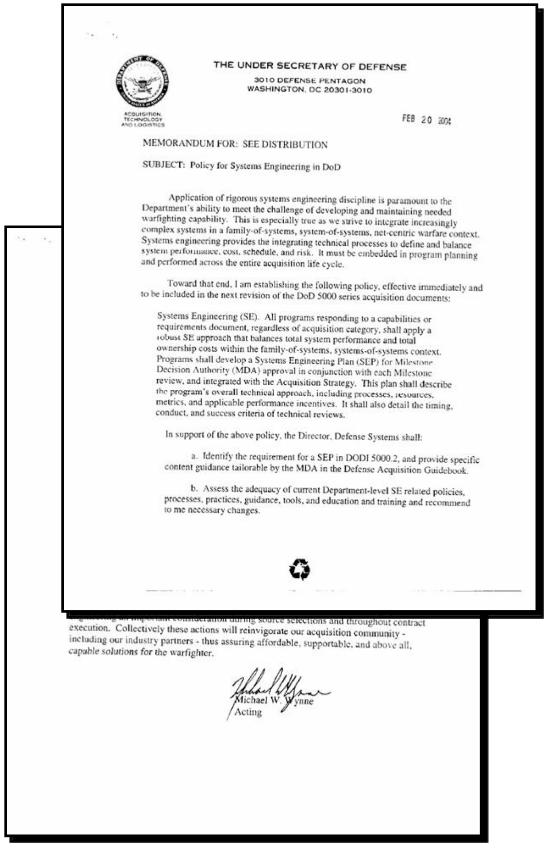


TARDEC is responsible for research, development and engineering support to more than **2,800** Army systems and many of the Army's and DoD's top joint warfighter development programs.

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Unclassified

SE Revitalization



ACQUISITION, TECHNOLOGY AND LOGISTICS

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

FEB 20 2004

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Policy for Systems Engineering in DoD

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

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

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

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

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

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

... execution. Collectively these actions will reinvigorate our acquisition community - including our industry partners - thus assuring affordable, supportable, and above all, capable solutions for the warfighter.

Michael W. Wynne
Acting

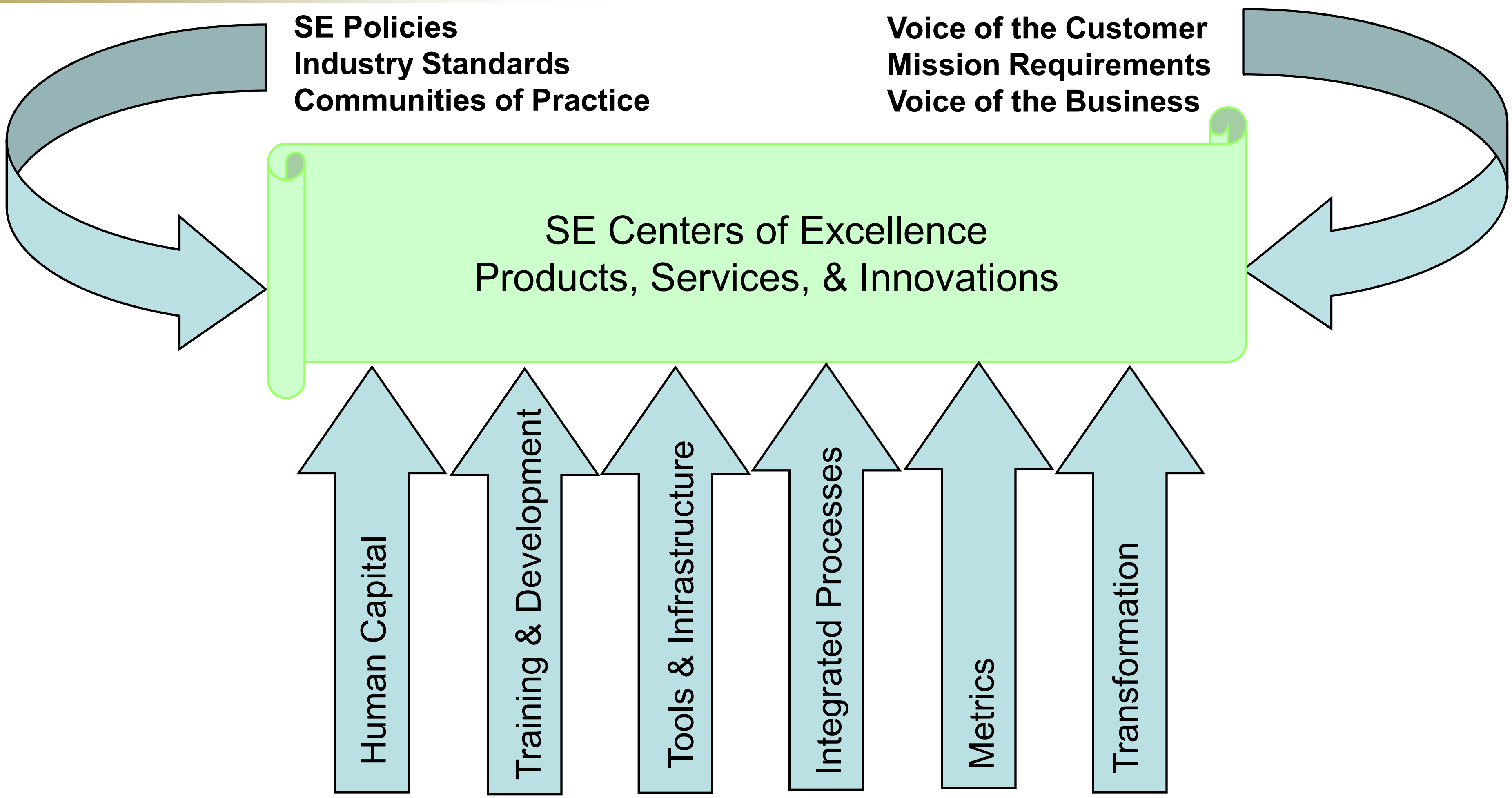
- **The Department of Defense (DOD) and the Department of the Army (DA) have promoted the revitalization of SE and have issued SE Policies aimed at the acquisition community.**
  - Under Secretary of Defense Acquisition, Technology and Logistics Policy for Systems Engineering (SE) in Department of Defense (DOD), 20 February 2004, Addendum 22 October 2004.
  - Department of the Army, Office of the Assistant Secretary of the Army Acquisition, Logistics and Technology (ASA(ALT)) Army Systems Engineering (SE) Policy, 13 June 2005.
- **RDECOM & TARDEC has also issued a SE Policy applying SE discipline to Science & Technology programs.**
  - U.S. Army Research, Development and Engineering Command (RDECOM) Systems Engineering (SE) Policy, 24 April 2007
  - TARDEC Systems Engineering (SE) Policy, 27 September 2007

All programs shall apply a robust SE approach that balances system performance with total ownership costs

Typical Challenges

- **Organizational**
  - Isolated pockets of SE practice
  - Competing stove piped processes
  - Lack of integration with business and management practices
  - Organizational Alignment to enable SE
- **Application of SE**
  - Across the lifecycle (concept through disposal)
  - Science and Technology Programs
  - Limited Budget
  - Synchronization Across Programs
- **Misconceptions**
  - Assign an SE to a Project & Systems Engineering Will Get done!
  - Train and Certify the Workforce in SE and SE Will Get done!
  - Take a Ride on the SE “V” (diagram) and SE Will Get done!
  - SE Definition
  - Everything is SE!

SE Framework



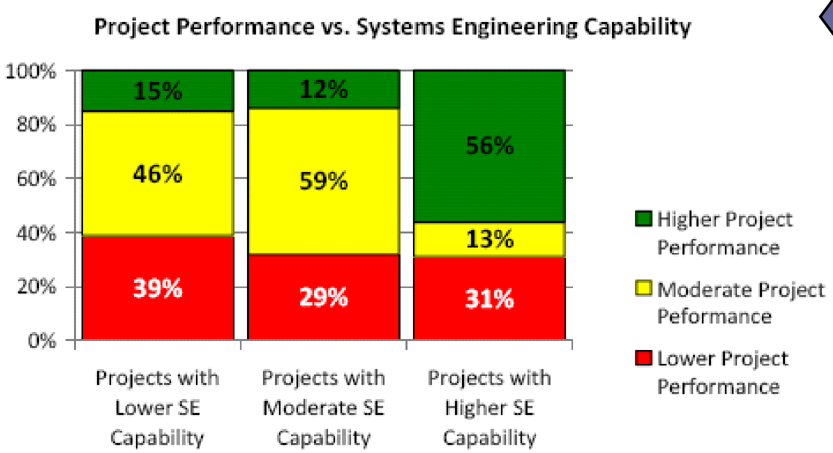
Established an SE Framework and an integrated organizational structure to enable SE!

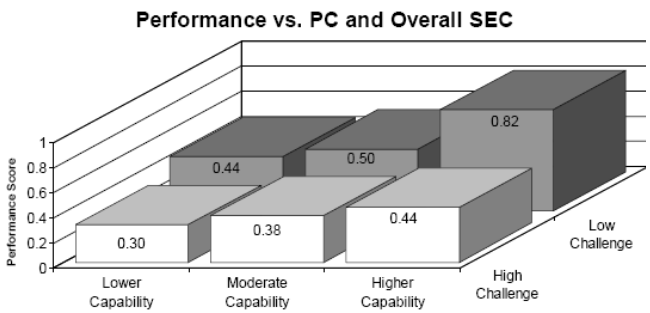
Strategy to Building SE Capability

- **Define and Document the Requirements**
  - Conduct QFD Sessions to Solicit the VOC
  - Benchmark Other SE Organizations/Efforts
  - Leverage DOD / Industry / Academia Studies
- **Baseline Capabilities**
  - Establish a Baseline of TARDEC's Systems Engineering Capabilities and Performance
  - Identify Areas for Improvement and Make the Business Case for Change Based on Risks and Opportunities
- **Capability Development Plan**
  - Build a focused and prioritized work plan to address gaps
  - Leverage Strengths and Best Practices from Industry
  - Institutionalize Systems Engineering

Systems Engineering Capability & Program Performance

Study demonstrated that projects with better Systems Engineering Capabilities delivered better Project Performance.



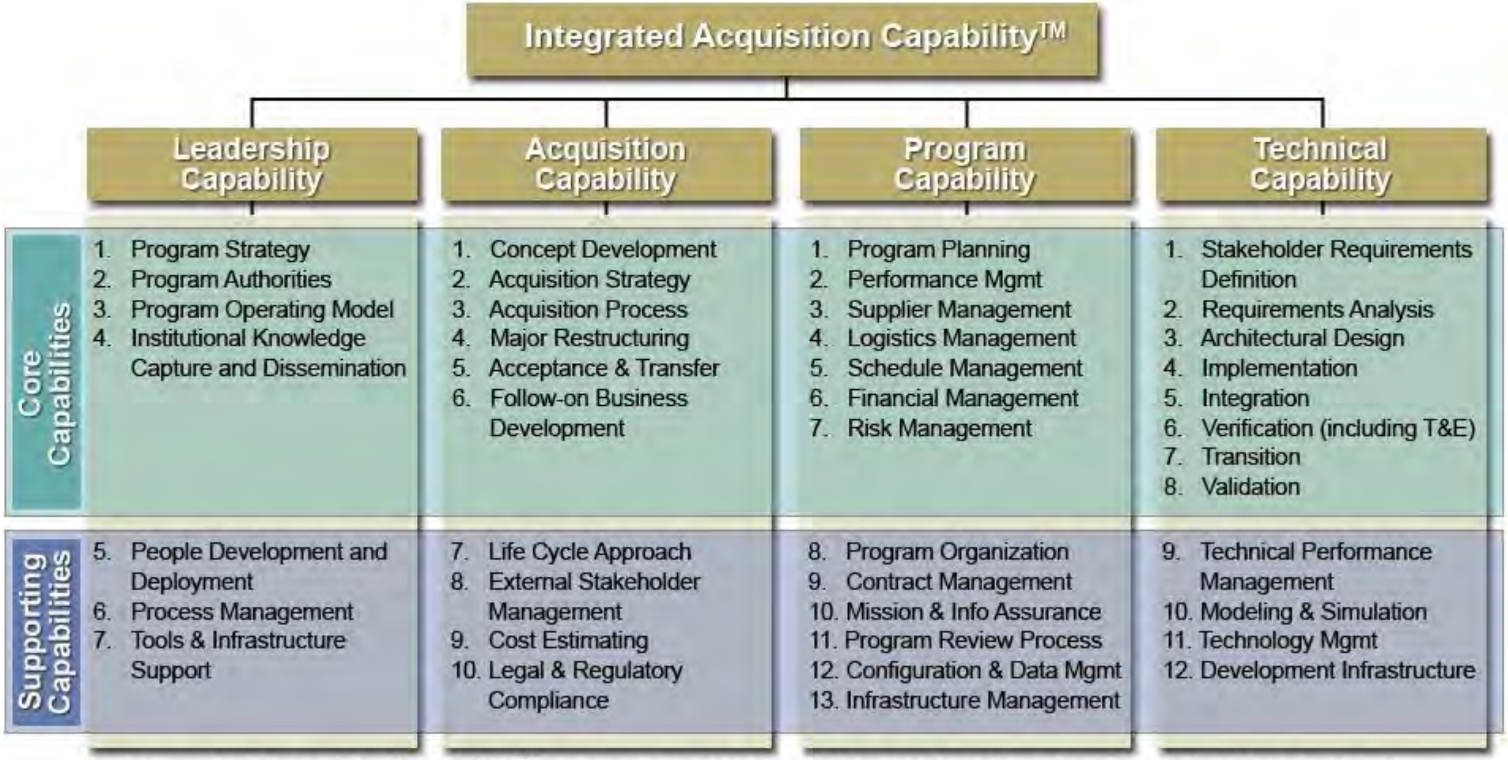


Statistical relationship with Project Performance is quite strong when both ***SE Capability and Project Challenge*** are ***considered together***

Supplier's Systems Engineering Capability[3]	Relationship to Project Performance	Relationship (Gamma[4])
Project Planning	Weak positive relationship	+0.13
Project Monitoring and Control	Weak negative relationship	-0.13
Risk Management	Moderately strong positive relation-ship	+0.28
Requirements Development and Management	Moderately strong positive relation-ship	+0.33
Trade Studies	Moderately strong positive relation-ship	+0.37
Product Architecture	Moderately strong to strong positive relationship	+0.40
Technical Solution	Moderately strong positive relation-ship	+0.36
Product Integration	Weak positive relationship	+0.21
Verification	Moderately strong positive relation-ship	+0.25
Validation	Moderately strong positive relation-ship	+0.28
Configuration Management	Weak positive relationship	+0.13
IPT-Related Capability	Moderately strong positive relation-ship	+0.34

Source: Software Engineering Institute and NDIA - Elm, Joseph P., et al. A Survey of Systems Engineering Effectiveness—Initial Results, November 2007

Booz Allen's Integrated Acquisition Capability™ (IAC)



Integrated Acquisition Capability™ is a proprietary methodology and trademark of Booz Allen Hamilton, Inc.

- Depicts the complete set of capabilities required to successfully execute a program
- Derived from multiple industry and government standards as well as extensive experience
- Provides a common framework for assessing and building capabilities across industries
- The IAC is a proprietary methodology easily tailored to each unique client environment

Building a Systems Engineering Capability Development Plan

INPUTS

- Integrated Acquisition Capability™ (IAC) Framework
- Direction from Organization on Focus Areas / Scope
- Previous Assessments
- Organizational Chart & Contact List
- Program Documentation (e.g. SE artifacts, processes, etc.)

Phase I

Preparation Phase
- Setup Assessment Tool
- Tailor Interview Questions
- Tailor Document Review List
- Schedule Interviews & Collect Documents

Phase II

Data Collection Phase
- Conduct Interviews
- Perform Document Reviews
- Explore Cross References
- Record Findings

Phase III

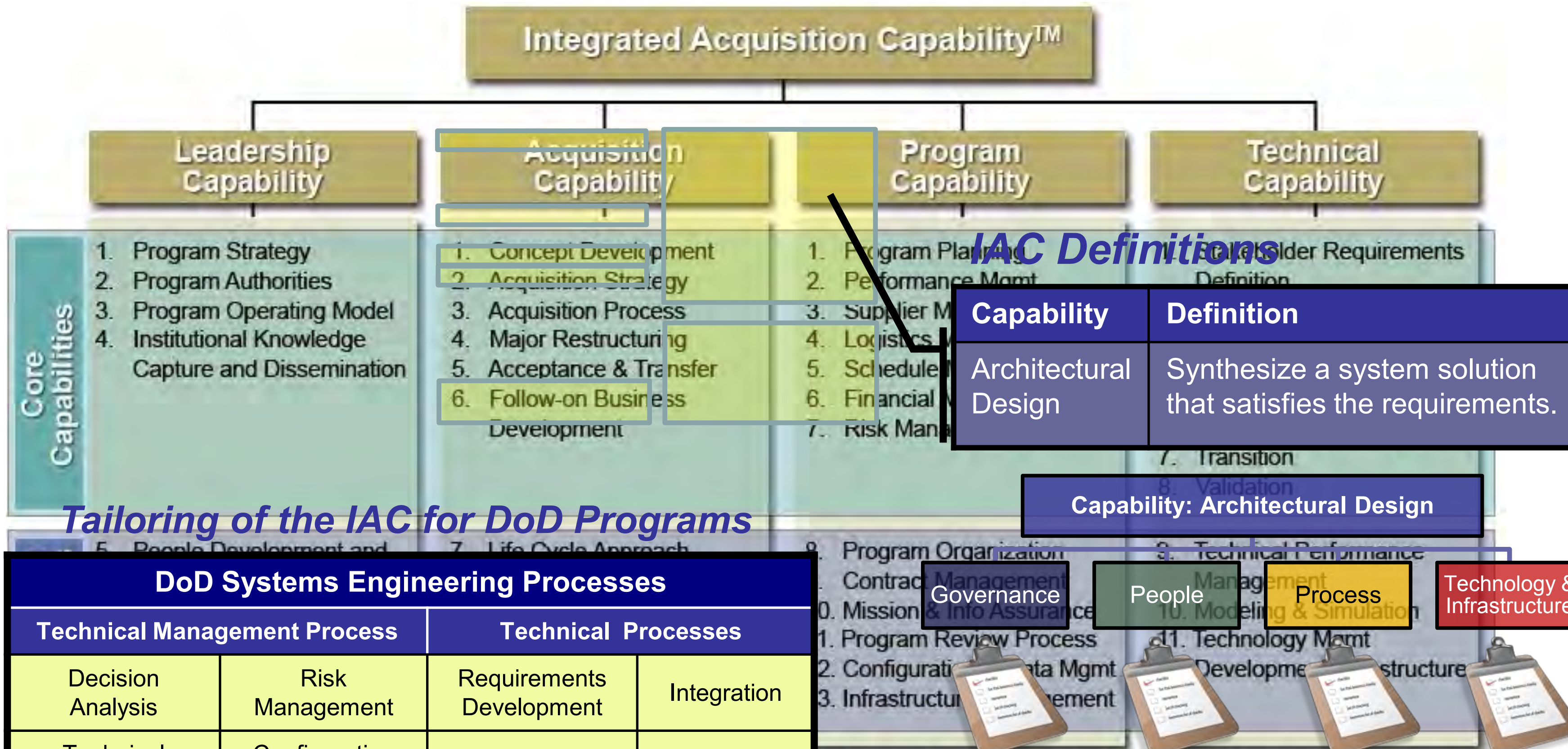
Analysis Phase
- Synthesize Data
- Identify Strengths & Weaknesses
- Score Capabilities
- Document Findings

OUTPUTS

- Capability Scorecard
- Identified Key Root Causes for Gaps
- Recommendations for Improvement / Prioritized Improvement Plan
- Capability Development Plan Final Brief and Report

Process to build an SE Capability Development Plan

Tailoring of the IAC Framework & Defining Scope



IAC Definitions

Capability	Definition
Architectural Design	Synthesize a system solution that satisfies the requirements.

Capability: Architectural Design

Governance | People | Process | Technology & Infrastructure

Tailoring of the IAC for DoD Programs

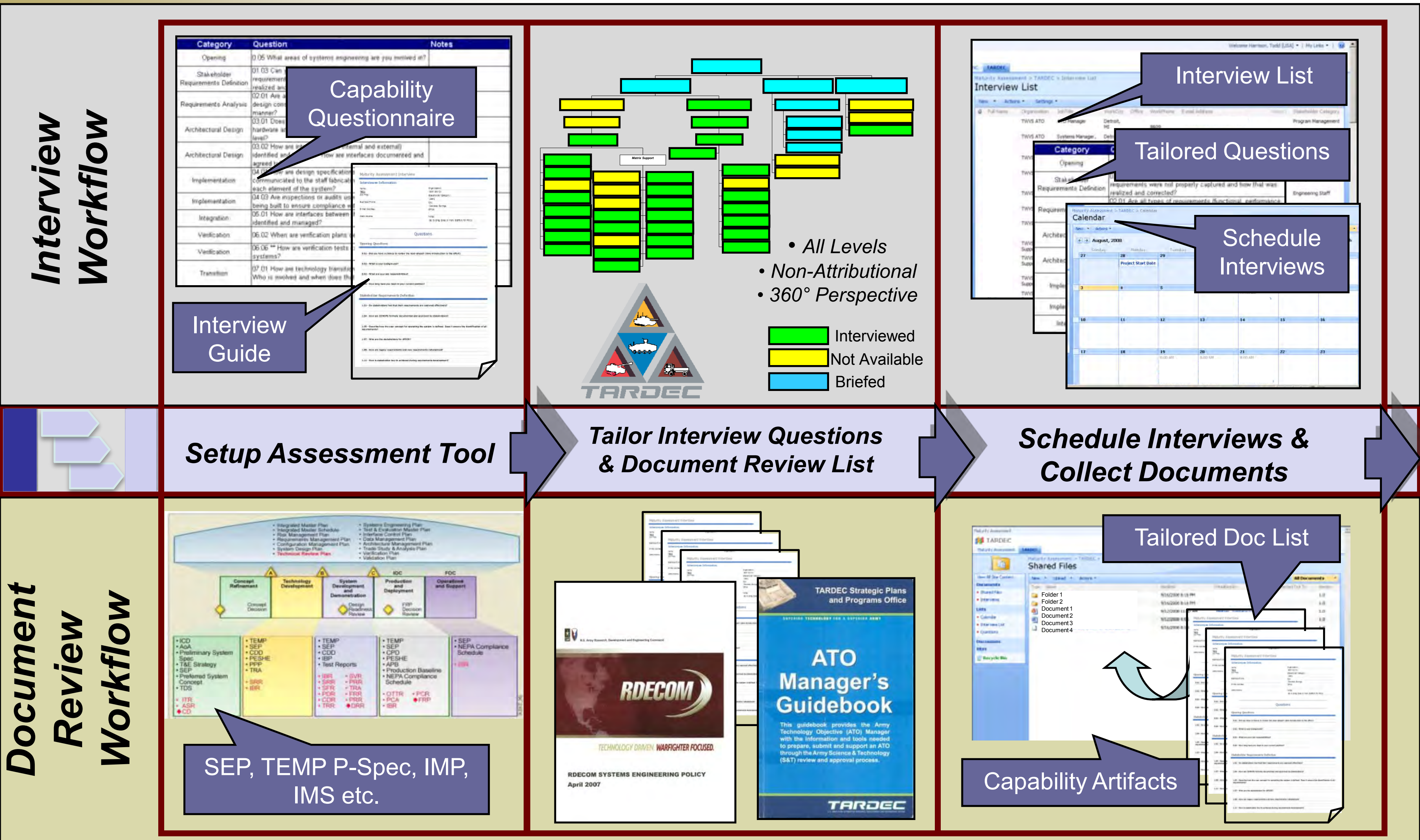
DoD Systems Engineering Processes			
Technical Management Process		**Technical Processes**	
Decision Analysis	Risk Management	Requirements Development	Integration
Technical Planning	Configuration Management	Logical Analysis	Verification
Technical Assessment	Technical Data Management	Design Solution	Validation
Requirements Management	Interface Management	Implementation	Transition

Source: Defense Acquisition University

...ology and trademark of Booz Allen Hamilton, Inc. ...ptable ... programs of ... zes from a wide range of high technology industries.

A complete capability requires the right **People** following a standard **Process** enabled by the proper **Technology & Infrastructure** in accordance with a defined **Governance** mechanism.

Assessing SE Capability Preparation Phase



Assessing SE Capability
Data Collection Phase

Interview Workflow

Conduct Interviews

Subjective Data

Store Data

Access Controlled

Team Database

Store Data

Objective Data

Explore Cross References

Record Findings

Require ments Analysis	02.01 Are all types of requirements (functional, performance, design constraints, regulatory, etc) captured in a consistent manner?

Notional Example: **Team uses a text document for regulatory requirements and a spreadsheet for new user requirements. Requirements tools are available but not used, RTM used by test did not include most recent changes.**

Document Review Workflow

Perform Document Reviews

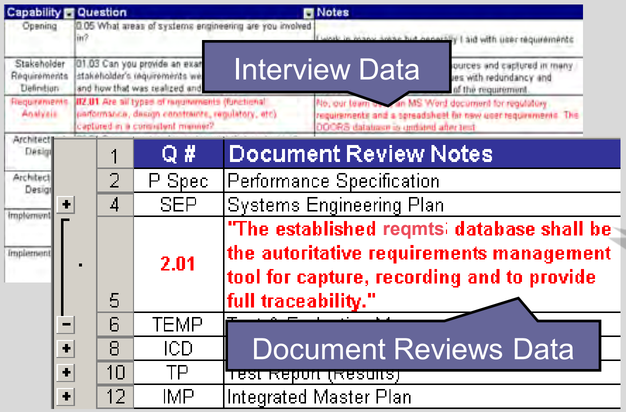
Notional Example: 02.01 **"The established reqmnts. database shall be the authoritative requirements management tool for capture and recording of new requirements to provide full traceability….changes must be approved.."**

4	SEP	Systems Engineering
5	2.01	"The established req[...]ts database shall be the autoritative requ[...]ements management tool for capture, rec[...]rding and to provide full traceability."
6	TEMP	Test & Evaluation Management Plan
8	ICD	Initial Capabilities Document
10	TP	Test Report (Results)
12	IMP	Integrated Master Plan

Doc	Docum[...]
P Spec	P[...]
SEP	Systems
TEMP	Test & E
ICD	Initial Ca
AoA	Analysis
TP	Test Rep
IMP	Integrated Master Plan
IMS	Integrated Master Schedule

Assessing SE Capability Data Analysis Phase

Synthesize Data & Identify Strengths & Weaknesses



Score Capabilities

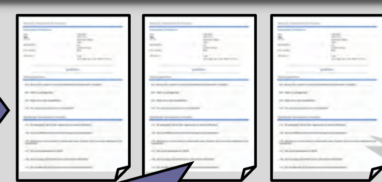
Category	Question	#	Criteria:	Justification:
Stakeholder Requirements Definition	01.01 Who are the stakeholders for the system?	4	Stakeholders are identified and understood across the program	Stakeholders were identified in the Acquisition Plan, SEP and Communication Plan consistently
	01.02 Do stakeholders feel that their requirements are captured effectively?		Stakeholder requirements are documented and available to stakeholders	Documented in multiple locations and documents not in accordance with SEP
	01.07 How are new requirements or changes in requirements vetted for approval?		New requirements and c… for approval	No formal vetting process with engineering staff and … ere changed … y
	01.04 How are requirements problems, such as conflicting stakeholder requirements, identified and resolved?		Requirem…	…ution for
	01.05 Is there a formally documented and approved Concept of Operations?		CONOPS is documented	
	01.08 ** How are stakeholder desires for interfaces and interoperability with external systems captured?		Requirements for interfa… external systems are do…	
	01.06 Are methods such as use cases, mission threads, etc. used to help develop and derive requirements? Are use cases developed in coordination with the system architects?		Used cases (scenarios) … requirements	…uirements
Requirements Analysis	02.02 What tool is used for storing and managing requirements?	3	Requirements are documented and stored in a central repository	
	02.06 Can you provide an example of how poorly defined requirements (e.g., un-testable, poorly defined) have been identified and resolved?		Issues with requirements are identified and resolved	
	02.01 Are all types of requirements (functional, performance, design constraints, regulatory, etc) captured in a consistent manner?		Requirements are captured in consistent format	Limited evidence of this
	02.05 Can you give an example of any requirements that do not have top-down traceability?		Lower level requirements are all traceable to higher level requirements	No traceability reported

Fully Capable	5
Strong Capability	4
Moderate Capability	3
Weak Capability	2
No Capability	1

Analyze Underlying Dimensions of Capability

2.0 Requirements Analysis Findings (Notional)	
Governance	While the program SEP calls for use of a req mgmt tool to manage requirements no governance mechanisms are in place for oversight. Requirements are changed without notifying key stakeholders
People	Some individuals who need access to the latest requirements on programs do not know how to access or use the tools.
Process	No formal overarching requirements management process was identified, team members create ad hoc methods across programs and do not follow processes within program SEPs.
Technology & Infrastructure	The Requirements Management tools available to the team are comprehensive and no issues with access for those trained in use of the tool

Document Findings



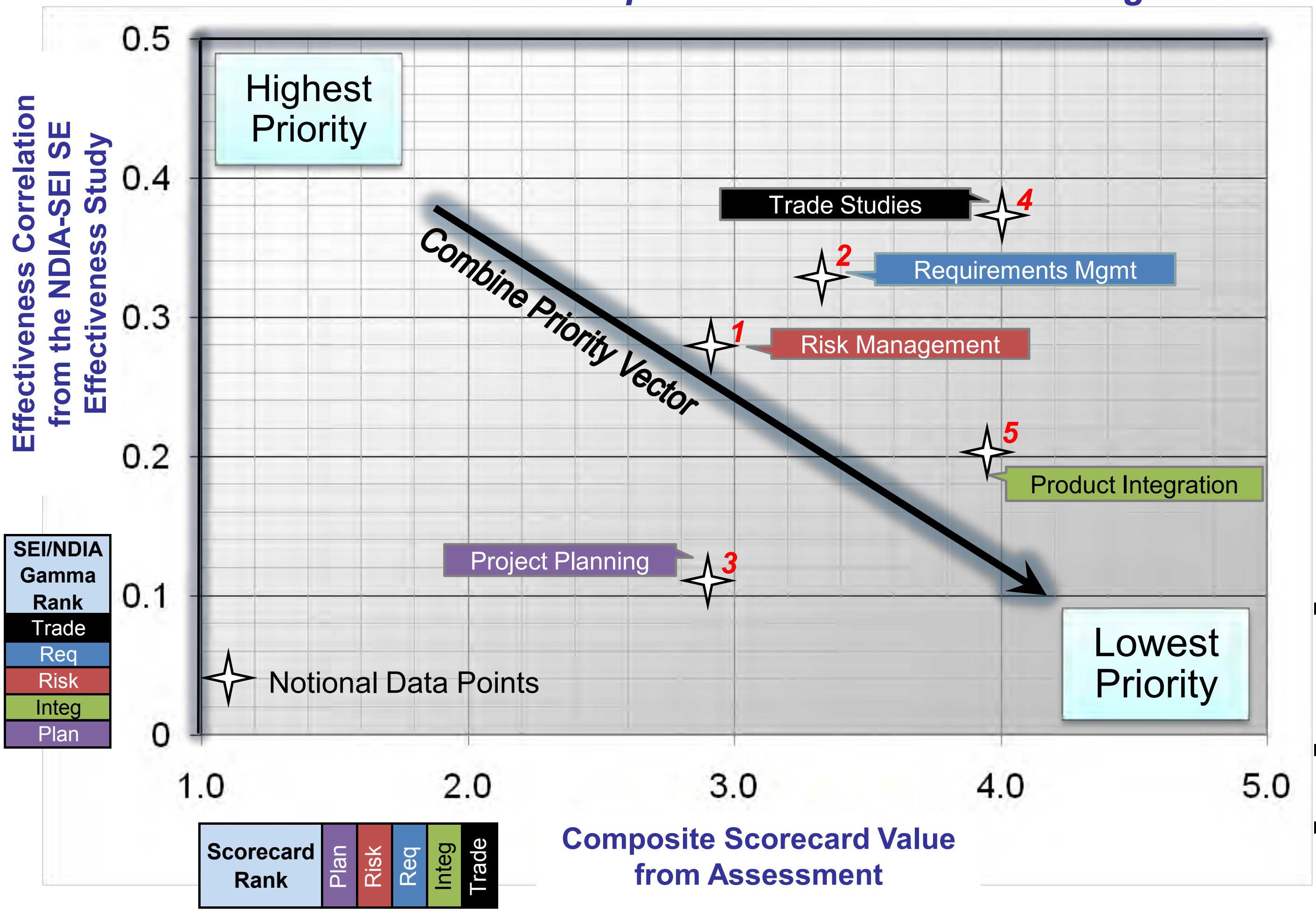
Interview Summary
Cross Reference
Underlying Issues

Formulate Recommendations

Based upon underlying dimensions, capability interdependencies & characterize impact

Assessment Results & SEI/NDA Study Findings

Plot of NDIA-SEI SE Effectiveness Study & Notional Independent Assessment Findings



Composite Ranking
Risk Management
Requirements Mgmt
Project Planning
Trade Studies
Product Integration

Plot provides interesting insight into rankings, however other factors must be considered for prioritization

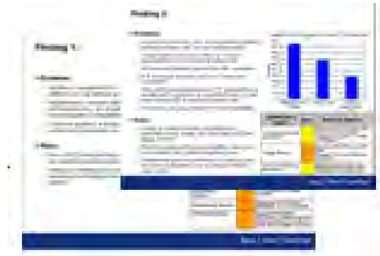
- Underlying causal factors from capability dimensions of People Process, Technology and Governance
- Balance of organizational risks and trades to optimize ROI
- Project, program or portfolio Phase(s), Schedule(s), Funding

Prioritized Systems Engineering Capability Development Plan

The Capability Development Plan:

- Leverages data and actual performance from the diagnostic to create tangible and actionable recommendations
- Hones in on underlying causes providing synergy in improvement efforts for greatest Return on Investment (ROI)
- Accounts for interdependencies between capabilities and provides necessary insight to prioritize efforts for rapid and immediate impact
- Lays our the necessary prioritized tasks Is a detailed and prioritized work plan

Findings & Recommendations



Underlying Dimensions

2.0 Requirements Analysis Findings (Notional)

Governance	While the program SEP calls for use of DOORs to manage requirements no governance mechanisms are in place for oversight. Requirements are changed without notifing key stakeholders
People	Some individuals who need access to the latest requirements on programs do not know how to access or use the tools.
Process	No formal overarching requirements management process was identified, team members create ad hoc methods across programs and do not follow processes within program SEPs.
Technology & Infrastructure	The Requirements Management tools available to the team are comprehensive and no issues with access for those trained in use of the tool

Core & Supporting SE Capabilities

Prioritized Plan
1. Requirements Mgmt
2. Risk Management
3. Project Planning
4. Product Integration
4. Trade Studies

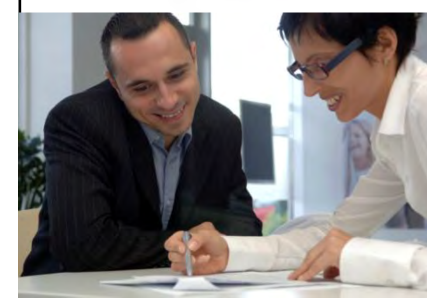
Plan & Schedule

Systems Engineering Capability Development Plan

Tank Automotive Research Development & Engineering Command

October 14, 2008

Prepared By: Booz Allen Hamilton, Inc.

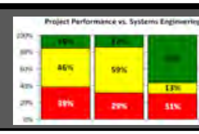


Plan creates a catalyst for change to institutionalize Systems Engineering

Summary

Premise:

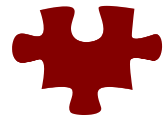
SE Capability = Program Performance



SE Capability is arguably one of the most important for companies that develop and integrate complex systems

Challenges

Typically Seen in Organizations

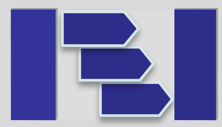


Benefits

Building a ***comprehensive view*** of capability with an understanding of ***interdependencies*** to create a high performing organization

Integrated Acquisition Capability a comprehensive framework to assess and build the capabilities essential for a successful system acquisition program

Obtaining unhindered and unbiased feedback and applying a ***proven approach for improvement***



Tailored, ***independent and objective review*** based upon industry standards and best practices. Dual path (two-way) verification ensures ***integrity of results***

Leverage resources to implement improvement efforts in lieu of core mission and Identifying key areas to ***improve performance***

Governance
People
Process
Technology & Infrastructure

Diagnostic ***identifies underlying causes*** of capability inhibitors and offers insight to provide ***rapid and synergistic improvements***

Establishing a concrete baseline from which to ***measure performance*** to appropriately adapt make course corrections

Fully Capable	5
Some Capability	4
Limited Capability	3
Very Little Capability	2
No Capability	1

Identifies ***improvement opportunities & strengths to leverage.*** Creates a ***Current State Baseline*** from which to track improvement.

Breaking down organizational barriers and ***building integrated capabilities***

Prioritized plan provides ***realistic and tangible recommendations*** and creates a catalyst for change ***to institutionalize Systems Engineering***

Conclusion:

Approach enables SE Maturation for *Increased Program Performance*

Unclassified

An Adaptable Architecture for the Airborne Electronic Attack (AEA) System of Systems (SoS)

Joe Wolfrom
Bruce Schneider

October 2008

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

APL
The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Approved for public release, Case Number 88ABW-2008-0319, 29 Sep 08

Intro

- This briefing was developed during funded research for the U. S. Air Force Aeronautical Systems Center for the AEA Capability Planning Manager (ASC/XRS)
- This briefing is unclassified in its entirety

Purpose Statement

- Discuss the methodology to build an ***adaptable System of Systems*** architecture that can be used to compare performance of alternative solutions.

- Definitions
  - Adaptable – capable of becoming suitable to a particular situation or use
  - System of Systems – a set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities

Outline

- AEA SoS Description
- Focus of Effort
- Methodology
- Architecture Challenges
- Solutions
- System Analyses

Airborne Electronic Attack System of Systems (AEA SoS) Description

- Limited number of AEA assets support multiple air and ground elements against multiple threats
- Requires informed AEA decisions across the theater in real-time
- Requires coordination between a variety of assets (SoS) to improve:
  - AEA tasking awareness
  - Flexibility and confidence to make changes
  - Overall AEA Efficiency
- Goal – to improve AEA support through interoperability & coordination
  - Information sharing
  - Management of assets

Focus of Effort

- Develop a means to verify that the SoS provides significant improvements to combat effectiveness
- Develop a means to quantify those improvements
- Determine which ‘attributes’ make a statistically significant difference

Methodology

- Build an adaptable architecture to model the AEA SoS
- Using the architecture as a baseline, perform Systems Analyses to determine and measure the improvements to combat effectiveness
  - Screening model – to identify the key ‘attributes’
  - High Fidelity model – to determine effectiveness

Architecture Challenges

- Need an *adaptable* architecture that represents various:
  - Configurations
  - Situations
  - Attributes

Architecture Challenge – Various Configurations

- **AEA SoS Architecture must be adaptable to many different configurations**
- **AEA SoS consists of many different players/roles**
  - **AEA Platforms** ***(Jammers)***
  - **Intelligence, Surveillance, and Reconnaissance (ISR) Platforms**
  - **Protected Element** ***(Bombers, Ground troops, etc)***
  - **Command Element** ***(Air Operations Center, Air Control aircraft, etc)***
  - **AEA Battle Management** ***(Operational-level, Tactical-level)***
- **Each role can be thought of as its own** ***Family of Systems***
- **Definition**
  - **Family of Systems – a set of systems that provide similar capabilities through different approaches**

Solution – Generic Activity Modeling

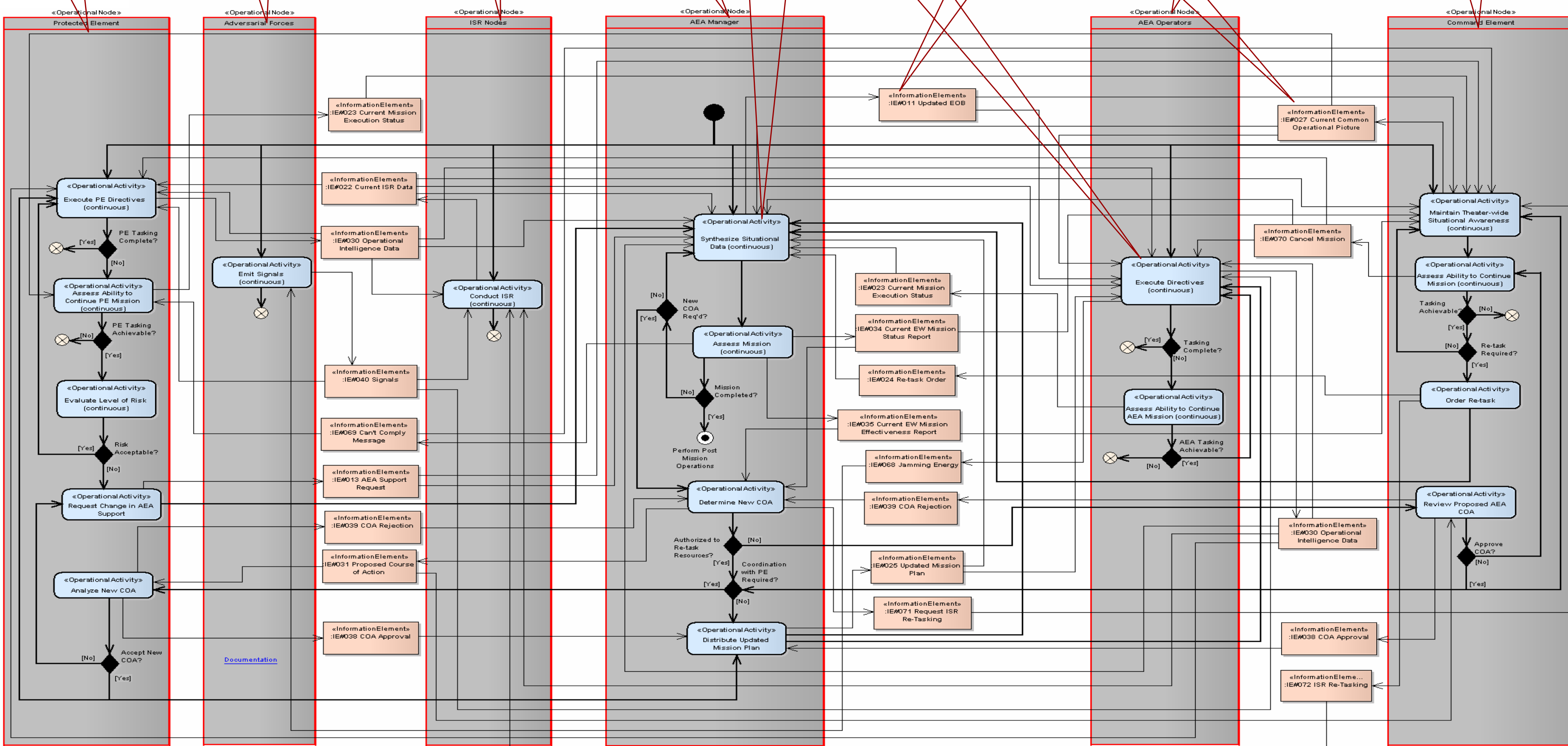
- **Activity diagrams - used to model activities and exchanges within the AEA SoS**
  - ***Abstract* Operational Node classes – defined to account for variable configurations**
  - ***Abstract* High Level Activities – defined for each operational node**
  - ***Abstract* Information Element classes – defined to represent the information exchanges between operational node activities**

- **Result – an all-encompassing "one size fits all" operational model**

- **Definitions**
  - **Generic – very comprehensive, relating to or descriptive of an entire group or class**
  - **Abstract – thought of or stated without reference to a specific instance; generalized**

Protected Element | Adversarial Forces | ISR Nodes | AEA Manager | Operational Activities | Information Exchanges | AEA Operators | Command Element

Notional Activity Model – Execute AEA Mission



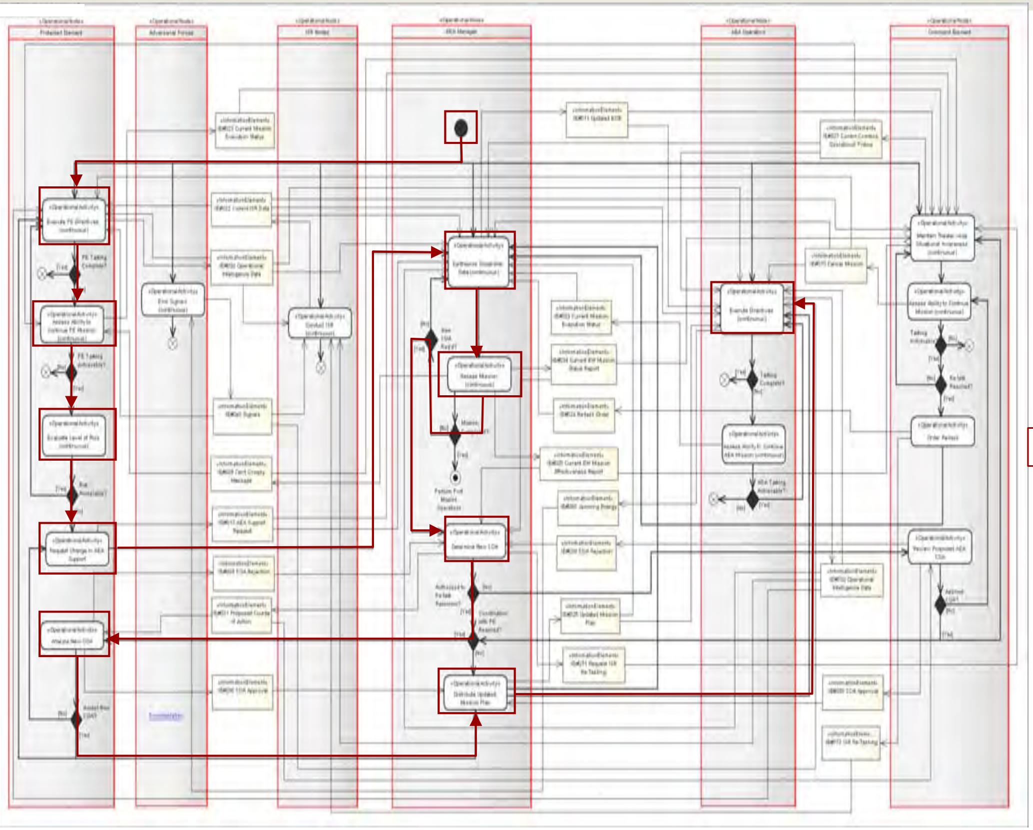
Architecture Challenge – Various Situations

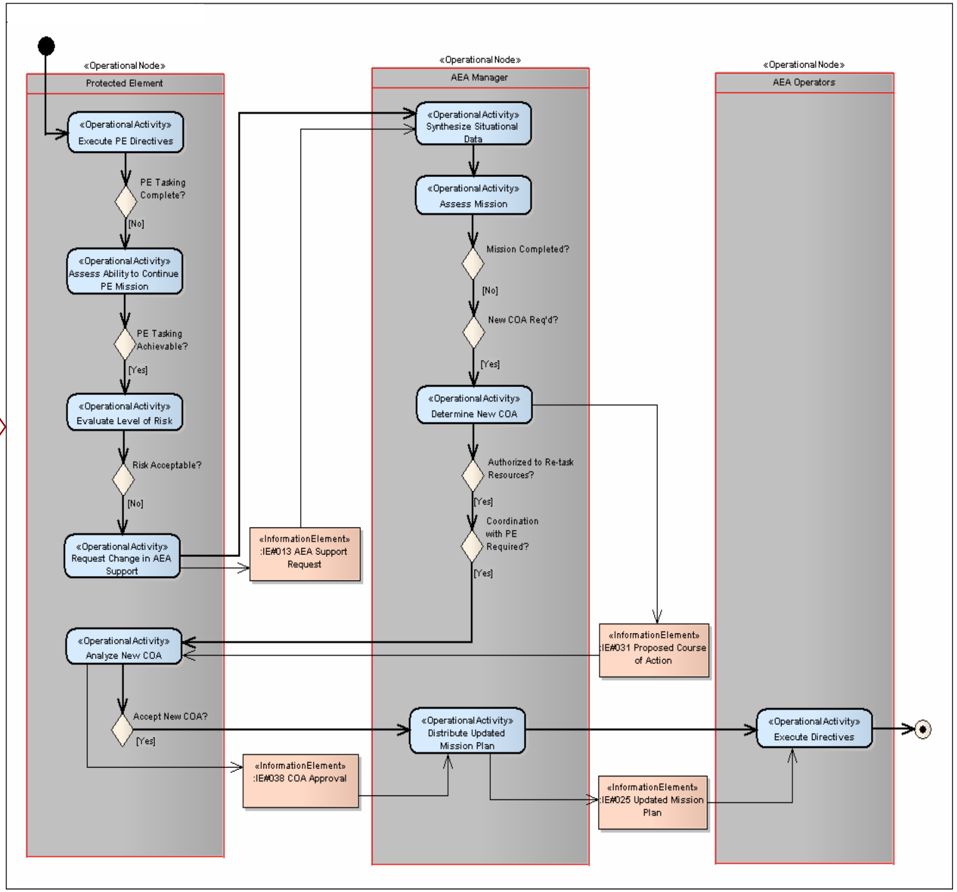
- AEA SoS Architecture must be adaptable to the many different ‘situations’ that may occur during a mission
  - New Jamming Request from the Protected Element
  - AEA Platform Malfunction
  - Change in Mission Priorities
  - Command Element Cancels Mission
  - React to a Pop-up SAM

Solution – Notional Modeling of Specific Situations

- **Activity diagrams – used to model specific 'situations'**
- **Derived from notional Execute AEA Mission Activity Diagram**
- **Each Situation represents a single thread through the architecture**

Solution – Notional Modeling of Specific Situations





Architecture Challenge – Various Attributes

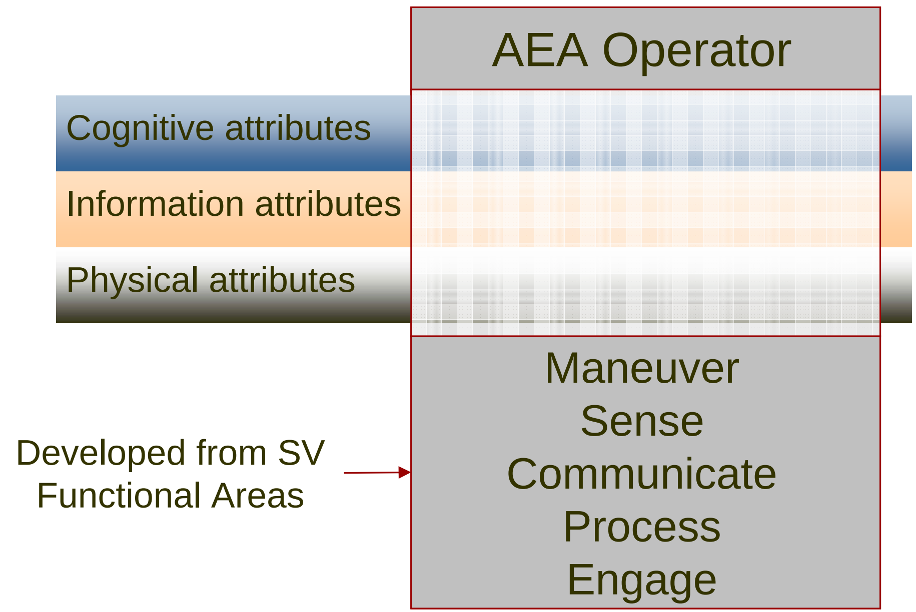
- The AEA SoS Architecture must be adaptable to take into account a number of various 'attributes' that can change from one mission to the next.

- Some examples out over 40 identified attributes:
  - AEA – PE Support Relationship
  - Communications Quality
  - Jammer Effectiveness

Using the adaptable architecture

Method:

1. **For each swimlane, show settings for appropriate <u>attributes</u>**
2. **Inside each swimlane, show standardized operations <u>functions</u>**
3. **Build multiple configurations (attributes & functions)**
4. **Model attribute and function interactions *using the architecture foundation***
5. **Simulate to compare performance from different configurations**



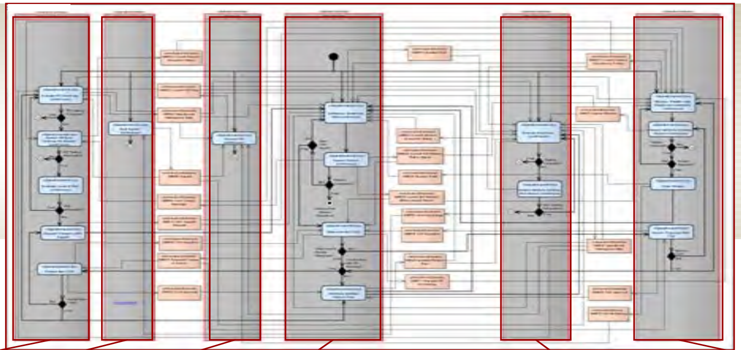
Functions

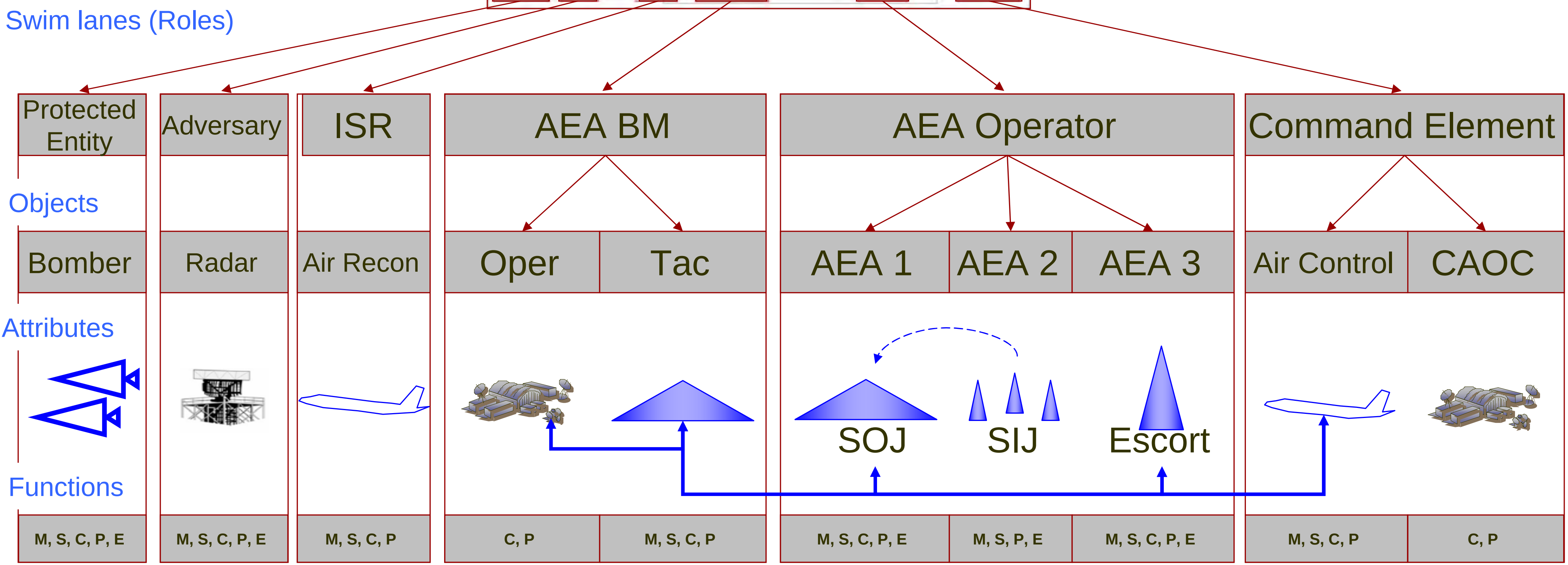
AEA Objects

AEA Operator

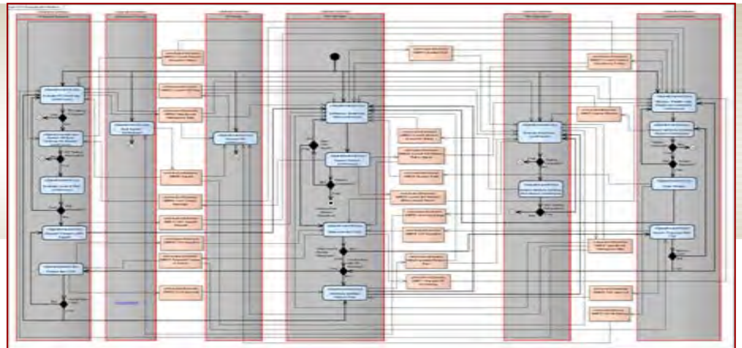
	AEA 1	AEA 2	AEA 3
Cognitive attributes — *Support Relations*	None / **Direct** / Close / TACON	**None** / Direct / Close / TACON	None / Direct / **Close** / TACON
Information attributes — *Comms quality* (Degraded / Nominal / Perfect)	Nominal	Perfect	Degraded
Physical attributes — *AEA Jammer Effectiveness*	Stand Off Jammer	Stand In Jammer	Escort Jammer
Functions	Maneuver Sense Communicate Process Engage	Maneuver Sense Communicate Process Engage	Maneuver Sense Communicate Process Engage

2. Single Configuration
(example)



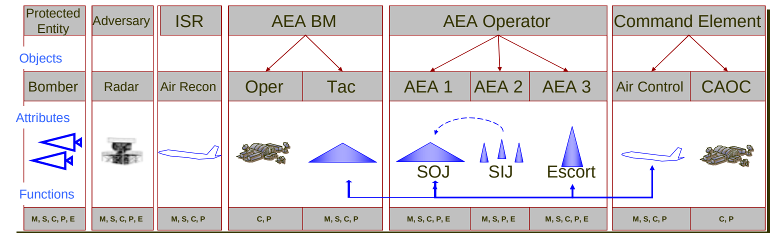


3. Multiple configurations

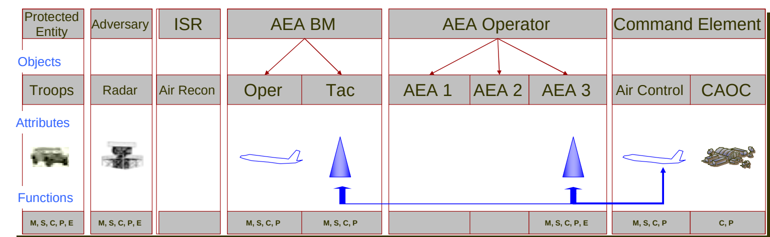


- **Each configuration accounts for all swim lanes & functions**
- **Each configuration has different:**
  - **Attributes**
    - **Cognitive / authorities**
    - **Information / communications**
    - **Physical / platform types**
  - **Functions**
    - **Attribute impacts on performance**

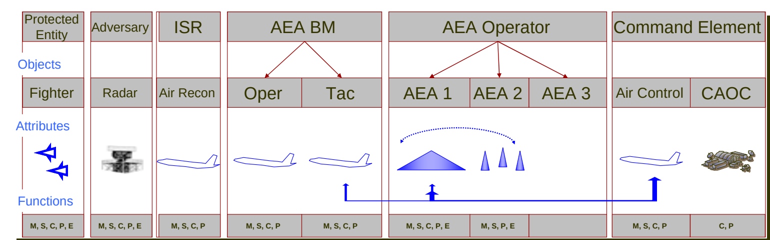
Configuration A



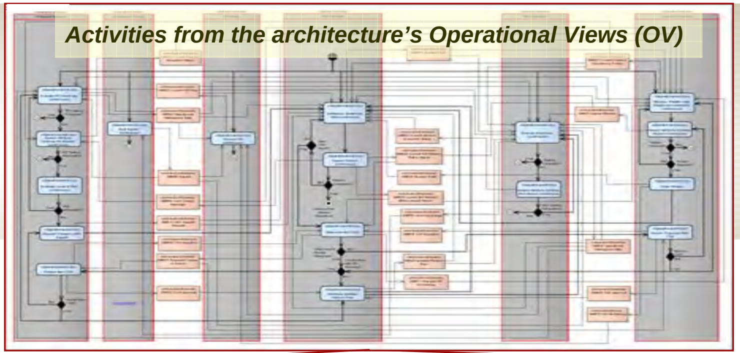
Configuration B



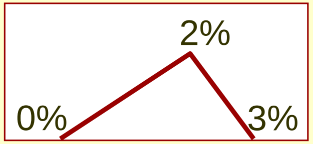
Configuration C



4. Attributes impact on functions



Nominal values shown. Simulations calculations generated from Triangle distributions (Lowest, Nominal, Highest)



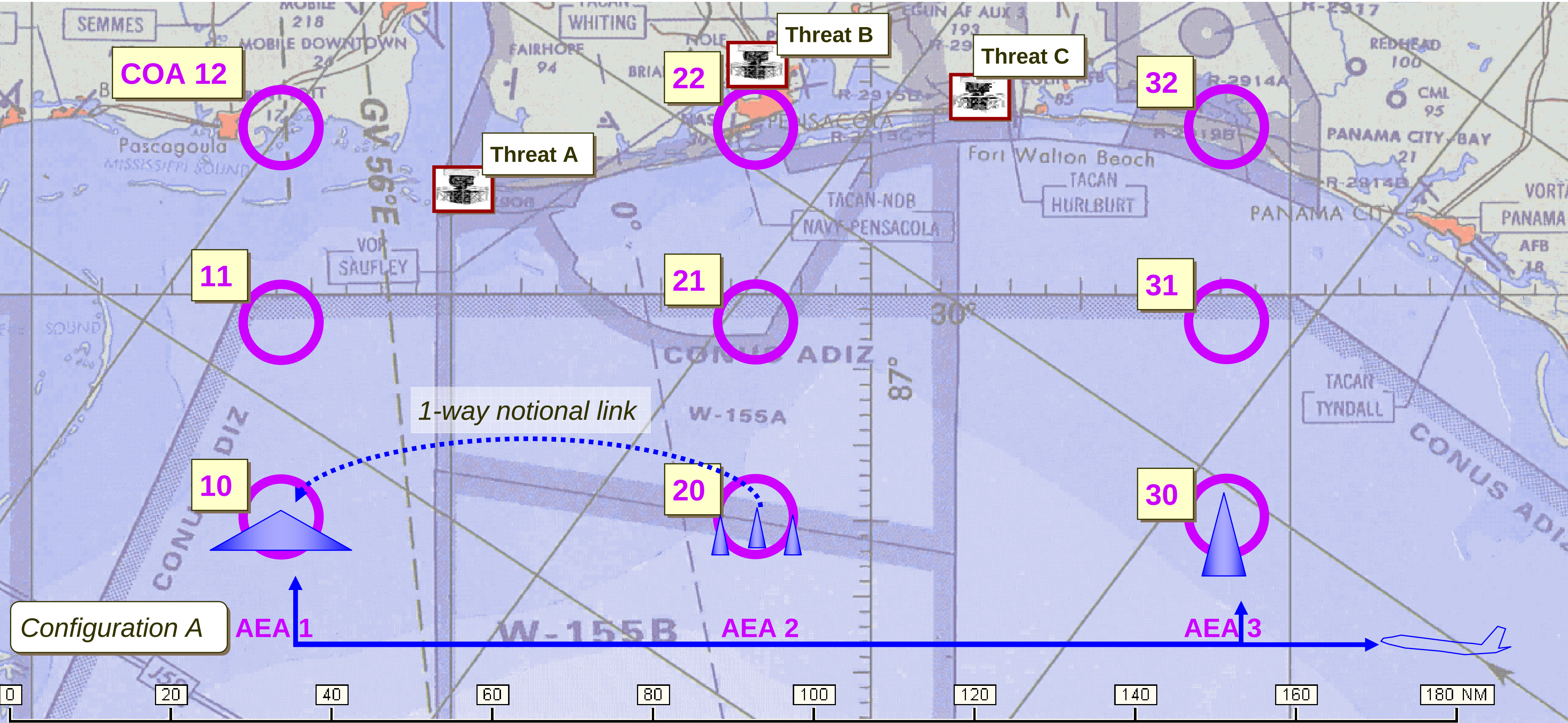
Attributes from configuration factors

Cognitive *AEA-PE Support Relationship*	Spatial relationships	Sensor interpretation	Message interpretation		▪ **None** ▪ **Direct** ▪ **Close** ▪ **TACON**	**Speed** **Nominal** **+2%** **+5%** **+5%**	Weapon control
Informational *Comms Quality*	Velocity and acceleration data	Sensor data/reports	▪ **Degraded** ▪ **Nominal** ▪ **Perfect**	**Speed** **90 sec** **43 sec** **0**	Algorithms		Weapon data
Physical *Effectiveness*	Platform characteristics	Sensor characteristics	Radio/Data Link characteristics		Computer characteristics		▪ **Effectiveness** ▪ **Effectiveness Error** ▪ **Jammer Location**
	Maneuver	**Sense**	**Communicate**		**Process**		**Engage**

Functions from the architecture's System Views (SV)

NOTIONAL Data

Simulation Courses of Action (COA)



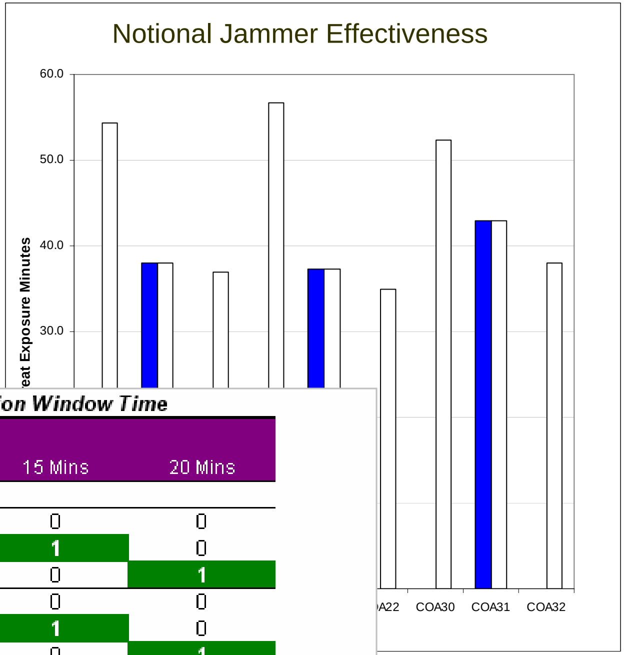
5. Simulate to compare performance from different configurations

- **Course Of Action (COA) Scorer model**
  - **Jammer location**
  - **Expected Jammer Effectiveness**
  - **Time to implement**

- **Monte Carlo Simulation**
  - **Attributes' effect on Battle Manager's Decision Window**

Do longer decision windows make a difference in AEA combat?

For these configurations, faster decisions increased jammer effectiveness by 45% and 53%



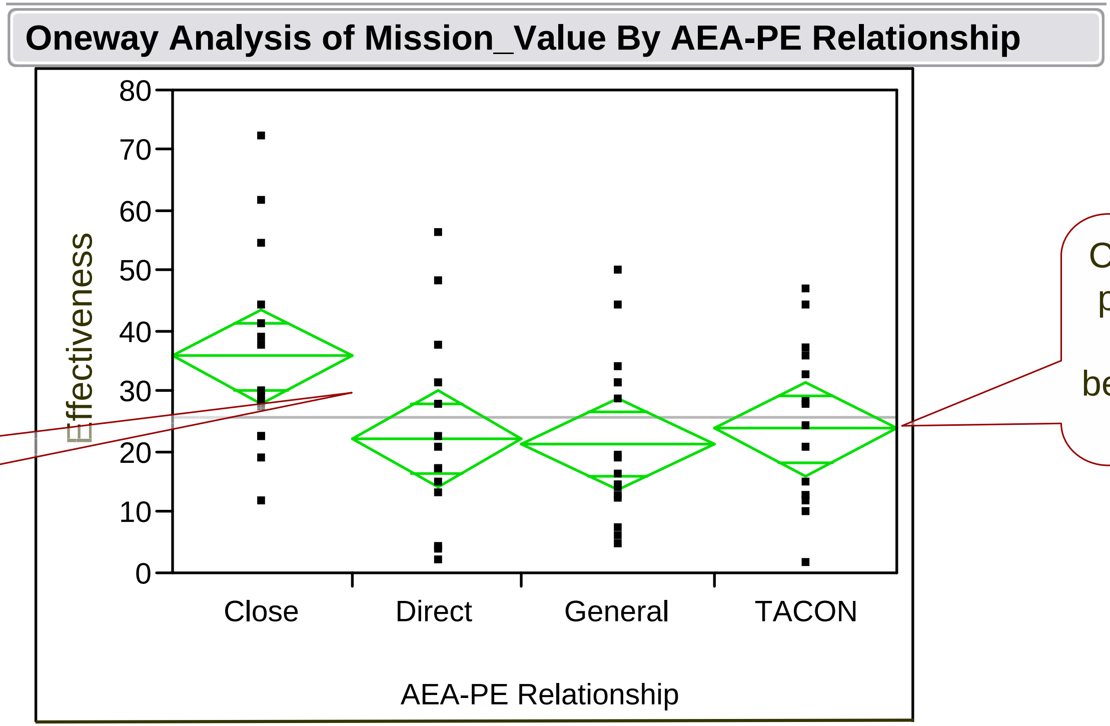
Decision Window Time

Scenario Summary	10 Mins	15 Mins	20 Mins
Changing Cells:			
COA10	1	0	0
COA11	0	1	0
COA12	0	0	1
COA20	1	0	0
COA21	0	1	0
CA022	0	0	1
COA30	1	0	0
COA31	0	1	0
COA32	0	0	1
Result Cells:			
Jammer effectiveness	163.3	118.3	110.0

Less is better

5. Simulate to compare performance from different configurations

Sample data plots using JMP ANOVA



Statistical different performance between these configuration factors

Can't see any performance differences between these factors

NOTIONAL Data

Adaptable Architecture Summary

- Adaptable Architecture provides a neutral arena to compare performance from multiple alternatives
- AA employs a capability-based approach vs platform-based approach to SoS solutions
- AA enables a comprehensive analysis across different force configurations and dynamic situations

Questions?

A Process Decision Table for Integrated Systems and Software Engineering

Barry Boehm and Jo Ann Lane, USC-CSSE

October 2008

Incremental Commitment Model (ICM): Nature and Origins

- Integrates hardware, software, and human factors elements of systems engineering
  - Concurrent exploration of needs and opportunities
  - Concurrent engineering of hardware, software, human aspects
  - Concurrency stabilized via anchor point milestones
- Developed in response to DoD-related issues
  - Clarify “spiral development” usage in DoD Instruction 5000.2
    - Initial phased version (2005)
  - Explain Future Combat System of systems spiral usage to GAO
    - Underlying process principles (2006)
  - Provide framework for human-systems integration
    - National Research Council report (2007)
- Integrates strengths of current process models
  - But not their weaknesses

ICM integrates strengths of current process models

But not their weaknesses

- V-Model: Emphasis on early verification and validation
  - But not ease of sequential, single-increment interpretation
- Spiral Model: Risk-driven activity prioritization
  - But not lack of well-defined in-process milestones
- RUP and MBASE: Concurrent engineering stabilized by anchor point milestones
  - But not software orientation
- Lean Development: Emphasis on value-adding activities
  - But not repeatable manufacturing orientation
- Agile Methods: Adaptability to unexpected change
  - But not software orientation, lack of scalability

Process Model Principles

Principles trump diagrams

1. Commitment and accountability
2. Success-critical stakeholder satisficing
3. Incremental growth of system definition and stakeholder commitment

4, 5. Concurrent, iterative system definition and development cycles

Cycles can be viewed as sequential concurrently-performed phases or spiral growth of system definition

6. Risk-based activity levels and anchor point commitment milestones

Used by 60-80% of CrossTalk Top-5 projects, 2002-2005

Common Risk-Driven Special Cases of the ICM

Special Case	Example	Size, Complexity	Change Rate % /Month	Criticality	NDI Support	Org, Personnel Capability	Key Stage I Activities : Incremental Definition	Key Stage II Activities: Incremental Development, Operations	Time per Build; per Increment
1. Use NDI	**Small Accounting**				**Complete**		**Acquire NDI**	**Use NDI**	
2. Agile	**E-services**	**Low**	**1 – 30**	**Low-Med**	**Good; in place**	**Agile-ready Med-high**	**Skip Valuation , Architecting phases**	**Scrum plus agile methods of choice**	**<= 1 day; 2-6 weeks**
3. Architected Agile	**Business data processing**	**Med**	**1 – 10**	**Med-High**	**Good; most in place**	**Agile-ready Med-high**	**Combine Valuation, Architecting phases. Complete NDI preparation**	**Architecture-based Scrum of Scrums**	**2-4 weeks; 2-6 months**
4. Formal Methods	**Security kernel; Safety-critical LSI chip**	**Low**	**0.3**	**Extra High**	**None**	**Strong formal methods experience**	**Precise formal specification**	**Formally-based programming language; formal verification**	**1-5 days; 1-4 weeks**
5. HW component with embedded SW	**Multi-sensor control device**	**Low**	**0.3 – 1**	**Med-Very High**	**Good; In place**	**Experienced; med-high**	**Concurrent HW/SW engineering. CDR-level ICM DCR**	**IOC Development, LRIP, FRP. Concurrent Version N+1 engineering**	**SW: 1-5 days; Market-driven**
6. Indivisible IOC	**Complete vehicle platform**	**Med – High**	**0.3 – 1**	**High-Very High**	**Some in place**	**Experienced; med-high**	**Determine minimum-IOC likely, conservative cost. Add deferrable SW features as risk reserve**	**Drop deferrable features to meet conservative cost. Strong award fee for features not dropped**	**SW: 2-6 weeks; Platform: 6-18 months**
7. NDI- Intensive	**Supply Chain Management**	**Med – High**	**0.3 – 3**	**Med- Very High**	**NDI-driven architecture**	**NDI-experienced; Med-high**	**Thorough NDI-suite life cycle cost-benefit analysis, selection, concurrent requirements/ architecture definition**	**Pro-active NDI evolution influencing, NDI upgrade synchronization**	**SW: 1-4 weeks; System: 6-18 months**
9. Hybrid agile / plan-driven system	**C4ISR**	**Med – Very High**	**Mixed parts: 1 – 10**	**Mixed parts; Med-Very High**	**Mixed parts**	**Mixed parts**	**Full ICM; encapsulated agile in high change, low-medium criticality parts (Often HMI, external interfaces)**	**Full ICM ,three-team incremental development, concurrent V&V, next-increment rebaselining**	**1-2 months; 9-18 months**
9. Multi-owner system of systems	**Net-centric military operations**	**Very High**	**Mixed parts: 1 – 10**	**Very High**	**Many NDIs; some in place**	**Related experience, med-high**	**Full ICM; extensive multi-owner team building, negotiation**	**Full ICM; large ongoing system/software engineering effort**	**2-4 months; 18-24 months**
10. Family of systems	**Medical Device Product Line**	**Med – Very High**	**1 – 3**	**Med – Very High**	**Some in place**	**Related experience, med – high**	**Full ICM; Full stakeholder participation in product line scoping. Strong business case**	**Full ICM. Extra resources for first system, version control, multi-stakeholder support**	**1-2 months; 9-18 months**

C4ISR: Command, Control, Computing, Communications, Intelligence, Surveillance, Reconnaissance. **CDR:** Critical Design Review.
DCR: Development Commitment Review. **FRP:** Full-Rate Production. **HMI:** Human-Machine Interface. **HW:** Hard ware.
IOC: Initial Operational Capability. **LRIP:** Low-Rate Initial Production. **NDI:** Non-Development Item. **SW:** Software

Case 1: Use NDI

- Exploration phase identifies NDI opportunities
- NDI risk/opportunity analysis indicates risks acceptable
  - Product growth envelope fits within NDI capability
  - Compatible NDI and product evolution paths
  - Acceptable NDI volatility, some open-source components highly volatile
  - Acceptable usability, dependability, interoperability
  - NDI available or affordable
- Example: Small accounting system
- Size/complexity: Low
- Anticipated change rate (% per month): Low
- Criticality: Low
- NDI support: Complete
- Organization and personnel capability: NDI-experienced
- Key Stage I activities: Acquire NDI
- Key State II activities: Use NDI
- Time/build: Driven by time to initialize/tailor NDI
- Time/increment: Driven by NDI upgrades

Case 2: Pure Agile Methods

- Exploration phase determines
  - Low product and project size and complexity
  - Fixing increment defects in next increment acceptable
  - Existing hardware and NDI support of growth envelope
  - Sufficient agile-capable personnel
  - Need to accommodate rapid change, emergent requirements, early user capability
- Example: E-services
- Size/complexity: Low
- Anticipated change rate (% per month): 1-30%
- Criticality: Low to medium
- NDI support: Good; in place
- Organization and personnel capability: Agile-ready, medium to high capability
- Key Stage I activities: Skip Valuation and Architecting phases
- Key State II activities: Scrum plus agile methods of choice
- Time/build: Daily
- Time/increment: 2-6 weeks

Case 3: Architected Agile

- Exploration phase determines
  - Need to accommodate fairly rapid change, emergent requirements, early user capability
  - Low risk of scalability up to 100 people
  - NDI support of growth envelope
  - Nucleus of highly agile-capable personnel
  - Moderate to high loss due to increment defects
- Example: Business data processing
- Size/complexity: Medium
- Anticipated change rate (% per month): 1-10%
- Criticality: Medium to high
- NDI support: Good, most in place
- Organization and personnel capability: Agile-ready, med-high capability
- Key Stage I activities: Combined Valuation and Architecting phase, complete NDI preparation
- Key State II activities: Architecture-based scrum of scrums
- Time/build: 2-4 weeks Time/increment: 2-6 months

Case 4: Formal Methods

- **Biggest risks: Software/hardware does not accurately implement required algorithm precision, security, safety mechanisms, or critical timing**
- **Example: Security kernel or safety-critical LSI chip**
- **Size/complexity: Low**
- **Anticipated change rate (% per month): 0.3%**
- **Criticality: Extra high**
- **NDI support: None**
- **Organization and personnel capability: Strong formal methods experience**
- **Key Stage I activities: Precise formal specification**
- **Key State II activities: Formally-based programming language; formal verification**
- **Time/build: 1-5 days**
- **Time/increment: 1-4 weeks**

Case 5: Hardware Component with Embedded Software

- Biggest risks: Device recall, lawsuits, production line rework, hardware-software integration
  - DCR carried to Critical Design Review level
  - Concurrent hardware-software design
    - Criticality makes Agile too risky
  - Continuous hardware-software integration
    - Initially with simulated hardware
- Low risk of overrun
  - Low complexity, stable requirements and NDI
  - Little need for risk reserve
  - Likely single-supplier software

Case 5: Hardware Component with Embedded Software *(continued)*

- **Example: Multi-sensor control device**
- **Size/complexity: Low**
- **Anticipated change rate (% per month): 0.3-1%**
- **Criticality: Medium to very high**
- **NDI support: Good, in place**
- **Organization and personnel capability: Experienced; medium to high capability**
- **Key Stage I activities: Concurrent hardware and software engineering; CDR-level ICM DCR**
- **Key State II activities: IOC Development, LRIP,FRP, concurrent version N+1 engineering**
- **Time/build: 1-5 days (software)**
- **Time/increment: Market-driven**

Case 6: Indivisible IOC

- Biggest risk: Complexity, NDI uncertainties cause cost-schedule overrun
  - Similar strategies to case 4 for criticality (CDR, concurrent HW-SW design, continuous integration)
  - Add deferrable software features as risk reserve
    - Adopt conservative (90% sure) cost and schedule
    - Drop software features to meet cost and schedule
    - Strong award fee for features not dropped
  - Likely multiple-supplier software makes longer (multi-weekly) builds more necessary

Case 6: Indivisible IOC *(continued)*

- **Example: Complete vehicle platform**
- **Size/complexity: Medium to high**
- **Anticipated change rate (% per month): 0.3-1%**
- **Criticality: High to very high**
- **NDI support: Some in place**
- **Organization and personnel capability: Experienced, medium to high capability**
- **Key Stage I activities: Determine minimum-IOC likely, conservative cost; Add deferrable software features as risk reserve**
- **Key State II activities: Drop deferrable features to meet conservative cost; Strong award fee for features not dropped**
- **Time/build: 2-6 weeks (software)**
- **Time/increment: 6-18 months (platform)**

Case 7: NDI-Intensive

- Biggest risks: incompatible NDI; rapid change, business/mission criticality; low NDI assessment and integration experience; supply chain stakeholder incompatibilities
- Example: Supply chain management
- Size/complexity: Medium to high
- Anticipated change rate (% per month): 0.3-3%
- Criticality: Medium to very high
- NDI support: NDI-driven architecture
- Organization and personnel capability: NDI-experienced; medium to high capability
- Key Stage I activities: Thorough NDI-suite life cycle cost-benefit analysis, selection, concurrent requirements and architecture definition
- Key State II activities: Pro-active NDI evolution influencing, NDI upgrade synchronization
- Time/build: 1-4 weeks (software)
- Time/increment: 6-18 months (systems)

Case 8: Hybrid Agile/Plan-Driven System

- Biggest risks: large scale, high complexity, rapid change, mixed high/low criticality, partial NDI support, mixed personnel capability
- Example: C4ISR system
- Size/complexity: Medium to very high
- Anticipated change rate (% per month): Mixed parts; 1-10%
- Criticality: Mixed parts; medium to very high
- NDI support: Mixed parts
- Organization and personnel capability: Mixed parts
- Key Stage I activities: Full ICM; encapsulated agile in high changed; low-medium criticality parts (often HMI, external interfaces)
- Key State II activities: Full ICM, three-team incremental development, concurrent V&V, next-increment rebaselining
- Time/build: 1-2 months
- Time/increment: 9-18 months

Case 9: Multi-Owner System of Systems

- Biggest risks: all those of Case 8 plus
  - Need to synchronize, integrate separately-managed, independently-evolving systems
  - Extremely large-scale; deep supplier hierarchies
  - Rapid adaptation to change extremely difficult
- Example: Net-centric military operations
- Size/complexity: Very high
- Anticipated change rate (% per month): Mixed parts; 1-10%
- Criticality: Very high
- NDI support: Many NDIs; some in place
- Organization and personnel capability: Related experience, medium to high
- Key Stage I activities: Full ICM; extensive multi-owner teambuilding, negotiation
- Key State II activities: Full ICM; large ongoing system/software engineering effort
- Time/build: 2-4 months Time/increment:18-24 months

Case 10: Family of Systems

- Biggest risks: all those of Case 8 plus
  - Need to synchronize, integrate separately-managed, independently-evolving systems
  - Extremely large-scale; deep supplier hierarchies
  - Rapid adaptation to change extremely difficult
- Example: Medical device product line
- Size/complexity: Medium to very high
- Anticipated change rate (% per month): 1-3%
- Criticality: Medium to very high
- NDI support: Some in place
- Organization and personnel capability: Related experience, medium to high capability
- Key Stage I activities: Full ICM; full stakeholder participation in product line scoping; strong business case
- Key State II activities: Full ICM; extra resources for first system, version control, multi-stakeholder support
- Time/build: 1-2 months Time/increment: 9-18 months

Frequently Asked Question

Q: Having all that ICM generality and then using the decision table to come back to a simple model seems like an overkill.

- **If my risk patterns are stable, can't I just use the special case indicated by the decision table?**

A: Yes, you can and should – as long as your risk patterns stay stable. But as you encounter change, the ICM helps you adapt to it.

- **And it helps you collaborate with other organizations that may use different special cases.**

Using the Incremental Commitment Model (ICM) to Help Execute Competitive Prototyping (CP)

—Charts with Notes—

Barry Boehm and Jo Ann Lane
University of Southern California
Center for Systems and Software Engineering
http://csse.usc.edu

Outline

- Motivation and Context
- Nature of the ICM
- Applying ICM Principles to CP
- Conclusions, References, Acronyms
  - Copy of Young Memo

Motivation and Context

- DoD is emphasizing CP for system acquisition
  - Young memo, September 2007
- CP can produce significant benefits, but also has risks
  - Benefits related to incremental commitment
  - Examples of risks from experiences, workshops
- The risk-driven ICM can help address the risks
  - Primarily through its underlying principles

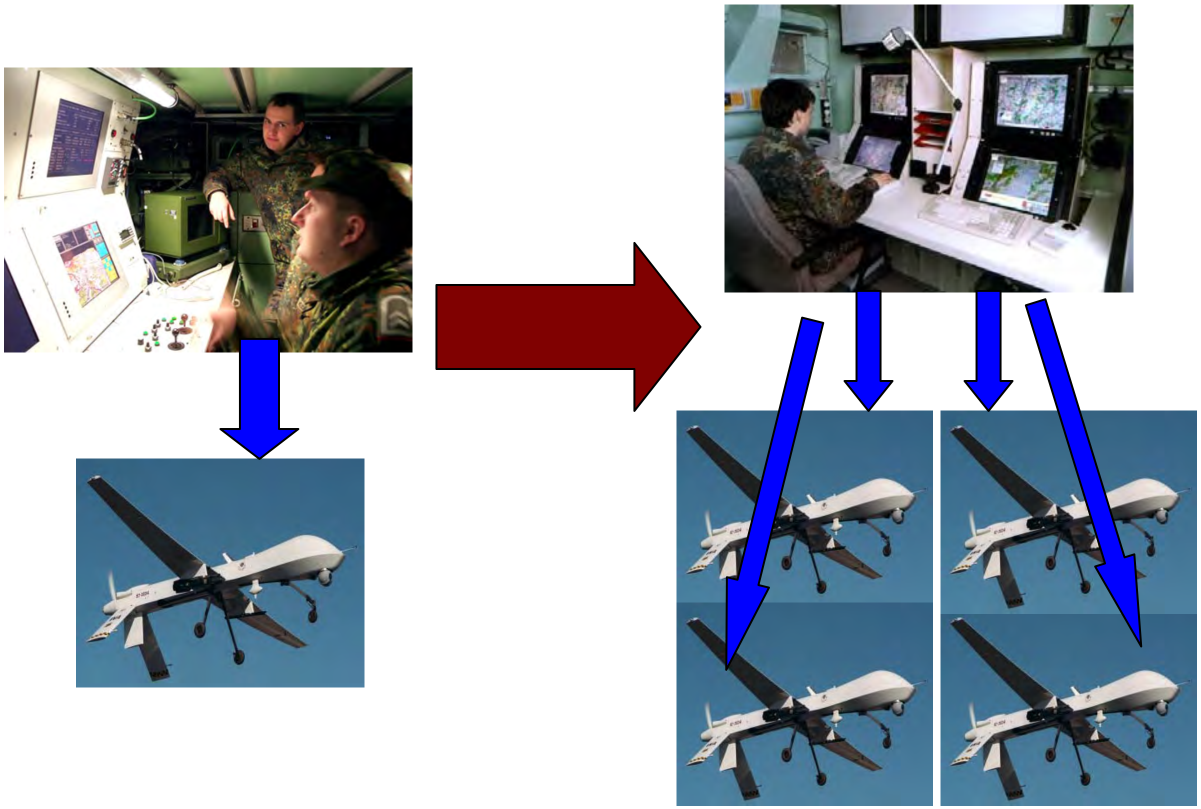
Young Memo: Prototyping and Competition

- Discover issues before costly SDD phase
  - Producing detailed designs in SDD
  - Not solving myriad technical issues
- Services and Agencies to produce competitive prototypes through Milestone B
  - Reduce technical risk, validate designs and cost estimates, evaluate manufacturing processes, refine requirements
- Will reduce time to fielding
  - And enhance govt.-industry teambuilding, SysE skills, attractiveness to next generation of technologists
- Applies to all programs requiring USD(AT&L) approval
  - Should be extended to appropriate programs below ACAT I

Incremental Commitment in Gambling

- **Total Commitment: Roulette**
  - Put your chips on a number
    - E.g., a value of a key performance parameter
  - Wait and see if you win or lose
- **Incremental Commitment: Poker, Blackjack**
  - Put some chips in
  - See your cards, some of others' cards
  - Decide whether, how much to commit to proceed

Scalable remotely controlled operations



Total vs. Incremental Commitment – 4:1 RPV

- **Total Commitment**
  - Agent technology demo and PR: Can do 4:1 for $1B
  - Winning bidder: $800M; PDR in 120 days; 4:1 capability in 40 months
  - PDR: many outstanding risks, undefined interfaces
  - $800M, 40 months: "halfway" through integration and test
  - 1:1 IOC after $3B, 80 months
- **CP-based Incremental Commitment [number of competing teams]**
  - $25M, 6 mo. to VCR [4]: may beat 1:2 with agent technology, but not 4:1
  - $75M, 8 mo. to ACR [3]: agent technology may do 1:1; some risks
  - $225M, 10 mo. to DCR [2]: validated architecture, high-risk elements
  - $675M, 18 mo. to IOC [1]: viable 1:1 capability
  - 1:1 IOC after $1B, 42 months

Example Risks Involved in CP

Based on TRW, DARPA, SAIC experiences; workshop

- Seductiveness of sunny-day demos
  - Lack of coverage of rainy-day off-nominal scenarios
  - Lack of off-ramps for infeasible outcomes
- Underemphasis on quality factor tradeoffs
  - Scalability, performance, safety, security, adaptability
- Discontinuous support of developers, evaluators
  - Loss of key team members
  - Inadequate evaluation of competitors
- Underestimation of productization costs
  - Brooks factor of 9 for software
  - May be higher for hardware
- Underemphasis on non-prototype factors

Milestone B Focus on Technology Maturity Misses Many OSD/AT&L Systemic Root Causes

1 Technical process (35 instances)
- V&V, integration, modeling&sim.

2 Management process (31)

3 Acquisition practices (26)

4 Requirements process (25)

5 Competing priorities (23)

6 Lack of appropriate staff (23)

7 Ineffective organization (22)

8 Ineffective communication (21)

9 Program realism (21)

10 Contract structure (20)

- Some of these are root causes of technology immaturity
- Can address these via evidence-based Milestone B exit criteria
  - Technology Development Strategy
  - Capability Development Document
  - Evidence of affordability, KPP satisfaction, program achievability

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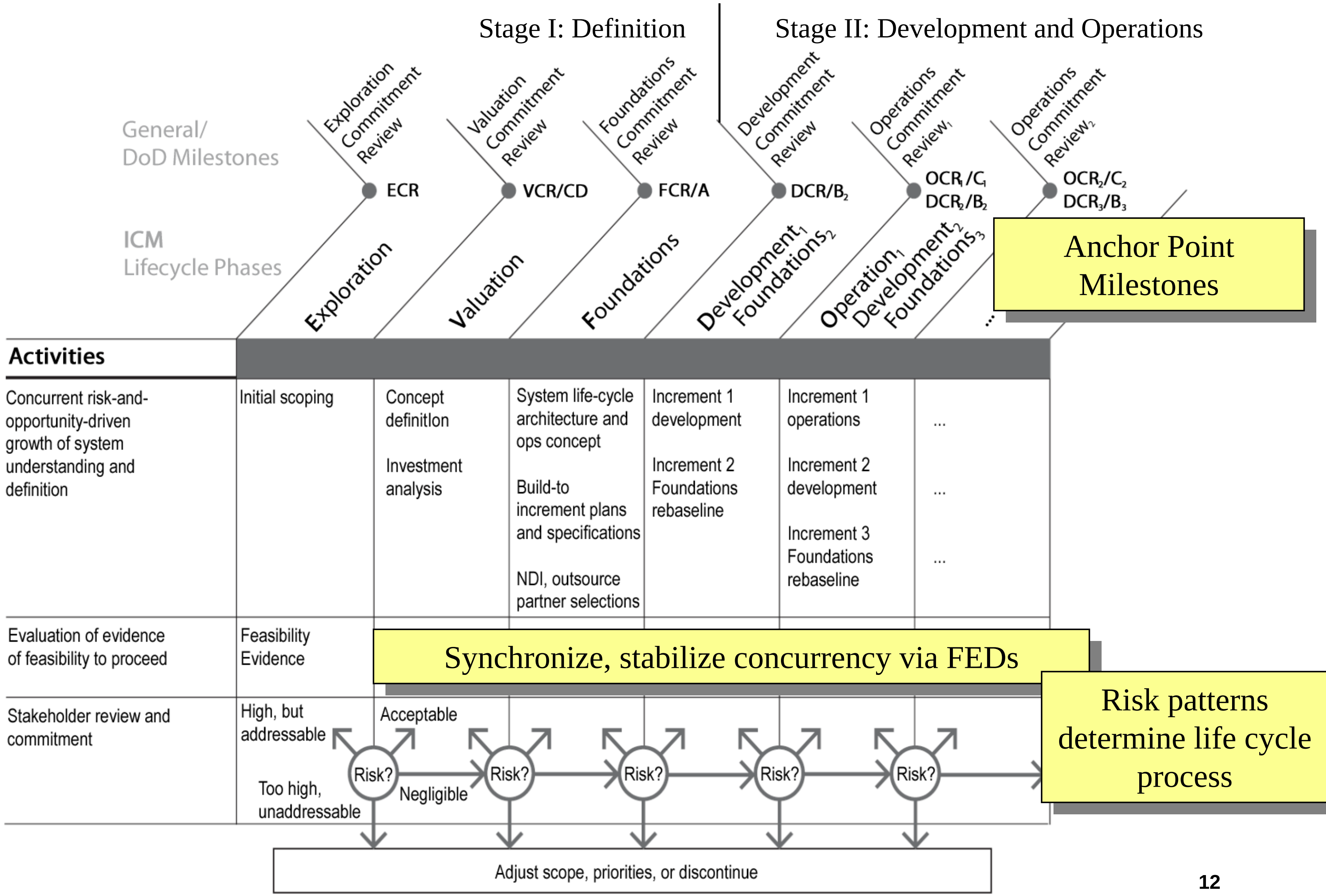
What is the ICM?

- **Risk-driven framework for tailoring system life-cycle processes**
- **Integrates the strengths of phased and risk-driven spiral process models**
- **Synthesizes together principles critical to successful system development**
  - **Commitment and accountability of system sponsors**
  - **Success-critical stakeholder satisficing**
  - **Incremental growth of system definition and stakeholder commitment**
  - **Concurrent engineering**
  - **Iterative development cycles**
  - **Risk-based activity levels and evidence-based milestones**

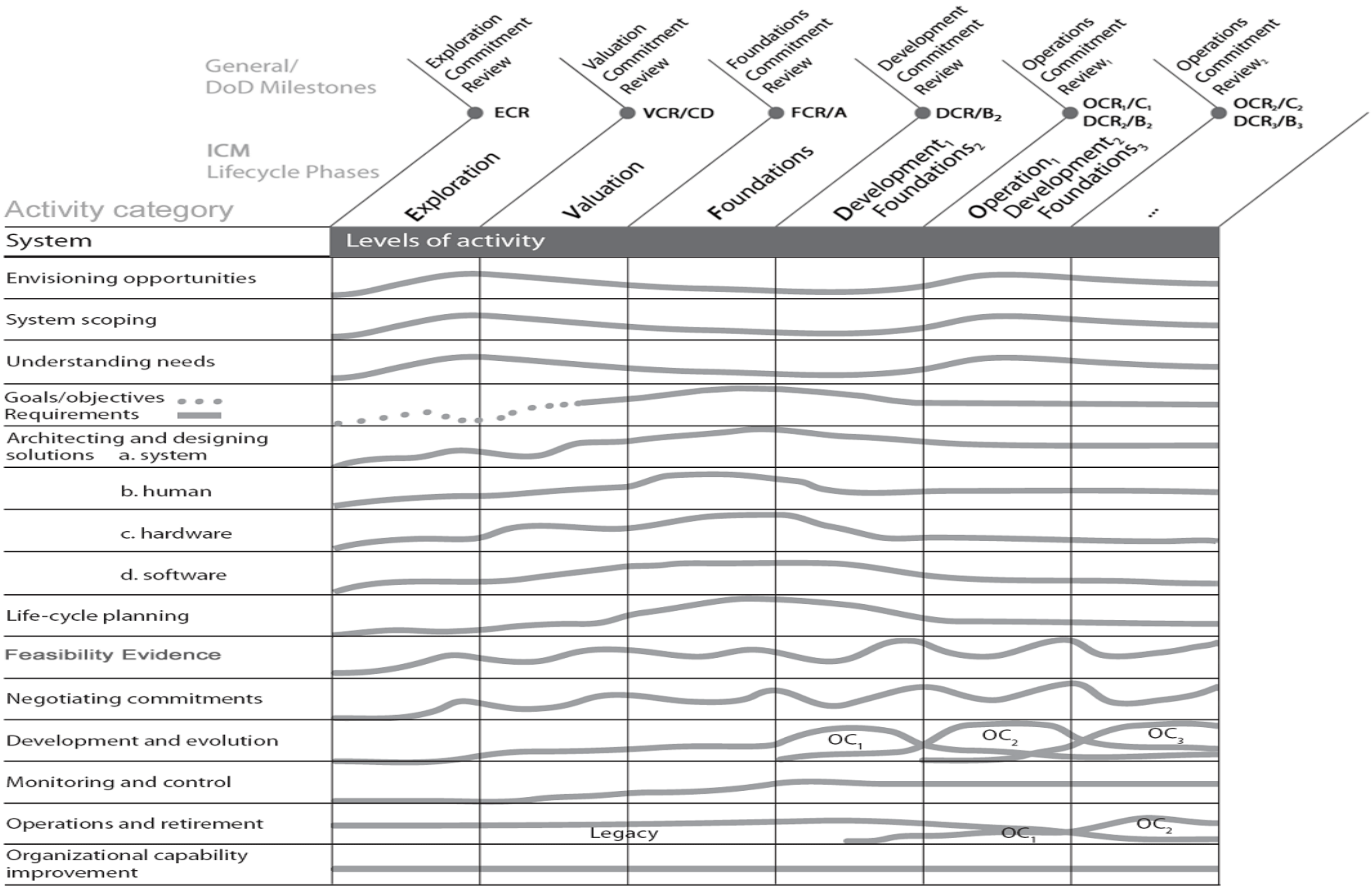
Principles trump diagrams…

Principles Used by 60-80% of CrossTalk Top-5 projects, 2002-2005

The Incremental Commitment Life Cycle Process: Overview



ICM HSI Levels of Activity for Complex Systems



Anchor Point Feasibility Evidence Description

- **Evidence provided by developer and validated by independent experts that:**

  If the system is built to the specified architecture, it will
  - **Satisfy the requirements: capability, interfaces, level of service, and evolution**
  - **Support the operational concept**
  - **Be buildable within the budgets and schedules in the plan**
  - **Generate a viable return on investment**
  - **Generate satisfactory outcomes for all of the success-critical stakeholders**
- **All major risks resolved or covered by risk management plans**
- **Serves as basis for stakeholders' commitment to proceed**

Can be used to strengthen current schedule- or event-based reviews

ICM Nature and Origins

- Integrates hardware, software, and human factors elements of systems engineering
  - Concurrent exploration of needs and opportunities
  - Concurrent engineering of hardware, software, human aspects
  - Concurrency stabilized via anchor point milestones
- Developed in response to DoD-related issues
  - Clarify "spiral development" usage in DoD Instruction 5000.2
    - Initial phased version (2005)
  - Explain Future Combat System of systems spiral usage to GAO
    - Underlying process principles (2006)
  - Provide framework for human-systems integration
    - National Research Council report (2007)
- Integrates strengths of current process models
  - But not their weaknesses

ICM Integrates Strengths of Current Process Models
But not their weaknesses

- V-Model: Emphasis on early verification and validation
  - But not ease of sequential, single-increment interpretation
- Spiral Model: Risk-driven activity prioritization
  - But not lack of well-defined in-process milestones
- RUP and MBASE: Concurrent engineering stabilized by anchor point milestones
  - But not software orientation
- Lean Development: Emphasis on value-adding activities
  - But not repeatable manufacturing orientation
- Agile Methods: Adaptability to unexpected change
  - But not software orientation, lack of scalability

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Applying ICM Principles and Practices to CP

- *When, what, and how much to prototype?*
  - *Risk management principle: buying information to reduce risk*
- Whom to involve in CP?
  - Satisficing principle: all success-critical stakeholders
- How to sequence CP?
  - Incremental growth, iteration principles
- How to plan for CP?
  - Concurrent engineering principle: more parallel effort
- What is needed at Milestone B besides prototypes?
  - Risk management principle: systemic analysis insights

When, What, and How Much to Prototype?

– Buying information to reduce risk

- When and what: Expected value of perfect information
- How much is enough: Simple statistical decision theory

When and What to Prototype: Early RPV Example

- Bold approach

  0.5 probability of success: Value VB_S = \$100M

  0.5 probability of failure: Value VB_F = - \$20M

- Conservative approach

  Value VC = \$20M

- Expected value with <u>no</u> information

  $EV_{NI} = \max(EV_B, EV_C) = \max(.5(\$100M)+.5(-\$20M), \$20M)$

  $= \max(\$50M-\$10M,\$20M) = \$40M$

- Expected value with <u>perfect</u> information

  $EV_{PI} = 0.5[\max(VB_S,VC)] + 0.5[\max(VB_F,VC)]$

  $= 0.5 * \max(\$100M,\$20M) + 0.5 * \max(-\$20M,\$20M)$

  $= 0.5 * \$100M + 0.5 * \$20M = \$60M$

- Expected value of perfect information

  $EVPI = EV_{PI} – EV_{NI} = \$20M$

- Can spend up to \$20M buying information to reduce risk

If Risk Exposure is Low, CP Has Less Value

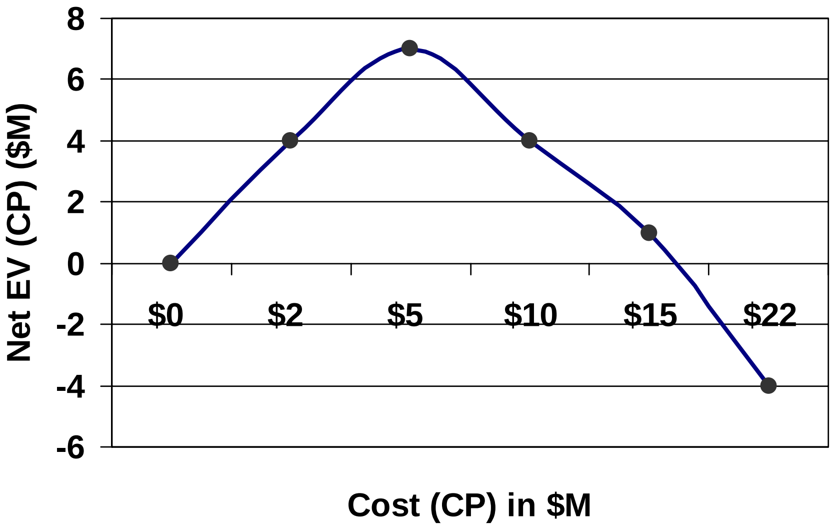
- Risk Exposure RE = Prob(Loss) * Size(Loss)

- Value of CP (EVPI) would be very small if the Bold approach is less risky
  - Prob(Loss) = Prob (VB_F) is near zero rather than 0.5
  - Size(Loss) = VB_F is near $20M rather than -$20M

How Much Prototyping is Enough?
– Value of imperfect information

- Larger CP investments reduce the probability of
  - False Negatives (FN): prototype fails, but approach would succeed
  - False Positives (FP): prototype succeeds, but approach would fail
- Can calculate EV(Prototype) from previous data plus P(FN), P(FP)

CP Cost	P(FP)	P(FN)	EV(CP)	EV(Info)	Net EV(CP)
0			$40M	0	0
$2M	0.3	0.2	$46M	$6M	$4M
$5M	0.2	0.1	$52M	$12M	$7M
$10M	0.15	0.075	$54M	$14M	$4M
$15M	0.1	0.05	$56M	$16M	$1M
$22M	0.0	0.0	$60M	$20M	-$2M



- Added CP decision criterion
  - The prototype can cost-effectively reduce the uncertainty

Summary: CP Pays Off When

- The basic CP value propositions are satisfied
  1. There is significant risk exposure in making the wrong decision
  2. The prototype can cost-effectively reduce the risk exposure
- There are net positive side effects
  3. The CP process does not consume too much calendar time
  4. The prototypes have added value for teambuilding or training
  5. The prototypes can be used as part of the product

Applying ICM Principles and Practices to CP

- When, what, and how much to prototype?
  – Risk management principle: buying information to reduce risk
- *Whom to involve in CP?*
  – *Satisficing principle: all success-critical stakeholders*
- *How to sequence CP?*
  – *Incremental growth, iteration principles*
- How to plan for CP?
  – Concurrent engineering principle: more parallel effort
- What is needed at Milestone B besides prototypes?
  – Risk management principle: systemic analysis insights

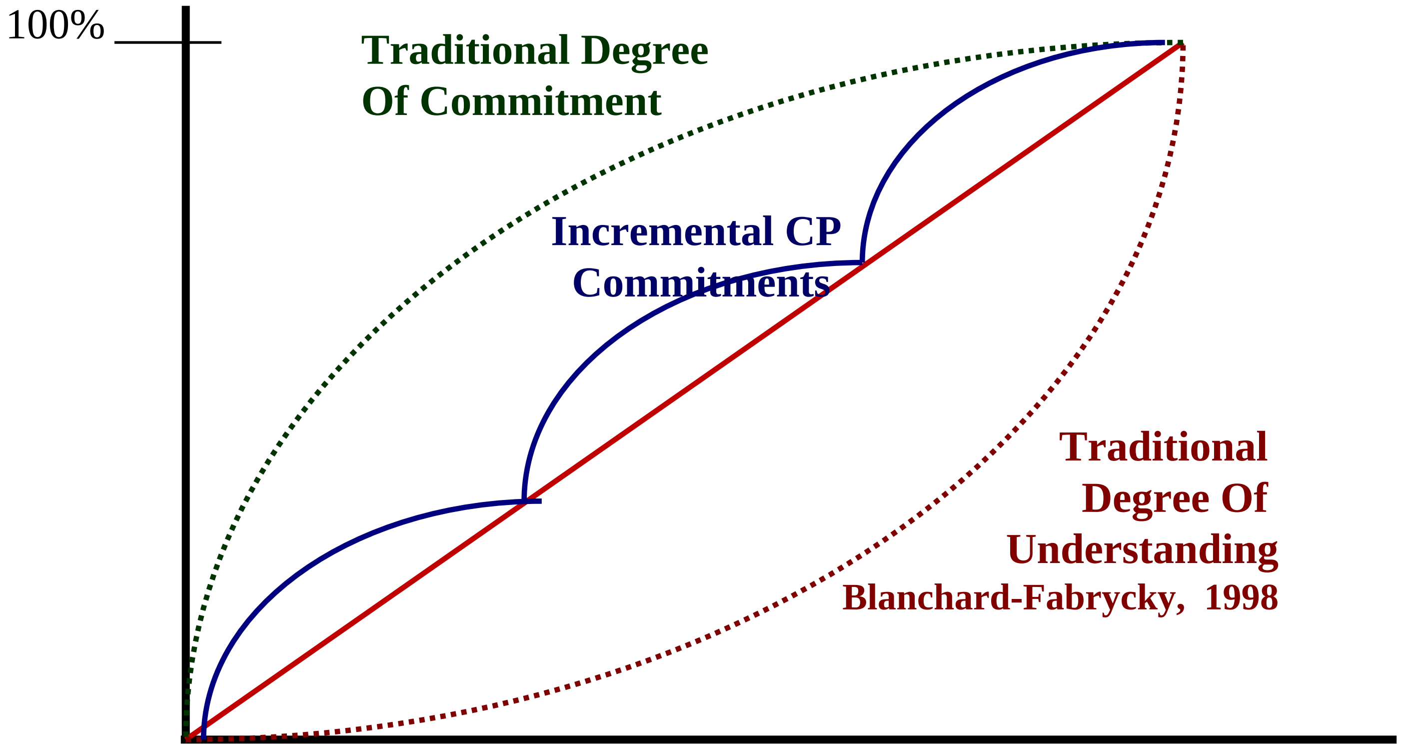
Whom to Involve in CP?

– Satisficing principle: All success-critical stakeholders

- Success-critical: high risk of neglecting their interests
  - Acquirers
  - Developers
  - Users
  - Testers
  - Operators
  - Maintainers
  - Interoperators
  - Others
- Risk-driven level of involvement
  - Interoperators: initially high-level; increasing detail
- Need to have CRACK stakeholder participants
  - Committed, Representative, Authorized, Collaborative, Knowledgeable

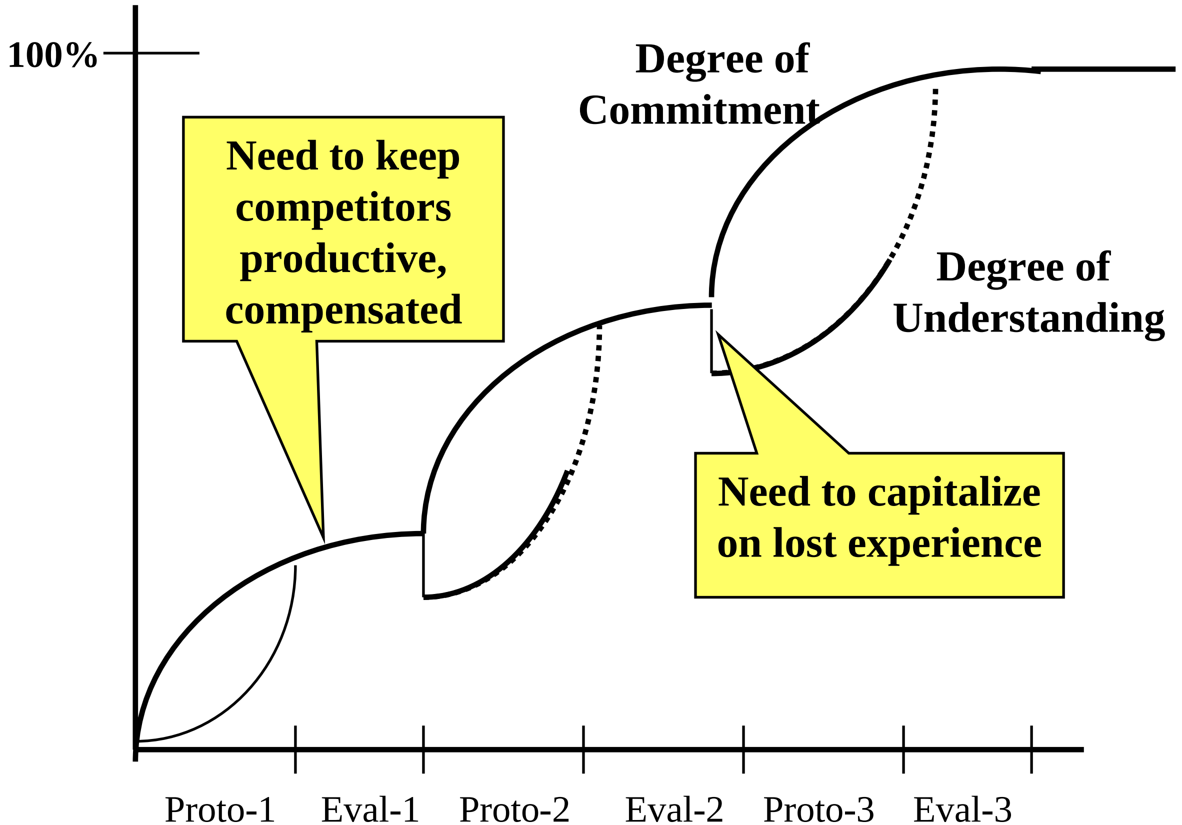
How to Sequence CP?

– Iterative cycles; incremental commitment principles



Actual CP Situation: Need to Conserve Momentum

- Need time to evaluate and rebaseline
- Eliminated competitors' experience lost



Keeping Competitors Productive and Supported During Evaluations

– Concurrent engineering principle

- Provide support for a core group within each competitor organization
  - Focused on supporting evaluation activities
  - Avoiding loss of tacit knowledge and momentum
- Key evaluation support activities might include
  - Supporting prototype exercises
  - Answering questions about critical success factors
- Important to keep evaluation and selection period as short as possible
  - Through extensive preparation activities (see next chart)

Keeping Acquirers Productive and Supported During Prototyping

- Adjusting plans based on new information
- Preparing evaluation tools and testbeds
  - Criteria, scenarios, experts, stakeholders, detailed procedures
- Possibly assimilating downselected competitors
  - IV&V contracts as consolation prizes
- Identifying, involving success-critical stakeholders
- Reviewing interim progress
- Pursuing complementary acquisition initiatives
  - Operational concept definition, life cycle planning, external interface negotiation, mission cost-effectiveness analysis

Applying ICM Principles and Practices to CP

- **When, what, and how much to prototype?**
  - Risk management principle: buying information to reduce risk
- **Whom to involve in CP?**
  - Satisficing principle: all success-critical stakeholders
- **How to sequence CP?**
  - Incremental growth, iteration principles
- **How to plan for CP?**
  - Concurrent engineering principle: more parallel effort
- ***What is needed at Milestone B besides prototypes?***
  - *Risk management principle: systemic analysis insights*

Later CP Rounds Need Increasing Focus on Complementary Practices

– By all success critical stakeholders

- Stakeholder roles, responsibilities, authority, accountability
- Capability priorities and sequencing of development increments
- Concurrent engineering of requirements, architecture, feasibility evidence
- Early preparation of development infrastructure (i.e., key parts of the architecture)
- Acquisition planning, contracting, management, staffing, test and evaluation

When to Stop CP

– Commitment and accountability principle: Off-ramps

- **Inadequate technology base**
  - Lack of evidence of scalability, security, accuracy, robustness, airworthiness, useful lifetime, …
  - Better to pursue as research, exploratory development
- **Better alternative solutions emerge**
  - Commercial, other government
- **Key success-critical stakeholders decommit**
  - Infrastructure providers, strategic partners, changed leadership

Important to emphasize possibility of off-ramps….

Acquiring Organization's ICM-Based CP Plan

- Addresses issues discussed above
  - Risk-driven prototyping rounds, concurrent definition and development, continuity of support, stakeholder involvement, off-ramps
- Organized around key management questions
  - Objectives (why?): concept feasibility, best system solution
  - Milestones and Schedules (what? when?): Number and timing of competitive rounds; entry and exit criteria, including off-ramps
  - Responsibilities (who? where?): Success-critical stakeholder roles and responsibilities for activities and artifacts
  - Approach (how?): Management approach or evaluation guidelines, technical approach or evaluation methods, facilities, tools, and concurrent engineering
  - Resources (how much?): Necessary resources for acquirers, competitors, evaluators, other stakeholders across full range of prototyping and evaluation rounds
  - Assumptions (whereas?): Conditions for exercise of off-ramps, rebaselining of priorities and criteria
- Provides a stable framework for pursuing CP

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CP Conclusions

- CP most effective in reducing technical risk
  - If project is low-risk, may not need CP
    - May be worth it for teambuilding
- Other significant risks need resolution by Milestone B
  - Systemic Analysis DataBase (SADB) sources: management, acquisition, requirements, staffing, organizing, contracting
- CP requires significant, continuing preparation
  - Prototypes are just tip of iceberg
  - Need evaluation criteria, tools, testbeds, scenarios, staffing, procedures
- Need to sustain CP momentum across evaluation breaks
  - Useful competitor tasks to do; need funding support
- ICM provides effective framework for CP plan, execution
  - CP value propositions, milestone criteria, guiding principles
- CP will involve changes in cultures and institutions
  - Need continuous corporate assessment and improvement of CP-related principles, processes, and practices

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List of Acronyms

CD	Concept Development
CP	Competitive Prototyping
DCR	Development Commitment Review
DoD	Department of Defense
ECR	Exploration Commitment Review
EV	Expected Value
EVNI	Expected Value, No Information
EVPI	Expected Value, Perfect Information
FCR	Foundations Commitment Review
FED	Feasibility Evidence Description
GAO	Government Accounting Office
ICM	Incremental Commitment Model
KPP	Key Performance Parameter
MBASE	Model-Based Architecting and Software Engineering
OCR	Operations Commitment Review
P(FN)	Probability of False Negatives
P(FP)	Probability of False Positives
RE	Risk Exposure
RUP	Rational Unified Process
V&V	Verification and Validation
VB	Value of Bold approach
VBS	VB for success
VBF	VB for failure
VC	Value of Conservative approach
VCR	Valuation Commitment Review

Competitive Prototyping Policy: John Young Memo

THE UNDER SECRETARY OF DEFENSE

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19 SEP 2007

ACQUISITION, TECHNOLOGY AND LOGISTICS

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(AT&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

2

Synchronizing M&S Plans Across Navy Acquisition

Or:

Prior Proper Prudent Planning Prevents Piss Poor Performance

21 October 2008

The insights presented here are those of the authors and do not reflect any official views.

We would like to thank NAVMSMO, NRL, and NMSO for their years of support.

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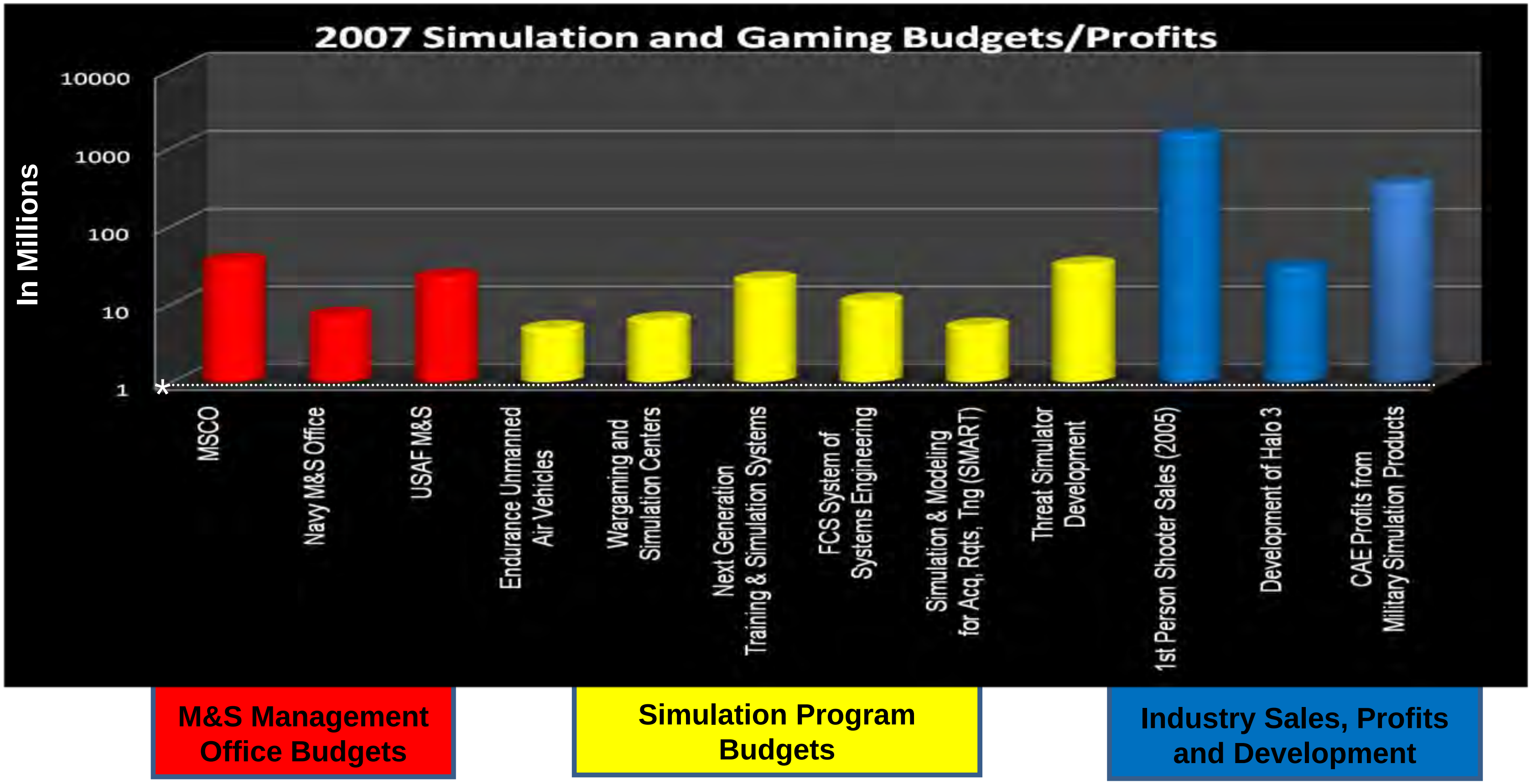
Outline

- Why M&S Planning
- Synchronize to Requirements
- Synchronize to Other Plans
- Synchronize to Future Activities
- Snapshot of Current Navy Acquisition M&S Plans
- Conclusions and Recommendations

M&S Investments



Large Expenditures in M&S!

Yet the Cost of Planning is Quite Low*

M&S Planning Can...

- **Identify cross-cutting requirements and potential synergies**
- **Associate funding expenditures and capability delivery**
- **Facilitate common technical infrastructures**
- **Establish relationships between key personnel**
- **Help coordinate individual efforts**

Relevance to Community

- Leaders / Sponsors
- Planners / Managers
- Developers / Implementers
- Operators / Users

That is:

Leave Any One Out at Your Peril

Empower and Involve

- The Willing
- The Impacted
- The Needed
- The Required

Guide and Iterate

- Spiral Development – With POA&M
- Include All Community Members
- Start General and Mature Specificity
- ***Stay*** in 'Swim Lane' of Plan Type

Interconnect to Other Documents

Baseline Assessment
Descriptive
Application Areas (and enablers)
Programs and Funding
Trends and Issues

Master Plan
Prescriptive
Navy-Wide Vision and Goal
Application Areas and Enablers
(associated visions and goals)
Strategies and Sequencing
NAVMSMO's Mission

Application and Enabler Road Maps
Proactive
Area visions and goals
Implementation, Objectives, Funding, Metrics
Processes, Resources, Timing
Organizational Missions

Investment Strategy
Fiscal
Simulation and Supporting Efforts
Analysis and Navy-Wide Rationalization and POMing
Dollars, Personnel, and Facilities with Potential for Synergy

Slide 6 - 18 May 2004

Account for External Activities

External Depends…

- Coalition, Joint, DoD, Other Service, …
- DHS, DoS, …
- Congressional, …
- Considering Each / All Can Improve the Plan

Define Terms and Timing!

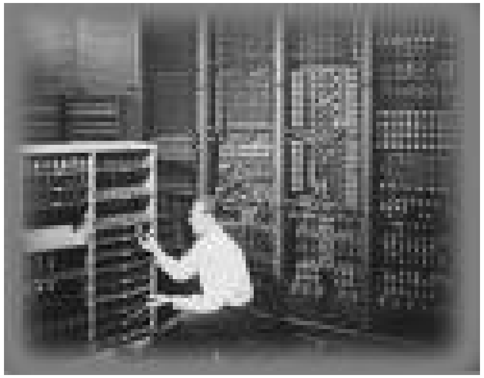
Master Plan ***"5-25 yrs"***	Vision = *Utility* of simulation to the Navy Enterprise Goals = Application and enabler sub-components of Navy-wide vision (long-term) Strategy = Overall actions taken to reach vision and goals
Business Plan ***"3-15 yrs"***	Vision = *Contribution* of simulation to application area or enabler (goals from above) Goals = More specific application area or enabler components (mid-term) Means = What needs to be done and *process improvements* Mission = Relevant organizational roles and responsibilities
Road Map ***"1-10 yrs"***	Goals = *Application* of M&S to meet systemic goals Objectives = Activities and tasks required to achieve goals (mid / near-term) Execution Approach = Means to accomplish goals and objectives (how, who, where) Sequencing, Timing, Resources = Order, duration (when), and investments needed Metrics = That reflect contribution / value and degree to which objectives have been met
Implementation Guide ***"1-3 yrs"***	Execution Approach = *Specific* steps / actions required (near / now-term) Context = Application of individual standards, codes of best practice, and similar Product = A POA&M of capabilities that will be delivered over time

and Strategic Plan, Investment Strategy, Program Plan, ...

Implementing Processes

- M&S Specific - ***Technical***
  - Visualization, Data, Time Management
  - Languages (JAVA), Availability (SOA), etc.
  - Hardware / Distribution Alignment
- M&S Context - ***Requirements***
  - Information Technology, Soft/Hardware, etc.
  - R&D / S&T / ACTDs
  - Commercial Developments
- M&S Relevant - ***Users***
  - Involve End Users Early and Often
  - Understand and Reflect the Problem Context with the M&S Use

Incorporation of Data



- Good
- And Evolve, to…
- Good Enough
- "The perfect is the enemy of the good enough"

Integration of Leadership

- Involve Leader (s) – AMAP
- Develop Broad "Top Cover"
- Iterate / Promulgate Ideas, Plans, Policies
- Implement (Enforce) Directives

(as much as possible!)

Snapshot of Today

- The US Navy M&S Acquisition Community has
  - Developed an M&S Business Plan Structure
  - Using it as a foundation for an ASN(RDA) M&S Road Map
  - RM includes Leadership, Infrastructure, and Similar
  - RDA interacts with all Navy M&S Communities
  - ***"Lead by Example While Gathering Steam"***

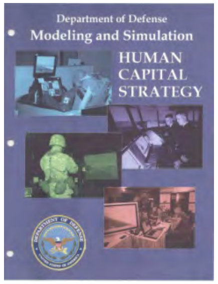
Conclusion – Planning Can Establish

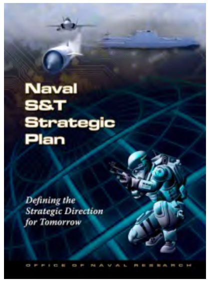
- ***"Shared vision / understanding of objectives***
- ***Commitment of the organization and its people***
- ***Ability to partition complexity into actionable parts***
- ***Use of intermediate steps***
- ***Application of proven methods and standards"****

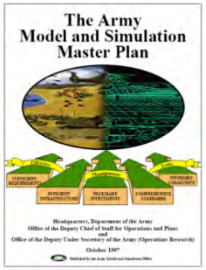
* Success Factors, SOS Engineering Conference, 25 July 2006, Mr. Carl Siel, ASN(RDA) CHENG

Recommendation

- *Plan!*







…

- *It's well worth the investment!*

Back-Up

Plans Promote... (I)

1. Conversion of the vision, goals, and strategy found in the Master Plan into specific (executable) actions and objectives
2. Better meeting of requirements through articulation, projection, and understanding of needs and capabilities available to address them
3. System life-cycle cost reduction by efficiently meeting requirements and through enabler alignment, synergy, and integration
4. Identification of system, decision, and process prerequisites, precedence, dependence, and sequencing
5. Establishment of technology insertion and modernization points and ways to leverage other Service, Joint, Government, and private enterprise initiatives
6. Definition of current and needed funding levels, programmatics, and relevant performance metrics*
7. Capabilities development, acquisition, and deployment priorities and approaches
8. Identification of organizational roles and responsibilities and proposed changes and enhancements

* - to include warfighter impact, opportunity costs, and similar measures of merit

Road Maps Promote... (II)

9. Statement of definitions, informing interested communities, and consolidation of relevant information, resources, and references
10. Base-lining of current systems and developing consensus on requirements
11. Plans to be formulated to meet current requirements and proactive approaches to be constructed to address long term needs
12. Development and agreement on process descriptions of needed and optional actions, decisions, information gathering and submission points, and roles and responsibilities of organizations and individuals
13. Effective orchestration of experiments, demonstrations (ACDs and ACTDs), systems developments and deployment, and organizational changes
14. System convergence, integration, and consolidation approaches that may be required
15. Characterization of challenges and approaches to meet them
16. Matching and aligning of future required capabilities, emerging software and hardware technologies, developing standards, and maturing design, development, and manufacturing methods

Process Enrichment℠ Boot Camp

An intensive introduction to a generic, enterprise-wide, strategic communication and continuous improvement methodology

Presented to The National Defense Industrial Association

October 23, 2008

Victor Elias

High Performance Technologies, Inc.

Process Enrichment[SM] Boot Camp

Briefing Outline

Strategic Communication
- Defined
- Themes of Performance
- A Thematic Strategic Management System
- Identifying Measurements of Strategic Performance

The Art of Process Enrichment[SM] in Competitive Warfare
- Quality Excellence: A New Definition
- Case Studies: Assessing Competitive Position
- Case Study: Assessing Market Value

Beyond Excellence: The Quest for Process Enrichment[SM]
- Reversing De-motivating Conditions
- Supporting an Innovative Culture
- Improving Your Customer's Products & Services
- Transformation to Serve Emergent Market Needs
- A Systems View of Continuous Improvement

Conclusion / Q & A

Strategic Communication: *Defined*

"Focused United States Government efforts to understand and engage key audiences to create, strengthen, or preserve conditions favorable for the advancement of United States Government interests, policies, and objectives through the use of coordinated programs, plans, themes, messages, and products synchronized with the actions of all instruments of national power."

– Joint Chiefs of Staff
JP 5-0

(For "United States Government" and "national" read "Enterprise")

We Shall Fight on the Beaches

June 4, 1940, House of Commons

"... We shall prove ourselves once more able to defend our Island home…

... We shall go on to the end, we shall fight in France, we shall fight on the seas and oceans, we shall fight with growing confidence and growing strength in the air, we shall defend our Island, whatever the cost may be, we shall fight on the beaches, we shall fight on the landing grounds, we shall fight in the fields and in the streets, we shall fight in the hills; we shall never surrender, and if, which I do not for a moment believe, this Island or a large part of it were subjugated and starving, then our Empire beyond the seas, armed and guarded by the British Fleet, would carry on the struggle, until, in God's good time, the New World, with all its power and might, steps forth to the rescue and the liberation of the old."

Listen To Speech

-- Winston Churchill

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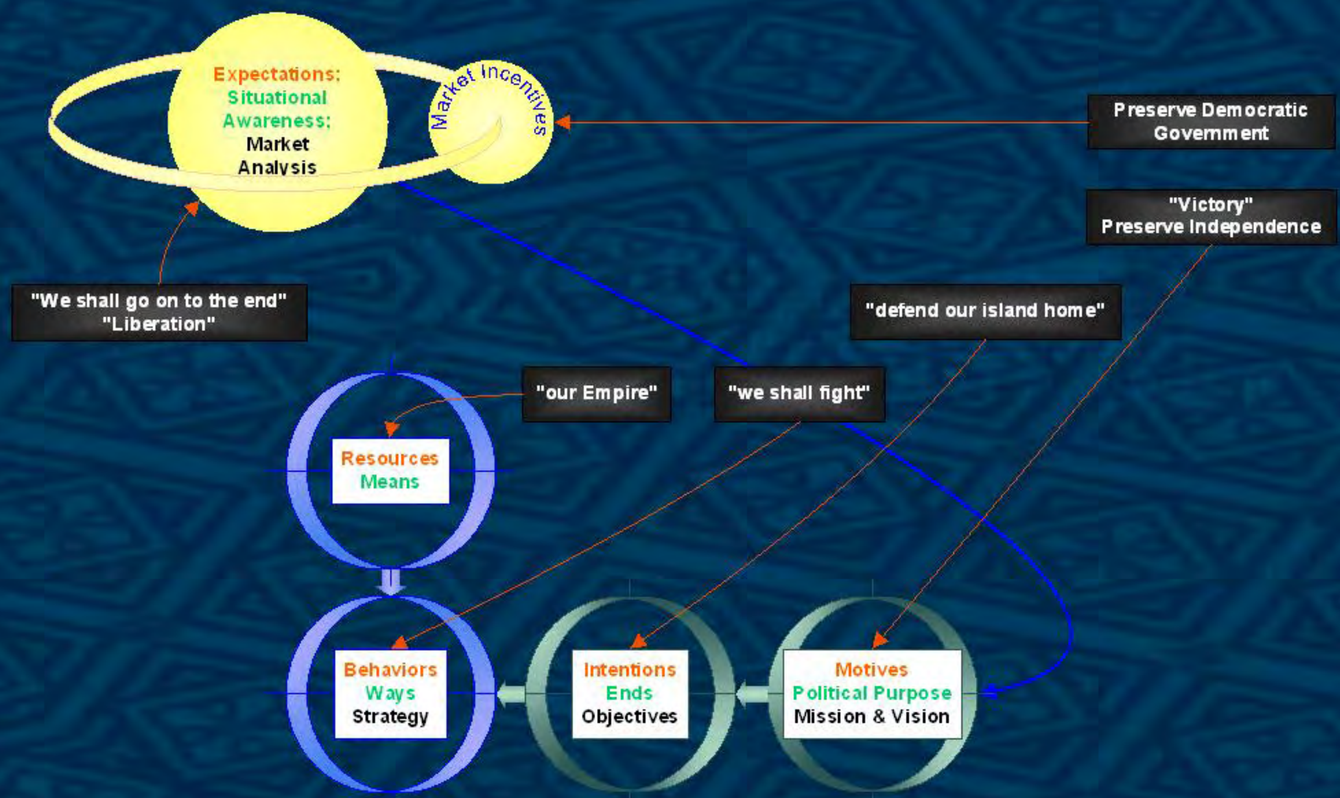
Strategic Communication: *The Structure*

Conceptually,
Market Incentives and Expectations regarding them produce Motives expressed as Intentions that are carried out through Behaviors using Resources.



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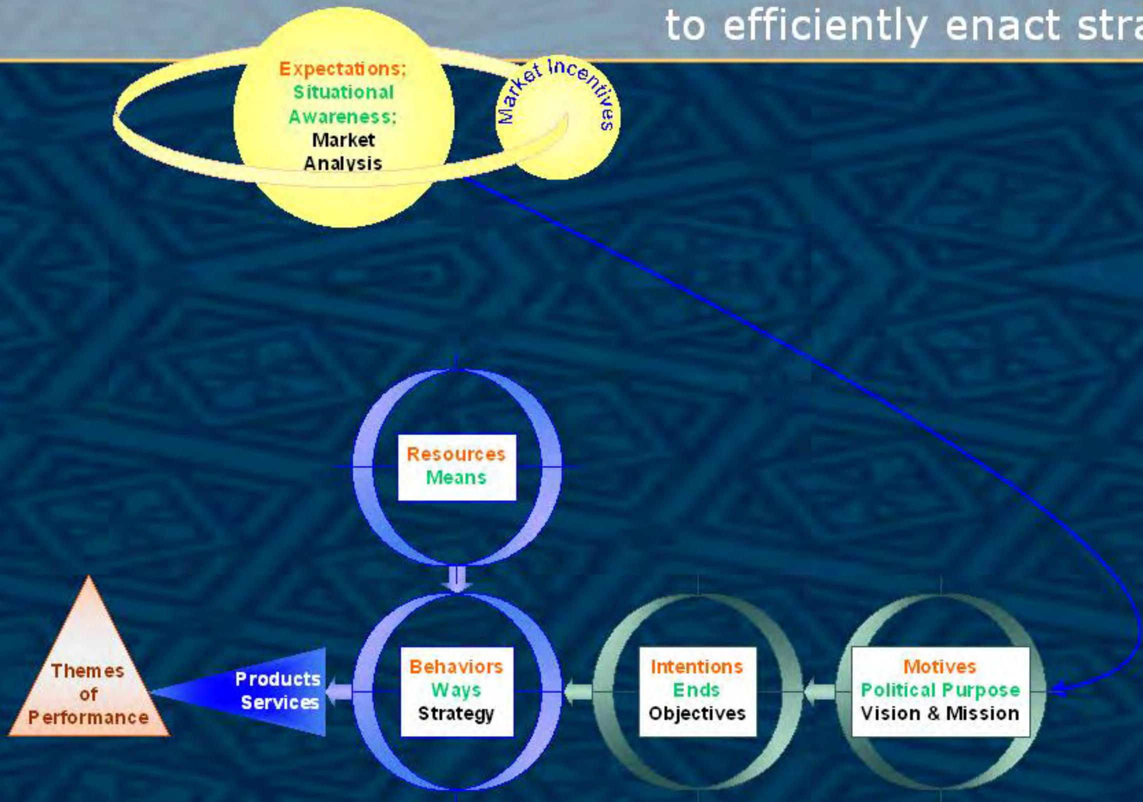
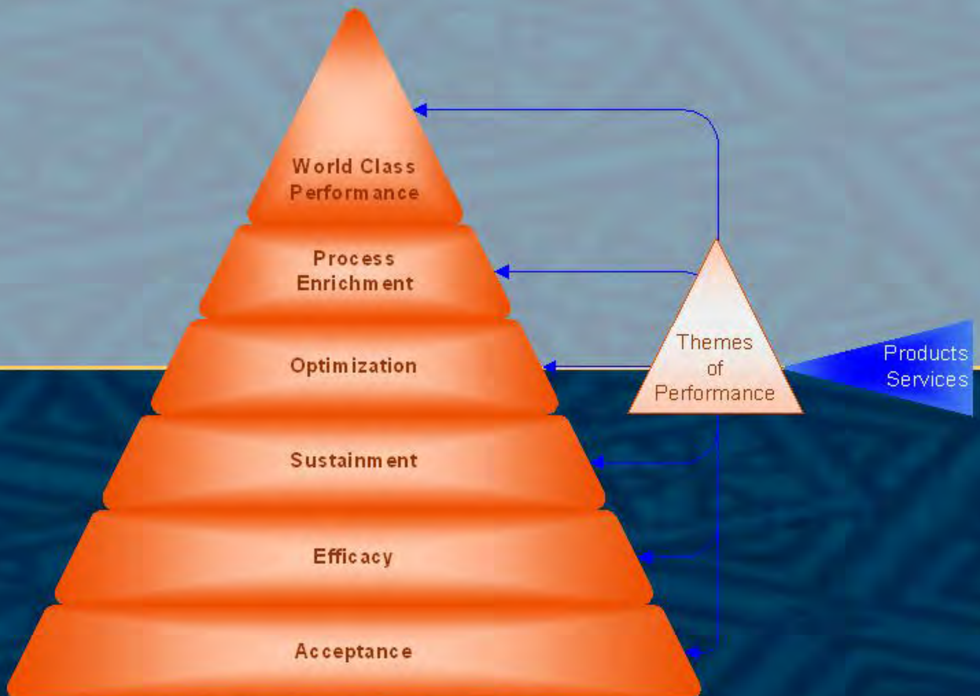
Strategic Communication: *Operationalizing The Message*

Process Enrichments' concepts of
Performance Units and
Themes of Performance
serve as a common language
that enables a systems engineering process
to efficiently enact strategic communication.



Strategic Communication: *The Enabling Concepts*



Anything
considered in terms of its performance
is a "Performance Unit."

- An Organization
- A Project
- A Service
- A Product
- A Process

Themes of Performance
are a set of 6
hierarchical, independent,
"Themes[1]"
that comprehensively describe
the performance qualities
of **any** Performance Unit.

([1]Themes: implicit, recurring, and coalescent central concepts, principles, qualities and/or ideas)

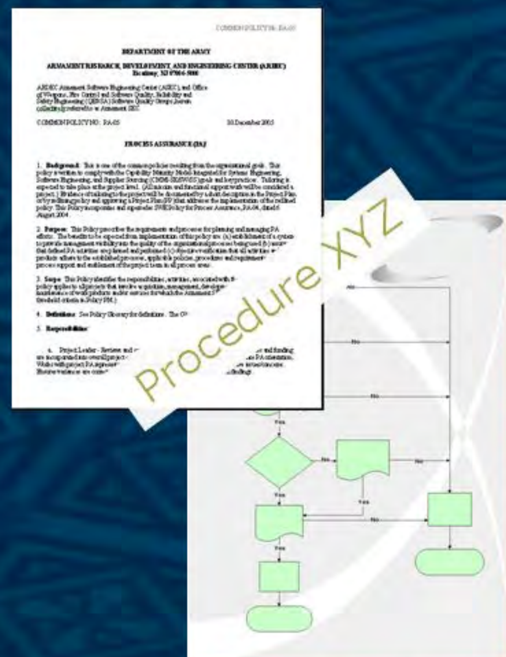
Strategic Communication: *Themes of Performance*

If the Performance Unit is **A Product** - for example: **Projectile XYZ**

Acceptance	Does Projectile XYZ fit in the launcher?
Efficacy	Will Projectile XYZ destroy the target?
Sustainment	How many Projectile XYZ's can be made per month?
Optimization	Can I make Projectile XYZ more dangerous to the target?
Process Enrichment℠	Can I transport Projectile XYZ without it exploding?
World Class Performance	Can other allied troops use Projectile XYZ?

Strategic Communication: *Themes of Performance*

If the Performance Unit is **A Procedure** - for example: **Procedure XYZ**



Acceptance	Can Procedure XYZ be performed without "dropping the ball" with respect to stakeholder interests?
Efficacy	Does Procedure XYZ make a useful contribution to how we do things?
Sustainment	Can repetitive Procedure XYZ be repeated?
Optimization	Is there One Best Way to perform Procedure XYZ?
Process Enrichment℠	Are people working against each other?
World Class Performance	Is Procedure XYZ performed the same way everywhere it's performed?

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Strategic Communication: *Themes of Performance*

If the Performance Unit is **An Organization** - for example, a Division responsible for Policies, Procedures, Templates, Tools & Training ("**guidance products**")

Acceptance	Are all necessary guidance products ready?
Efficacy	Are people using the guidance products?
Sustainment	Is the organization manageable?
Optimization	Are all practices Best Practices?
Process Enrichment℠	Is the organization using the best ideas employees put forward?
World Class Performance	Does the organization have marketable competitive advantages in performance?

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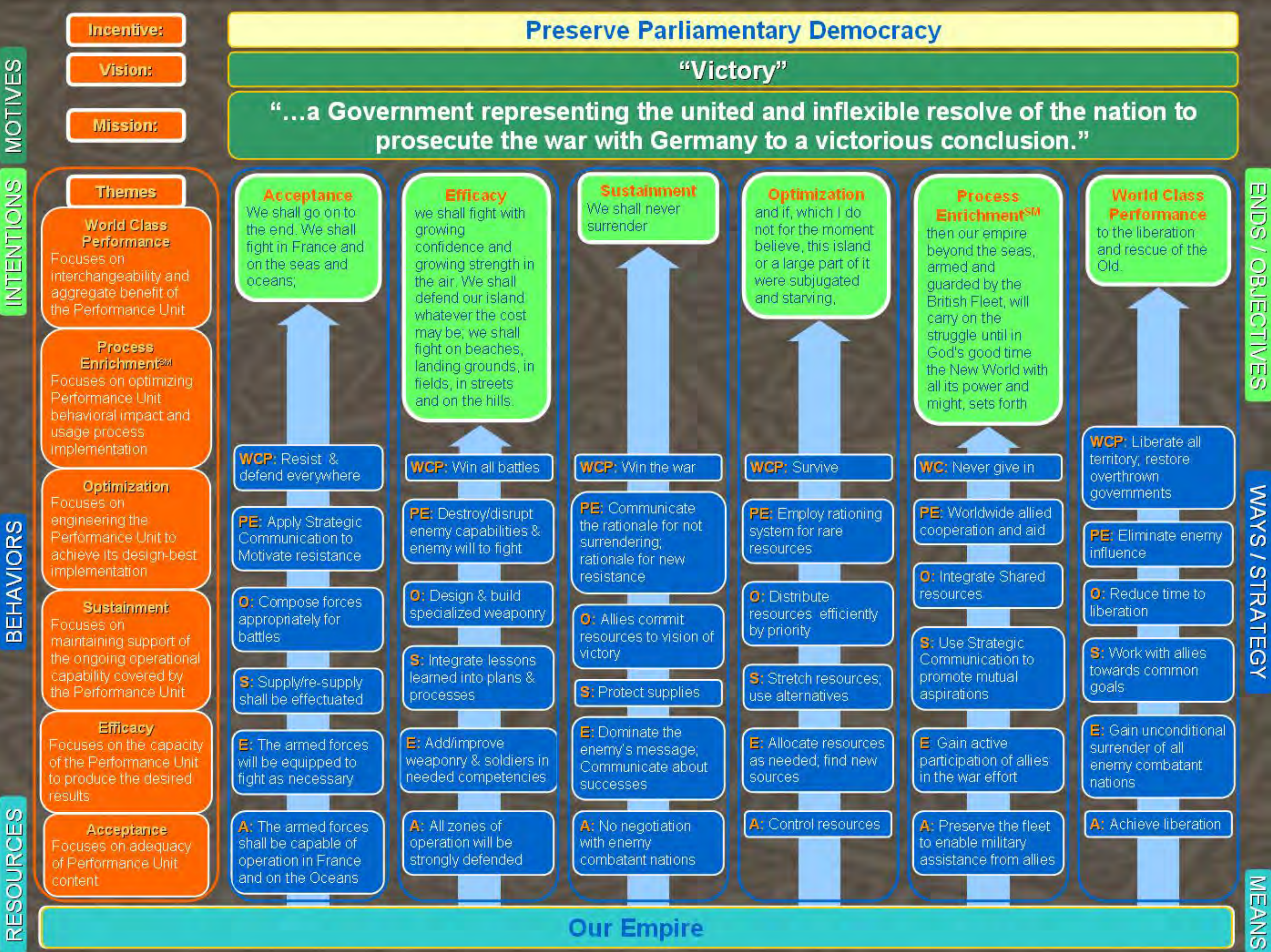
Strategic Communication: *Themes of Performance*

Themes of Performance	Performance Unit : The Message - Expression of Strategic Motives & Intentions
Acceptance Focuses on adequacy of Performance Unit content	We shall go on to the end. We shall fight in France and on the seas and oceans;
Efficacy Focuses on the capacity of the Performance Unit to produce the desired results	we shall fight with growing confidence and growing strength in the air. We shall defend our island whatever the cost may be; we shall fight on beaches, landing grounds, in fields, in streets and on the hills.
Sustainment Focuses on maintaining support of the ongoing operational capability covered by the Performance Unit	We shall never surrender
Optimization Focuses on engineering the Performance Unit to achieve its design-best implementation	and if, which I do not for the moment believe, this island or a large part of it were subjugated and starving,
Process Enrichment Focuses on optimizing Performance Unit behavioral impact (employee/customer motivation) and usage process implementation (ease of performance, satisfaction, etc.)	then our empire beyond the seas, armed and guarded by the British Fleet, will carry on the struggle until in God's good time the New World with all its power and might, sets forth
World Class Performance Focuses on interchangeability and aggregate benefit of the Performance Unit	to the liberation and rescue of the Old.



MOTIVES
INTENTIONS
BEHAVIORS
RESOURCES
Incentive:
Preserve Parliamentary Democracy
Vision:
"Victory"
Mission:
"…a Government representing the united and inflexible resolve of the nation to prosecute the war with Germany to a victorious conclusion."
Themes
World Class Performance Focuses on interchangeability and aggregate benefit of the Performance Unit
Process Enrichment℠ Focuses on optimizing Performance Unit behavioral impact and usage process implementation
Optimization Focuses on engineering the Performance Unit to achieve its design-best implementation
Sustainment Focuses on maintaining support of the ongoing operational capability covered by the Performance Unit
Efficacy Focuses on the capacity of the Performance Unit to produce the desired results
Acceptance Focuses on adequacy of Performance Unit content
Acceptance We shall go on to the end. We shall fight in France and on the seas and oceans;
WCP: Resist & defend everywhere
PE: Apply Strategic Communication to Motivate resistance
O: Compose forces appropriately for battles
S: Supply/re-supply shall be effectuated
E: The armed forces will be equipped to fight as necessary
A: The armed forces shall be capable of operation in France and on the Oceans
Efficacy we shall fight with growing confidence and growing strength in the air. We shall defend our island whatever the cost may be; we shall fight on beaches, landing grounds, in fields, in streets and on the hills.
WCP: Win all battles
PE: Destroy/disrupt enemy capabilities & enemy will to fight
O: Design & build specialized weaponry
S: Integrate lessons learned into plans & processes
E: Add/improve weaponry & soldiers in needed competencies
A: All zones of operation will be strongly defended
Sustainment We shall never surrender
WCP: Win the war
PE: Communicate the rationale for not surrendering; rationale for new resistance
O: Allies commit resources to vision of victory
S: Protect supplies
E: Dominate the enemy's message; Communicate about successes
A: No negotiation with enemy combatant nations
Optimization and if, which I do not for the moment believe, this island or a large part of it were subjugated and starving,
WCP: Survive
PE: Employ rationing system for rare resources
O: Distribute resources efficiently by priority
S: Stretch resources; use alternatives
E: Allocate resources as needed; find new sources
A: Control resources
Process Enrichment℠ then our empire beyond the seas, armed and guarded by the British Fleet, will carry on the struggle until in God's good time the New World with all its power and might, sets forth
WC: Never give in
PE: Worldwide allied cooperation and aid
O: Integrate Shared resources
S: Use Strategic Communication to promote mutual aspirations
E: Gain active participation of allies in the war effort
A: Preserve the fleet to enable military assistance from allies
World Class Performance to the liberation and rescue of the Old.
WCP: Liberate all territory; restore overthrown governments
PE: Eliminate enemy influence
O: Reduce time to liberation
S: Work with allies towards common goals
E: Gain unconditional surrender of all enemy combatant nations
A: Achieve liberation
ENDS / OBJECTIVES
WAYS / STRATEGY
MEANS
Our Empire

"Strategic Communication is the active ingredient
in a systems engineering process
that integrates
the essential innovative and creative direction
of the enterprise' guiding motives
and creates enduring enterprise performance quality excellence."

-- *Victor Elias*

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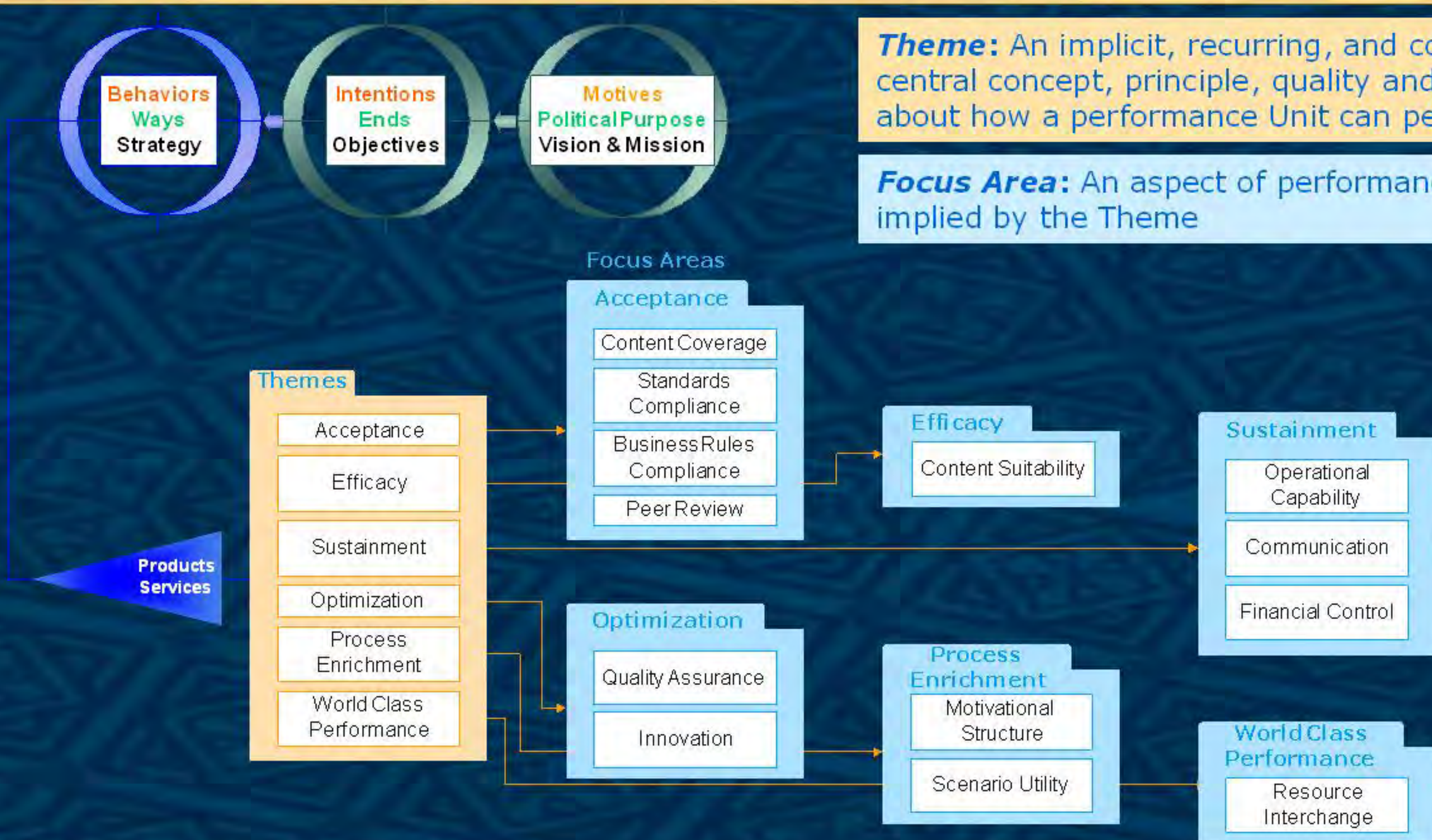
Identifying Measurements of Strategic Performance

***Theme*:** An implicit, recurring, and coalescent central concept, principle, quality and/or idea about how a performance Unit can perform.

***Focus Area*:** An aspect of performance that's implied by the Theme



Acceptance: Focuses on adequacy of Performance Unit content

Efficacy: Focuses on the capacity of the Performance Unit to produce the desired results

Sustainment: Focuses on maintaining support of the ongoing operational capability covered by the Performance Unit

Optimization: Focuses on engineering the Performance Unit to achieve its design-best implementation

Process Enrichment℠ Focuses on optimizing Performance Unit behavioral impact (employee/customer motivation) and usage process implementation (ease of performance, satisfaction, etc.)

World-Class Performance: Focuses on interchangeability and aggregate benefit of the Performance Unit

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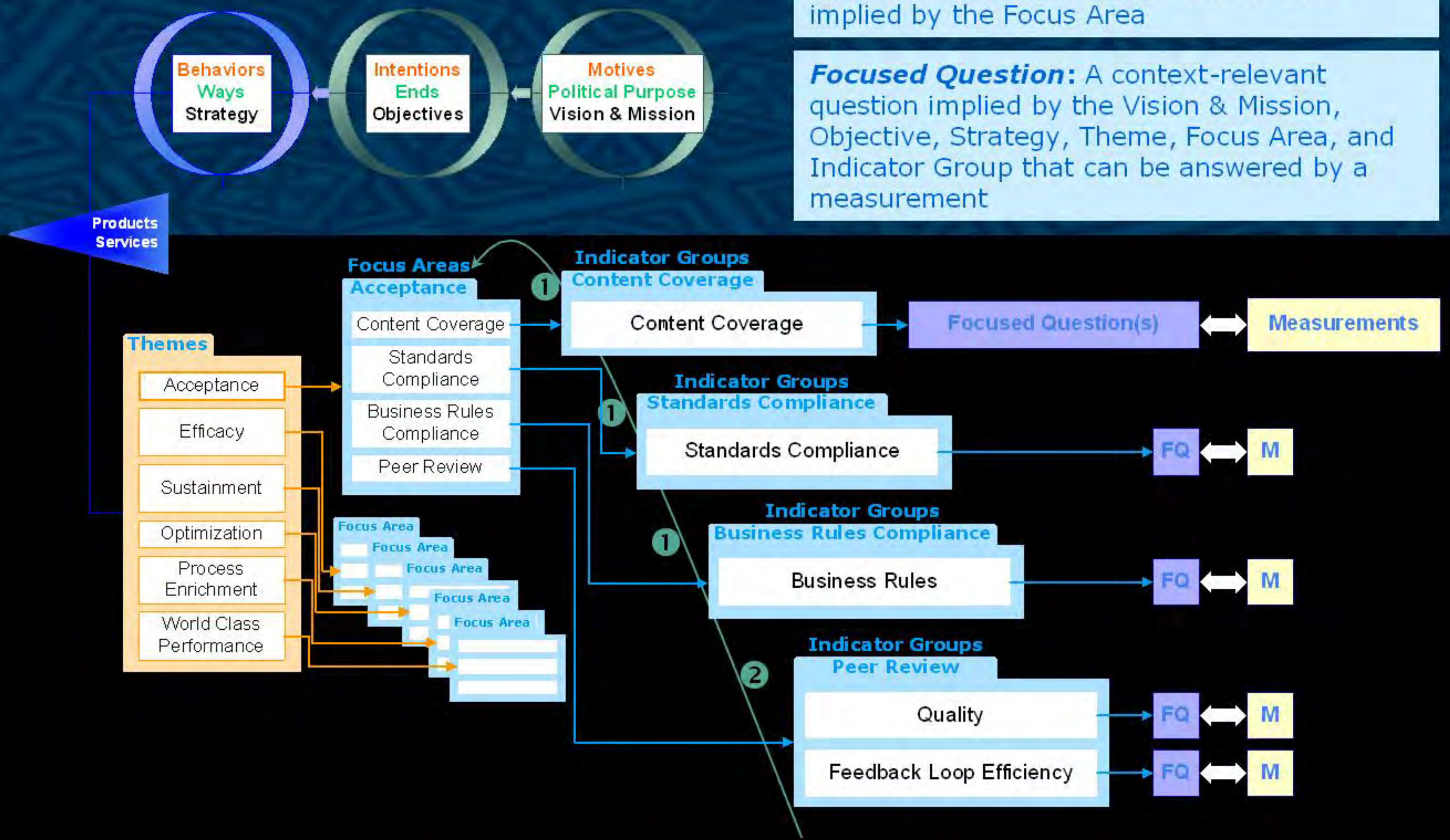
Identifying Measurements of Strategic Performance

Indicator Group: A group of indicators implied by the Focus Area

Focused Question: A context-relevant question implied by the Vision & Mission, Objective, Strategy, Theme, Focus Area, and Indicator Group that can be answered by a measurement



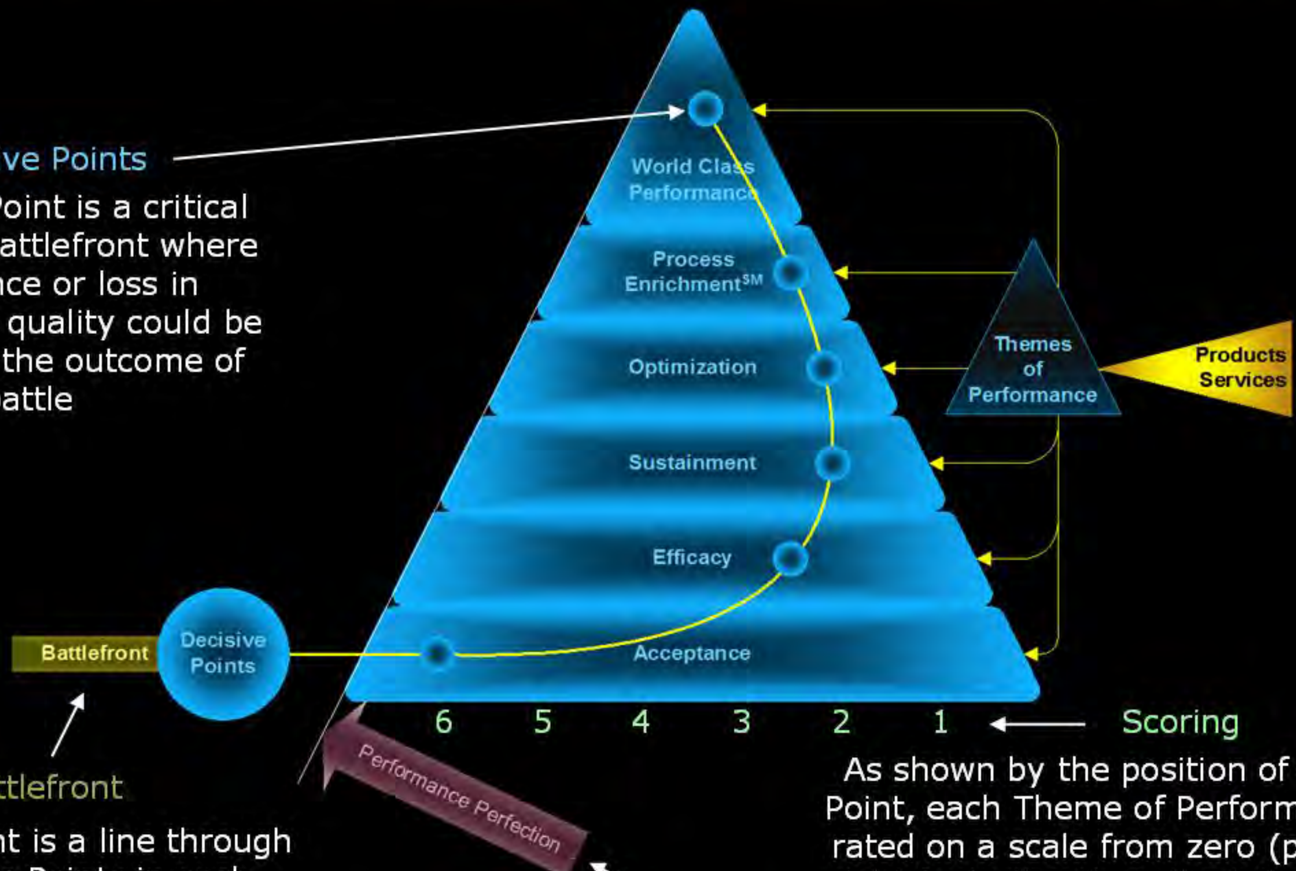
Note: Some Focus Areas have only ❶ Indicator Group, other Focus Areas have up to ❻.

Process Enrichment[SM] Boot Camp

The Art of Process Enrichment in Competitive Warfare

Decisive Points

A Decisive Point is a critical part of the battlefront where an advance or loss in performance quality could be decisive on the outcome of battle



Scoring

As shown by the position of each Decisive Point, each Theme of Performance has been rated on a scale from zero (poorest) on the right & six (best) on the left of the pyramid

Battlefront

The battlefront is a line through the Decisive Points in each Theme of Performance. The battlefront holds the shape of the strategy and it establishes the competitive position

Performance Perfection

Performance Units scoring 6 in all 6 Themes of Performance are considered perfect

Quality Excellence: *Necessary Improvements*

"It is no use saying, 'We are doing our best.' You have got to succeed in doing what is necessary."

-- Winston Churchill

Quality Excellence (Q), as shown, is the highest level of performance quality – represented by the green curve through the decisive points in each Theme of Performance – that a majority of customers in the target market are ready, willing, and able to pay for.

The gap in performance quality rating from Actual Performance (A), as shown in Blue, to the quality excellence rating, should serve as a clear mandate to plan and implement necessary improvements, until the green rating is achieved.

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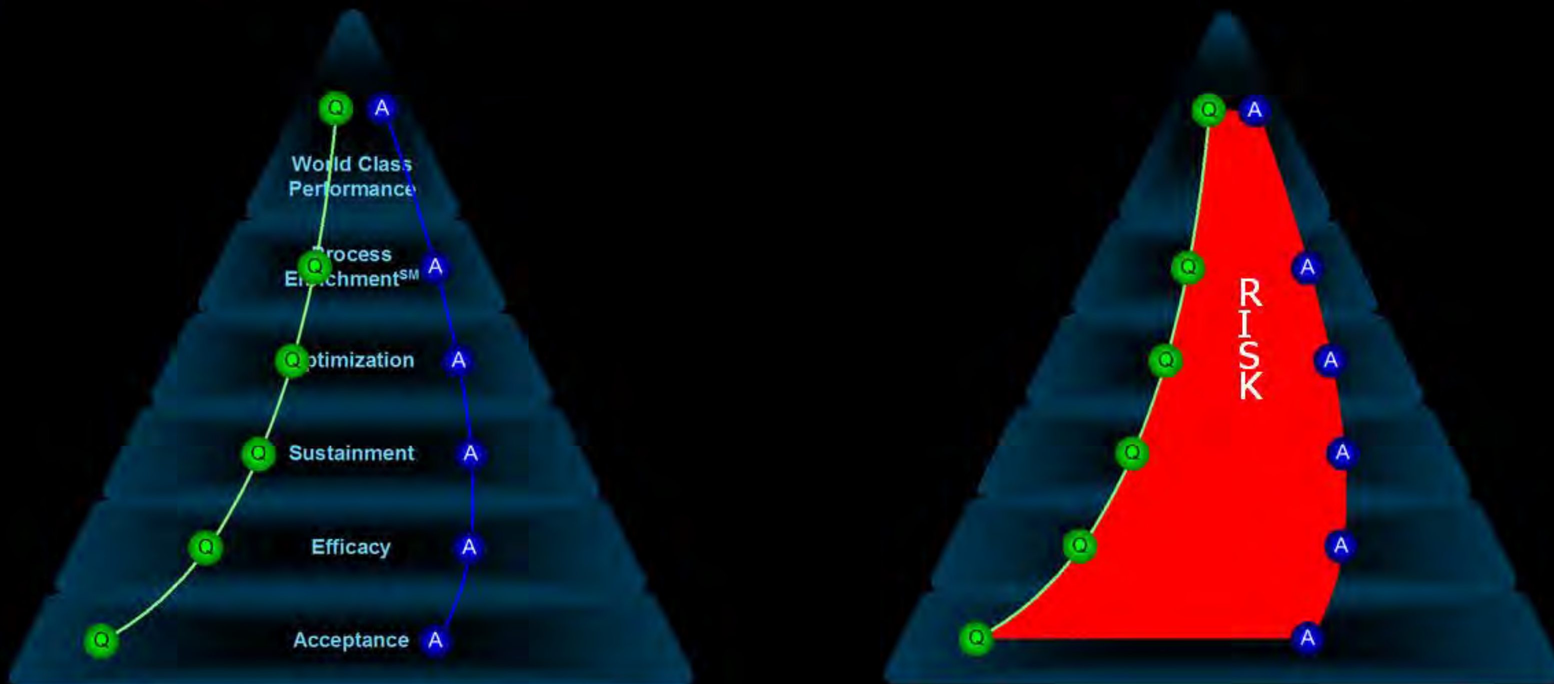
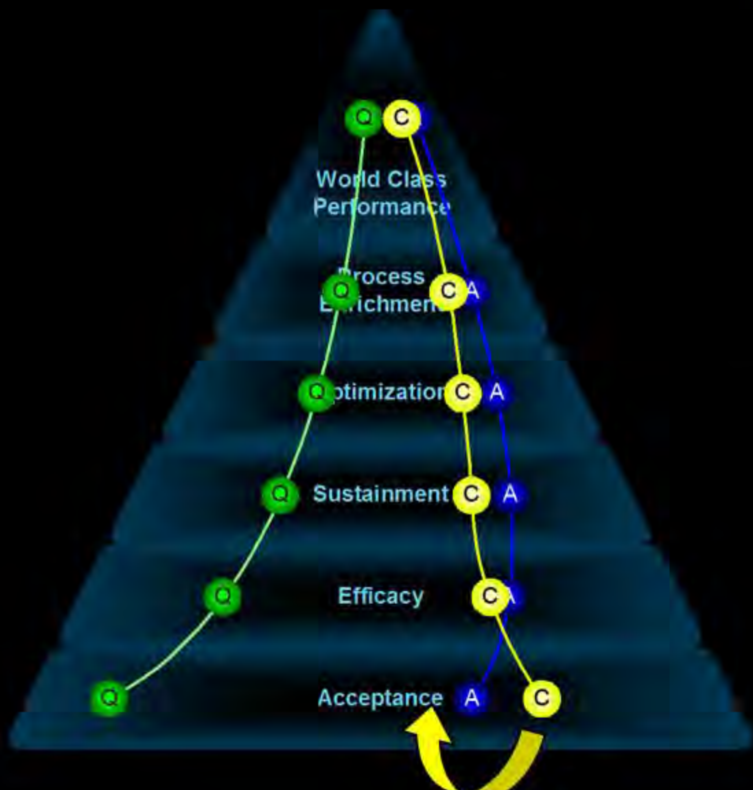
Quality Excellence: *The Risk of Poor Performance*



The deficit in performance quality in the zone between "A" and "Q" represents a competitive risk because it serves as an incentive to new entrants or other competitors who may find this gap in performance (failure to make necessary improvements) a challenge that they can fulfill.

This is the risk of poor performance.

Quality Excellence: *The Consequences of Poor Performance*



Product or Service (A) has 50% of the market share and new, Competing Product or Service (C) has the other 50%.

(A) has lost 50% of its market share to (C) as a **consequence** of the realized risk of poor performance. Poor performance was an incentive for (C) to enter the market.

The cost of quality for (A), so far, has been 50% of their market share.

If (C) improves it's Acceptance Theme performance so it's better than (A), (C) should expect to secure 100% of the market share – putting (A) out of business.*

For (C), if the value of the additional 50% of the market share is greater than the investment to exceed (A)'s performance – they should do it – and they should plan to continue improving up to (Q).

*Assuming equivalent competitive circumstances for decision factors other than performance (i.e. convenience, loyalty, selling to relatives, etc.)

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Quality Excellence: *A New Definition*

"Quality Excellence is the absence of the risk of poor performance in each Theme of Performance"

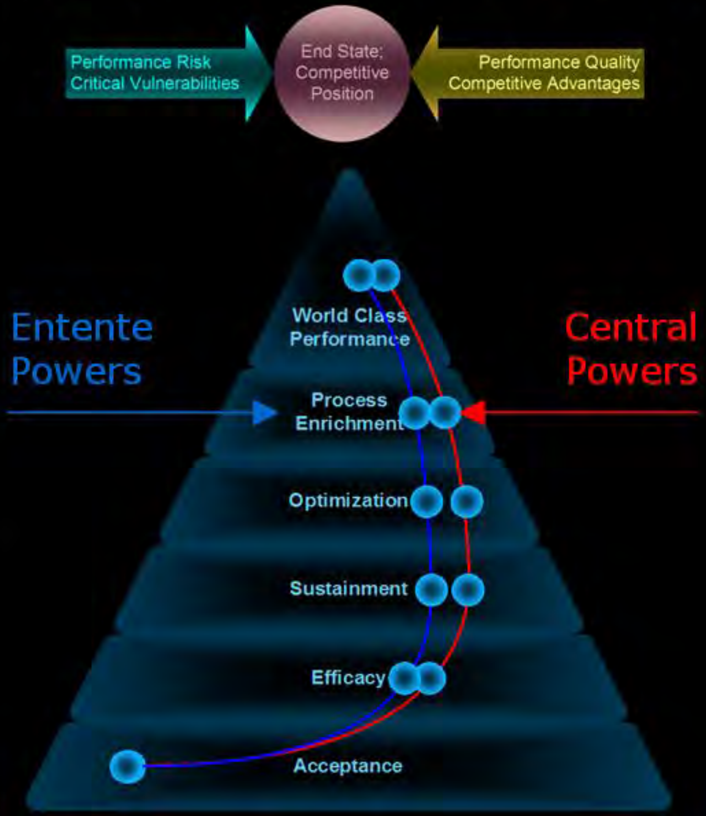
– *Victor Elias*

Case Study

The War To End All Wars (WWI)
Assessing Competitive Position

"There was no other point on any of the war fronts, extending over hundreds of miles, where an equal advance could achieve the same strategic result"

– Winston Churchill



Competitive Advantage:
use excess ships against coastal fortresses; land troops before coast is fortified by the enemy

Critical Vulnerability:
light defenses in the Turkish Dardanelles

A Mutually Destructive Market
Each side became operationally efficient in trench warfare, but the stalemate wouldn't break. Losses on both sides were heavy.

The British Fleet at the Dardanelles

Case Study

The 1967 Six-Day War

Assessing Competitive Position

Israeli Air Force

Refit Cycle Time = 7 ½ Minutes

Yield = 4 sorties/day

Egyptian Air Force

Refit Cycle Time > 2 Hours

Yield = 2 sorties/day

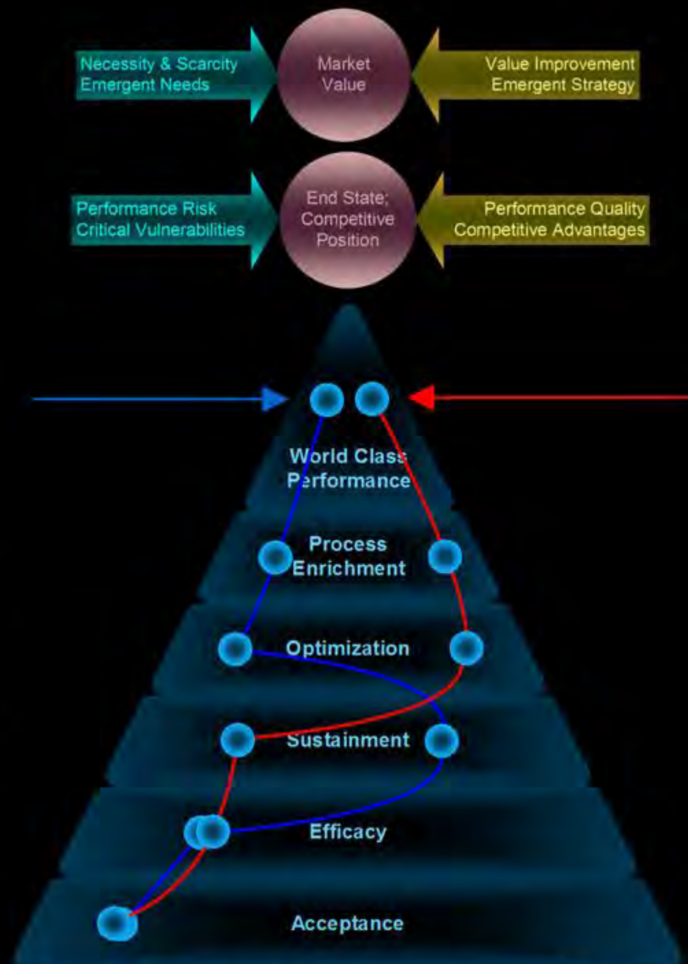
In the first 170 minutes, 300 out of 340 Egyptian aircraft were destroyed.*
By noon of the 2nd day, the Egyptian, Jordanian and Syrian Air Forces, with about 450 aircraft, were destroyed... As were most of the 18 airfields in Egypt. Israel lost 26 aircraft.

* "The Six Day War," Randolph & Winston Churchill, 1967

Case Study

The 1967 Six-Day War

Assessing Market Value



Israeli Air Force Switches Targets

Jordan Attacks

The *value* of Israel's superior strategy in refit cycle time demonstrated a World Class capability to switch targets and meet the emergent need to destroy the Jordanian Air Forces' capability to operate

Defective Strategic Communication

* "The Six Day War," Randolph & Winston Churchill

Process Enrichment℠ Boot Camp

Class of 2008

Congratulations Graduates!

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Mapping Acquisition Requirements from Capabilities in a Net-Centric Enterprise – Creating a Capabilities Engineering Framework

Jack Van Kirk
Ira Monarch

NDIA 11th Annual Systems Engineering Conference 10/20-23

Software System Acquisition Problem Areas

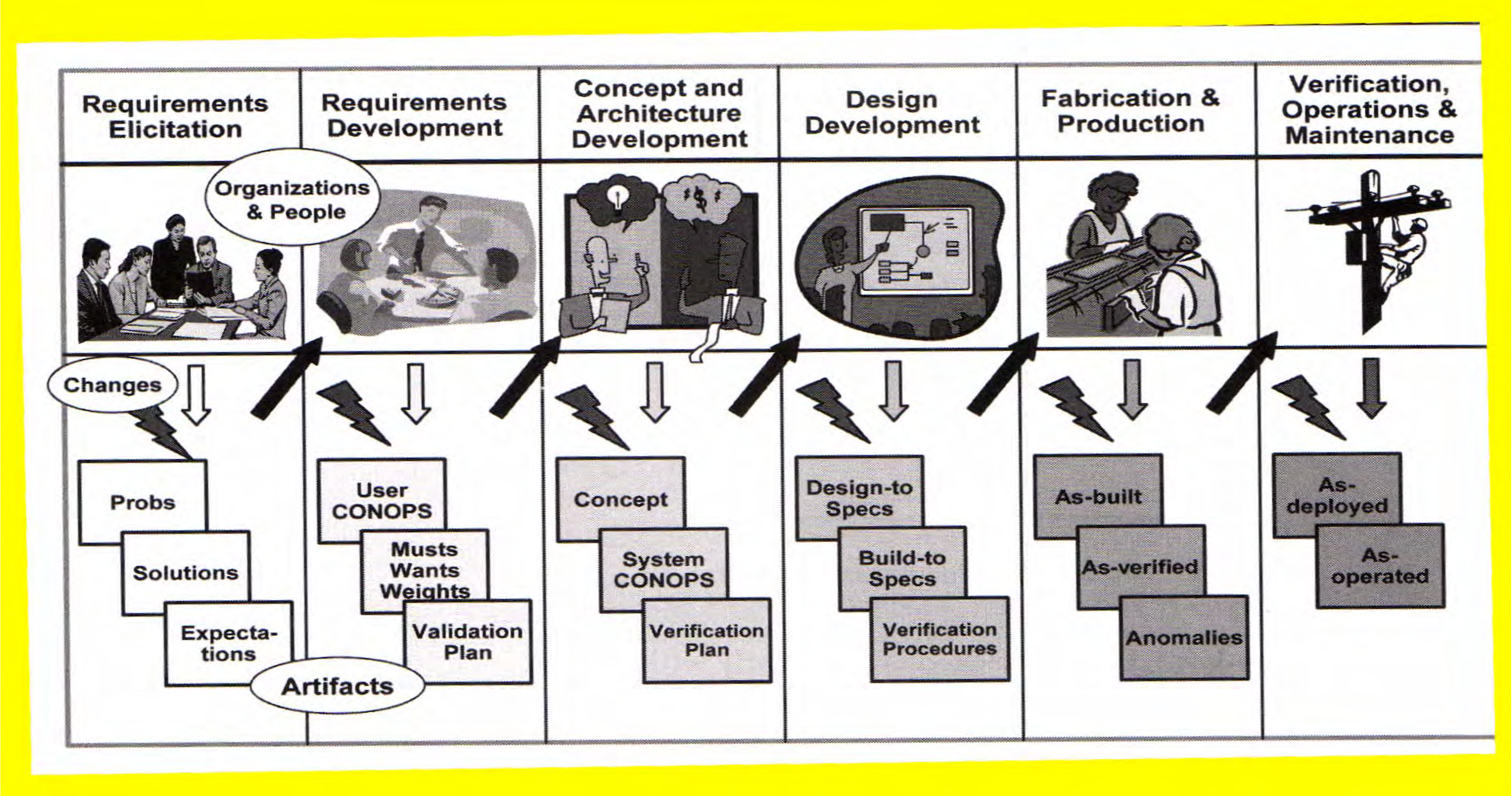
Requirements Always High on the List

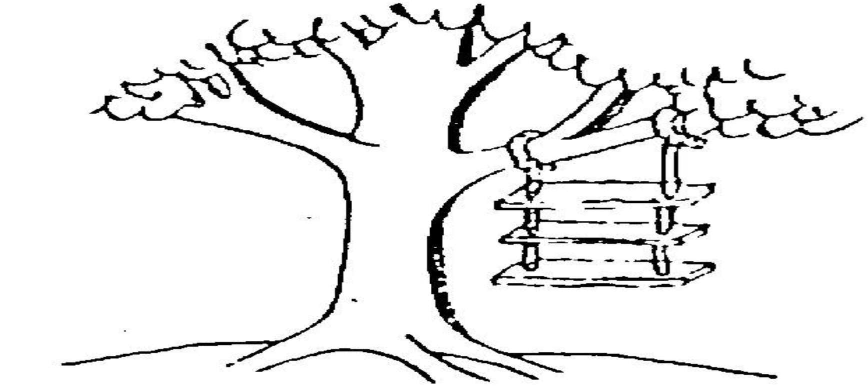
- **ACAT I Acquisition Programs under scrutiny (GAO 04-393) – significant issues published**
- **Boehm : 'Reasons Why Programs Fail' – Inadequate Requirements a major causal factor**
- **Sandish Report and others: Inadequate requirements source of cost and schedule overruns and performance shortfalls**

Little Evidence of Requirements Engineering in place

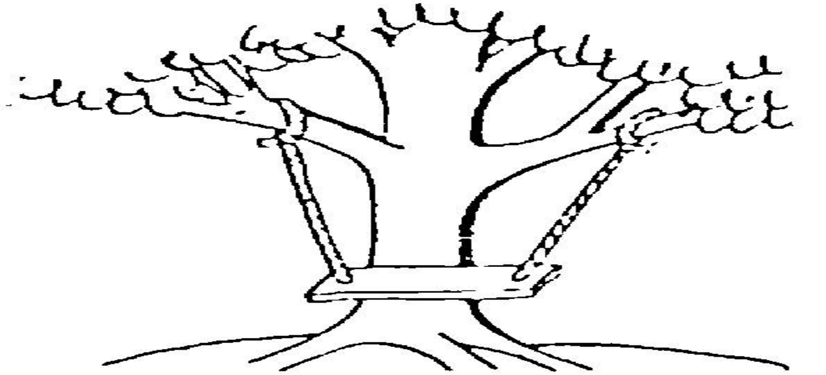
	Project Management Best Practices	Skills Training	Software Architecture	Requirements	Interoperability	Process
DSB 2000 Report	✸	✸	✸	✸		✸
Army Lessons Learned Workshop	✸	✸	✸	✸		✸
FBCB2 Arch. Study			✸	✸		
TAI - Systemic Analysis	✸	✸	✸	✸		✸
SECs' Top-5 Problems	✸	✸	✸	✸	✸	✸
PMO Survey	✸	✸		✸	✸	✸
Emerging Benchmark Results	✸	✸	✸	✸	✸	✸

Classic Requirements Management

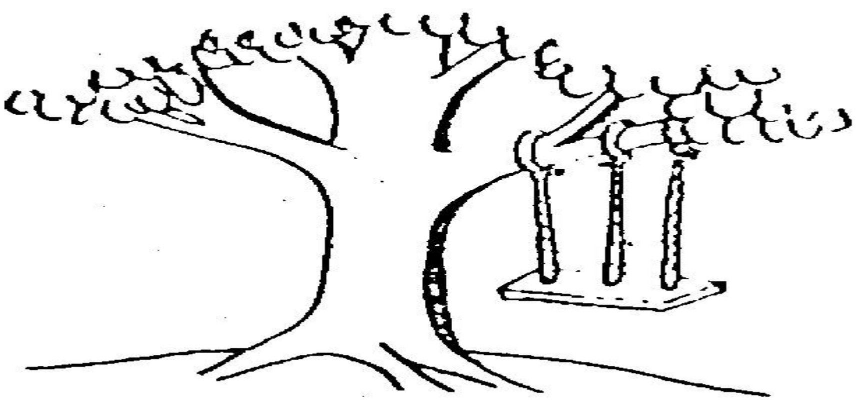




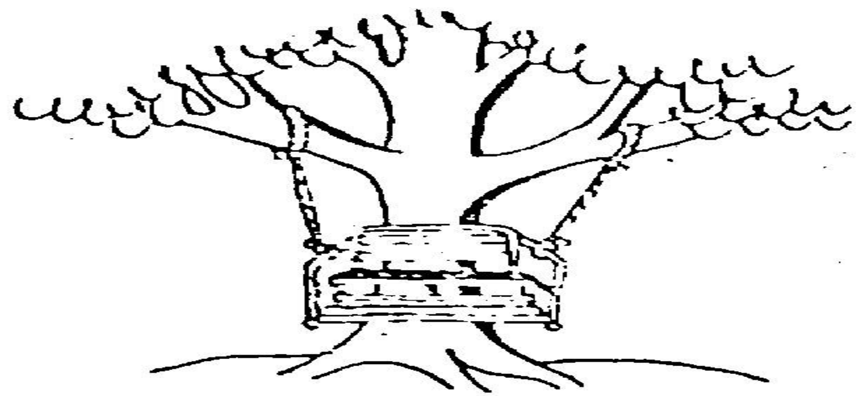
As Operations Requested It



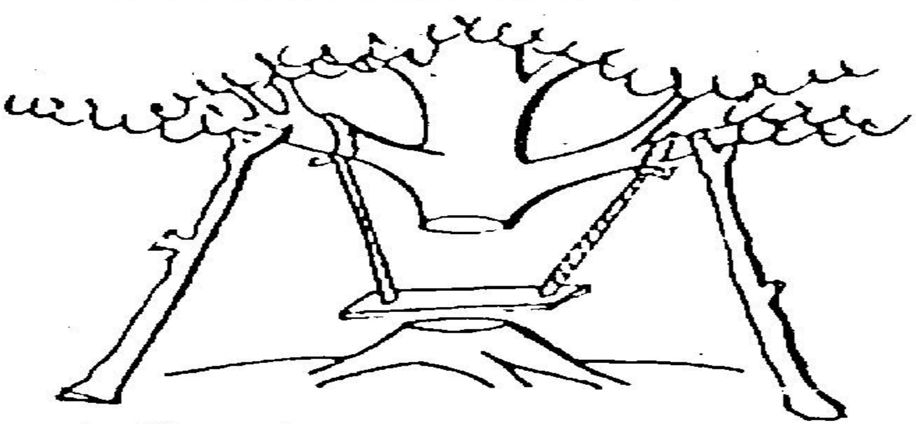
As Engineering Designed It



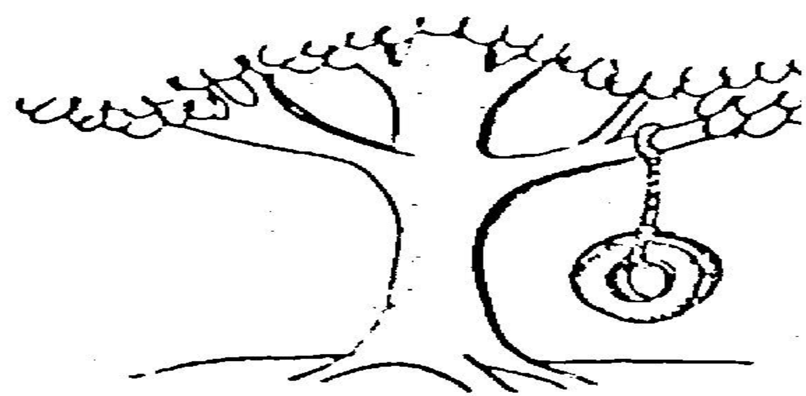
As Procurement Ordered It



As Accounting Paid For It



As Plant Maintenance Installed It



What the Soldier Wanted!

The Capability Turn in Requirements Development: A Domain-Centered Approach

Software quality in digitized systems depends on how well the software represents and is responsive to the domain contexts in which the systems operate.

A capability driven approach* builds on domain centered approaches – capabilities are defined wrt to a context containing multiple domains.

User-driven, domain-driven & capability-driven approaches to software intensive system acquisition all point in a similar direction –

The voice of the customer, in this case the warfighter, must be heard down to the software technologist.

The voice of the software technologist has to be heard by the warfighter

* Capability driven approaches in the military stem from the Joint Capabilities Integration and Development System (JCIDS) created by the Chairman of the Joint Chiefs of Staff (CJCS)

The Capability Turn in Requirements Development: Difficulties

In the US military, capability driven approaches are difficult to implement due to

- the huge numbers of people involved and their very different perspectives (e.g., warfighter vs. bureaucrat vs. technologist)
- the rapidly changing and uniqueness of threats
- the pace of information technology.

From analysis of 10s of 1000s of Problem and Trouble Reports it appears that capability driven approaches are not informing the software as well as they could.

- Software problems are not stated in terms of capabilities being adversely affected
- Software solutions do not refer to how enablement of capabilities can be improved

Overcoming Difficulties for the Capability Turn:
A Framework for Capability Engineering

The aim of Capability Engineering (CE) is to meet the challenges capability & domain driven approaches face.

CE is the mutual formulation of joint capabilities and acquisition requirements for multiple

- platforms
- systems/subsystems that work with or in these platforms.

CE supports traceability and validation of requirements specifications from capabilities

The Capability Engineering Framework (CEF) provides knowledge management support for CE.

The CEF identifies, annotates and organizes exemplary practices.

The Five Dimensions of CEF

The five CEF ***Dimensions*** organize and document support for “good practices” in capability engineering:

1. **Organization** – the infrastructure of virtual organizations, which are multiple organizations using both on-line and face-to-face interaction in an integrated fashion.
2. **Process** – the production of work products and ultimately the product itself, especially to processes that are inter-organizational.
3. **Information – (a) finding patterns of information through text and data mining; (b) structuring information via domain & quality models across stakeholders; and (c) organizing information flow to support building and validating material solutions.**
4. **Evaluation** – assuring quality of both product and process, and especially the tie between the two.
5. **Learning** – the integration of evaluations and other forms of feedback at the enterprise level (both PEO and SoS or FoS) into actionable improvements.

Current CEF work focuses on the **Information** dimension in support of Battle Command (BC) Capability Portfolio Management (CPM).

Information Dimension: Benefits

There are several benefits of capability & domain driven BC software design.

1. Traceability, and therefore validation, of multiple software systems and systems of systems is facilitated.
   - Currently, traceability is missing and validation is reduced to verifying mission threads
   - S &T opportunities are under appreciated because of insufficient mutual understanding between warfighter and software technologist
2. Composing system of systems to enable capabilities that none of the systems alone can enable will be better understood.
   - Current capability documents provide a partial picture of how systems can or should fit together
   - There is no common ground for reasoning about system composition.
3. Capability Portfolio Management across programs in a PEO and across PEOs will be facilitated.

The Information Dimension: Sources

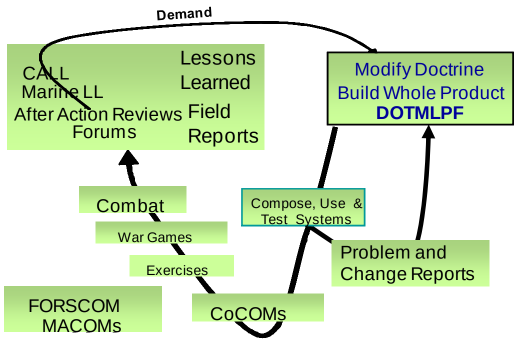
In order to represent the domains guiding capability driven software,

- sources of domain expertise and information have to be tapped
- processes for domain modeling must be established.

In the military, much of the expertise is written down in the form of

=> **1. Joint Capability Areas**

2. Concept Documents
3. Doctrine
4. Capability Documents (ORDs, ONS, ICDs, CDDs, CPDs…)
5. Information Support Plans (ISPs)
6. User Functional Descriptions
7. Problem and Trouble Reports
8. Shortfalls and Warfighter Outcomes
9. Exercise After Action Reviews, Independent Evaluation Results



Joint Capability Area Focus: Battle Command Capability 1

Command & Control

Organize

- Establish & maintain unity of effort w/ mission partners
  - Develop Trust
  - Estab & Cultivate Rel w Msn Partners
  - Estab & Cultivate Rel w Partner Orgs
- Structure organization to mission
  - Define structure
  - Assess Staff Capabilities
  - Delegate Authority
  - Identify Capabilities Needed
  - Integrate Capabilities
  - Estab Commanders' Expectations
- Foster organizational collaboration
  - Estab Collaboration Policies
  - Estab Collaborative Procedures

Understand

- Organize Information
- Develop Knowledge and Situational Awareness
- Share Knowledge and Situational Awareness

Planning

- Analyze problem
  - Analyze Guidance
  - Review Rule Set
  - Review Situation
  - Determine Need for Action
  - Prepare Estimates
- Apply situational understanding
  - Assess Available Capabilities
  - Evaluate Environment
  - Determine Vulnerabilities
  - Determine Opportunities
- Develop strategy
  - Determine Force Readiness
  - Determine Resources
  - Adapt Strategy
  - Align Strategy
  - Develop Assumptions
  - Develop Objectives
  - Determine End State
  - Review Existing Plans
- Develop courses of action
  - Understand Objectives
  - Develop Options
  - Establish Selection Criteria
- Analyze courses of action
  - War game courses of actions
  - Compare courses of actions

Decide

- Manage risk
  - Validate Targets
  - Formulate Crisis Assessment
  - Provide Friendly Force Combat Identification
  - Direct Consequence Management
- Select actions
  - Select course of action
  - Select Plan
  - Terminate
- Establish rule sets
- Establish intent and guidance
  - Establish Priorities
  - Establish Standards
  - Establish Rule Sets
- Intuit
  - Recognize Key Triggers
  - Modify Actions

Direct

- Communicate intent and guidance
  - Issue Estimates
  - Issue Priorities
  - Issue Rule Sets
  - Provide CONOPS
- Task
  - Synchronize Operations
  - Synchronize Execution across Phases
  - Issue Plans
  - Issue Orders
- Establish metrics
  - Establish Performance Measures
  - Establish Effectiveness Measures

Monitor

- Assess compliance with guidance
  - Assess Employment of Forces
  - Assess Manner of Employment
- Assess effects
  - Assess Battle Damage
  - Assess Effects of Deception Plan
  - Assess Munitions Effects
  - Assess Performance
  - Assess Re-Engagement Requirement
  - Assess Operational Effects of Strategic Communications
- Assess achievement of objectives
  - Assess guidance

Joint Capability Area Focus:
Battle Command Capability 2

Battlespace Awareness

Intel, Surveil, & Recon
- ISR Planning & Direction
  - Define & Prioritize Rqmts
  - Develop a Collection Strategy
  - Task & Monitor CPED Resources
  - Evaluation & Feedback
- Collection
  - Signals
  - Imagery
  - Materials
  - Human
  - Open source
  - Direction
- Processing / Exploitation (CNE)
  - Correlate
  - Convert
  - Exploit
- Analysis & Production
  - Intel Prep of Opnl Environment
  - Intel Spt to Situational Understanding
  - Indications & Warnings
  - Intel Spt to Targeting, FP & IO
  - Battle Damage Assessment
  - Science & Technology
  - Counter Intelligence
- ISR Dissemination

Environment
- Collect
- Analyze
- Predict
- Exploit

Net-Centric

Information Transport
- Switching and Routing
- Wireless
- Wired

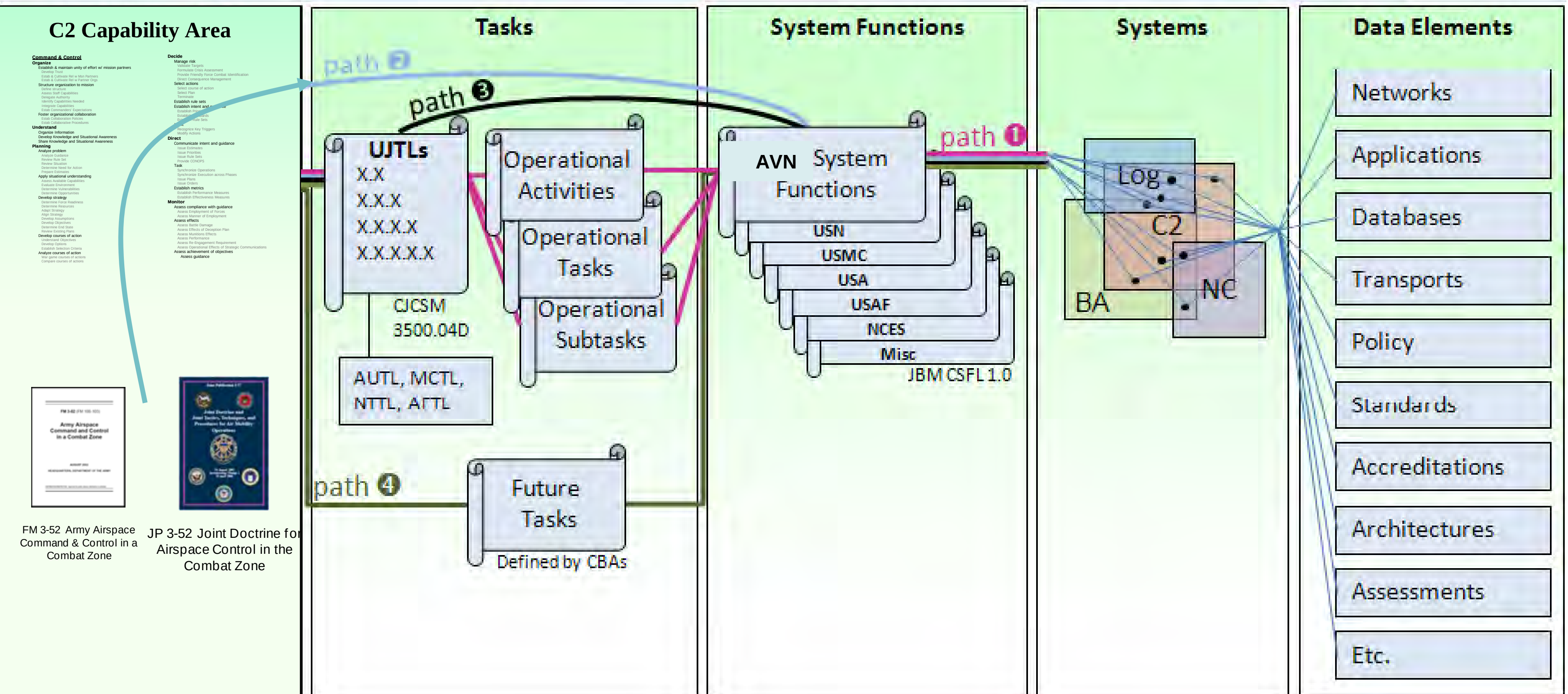
Enterprise Services
- Core Enterprise Services
  - Collaboration
  - Mediation
  - Discovery
  - Messaging
- Information Sharing/Computing
  - Data Storage
  - Data Processing
  - COI Services
- Position Navigation and Timing

Net Management
- Optimized network functions & resources
- Deployable, scalable & modular networks
- Spectrum Management
- Cyber Management

Information Assurance
- Secure Information Exchange
  - Ensure Authorized Access
- Protect Data and Networks
  - Monitor IA Status
  - Track User Actions
  - Prevent Network Attack
  - Protect Data from Modification
- Respond to Attack / Event
  - Detect & Respond to Attacks
  - Detect & Respond to Event

Capability to System Mapping:

Joint Common System Function List (JFCOM- JSIC)



- **Mapping <u>systems</u> to <u>system functions</u> enables traceability to Joint & Army-wide operational capabilities**
- **The Joint Common System Function List (JCSFL) is cumbersome & manually applied by JSFL experts.**
- ***Successful mapping may be facilitated by automated support that could leverage the JCSFL***
- **Engage with PEOs to evaluate current proposed JCSFL mappings & viability of automated support**
- **Proposed manual mappings include AMPS, DCGS, FBCB2, FCS, GCCS, JWARN, Prophet, SaaS, TAIS**

Capability to System Mapping:
Concept Maps & Domain Modeling

Both automated and interactive analyses will be performed on collections of documents chosen from each information source.

Automated content analysis will produce ***concept maps*** of selected information sources.

Concept maps will be ***interpreted and aligned*** to the extent possible.

The aim is to find conceptual links among maps of the information sources that will support ***domain modeling*** of BC contexts.

The BC context currently being investigated is Army Aviation.

The current focus is to align BC enabling systems as specified by PEO Aviation with planning capabilities as specified by TRADOC.

Methodology : Content Analysis & Concept Maps

Semi-automated content analysis uses automated text analysis tools to identify recurring concepts & clusters of concepts:

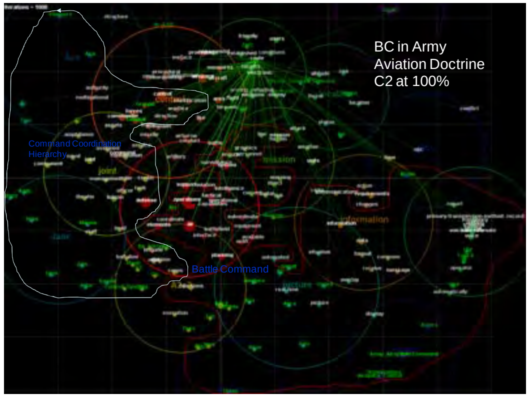
- Concepts are synonyms of strongly related co-occurring terms identified in automatically generated affinity lists
- Concept Clusters are collections of co-occurring concepts
  - more strongly related to each other than to concepts in other clusters
  - named by automatic selection of the concept most strongly related to other concepts in the cluster

Concept Clusters are represented graphically as Venn diagrams.

- concepts labeling dots are in concept clusters represented as circles
- dots can be linked by lines whose brightness represents frequency of co-occurrence
- dots can appear in the overlap of two (or more) circles
- circle size based on distribution of concepts included in the circle (not importance)
  - brightness represents interconnectedness of concepts in the circle

Content Analyses and The Role of Interpretation

Map overlays can delimit groups of concepts from more than one concept cluster according to human interpretation, e.g., BC, BC enablers, helicopters



Interpretation also depends on posing and answering specific questions,

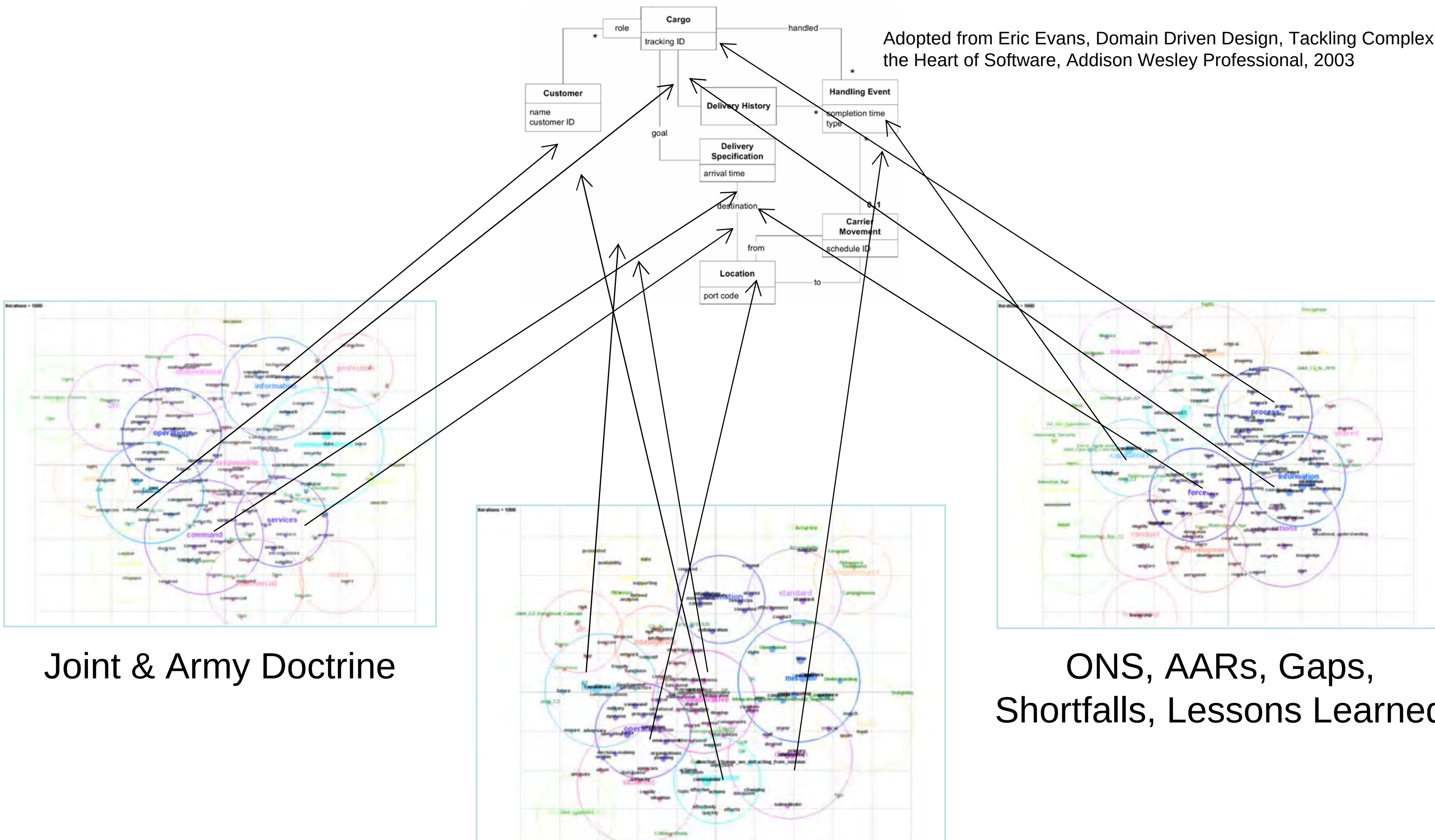
- **Question:** Are there concepts that trace back from documentation of BC software intensive systems to documentation of BC capabilities?
- **Traceability Potential:** **Route** and its role in BC planning is one such concept.

The maps shown require additional interpretation in collaboration with combatants, domain experts, requirements and capability developers and testers.

Aligning Concept Maps: On the Way to Domain Modeling

Shared Kernel (e.g., route)

Adopted from Eric Evans, Domain Driven Design, Tackling Complexity in the Heart of Software, Addison Wesley Professional, 2003



Joint & Army Doctrine

ONS, AARs, Gaps, Shortfalls, Lessons Learned

ORDs, Capability Documents, UFDs & ISPs

Interpreting *Route* in Army Aviation Concept & Doctrine

Operations Concept (2008):

- *Route* plays a role in BC capabilities enabled by software intensive systems and is used in Army Aviation operations
- More specifically, *route* is used in C2 planning and to a lesser extent in other BC activities and BC enabling systems
- Though several specific helicopters are mentioned, *route* links to two – AH-64D & ARH-70

Operations Doctrine (2008 draft 2007):

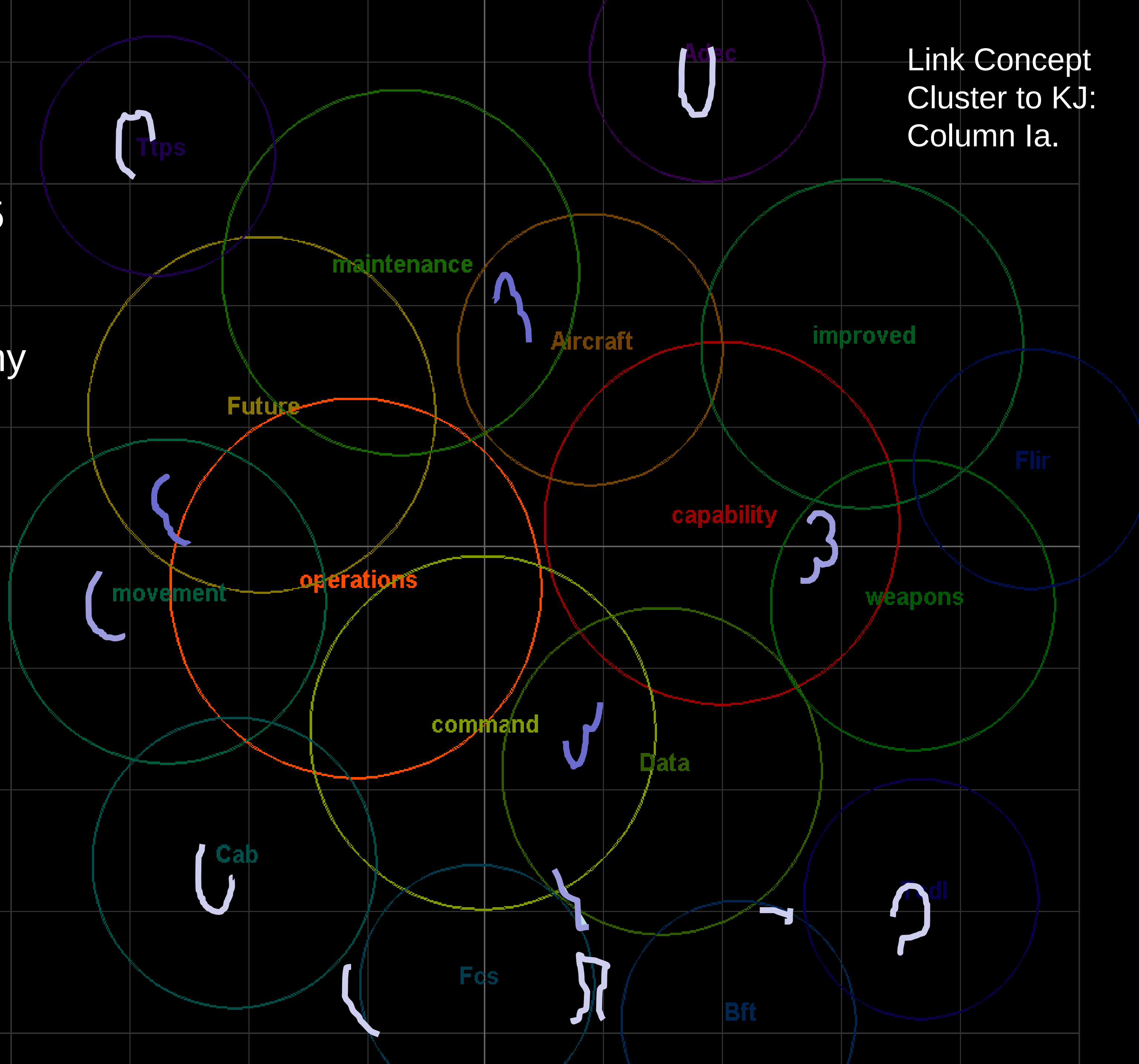
- *Route* plays a role in an Aircraft's flight & C2 operations, and also wrt planning
- *Route* & planning link to BC concepts but are somewhat separated from BC discussion
- *Route* links to discussion of specific helicopters – not the specific aircraft but concepts discussed with these, e.g., radar, infrared systems & visualizing

ons = 1000

TP 525-7.15 (Concept Capability Plan for Army Aviation Operations 2015-2024):

Concept Clusters

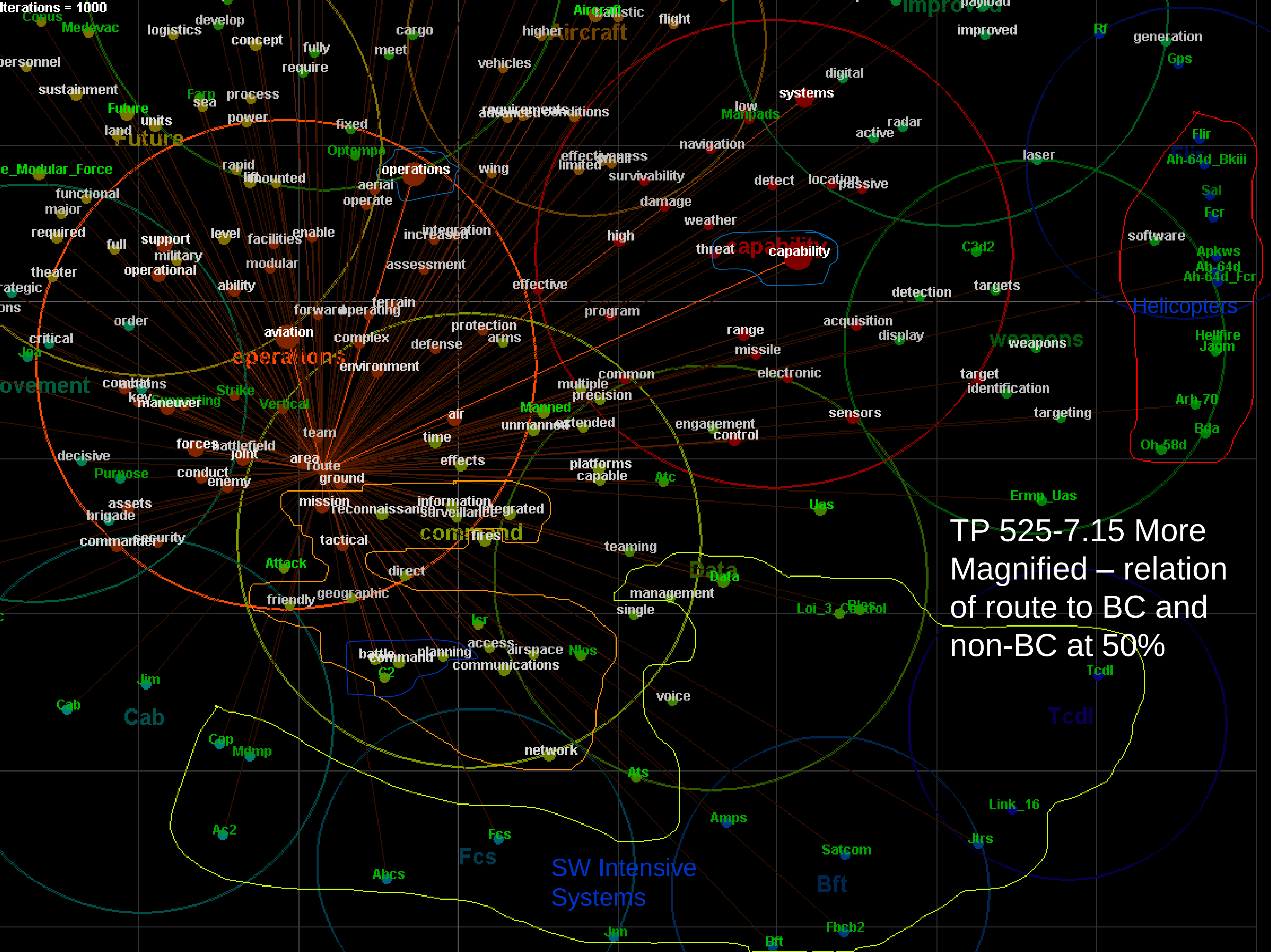
Link Concept Cluster to KJ: Column Ia.



Core

Near Core

Peripheral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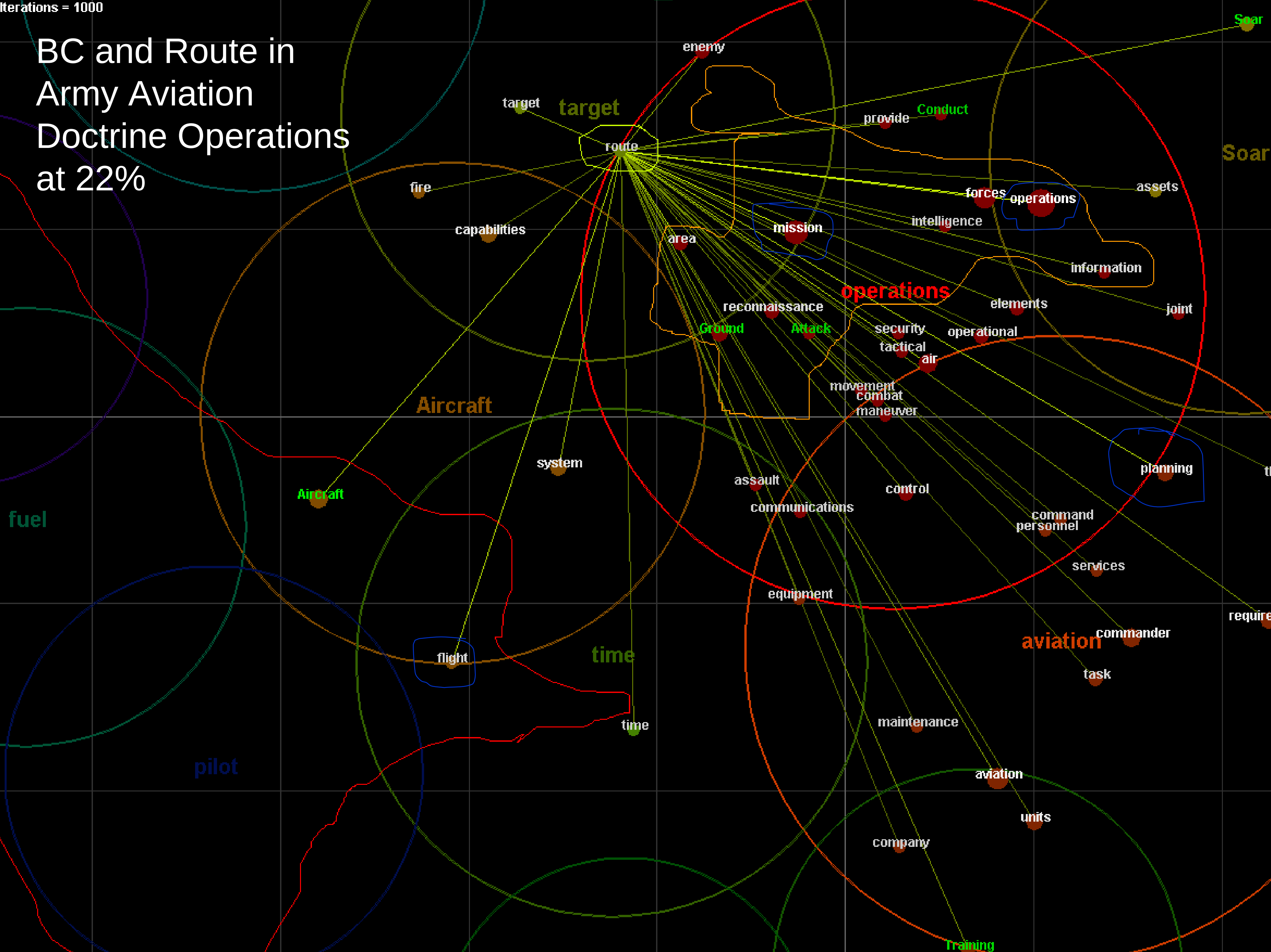
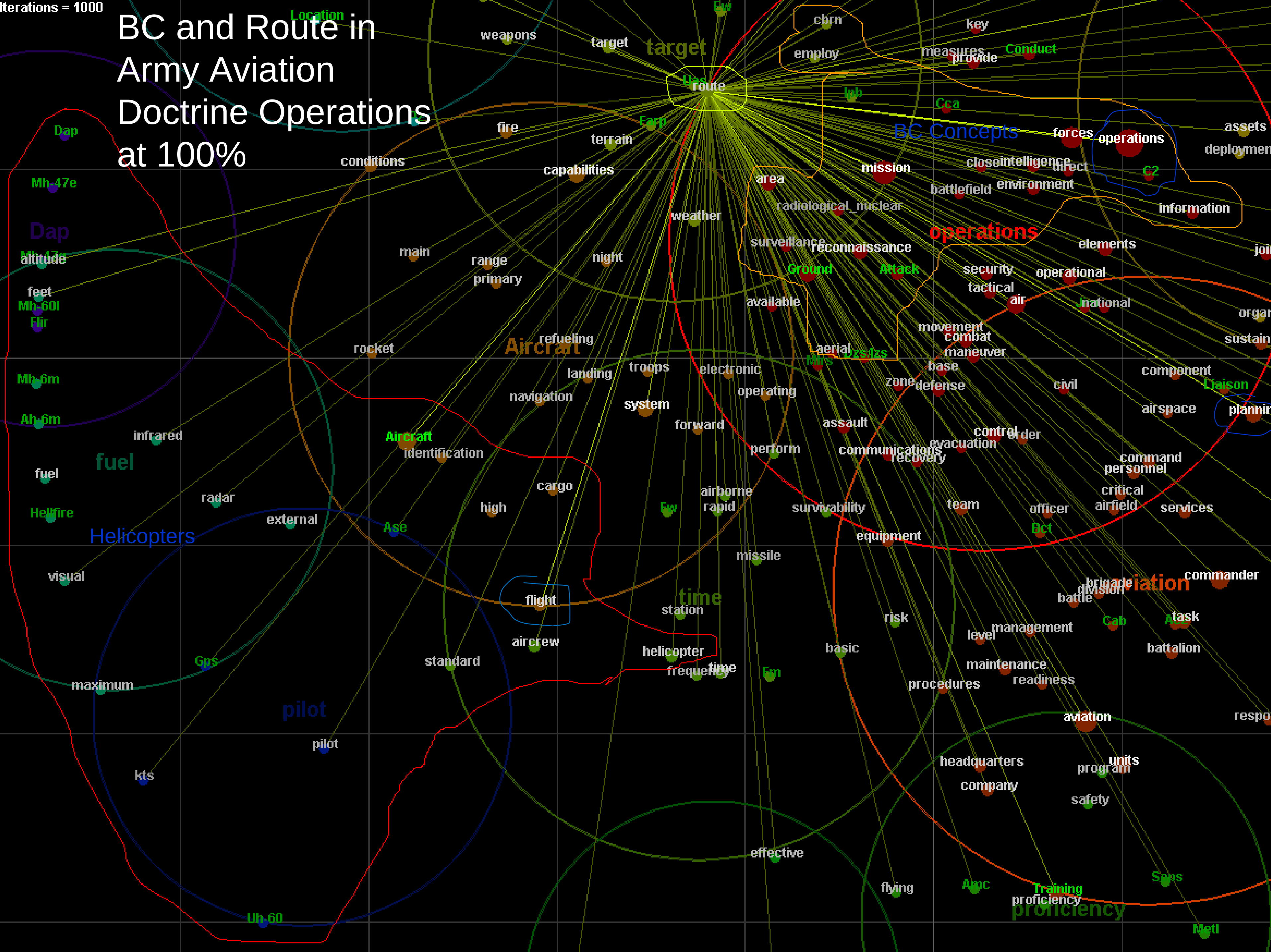
TP 525-7.15 More Magnified – relation of route to BC and non-BC at 50%
operations
capability
command
Future
Aircraft
Improved
Helicopters
weapons
Data
Tcdl
Cab
Fcs
Bft
SW Intensive Systems
develop
logistics
concept
cargo
meet
fully
require
flight
higher
vehicles
improved
generation
Gps
Rf
payload
personnel
sustainment
process
power
fixed
units
land
digital
systems
low
Manpads
radar
active
navigation
Optempo
Flir
Ah-64d_Bkiii
Sal
Fcr
laser
wing
rapid
operations
aerial
operate
survivability
damage
detect
location
passive
weather
functional
major
required
full
support
military
level
facilities
enable
integration
increased
high
threat
capability
software
Apkws
Ah-64d
Ah-64d_Fcr
C3d2
theater
operational
modular
assessment
effective
detection
targets
order
critical
terrain
aviation
complex
defense
protection
arms
program
range
missile
acquisition
display
weapons
Hellfire
Jagm
environment
common
multiple
precision
electronic
target
identification
Arh_70
key
maneuver
Strike
Vertical
Manned
air
unmanned
extended
engagement
control
sensors
targeting
Bda
Oh-58d
team
time
decisive
forces
battlefield
joint
area
route
effects
ground
platforms
capable
Atc
Ermp_Uas
Purpose
conduct
enemy
mission
reconnaissance
information
surveillance
integrated
Uas
assets
brigade
commander
security
tactical
fires
teaming
Attack
direct
Data
management
single
Loi_3_Control
friendly
geographic
Isr
battle
command
planning
access
airspace
Nlos
communications
C2
voice
Tcdl
Jim
Cab
Cop
Mcmp
network
Ats
Link_16
Ac2
Amps
Jtrs
Fcs
Satcom
Abcs
Jnn
Bft
Fbcb2

BC and Route in Army Aviation Doctrine Operations at 22%




Iterations = 1000
BC and Route in Army Aviation Doctrine Operations at 100%
Location
weapons
target
target
Uas
route
chrn
employ
key
measures
provide
Conduct
Inb
Cca
BC Concepts
forces
operations
assets
deployment
C2
Farp
fire
terrain
conditions
capabilities
mission
area
closeintelligence
direct
battlefield
environment
information
Dap
Mh-47e
Dap
altitude
feet
Mh-60l
Flir
weather
radiological_nuclear
operations
surveillance
reconnaissance
elements
main
range
primary
night
Ground
Attack
security
operational
tactical
air
national
available
movement
combat
maneuver
organ
sustain
rocket
refueling
Aircraft
aerial
base
zone
defense
civil
component
Liaison
airspace
planning
Mh-6m
Ah-6m
landing
navigation
troops
electronic
operating
system
forward
assault
control
order
infrared
fuel
fuel
Aircraft
identification
perform
communications
evacuation
recovery
command
personnel
radar
cargo
high
airborne
rapid
survivability
team
officer
critical
airfield
services
Hellfire
external
Ase
Fw
Bct
equipment
Helicopters
missile
visual
flight
time
station
risk
brigade
division
battle
aviation
commander
Cab
task
aircrew
helicopter
level
management
battalion
standard
basic
frequency
time
maintenance
readiness
Gps
procedures
maximum
aviation
pilot
pilot
headquarters
program
units
company
safety
kts
effective
flying
Amc
Training
proficiency
proficiency
Sops
Uh-60
Metl

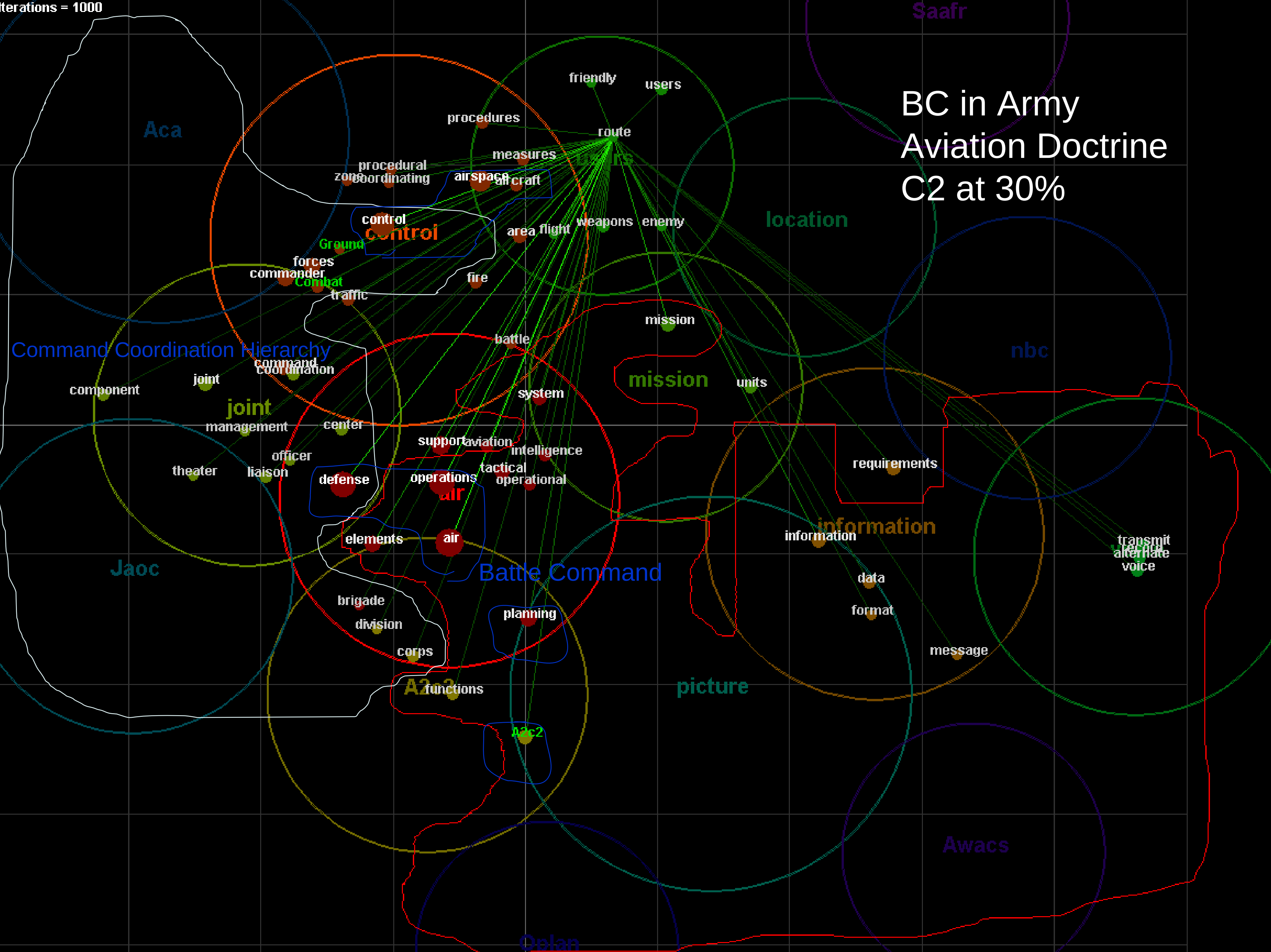
Interpreting *Route* in Army Aviation C2 Doctrine and Planning System DFD

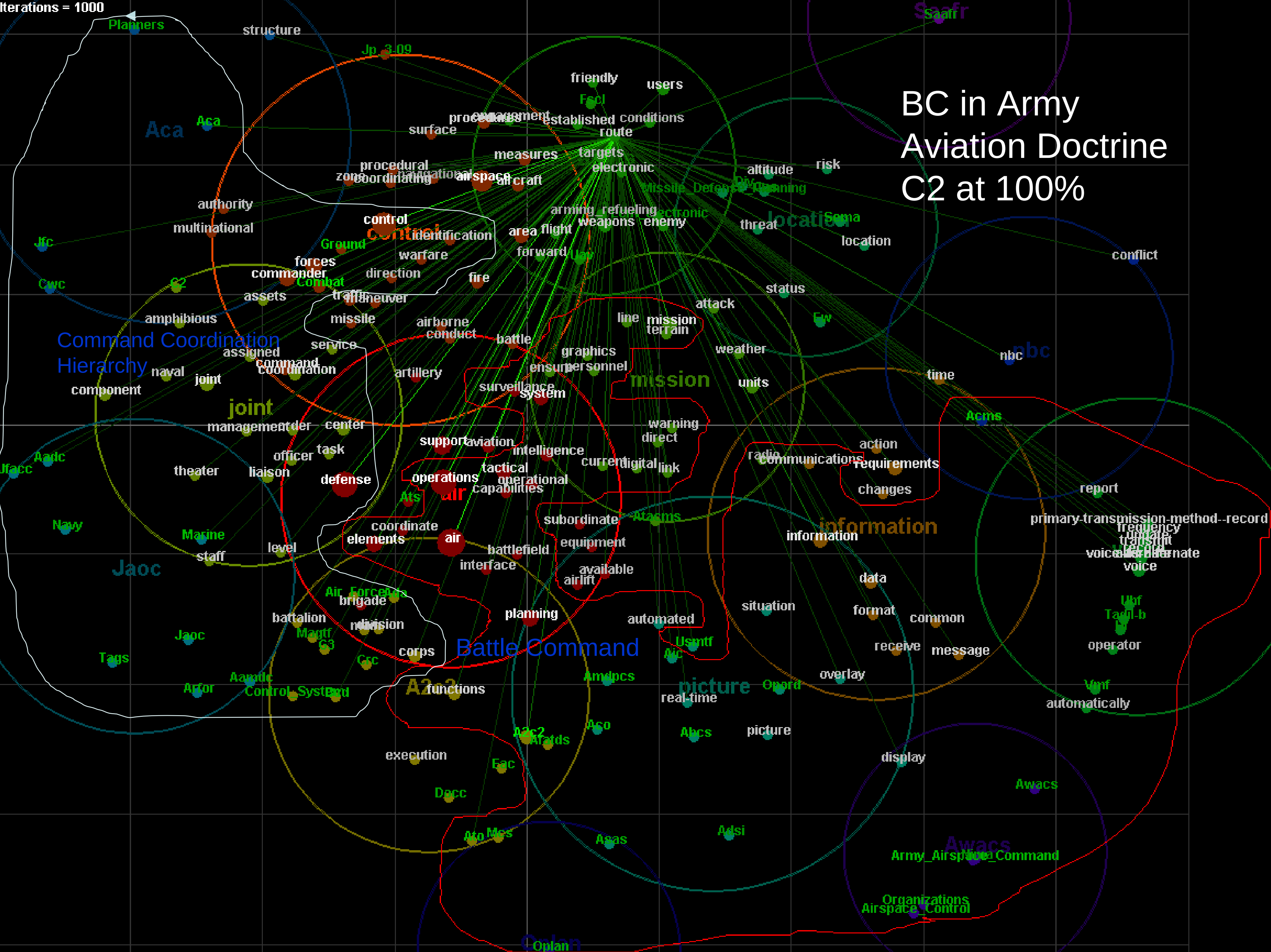
C2 Doctrine (2002):

- *Route* plays a role in air defense operations & control of the aircraft in airspace
- It is used in planning and A2C2 and to a lesser extent in the command coordination hierarchy
- Planning is within the BC overlay that includes concepts of BC & its enablers
- No mention of specific helicopters

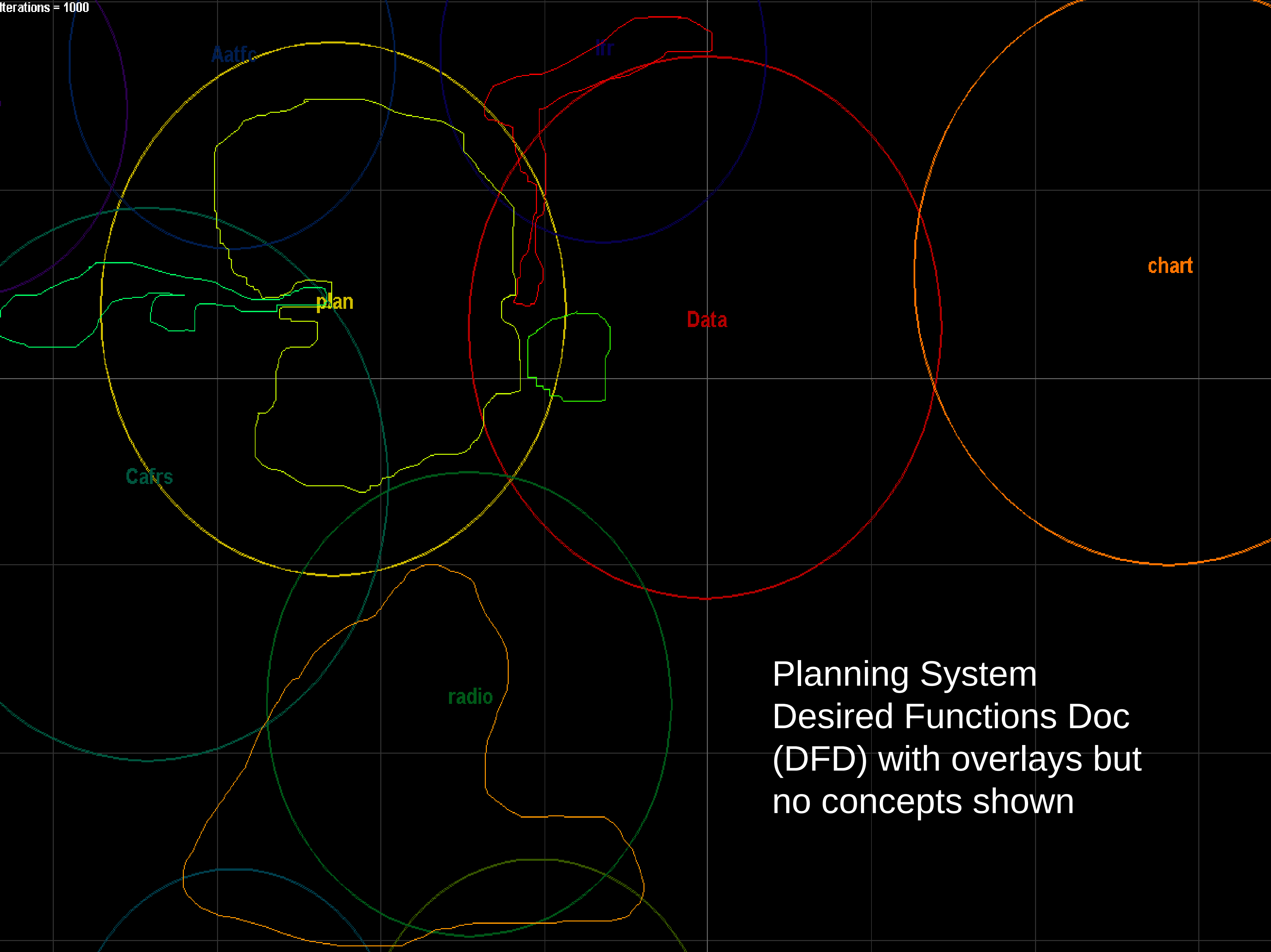
Planning System Desired Functions Document (2007)

- The focus is on *route's* role in planning capability & the aircraft's flight/mission
- Also in focus are information systems as capability enablers and Data as rendered in charts
- The overlay of BC concepts is contained in the Plan concept cluster, as is route
- Closely related overlays specifically refer to BC enabling (BCE) software intensive systems & helicopters

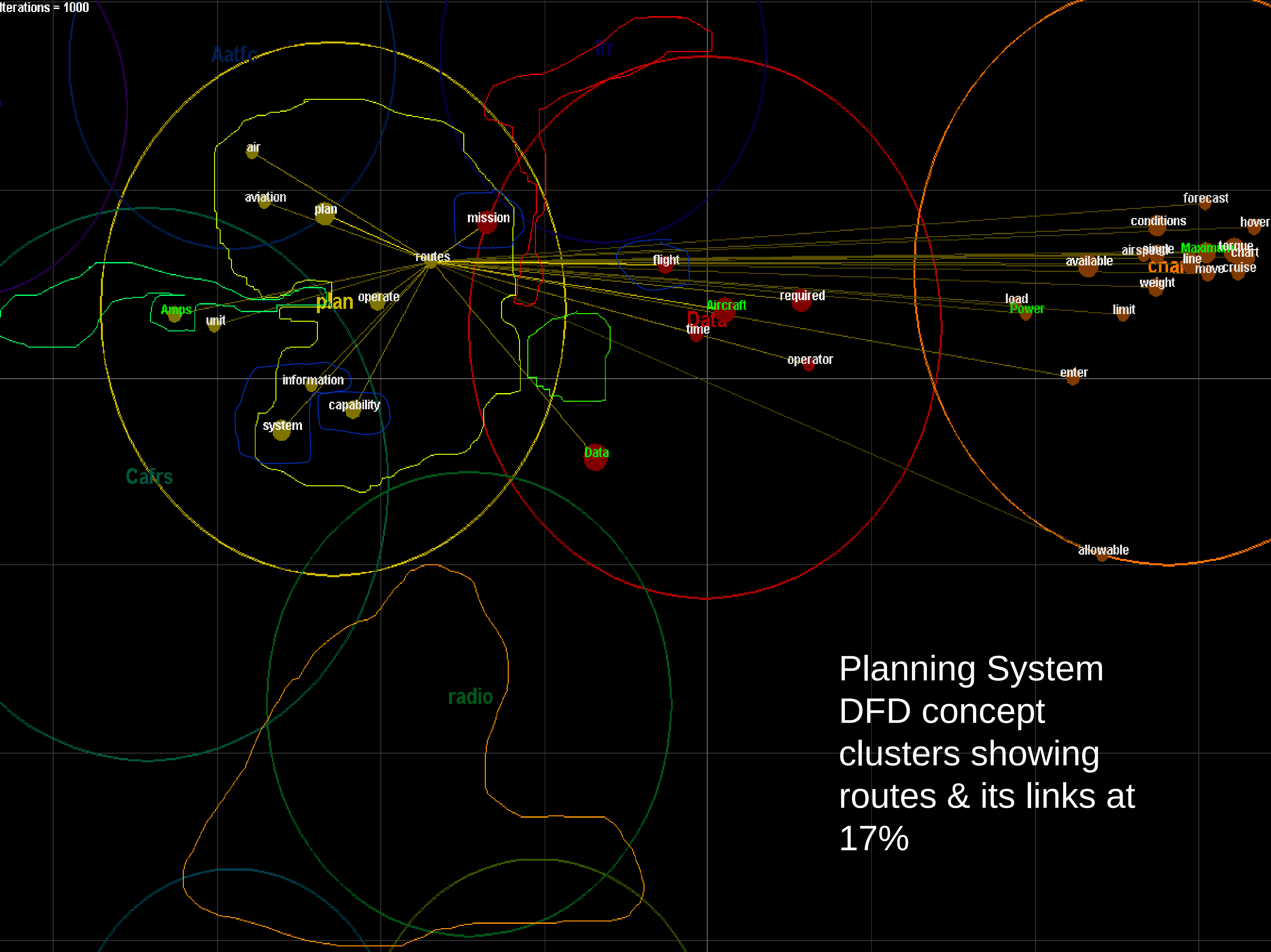

Iterations = 1000
BC in Army Aviation Doctrine C2 at 30%
Saafr
Aca
friendly
users
route
procedures
measures
procedural
zone
coordinating
airspace
aircraft
control
control
Ground
area
flight
weapons
enemy
location
forces
commander
Combat
traffic
fire
mission
battle
mission
units
nbc
Command Coordination Hierarchy
command
coordination
joint
component
joint
management
center
system
support
aviation
intelligence
officer
theater
liaison
defense
operations
tactical
operational
air
requirements
information
information
transmit
alternate
voice
elements
air
Battle Command
Jaoc
data
brigade
division
planning
format
corps
message
A2c2
functions
picture
A2c2
Awacs
Oplan



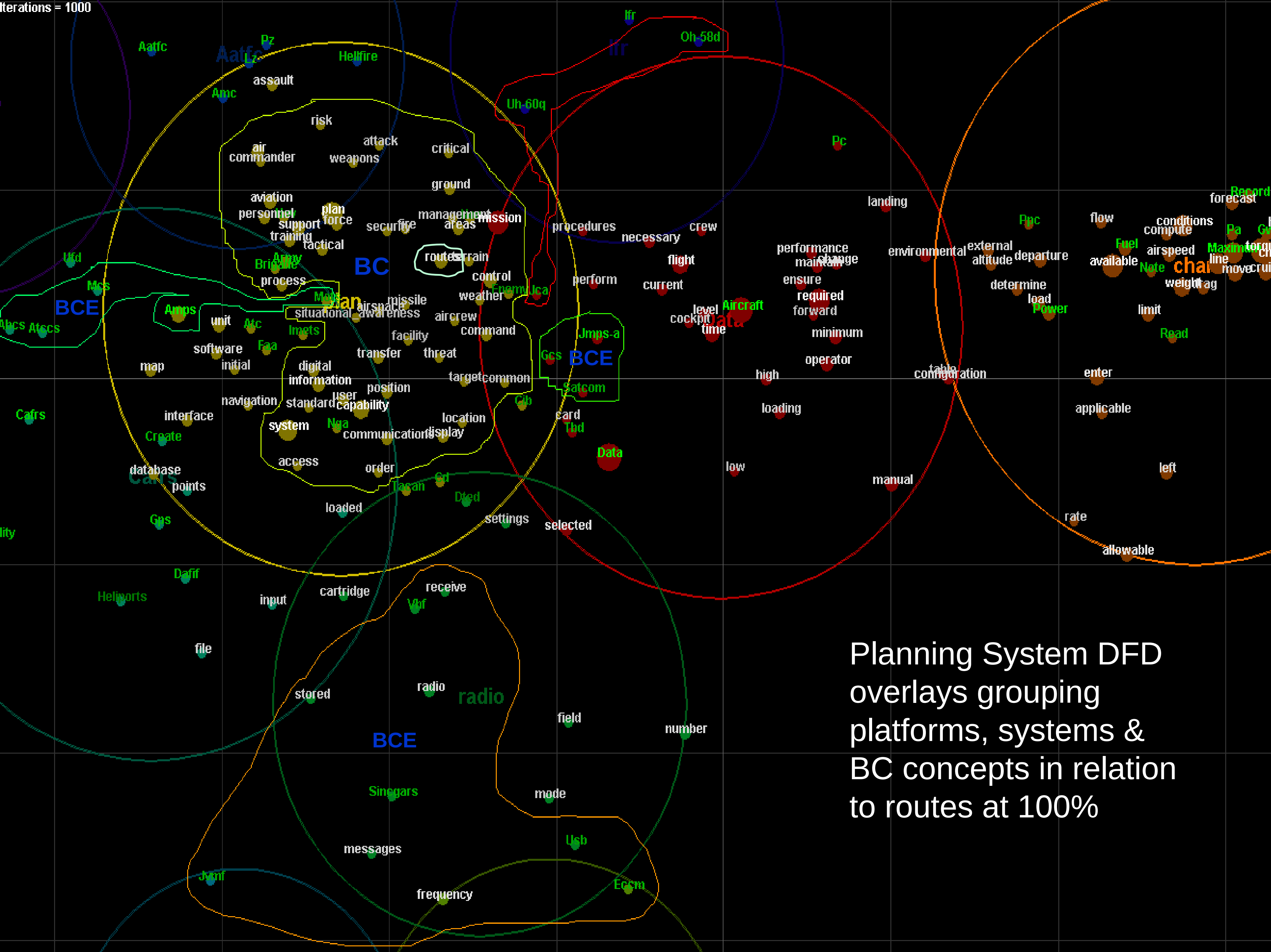
Iterations = 1000
BC in Army
Aviation Doctrine
C2 at 100%
Command Coordination
Hierarchy
Battle Command
Aca
joint
Jaoc
control
air
mission
information
picture
nbc
A2c2
Awacs
Oplan
Planners
structure
Jp_3-09
friendly
users
Fscl
established
conditions
route
surface
measures
targets
electronic
procedural
coordinating
airspace
aircraft
authority
multinational
Jfc
Cwc
C2
forces
commander
Combat
Ground
identification
warfare
direction
fire
assets
maneuver
missile
airborne
conduct
battle
amphibious
assigned
service
command
coordination
naval
joint
component
artillery
graphics
personnel
surveillance
system
line
mission
terrain
attack
status
weather
units
altitude
risk
threat
location
conflict
time
Acms
warning
direct
center
task
officer
theater
liaison
defense
support
aviation
intelligence
current
digital
link
tactical
operations
operational
capabilities
Ats
coordinate
elements
battlefield
interface
subordinate
equipment
available
airlift
Atacms
radio
communications
action
requirements
changes
report
primary-transmission-method--record
voice
Aadc
Jfacc
Navy
Marine
staff
level
Air_Force
brigade
battalion
division
Magtf
G3
corps
Jaoc
Tags
Arfor
Aamdc
Control_System
Crc
functions
planning
automated
Usmtf
Aic
Amdpcs
real-time
Opord
situation
data
format
common
receive
message
overlay
operator
Vmf
automatically
Ubf
Tadil-b
execution
A2c2
Aatds
Aco
Abcs
picture
display
Awacs
Fac
Dccc
Ato
Mcs
Asas
Adsi
Army_Airspace_Command
Organizations
Airspace_Control
Saafr



Planning System Desired Functions Doc (DFD) with overlays but no concepts shown



Planning System DFD concept clusters showing routes & its links at 17%



Planning System DFD overlays grouping platforms, systems & BC concepts in relation to routes at 100%

Analysis of Army Aviation BC Documentation:
Planning System STRs

Planning System Development STRs (2008):

•*Route* is thematic and consists of points created by a user in dialog with the software modules SAGE & AWE manipulating messages & files

•*Routes* are imported from files, created, selected and displayed

•Data changes and changing values occur and are linked to *route*

•All the above are implicated in errors

Planning System Post-Development STRs (2008):

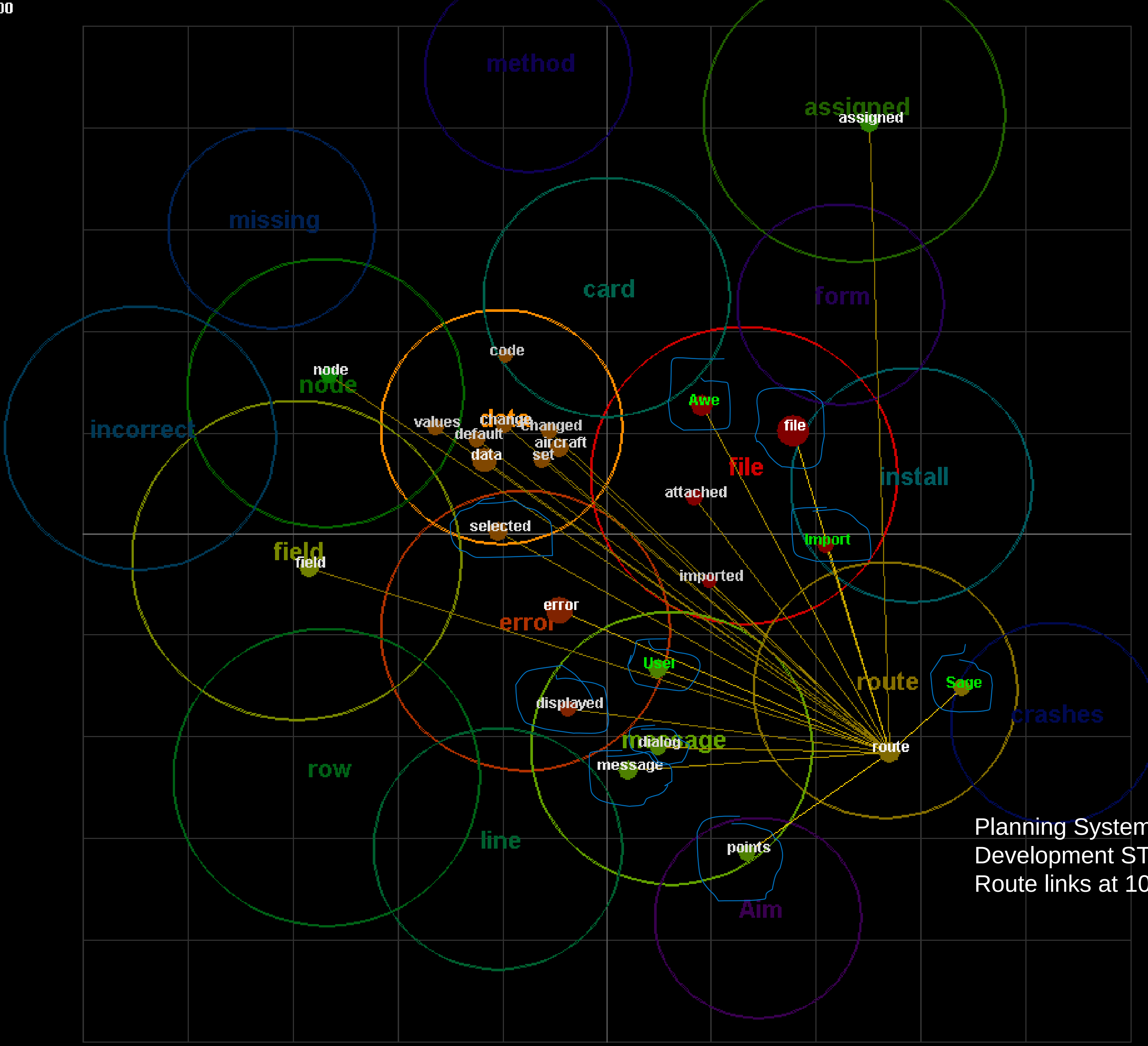
•*Route* consists of points graphically displayed in dialog with SAGE, though change is associated with *route* not data

•Graphics and dialog are now thematic

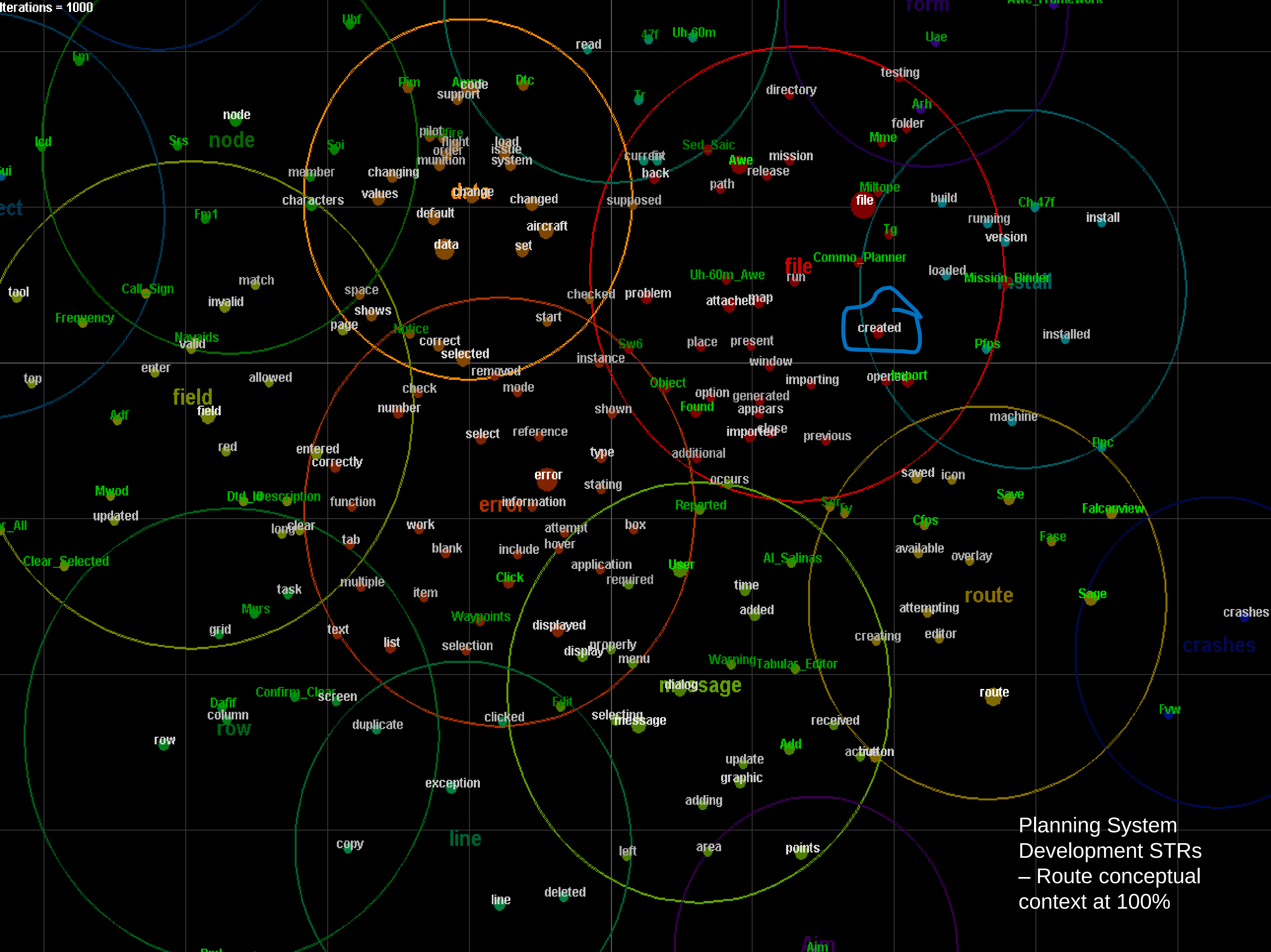
•File, message and user are most associated with error.

•Imported waypoints are now closely associated with *route* as is Mission Planning

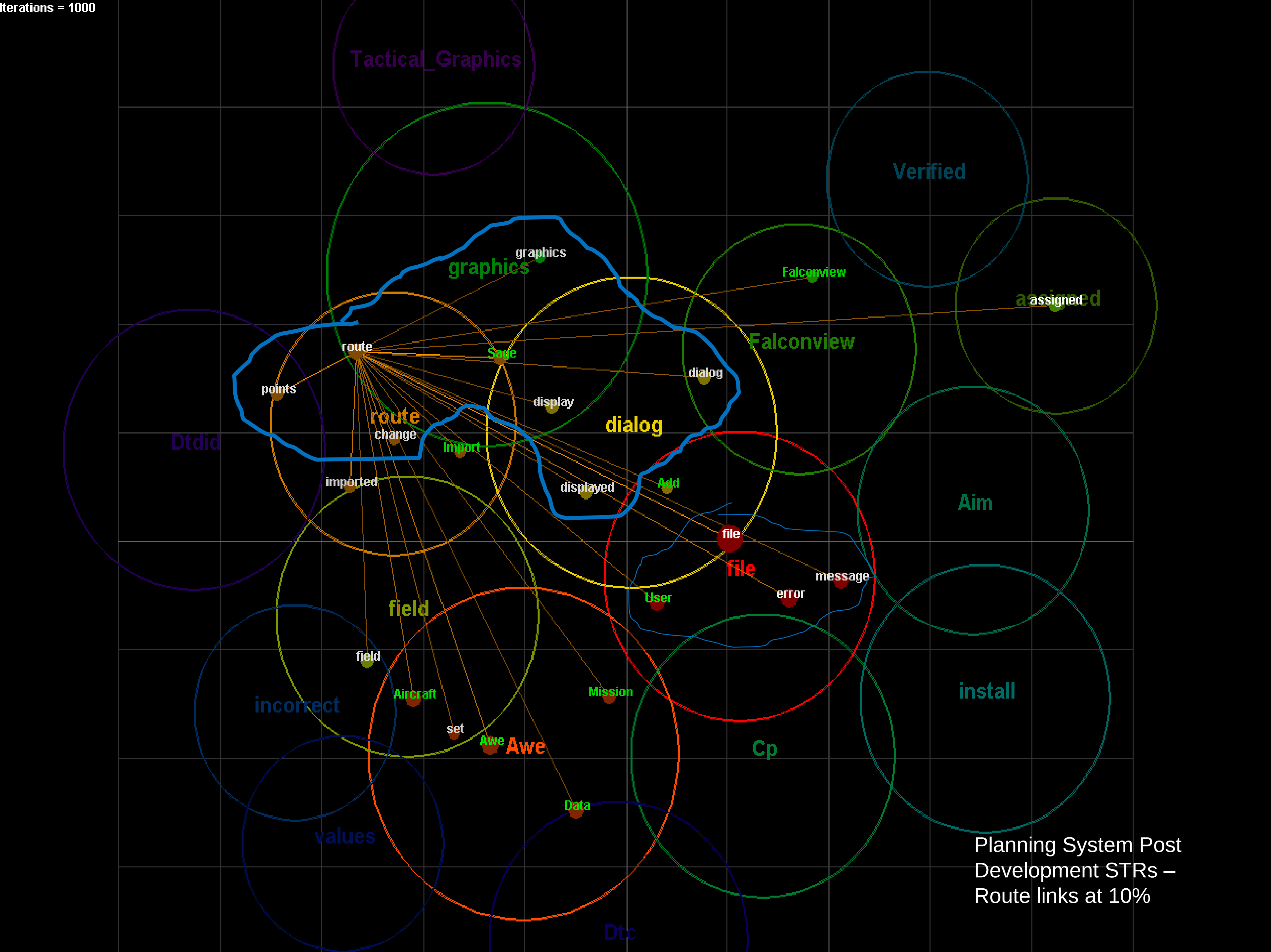
Iterations = 1000



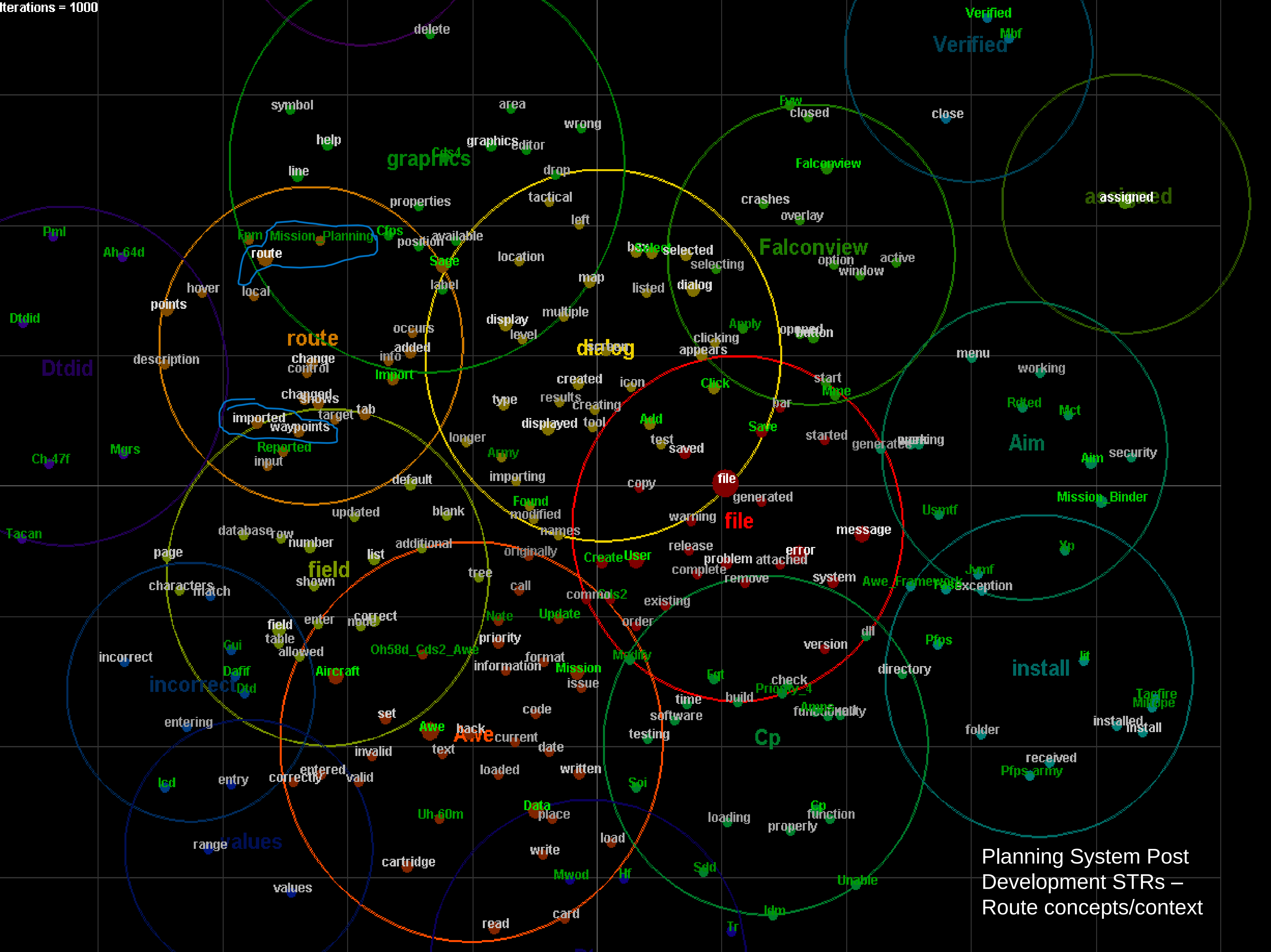
Planning System Development STRs – Route links at 10%



Planning System Development STRs – Route conceptual context at 100%



Planning System Post Development STRs – Route links at 10%



Planning System Post Development STRs – Route concepts/context

Analysis of Army Aviation BC Documentation:
Planning System STRs– Route as Domain Concept

The Planning System STRs are not capability focused, and rather given to buttonology, but they do make contact with BC contexts and domains through route and user.

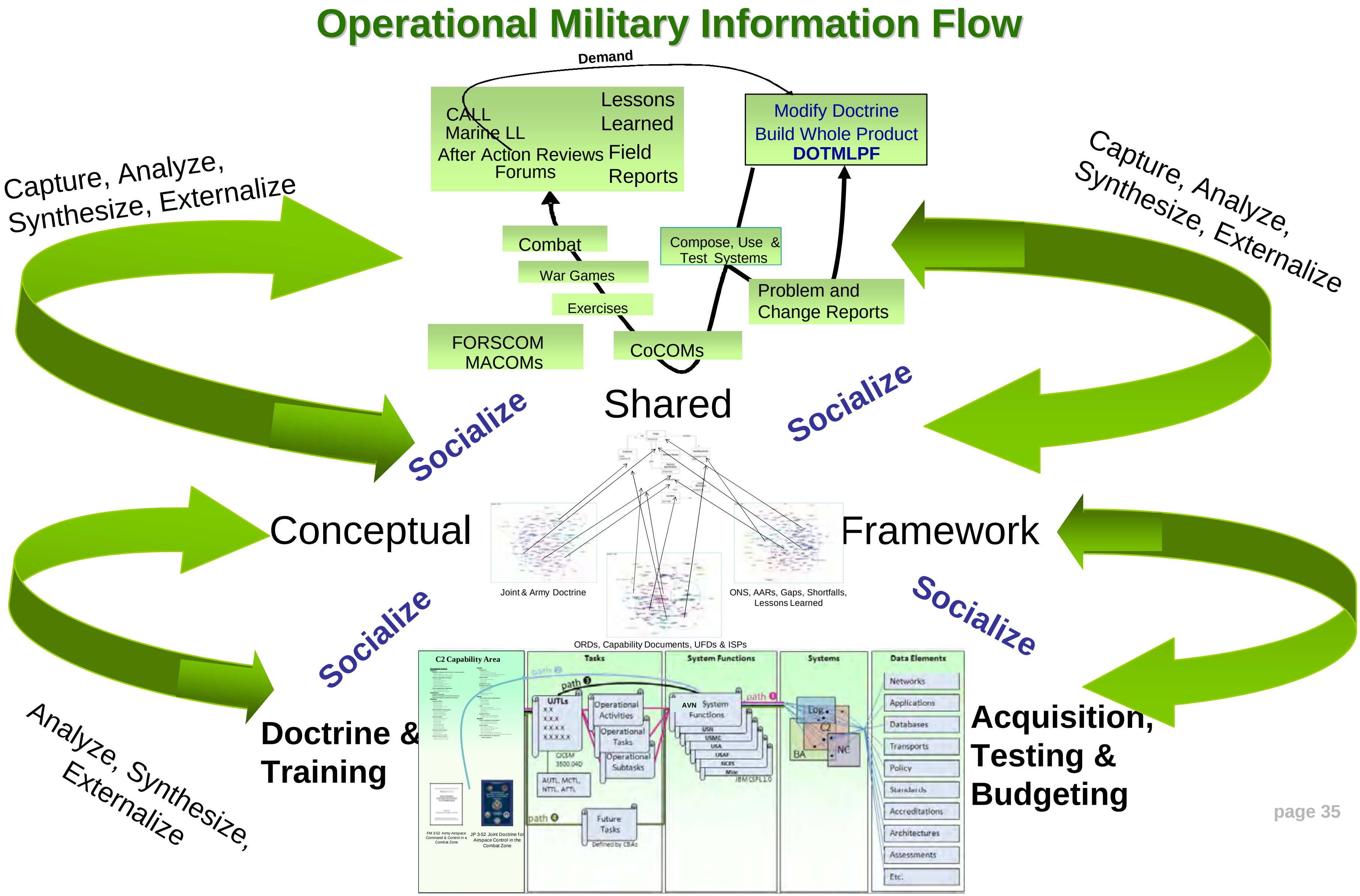
Route is a domain concept that needs to be represented via domain modeling of BC Aviation contexts informing software development, acquisition and testing.

We have shown that TRADOC pamphlets, doctrine and DFDs could be utilized so that capability, domain and user centered testing has impact on prioritizing maintenance, refinement and evolution of systems.

We are planning meetings with combat and material developer domain experts to identify more concepts like *route* that will be sufficient for building

- **domain models in each sphere of expertise**
- **aligning the models in the Army Aviation BC context**

Summary:
Establishing Shared Conceptual Structures



Thank you for your attention!

For further information,
please contact:

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256.955.0698

or

Ira Monarch
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Best Practices Clearinghouse:
Making Lessons Learned Come Alive and Be Practical

Defense Acquisition University

Fraunhofer USA, Inc
Center for Experimental Software Engineering Maryland

CSC

Forrest Shull,
Fraunhofer Center Maryland

NDIA Systems Engineering Conference
October 2008

Objectives

- **Review the DoD Acquisition Best Practices Clearinghouse (BPCh) approach and tool**
- **Describe our processes for working with both structured and unstructured content**
  - And raise interest in submitting your own content
- **Discuss some of the emerging priorities and best practices we are finding**

The DoD Acquisition Best Practices Clearinghouse

What makes BPCh unique?

Contents

- Not all best practices are "best" for everybody
  - Content includes descriptions of past results in context, not just what to do
  - Allows context-sensitive search (show me just the practices that programs like mine have used)
  - Recommendations built on evidence
- Pointers to existing sites, resources, examples

Overview of building content

Name: Practice *X*		**Practice Maturity**

Σ

- Practice X has been successfully applied …
- Use It to …
- For more information click on the following links:
  - …

(Bronze) (Silver) (Gold)

Evidence 1

Source
Context
Results

Evidence 2

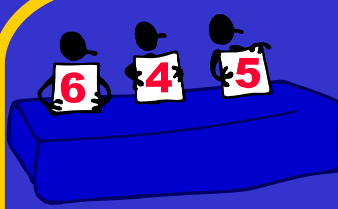
Source
Context
Results

Evidence 3

Source
Context
Results

Evidence 4

Source
Context
Results



Definitions

- A **practice** is:
  - 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
  - May be: A process, method, technique, standard...

- **Evidence** about a practice:
  - Is a description of an experience which provides a better understanding of a situation
  - Similar to a *lesson learned*
  - Composed of:
    - a practice,
    - a context and
    - a discernible result.

Contents

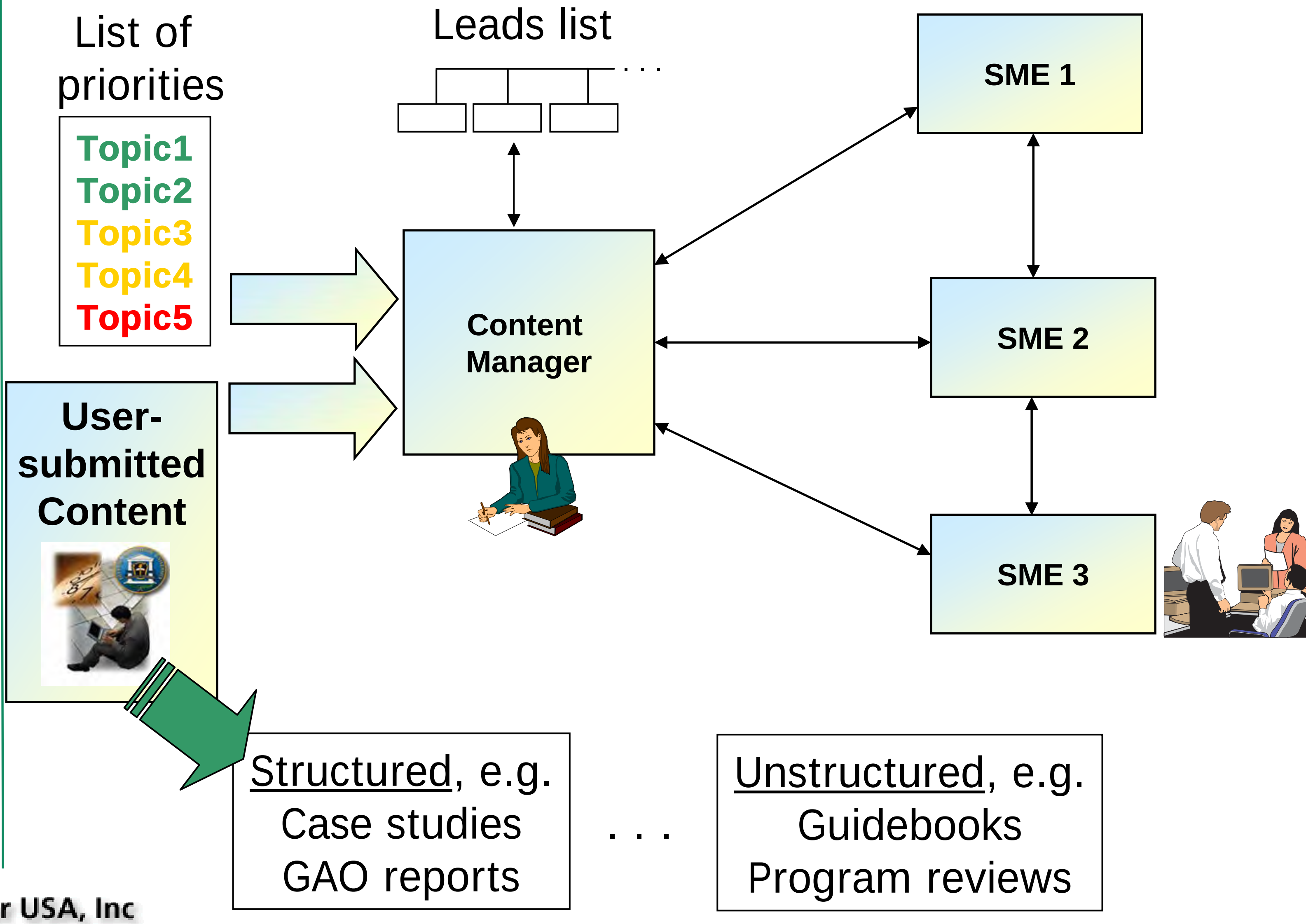
Representing Context

- Any piece of evidence is tagged according to where it was drawn from:
  - **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)

Contents

BPCh Content Manager and Subject Matter Experts (SMEs)

Contents



Current Priorities

- As determined by Content Advisory Group, input from independent review teams, conference feedback:
  - Logistics
  - Systems Engineering
  - Modeling & Simulation (M&S)
  - Program Management
  - System Assurance
  - Contracting

Contents

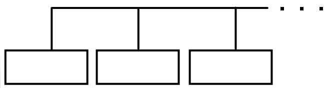
Example: Air Force Institute of Technology (AFIT) Case Studies

Contents

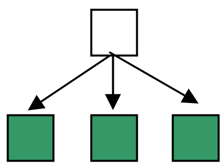
- Intro to BPCh
- ▶ Processes and examples
- The users' view
- How can I get involved?

Example: AFIT Case Studies

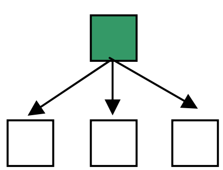
Contents



- Identifying practice leads:
  - **AFIT 'learning principles' explicitly identified important lessons contributing to success / failure of systems analyzed**
    - Mostly SE, PM



- Creating evidence:
  - **The case studies provide in-depth examination of a particular program that could be mined for evidence**



- Fleshing out practices:
  - **Working with AFIT personnel and case study analysts to provide appropriate detail about the practices.**

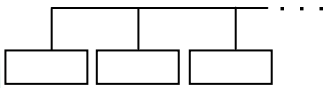
Example: AFIT Case Studies

Contents

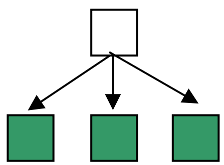
- Example results:
  - New / ***Modified*** Practices:
    - ***Invest in*** and retain core engineers and staff
    - Integration of requirements and design process
    - Effective validation and verification requires a firm requirements baseline
    - Implement technology development plan when technology spans multiple programs
  - Existing Practices:
    - Independent Reviews
    - Work Breakdown Structure
    - Distributed Work Allocation
    - Architectural Trade-off Analysis Method (ATAM)
    - Systems Engineering Plan (SEP) Preparation Guide

Example: Program Support Reviews

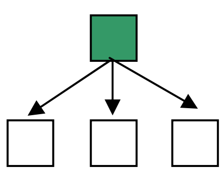
Contents



- Identifying practice leads:
  - **Conducted a brainstorming session with technical experts to capture trends, recurring problems**



- Creating evidence:
  - **Reviewers provided insights from the programs they reviewed, that illustrate the practices they discussed**



- Fleshing out practices:
  - **Plan to conduct follow-up meetings with the programs themselves to get more detail about *how* practices were implemented**

Example: Program Support Reviews

Example practices:

- Include requirements database in Request for Proposal (RFP) process
- Get potential bidders to comment on SRR before RFP
- Develop system engineering plan prior to RFP release and include RFP
- Independent cost & schedule estimate
- Independent reviews
- Establish a battle rhythm for reports
- Integrated Developmental Test / Operational Test (DT/OT)

Other Emerging Practices: Logistics

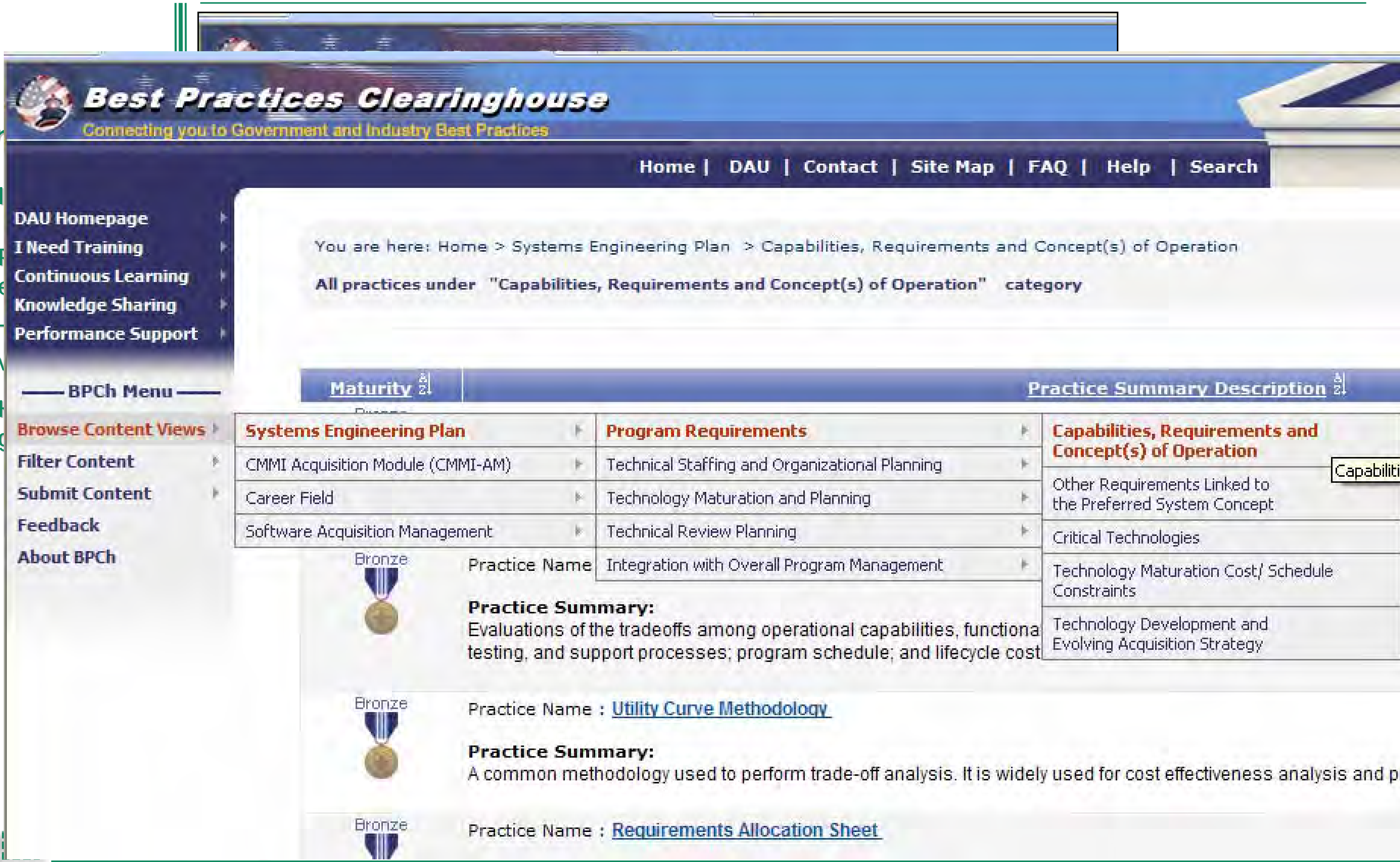
- Performance-Based Logistics (PBL)
  - Business Case Analysis
  - Award Contract
  - Supply Chain Management
  - Performance-based agreements
  - Resource: DAU Acquisition Community Connection (ACC) PBL toolkit
- Sustainment
  - Technology Insertion
  - Software Sustainment
  - Item Unique Identification (IUID) / Radio Frequency Identification (RFID)
  - Independent Logistics Assessments
  - Prognostics & Health Management and Enhanced Diagnostics

Other Emerging Practices: M&S

Contents

- Involve Operational Test Authority in M&S planning to support DT/OT objectives
- Develop M&S plans and integrate with Test Evaluation and Management Plan (TEMP)
- M&S reuse
  - Based on: domain info, conceptual model, algorithms, software components, input data sets…
- Include M&S in contractual provisions
  - Addressing: representation requirements, data rights, M&S planning and documentation, ownership of resources…

What the User Sees… An Example Practice



What the User Sees… An Example Practice

Practice : Software Formal Inspections

Evidence (11) , Resources (2)

Practice Details | **Evidence** | Resources | Summary

Evidence Name	Rating	Overall Perception	Quality Experience Report	Criticality	Primary Benefit
What We Have Learned about Fighting Defects	8		Via interview		Improved Quality
Applying Program Comprehension Techniques to Improve Software Inspections	12		Workshop publication		Reduced Cost
Report on the Loss of the Mars Climate Orbiter Mission	9		Technical report (within an organization or university)		
The Empirical Investigation of Perspective-Based Reading	13		Archival journal publication (e.g. IEEE Transactions on Software Engineering)	Normal	Improved Quality
Comparing the Effectiveness of Software Testing Strategies	14		Archival journal publication (e.g. IEEE Transactions on Software Engineering)		Improved Quality
Space Shuttle Primary Onboard Software Development: Process Control and Defect Cause Analysis	12		Technical report (within an organization or university)	Safety critical	Improved Quality
Key Lessons in Achieving Widespread Inspection Use	17		Trade journal publication (e.g. CrossTalk)	Don't know	Reduced Cost
Experience with Inspection in Ultralarge-Scale Developments	18		Conference publication or 2nd-tier publication (EMSE, IEEE Software, CACM)	Don't know	Reduced Cost
An Analysis of Defect Densities Found During Software Inspections	19		Archival journal publication (e.g. IEEE Transactions on Software Engineering)		Improved Quality

Current SMEs

Contents

- **Systems Engineering**
  - Dona Lee dona.lee@syseng-so.com
  - Mike Ucchino michael.ucchino@afit.edu
- **Logistics**
  - Bruce Hatlem bruce.hatlam@dau.mil
  - Jill Garcia jill.garcia@dau.mil
- **Modeling & Simulation (M&S)**
  - Mike Truelove mike.truelove@syseng-so.com
- **Program Management, System Assurance, Contracting**
  - None participating
- **Software Acquisition Management**
  - Larry Baker larry.baker@dau.mil
  - Bob Skertic robert.skertic@dau.mil

How can I participate?

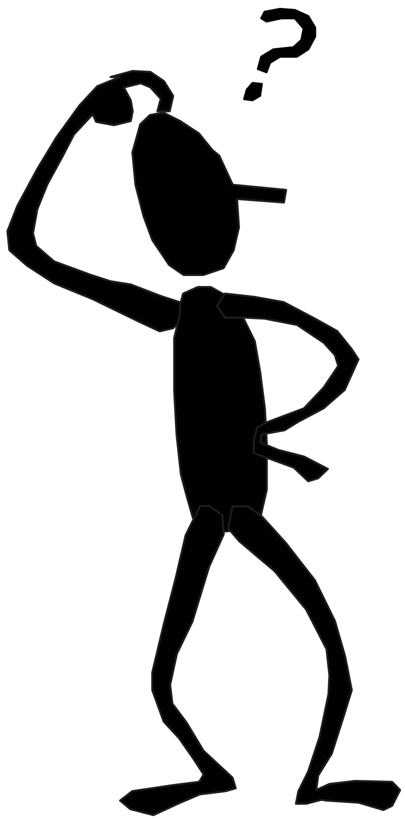
Contents

- Visit: https://bpch.dau.mil
- 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

- Fill out our questionnaires…
  - *To suggest other content*
  - *To volunteer as a SME*

Questions?

Contents



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or

Mike Lambert
Michael.Lambert@dau.mil
703-805-4555

List of used abbreviations

ACC:	Acquisition Community Connection
ACAT:	Acquisition CATegory
AFIT:	Air Force Institute of Technology
BPCh:	(Acquisition) Best Practices Clearinghouse
CoP:	Communities of Practice
COTS:	Components Off The Shelf
DAU:	Defense Acquisition University
DT/OT	Developmental Test / Operational Test
DoD:	U.S. Department of Defense
IUID	Item Unique Identification
M&S	Modeling and Simulation
OSD:	Office of the Under Secretary of Defense
PBL:	Performance Based Logistics
PM:	Program/Project Manager
RFID	Radio Frequency Identification
SE:	Systems Engineering
SMEs:	Subject Matter Experts
SSR	System Requirements Review
TEMP	Test Evaluation and Management Plan

Contents

11th Annual Systems Engineering Conference

Prognostics to Improve Mission Readiness and Availability

Sony Mathew

calce

Center for Advanced Life Cycle Engineering

University of Maryland,

College Park, MD 20742

www.prognostics.umd.edu

Mission Readiness and Availability

- Mission readiness of a product is a measure of the time needed for a product to be in full operational state.
- Mission readiness is directly proportional to the products availability to the customer.
- Availability is the probability that a product will in operational state at a given time.

$$Availaility = Uptime / (Uptime + Downtime)$$

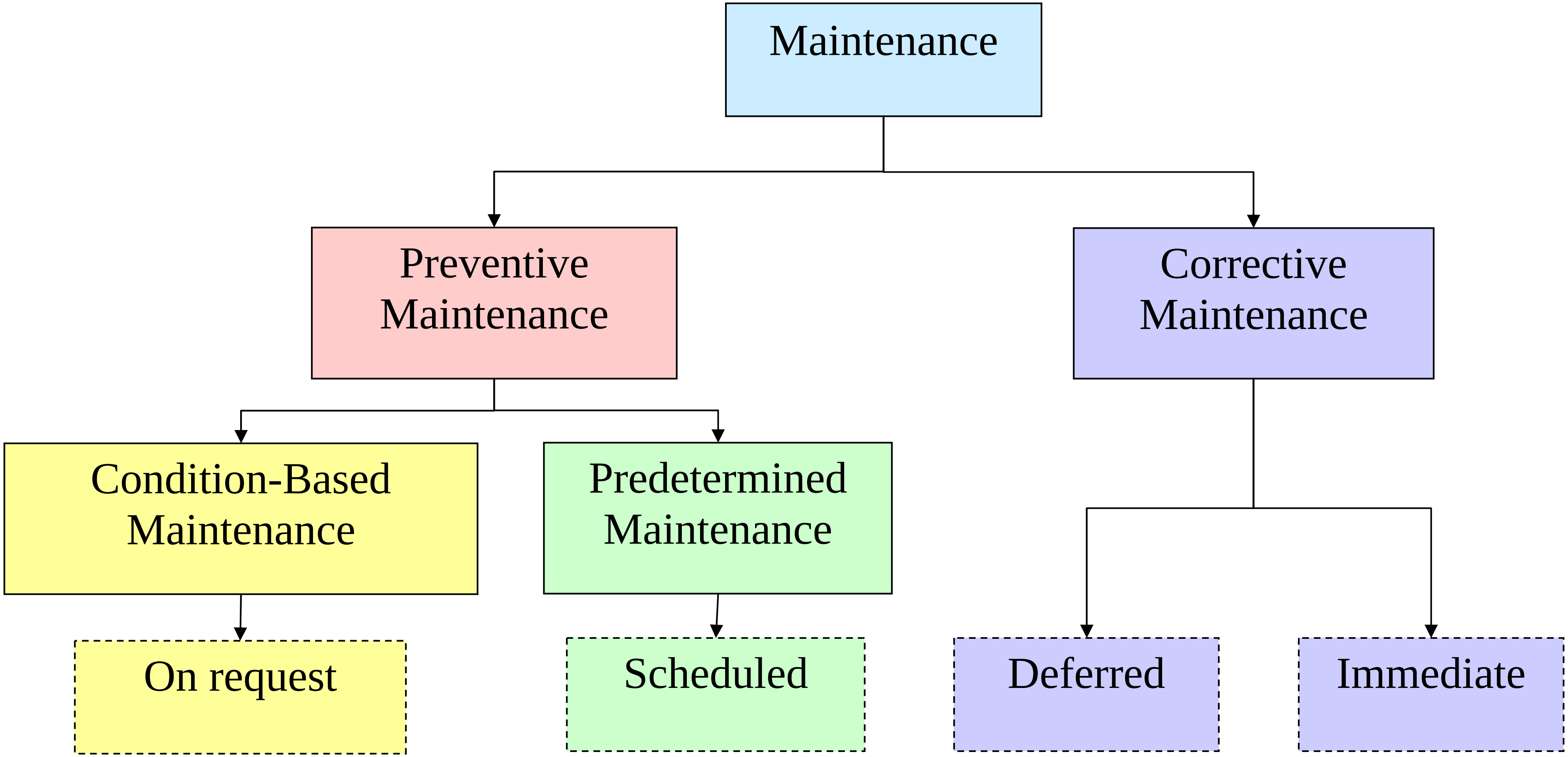
- Lower the down-time, higher will be the availability.
- Product maintenance and logistics play a major role in ensuring more availability and better mission readiness of the product.

Useful Terms

- **Health:** A product's health is the general state of the product with respect to the expected normal operating condition.
- **Health monitoring:** a process of measuring and recording the extent of deviation and degradation from a normal operating condition
- **Prognostics**: the process of predicting the future health of a product by analyzing the recorded deviation or degradation.
- **CBM** (Condition-Based Maintenance): is a preventive and predictive approach to maintenance based upon the evidence of need.

Condition Based Maintenance (CBM)

The objective of CBM is to assess a product's health during operation and determine if and when maintenance is needed.



Outcomes of Maintenance Decisions

Corrective	Predetermined	CBM
Unanticipated Failure	Regular Maintenance	Health Monitoring
• Hazardous • Costly • Unscheduled maintenance	• Must inspect, repair or replace after fixed time or operational interval • Can be costly • Can induce failures • Increased down-time	• Maintenance is forecasted • Continuous monitoring of health can decrease down-time • Product sustainment, and re-use options can be determined

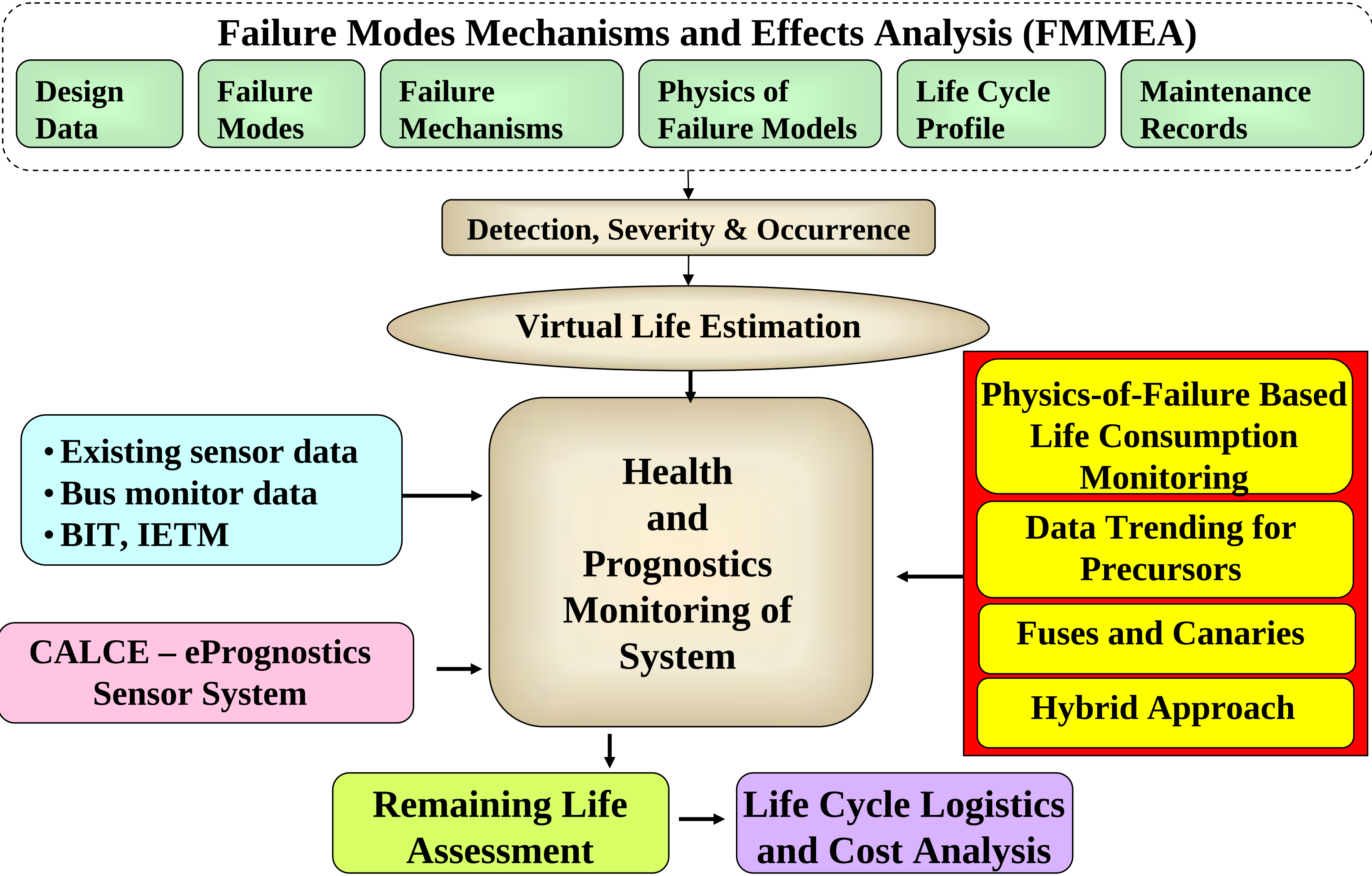
Prognostics for CBM

- One of the key enablers of CBM is the development of the PHM technology.
- PHM assesses and quantifies the extent of deviation or degradation from an expected normal operating condition.
- A symptom of impending failure or anomalous behavior can be identified with the aid of health monitoring and prognostics techniques.
- Knowledge of prognostic distance allows informed logistics and maintenance decisions.

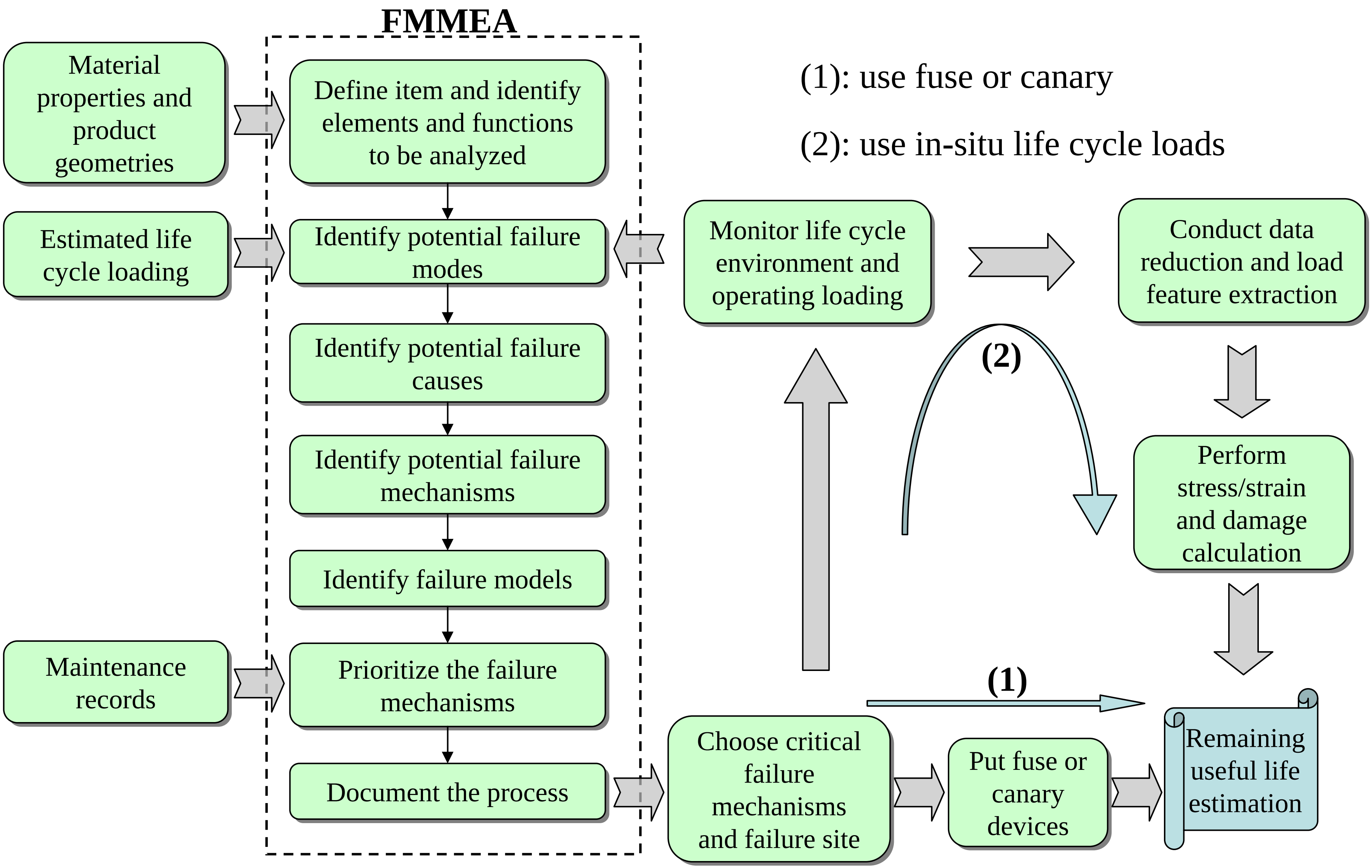
Why PHM?

- Provide an early warning of failures
- Forecast maintenance as needed: avoid scheduled maintenance and extend maintenance cycles [condition based maintenance]
- Predict the product's reliability
- Assess the potential for life extensions
- Provide efficient fault detection and identification, including evidence of "failed" equipment found to function properly when re-tested (no-fault found).
- Improve future designs and qualification methods
- Reduce amount of redundancy

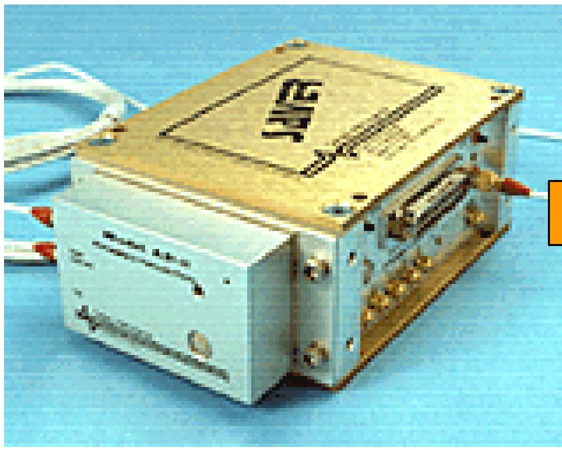
CALCE Approach



CALCE PoF based PHM Methodology

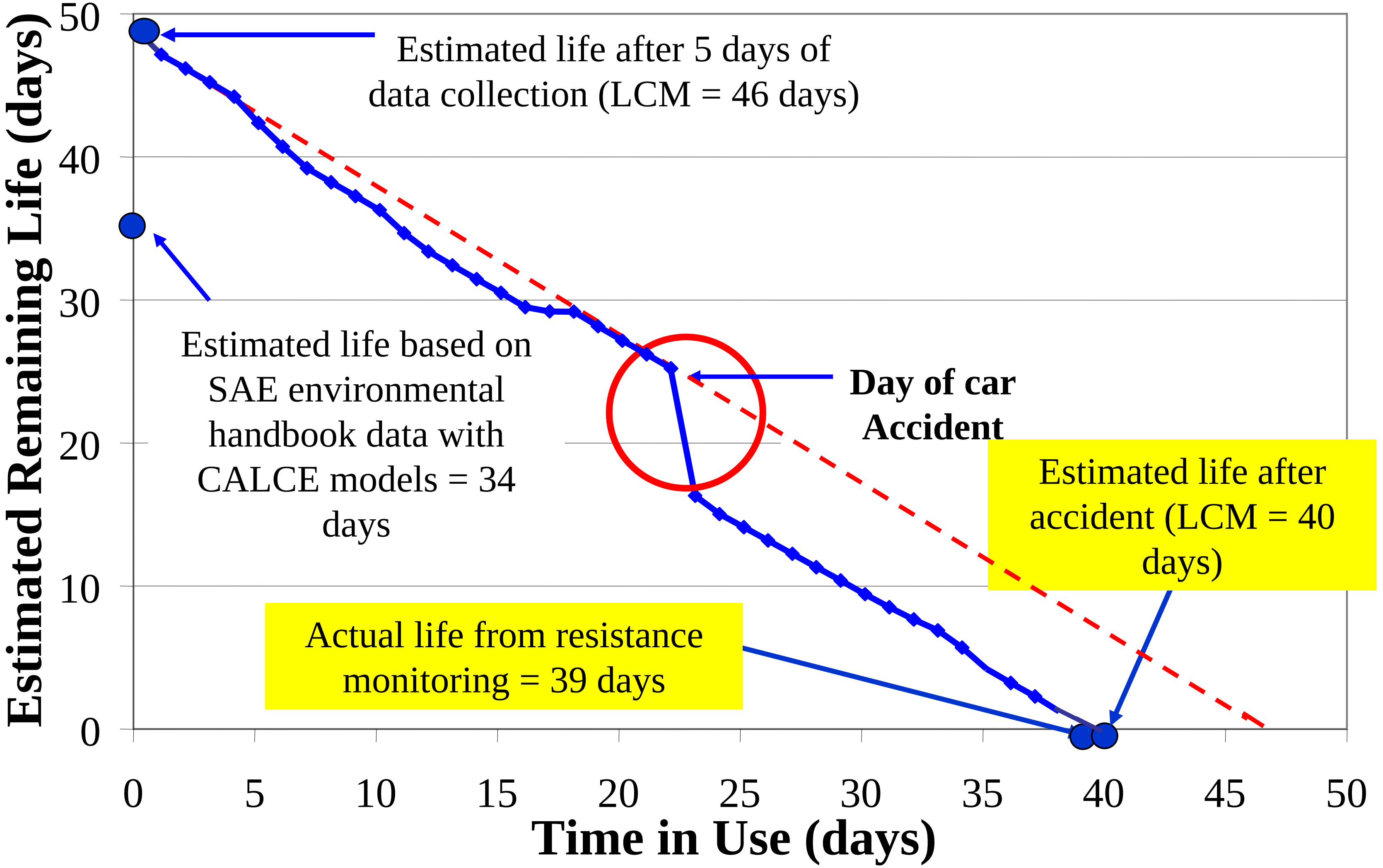


Predicting Remaining Life Based on Physics of Failure (1/2)



Monitored environmental and operating conditions of test board → Simplified data (e.g., data reduction, and cycle counting) → Performed physics-of-failure based stress and damage assessment → Obtained the remaining life

Predicting Remaining Life Based on Physics of Failure (2/2)



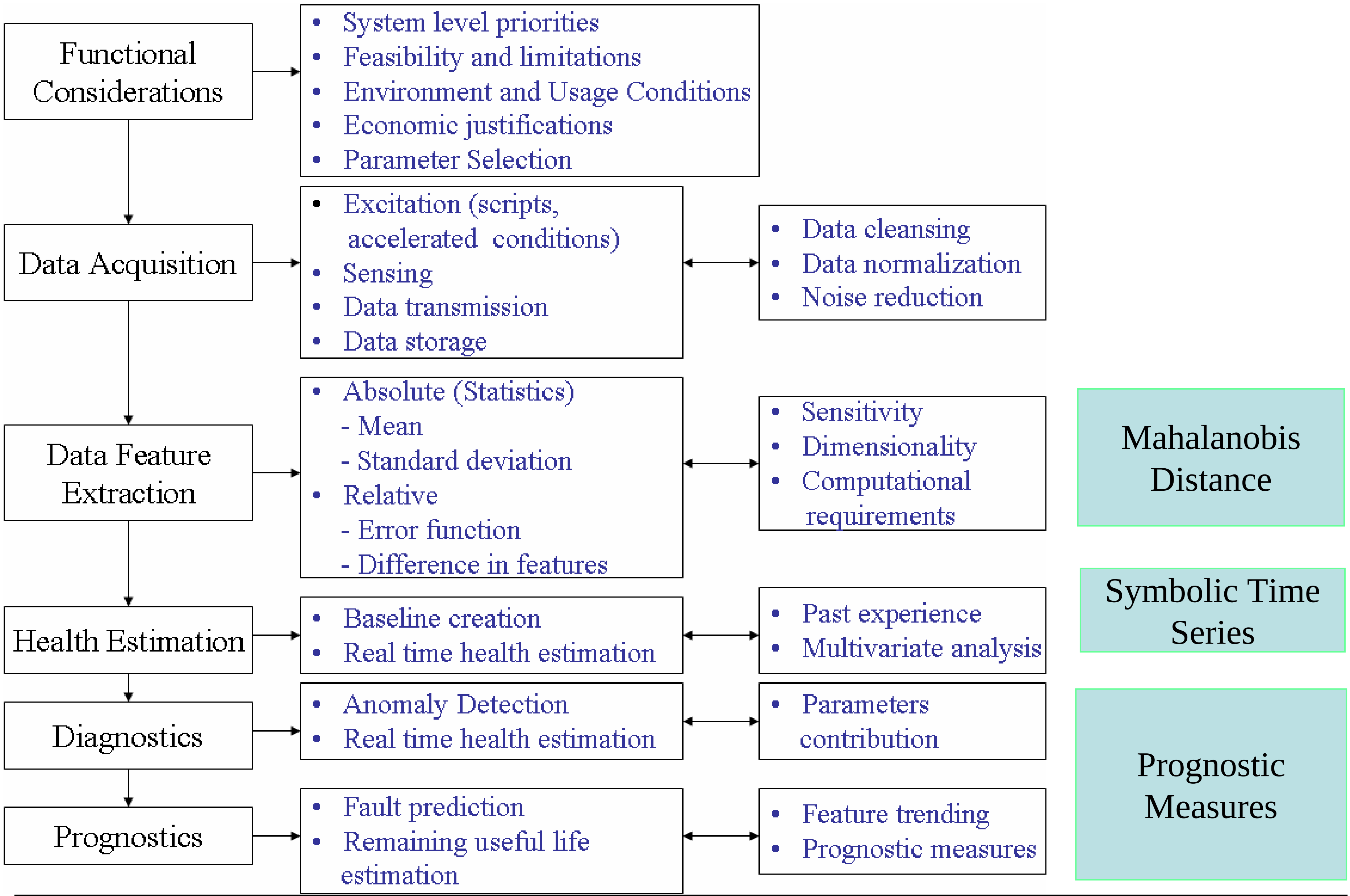
Remaining Life Assessment of NASA Space Shuttle Remote Manipulator System (SMRS) Electronics

- The SRMS is used to place satellites, space station equipment and other payloads in orbit. The first SRMS flew on the space shuttle mission STS-2 in November 1981.
- By using the existing sensor data, along with inspection and physics-of-failure software analysis, it was found that there was little degradation in the electronics and they could be expected to last another 20 years.

Army AMSAA –CALCE Project
Two Year Demonstration System

- The objective of this project was to demonstrate predictive capabilities for the remaining life of electronic components mounted in military vehicles.
- The project centered around exposing test boards with electronic components mounted on them to on and off road terrain.
- Field failures agreed quite well with the predicted failure using the monitored PWB strain and existing CALCE failure models.

Considerations for Data-Driven PHM



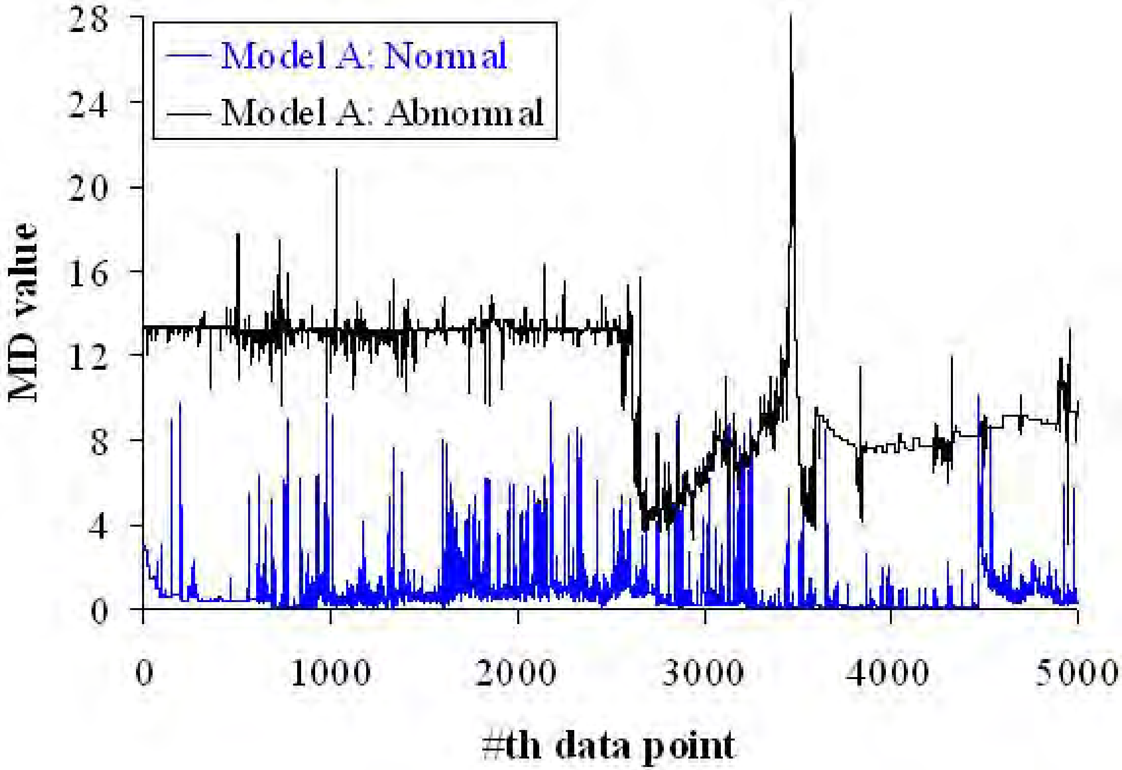
Case Study: Data Driven Approach

- Computers are complex electronics systems and can be used as a test vehicle for developing robust prognostics methodologies.
- A baseline was generated using 10 new computers.
- A total of 72 experiments were conducted.
- Duration of data collection at each setup was approximately three hours.

- Environmental conditions
  1. 5°C with uncontrolled Relative Humidity
  2. 25°C with 55% RH
  3. 25°C with 93% RH
  4. 50°C with 20% RH
  5. 50°C with 55% RH
  6. 50°C with 93% RH
- Usage Levels
  1. L1: Benign
  2. L2: Low
  3. L3: Medium
  4. L4: High
- Three Power Settings

- Parameters identified for health monitoring
  - Device information
    - fan speed, LCD brightness
  - Thermal information
    - CPU temp, motherboard temp, graphics card temp
  - Performance management information
    - %CPU usage, %C1, %C2, %C3, % CPU throttle

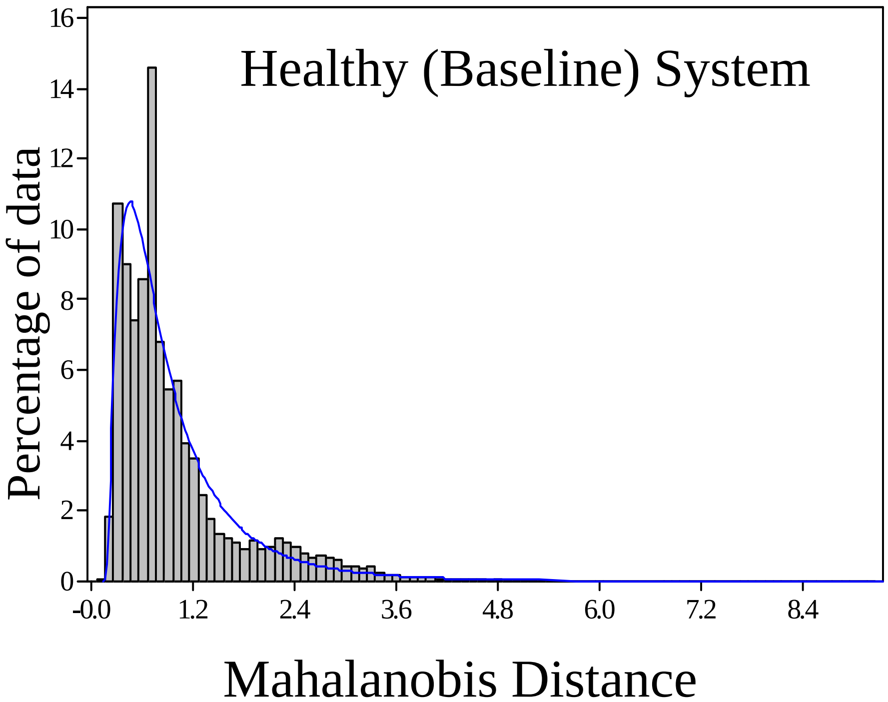
Comparison of Mahalanobis Distance (MD) Values for Normal and Abnormal Systems



Stats (Model A)	Normal	Abnormal
Mean of MD	0.83	10.72
Std.dev of MD	1.16	3.13

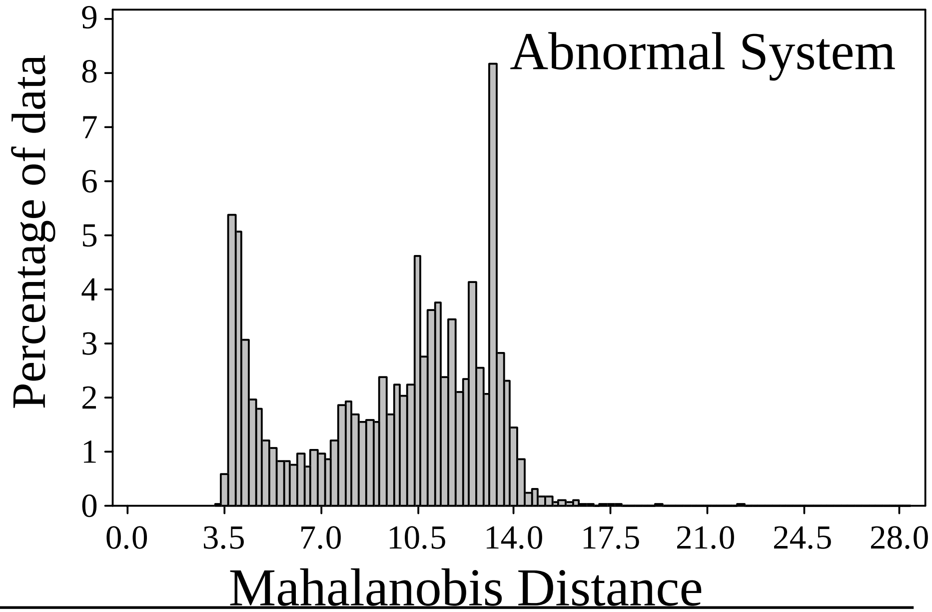
- The data from the 10 new computers used to form the baseline.
- Utilizing the correlations between the measured parameters MD reduces the multivariate data to a univariate data.
- An NTF computer (Abnormal) was tested and the same parameters were recorded as for the baseline computers.
- The MD values for the Abnormal system showed faulty behavior at time zero.

Comparison of Histogram of MD Values



- 3-parameter lognormal distribution fit for the baseline MD value and more than 95% data is covered by the distribution

- Test computer shows different distribution of MD values as compared to baseline computer
- This demonstrates the test computer has different signature

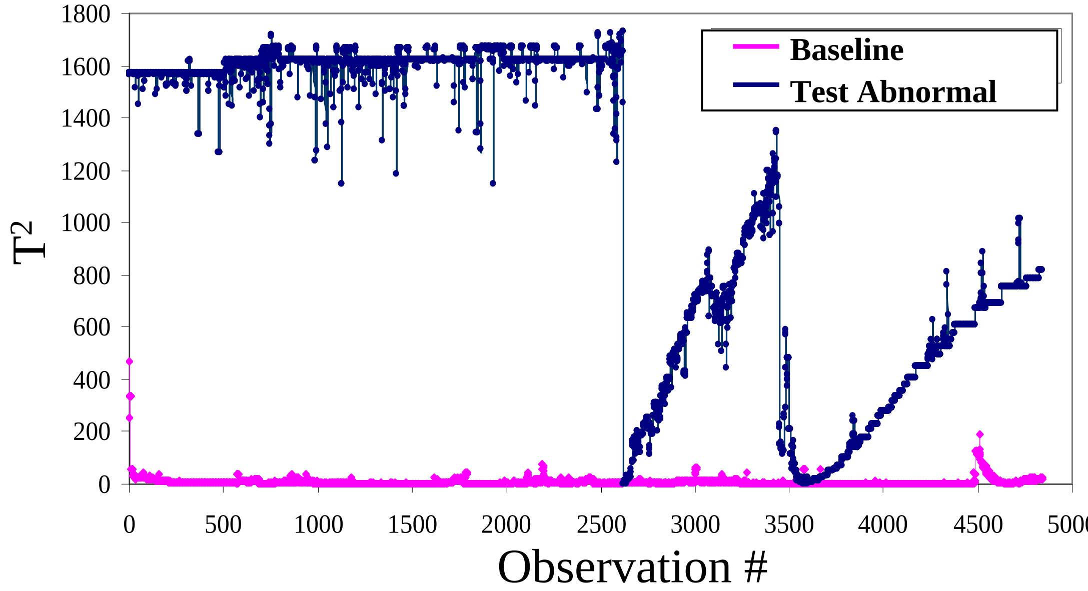


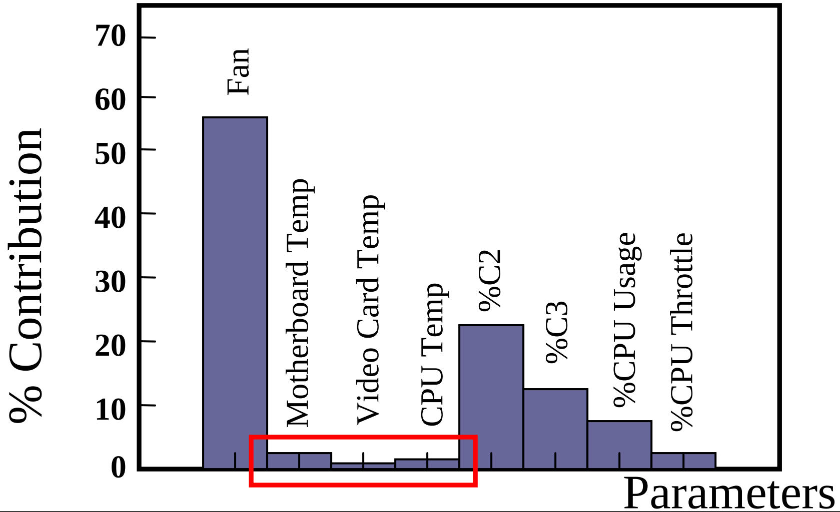
Principal Component Analysis

- Principal Components Analysis (PCA) is used in a wide array of applications to reduce a large data set to a smaller one while maintaining the majority of the variability present in the original data.
- Two statistical indices, the Hotelling Squared (T^2) and squared prediction error (SPE) are used in the PCA.
- The SPE statistic is related to the residuals of process variables and is a reliable indicator to a change in the correlation structure.
- The Hotelling T^2 score measures the Mahalanobis Distance from the projected sample data point to the origin in the signal space defined by the PCA model.

Projection Pursuit: Analysis Results – T^2

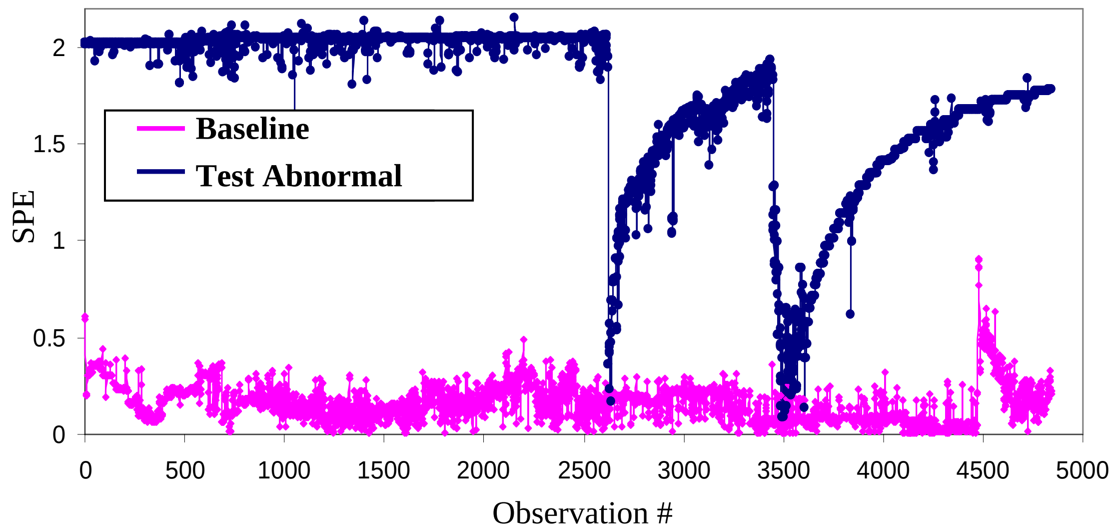
- Tested a computer showing abnormal behavior against a baseline.
- From the T^2 analysis, test computer shows a distinction from the baseline data
- The contribution plot identifies the fan speed as the dominant parameter that contributes to the shift from the baseline.

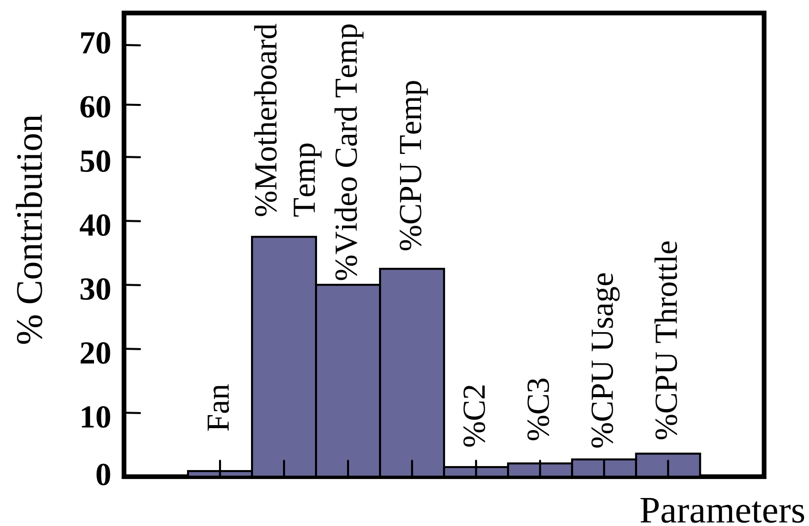




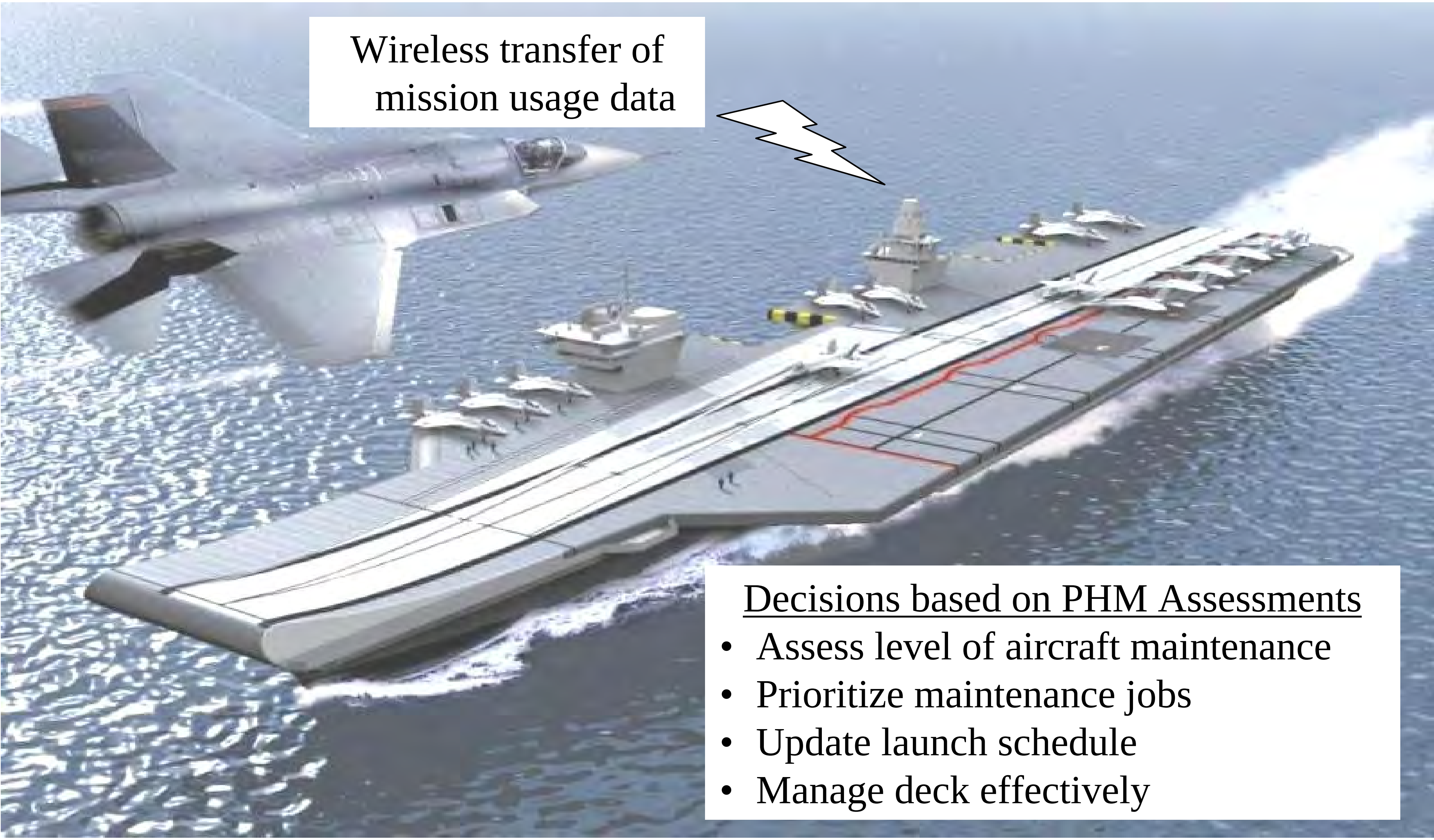
Projection Pursuit: Analysis Results - SPE

- The SPE feature also classifies the test computer as different from the baseline.
- All temperatures are dominant in the residual space and are identified as the influencing factors for the fan speed.





Prognostics Health Monitoring Enabled Logistics Decisions for Aircraft Carrier



Wireless transfer of mission usage data

Decisions based on PHM Assessments

- Assess level of aircraft maintenance
- Prioritize maintenance jobs
- Update launch schedule
- Manage deck effectively

Conclusions

- Prognostics using approaches including PoF based life consumption monitoring, data trending and analysis, and use of canaries can be achieved.
- Prognostics and health monitoring provides advanced warning of failure or abnormal behavior and thereby helps determine the mission readiness and availability of the product.
- Assessment of remaining life helps drive the cost effective logistics decisions.
- Condition based maintenance can be implemented with the help of health monitoring and prognostics technologies.

CALCE

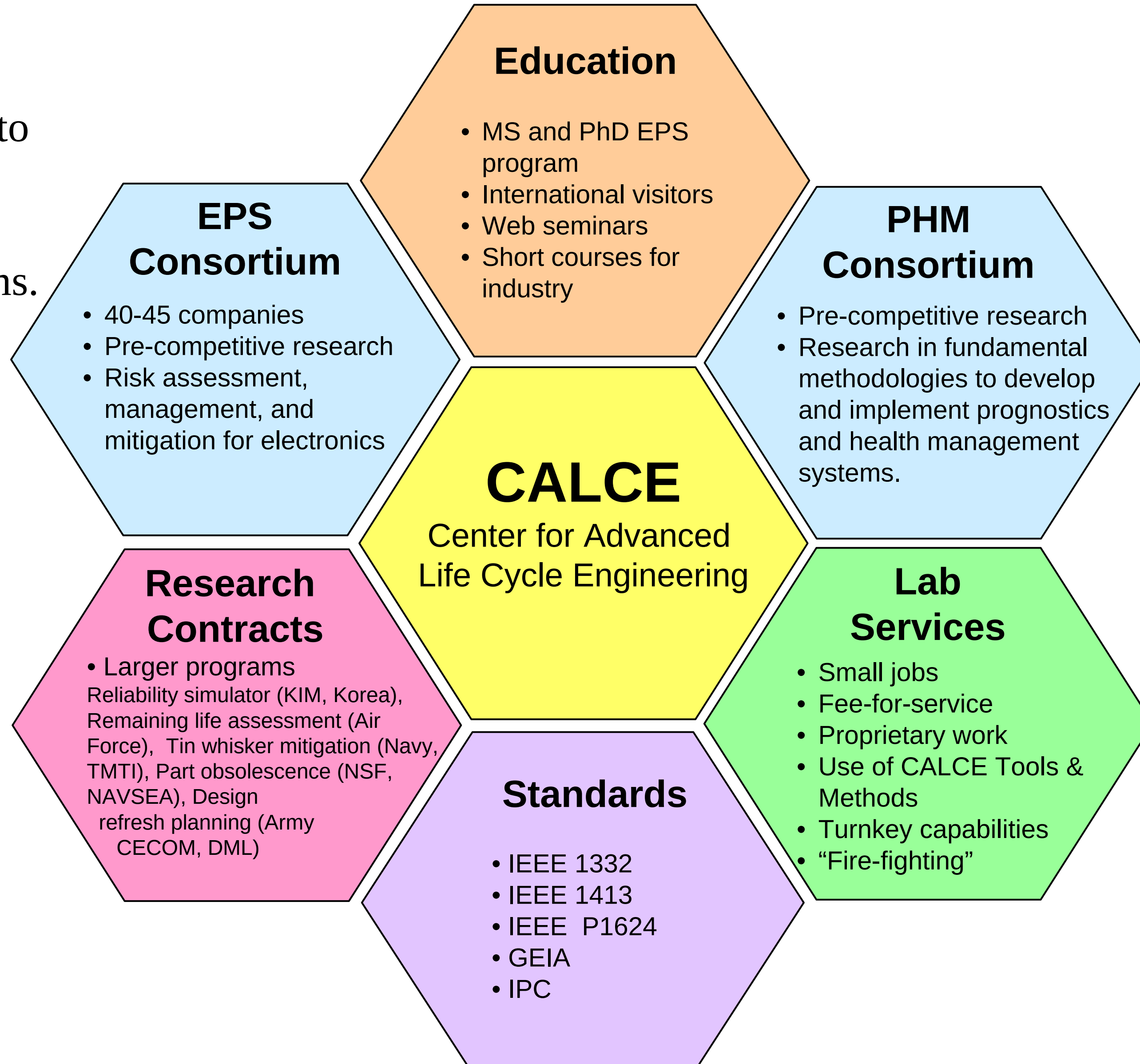
CALCE founded in 1987 is dedicated to providing a knowledge and resource base to support the development and sustainment of competitive electronic products and systems.

Focus areas:

- Physics of failure
- Design for reliability
- Accelerated testing
- Qualification
- Supply chain management .
- Obsolescence
- Prognostics

Personnel:

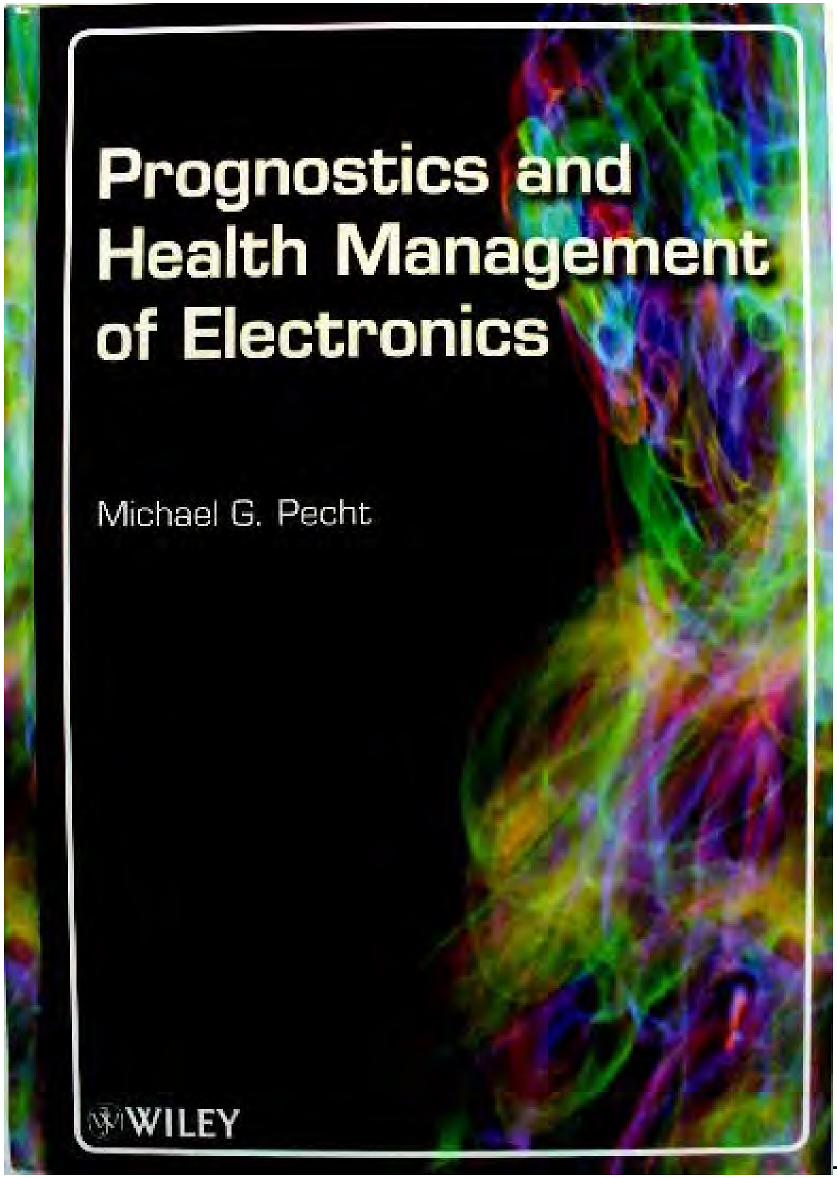
- 21 research faculty
- 6 technical staff
- 60+ PhD students
- 30+ MS students
- 11 visiting scholars



CALCE Research Focus in PHM

- Developing the capability to learn from data, detect changes in real-time and predict the future performance of electronic systems.
- Integrating the center's expertise in reliability and physics of failure (PoF) of electronic components into hybrid data driven models for autonomous system prognostics and diagnostics.
- Researching and developing prognostic and health management technologies that will enable autonomous fault diagnostics and prognostics in electronic systems such that reliability mitigations can be implemented.

PHM Book



- Overviews the **concepts of PHM** and the techniques being developed.
- Discusses the **state-of-the-art** in sensor systems.
- Discusses the various data driven/ statistical **models and algorithms**.
- Discusses the **physics-of-failure** based prognostics approaches.
- Overview of the implementation costs and **return on investment** (ROI).
- Provides a **roadmap** based on the current challenges and opportunities for research and development of PHM, and
- Discusses the activities of the major players in the prognostics research field, including **companies**, **academia** and **government** organizations.

Why Design for Testability Sooner?

21 October 2008

Bruce Bardell, Technical Fellow

Bradley Chief Architect

BAE Systems

Agenda

- Ground Combat Vehicle Capabilities
- Levels of Maintenance
- Diagnostic Technology Evolution – past and future
- Prognostics Definition
- Diagnostics Concept Design and Decomposition
- Possibilities for Enhancement
  - Unit Level Diagnostics (8)
  - Direct Support Diagnostics (5)
  - Unit Level Diagnostics & Prognostics (1)
  - Prognostics (3)

Ground Combat Vehicle Overview - Vehicle Capabilities

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- **Level of Technology in capabilities typical of Ground Combat Vehicles**
  - **Mobility**
  - **Lethality**
  - **Communication**
  - **Survival**
  - **Transport**

Vehicle Capabilities - Mobility

- **Major components**
  - **Turbocharged or supercharged reciprocating diesel engine**
  - **Hydraulically controlled automatic transmission**
  - **Other loads – hydraulic pumps, pneumatic pumps, refrigeration compressors, direct drive engine compartment cooling fans, electrical generators, and the supercharger**

Vehicle Capabilities – Lethality

- Capabilities Provided
  - target sighting
  - weapon pointing
  - ammunition management
  - round discharge
- Technology Evolution – target sighting
  - hard-mounted passive telescope with elevation axis adjustment
  - Remote superelevation adjustment
  - Electronic measurement of target range
  - Coupling target range measurement to superelevation adjustment
  - Imaging of other than visible wavelengths
  - Rasterized video imagery to permit display on conventional CRTs and emerging flat panel displays
  - Remote viewing at selected crew workstations

Vehicle Capabilities – Lethality continued

- **Technology evolution – weapon aiming**
  - Manual operation
  - Hydraulics, reducing gunner workload
  - Electrical as power electronics became more capable
  - Rate commanded directors
  - Analog servos allowed combining the operator command with an inertial gyro input yielding inertial-stabilization
  - Digital servos made inclusion of other battlefield factor corrections easier to implement, reducing the gunner’s workload again
- **Technology Evolution – Weapon Control**
  - Mechanical recharge on recoil
  - Electronic monitoring and control managing feeders and improving gunner convenience and safety

Vehicle Capabilities – Survival

- Redundancy
- Battle damage protection

Vehicle Capabilities – Not Explored

- **Communication**
- **Transport**

Supportability – Current Levels of Maintenance

- Unit Level (Organizational Level) – the Motor Pool
- Direct Support (Intermediate Level)
- Depot (typically the manufacturer)

Diagnostic Technology Evolution

- **Before 1981**
  - **Multimeters**
    - **Vehicle Schematics**
  - **Vehicle Test Meter (STE-ICE)**
    - **Automotive Diagnostic Connector Assemblies & Transducers**
    - **Technical Manual troubleshooting**
- **1981**
  - **Controllable Interface Box (STE-M1/FVS)**
    - **Weapon System Diagnostic Connector Assemblies**
    - **Maintainer-augmented fault isolation**
    - **Fault isolate to single LRU**
    - **Matured over next several years with data collected in Production**
  - **Direct Support Electrical System Test Set**
    - **Replicates vehicle interfaces on bench**
    - **Fault isolate to single SRU**
    - **Matured over next several years with data collected in Production**
- **1985**
  - **Weapon aiming subsystem**
    - **Conversion to digital enabled built-in fault isolation routines**
    - **Accessible via plug-in terminal**
- **2001**
  - **Turret upgrade**
    - **Systemic BIT requirement**
    - **Fault isolation performed by main system computer**
    - **Capabilities available statused to Commander**
    - **Degraded Modes**
    - **Improvements to Direct Support testing**

Diagnostic Technology – Future

- **Near term**
  - **LRUs subject to obsolescence redesign include BIT and Fault Isolation to the SRU level, when possible based solely on monitoring internal LRU behavior only**
  - **Results saved to persistent memory and made available to a plug-in terminal, making the Direct Support plug-in test equipment that fault isolates to SRUs is no longer required for those LRUs.**
- **Longer term**
  - **Continue to include BIT and Fault Isolation to the SRU level in LRUs subject to obsolescence redesign**
  - **Include system wide enhancements so that LRUs external behavior can be stimulated and sensed and the results communicated so the LRU is able to react to external observations and perform a more complete fault detection and isolation**
  - **The results are saved to persistent memory and made available to a plug-in terminal.**

Prognostics – A Definition

- **Implementation**: Prognostics requirements are beginning to creep into contemplated and funded efforts, but still as a placeholder
- **Purpose**: To estimate remaining useful life when that life is nearing its end
- **Technical Requirement**: Predict when end-of-life will occur within the next mission, or the period of time the vehicle is away from the motor pool. More advance warning is needed if the replacement part is not on hand. Obviously, the duty cycle of each prognosed component is critical in determining remaining life in units of vehicle power-on time.

Diagnostics Concept Design and Decomposition

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- **Initial diagnostics concept work should entail**
  - assessing allocated realizable MTBF
  - projected mission reliability
  - development and unit production cost, weight, and volume
- **When completed, that diagnostics concept work should result in**
  - definitions
  - requirements
  - standardized interfaces
  - implementation suggestions
- **Then the emerging system and subsystem design concepts can evolve to include**
  - appropriate partitioning between the tactical and diagnostic functions
  - appropriate level of inherent fault detection algorithms and hardware to meet the fault isolation requirement and intended support interface
- **The following are just a few examples of capabilities that can be realized with early availability of diagnostics requirements and concepts.**

Possibilities to Enhance Unit Level Diagnostics

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- Minimize suboptimal compliance with requirements by enabling planning, design, and review of compliance early in the subsystem design cycle.
- Assure that pass/fail limits, algorithms, and crew/operator messages are updatable separately from the tactical software, so diagnostics maturation can follow an independent path from tactical anomaly resolution and feature addition.
- Characterize abnormal behavior down to the chip level.
- Architect intrusive tests such that they may be executed without affecting the in-vehicle operation of the electronics assembly.
- Improve LRU interface integrity fault detection via boundary scan at the LRU's system interface.
- Include the ability to tailor diagnostic pass/fail limits conditionally to minimize false alarms and nuisance trips based on vehicle mode of operation.
- Include LRU degraded modes (such as reduced processor power consumption) to compliment system level degrade modes.
- Include tests of system interconnect media in selected LRUs to detect and localize breaks, degradation, and missing terminators.

Possibilities to Enhance Direct Support Diagnostics

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- Include an LRU-level persistent memory to log timestamped pass-to-fail and fail-to-pass transitions in conjunction with data potentially important to a root cause analysis (input voltage, internal temperature, value of analog inputs, processor load, memory utilization, etc.). This supports bench level repair and engineering root cause analysis of failures.
- Include a standardized interface from the LRU to bench power and a USB or other standardized serial interface port to enable a general purpose computer to offload the fault detection log and fault isolation results, manage the persistent memory, and optionally accept software updates for the LRU or for the entire vehicle.
- Allow the system to augment LRU interface fault detection – with results reported to the LRU for storage in it's persistent memory for bench level repair.
- Include sufficient system level redundancy and partitioning to support reconfiguration to maintain full capability or introduce degraded modes in the presence of faults. Examples are maintaining full capability via alternate processing and communication resources, degradation by invoking less automated capabilities, reducing Crewstation access to capabilities, etc.
- Combine manufacturing test requirements with system and LRU test requirements and satisfy with a single solution.

Possibilities to Enhance both Unit Level Diagnostics and Prognostics

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- **If sensor requirements for diagnostics/prognostics differ from those for tactical operation, select sensors suitable for meeting all requirements.**

Possibilities to Enhance Prognostics

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- The follow-on to an agreement of additional transducers required for prognostics is to implement the interfaces and reserve processing power required to detect degradation (this approach may involve high frequency characterization of mechanical systems to determine degradation).
- Consider including board-resident test software to track component degradation over time.
- Include chip-level monitoring of temperature and input current if deemed pertinent for prognostics.

Open Architecture in Electronics Systems

23 October 2008
Bruce Bardell, Technical Fellow
Bradley Chief Architect
BAE Systems

Open Architecture, 10 years ago

BAE SYSTEMS

- **Goals of "Open Architecture"**
  - to guarantee the previously-developed military subsystems were usable in platforms under development
  - new subsystems being developed for use in new platforms could be reused in future platforms
- **How is "future platform reuse" supported?**
  - Maximize use of Industry Standards
  - Minimize custom design content of any "Vetronics" item that has a commercial equivalent
- **How well did this work? See next slide.**

Vetronics is vehicle computer resources, vehicle busses, peripheral electronics such as sights, human/machine interface boxes, electronic GFE, etc.

Open Architecture, 10 years ago
What is "Open" – What was the Result?

Standard 28 VDC Vehicle Power Source	
Standardized command / response & communication busses, such as MIL-STD-1553B & Ethernet	
Standardized interfaces, such as VGA, RS170	
RS-232, RS422, RS423	
Standard backplane, such as VME	
Use of "Middleware" OE to permit computer HW update	
Standard form factor circuit cards	

Open Architecture, 10 years ago
What is "Open" – What was the Result?

BAE SYSTEMS

Standard 28 VDC Vehicle Power Source	Compatible with most GFE
Standardized command / response & communication busses, such as MIL-STD-1553B & Ethernet	Electrical compatibility, but must comply with GFE ICD
Standardized interfaces, such as VGA, RS170	Electrical and waveform compatibility
RS-232, RS422, RS423	Electrical compatibility, but must comply with GFE ICD
Standard backplane, such as VME	Basic compatibility, but VME spec. includes a "custom" connector
Use of "Middleware" OE to permit computer HW update	No Application impact when obsolescence redesign(s) introduced
Standard form factor circuit cards	No benefit. Function density, environmentals, and "custom" connector required custom CCAs.

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Wikipedia Definition, 21 Oct 2008

- Open architecture **is a type of computer architecture or software architecture that allows adding, upgrading and swapping components. For example, the IBM PC has an open architecture, whereas the Amiga 500 home computer had a** closed architecture**, where the hardware manufacturer chooses the components, and they are not generally upgradable.**
- **(Deleted definition that relates to Architectural Design of Buildings)**
- **Open architecture allows potential users to see inside all or parts of the architecture without any proprietary constraints. Typically, an open architecture publishes all or parts of its architecture that the developer or integrator wants to share. The open business processes involved with an open architecture may require some license agreements between entities sharing the architecture information.**

21 Oct 2008 Wikipedia Definition, parsed

- Characteristics of Open architecture
  - **allows adding, upgrading and swapping components**
    - **For example, the IBM PC has an open architecture, whereas the Amiga 500 home computer had a** closed architecture**, where the hardware manufacturer chooses the components, and they are not generally upgradable.**
  - **allows potential users to see inside all or parts of the architecture without any proprietary constraints**
    - **Typically, an open architecture publishes all or parts of its architecture that the developer or integrator wants to share. The open business processes involved with an open architecture may require some license agreements between entities sharing the architecture information.**

Building on the Wikipedia 21 Oct 2008 Definition (1 of 2)

BAE SYSTEMS

Wikipedia	Possible Manifestation in Vehicle Design	How does Vehicle Design Enable?
Allows adding, upgrading and swapping components	Uses standard power levels	Meet Military standard vehicle and industry standard backplane bus voltage levels
	Uses standard form factor and connectors	Select and implement commercial standard card and connector specifications
	Meets environmentals	Provide an environment that adapts vehicle environmentals to commercial specifications
	Uses standard communication busses	Use popular commercial busses
	Follows communications standards	Use accepted protocols for communication busses
	Comes with drivers that bridge component to OS	Software architecture contains a “driver” layer, and implements appropriate standards
	Software runtime is compatible with OS	Use an Operating Environment “Middleware” to isolate applications from OS
	Firewalls for hard real time applications	Architecture to include resource management to assure resource starvation doesn’t occur

Building on the Wikipedia 21 Oct 2008 Definition (2 of 2)

BAE SYSTEMS

Wikipedia	Possible Manifestation in Vehicle Design	How does Vehicle Design Enable?
allows potential users to see inside all or parts of the architecture without any proprietary constraints	Documentation partitioned to describe services, communication & task management interfaces of core and upgradeable capabilities; no documentation of sensitive capabilities	Assure appropriate development documents are suitable for public release

BAE SYSTEMS

Do the Assumed 2008 Open Architecture Goals Add New Requirements? (1 of 2)

Goals of Today's Open Architecture Definition for Military Vehicles	Possible Manifestation in Vehicle Design	How does Vehicle Design Enable?
Avoid developing unique designs and proprietary solutions when industry accepted standards exist	Use industry accepted standards, covered earlier	Covered earlier
Enable use of commercial hardware and software solutions, when suitable	Use commercial hardware	Adapt between vehicle and commercial environmentals. Covered earlier
	Use commercial software	Provide middleware or Operating Environment to isolate OS from commercial SW. Covered earlier
		Possibly modify design of commercial software
Maximize upgradeability with commercial hardware and software solutions, when suitable	Covered above	Covered Above

Do the Assumed 2008 Open Architecture Goals Add New Requirements? (2 of 2)

BAE SYSTEMS

Goals of Today's Open Architecture Definition for Military Vehicles	Possible Manifestation in Vehicle Design	How does Vehicle Design Enable?
Support not-well-defined or constrained increases in platform computer resource needs.	Include reserve space for additional hardware	Leave room for new chassis or empty slots in existing chassis
	Include space for additional memory capacity	
	Include reserve electrical power to run that hardware	Add reserve to power budget
	Include present and future voltage levels to power that hardware	Provide traces to empty slots for possible future power supply CCAs
	Include space and data bus allocations for user interface escalation	Provide connector reserve capacity or extra unused connectors

Mapping of Prior Definitions to U.S. Navy Open Architecture Definition

LynuxWorksTM Website Definition of U.S. Navy Open Arch.	Covered Earlier?	How does Vehicle Design Enable?
Modular design and design disclosure	Yes	
Reusable application software	No	Requires application software works with standard or disclosed APIs, system unique parameters must be loaded at runtime
Interoperable joint warfighting applications and secure information exchange	Not covered, per se	Provide computer resources and APIs for applications and a certified architecture for secure info. exchange
Life-cycle affordability	Not articulated	Meet all aforementioned requirements
Encouraging competition and collaboration through development of alternative solutions and sources		

The Seven Affordability Sins of Logistics System Integration

Tom Herald, Ph.D.
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Simulation, Training & Support

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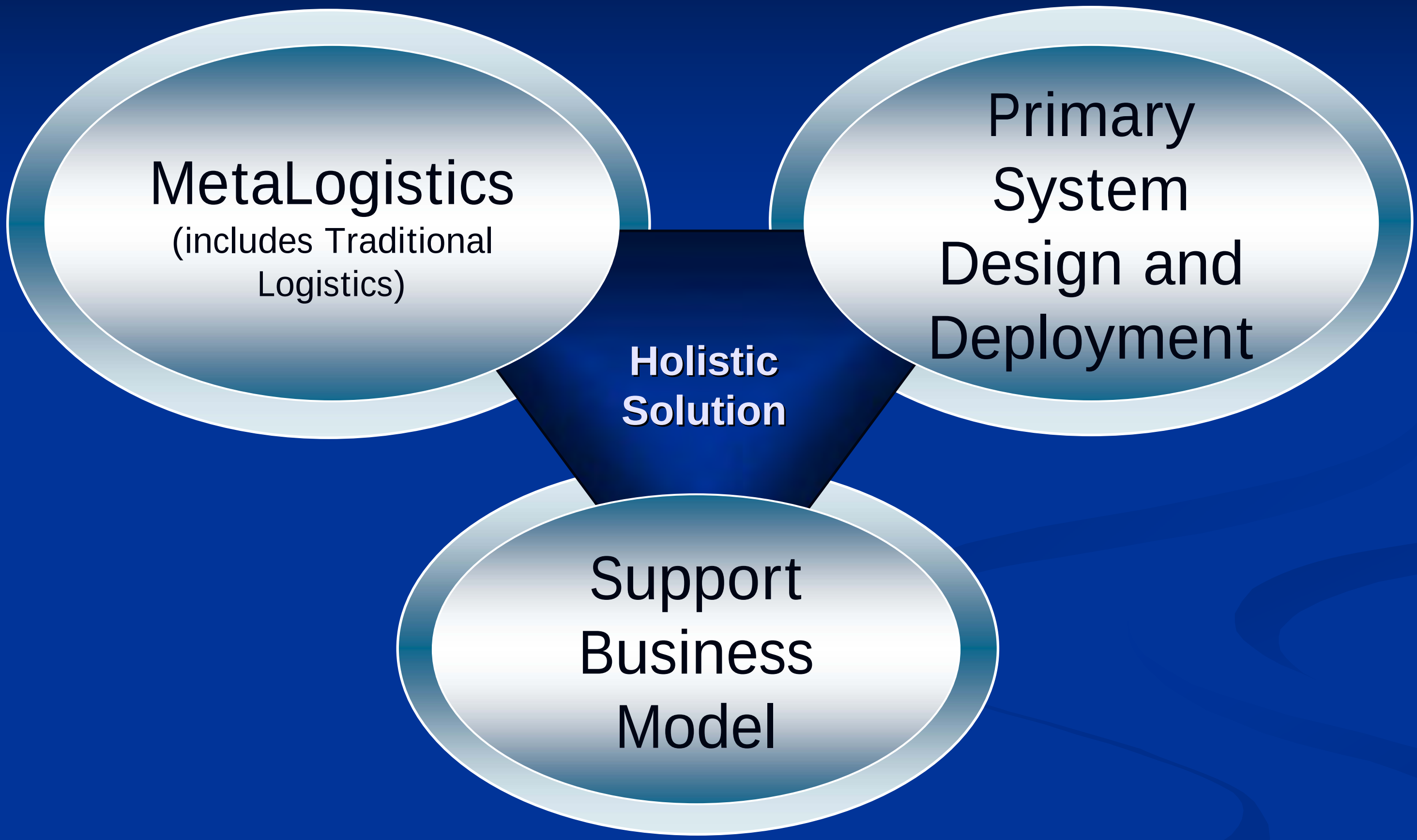
Info Systems &Global Sustainment

Attributes of System Operational Effectiveness



The focus and funding are often centered on delivering tactical systems; however, a more holistic focus is on delivering mission capabilities.

How do we move our focus to “Mission” vs. “System”?

- As the DoD’s business model continues to evolve, its focus on meeting varying mission needs within a bounded O&S budget is pushing for some kind of an evolutionary business approach.
- Our Processes and Tools are “System (or Platform)-centric”
- What else is needed in order to perform a mission? What is driving increasing O&S costs, reducing much need modernization funds?
- Unfortunately, Enabling Systems are still often implemented AFTER the delivered tactical system and as an externally designed system. This approach has been successful for many years, but TODAY does not lead to the most AFFORDABLE and mission ready systems.

“Always design a thing by considering it in its next larger context – a chair in a room, a room in a house, a house in an environment, and an environment in a city plan.”

- Eliel Saarinen, Finnish Architect

Helsinki, Finland Railway Station

The Seven Affordability Sins . . .

- Sin 1: Insufficient customer needs analysis (i.e. dig deeper and broader)
- Sin 2: Belief that all requirements can be deduced before the system is deployed.
- Sin 3: Ignore the system requirements necessary to permit enabling systems success.
- Sin 4: Usability design that is engineering-centric versus user-centric.
- Sin 5: Designs without the human-in-the-loop considerations.
- Sin 6: Acquisition cost focused.
- Sin 7: Limited consideration for net-centric environment integration.

Approaches for improving the affordability of mission success, through a more holistic approach for designing complex systems

Sin 1: Insufficient customer needs analysis (i.e. dig deeper and broader).

- **Issue:** By not digging to the 'root need', an incorrect support enabling system solution may result.
- Learning opportunities:
  - **'Carrier Electro-Magnetic Radiation Signature'**
    - Accurate Design Algorithms
    - Successful Design implemented on a helicopter platform
    - BUT: Puts humans in harms way (Helicopter Pilots say . . .)
    - Technical merit beauty, but failure to meet holistic operational expectations.
  - **Aerial Common Sensor ISR Army Aircraft**
    - Requirements creep to include cross-service utilization with Navy
    - More customers often means more needs
    - Tends to cumulatively add to functionality versus integrate easily with existing functionality (a bolt-on functional mentality)
    - This program was terminated due to unacceptable growth in weight, that drove increase in cooling and power requirements that became a negative viscous cycle.

Sin 1 Conclusion . . .

- Requirements Management (creep) is often cited as a root cause for unsuccessful programs.
- Wait a minute! We're smart engineers, we know that requirements creep is a problem, So WHY does it keep happening?!
  - No schedule time for sufficient customer needs analysis
  - No holistic enabling system (support) integration
- Result: The Primary and Support Systems are not integrated and thus the requirements evolve separately.
- Thought: What about the "Development Environment System?"

Discovery and evolution through the design phase is natural. Needs analysis done well accelerates functional discovery AND minimizes unforeseen requirements creep.

Sin 2: Belief that all requirements can be deduced before the system is deployed.

- **As an extension of Sin 1:** Even excellent needs analysis may still assumes a-priori knowledge of the full breadth of the operational uses, environments, laws, etc. This is typically NOT a reasonable assumption.
- Learning opportunities:
  - **Acoustic Rapid COTS Insertion (ARCI) Navy program**
    - Requirements are the variable; cost and schedule are locked
    - System obsolescence (support) and functional growth are merged
    - The system to evolves capabilities annually
  - **Aircraft weight grows at the rate of '1-pound per day of deployed operations'**
    - Bolt-on functionality growth approach
    - ~ 300 pounds per year for 20 years = 6000 pounds!
    - Also additions to size, weight, power, cooling, logistics footprint.
    - Knowing this military history, do we design for this in mind??

Sin 2 Conclusion . . .

- Clearly define a tradable space for system evolution that becomes your decision algorithm for changes.
  - Consider Life Cycle Cost, Reliability, Risk, and Performance as a 4-dimensional trade space as a means of managing growth requests.
- Ensure that the architecture is truly open and permits evolution of the underlying hardware and software physical solutions

Army OODA Loop – In battle situations there is a constant loop of Observe, Orient, Decide and Act. Continuously manage emergent information.

Suggestion: Instead of fearing requirements creep, we should embrace the dynamic nature of a system design through incremental, spiral, and agile development methods.

Sin 3: Ignore the system requirements necessary to permit enabling systems success.

- **Issue:** Enabling systems often do not get 'equal design focus' and yet the impacts of a flaw in the enabling systems are often program show-stoppers
- Learning Opportunities:
  - F-117 Nighthawk – First stealth fighter
    - Disruptive technology that revolutionized battle options
    - Still one of the finest, most technologically-advanced fighters in aviation history.
    - World-class mission capabilities as evidenced during Desert Storm
    - The initial design focus was stealth fighting capability, quickly.
    - The enabling system operational consideration was given a "back-seat".
    - The enabling systems also have world-class records with keeping the aircraft flying; however, the costs for this support are quite high. .
  - New environments (Desert to Rain Forest to South Pole), New uses (unforeseen requirements), and Emerging threats
    - These conditions can take an apparently successful system solution and render it unsuccessful. Desert Storm was an eye-opener for the assumption that performance and reliability were the same in a high-grit, high-heat environment.
    - Getting the enabling system materiel "in country" was efficient, but made useless because the enabling system was not designed to get them to "point of use"

Conclusion 3 . . .

- Does your system requirements management database have derived supportability requirements included?
- Typically not; however, the high-level supportability requirements are often delineated in the Originating Requirements Document or the Statement of Work.

The "best performing system design ever" will still fail if the consumables and logistics tail are not sufficient to ensure system Operational Effectiveness.

Integrated design for support – Supportable design – Support the design affordably

Sin 4: Usability design that is engineering-centric versus user-centric.

- **Issue:** Designers are too often enamored with functional elegance and flexibility making everything in the solution a variable; however this demands too much user interaction and intimate process knowledge in order to properly provide inputs and interpret system outputs.
- Learning Opportunities:
  - **MOP4 operations**, where soldiers are wearing Chem-Bio suits
    - Allow for system operations with bulky gloves
    - Extreme environments, fatigue, heat, cold, etc.
  - Move toward **Autonomic Logistics** versus traditional support options
    - More system integration
    - User-centric designs and focus, versus functional decompositions
    - Learning systems versus static systems

Conclusion 4 . . .

- Marine Corp Embedded Platform Logistics System (EPLS) Gene Morin, Program manager is quoted as saying, **“I want my Marines to have their fingers on triggers and not on keyboards.”**
- This says it concisely. Logistics support systems should “make things happen, when they need to happen, and without human intervention if at all possible”.

Suggestion: Carefully trade functional flexibility with user simplicity. To this end, possibly consider multiple modes, Users and Use Cases. WHEN at a minimum? At all Design Reviews.

User-centric design methodologies, and using the recommendation from Sin 1, ensure that deep dive analysis distills the relevant information which can be absorbed in a “User glimpse”.

Sin 5: Designs without the human-in-the-loop considerations.

- **Issue:** Major Total Ownership Cost (TOC) and System effectiveness are driven by Humans in the System
- Learning Opportunities:
  - **Air Bag Design (initial designs)**
    - Requirements defined in early ’80’s and deployed in early ’90’s
    - Design for men only (50 Percentile Male)
    - The Air Bags themselves were causing female fatalities
  - **U2 Spy Plane***
    - Disruptive technology with landmark capabilities
    - 70,000+ ft altitude and extended loiter times*
    - Requires space suits for pilots, no relief, no physical movement possible, etc. The pilot was a back-seat consideration.

Would we design the U2 today or might we use a UAV for the mission?

* Source: www.wikipedia.com

Conclusion 5 . . .

- Fight the tradition of 'the way things have always been done', and intentionally put the human inside your system design requirements boundary.
- It may then become obvious that the human is being expected to do 'too much', and therefore, the design team should explore automated and autonomous alternatives for the system solution.

How does the human interact with your system?
Human at risk? Human overloaded (information, attention, actions)?

You may also discover that the maintenance and upgrade for Automation is much cheaper than the humans that are freed up.

Sin 6: Acquisition cost focused.

- **Issue:** A focus on acquisition cost alone when making design decisions is a typical approach; however, leaves much affordability opportunities unleveraged.
  - 70% of the O&S costs are determined as soon as requirements are set.
  - Wait a minute . . . Isn't this a good thing?

- Learning Opportunities:
  - **F-35 Multi-national and Joint-forces Fighter:**
    - Mission Reliability (Operational Availability) is a Key Performance Parameter (TOC too)
    - KPP's for: Sortie Generation Rate and Logistics Footprint
    - $135 B or a 56% estimated TOC savings compared to legacy systems
    - Mission Reliability of over 90% and a 30 day self sustained mission
    - 12% or $16B is expected to come from Enabling System Automation Prognostics & Autonomics
  - **Advanced Amphibious Assault Vehicle:**
    - Acquisition program focused on mature technology and O&S costs.
    - Program office co-located with contractor facility and extensive use of end user assessment of system operational effectiveness.
    - Extensive reliability testing with common components of other Marine Corp. weapons systems.
    - Initial O&S cost savings = $29 million.

Conclusion 6 . . .

- Evolutionary Acquisition approach to design.
  - Incremental development which assumes Life Cycle as a requirement of the Enabling System AND also as a Mission Requirement of the Primary System.

- The design “end state” needs to include the system life cycle through to disposal.

TOC and Performance must be of equal importance in the design trade space.

Move is from a ‘point solution’ (Performance) to an ‘evolutionary solution’ perspective.

Sin 7: Limited consideration for net-centric environment integration.

- **Issue:** In a typical development environment, the design team focuses on the requirements for which they are paid to innovatively solve. Also typically, this is viewing the system as a stand-alone entity with interfaces to the world around it.
- The challenge is not as simple as 'does this system talk to that system' but rather the emergent system of systems capabilities and challenges that occur when systems are connected within a network-centric environment.

Conclusion 7 . . .

$$P_{NCS} = \sum_{i=1}^{N} P_i + \sum_{\substack{i=1\\ j=1}}^{N} \left(\sum_{k=1}^{M} \left(P_i \cap P_j\right)_k \right);$$

For all $i \neq j$ AND where $k > 0$ (i.e. the system pairing has connectivity)

- P_{NCS} = The total performance of the Network-Centric System
- P_i = The performance capability of a Stand Alone System (no network connection)
- P_j = The performance capability of a Stand Alone System (no network connection)
- N = The number of Independent Systems (Network Nodes)
- M = The number of independent functional connection paths for a P_i and P_j pairing
- $P_i \cap P_j$ = This intersection represents the resultant performance from the system connectivity, which could be Zero if there is no system advantage or detractor, Positive if the connectivity advantages the ConOps (Mission Needs) or Negative if the connectivity is not required by the ConOps (i.e. outside of the mission performance boundaries)

The net-centric whole is greater than the sum of the systems.
Pairwise additive capabilities, Triples additive capabilities, . . .
Some capabilities are Good and some are Negative in YOUR system.

Principal Recommendations

- Focus on the mission needs, make time for and dig deep to root out the true stakeholder needs.
- Ensure the system is affordably evolvable through the support life cycle.
- The Primary and Enabling Systems must be holistically designed as a single complex System of Systems.
- Document and decompose ALL of the requirements.
- A combined and equal focus of performance and support requirements during design for total system performance responsibility.

Thought: These recommendations outline a more inductive approach to our traditionally deductive engineering paradigm.

SenseResponder LLC
(DRAFT DOCUMENT!!!)

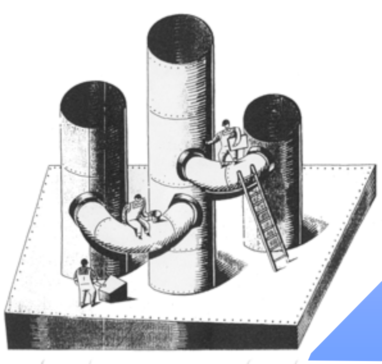
Network Centric Engineering Use of NCOIC Processes and Tools in a Logistics Example

SenseResponder LLC
Tom Dlugolecki – President
(619) 379-2512
22 OCT 2008

SenseResponder LLC Goal

Net-Enabled Logistics Future

Stovepiped Systems, Point-to-Point Networks



NCOIC Membership Comes From These Countries

Australia

Belgium

Canada

Denmark

Finland

France

Germany

Ireland

Israel

Italy

Poland

Spain

Netherlands

Romania

South Korea

Sweden

Switzerland

Turkey

United Kingdom

United States

NCOIC welcomes global membership

Sample NCOIC Members

Members are Global Leaders:

Academic institutions

Air Traffic Management providers

Service providers
- Consulting
- Engineering
- Logistics

Defense suppliers
- All military services
- Multinational

Government agencies

Human service agencies

Integrators
- Commercial systems
- Defense systems

IT firms
- Communications
- Data management
- Human-Machine interface
- Information assurance

Standards bodies

Just a few of the names that you might recognize…

Current Composition of Advisory Council

AC Chairman	Honorable Keith Hall
AC Vice Chairman	General (Ret) Harald Kujat
Swedish MoD	BG Hakan Bergstrom
Joint Staff	VADM Nancy E. Brown, USN
UK MoD	AVM Stuart D. Butler, RAF
Department of Homeland Security	Honorable Jay M. Cohen
Defense Information Systems Agency	Lt Gen Charles E. Croom, Jr., USAF
Italian MoD	Maj. Gen. Pietro FINOCCHIO, ITAF
German Mod	Dr. Gerhard van der Giet
Allied Command Transformation	MGen Koen Gijsbers, RNLA
Assistant Sec of Def/NII	Honorable John Grimes Mr. Jack Zavin
NATO Headquarters C3 Staff	Maj Gen Georges D'Hollander, BE AR
Australian Defence Organisation	RADM Peter Jones
AC Chairman Emeritus	Honorable Paul G. Kaminski
National Geospatial-Intelligence Agency	Dr. Robert Laurine
European Defense Agency	*Mr. Carlo Magrassi
Office of Director of National Intelligence	Honorable Dale Meyerrose
Office of the Secretary of the Air Force	Lt Gen Michael Peterson, USAF
French MoD	BGen Blandine Vinson-Rouchon, DGA
Former ASD/NII	Honorable John Stenbit
US Army	LTG Jeffrey Sorenson
NATO C3 Agency	Mr. Dag Wilhelmsen
NATO CISSA	LtGen Ulrich Wolf
US Joint Forces Command	LTG John R. Wood, USA

*First time attendee

Current S&RL Global Government Participants/CRADA Holders/Members

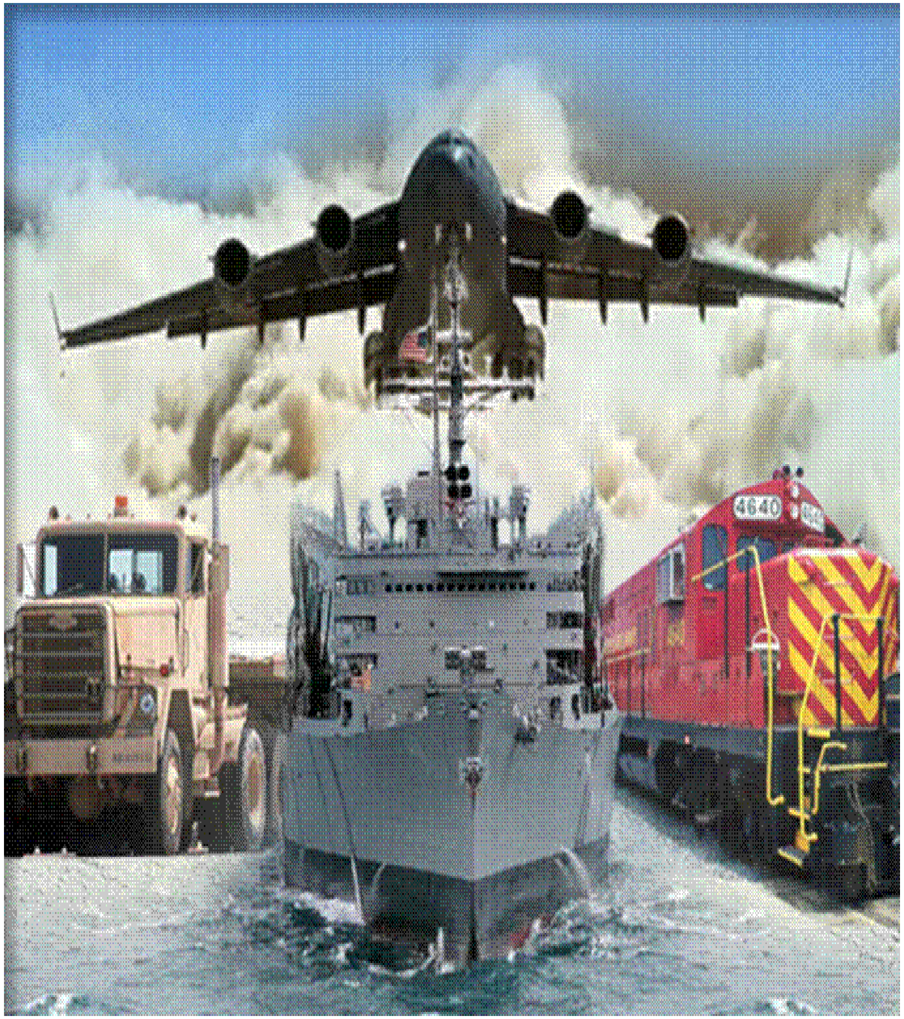
- OSD – ATL (Acquisition Technology & Logistics)
- DISA (Defense Information Services Agency)
- JFCOM (Joint Forces Command)
- NNWC (Naval Network Warfare Command)
- MARCORSYSCOM (Marine Corps Systems Command)
- NATO (North Atlantic Treaty Organization)
- EDA (European Defense Agency)
- ACT (Allied Command Transformation)
- NC3A (NATO C3 Architecture)
- DAU (Defense Acquisition University)
- ONR (Office of Naval Research)
- DLA (Defense Logistics Agency)
- BTO (Business Transformation Office)
- Force Transformation Office (Sense & Respond Logistics)
- DOD Australia

Discussion Objectives

- Show the Strategic Plan to develop a Global Network Centric Logistics Environment.
- Introduce Network Centric Engineering and its application on various projects.
- Designing a Logistics NCE using Operational Descriptions, Standards, Patterns, and Building Blocks.
  - Requirements Validation
    - Operational Descriptions; SCOPE; Well Formed Requirement
  - Standards
  - Patterns
  - Building Blocks

Network Centric Logistics Strategic Plan

1. Identify & Enhance Network Centric Logistics Requirements, Standards, Patterns, and Building Blocks.
2. Build on this framework for a global, commercial & government, logistics community of interest focused on collaboration.
3. Apply the processes & toolset to integrate global network super nodes.
   A. SCLA/DOD: JDDSP (Joint Power Projection Support Platform)
   B. US DOD/NATO/AUSCANNZUKUS: Joint & Coalition SeaBase
   C. NATO: NRF TC (NATO Response Force Training Center)
   D. Commercial Global Logistic Distribution Centers



"Just in Time Delivery" to the Military, Using Commercial Transport Mechanisms (Wal Mart and FedEx style delivery)

Network Centric Engineering Core Competencies

- Requirements Capture
  - Operational Description
  - CONOPS
  - JCIDS Processes and Documents
  - SCOPE (Systems-Capabilities-Operations- Programs- Enterprises) Analysis
  - WFR (Well Formed Requirement) Model
  - Business Process Mapping
  - Other Tools (SCOR, NCAT, etc.)
- Architecture and Lexicon Development
- Modeling and Simulation
- Standards Framework Design and Development
  - Data Sharing Concept and Design
- Operational and Technology Capability Patterns and Guidance
- System and Network Selection from the Building Blocks Repository
- Prototype Building
- Test and Experimentation (Build a little, Test a little, Learn a Lot)
  - Human Systems Integration (DOTMLPF)

Network Centric Engineering for JDDSP Example

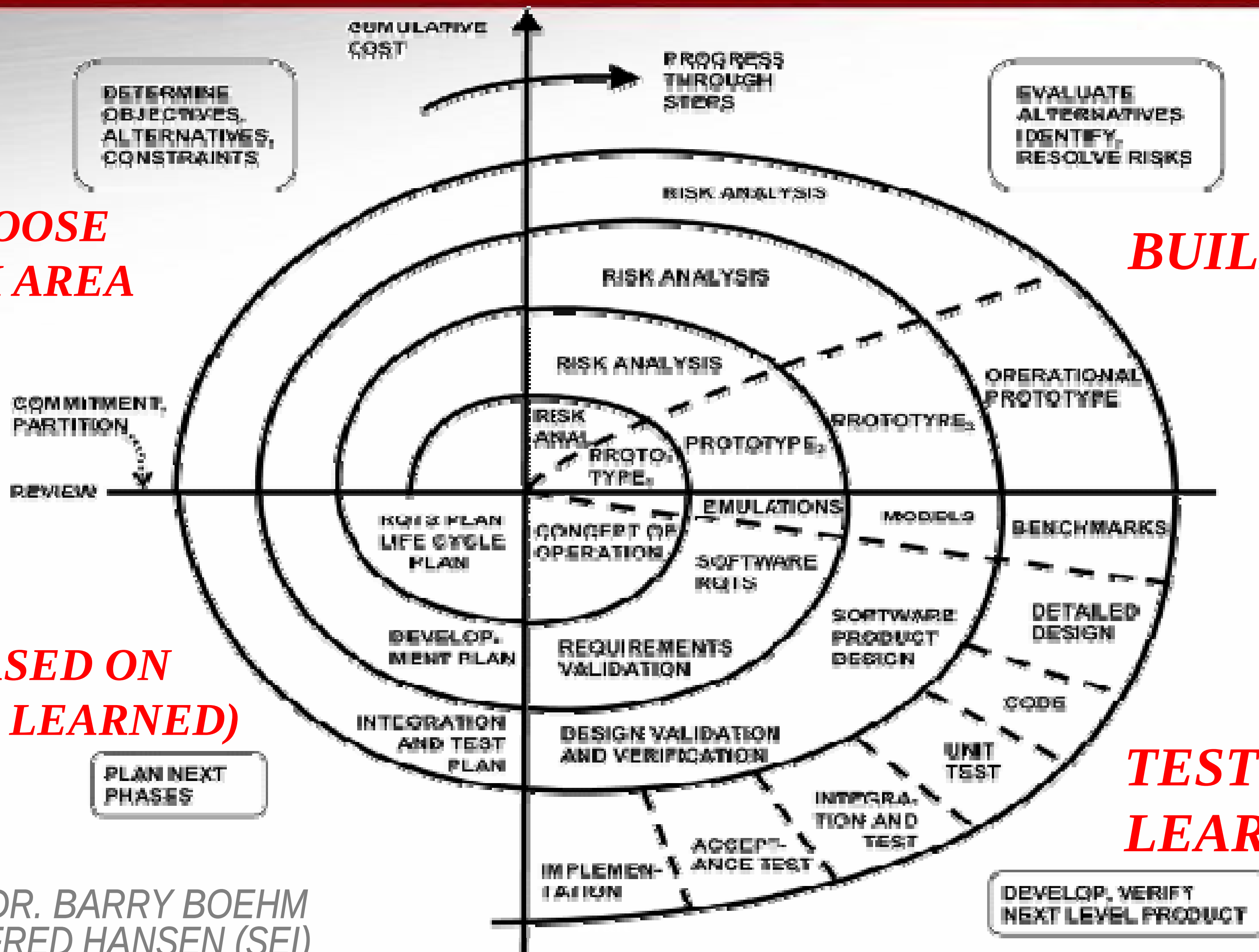
- Requirements Capture (Business Process Analysis)
  - CONOPS => Initial Capabilities Documents
- Process Mapping & Modeling Operations Activities
  - SYSML and Other Models for Various Use Cases and Scenarios
- Architecture Design & Development (Service Oriented Architecture Artifacts)
  - Standards Selection-Integration (NSWG, DISR, SCOPE Analysis, PFC, …)
  - Service Oriented Architecture: GIG Integrated, Open Standards, XML, ...
- Site Physical and Cyber Site Security Plan (Information Assurance)
- JDDSP Experimentation Plan Development (Operational Test-bed Activity)
  - Pacific Northwest Corridor (Force Deployment) Experiment
  - Dole Pacific Shipping (Commercial Distribution) Experiment
  - TATRC Class VIII (Force Sustainment – Sense & Respond Logistics) Experiment
- Sea-Basing Template (JDDSP Interface)
- Prototype Build (System of Systems Integration)
- Execute Experiment to Fill Gaps in Rationale
- Perform Demonstration
  - Human System Integration: DOTMLPF
  - Mission Capability Packages

TRACK #1: EXPERIMENTATION

Risk Reduction through Experimentation

CHOOSE RISK AREA

BUILD



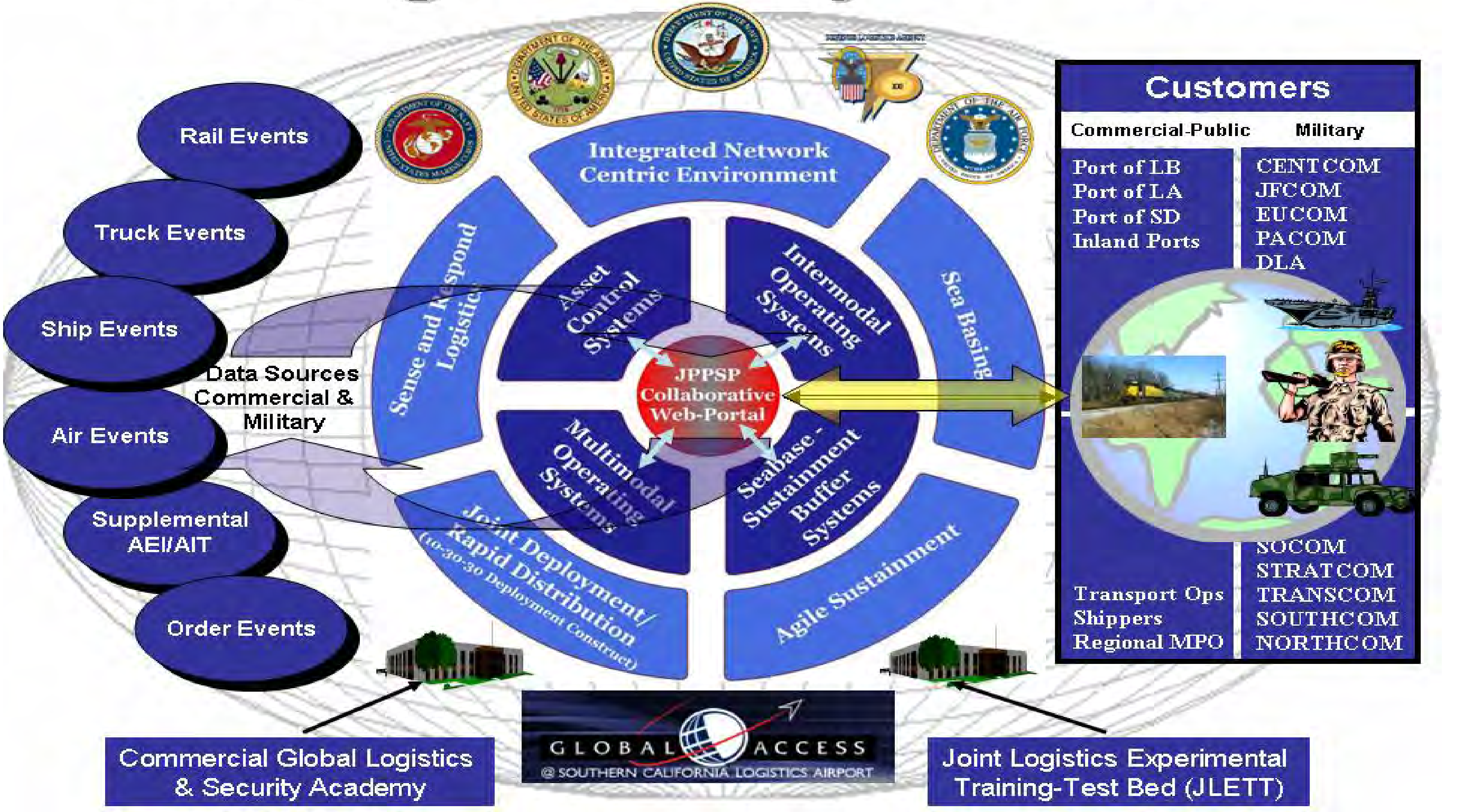
PLAN (BASED ON LESSONS LEARNED)

TEST & LEARN

CREDIT TO: DR. BARRY BOEHM (USC) & WILFRED HANSEN (SEI)

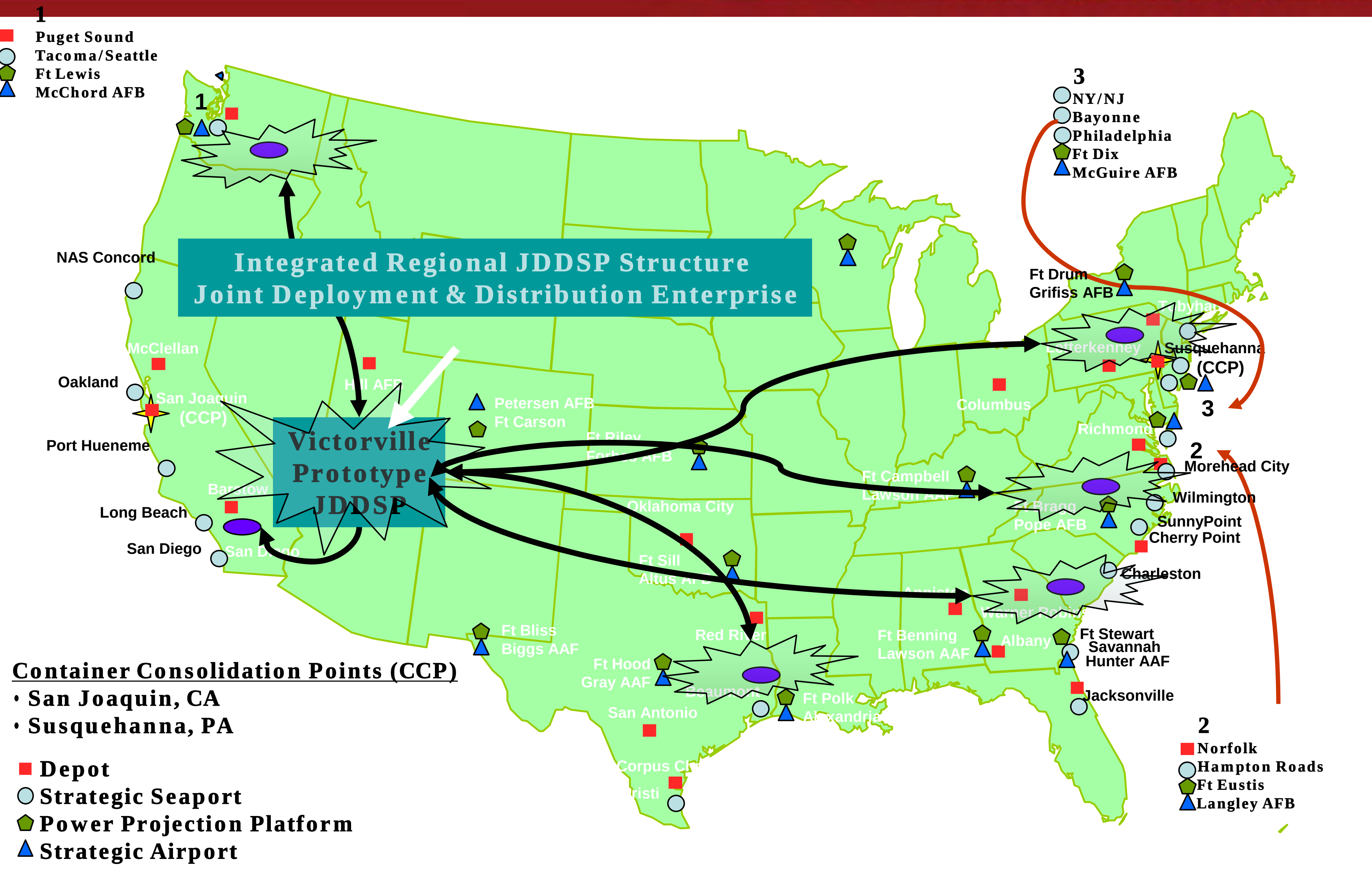
NCL Operational Capability at the JPPSP

Strategic Mobility 21 – OV-1

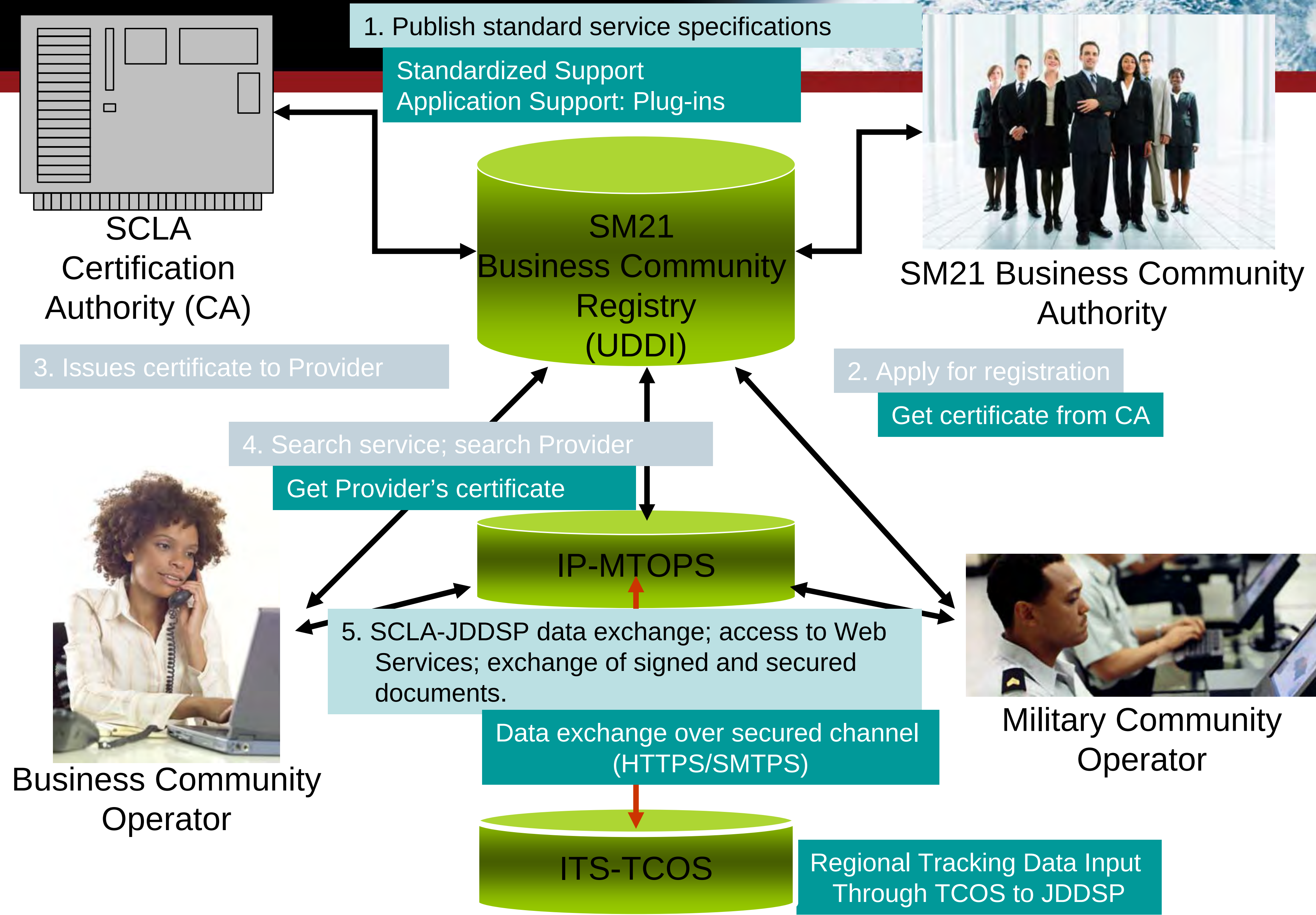


JDDSP Developed to Support:

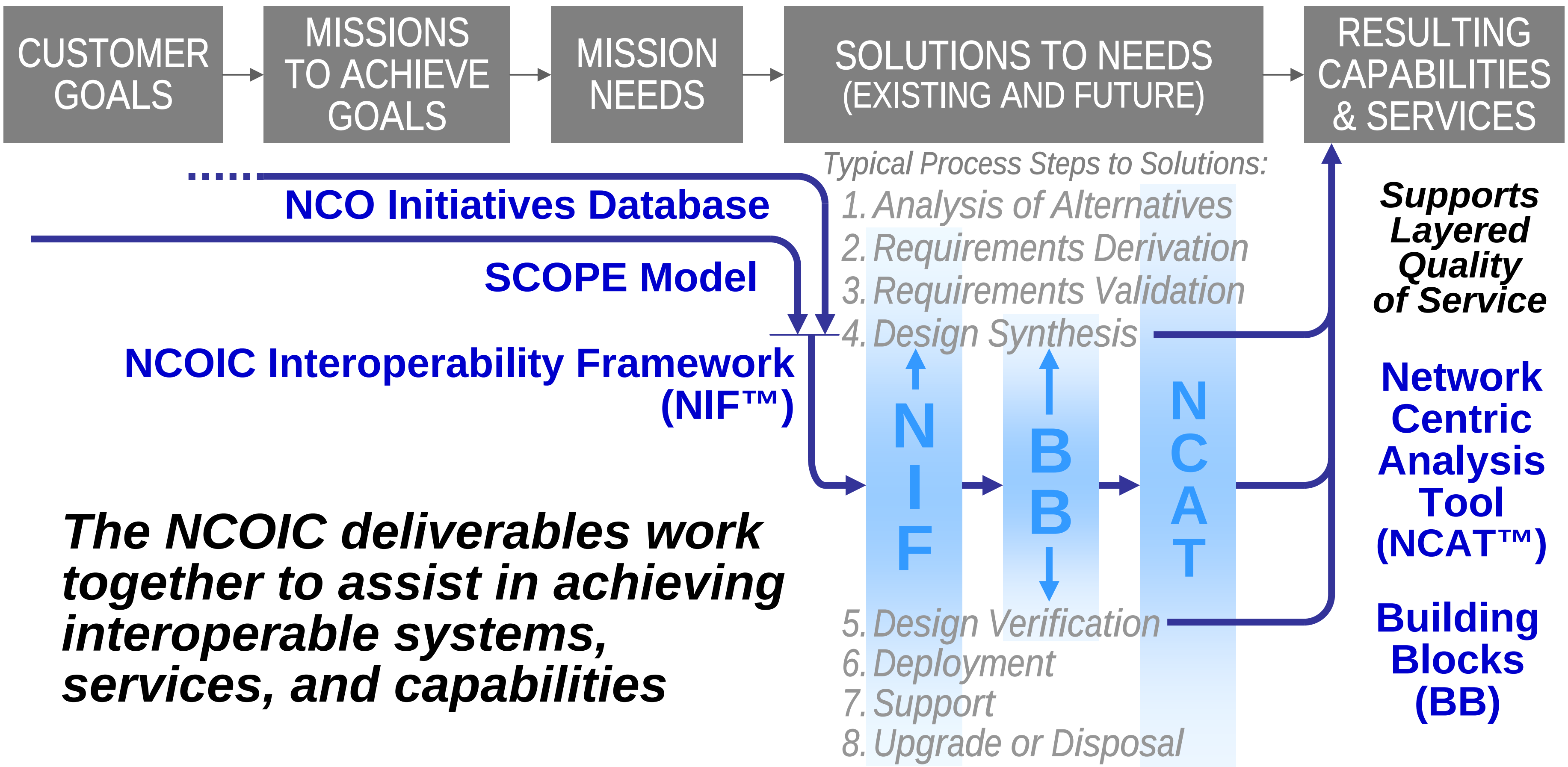
POWER PROJECTION PLATFORMS, STRATEGIC AIR PORTS, SEAPORTS, & DOD DEPOTS



SCLA Business Community SOA



The Process, Tools, and Guidance



The NCOIC deliverables work together to assist in achieving interoperable systems, services, and capabilities

Expeditionary Force Deployment Operational Description

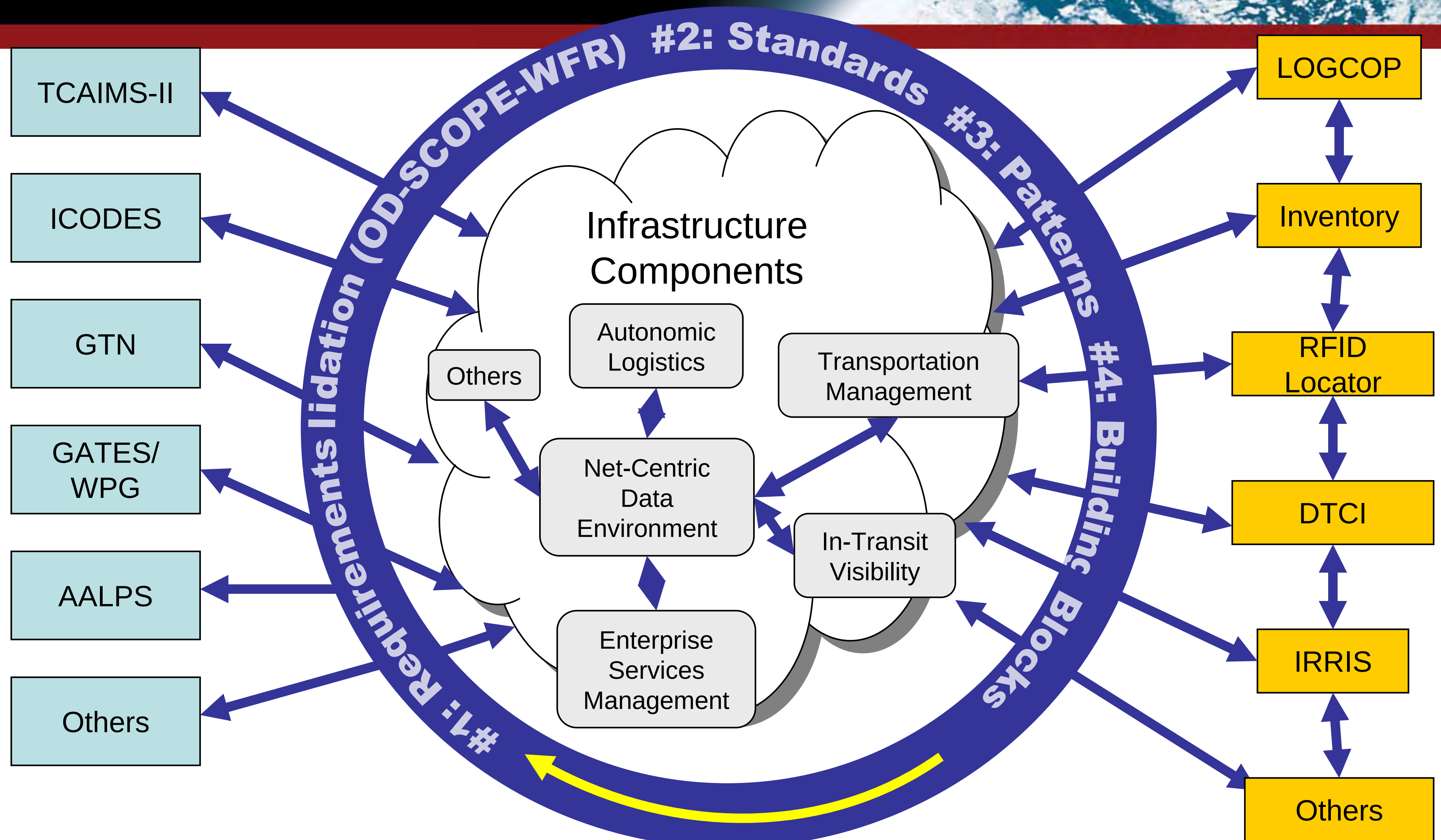
- NCOIC - ONR JDDSP – SR LLC Subject Matter Experts develop an Expeditionary Force Deployment Operational Description (EFD OD), Mission Threads, Scenarios, and CONOPS.

- EFD OD informs the list of standards and application processes on information security and other functions for IT network design.
  - Defined the Potential Patterns to Define Log Domain.
  - Initiated Building Blocks Database for Log Domain.

- Develop NIF patterns that describe Interoperability Criteria to accomplish the Logistics “Total Asset Visibility” mission and use existing commercial infrastructure to deploy/sustain, without disrupting commercial enterprise.
  - e2e visibility replaces 30-day “Iron-Mountain”.
  - Logistics UDOP picture provides max collaboration.

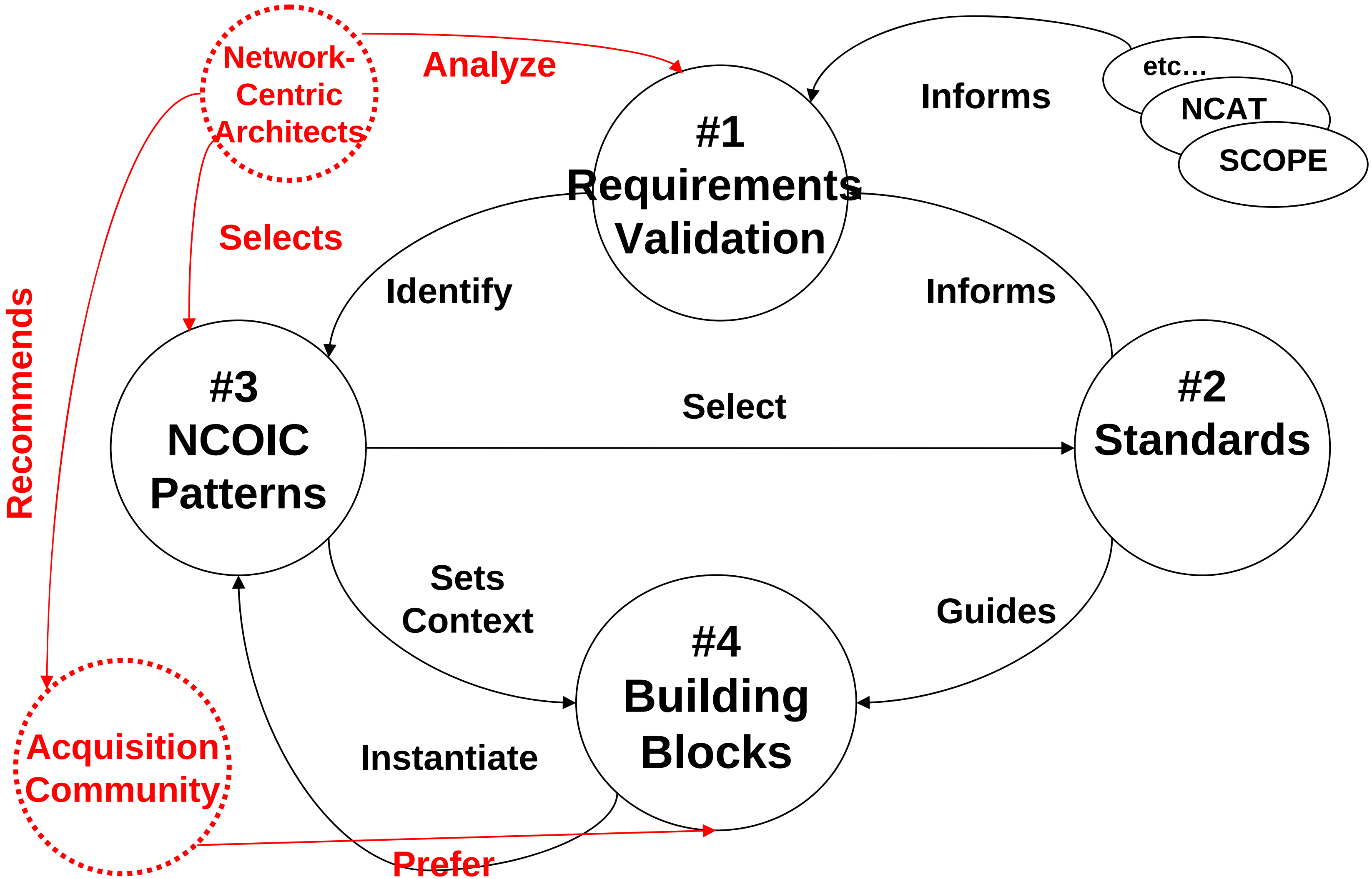
“Just in Time Delivery” to the Military, Using Commercial Transport Mechanisms (Wal-Mart and FedEx style delivery)

Combining Legacy and New Systems in a Network Centric Logistics Node



SenseResponder LLC assists in Requirements Validation; Standards Identification and Cross Linking; Pattern Development for Interoperability Guidance; and a COTS/GOTS Products & Services "Building Blocks" Repository.

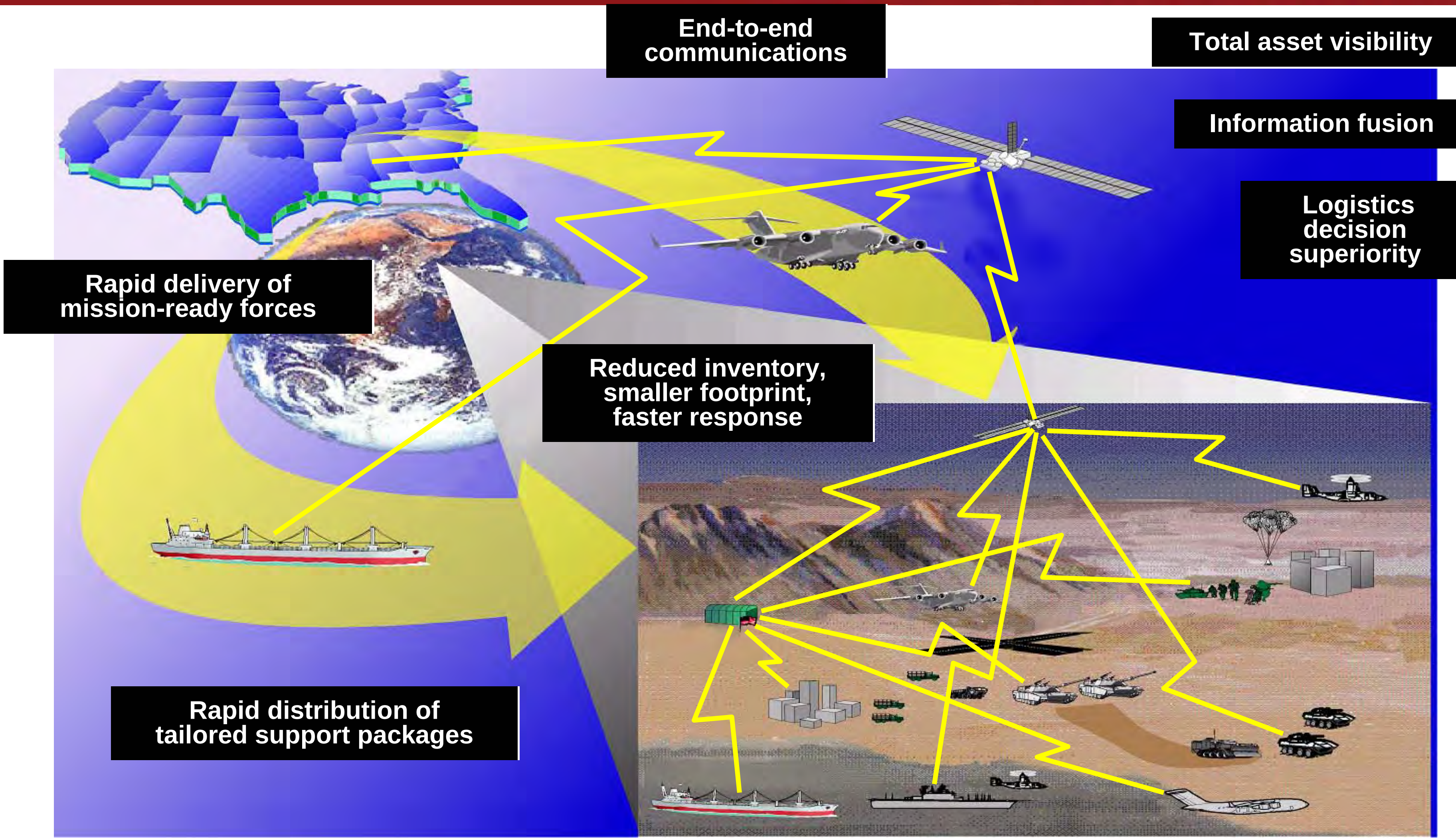
Designing an NCE (Network Centric Environment)



#1: Requirements Validation

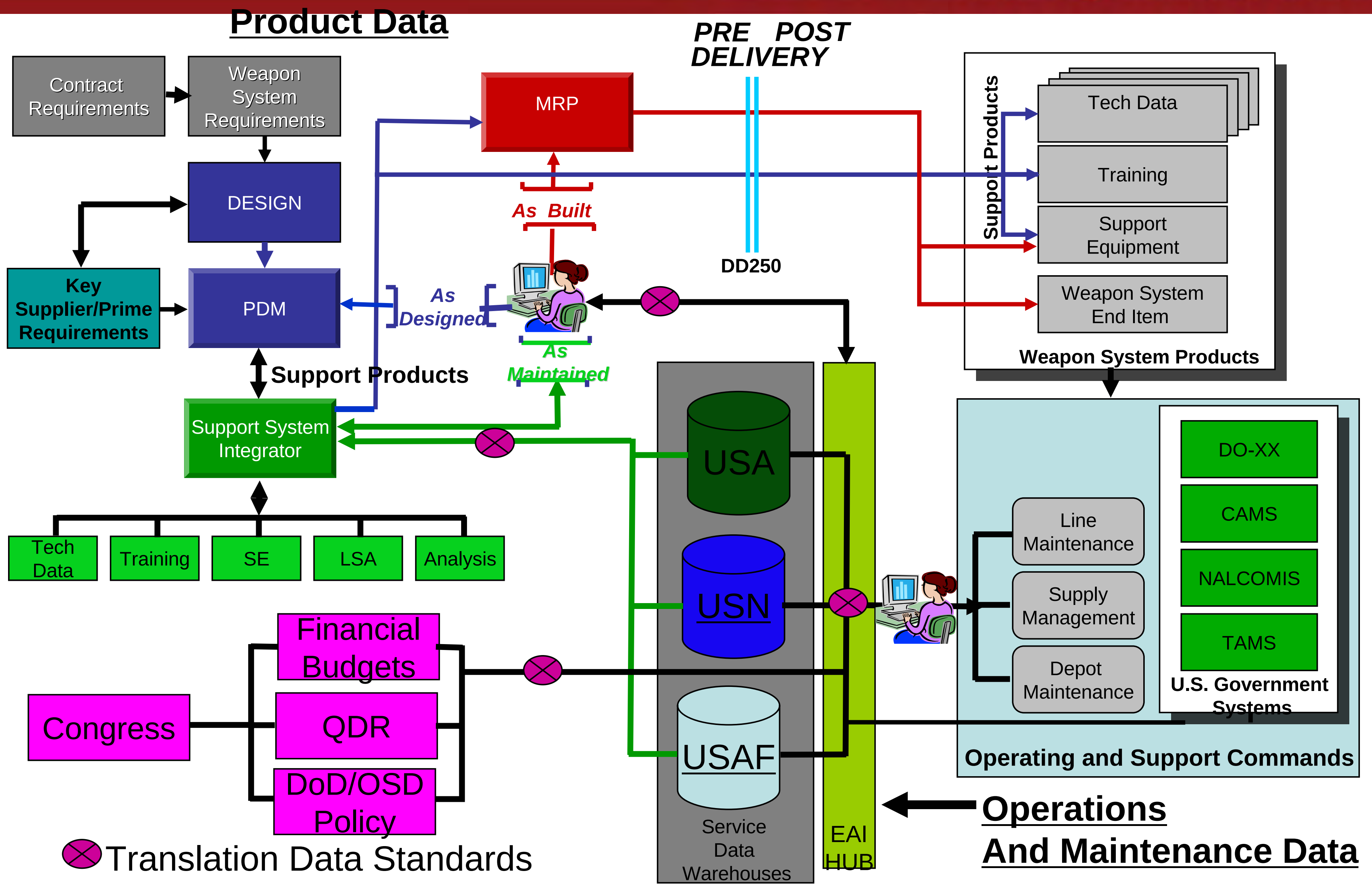
- OD (Operational Description)
- SCOPE (Systems - Capabilities - Operations - Programs - Enterprises) Analysis
- WFR (Well Formed Requirement) Model

Logistics "Operational" Capability

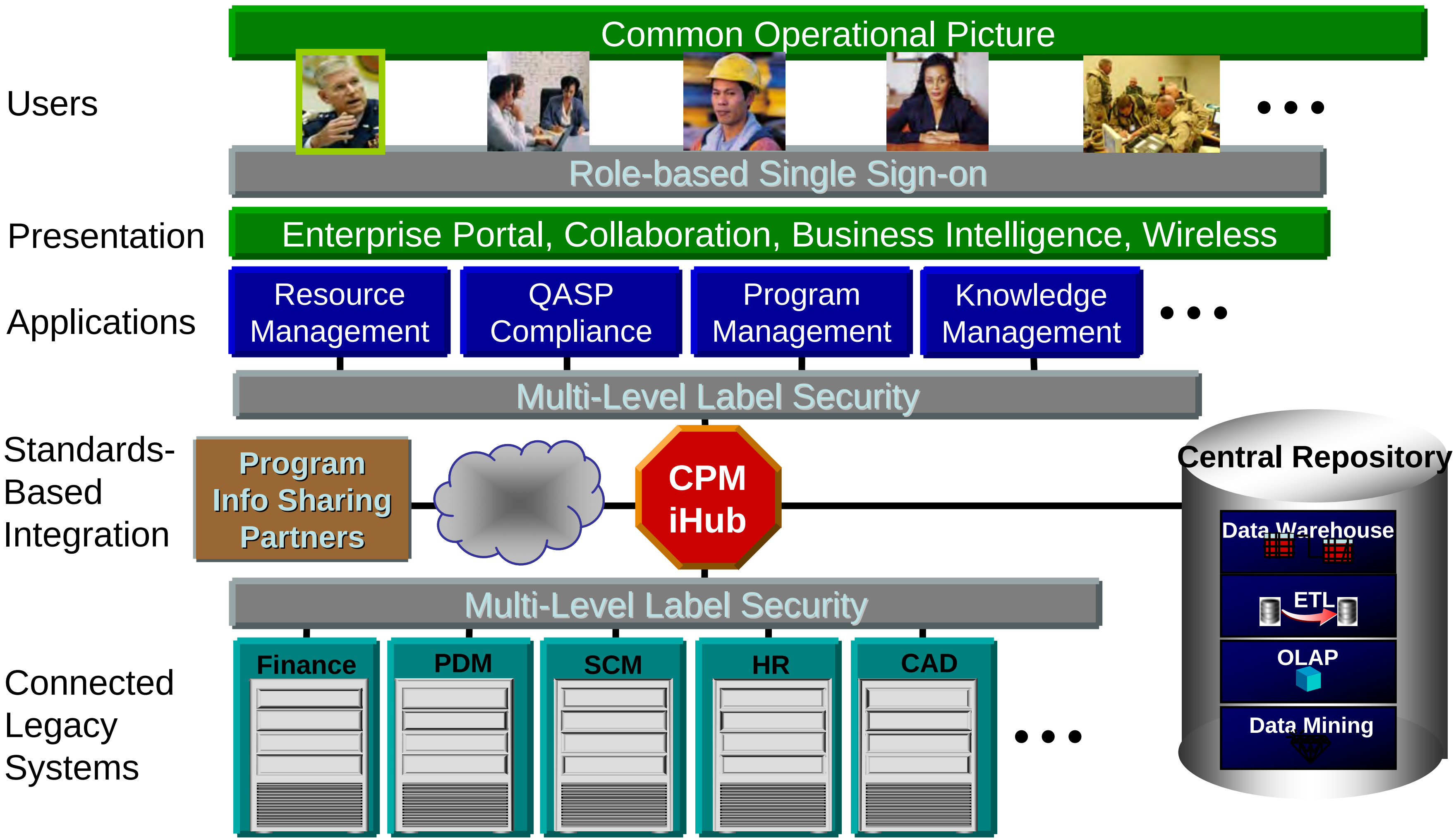


Bottom line: Forces in theater — whether forward-stationed or deployed — deliver more capability, require less support

Logistics "Technical" Capability



Logistics Architecture Solution



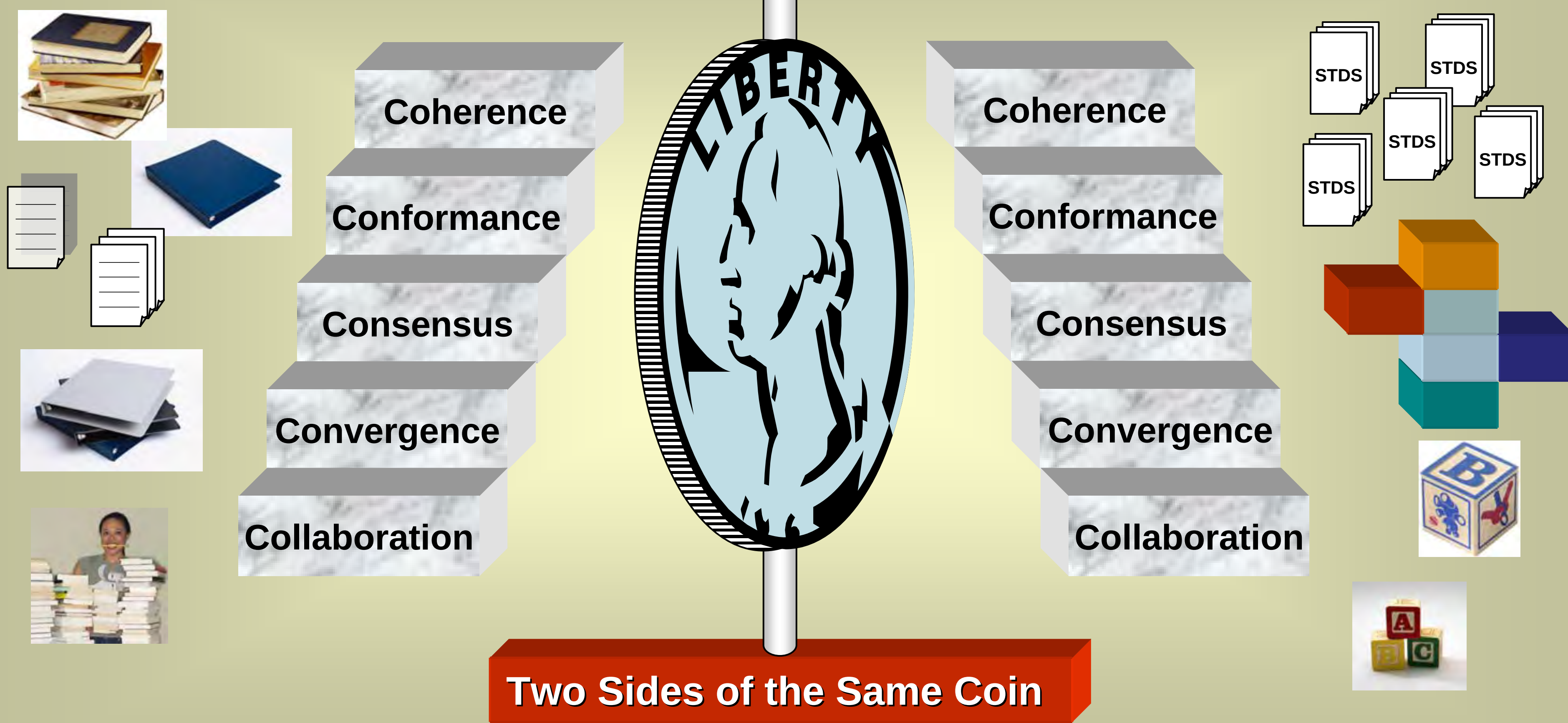
Sample Sense & Respond Logistics Operational Description Document

1. Introduction
2. Architecture Principles and Artifacts
3. S&RL Problem Description
4. S&RL Interoperability Solutions
5. Attributes or Global Aspects
6. Enabling Technology Patterns
7. Interoperability
8. S&RL Open Protocols and Standards
9. Business Model Implications
10. Applicable NCOIC PFCs and External References
11. Network Centric Engineering the JDDSP (Joint Deployment Distribution Support Platform)

Well Formed Requirement

CUSTOMERS
Well Formed Requirements

INDUSTRY
Standards, Patterns and Building Blocks



Dimensions of a Requirement

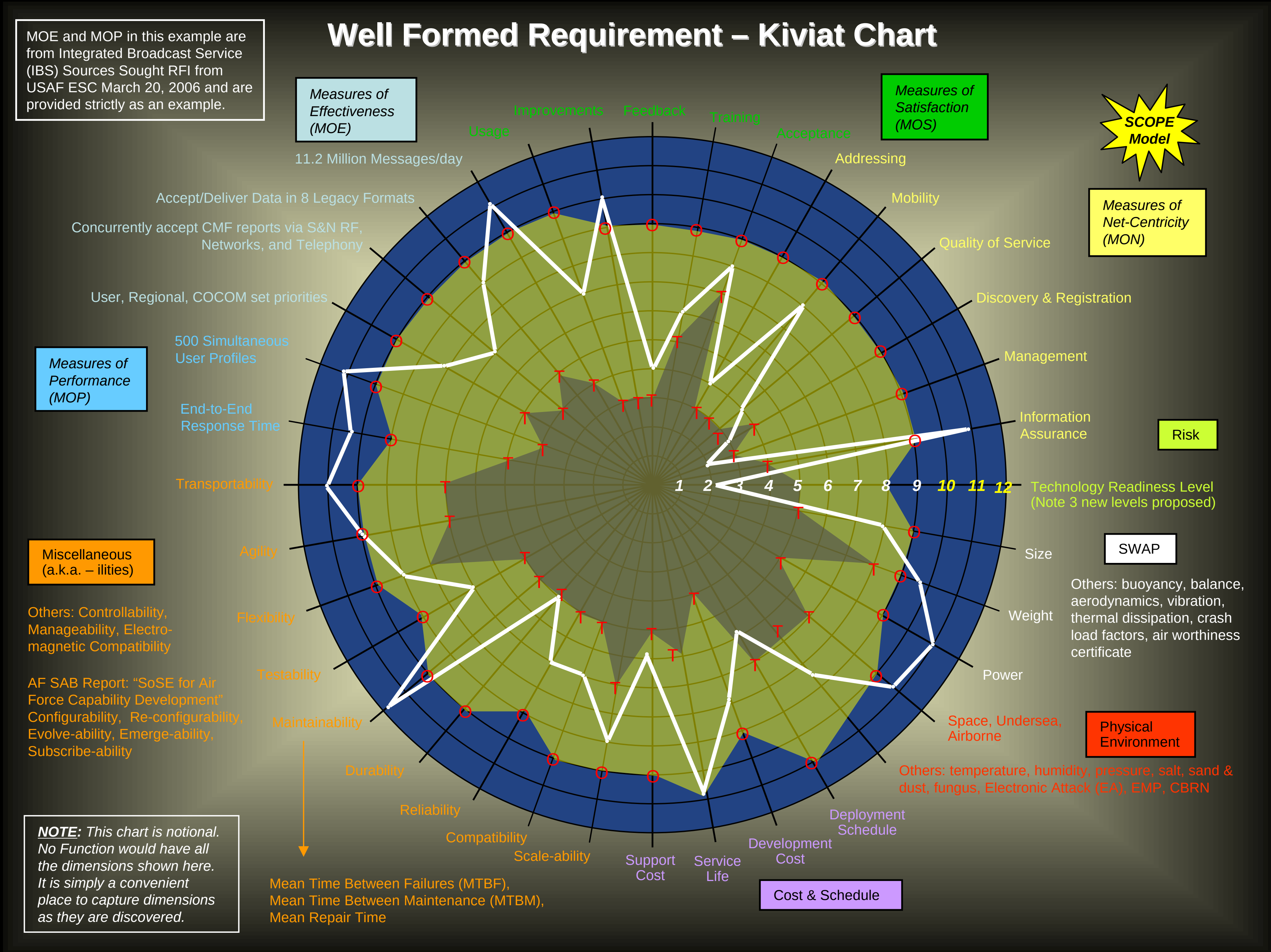
- **Function**
  - **what is to be done**
  - **Usually text description today, but could be a video, simulation, animation, etc.**
  - **Granularity can be from a capability to a service**
- **Constraints –what tolerances must be met**
  - **Measures of Effectiveness (MOE)**
  - **Measures of Performance (MOP)**
  - **Measures of Net-Centricity (MON) – new and analyzed in NCOIC SCOPE model**
  - **Measures of Satisfaction (MOS) – new to DoD**
  - **Size, Weight, And Power (SWAP)**
  - **Costs and Schedules**
  - **Risk Tolerance (TRL - Technology Readiness Level)**
  - **Miscellaneous (a.k.a. the "ilities"**
- **Operational Context**
  - **Physical Environment**

From Requirements to Solution

- Function and Operational Context are usually well understood and unchangeable [*without doctrine or CONOPs rework]
- Solution usually requires trade-offs among the multiple constraint dimensions
  - For example trading reduced durability for lighter weight
- Some constraints are more inflexible than others or have tighter range of values in different Operational Contexts
  - Reliability (MTBF) for space-based radio transmitter on a missile launch early detection satellite much higher and less negotiable than for a tower-based radio transmitter for the Voice of America
- Selected solution is often the alternative that:
  - performs the function…
  - in the operational context…
  - and “best fits” the customer and contractor “agreed upon” blend of constraints resulting from trade-offs determined during architecture or system design

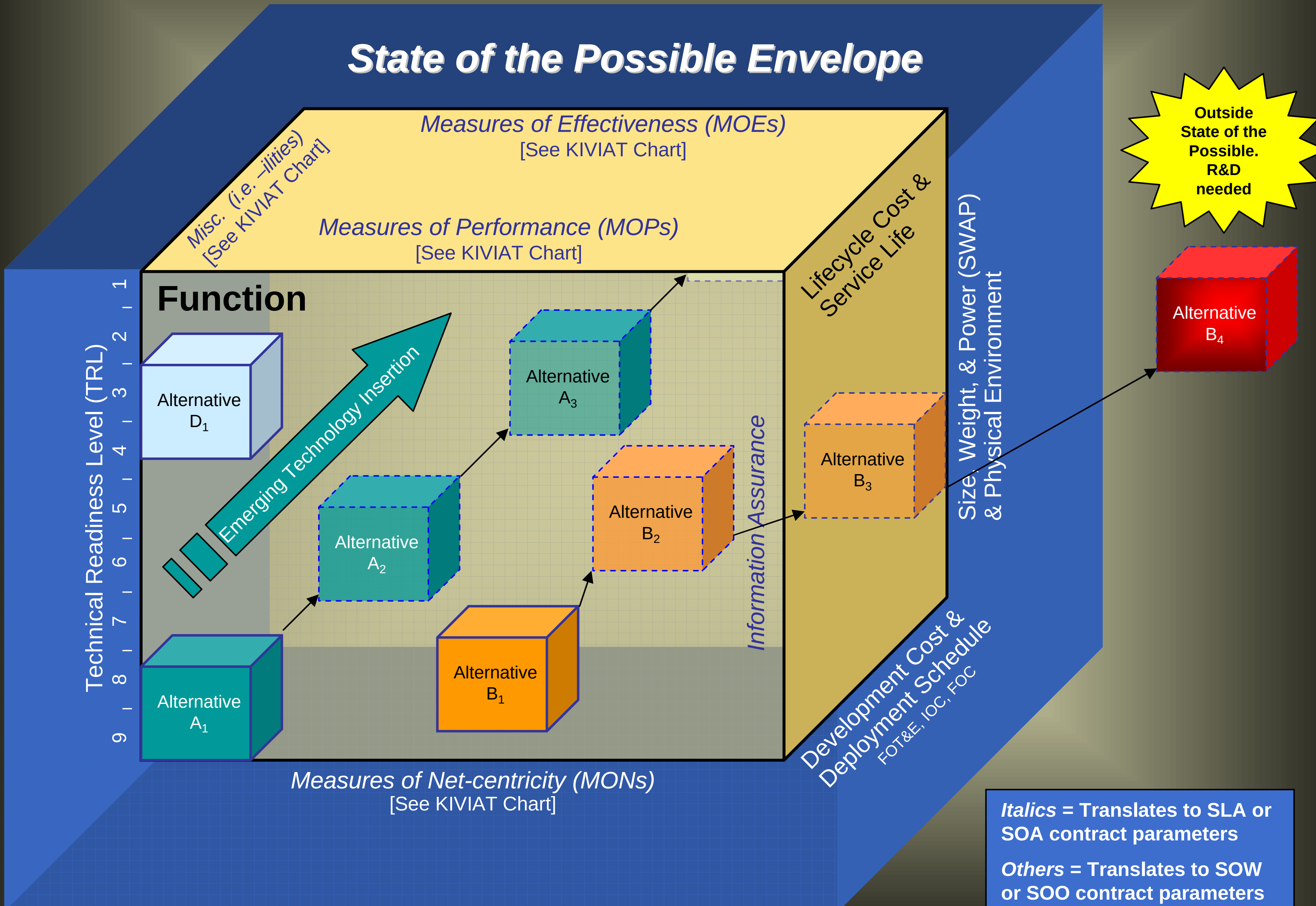
Policy vs. Contractual vs. Service Level Agreement

- **For a given Function In a given Operational Context:**
  - Some requirement dimensions will be best specified as contractual obligations such as acceptance criteria or incentive fee items
  - One time measurement against specification
- **Some requirement dimensions will be best specified as Service Level Agreements (SLAs)**
  - Continuous measurement against specification
- **Some requirement dimensions will be consensus globally, some nationally, some military vs. commercial, and some within COI**

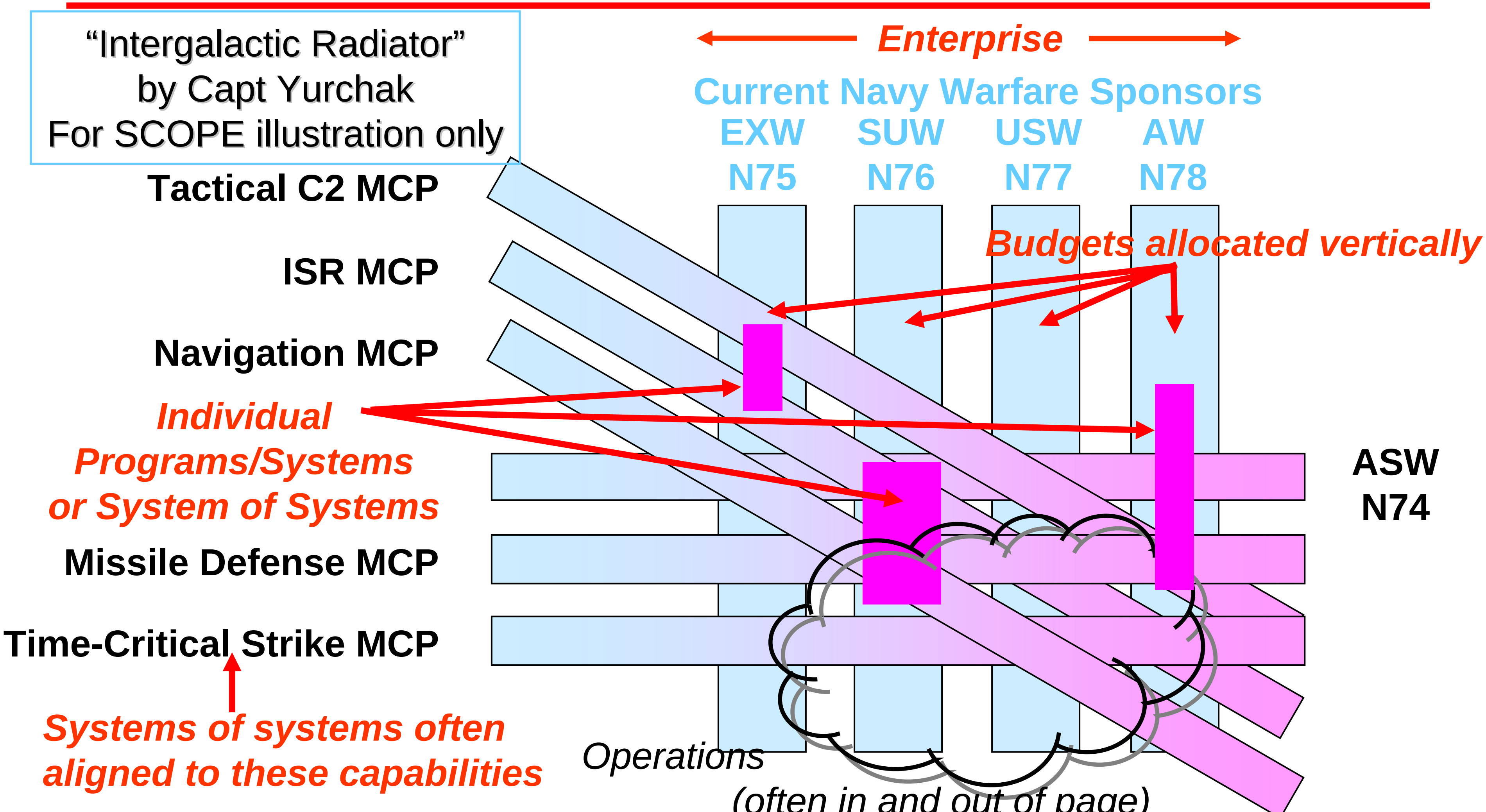


Well Formed Requirement – Kiviat Chart
MOE and MOP in this example are from Integrated Broadcast Service (IBS) Sources Sought RFI from USAF ESC March 20, 2006 and are provided strictly as an example.
Measures of Effectiveness (MOE)
Measures of Satisfaction (MOS)
SCOPE Model
Measures of Net-Centricity (MON)
Measures of Performance (MOP)
Miscellaneous (a.k.a. – ilities)
Risk
SWAP
Physical Environment
Cost & Schedule
Usage
Improvements
Feedback
Training
Acceptance
Addressing
Mobility
Quality of Service
Discovery & Registration
Management
Information Assurance
Technology Readiness Level (Note 3 new levels proposed)
1 2 3 4 5 6 7 8 9 10 11 12
Size
Weight
Power
Space, Undersea, Airborne
Others: buoyancy, balance, aerodynamics, vibration, thermal dissipation, crash load factors, air worthiness certificate
Others: temperature, humidity, pressure, salt, sand & dust, fungus, Electronic Attack (EA), EMP, CBRN
Deployment Schedule
Development Cost
Service Life
Support Cost
Scale-ability
Compatibility
Reliability
Durability
Maintainability
Testability
Flexibility
Agility
Transportability
11.2 Million Messages/day
Accept/Deliver Data in 8 Legacy Formats
Concurrently accept CMF reports via S&N RF, Networks, and Telephony
User, Regional, COCOM set priorities
500 Simultaneous User Profiles
End-to-End Response Time
Others: Controllability, Manageability, Electro-magnetic Compatibility
AF SAB Report: "SoSE for Air Force Capability Development" Configurability, Re-configurability, Evolve-ability, Emerge-ability, Subscribe-ability
Mean Time Between Failures (MTBF), Mean Time Between Maintenance (MTBM), Mean Repair Time
NOTE: This chart is notional. No Function would have all the dimensions shown here. It is simply a convenient place to capture dimensions as they are discovered.

ANALYSIS of ALTERNATIVES



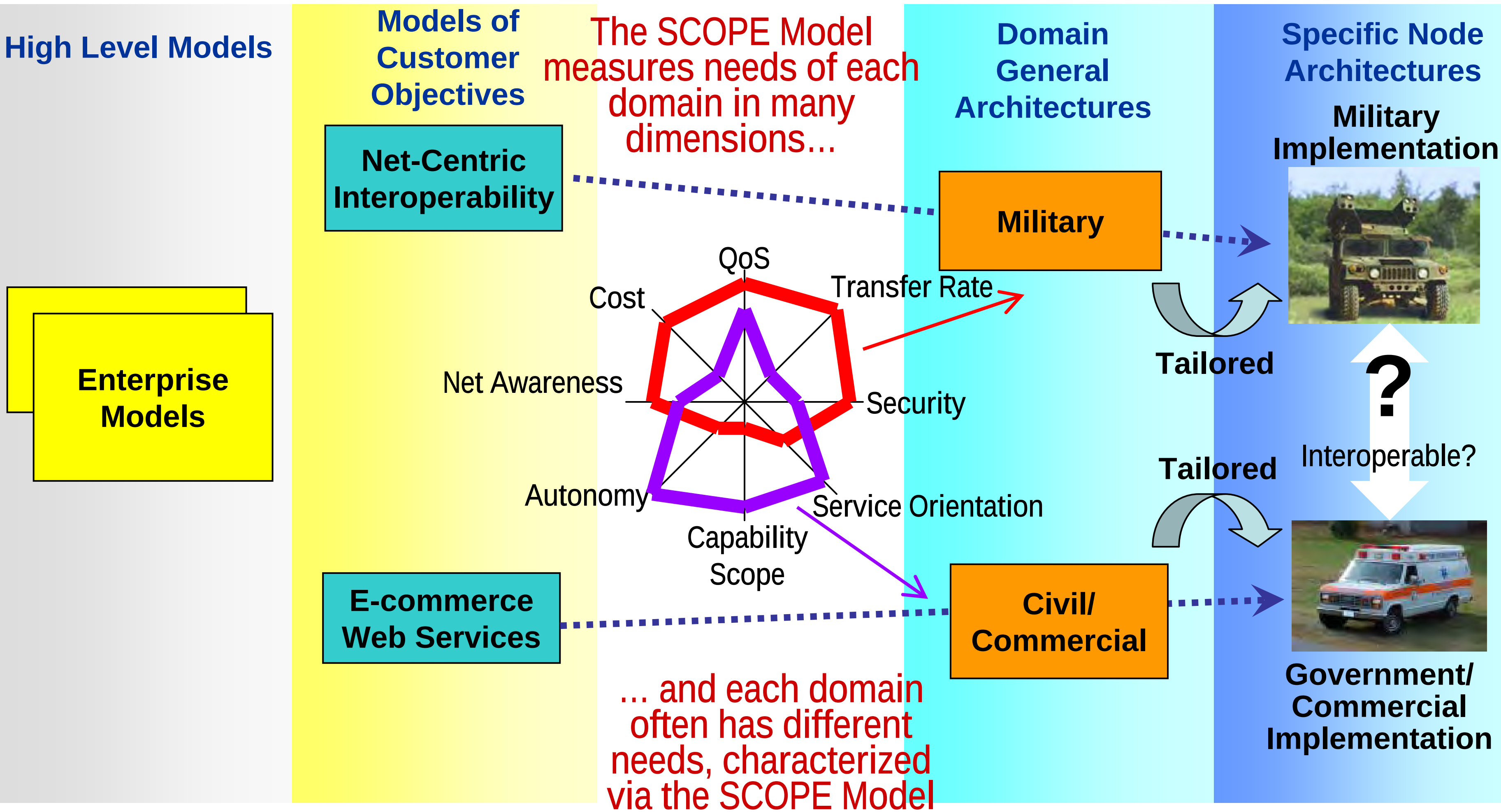
Relating Systems, Capabilities, Operations, Programs, and Enterprises (SCOPE)



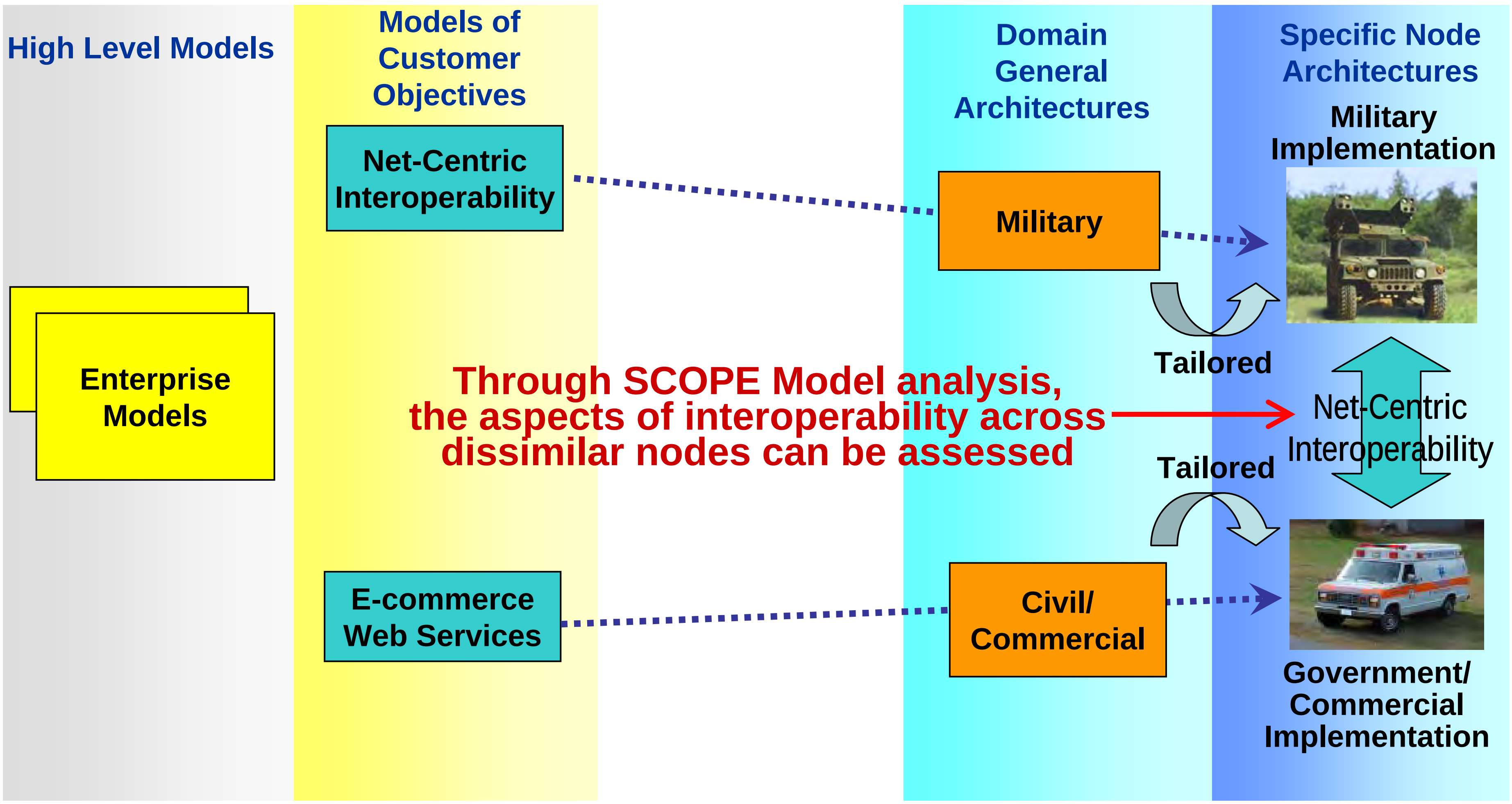
Illustrates Complex Dependencies in Capability Acquisition

The Role and Value of the SCOPE Model

SCOPE: ***S***ystems, ***C***apabilities, ***O***perations, ***P***rograms, and ***E***nterprises



The Role and Value of the SCOPE Model



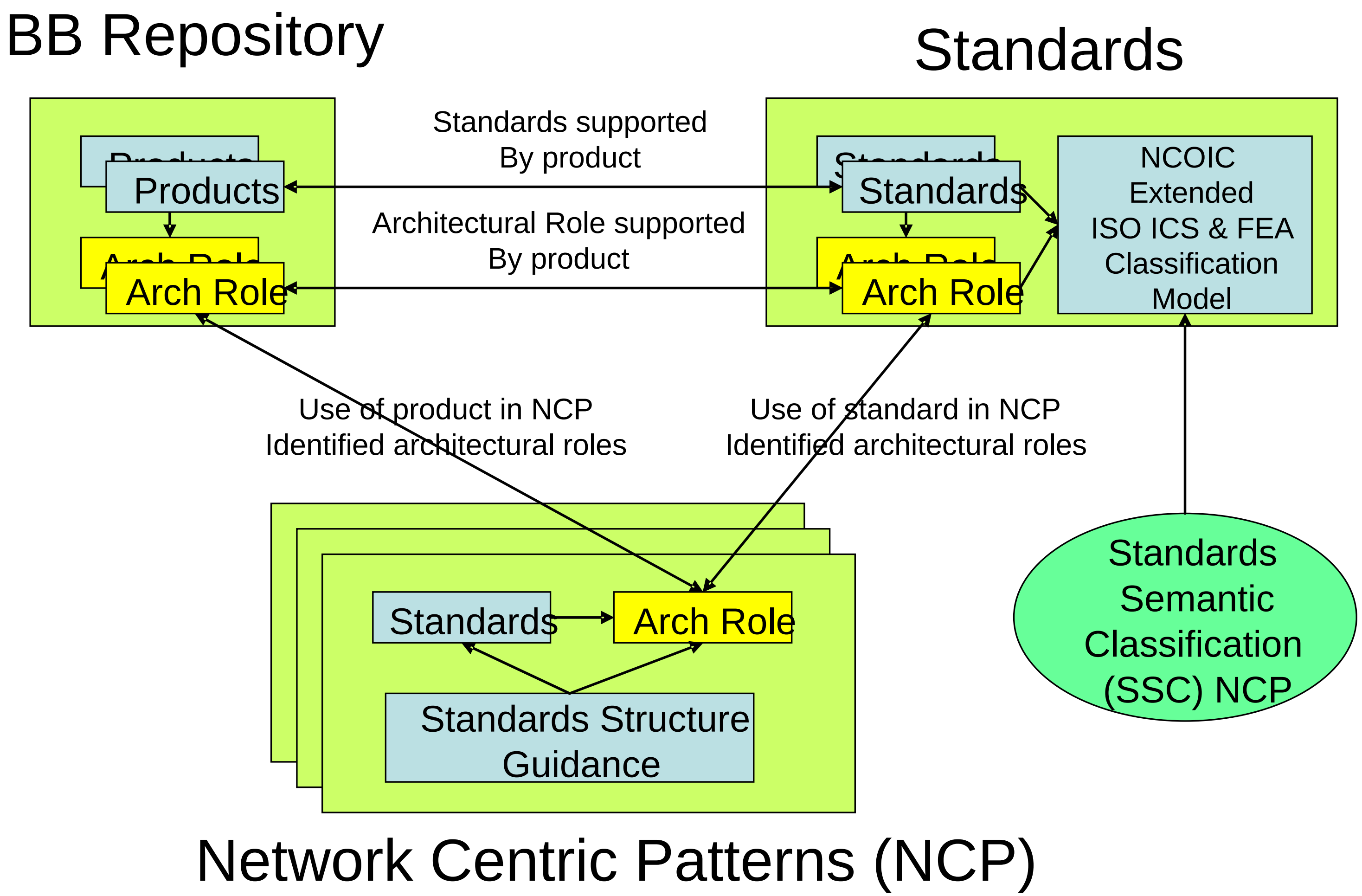
Capability Scope Dimensions

Dimension \ Value	Narrower Scope ←		→ Broader Scope	
Overall Scope and Types of Enterprise	**Single Unit**	**Single Service or Agency**	**DoD-Wide**	**World-Wide**
Capability Breadth	**Single Functional Domain/Service**	**Multi-Domain, Multi-Service**	**Multi-Dept, NGO, Industry**	**Coalition, Multi-Enterprise Type**
Capability Depth	**Single Level**	**Two Levels**	**Three Echelons**	**Four or More Echelons**
Organizational Model and Culture	**Rigid Hierarchy, Vertically Integrated**	**Adaptive Hierarchy, Interact Horizontally**	**Flat, Empowered, Open to Partnering**	**Adaptive, Social, Interdependent**
Unity of Life Cycle Control/Alignment	**Single DoD Acquis. Exec**	**Multiple DoD Acquis. Exec**	**DoD & US Syst. Owners**	**Multi-National Syst. Owners**
Acquisition Congruence (SD)	**All Systems on Same Timeline**	**Timeline within 2 years**	**Timeline within 5 years**	**Timelines >5 years apart**
Semantic Interoperability	**Single Domain Vocabulary**	**Multi-Domain Vocabulary**	**Single Language**	**Multiple Languages**
Operational Context (SD)	**Single Ops Context**	**Multiple Ops Contexts**	**Future/Past Integration**	**Hypothetical Entities**

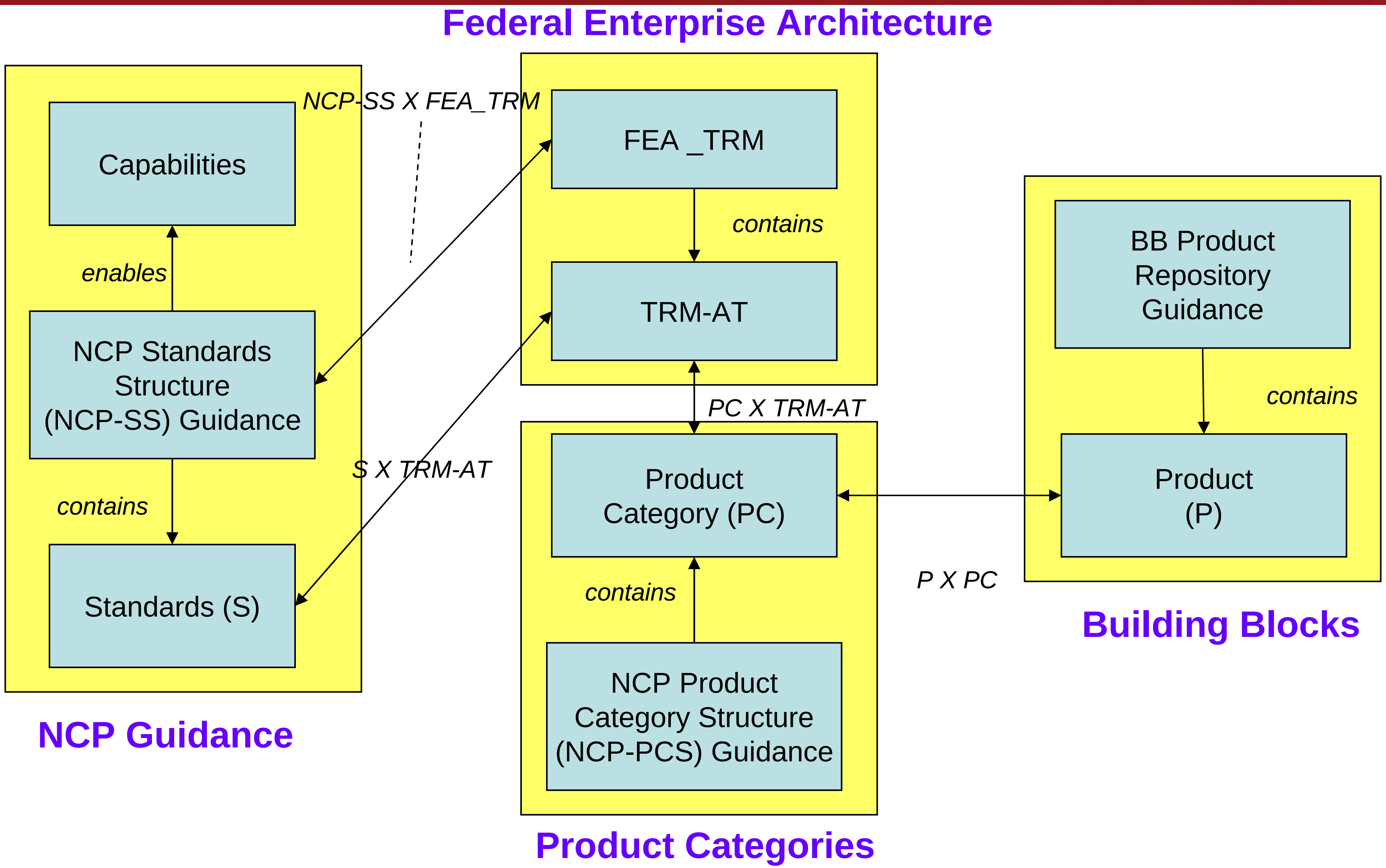
#2: Standards

- Identification
- Analysis
- Linked to Architecture Role, Products, Guidance

Linking Network Centric Guidance and Technology with Standards



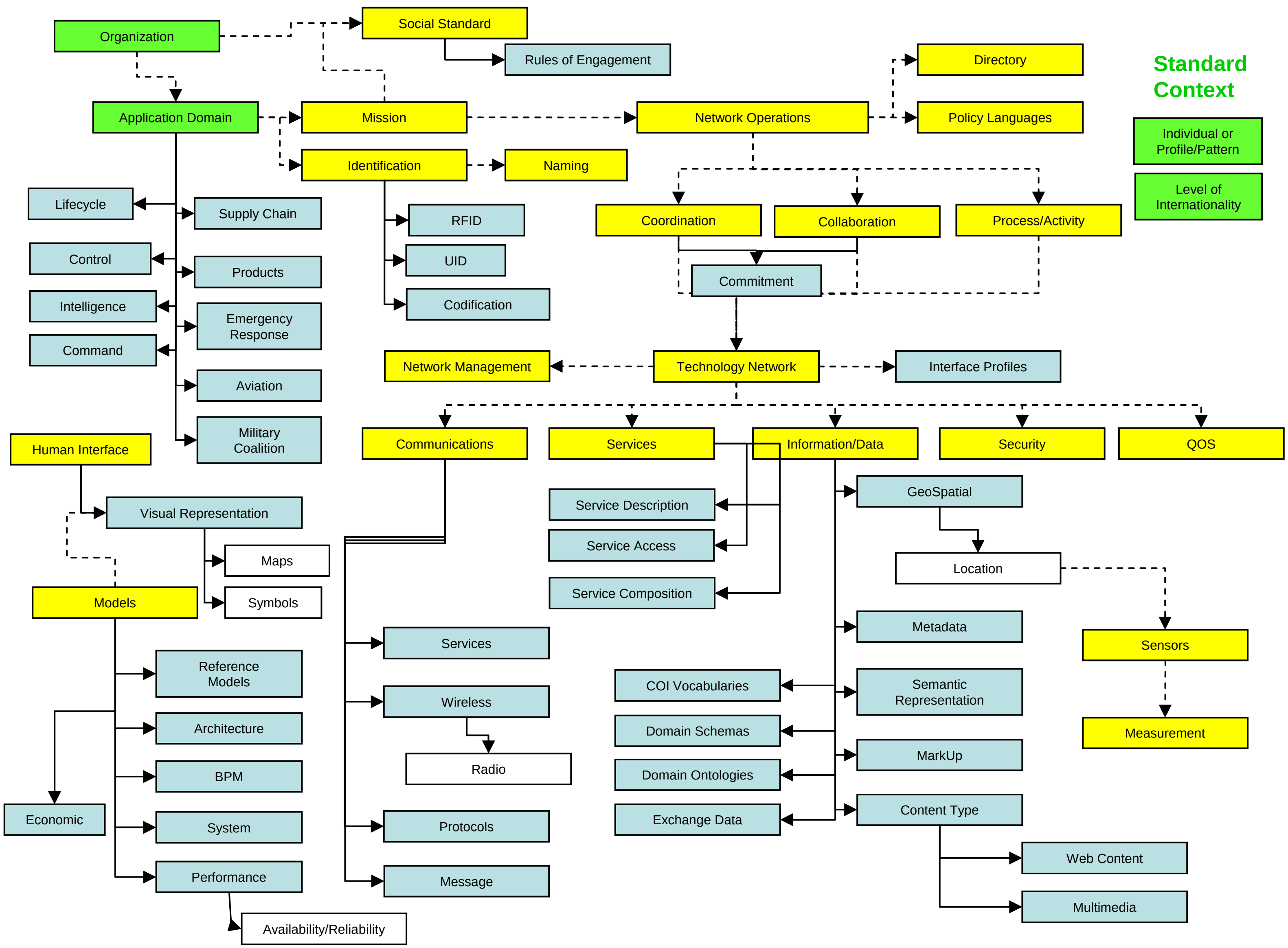
Direct Product Mapping of Standards, Product Categories and Products



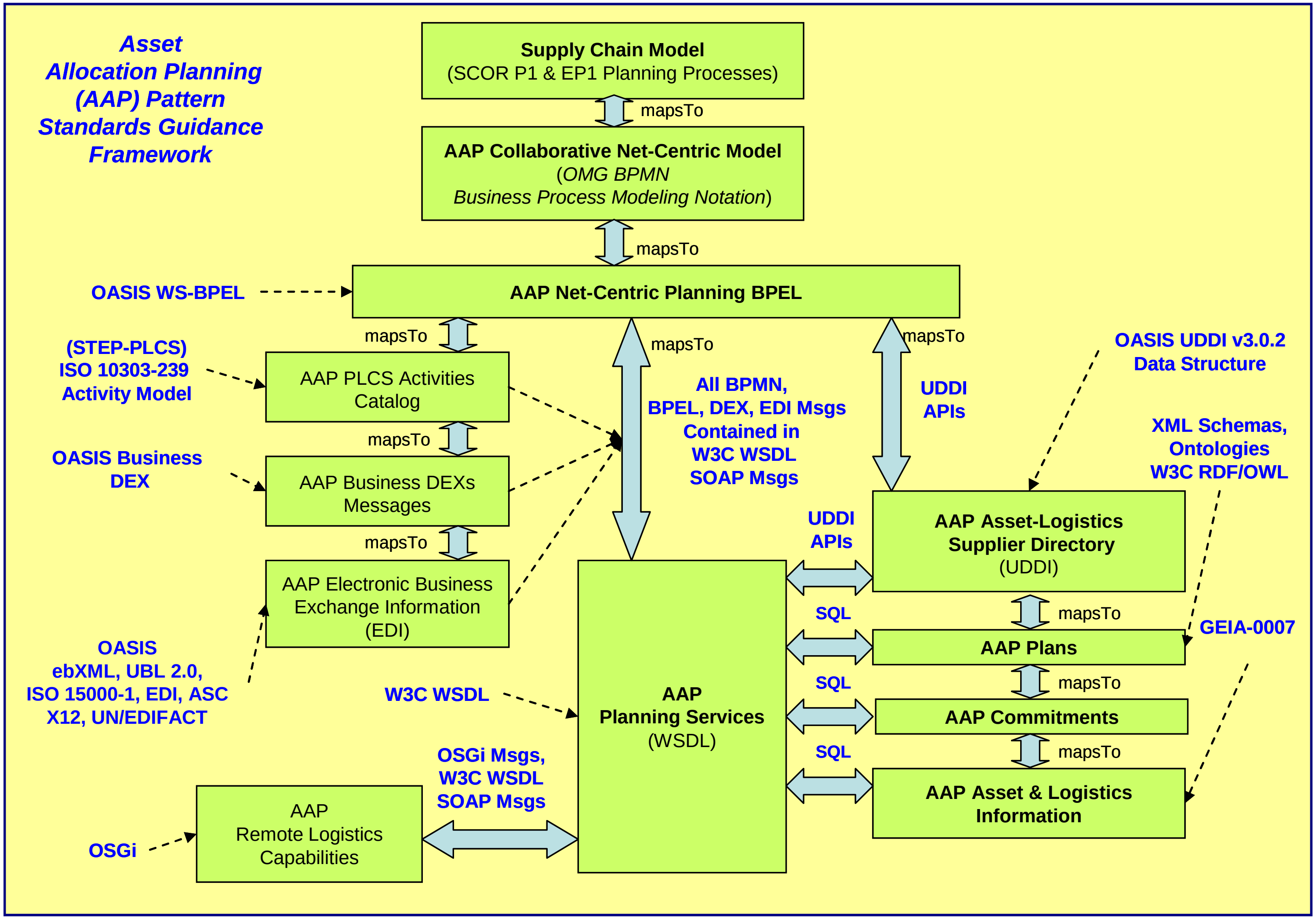
Benefits of Standards Classification

- Aggregation of knowledge by the international community about the architectural uses of standards for Network Centric Operations.
- Enables any organization to contribute to and discover architectural uses of standards.
- Evolution of a standards framework about concepts of architectural roles, a vocabulary to label them, and a model to relate them.
- Enables Product Managers to determine if their products support the NCP standards guidance and discover International uses of standards for the architectural roles of their products.
- Enables your organizations products and services with standards applications to be integrated into Federal Enterprise Architecture reference models and thereby the architectural and implementation plans of organizations complying with the FEA.

Architectural Role/Technology Classification Model

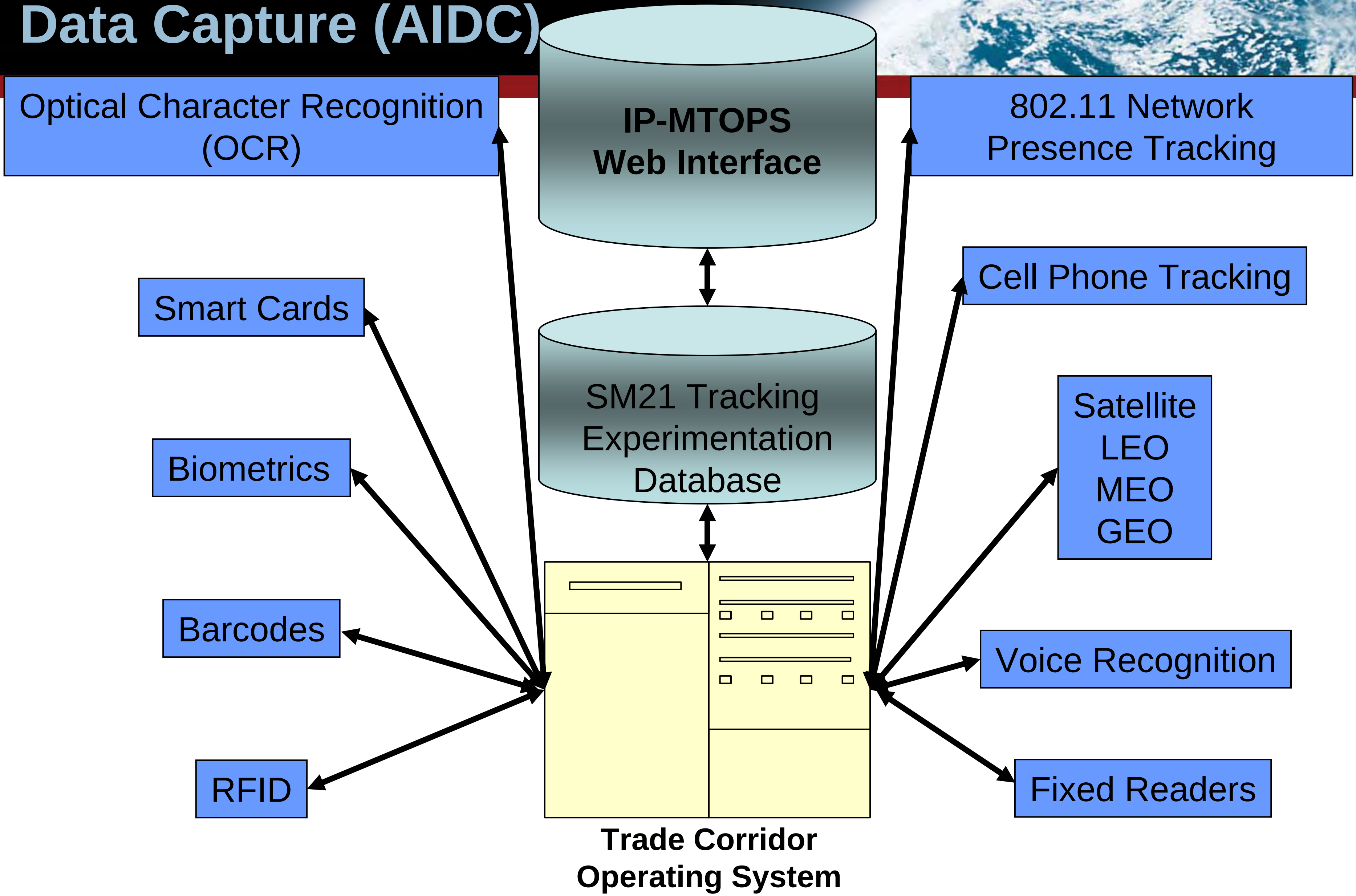


AAP Standards Framework for Logistics Domain



- Architectural Guidance
- Standards Guidance

Automatic Identification and Data Capture (AIDC)

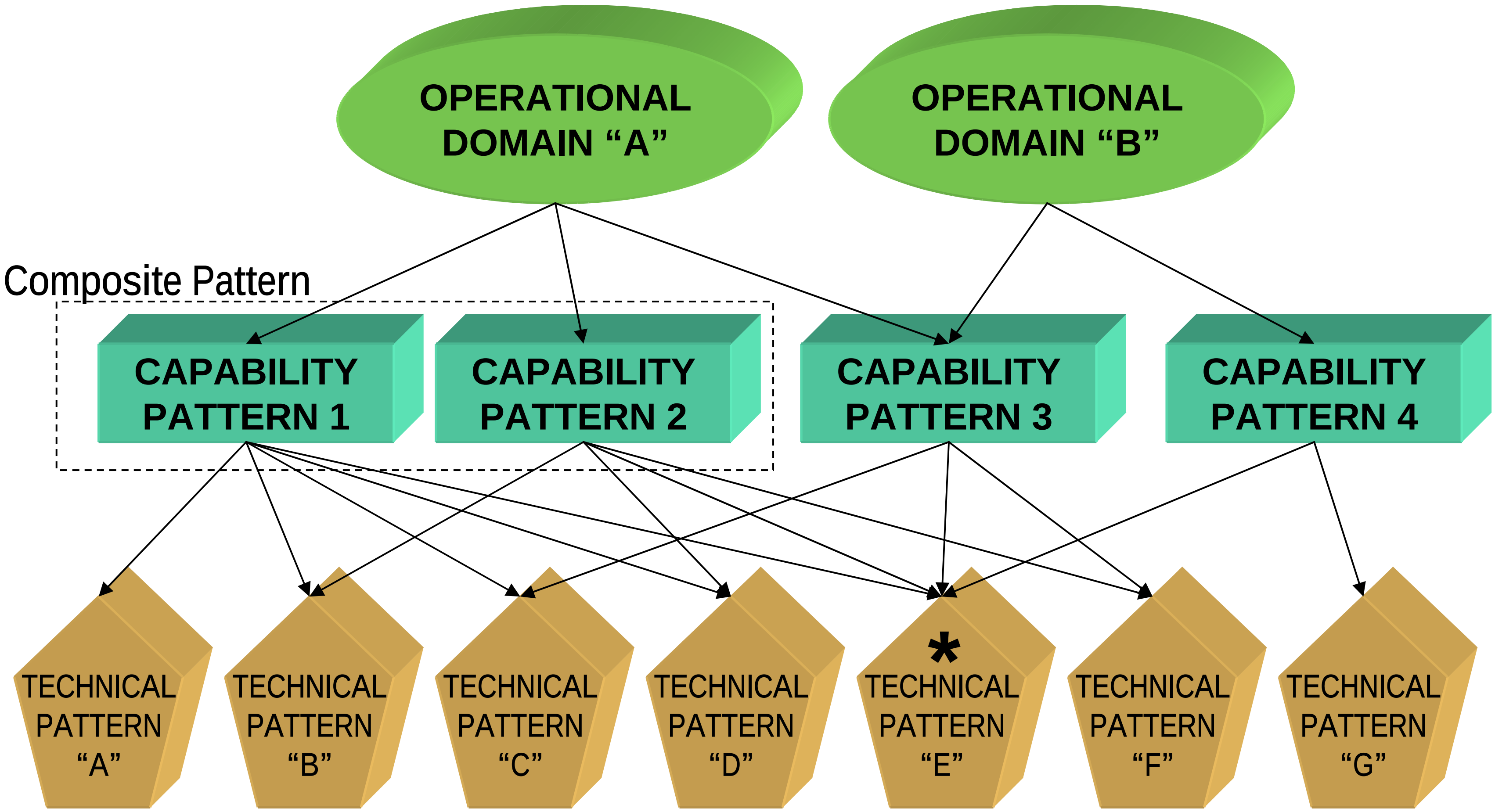


Note: This is an illustrative concept diagram. Firewalls and other details are omitted from the depiction

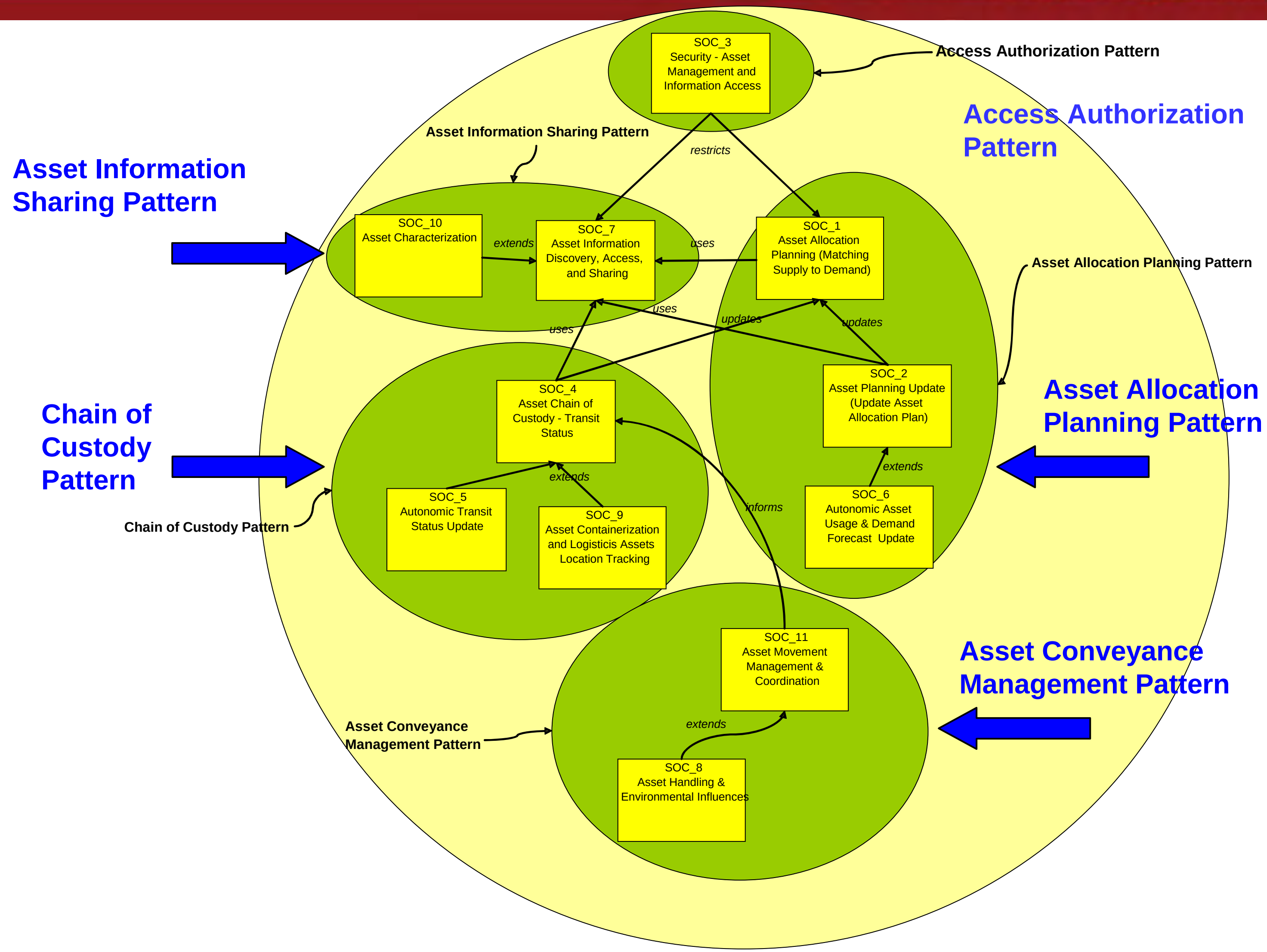
#3: Patterns

- Net-Centric Pattern Technology
- Specialized Frameworks
  - Information, Communications, Services, Security
- Interoperability Criteria and Guidance
  - Building Codes

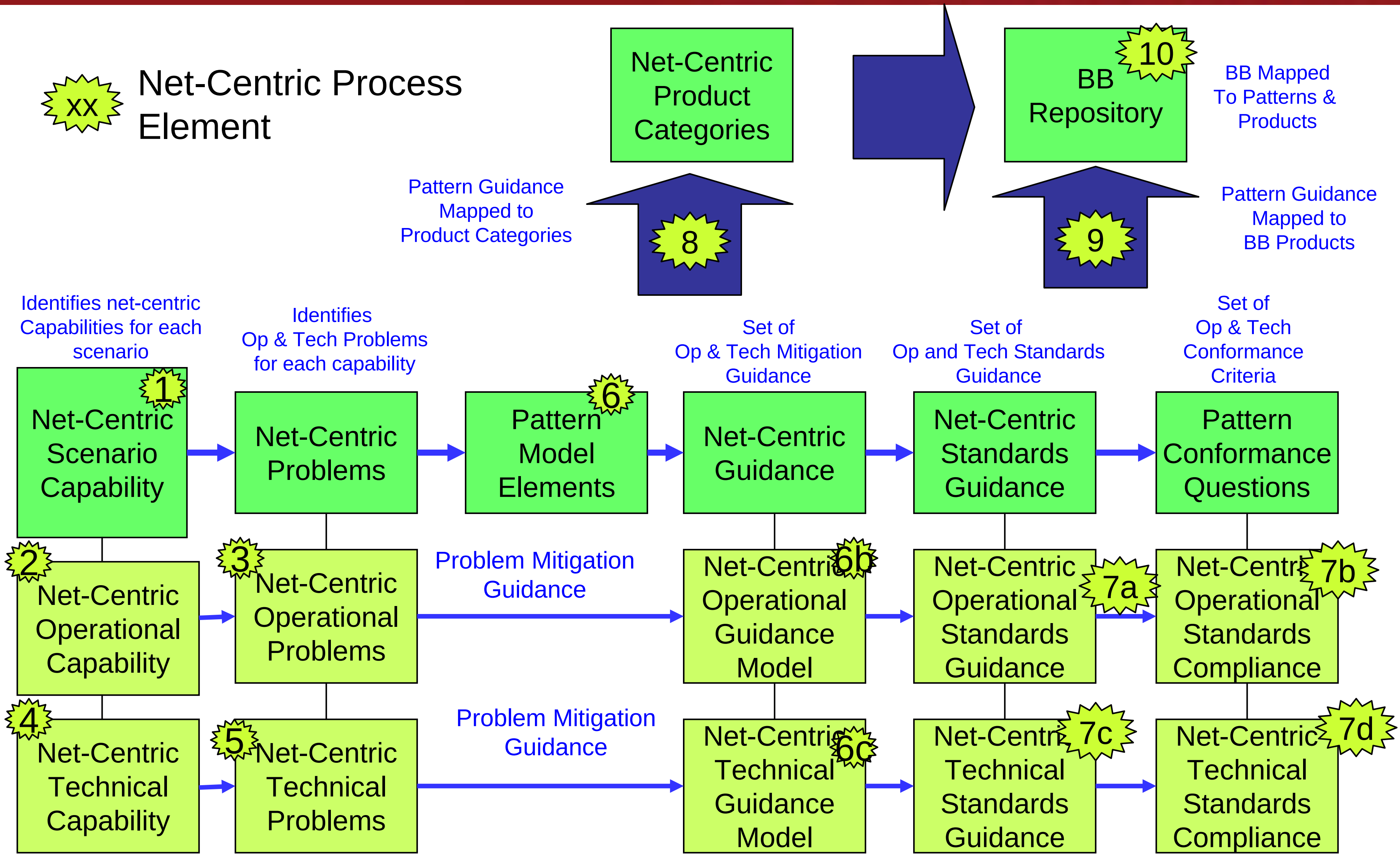
Three Major Categories of NCOIC Patterns



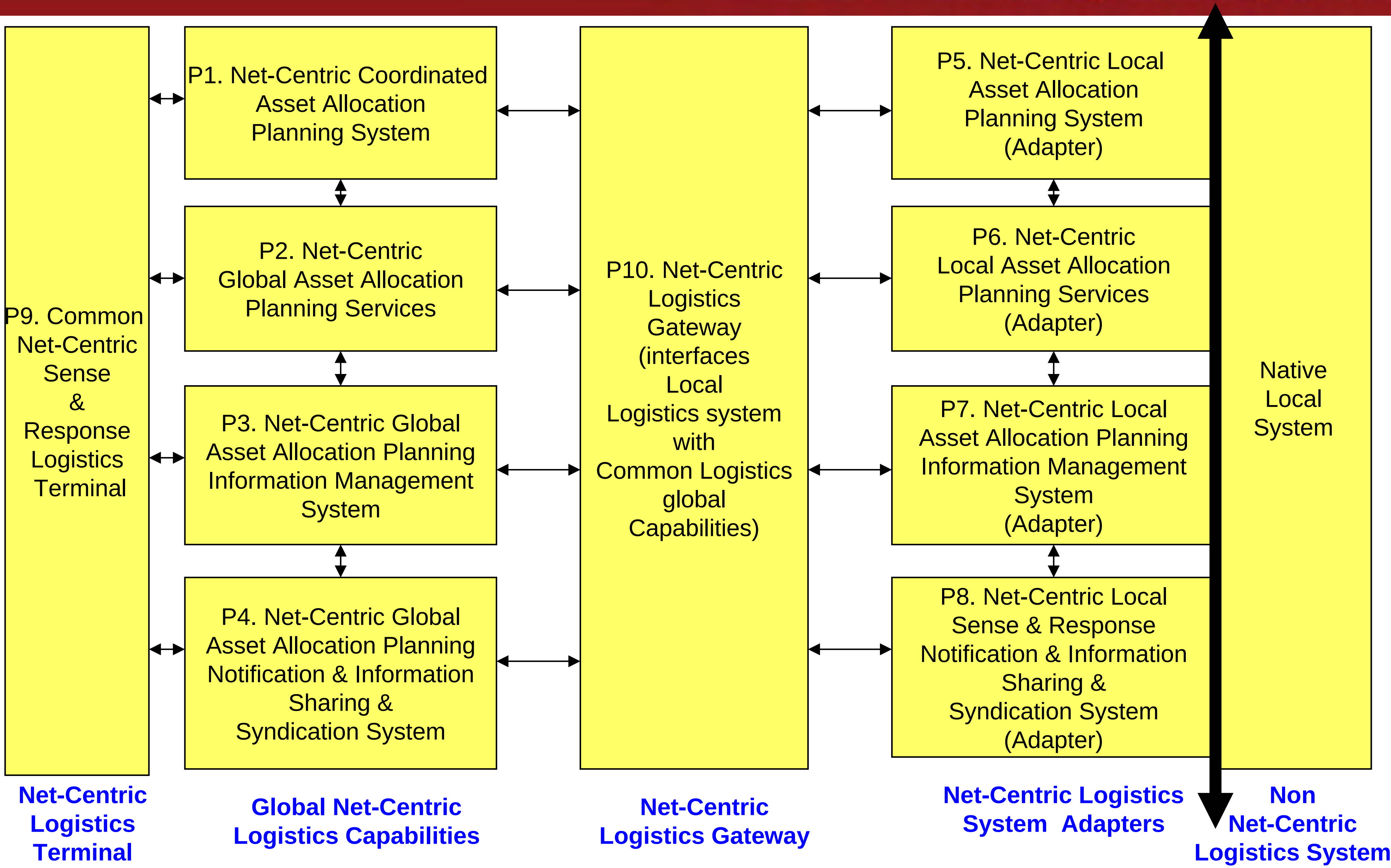
Net-Centric Total Asset Visibility Composite Pattern and Component Capability Clusters



Net-Centric Pattern Guidance



Network Centric Logistics Environment Product Categories (P1-P10)



Framework to Pattern to Guidance Matrix

AAP Standards Framework Element	Role in AAP Pattern	Standards Guidance
Supply Chain Model	The SOCR model identifies typical supply chain AAP business level processes and activities defined which are then supported by the processes and activities in the BPMN model.	Supply Chain Council – SCOR Supply Chain Operations Reference model P1 and EP1 Planning Operations
AAP collaborative Net-Centric Model	This business process model describes the net-centric interactions across a set of business activities for multiple organizations participating in a joint asset and logistics planning operation. The model is specified in BPMN standard notation and is exchangeable across BPMN tools using the WfmC XPDL standard. The top level coordination planning messages associated with synchronized business process activities are defined in the AAP BPMN model as well as the relevant scoep ofteh passed data objects.	OMG - BPMN Business Process Model Notation WFMC - XPDL XML Process Definition Language
AAP Net Centric Planning BPEL	This set of BPEL processes are derived from the AAP BPMN model and control the orchestration of AAP Planning services.	OASIS - WS-BPEL Web Services Business Process Execution Language
AAP Planning Services	This is a set of common planning services that enable collaboration in joint asset and logistics planning activities for multiple systems and organizations. The intent is that each native local system will provide adapters to interact with a set of common AAP planning services. The generic interactions to the AAP web services are specified with WSDL soap messages, while the service itself is described by WSDL. The data exchanged in the AAP services is defined appropriate to the type of service and the content specified by AAP PLCS Activities catalog, AAP Business DEX messages, and AAP EDI content to support the BPEL processes and the BPMN process message synchronization. One of the services supports access to the UDDI Logistics and Asset Directories	W3C WSDL W3C SOAP BPMN BPEL DEX EDI UDDI APIs

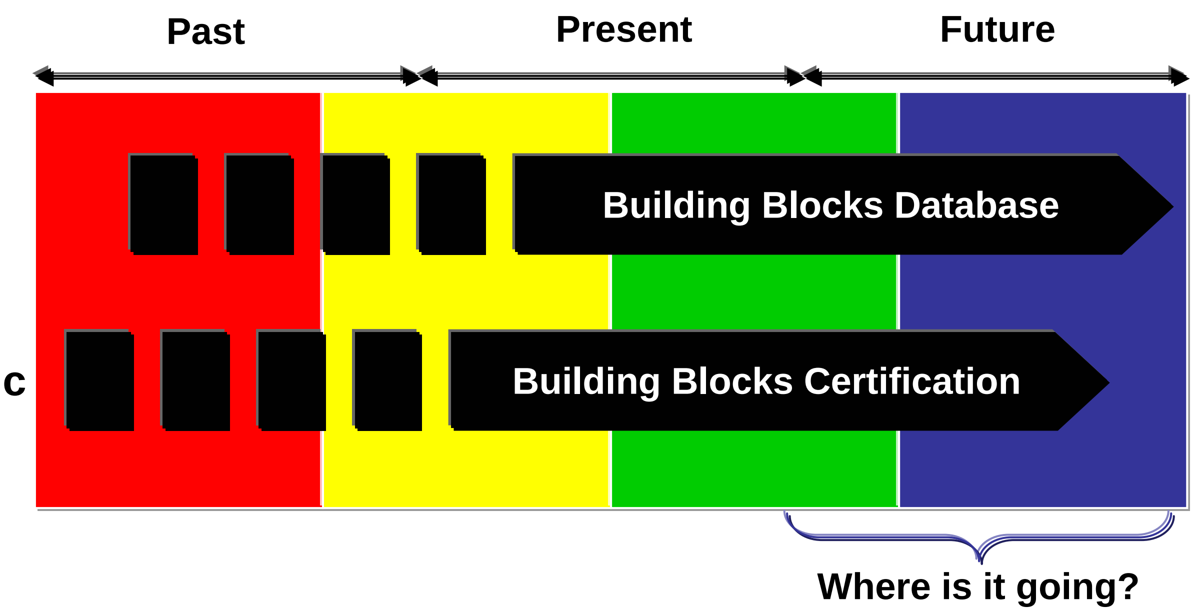
#4: Building Blocks

- COTS & GOTS Repository
- Building Block GUI and Algorithm
- Impartial 3rd Party Certification

Building Blocks

NCOIC aides customers in achieving design synthesis & design verification via the work of the Building Blocks (BB) Functional Team

- **BB database is a public catalog of pattern-compliant building blocks available for inquiry by member and public entities**
- **BB self-verification criteria for candidate re-usable off-the-shelf products**



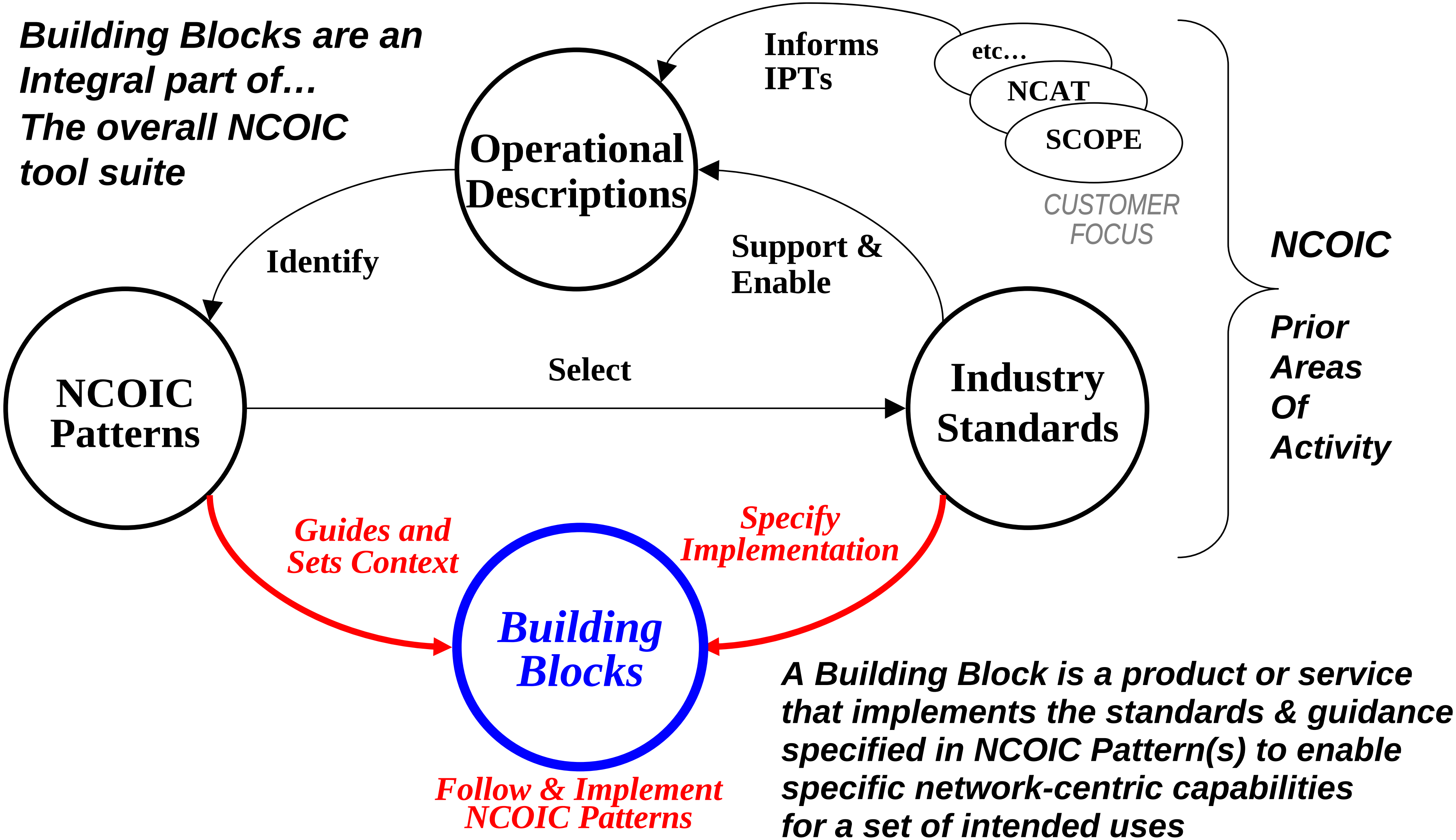
Integration of products of interest to NATO will increase the efficacy of the BBdb.

Products achieving certification will reinforce NCOIC value chain

•SCOPE – characterize interoperability dimensions
•NIF (v2) - patterns & guidance for potential solutions
•BBdb - catalog of NIF-Compliant OTS products
•NCAT - assessment of reaching interoperability goals

The Building Blocks Perspective

Building Blocks are an Integral part of… The overall NCOIC tool suite



A Building Block is a product or service that implements the standards & guidance specified in NCOIC Pattern(s) to enable specific network-centric capabilities for a set of intended uses

What are the problems that the NCOIC is solving?

- The acquisition community wants to know how (and to what extent) vendors' offerings may work together
- Vendors need to understand how their products and services may be used in network-centric systems needed by the overall customer community
- Both should recognize which standards and guidance to use in order to assure:
  - Desired network-centric capability
  - Interoperability between and among other products

Building Blocks help solve these problems with real products and services that can be effectively used to achieve network-centric capabilities

What Are Building Blocks?

- A Building Block is:
  - A product or service that implements the standards and guidance specified in NCOIC Pattern(s) to enable specific network-centric capabilities for a set of intended uses
- Building Blocks ARE NOT:
  - An architecture
  - A stand-alone, complete solution
  - A self-proclaimed sales pitch
  - Future “vaporware”, promised but not yet available

Value of Building Blocks: They identify real products or services that enable specific network-centric capabilities in order to use them with confidence

The Value of Building Blocks

Building Blocks help to match Buyer and Supplier Expectations

- Provides a registry of real products and services that allows procurement activities and system integrators to identify which items meet the NCOIC criteria
  - A means for products to be visible across multiple functional areas and markets
- Provides a Certification and Trademarking program to promote the identification and procurement of conformant network-centric components and services

Our customers are asking for NCOIC guidance– Building Blocks provides this

Building Blocks Promote NCOIC-Compliant Off-The-Shelf Products

CUSTOMER GOALS → MISSIONS TO ACHIEVE GOALS → MISSION NEEDS → SOLUTIONS TO NEEDS (EXISTING AND FUTURE) → RESULTING CAPABILITIES & SERVICES

NCO Initiatives Database

SCOPE Model

NCOIC Interoperability Framework (NIF™)

Typical Process Steps to Solutions:

1. Analysis of Alternatives
2. Requirements Derivation
3. Requirements Validation
4. DESIGN SYNTHESIS

NIF → BB + NCAT

5. DESIGN VERIFICATION
6. Deployment
7. Support
8. Upgrade or Disposal

Supports Layered Quality of Service

Network Centric Assessment Tool (NCAT™)

Building Blocks (BB)

(details on next few pages)

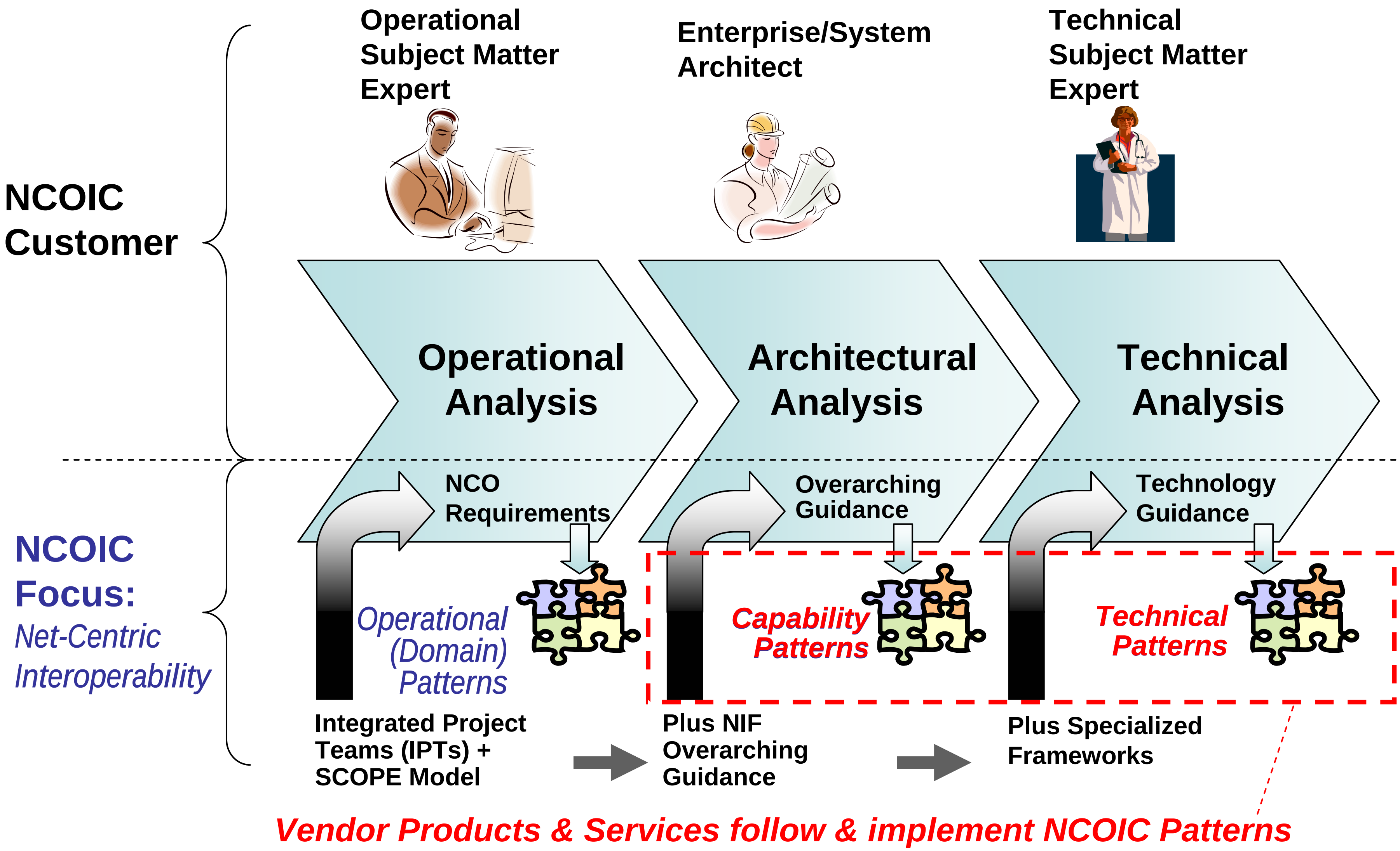
The NCOIC Building Blocks process:

- **Vendors offer & describe candidates**
- **Vendors complete Certification Process**
- **Vendors granted rights to use "NCOIC Certified" logo**
- **Conformant BB listed in the BB Database**
- **Architects use certified products in system designs**

Modeling & Simulation and Demonstrations of missions, needs, & solutions

Test & Evaluation of solutions & results

Building Blocks Implement NCOIC Patterns: Standards & Guidance



The Benefits of Building Blocks

- Exposes products to a broader market base
- Promotes entry into new Network-Centric markets with specific products and services
  (from a Product Manager's perspective)
- Reduces risk in all phases of the capability acquisition lifecycle
  (including use of vendor products in network-centric system designs)
- Potential business value of reducing cost and risk of certification effort
- Adds focus to standards compliance strategy
- Accelerates implementation of network-centric solutions
- Provides NCOIC guidance for use in procurements

Helps all stakeholders to achieve the benefits of the NCOIC Patterns

Sample Logistics Building Block Repository

STANDARDS:

- SCOR Supply Chain Operations Model
- OMG Business Process Modeling Notation
- AAP UDDI (Log Asset Supplier Directory)
- OASIS WS BPEL (Business Process Execution Language)
- OASIS Business DEX (Data Exchange)
- AAP WSDL (Web Services Description Language)
- EDI (Electronic Data Interchange)
- Others

PRODUCTS AND SERVICES (NOTIONAL):

- CDM ICODES (Integrated Cooperative Decision Making)
- Transcore eZGO and 3sixty
- Hewlett Packard Real Time Enterprise ZLE
- US TRANSCOM GTN (Global Transportation Network)
- Others

Way Forward

- Unite Diverse Logistics Communities of Interest Stakeholders by Leveraging the NCOIC Processes and Tools.
- Further develop the Logistics Standards Framework in union with DOD, NATO, Commercial, and other Stakeholders.
- Develop remaining identified Patterns for the global logistics application domain.
- Certified products for the Global Logistics Products and Services Repository.

SUPPORT SLIDES

Building Blocks Certification

- "NCOIC Certified" logo on a product or service
  - **Gives buyers assurance that vendor promises of “network-centric capabilities” are backed up by specific conformance to NCOIC Patterns**
  - **Allows conforming vendors to advertise this assurance to their customers while ensuring that non-conforming vendors cannot**
  - **Does not change existing company and industry certification programs**
- Vendors complete an application process to certify products and services against the specifications in an NCOIC Pattern
  - **NCOIC's Certification Authority reviews application for completeness**
  - **If OK, then the product or service is listed as being certified in the Building Blocks database**
  - **A formal challenge process allows anyone to dispute a particular vendor's compliance claim**
  - **Vendors must enter into a Trademark License Agreement to use the "NCOIC Certified" logo**
- Architects and designers consult the NCOIC Building Blocks database for NCOIC Certified products and services

Next Steps for Building Blocks

- We have several NCOIC Operations Patterns in work, e.g.:
  - For Sense & Respond Logistics: Asset Allocation Planning (AAP)
  - For NATO/Coalition: Friendly Force Tracking Interoperability (FFTI)
  - For Emergency Response: Hastily-Formed Networks
- We anticipate that many Technical Patterns will be developed to support these and other operational domains
- Implement pilot process for Building Blocks
  - Prior demos and discussions about Building Blocks database, now ready for actual use
  - Vendors to vet the above patterns and associated standards by submitting candidate products into the BB process
  - Acquisition community feedback on how Building Blocks benefits the acquisition process
  - Incorporate “lessons learned” to improve the BB process

Value Add… if you so choose

Building Block Demonstration

GLOBAL COMMERCIAL AND GOVERNMENT,

COTS AND GOTS,

HARDWARE AND SOFTWARE,

PRODUCTS.

Applying the Tenets of Military Planning and Execution to Project and Systems Engineering Management

Systems, Software, and Solutions Operation

Tony Lindeman, PMP
Senior Systems Engineer
SAIC
philip.a.lindeman@saic.com

"In preparing for battle, I have always found that plans are worthless, but planning is indispensable."

General Dwight D. Eisenhower
34th President of the United States

Purpose

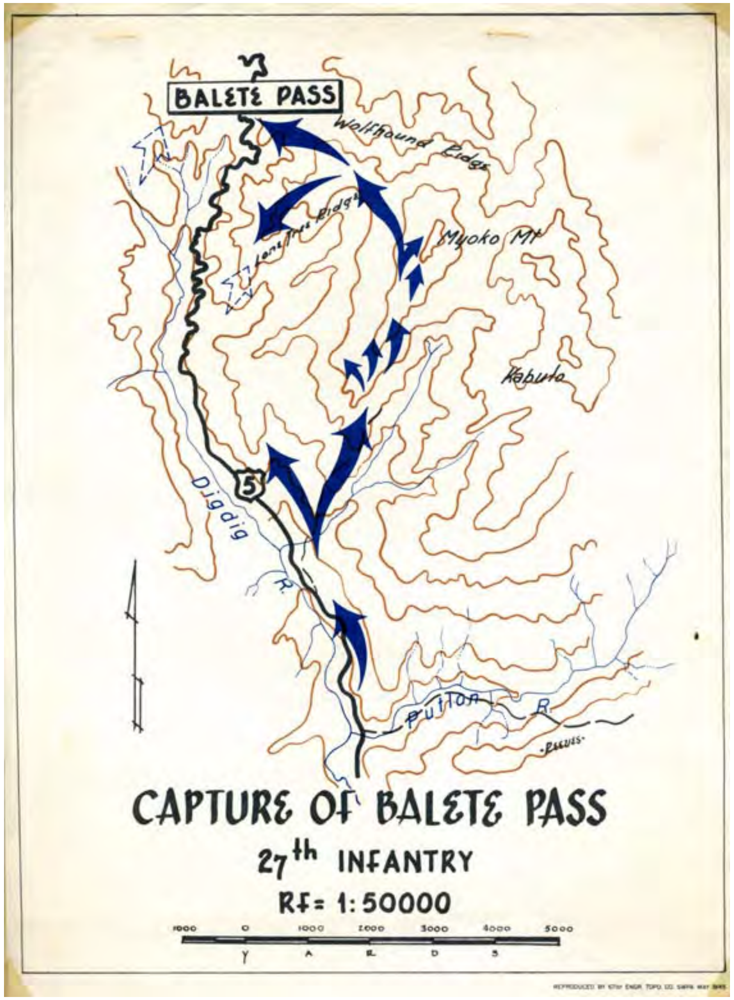
- Provide aspiring Systems Engineers with insight into how basic tenets of military planning and execution can be used to plan and monitor the successful execution of a project.

Terminology to Represent Generic Systems Engineering Processes

- **Technical Management Processes**
  - Decision Analysis
  - Technical Planning
  - Technical Assessment
  - Requirements Management
  - Risk Management
  - Configuration Management
  - Technical Data Management
  - Interface Management
- **Technical Processes**
  - Requirements Development
  - Logical Analysis
  - Design Solution
  - Implementation
  - Integration
  - Verification
  - Validation
  - Transition

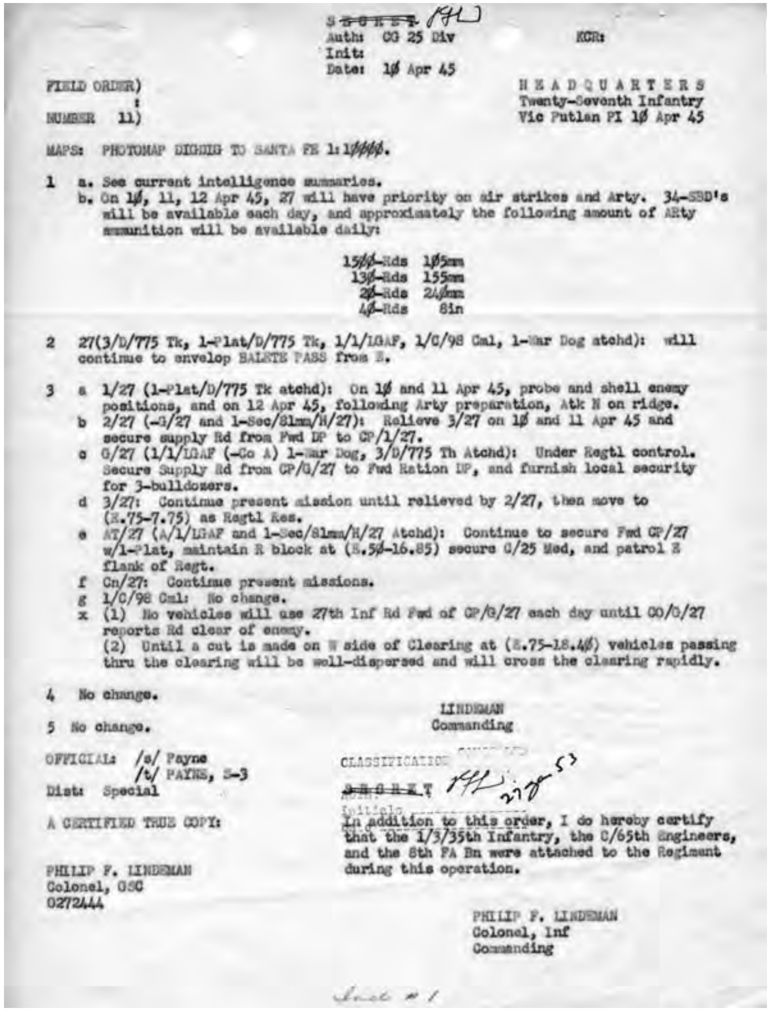
Commander's Intent

- **Communicate the overall objective in general terms and leave the detailed planning to lower echelons**
- **Centralized planning; decentralized execution**



Mission Planning

- Commander's Intent
- Tactical objective(s)
- Prioritization
- Success criteria
- Logistics
- Contingency plans based on risk assessment
- Communication



SECRET
Auth: CG 25 Div
Init:
Date: 1Ø Apr 45

KCR:

FIELD ORDER)
:
NUMBER 11)

HEADQUARTERS
Twenty-Seventh Infantry
Vic Putlan PI 1Ø Apr 45

MAPS: PHOTOMAP DIGDIG TO SANTA FE 1:1ØØØØ.

1 a. See current intelligence summaries.
b. On 1Ø, 11, 12 Apr 45, 27 will have priority on air strikes and Arty. 34-SBD's will be available each day, and approximately the following amount of ARty ammunition will be available daily:

15ØØ-Rds 1Ø5mm
13Ø-Rds 155mm
2Ø-Rds 24Ømm
4Ø-Rds 8in

2 27(3/D/775 Tk, 1-Plat/D/775 Tk, 1/1/LGAF, 1/C/98 Cml, 1-War Dog atchd): will continue to envelop BALETE PASS from E.

3 a 1/27 (1-Plat/D/775 Tk atchd): On 1Ø and 11 Apr 45, probe and shell enemy positions, and on 12 Apr 45, following Arty preparation, Atk N on ridge.
b 2/27 (-G/27 and 1-Sec/81mm/H/27): Relieve 3/27 on 1Ø and 11 Apr 45 and secure supply Rd from Fwd DP to CP/1/27.
c G/27 (1/1/LGAF (-Co A) 1-War Dog, 3/D/775 Th Atchd): Under Regtl control. Secure Supply Rd from CP/G/27 to Fwd Ration DP, and furnish local security for 3-bulldozers.
d 3/27: Continue present mission until relieved by 2/27, then move to (E.75-7.75) as Regtl Res.
e AT/27 (A/1/LGAF and 1-Sec/81mm/H/27 Atchd): Continue to secure Fwd CP/27 w/1-Plat, maintain R block at (E.5Ø-16.85) secure C/25 Med, and patrol E flank of Regt.
f Cn/27: Continue present missions.
g 1/C/98 Cml: No change.
x (1) No vehicles will use 27th Inf Rd Fwd of CP/G/27 each day until CO/G/27 reports Rd clear of enemy.
(2) Until a cut is made on W side of Clearing at (E.75-18.4Ø) vehicles passing thru the clearing will be well-dispersed and will cross the clearing rapidly.

4 No change.

5 No change.

LINDEMAN
Commanding

OFFICIAL: /s/ Payne
/t/ PAYNE, S-3

Dist: Special

CLASSIFICATION
~~SECRET~~

A CERTIFIED TRUE COPY:

In addition to this order, I do hereby certify that the 1/3/35th Infantry, the C/65th Engineers, and the 8th FA Bn were attached to the Regiment during this operation.

PHILIP F. LINDEMAN
Colonel, GSC
O272444

PHILIP F. LINDEMAN
Colonel, Inf
Commanding

"Systems" Thinking

- Big picture, puzzle solvers
- Decomposition, flowdown, allocation, and traceability
- Hierarchal mindset
  - Organization
  - Specifications
  - WBS
  - Risk
  - Communication

- Rigor and discipline do not stifle creativity
- Mathematically inclined – "work has volume"

SAIC® From Science to Solutions

Command Center – "War Room"

- Iterative process
  - Inputs → Decisions → Outputs → Assessment
  - Ensuring effort is value added
- Current Operations and Future Operations
- Reallocate resources as battlefield is shaped and evolves
- Maintain momentum of keeping overall effort moving forward

Planning

- **Reluctance to expend significant effort**
  - Playing field is constantly changing
  - Obsolete as soon as it's put into place
- **Types of planning**
  - Rough Order of Magnitude (ROM) planning
  - Initial baseline planning
  - Re-baseline planning
  - Contingency planning
- **Baseline plan vs. roadmap**
  - Detailed plans vs. convergence of effort
  - Precision vs. general direction
  - Know when to focus on the specifics vs. generalities

Planning Process

- Breaking down what appears to be an insurmountable challenge into manageable and achievable activities
- Iterative process between detailed scheduling of tasks and achieving intermediate objectives
- Identifying
  - Program milestones
  - Key Decision Points (KDPs)
  - Technical reviews and milestones
- Measuring progress in terms of pre-defined success criteria and demonstrating intermediate capability

Obtain excruciating scrutiny and eventual buy-in

SAIC
From Science to Solutions

Execution

- Mission planning and briefing
  - Objective(s)
  - Success criteria
  - Contingency plans for risks and emergencies
- Pilot mentality
  - Power required can exceed power available
  - Running out of fuel can ruin your day!
  - Maintaining altitude and airspeed with constant power setting
    - Scan and crosscheck instruments
    - Small and minimal control inputs vs. jerky and erratic
- Threat Missiles inbound – how do decisions get made!
  - Having sufficient data and information
  - Timeliness
- Holding forces in reserve
  - Deploy to exploit or counter a threat
  - Establish criteria for deploying when and how much
- Expending too much on real-time monitoring

Summary

- "Systems" thinking
- Planning – scrutiny & buy-in
- Command Center – Segment Current & Future Operations
- IMS vs. Roadmap focus
- Making timely and effective decisions
- Monitor and measure execution in order to efficiently and effectively apply minor course corrections
- Manage reserves to exploit opportunities and repel threats

Cross-Command Collaboration Effort (3CE)

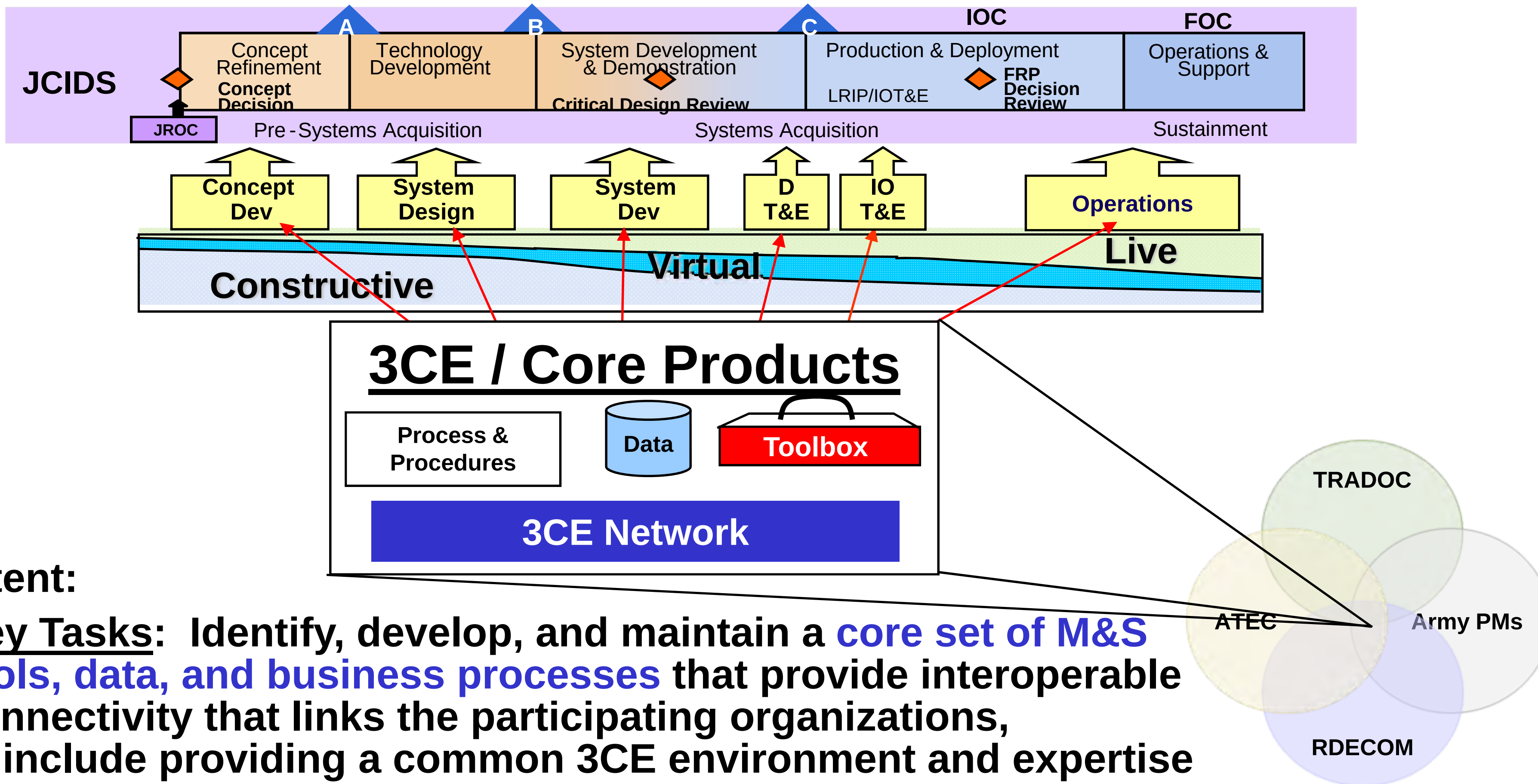
3 October 2008

Purpose and Agenda

- **Purpose: Provide information on the Cross Command Collaboration Effort (3CE).**
- **Agenda:**
  - **Background and Overview**
  - **Capability**
    - **Network**
    - **Knowledge Repository**
    - **Requirements Identification and Decomposition**
    - **Systems Engineering Process**
    - **Documents: Processes and Procedures**
    - **Planning: Cross Command M&S Investment Strategy**
  - **Application**
    - **FCS Spin Out**
    - **Tools**
  - **Summary and Way Ahead**

What … 3CE Mission and Intent – Unique Capability

Mission: Develop a cross command Army M&S and data environment for design, development, integration, and testing of capabilities, systems, and prototypes.



Intent:

Key Tasks: Identify, develop, and maintain a core set of M&S tools, data, and business processes that provide interoperable connectivity that links the participating organizations, to include providing a common 3CE environment and expertise for the Army to leverage.

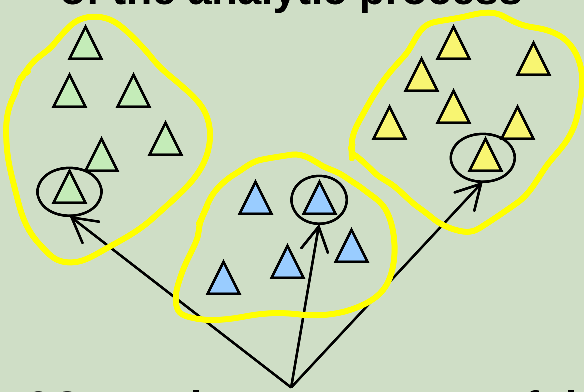
End State: A 3CE environment that meets the common requirements of all three commands and Army PMs to conduct distributed DOTMLPF development.

Program Life Cycle Support … a Paradigm Change

The 3CE is focused on identifying and developing an M&S environment that meets the common requirements of all three commands and PM FCS BCT to conduct distributed DOTMLPF development.

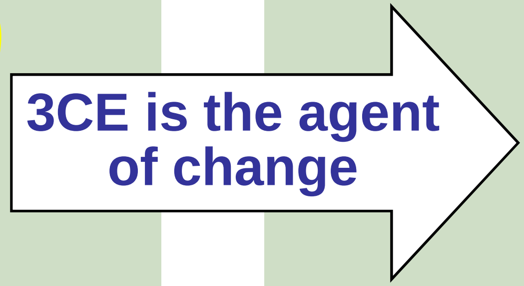
Current Operations

There are numerous, independent command analytic activities.
MoM decomposition is a basic component of the analytic process



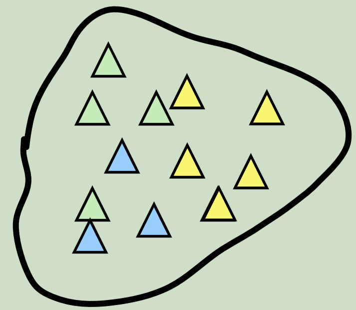
PM FCS may leverage some of these activities in support of time sensitive, program specific decisions.

The independent activities lead to discrete tool (e.g. M&S) capability development; sufficient to satisfy the immediate decision requirement and often not capable of supporting reuse requirements.



Future Operations

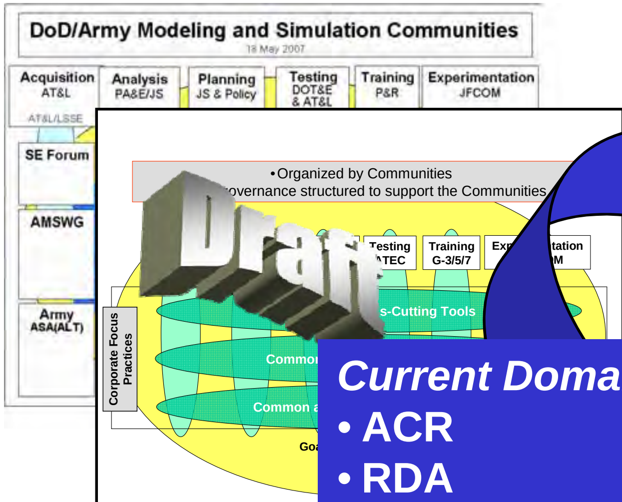
Integrated analytic activities conducted IAW standard operating procedures.



PM FCS leverages 3CE to develop a reusable M&S environment that is capable of supporting life cycle program decisions.

Standard processes, procedures, and a common M&S environment provides the means to conduct more integrated and collaborative DOTMLPF development.

3CE … How is This Effort Different?

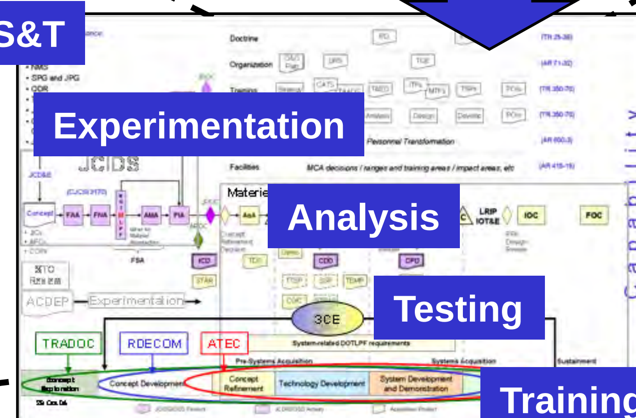


Current Domains
- **ACR**
- **RDA**
- **TEMO**

Problem**: *At DoD, Joint, and Service level, there exist M&S concepts, strategies, and policies to enable an "integrated M&S and data vision" … no resources are allocated for delivering an integrated solution set across the program lifecycle – currently have stovepipe solutions for S&T, experimentation, analysis, testing, and training.***

Application Gap

COA**: *To fill the "gap of integrated solution application," 3CE enables:***
- ***Horizontal integration across M&S communities.***
- ***"Fuzed application" of M&S and data solutions.***
- ***Program lifecycle application***
- ***Cooperative implementation – 3CE Network.***



S&T

Experimentation

Analysis

Testing

Training

Application Gap

S&T **Experimentation** **Analysis** **Testing** **Training**

Envisioned Benefits of 3CE to…

The Army

- Provides consistent representation through common tools and data IAW established standards and best practices.
- Provides the capability to leverage a single event for multiple purposes.
- Provides and develops environment capabilities that are traceable to user needs and design requirements.
- Enhances current M&S capabilities and reuse.
- Provides a leave behind capability to support future SoS acquisition programs.

ATEC	RDECOM	TRADOC	Program
• Provides a consistent environment for M-T-M • Reduces preparation time for a test • Provides reusable and consistent metrics from development to test • Enhances training proficiency on test equipment	• Enables consistent data from field tests • Reduces the number of data requests • Enables leveraging operational capabilities for engineering and performance tests	• Enables VV&A to test standards for M-T-M • Reduces time to obtain characteristic data from the program • Leverages multiple events for training • Provides a single environment for analysis, test, and training	• Provides a single POC for GFX selection • Leverages command events for multiple purposes • Reduces the M&S and data coordination requirements • Reduces funding for duplicative M&S efforts

Roles of 3CE

3CE will:

- Support FCS program acquisition decisions.
- Enable AETF application.
- Assess current capabilities to satisfy requirements; identify potential M&S solution providers and capability gaps.
- Integrate and configuration manage M&S capabilities that are common across commands into the Bliss-WSMR LVC environment.
- Provide a means to collaborate cross-command and cross-domain capabilities.
- Establish and share a set of standards, best practices, and expertise.
- Provide a leave-behind capability for future analytic, training, and testing support to acquisition programs.

3CE will not:

- Replace a command's unique mission roles and responsibilities.
- Replace a command's unique M&S capabilities.
- Replace a command's unique data capabilities.
- Impose 3CE capabilities on command unique missions.
- Operate, maintain, or manage a command's distributed network.

As the integrator of an environment, 3CE focuses on common and consistent capabilities to enable cross command collaboration, synergy, and reusability.

Purpose and Agenda

- **Purpose: Provide information on the Cross Command Collaboration Effort (3CE).**
- **Agenda:**
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3CE Network

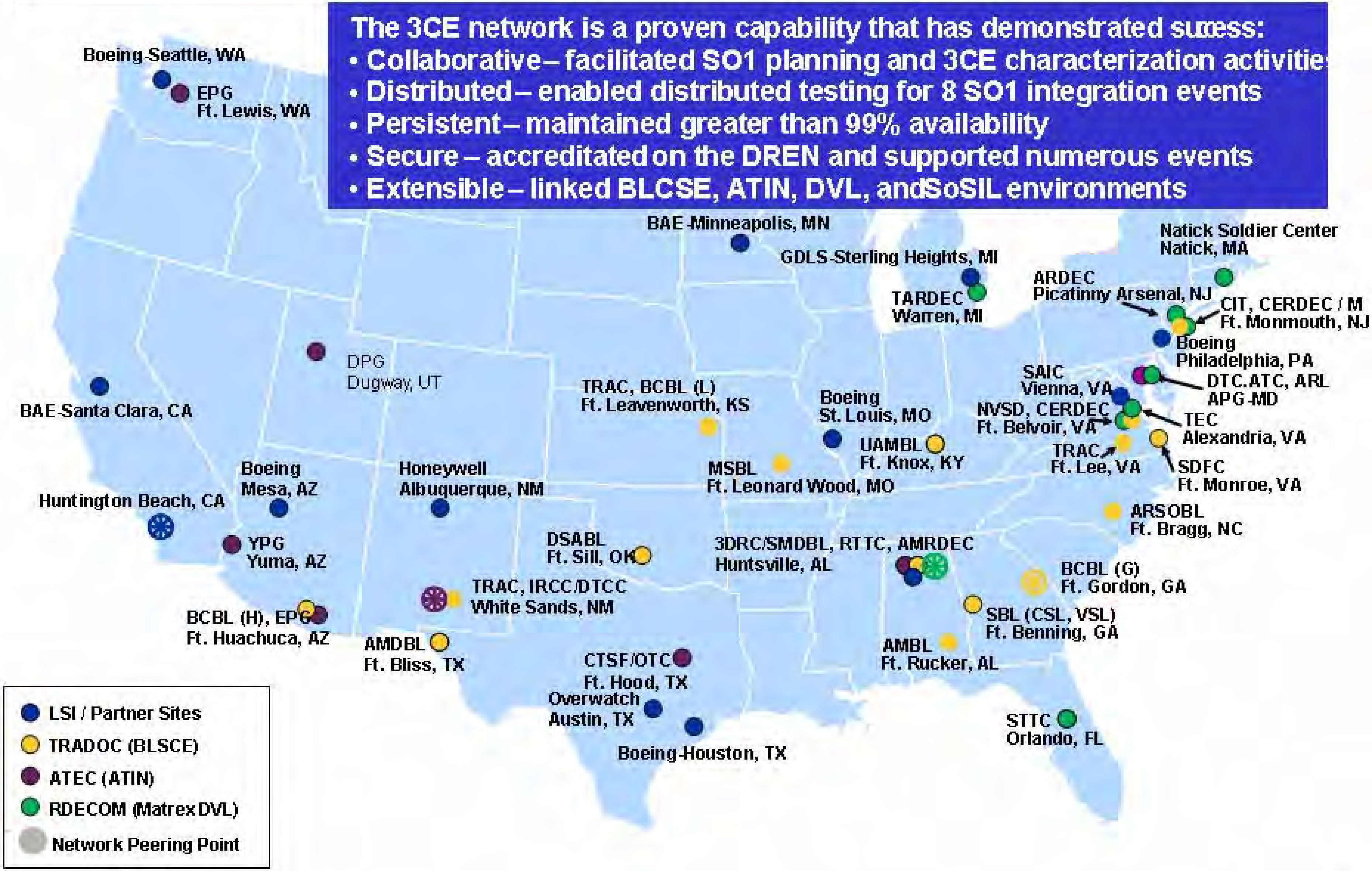
- **Network**
  - **Established 3CE network consisting 52 total nodes built from 4 "Command" networks**
    - **TRADOC- BLCSE (Battle Labs and Analysis Centers)**
    - **ATEC- ATIN (Test Centers)**
    - **RDECOM- DVL (Research labs)**
    - **PM LSI – Sys of Systems Integrated Labs**
  - **Provides capability to conduct distributed experimentation, testing and analysis.**
    - **Extensible to other activities**
  - **Provides collaboration services**
    - **VTC**
    - **Voice over IP**
    - **Data and file storage**
  - **Persistent Network available 24/7/365**

Updating Network MOAs and Accreditation to support select Multi National participants in Army directed events.

3CE Network … A Proven Capability

The 3CE network is a proven capability that has demonstrated success:

- **Collaborative – facilitated SO1 planning and 3CE characterization activitie**
- **Distributed – enabled distributed testing for 8 SO1 integration events**
- **Persistent – maintained greater than 99% availability**
- **Secure – accreditated on the DREN and supported numerous events**
- **Extensible – linked BLCSE, ATIN, DVL, and SoSIL environments**



Why the Need for a Knowledge Repository (KR)?

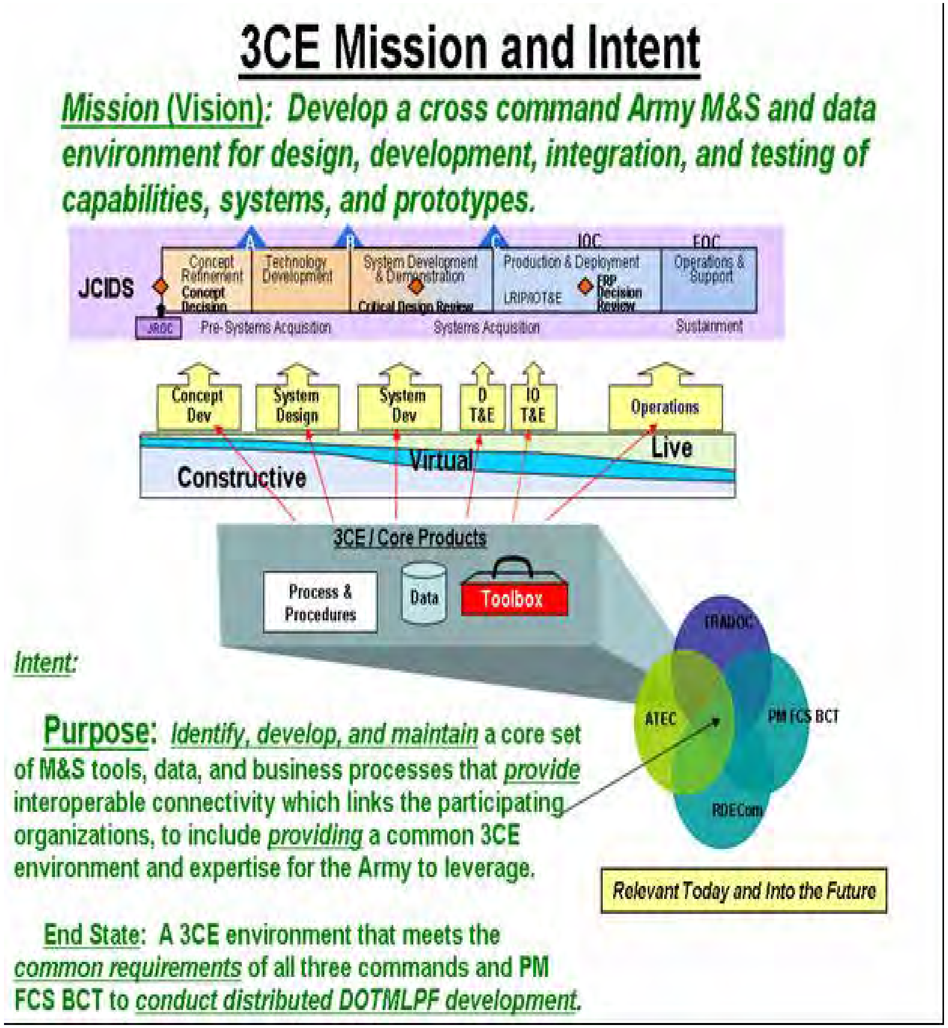
The 3CE KR is needed by multiple users to enable mission execution …

3CE Team Members (Internal Users)

- Facilitate team member coordination
- Enable development, test, and integration activities relating to 3CE's mission and intent.
  - Enable Collaboration
  - Enable Document Sharing
  - Establish processes and procedures to ensure KR contains current and validated information

3CE Commands & PMs (External Users)

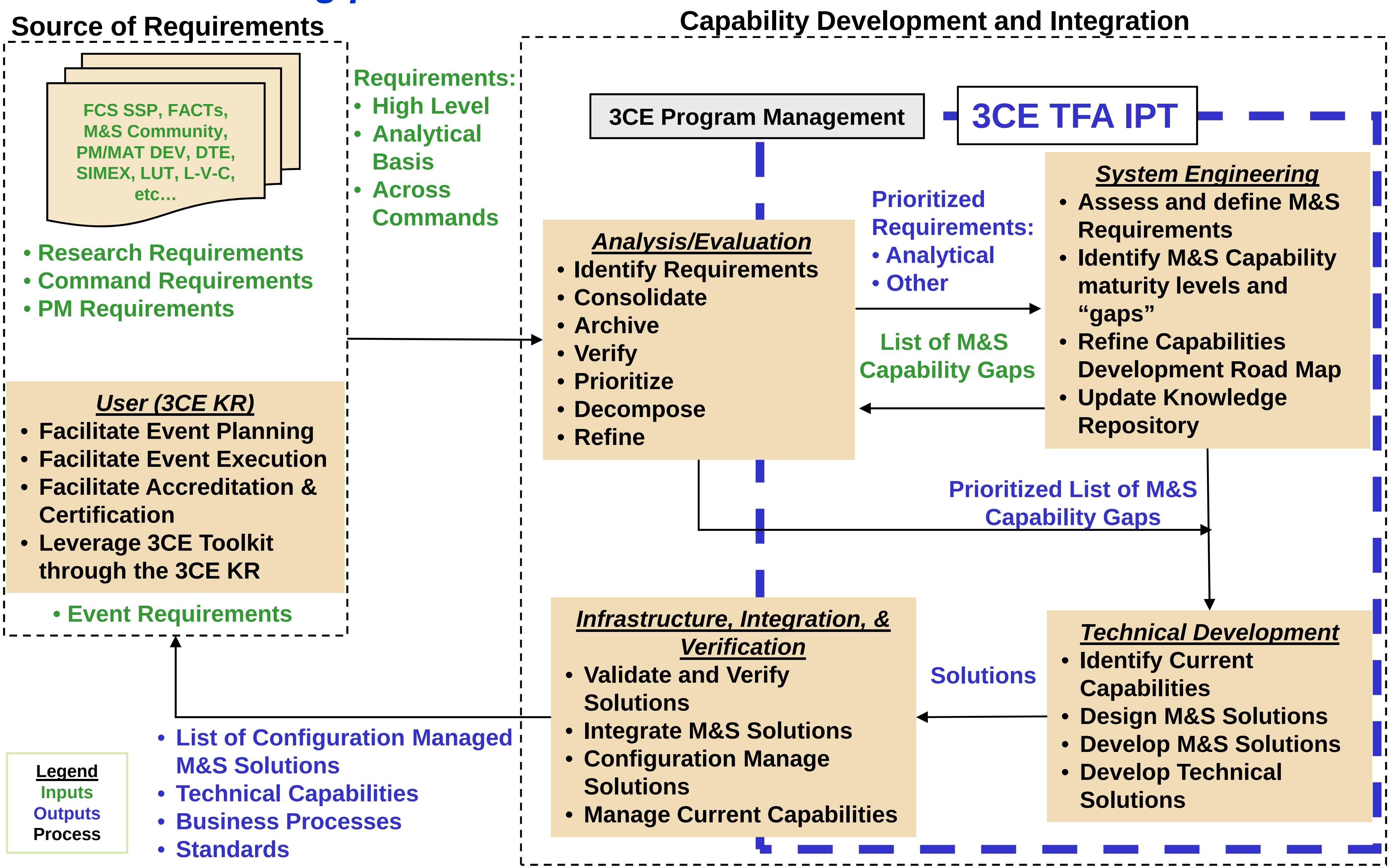
- Satisfy information needs
  - 3CE capabilities (tools, network)
  - 3CE processes
  - 3CE data
- Satisfy event coordination needs
  - Support the planning, development, execution, and reporting of events
  - Facilitate cross command data visibility and accessibility



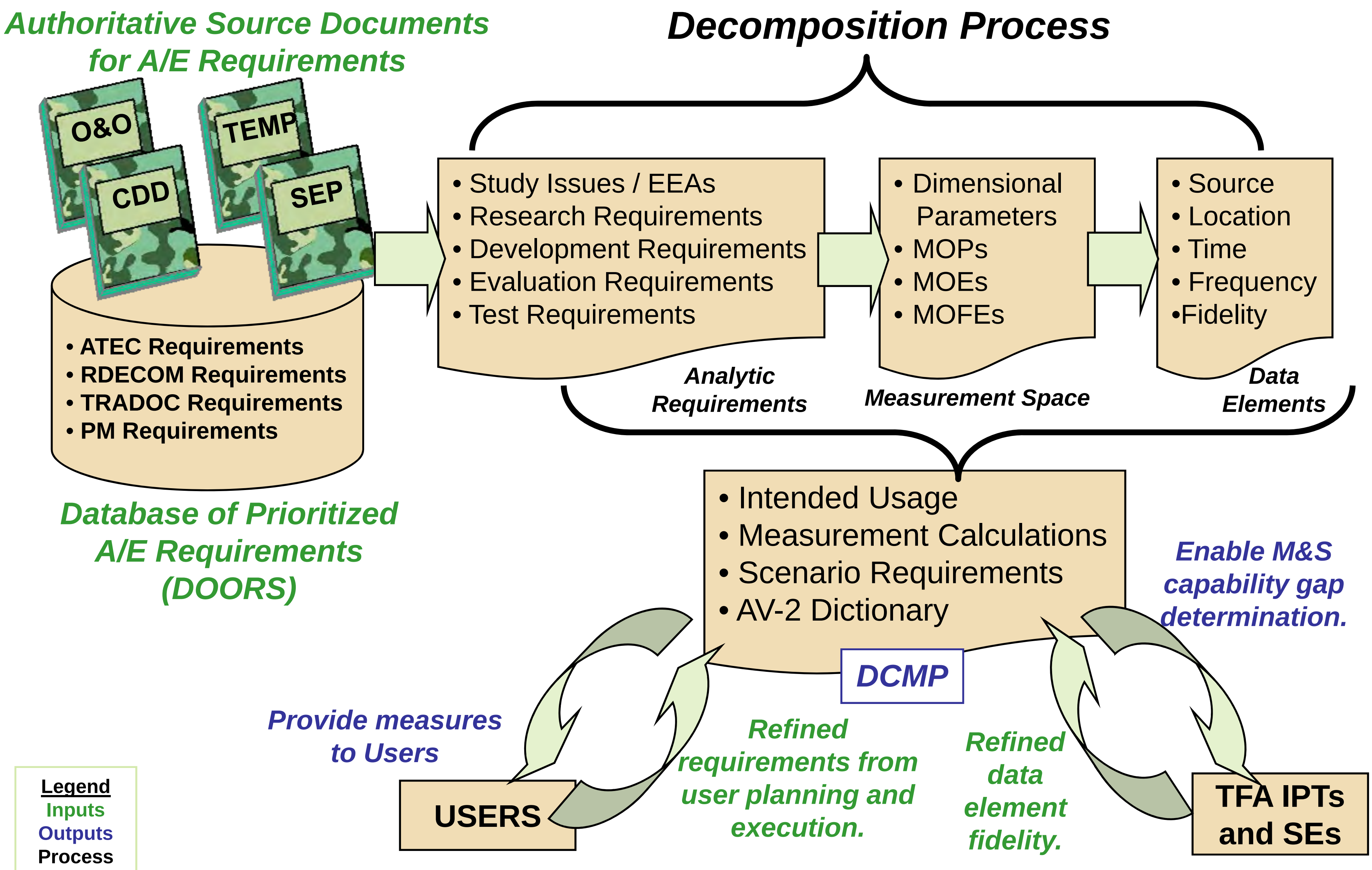
… its demand has a proven reputation for enabling mission success.

How do We Function? … 3CE Overarching Process

The overarching process describes how 3CE will execute its mission…



Analyst/Evaluator Requirement Decomposition



Requirement Types

User Requirements	A/E Requirements	M&S Requirements
CDD/ORD Requirements	**Analytic Requirements**	**Capability Requirements**
Ends	**Ways**	**Means**
Verify that the material solution must be capable of detecting a minefield 90% of the time.	• *MOE/MOP* ➢ *# of mines detected* ➢ *% of mines detected* ➢ *# systems destroyed* ➢ *% of systems destroyed*	*The test system shall simulate minefield detection and breaching.*
Mission Need	**Capability**	**Requirement**

What "requirements" are we identifying?

Tool Selection Using the 3CE Knowledge Repository

1

ATEC

RDECOM

TRADOC

Program/event Requirements Input

User Queries
(based on user requirements)

2

3CE KR (AKO)

Analytical Requirements
Technical Requirements
MOP Context Views
OVs and SVs
Supporting Data

"AS-IS" tool capabilities

KR Tool Selection Process

3

4

- Capabilities aligned to user requirements
- Example requirements
- Products aligned to user requirements (analytical, operational, & technical
- M&S tool/data collaboration/ sharing

How Do We Involve the M&S Community?

1 Endstate

M&S Needs
- ATEC
- RDECOM
- TRADOC
- PM/LSI

Considerations
- OOS
- Network
- Infrastructure

3CE AC Needs
- CONOP-based
- Endstate Focused
- Prioritized

Decomposed AC Needs
- Executable Task Level
- Product Focused
- Interdependent

Common Schedule
- Long-Range Development
- Command/PM Activities
- Command/PM Events
- Command/PM Areas of Emphasis

3CE Strategy
- Needs-Based
  - AC
  - Commands
  - PM
- Endstate Focused

2 Current State

FY07 PEP
- Tasks
- Products
- Metrics

FY07 Assessment
- Metric-based
- Task Progress
- Task Completion
- Product Status

AC Need Tasks Assessment
- Aligns Need Tasks to FY07 Tasks
- Assesses Need Tasks
- Refines Status

AC Need Assessment
- Applies Task Status
- Updates Need Status
- Facilitates PRM

3 Future State

Cross Command Collaboration Effort (3CE)

FY08 Project Execution Plan (PEP)

FY08 Tasks
- PRM-Based
- Endstate Focused
- Mutually Supporting
  - Commands
  - PM
  - OOS
  - Network
  - Infrastructure

3CE PRM
- Needs-Based
- Status Focused
- FY08 – FY12
- Command/PM Aligned

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Accomplishments to Date for FCS

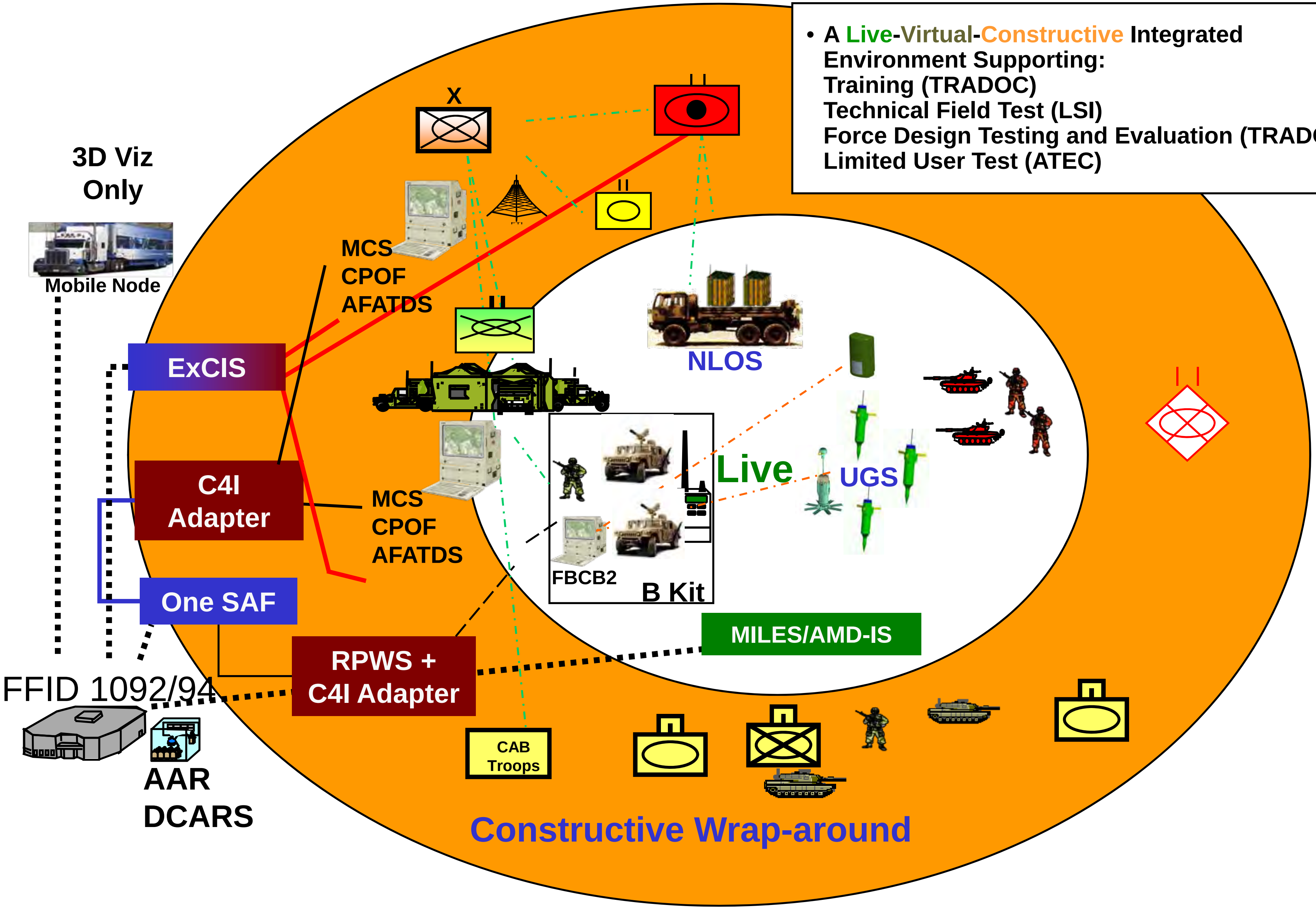
Event Support

- Experiment 1.1
  - Linked over 3CE sites
  - Provided live video and AAR for experiment
  - Ability to share lessons learned throughout Army real time.
- SO simulation federation
  - Identified requirements
  - Identified solutions
  - Conducting integration to provide common solution to 4 events.

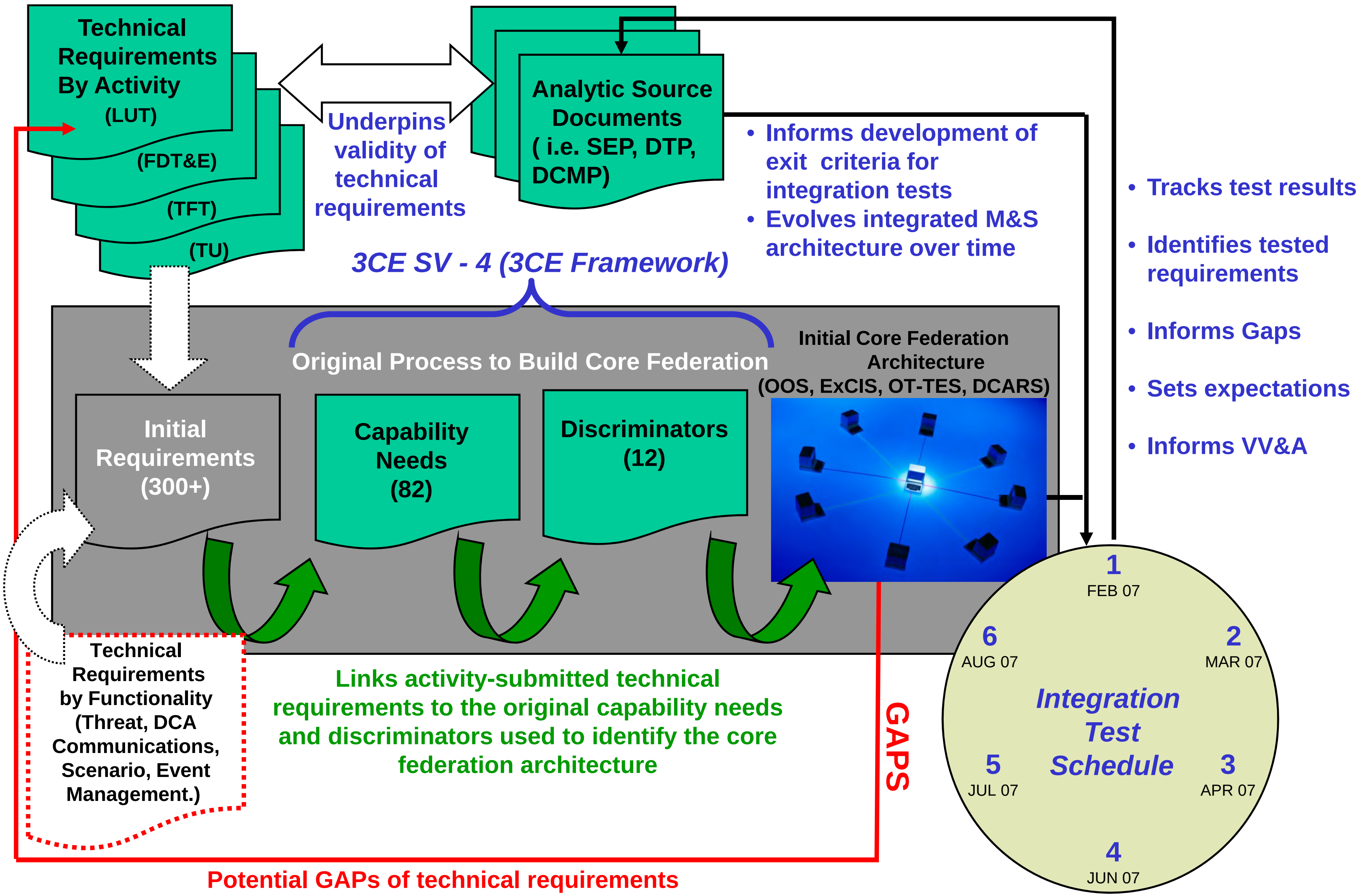
A 3CE environment that meets the common requirements of all three commands and PM FCS BCT to conduct distributed DOTMLPF development.

An Applied Example … 3CE Supporting SO

- A Live-Virtual-Constructive Integrated Environment Supporting: Training (TRADOC) Technical Field Test (LSI) Force Design Testing and Evaluation (TRADOC) Limited User Test (ATEC)



Enabling SO1 Integration … Requirements Focused



Potential GAPs of technical requirements will inform the ability to achieve analytic requirements

Purpose and Agenda

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Summary

As the integrator of an environment, 3CE focuses on common and consistent capabilities to enable cross command collaboration, synergy, and reusability …

- **Provides consistent representation through common tools and data IAW established standards and best practices.**
- **Provides the capability to leverage a single event for multiple purposes.**
- **Provides and develops environment capabilities that are traceable to user needs and design requirements.**
- **Enhances current M&S capabilities and reuse.**
- **Provides a leave behind capability to support future SoS acquisition programs.**

… through the activities in support of SO integration, 3CE will have an instantiation of this capability to support future user activities across the Army.

- **Provide a core federation with supporting functional, interoperability, event management, and data collection and analysis tools.**
- **Provide an accessible knowledge repository that provides the processes, procedures, standards, and expertise to leverage 3CE capabilities.**
- **Provide a persistent and secure network that enables collaboration and interoperability across the commands and the PM/LSI.**

The Effectiveness of Systems Engineering: on DoD System Development Programs

NDIA Systems Engineering Conference

21 October 2008

Ken Ptack, CSEP

SE Effectiveness -
Overview

The SE Effectiveness Survey

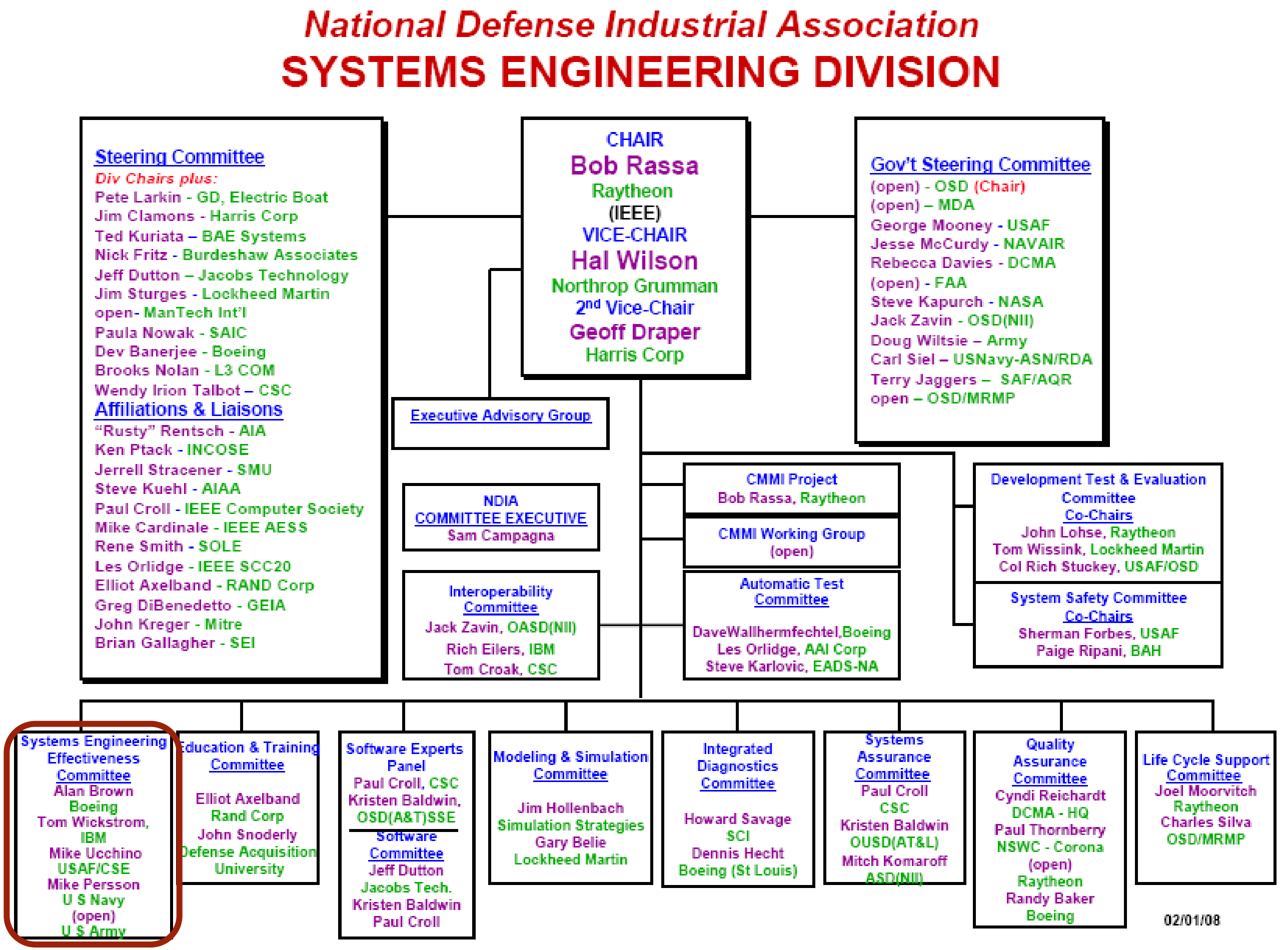
Quantifies the relationship between the application of Systems Engineering best practices and the performance of system development projects

Projects with better Systems Engineering capabilities deliver better Project Performance!

TODAY'S OUTLINE

1. Rationale and Background
2. The Challenge
3. The Rigor
4. The Results!
5. Conclusions & Caveats

NDIA SE Division – Org Chart



Survey Rationale and Background

Previous Studies - Summary

STUDY		APPLICABILITY		
Author & Background	Findings	SE Activities	Definition of Success	Characteristics of Project
Gruhl (1992) 32 NASA Pgms	8-15% Upfront Best	First two of five development phases	Cost (Less cost overrun)	Large; Complex; all NASA
Herbsleb (1994) 13 CMM Companies	Process Improvement ROI 4.0 – 8.8	CMM Process Areas	Cost (Cost reduction through SE investment)	Various; federal contracting
Honour (2004) Survey INCOSE SEs	15-20% of project should be SE	Overall SE level of effort (Cost) & related SE quality	Cost & Schedule	Various sizes (measured by total project cost)
Boehm & Valerdi (2006) COCOMO II	SE importance grows with project size	COCOMO II RESL (Architecture and Risk)	Cost	Various sizes, but software systems only
Boehm & Valerdi (2004) COSYSMO	Estimate within 30% effort 50% - 70% of time	33 activities defined by EIA 632	Cost	Mostly successful projects from federal contractors
Ancona & Caldwell (1990) Boundary Management	Managing team boundary 15%; more is better	Team boundary activities – interface between team and external	Product Performance (Successfully marketed products)	Technology products
Frantz (1995) Boeing side-by-side projects	More SE yielded better quality & shorter duration	Defined by Frantz	Product Performance & Schedule (Quality of product and duration of project)	Three similar systems for manipulating airframes during assembly

Mink, 2007

Does this sound familiar?

NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION STRENGTH THROUGH INDUSTRY & TECHNOLOGY

The SE efforts on my project are critical because they …

… pay off in the end.

… ensure that stakeholder requirements are identified and addressed.

… provide a way to manage program risks.

… establish the foundation for all other aspects of the design.

… optimize the design through evaluation of alternate solutions.

We need to minimize the SE efforts on this project because …

… including SE costs in our bid will make it non-competitive.

… we don't have time for '*paralysis by analysis*'. We need to get the design started.

… we don't have the budget or the people to support these efforts.

… SE doesn't produce deliverable outputs.

… our customer won't pay for them.

•These are the ASSERTIONS, but what are the FACTS?

The Problem

It is difficult to justify the costs of SE in terms that program managers and corporate managers can relate to.

- The costs of SE are evident
  - Cost of resources
  - Schedule time
- The benefits are less obvious and less tangible
  - Cost avoidance (e.g., reduction of rework from interface mismatches)
  - Risk avoidance (e.g., early risk identification and mitigation)
  - Improved efficiency (e.g., clearer organizational boundaries and interfaces)
  - Better products (e.g., better understanding and satisfaction of stakeholder needs)

The Questions

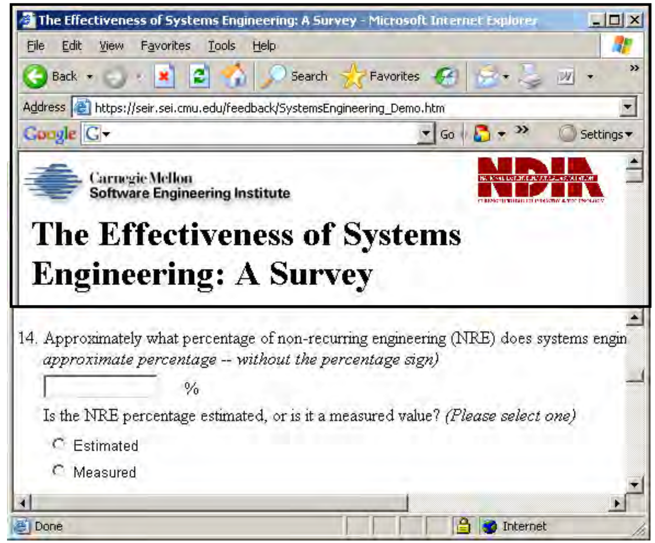
- **How can we quantify the effectiveness and value of SE?**
- **How does SE benefit program performance?**

The Solution

Obtain quantitative evidence of the costs and benefits of Systems Engineering

The Challenge –
SE Effectiveness Survey

Hypothesis: The effective performance of SE best practices on a development program yields quantifiable improvements in the program execution (e.g., improved cost performance, schedule performance, technical performance).



Objectives:

- Characterize effective SE practices
- Correlate SE practices with measures of program performance

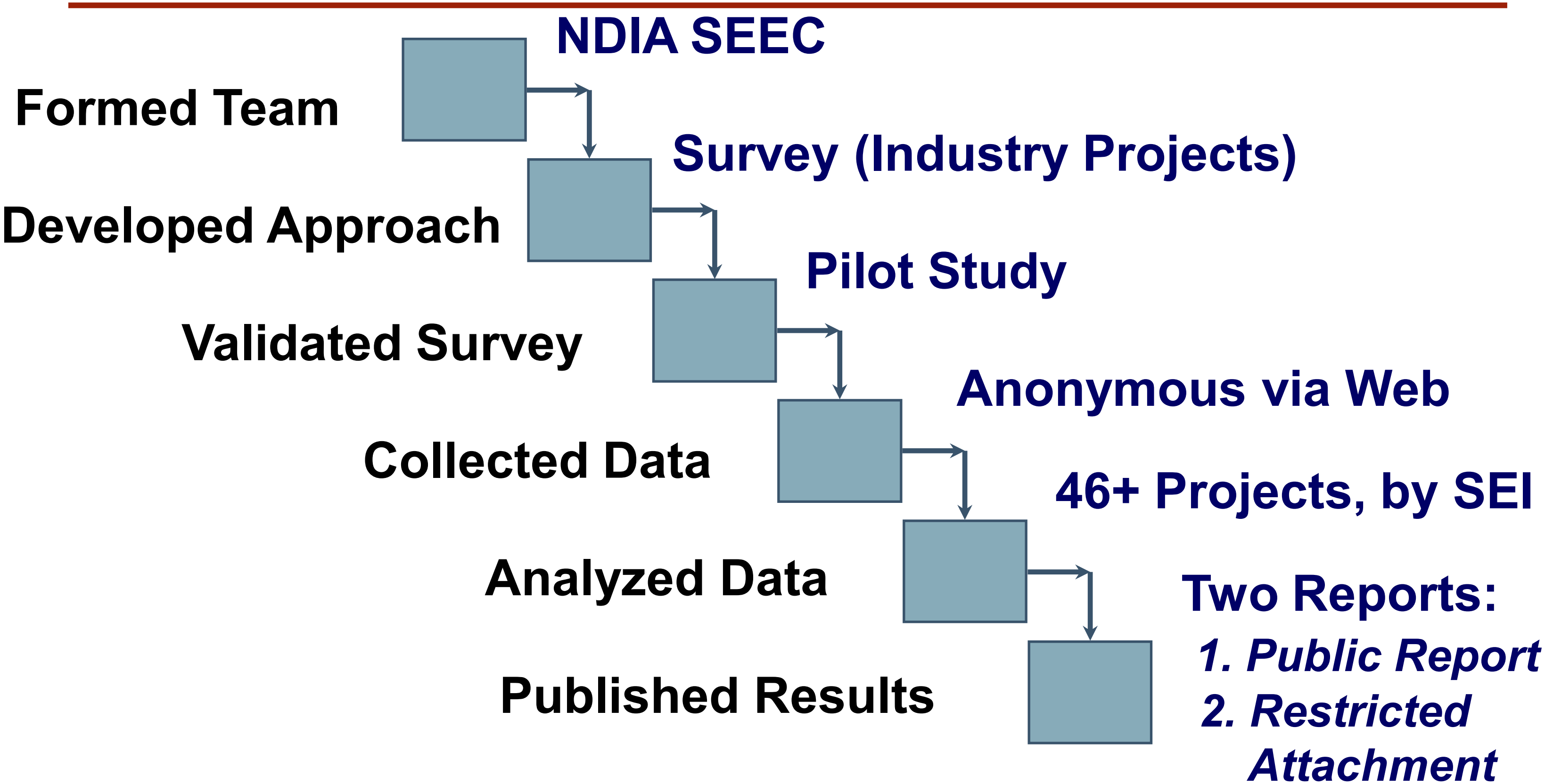
Approach:

- Distribute survey to NDIA companies
- SEI analysis and correlation of responses

Survey Areas:

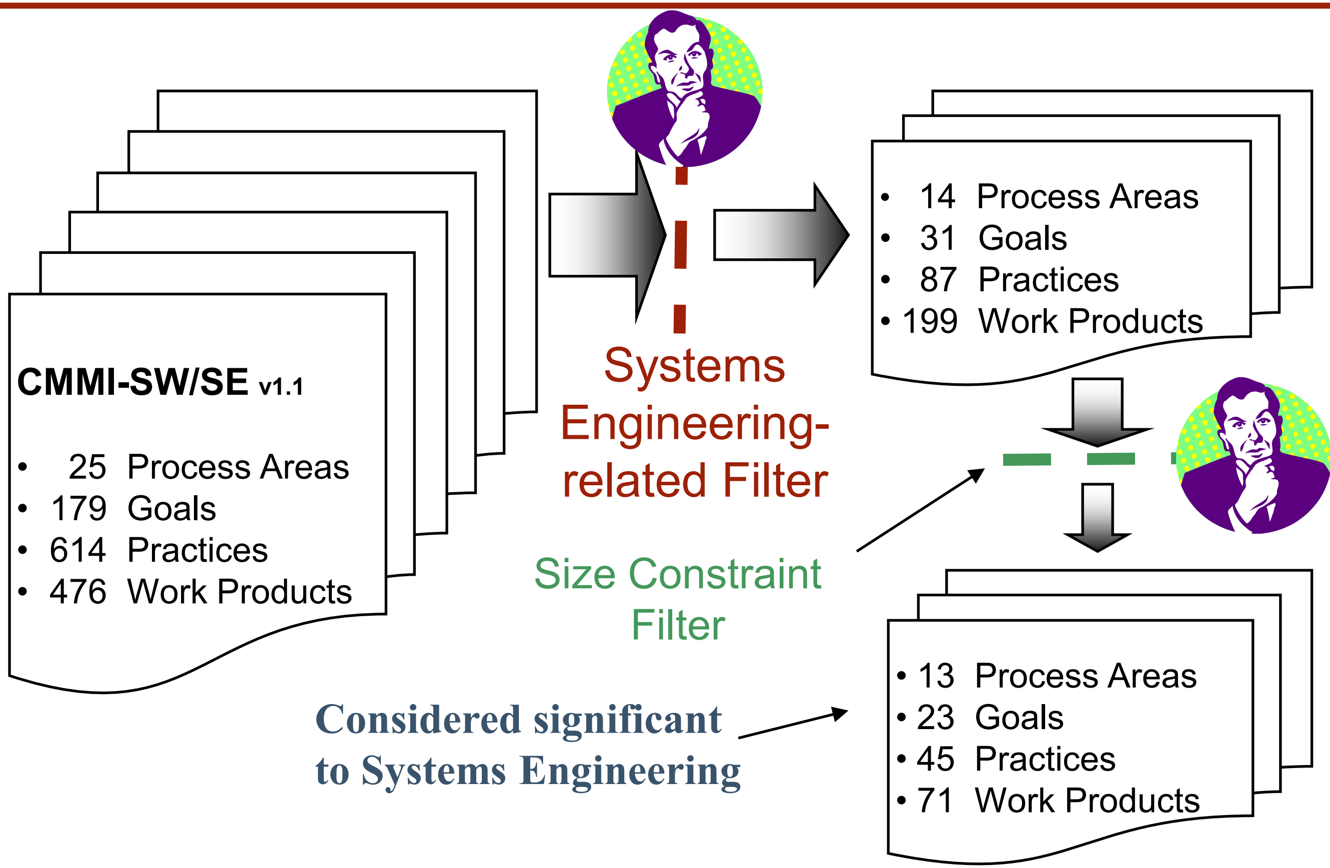
Process definition
Project planning
Risk management
Requirements development
Requirements management
Trade studies
Interfaces
Product structure
Product integration
Test and verification
Project reviews
Validation
Configuration management
Metrics

The Rigor -
Followed Planned Lifecycle



This study spanned three + years

The Rigor -
Formally Selected Set of SE Activities



Survey was developed based on standards and recognized SE experts

Candidate Methods:
Case Studies

Method

- Establish collaboration with one (or a few) defense contractor(s)
- Choose a few completed projects
- Collect and analyze data to quantify the costs and benefits of the SE applied to the projects

Pros

- In-depth, multi-faceted study

Cons

- Reluctance of contractors to expose sensitive data
- Lack of data
  - Consistency: No generally accepted definition of SE
  - Availability: 1) SE efforts not often budgeted and tracked
    2) Benefits of SE are difficult to quantify
- Lack of generalization
  - "That doesn't apply to us; we do it differently."
  - "That's just one (or a few) project(s)."

Candidate Methods:
Organizational Survey

Method
- Survey defense contractor organizations
- Collect and analyze data to quantify the costs and benefits of SE applied within the organization

Pros
- Based on a representative sample of the industry

Cons
- Reluctance of contractors to expose sensitive data
- Lack of data
  - Consistency:
    1) No generally accepted definition of SE across organizations
    2) Uneven application of SE within organizations
  - Availability:
    1) SE efforts not often budgeted and tracked
    2) Benefits of SE are difficult to quantify

Candidate Methods:
Project Survey

● ✓

Method

- Survey individual defense contractor projects
- Collect data on the application of selected SE practices
- Collect data on the overall performance of the project
- Analyze results to identify relationships between SE application and project performance

Pros

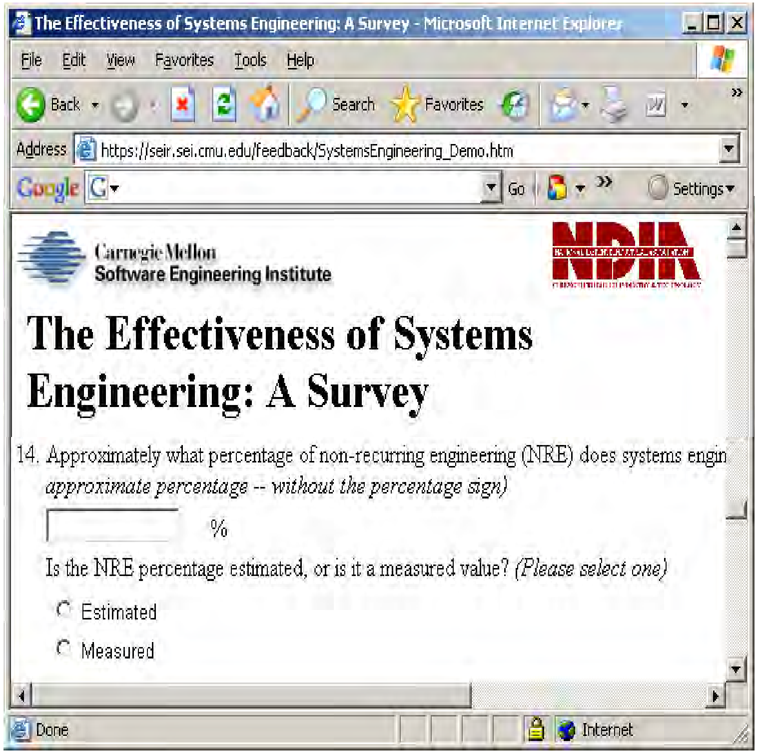
- Based on a representative sample of the industry
- The survey provides a common definition of SE
- Project performance data is widely available

Cons

- Reluctance of contractors to expose sensitive data

Implementation of the Systems Engineering Effectiveness Survey (SEES)

1. Define the goal
2. Choose the population
3. Define the means to assess usage of SE practices
4. Define the measured benefits to be studied
5. Define the „other‟factors to be studied
6. Develop the survey instrument
7. Execute the survey
8. Analyze the results
9. Report
10. Plan future studies



Population and Sampling Method

Population

- DoD prime contractors and subcontractors who produce products (as opposed to services).

Sampling Method

- NDIA SE Division represents a reasonable cross section of the chosen population
- Invite all product-supplying organizations within the NDIA SE Division to participate.
- Random sampling within each organization

Assessment of SE Practices 1

•Question #1

•What SE activities do you apply to your project?

Challenge

- No generally accepted definition of what IS and what IS NOT a part of SE.
  - "How much SE do you do on your project?" ⇐ No answer
- SE is often embedded in other tasks and not budgeted separately
  - "How much does your project spend on SE?" ⇐ No answer

Solution

- Avoid a defining SE
  - Too much controversy
- Ask about the results of activities that are generally agreed to be SE

Assessment of SE Practices 2

Based on CMMI-SE/SW v1.1

Focused on identifying tangible artifacts of SE activities

- Work products

Work Products chosen by a panel of SE experts from government, industry, and academia

- First pass - selected CMMI Work Products that were (in the judgment of the SE expert panel) related to SE
- Second pass – selected SE-related Work Products that were (in the judgment of the SE expert panel) most significant

Assessment of SE Practices 3

- **CMMI-SE/SW/IPPD** v1.1
- 25 Process Areas
- 179 Goals
- 614 Practices
- 476 Work Products

•Systems Engineering-related Filter

- 14 Process Areas
- 31 Goals
- 87 Practices
- 199 Work Products

•Size Constraint

•Considered significant to Systems Engineering

- 13 Process Areas
- 23 Goals
- 45 Practices
- 71 Work Products

•Survey content is based on a recognized standard (CMMI)

Assessment of SE Practices 4

Goal	PRACTICE	WORK PRODUCT	SE Work Product	KEY SE WP	Q#
Integrated Project Management for IPPD					
SG 1: Use the Project's Defined Process - The project is conducted using a defined process that is tailored from the	SP 1.1-1: Establish the Project's Defined Process - Establish and maintain the project's defined process.	The project's defined process			
	SP 1.2-1: Use Organizational Process Assets for Planning Project Activities - Use the organizational process assets and measurement repository for estimating and planning	Project estimates			
		Project plans			
	SP 1.5-1: Contribute to the Organizational Process Assets ... measures, and documented ... assets.	Proposed improvements to the organizational process assets			
		Actual process and product measures collected from the project			
		Documentation (e.g., exemplary process descriptions, plans, ... checklists, and lessons learned)			
		Presentation ... activities			
		Published principles, shared-vis... and objectives (e.g., posters, wallet cards published on posters suitable for wall hanging)			
SG 4: Organize Integrated Teams for IPPD - The integrated teams needed to execute the project are identified, defined, structured, and tasked.	SP 4.1-1: Determine Integrated Team Structure for the Project - Determine the integrated team structure that will best meet the project objectives and constraints.	Assessments of the product and product architectures, including risk and complexity	Y		
		Integrated team structures based on the WBS and adaptations	Y	Y	Proj05 Proj06
		Alternative concepts for integrated team structures that include responsibilities, scope, and interfaces	Y		
		Selected integrated team structure	Y		
	SP 4.2-1: Develop a Preliminary Distribution of Requirements to Integrated Teams - Develop a preliminary distribution of requirements, responsibilities, authorities, tasks, and interfaces to teams in the selected integrated team structure.	Preliminary distribution of integrated team authorities and responsibilities	Y		
		Preliminary distribution of the work product requirements, technical interfaces, and business (e.g., cost accounting, project management) interfaces each integrated team will be responsible for satisfying	Y		
	SP 4.3-1: Establish Integrated Teams - Establish and maintain teams in the integrated team structure.	A list of project integrated teams	Y		
		List of team leaders	Y		
		Responsibilities and authorities for each integrated team	Y	Y	Proj03
		Requirements allocated to each integrated team	Y		
		Measures for evaluating the performance of integrated teams	Y	Y	Proj04
	relative priority.				

Goal	PRACTICE	WORK PRODUCT	SE Work Product	KEY SE WP	Q#
SG 4: Organize Integrated Teams for IPPD - The integrated teams needed to execute the project are identified, defined, structured, and tasked.	SP 4.1-1: Determine Integrated Team Structure for the Project - Determine the integrated team structure that will best meet the project objectives and constraints.	Assessments of the product and product architectures, including risk and complexity	Y		
		Integrated team structures based on the WBS and adaptations	Y	Y	Proj05 Proj06
		Alternative concepts for integrated team structures that include responsibilities, scope, and interfaces	Y		
		Selected integrated team structure	Y		

- Identified as key SE artifacts
- Identified as SE artifacts

Assessment of SE Practices 5

- **SE Work Products chosen in the following CMMI Process Areas:**

CMMI Process Area		# WP	
Organizational Process Definition	OPD	1	
Project planning	PP	10	
Risk management	RSKM	6	
Requirements development	RD	8	
Integrated Project Management	IPM	3	
Requirements management	RM	10	
Configuration management	CM	7	
Technical Solution	TS	13	Trade studies Interfaces Product architecture
Product Integration	PI	1	
Verification	VER	10	
Validation	VAL	2	

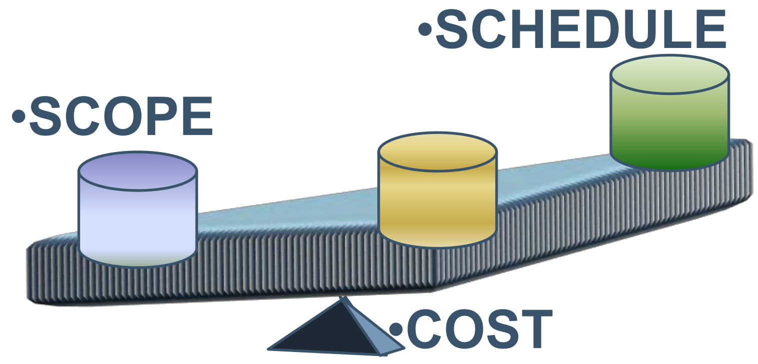
Assessment of Project Performance

•Question #2

•**How is your project going?**

Address TOTAL Project Performance

- Project Cost
- Project Schedule
- Project Scope



Focus on commonly used measurements

- Earned Value Management (CPI, SPI, baseline management)
- Requirements satisfaction
- Budget re-baselining and growth
- Milestone and delivery satisfaction

Assessment of Other Factors

•Question #3

•What other factors affect project performance?

SE Capability is not the ONLY thing that can impact Project Performance. What about:

- **Project Challenge** – some projects are more complex than others
  - Lifecycle scope, technology maturity, interoperability needs, precedence, size, duration, organizational complexity, quality of definition
- **Acquirer Capability** – some acquirers are more capable than others
  - Requirements quality, acquirer engagement, consistency of direction
- **Project Environment** – projects executed in and deployed to different environments have different needs
  - Acquiring organization, user organization, deployment environment, contract type, developer's experience, developer's process quality

Developing the Survey Instrument:

Requirements

Target Respondent

- Program / Project Manager or designee for individual projects

Deployment

- Web based
- Anonymous
  - No questions eliciting identification of respondent, project, or organization

Target Response Time

- Average: 30 minutes
- Maximum: 60 minutes

Developing the Survey Instrument:

Questionnaire Structure

Section 1 - Project Characterization

- Project Challenge
- Acquirer Capability
- Project Environment

Section 2 - SE Capability Assessment

- Process Definition, Project Planning & Risk Management
- Requirements Development, Requirements Management & Trade Studies
- Interfaces, Product Structure & Integration
- Verification, Validation, & Configuration Management

Section 3 - Project Performance Assessment

- Earned Value Management
- Other Performance Indicators

Developing the Survey Instrument:
Question Formats 1

Quantitative Questions

- Some questions require numeric answers
  - What is the current total contract value of this project?
- Other questions require an approximate numeric response
  - The schedule of this project's critical path when compared to the current IMS approved by the acquirer is:
    ☐ Greater than 6 months late
    ☐ Greater than 3 months late
    …
    ☐ Greater than 6 months early

Free Form Questions

- Provides an opportunity for the respondent to enter his thoughts
  - What performance indicators (beyond cost and schedule) have been particularly useful in managing your project?

Developing the Survey Instrument:
Question Formats 2

Likert Items

- Many of the questions assessing SE Capabilities use a “Likert” format
  - a psychometric scale commonly often used in survey research
  - respondents specify their level of agreement to a statement

“My project has a <*work product*> with <*defined characteristics*>”

☐Strongly Disagree ☐Disagree ☐Agree ☐Strongly Agree

•Example

•This project has a top-level plan, such as an Integrated Master Plan (IMP) that is an event-driven plan (i.e., each accomplishment is tied to a key project event.

•☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

Developing the Survey Instrument:
Testing 1

Deployed to volunteers among the organizations participating in the development of the survey

Interviews with respondents addressing:

- Understanding of the questions
  - Nearly all questions interpreted without ambiguity
  - Some rewording to ensure consistent understanding
- Time required for completion
  - Typical 45 minutes. Maximum >2 hours
  - Issues with questions requiring quantitative inputs
- Suggestions for improvements

Developing the Survey Instrument:
Testing 2

Questionnaire revised to address results of initial testing

- Elimination of questions
- Replacement of pure quantitative questions with approximate quantitative questions
  - Selection of ranges of values rather than the entry of numeric values
  - Provided cues for the level of detail desired

Redeployed for testing

- All questions interpreted without ambiguity
- Time required for completion
  - Typical 30 minutes. Maximum 60 minutes

Survey Deployment

Challenges	Solutions
Ease of Participation •Method of response must be easy to encourage maximum participation	• Deployment and response via the internet
Confidentiality •Many NDIA members represent commercial defense contractors. •Proprietary data cannot be exposed	• Data collection and analysis done by the SEI. Only aggregated results provided
Anonymity •Further protection of proprietary data	• No questions soliciting respondent, project, or organization identification • "blind" authentication for survey login
Incentivization • Respondents and their organizations need a reason (beyond altruism) to participate	• Respondent solicitation through company management hierarchy • Early access to survey results to support benchmarking and process improvement

Survey Deployment:

Respondent Solicitation 1

Review the roster of “Active Members” of the NDIA Systems Engineering Division

Select organizations that develop and produce products (rather than services)

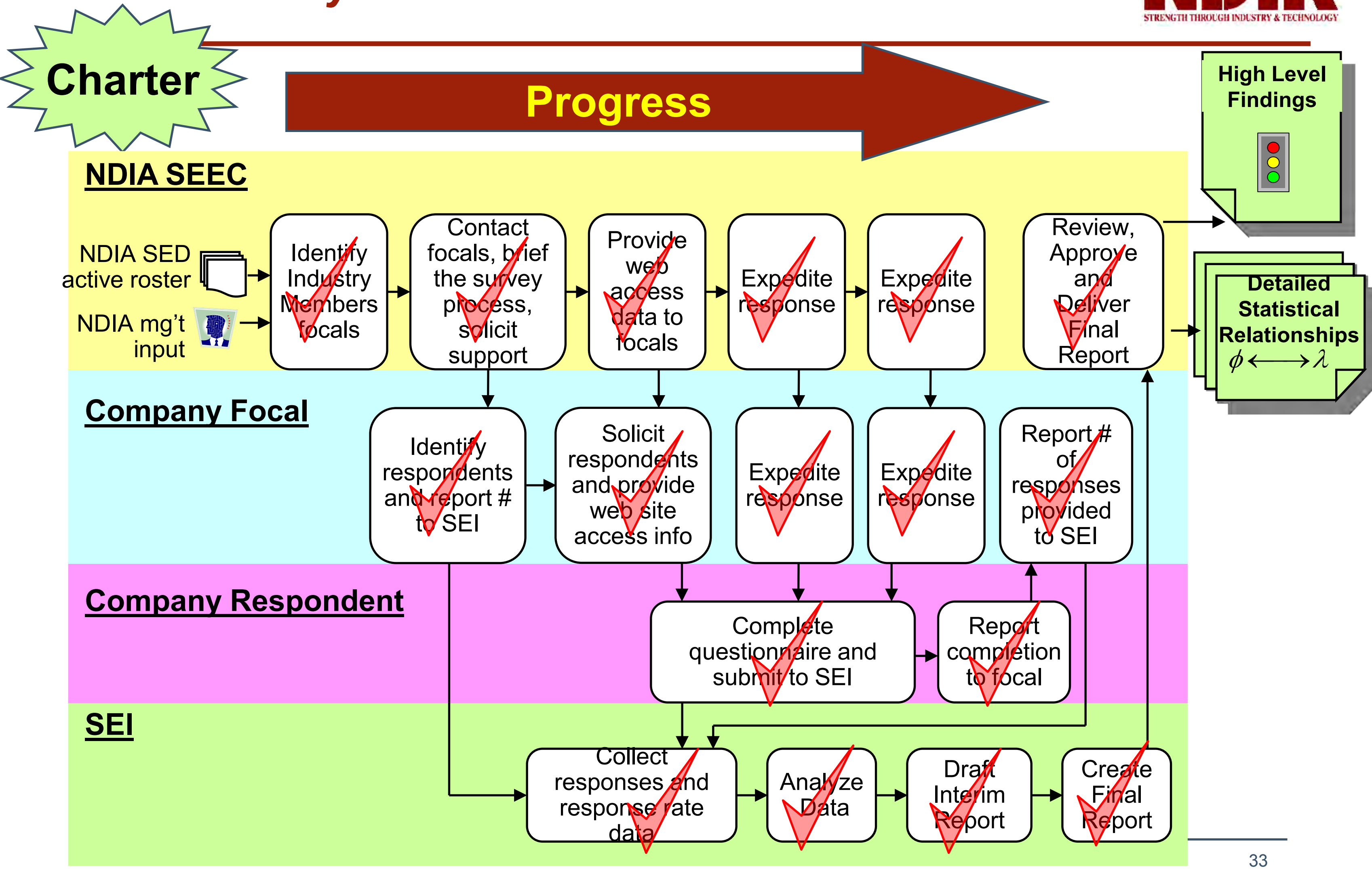
Identify “focal” person within each organization

- Involved with / interested in SE
- As high as possible within the organization’s management hierarchy

Contact Focals

- Brief the survey and solicit their support within their organization
- Ask them to solicit respondents, and provide the tools to assist them
  - Respondent solicitation by proxy enhances anonymity

The Rigor –
SEEC Survey Process



The Rigor – *Survey Methodology*

Survey Population	**Organizations developing products in support of government contracts (prime or subcontractors).**
Sampling Method	**Invitation to qualifying active members of NDIA Systems Engineering Division. Random sampling within organization.**
Survey Deployment	**Web deployment (open August 10, 2006 - November 30, 2006). Anonymous response. Questions based on CMMI-SE/SW/IPPD v1.1**
Target Respondent	**Program Manager or designee(s) from individual projects**
Questionnaire Structure	**1. Characterization of the project /program under consideration 2. Evidence of Systems Engineering Best Practices 3. Project / Program Performance Metrics**
Target Response Time	**30 – 60 minutes**
Responses	**64 survey responses (46 complete; 18 partial, but usable)**
Analysis	**Raw data analyzed by Software Engineering Institute. Analysis results reviewed by NDIA SE Effectiveness Committee.**
Reports	**1. Public NDIA/SEI report released November 2007. 2. Restricted attachment, details provided to respondents only.**

The Rigor –
Analysis

***Perf* = *f* (*PC*, *PE*, *SEC*, *AC*)**

where:

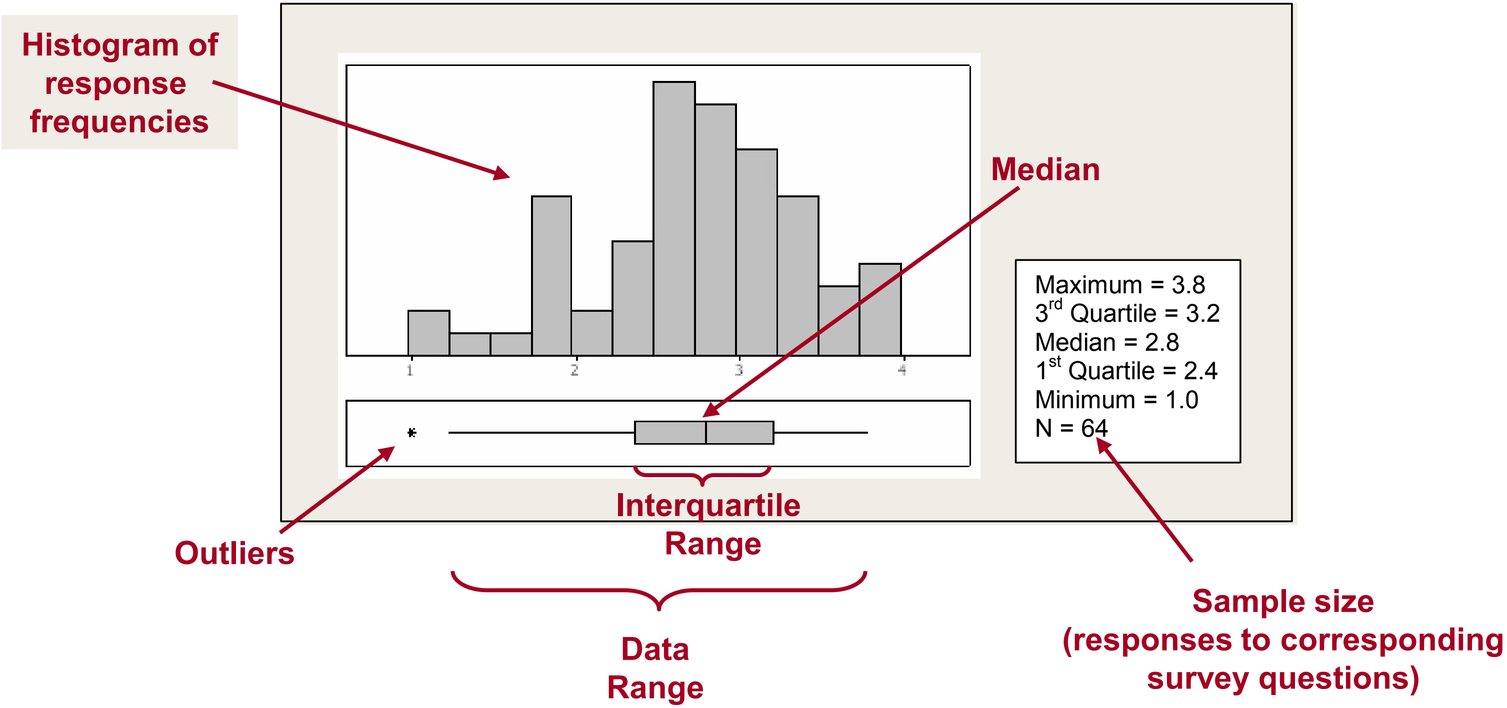
Perf = Project Performance
PE = Project Environment
SEC = Systems Engineering Capability
PC = Project Challenge
AC = Acquirer Capability

SEC can be further decomposed as:

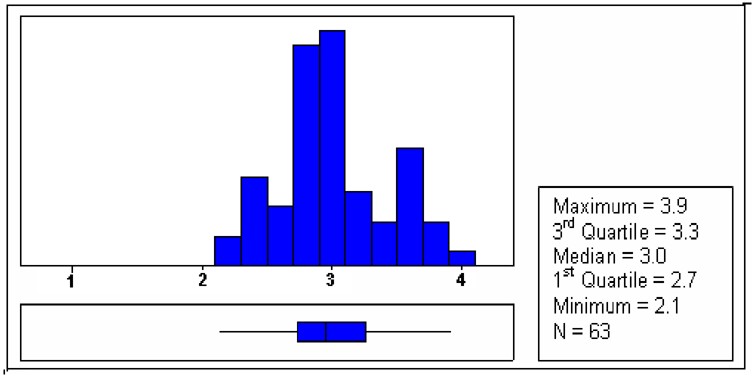
- Project Planning
- Project Monitoring and Control
- Risk Management
- Requirements Development and Management
- Technical Solution
  - Trade Studies
  - Product Architecture
- Product Integration
- Verification
- Validation
- Configuration Management
- IPT-Based Capability

SE capabilities and analyses are fully defined by mappings of associated survey question responses

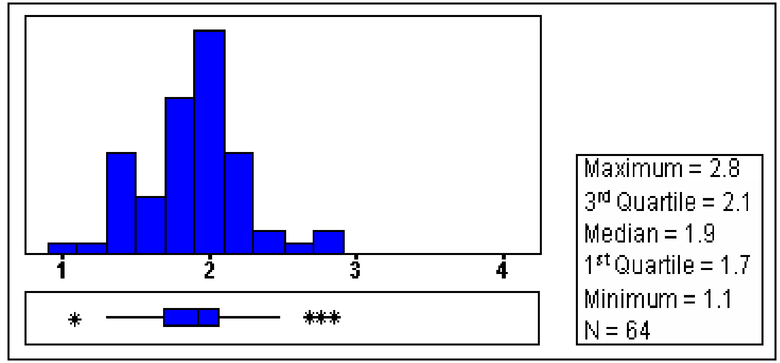
The Rigor - *Terminology and Notation*
Distribution Graph



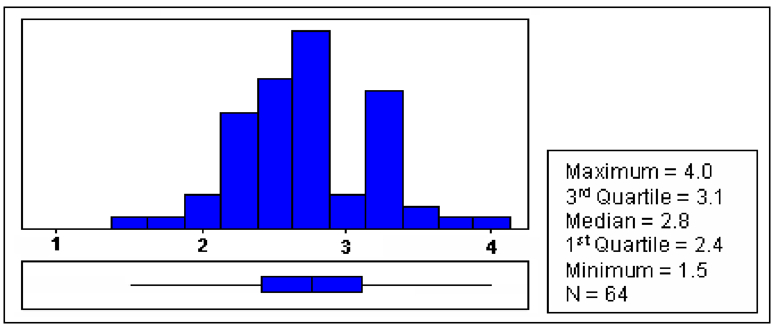
The Rigor -
Validation of Survey Responses



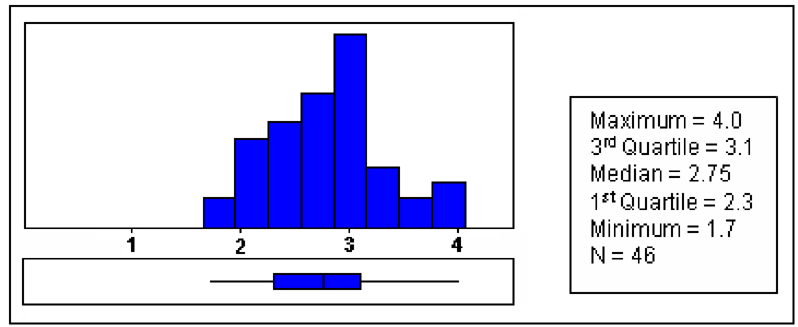
Overall SE Capability (SEC)



Project Challenge (PC)



Acquirer Capability (AC)



Project Performance (Perf)

Analyzed distributions, variability, relationships…
To ensure statistical rigor and relevance

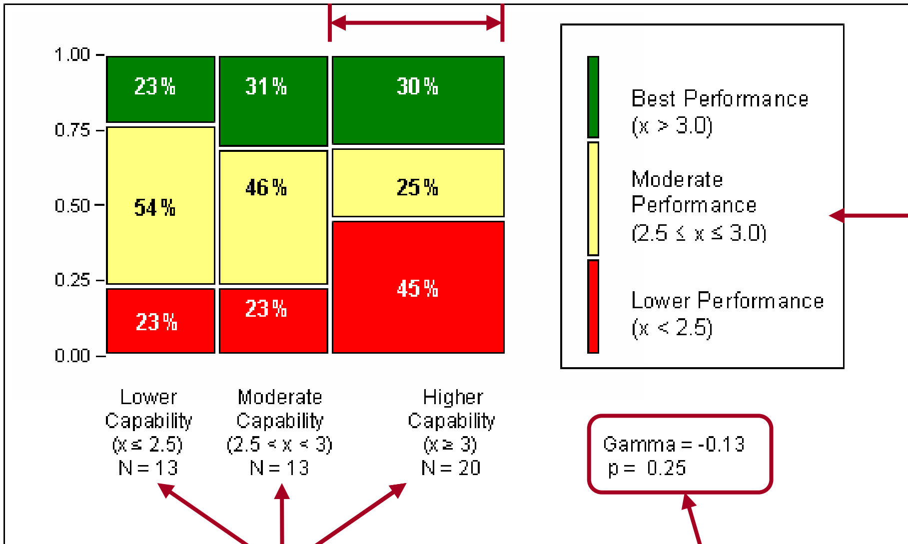
Analysis

MOSAIC Charts 1

Variable A		Variable B: Low	Variable B: Med	Variable B: High
	High	•A=High •B=Low	•A=High •B=Med	•A=High •B=High
	Med	•A=Med •B=Low	•A=Med •B=Med	•A=Med •B=High
	Low	•A=Low •B=Low	•A=Low •B=Med	•A=Low •B=High

The Results! - *Terminology and Notation*
Mosaic Chart

Column width represents proportion of projects with this level of capability



Relative performance distribution of the sample

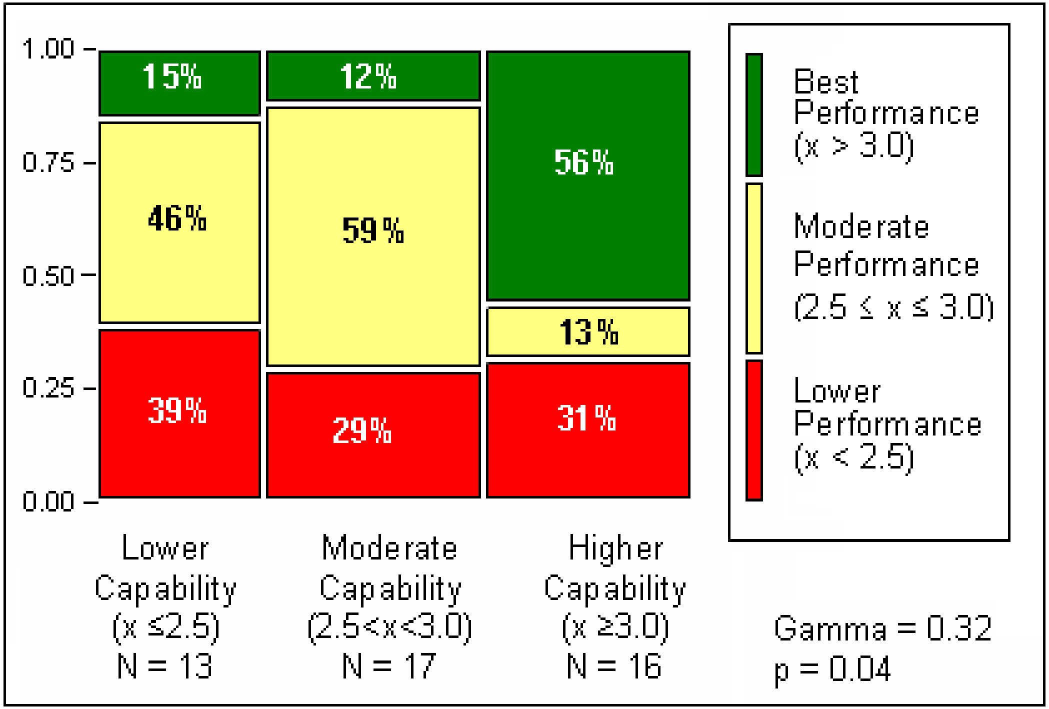
Projects exhibiting a given level of relative capability (Lowest, Intermediate, Highest); Sample size and distribution for associated survey responses (capability + performance)

Measures of association and statistical test

<u>Gamma</u>: measures strength of relationship between two ordinal variables

<u>p</u>: probability that an associative relationship would be observed by chance alone

The Results! – *Total SE Capability (SEC) vs. Project Performance (Perf)*

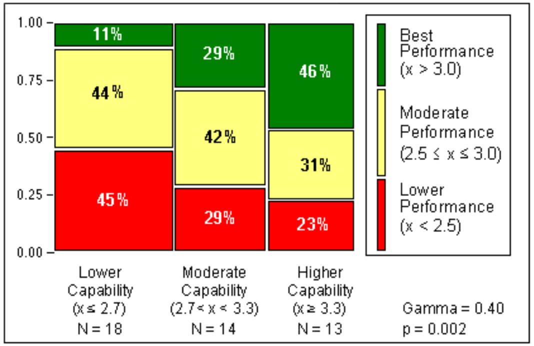


Projects with better Systems Engineering Capabilities deliver better Project Performance (cost, schedule, functionality)

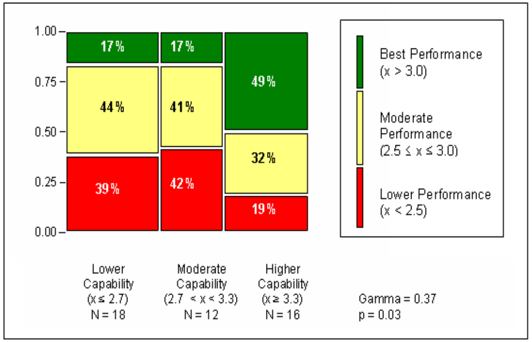
The Results! - *Higher SE Capabilities are Related to Better Program Performance*

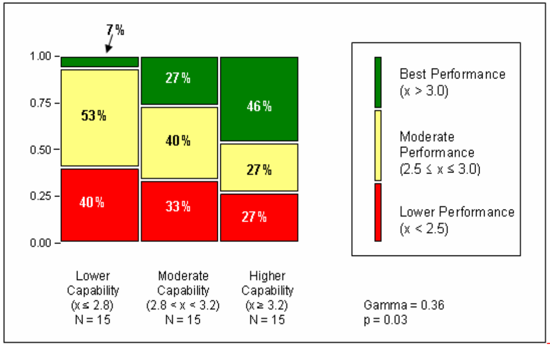
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

1. Product Architecture

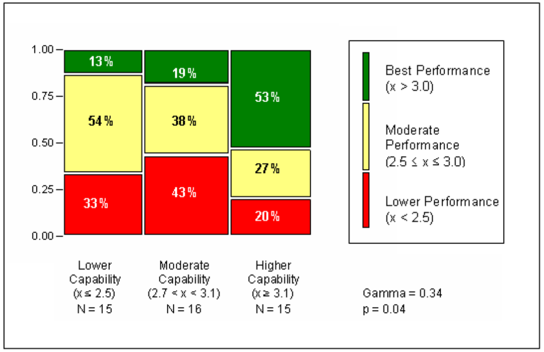


2. Trade Studies

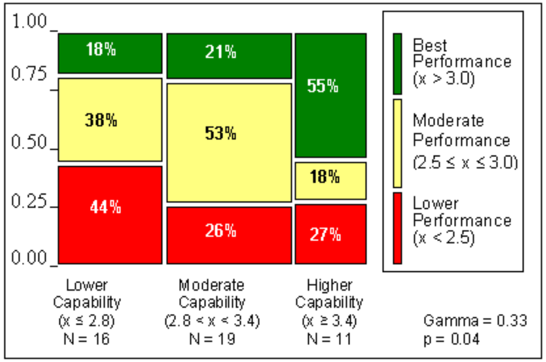




3. Technical Solution



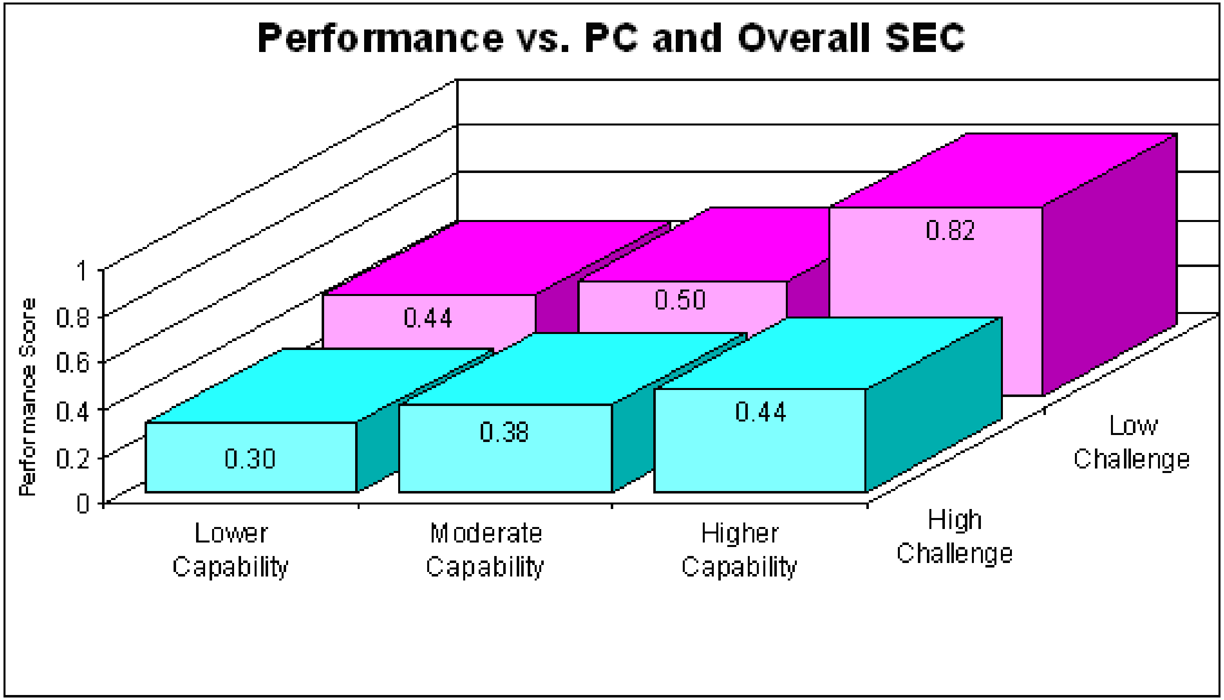
4. IPT Capability



5. Requirements

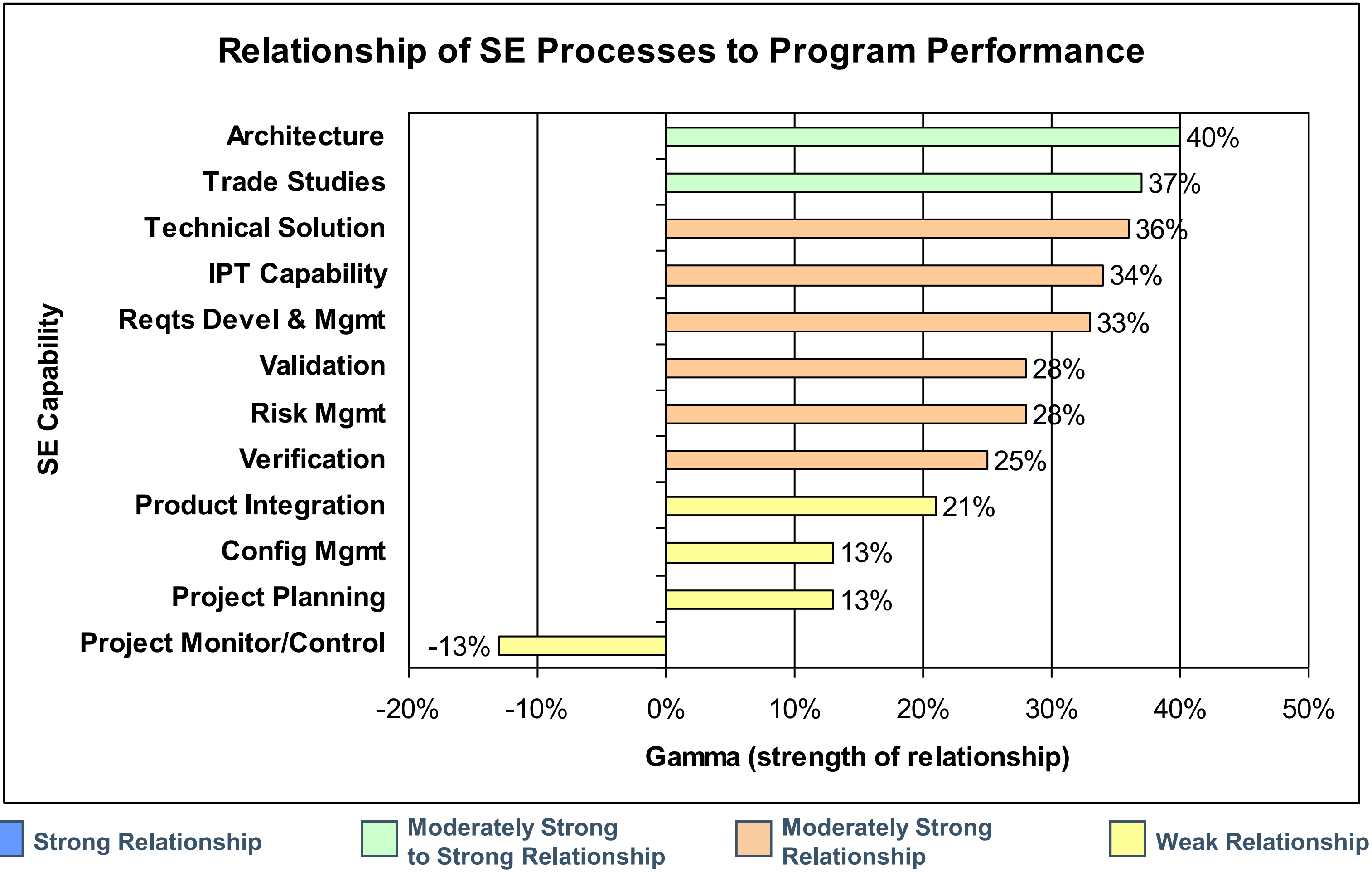
The Results! - *Relating Project Performance to Project Challenge and SE Capability*

Project challenge factors:
- **Life cycle phases**
- **Project characteristics** (e.g., size, effort, duration, volatility)
- **Technical complexity**
- **Teaming relationships**



Projects with better Systems Engineering Capabilities are better able to overcome challenging environments

The Results! -
Summary of Process Relationships



Value of the Research

Provide guidance for defense contractors in **planning capability improvement efforts**

Establish an **SE Capability Benchmark** for defense contractors

Provide **justification** and defense of defense contractor **SE investments**

Provide **guidance for acquirer evaluations** and source selections

Provide **guidance for contract monitoring**

Provide recommendations to OSD for areas to **prioritize SE revitalization**

Conclusions & Caveats -
Summary

SE Effectiveness
- Provides credible measured evidence about the value of disciplined Systems Engineering
- Affects success of systems-development projects

Specific Systems Engineering Best Practices
- Highest relationships to activities on the “left side of SE Vee”
- The environment (Project Challenge) affects performance too:
  - -Some projects are more challenging than others ... and higher challenge affects performance negatively in spite of better SE
  - -Yet good SE practices remain crucial for both high and low challenge projects

Conclusions & Caveats -
Next Steps

- **Correlate Report Findings with Other Sources**
  - Correlate report findings with results of OSD systemic root cause analysis project (SEEC/OSD work group established)
- **Pursue Specific Improvement Recommendations with OSD**
  - Policy, Compliance, Education, Data Collection (specific recommendations submitted to OSD)
- **Conduct Additional Analysis of Collected Data**
  - Independent Verification & Validation
  - Discover other relationships and correlations
- **Expand the Survey to Gauge Improvements**
  - Incorporate Lessons Learned from participants
- **Expand the Survey to Commercial Industries**
  - Discussion with IEEE AEES Board of Governors
- **Survey Acquirers**

Survey Results

"A *Survey of Systems Engineering Effectiveness--Initial Results*" (CMU/SEI-2007-SR-014) available for download as a PDF file on the SEI web site at:

http://www.sei.cmu.edu/publications/documents/07.reports/07sr014.html

Acknowledgements

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SE Effectiveness

Questions?

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Back - up

DoD Systemic Root Cause Analysis
- Why do projects fail?

NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

…We Don't Start Them Right

- Insufficient requirements analysis and definition at program initiation
  - Not tangible, measurable, testable, stable
  - User R&M requirements are not underpinned by sound rationale
- Acquisition strategies based on poor technical assumptions, competing budget priorities, and unrealistic expectations
- Budget not properly phased
- Lack of rigorous systems engineering approach
- Schedule realism – success oriented, concurrent, poor estimation and/or planning
- Inadequate test planning – breadth, depth, resources
- Optimistic/realistic reliability growth – not a priority during development
- Inadequate software architectures, design/development discipline, and organizational competencies
- Sustainment/life-cycle costs not fully considered (short-sighted)

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…We Don't Manage Them Right

- Insufficient trade space
  - Resources, schedule, performance, requirements
- Insufficient risk management
- Inadequate IMP, IMS, EVMS
- Most programs lack quantifiable entrance/exit criteria
- Maturing "suitability" (e.g., RAM) is not always a priority
- Maturing "effectiveness" is not always a priority
- Concurrent test program; inadequate scope due to schedule and resource insufficiencies, etc.
- Inadequate OTRR process – no strong DT&E gate prior to IOT&E
- Inadequate government staff; Inexperienced and/or limited contractor staffing
- Poorly defined IPT roles, responsibilities and authority
  - Overall poor communications across government and industry staff

SYSTEMS & SOFTWARE ENGINEERING – December 6, 2007 Page 6 of 21

Top 10 Emerging Systemic Issues
(from 52 "Deep Dive" Program Reviews since Mar 04)

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

SYSTEMS & SOFTWARE ENGINEERING – December 6, 2007 Page 7 of 21

Root causes from DoD analysis of program performance issues appear consistent with NDIA SE survey findings.

<u>Reference</u>:
Systemic Root Cause Analysis,
Dave Castellano, Deputy Director Assessments & Support, OUSD(A&T)
NDIA Systems Engineering Conference, 2007
and NDIA SE Division Annual Planning Meeting

Recommendations

1. Policy: **Develop policy requiring programs to apply SE practices known to contribute to improved project performance.**
   - Contractual compliance to bidder's SE processes
2. Compliance: **Ensure that SE practices and associated work products are applied to projects as promised and contracted.**
   - Verification via evaluations, audits, milestones, reviews
3. Education: **Train program staff in the value and importance of SE and in the application of SE policy.**
   - Including SE value, policy, technical evaluation
4. Data Collection: **Establish means to continue data collection on the effectiveness of SE to enable continuous process improvement.**
   - Follow-on surveys, analysis, trending

Conclusions & Caveats -
Consistent with "Top 10 Reasons Projects Fail"*

1. **Lack of user involvement**
2. **Changing requirements**
3. **Inadequate Specifications**
4. **Unrealistic project estimates**
5. **Poor project management**
6. **Management change control**
7. **Inexperienced personnel**
8. **Expectations not properly set**
9. **Subcontractor failure**
10. **Poor architectural design**

*** Project Management Institute**

Matching items noted in RED

Above Items Can Cause Overall Program Cost and Schedule to Overrun

Conclusions & Caveats -

Consistent with "Top 5 SE Issues" (2006)*

- Key systems engineering practices known to be effective are not consistently applied across all phases of the program life cycle.

- Insufficient systems engineering is applied early in the program life cycle, compromising the foundation for initial requirements and architecture development.

- Requirements are not always well-managed, including the effective translation from capabilities statements into executable requirements to achieve successful acquisition programs.

- The quantity and quality of systems engineering expertise is insufficient to meet the demands of the government and the defense industry.

- Collaborative environments, including SE tools, are inadequate to effectively execute SE at the joint capability, system of systems, and system levels.

* OUSD AT&L Summit

Matching items noted in **RED**

The Results! -
Summary of Relationships

Driving Factor	Relationship to Project Performance	
	Description	Γ
Requirements and Technical Solution Combined with Project Challenge	Very strong positive	+0.63
Combined Requirements and Technical Solution	Strong positive	+0.49
Product Architecture	Moderately strong to strong positive	+0.40
Trade Studies	Moderately strong to strong positive	+0.37
IPT-Related Capability	Moderately strong positive	+0.34
Technical Solution	Moderately strong positive	+0.36
Requirements Development and Management	Moderately strong positive	+0.33

Driving Factor	Relationship to Project Performance	
	Description	Γ
Total Systems Engineering Capability	Moderately strong positive	+0.32
Project Challenge	Moderately strong negative	-0.31
Validation	Moderately strong positive	+0.28
Risk Management	Moderately strong positive	+0.28
Verification	Moderately strong positive	+0.25
Product Integration	Weak positive	+0.21
Project Planning	Weak positive	+0.13
Configuration Management	Weak positive	+0.13
Process Improvement	Weak positive	+0.05
Project Monitoring and Control	Weak negative	-0.13

360 Degree View of the Technology, Strategy and Business

National Defense Industrial Association
11th Annual Systems Engineering Conference
San Diego, California, USA, October 20-23, 2008

Min-Gu Lee

Chief Architect
Lockheed Martin ITS-ESE Program

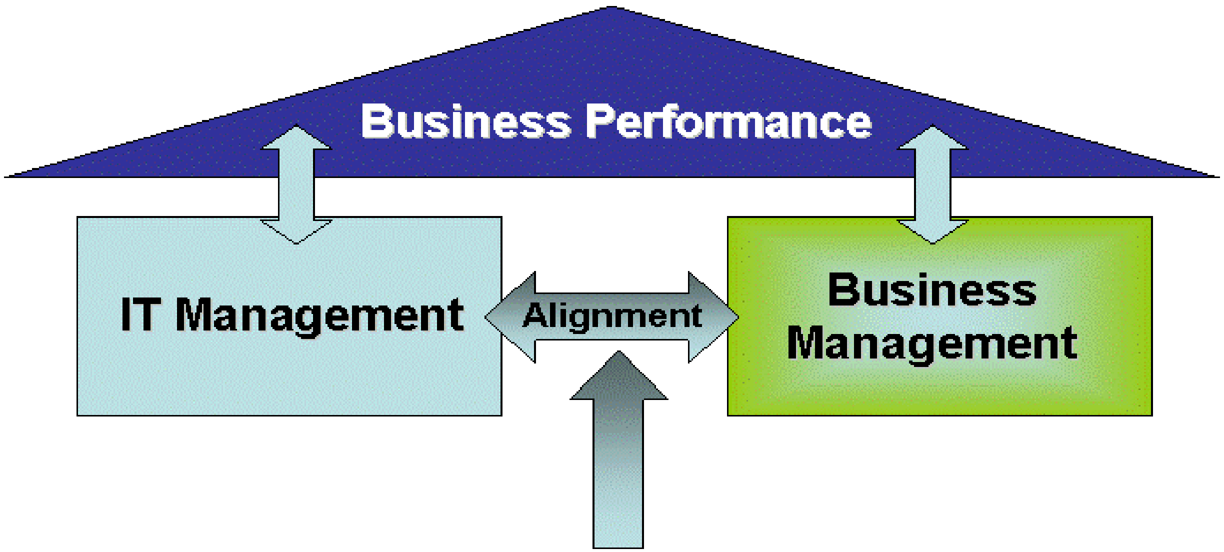
Chief Technology Officer
Lockheed Martin Environmental & Technical Services Line of Business

Dr. Shue-Jane L. Thompson

Director, Solutions Strategies
Lockheed Martin Enterprise Solutions & Services

Agenda

- Social Concerns
- Paradigm Shift
- 360-Degree View
- SE Leadership Theory
- Thompson's Alignment Model
- Success Story
- Emerging Alignment Themes
- Conclusion
- Q & A



Social concerns and theoretical interests

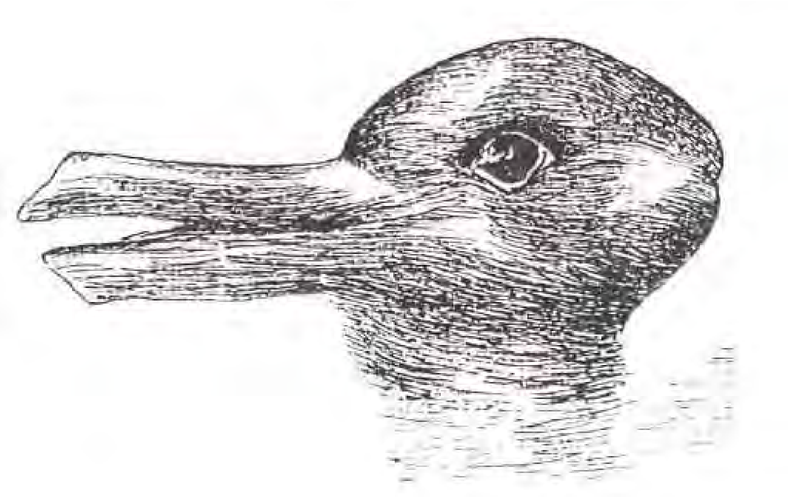
- Lack of understanding IT's business value
- Ever changing organizational structure
- Danger of IT overspending
- Increasing IT spending
- Increasing dependence on IT
- The changing CIO roles
- IT and business alignment is a must
- The pressing urgency
- Establish irreversible momentum for change

Thompson (2008)

What is a Paradigm Shift?

LOCKHEED MARTIN
We never forget who we're working for™

- Thomas Kuhn (1962) first used this term in his influential book, "The Structure of Scientific Revolutions", to describe a change in basic assumptions within the ruling theory of science.
- Jastrow (1899) used the duck-rabbit optical illusion to demonstrate the way in which a paradigm shift could cause one to see the same information in an entirely different way.
- The term has been adopted since the 1960s and applied in non-scientific contexts (Wikipedia)



The famous duck-rabbit ambiguous image. Is it a duck? Is it a rabbit?

Source: Jastrow, J. (1899). The mind's eye. Popular Science Monthly, 54, 299-312.

Paradigm Shift for SE Professionals

View, Understand, Map, & Manage

Individual Contributor **Program Leadership**

Paradigm Shift for SE Leaders

- 360-Degree Leader
  - Serves others
  - Needs to practice and be trained
  - Works as a program leader
  - Shines as a setting sun: Make others successful
- Strategy & Business Leader
  - Encourages Teamwork
  - Works as a Coordinator
  - Makes wise decisions
  - Works as a project leader
  - Has risk of losing passion of technical leadership
  - Shines as a high noon: Strong
- Technology Leader
  - Is a leader of technology
  - Is a hero/heroine for warriors
  - Works as a technical task leader
  - Has risk of asking too much of a control
  - Shines as a rising sun: Potential

Program Leadership

Individual Contributor

- Leadership
  - Visionary: Provide vision for changes
    - Core values (what we stand for, that is, Imagination: Walt Disney)
    - Core purpose (why we exist, that is, To make people happy: Walt Disney)
    - Envisioned future includes long-term goals (that is, Become the Harvard of the West: Stanford University, 1940s)
  - Technical
  - Business
  - Functional
  - Managerial: Produce plans for stability and leaders
- Technology
- Process
- People

Boehm & Ross' (1989) Leadership Theory

- Theory W
  - Negotiator
  - B.W. Boehm and R. Ross,1989
  - Make everyone a winner
- Theory Z
  - Facilitator
  - Motivation and Productivity (Gellerman, 1978)
  - Do up-front investment in developing shared values and arriving at major decisions by consensus within an organization
- Theory Y
  - Coach
  - Productive Software Management (Evans, Piazza, & Dolkas, 1983)
  - Stimulate creativity and individual initiative
- Theory X
  - Autocrat
  - Scientific Management (Taylor, 1911)
  - Do more precise time and motion studies
  - Organize jobs into well-orchestrated sequences of tasks

360-Degree Leader

Strategy & Business Leader

Technology Leader

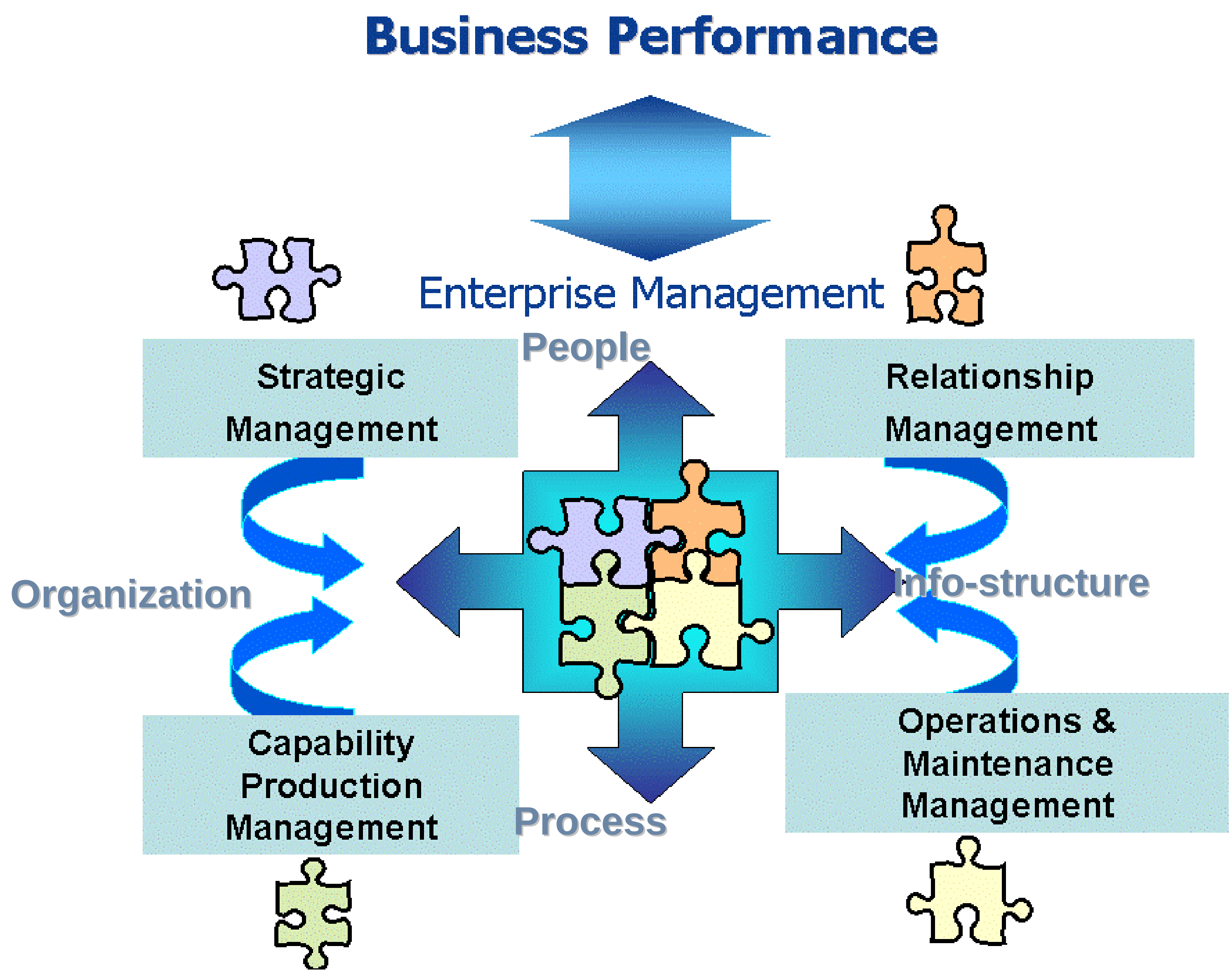
Boehm, B. W., & Ross, R. (1989). Theory-w software project management: Principles and examples. IEEE Transactions on Software Engineering, 15(7), 902-916.

Poppendieck's (2007) SE Leadership Theory

- Builder of Learning Organizations
  - Here is our purpose and direction – I will guide and coach!
- Group Facilitator
  - You are empowered!
- Task Manager
  - Here is what to do and how to do it!
- Bureaucratic Manager
  - Follow the rules!

The role of leadership in software development by Mary Poppendieck, 2007 (Originally from The Toyota Way, Jeffery Like, p. 181)

- Shape the Future
- Build Effective Relationships
- Energize the Team
- Deliver Results
- Model Personal Excellence, Integrity, and Accountability


Business Performance
Enterprise Management
People
Strategic Management
Relationship Management
Organization
Info-structure
Capability Production Management
Process
Operations & Maintenance Management

- Program Overview:
  - Provides a wide range of systems engineering services to a civilian government agency nationwide
  - Nine-year contract worth approximately $700 million
  - Indefinite Delivery/Indefinite Quantity (IDIQ)

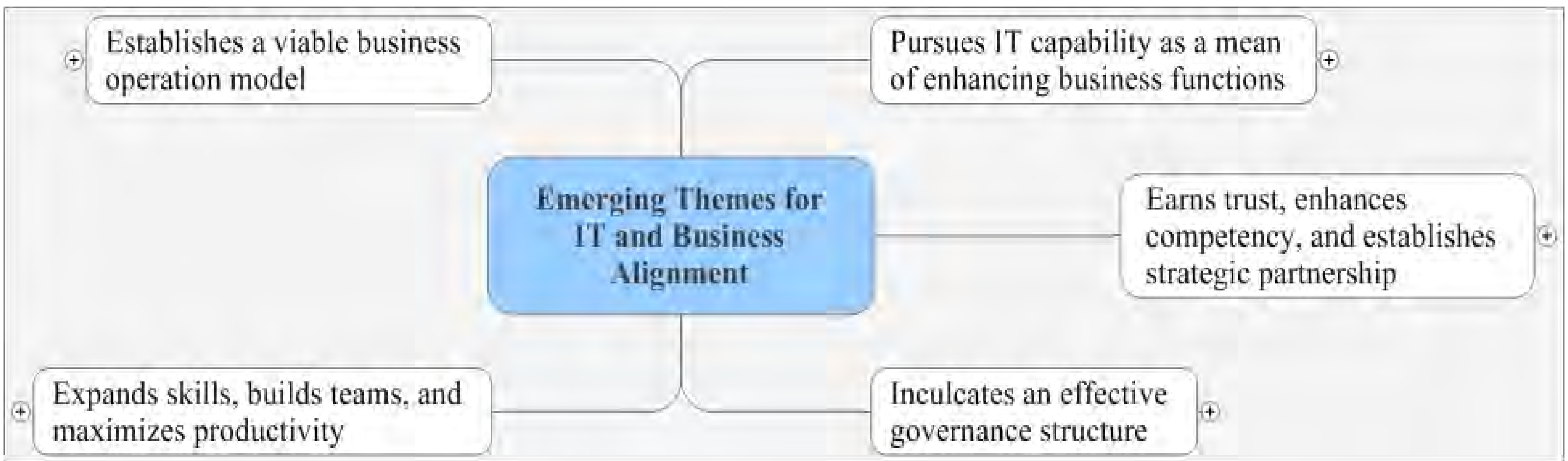
Initiative 1: Unified Development Environment - TECHNOLOGY

- Restructured and empowered to implement the program-wide technology governance and sharing
  - Architectural Control Board (ACB)
  - Organizational Process Group (OPG)
  - Sr. Technical Council
- Established
  - Chief Technology Officer (CTO) 360-Degree Dashboard
  - Technology Inventory
  - Distributed Software Development Team (Develop globally, manage centrally)
  - Continuous Integration & Automated Testing
  - Standard Defect Tracking
  - Document and Knowledge Management
  - Removing Accidental Complexity from Architectures
  - Challenge – Action – Results

- Collaborate with
  - Customer
    - Enterprise Architecture (EA) Workgroup
    - Web Workgroup
    - Portal Workgroup
    - SOA Workgroup
    - GIS Workgroup
    - National Computer Center
  - Industry
    - Software Vendors
    - Consortia
  - LM
    - LM Engineering Process Improvement Group
    - LM Center of Excellence (COE)
    - LM IS&GS Advanced Technology Group
    - LM NexGen
    - LM I&KS Technical Council

- Provide the active and quality support to the Task Order Project Officers (TOPO) and Contract Technical Managers (CTM) to solve their business challenges in a timely fashion.
- Conduct the analysis of customer needs to ensure the program provides the leading-edge solutions that meet and exceed customer expectations.
- Restructure one of Task Orders to include consultations on the Enterprise Tools Best Practices.

- Establish a viable business operation model
- Earn trust, enhance competency, and establish strategic partnerships
- Pursue IT capability as a means of enhancing business functions
- Expand skills, build teams, and maximize productivity
- Instill an effective governance structure



(Thompson, 2008)

- 360-Degree View is proven to be necessary and helpful for further aligning business and technology
- Business management aligned with technology planning often enhances business performance (Thompson, 2008)

Thompson, S. (2008). A Qualitative Study of Successful Practices in Aligning Information technology and Business Management

Questions?

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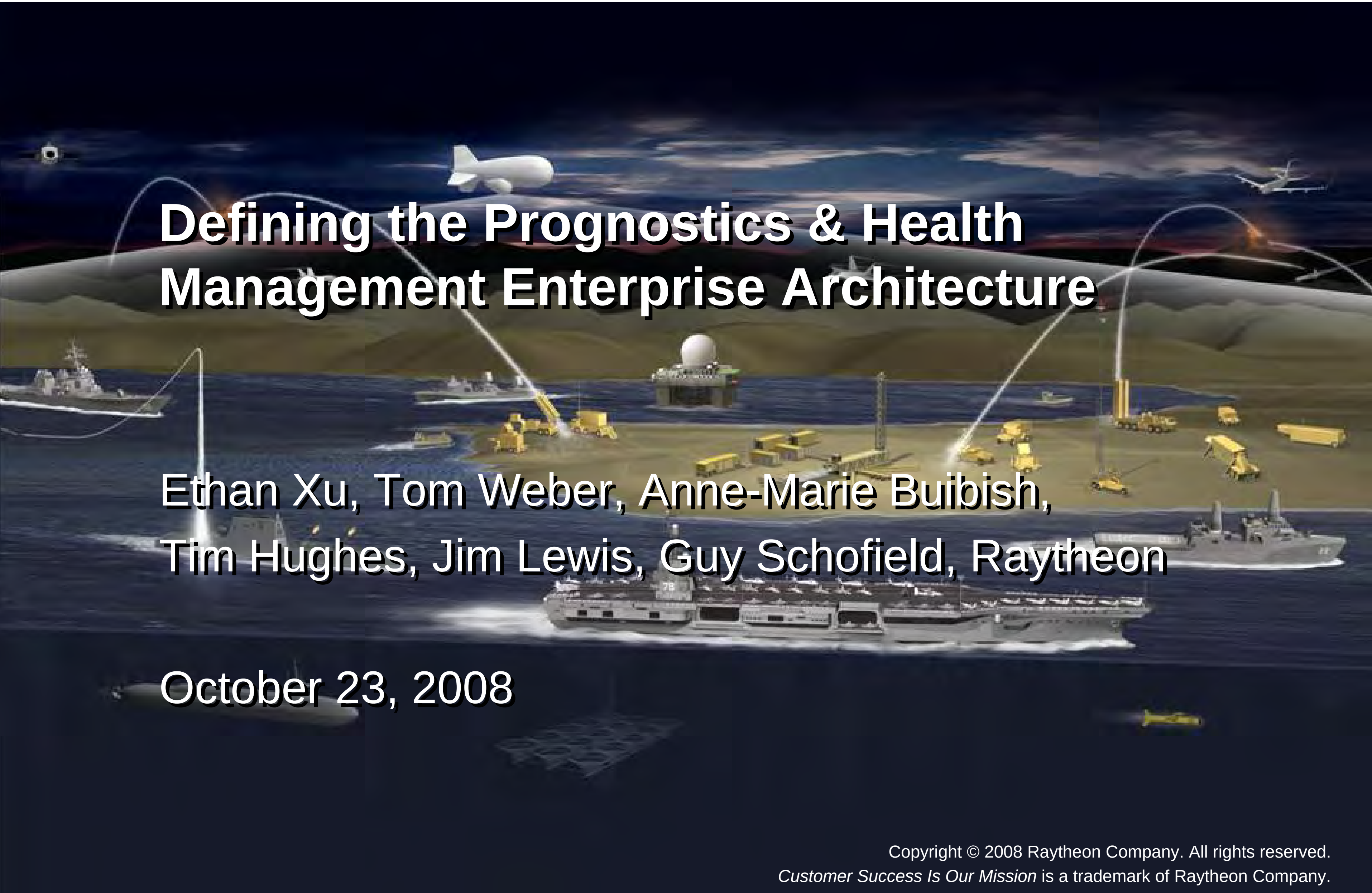
Raytheon

Customer Success Is Our Mission



Defining the Prognostics & Health Management Enterprise Architecture

Ethan Xu, Tom Weber, Anne-Marie Buibish,
Tim Hughes, Jim Lewis, Guy Schofield, Raytheon

October 23, 2008

Outline

Raytheon
Integrated Defense Systems

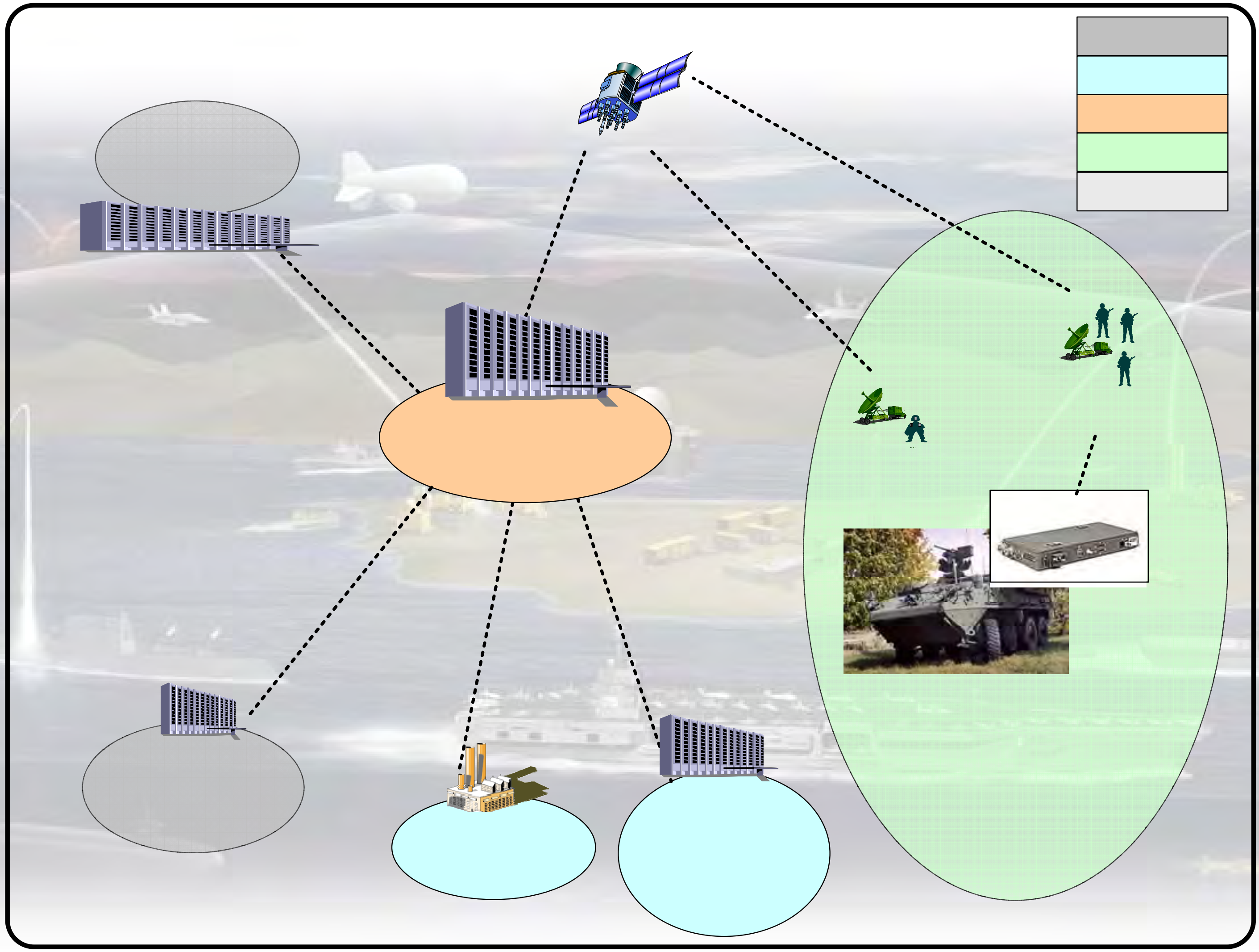
- Cases for Action
- Health Management Enterprise Architecture
- Prognostics Systems in the PHM Enterprise
  - Prognostics Design & Development
  - Prognostics & Health Management Concept
- Total Asset Visibility Systems in the PHM Enterprise
  - Total Asset Visibility Concept
  - Example Mesh Network
- Health Management Enterprise Information Flow
- Communications Architecture Considerations
- Role of Logistics Planning in Mission Planning
- Borrowing from Semantic Web Concepts
- Conclusion

Cases for Action

Raytheon
Integrated Defense Systems

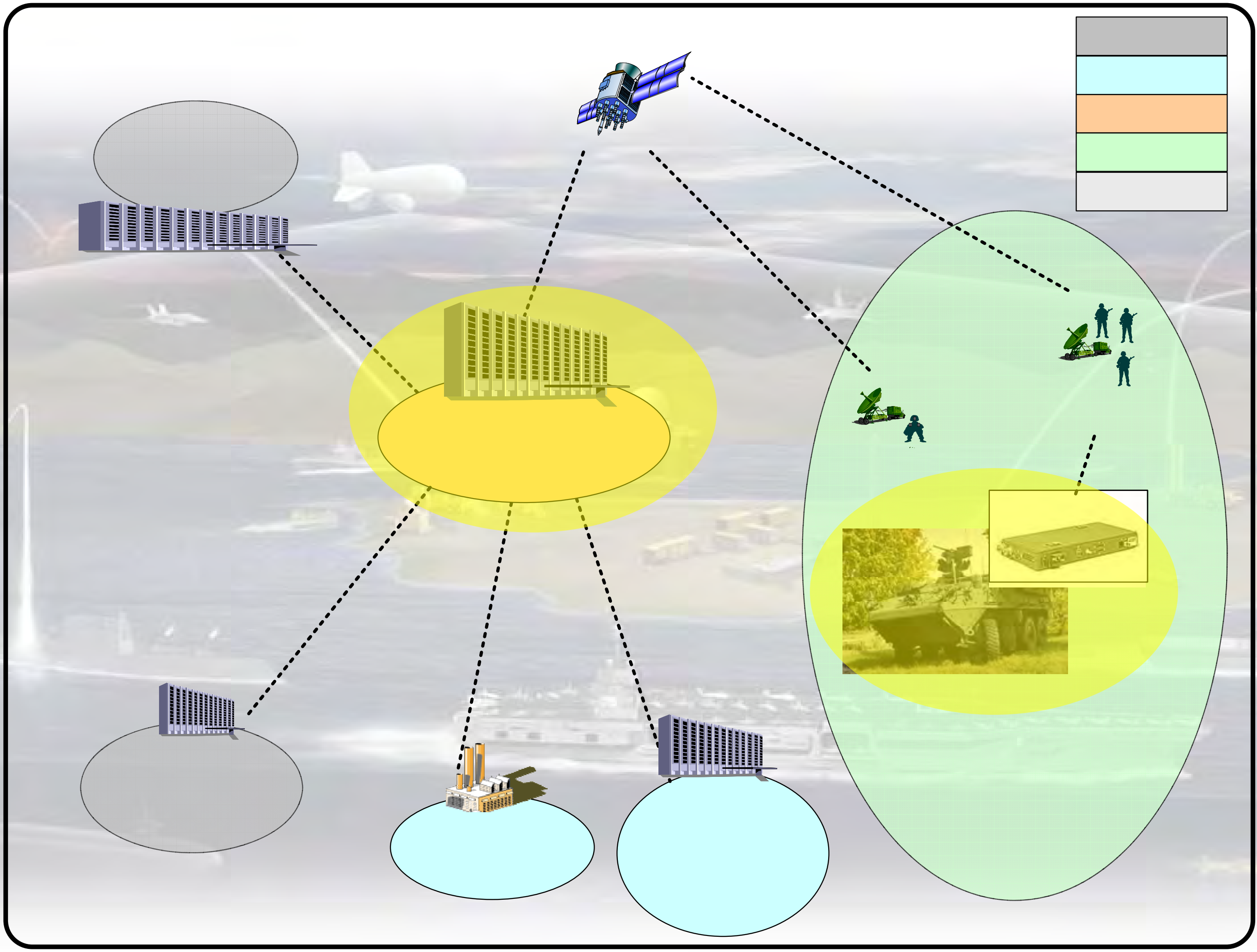
- Customers are demanding Prognostics & Health Management solutions for extending product life.
- Test costs are rising due to complex design and test requirements.
- In the short run, missions can fail due to unpredicted failures.
- In the long run, system performance is not well maintained.
- We can guarantee system performance and lower maintenance by predicting failures before they occur.
  - These strategies require Prognostics & Health Management Technologies and an overall Condition Based Maintenance strategy.

Health Management Enterprise Architecture



Mission

Prognostics Systems in the PHM Enterprise

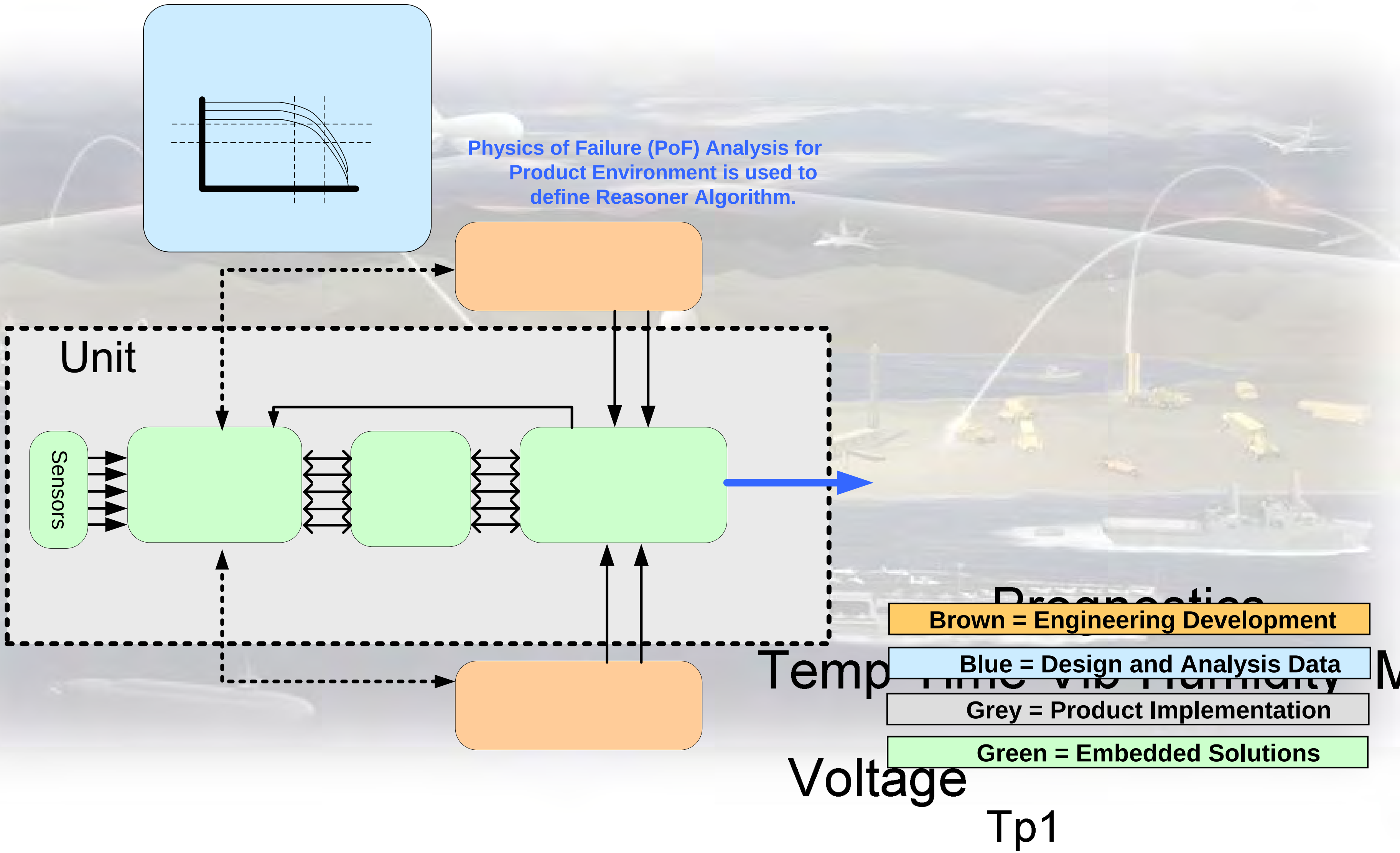


Mission

Planning

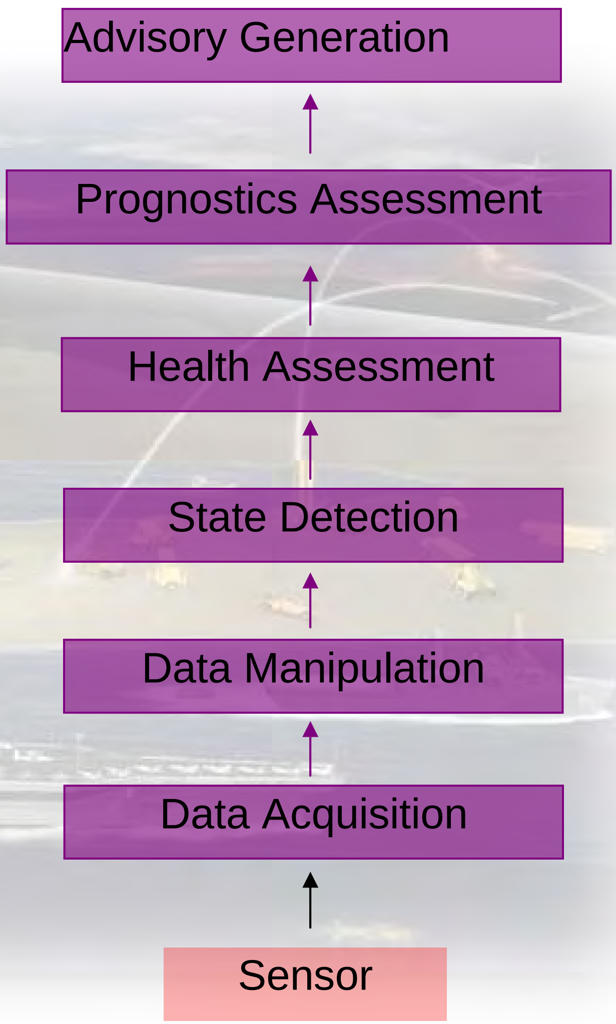
Prognostics Design & Development

Raytheon
Integrated Defense Systems



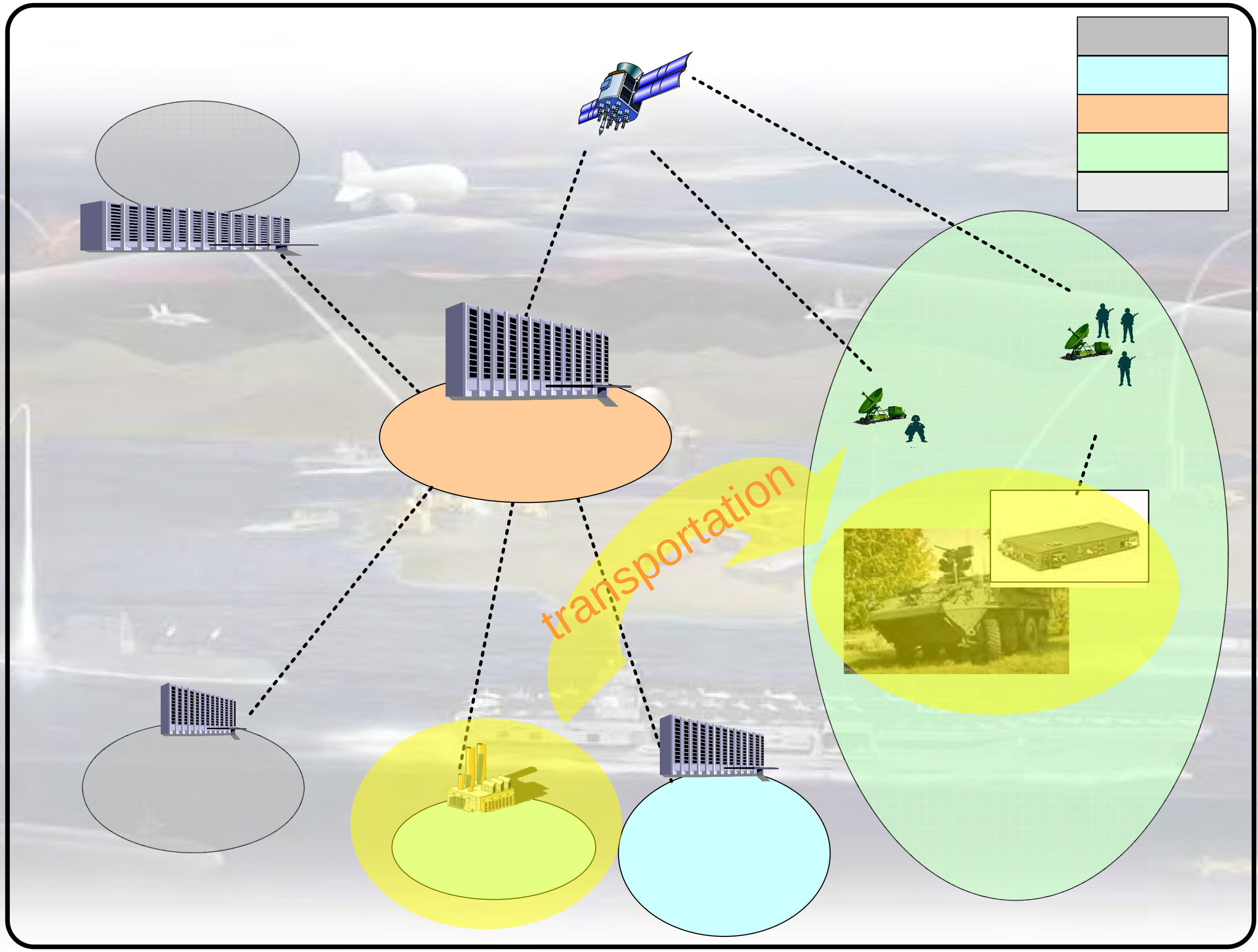
Prognostics & Health Management Concept

- Purpose: By predicting system Remaining Useful Life, we can remedy failures before they occur.
- Health Assessment step: Determine current state.
  – e.g. Fuel levels are low -> Fuel is urgently needed.
- Prognostics Assessment: Project future state.
  – e.g. Ship radar will fail in the next 72 – 96 hours.— Order a replacement part immediately.
- Advisory Generation: Recommend maintenance strategy based on overall system or fleet health.
- These functions can be performed on or off-board the platform of interest.



Total Asset Visibility Systems in the PHM Enterprise

Raytheon
Integrated Defense Systems



Mission

Total Asset Visibility Concept

Thinking beyond RFID

Raytheon
Integrated Defense Systems

We are developing technologies:

- Which enable nodes to report status by forwarding data through a mesh network.
- That allow assets to be tracked throughout their lifecycle—not just during shipment.
  - This allows us to track when and where failures occur.
  - Better failure diagnosis and prognosis becomes possible.

For the Future:

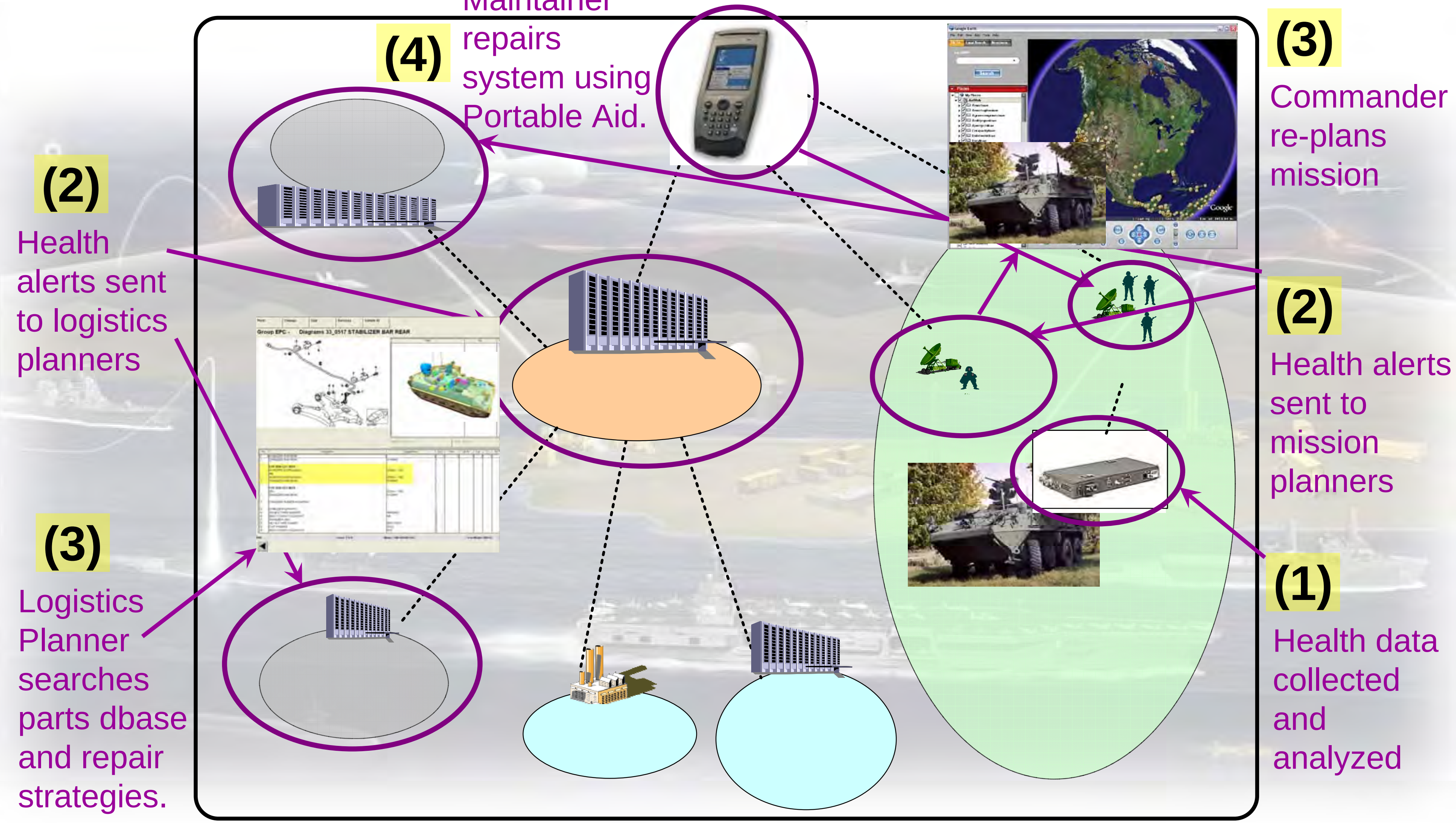
- We are miniaturizing Wireless Sensor Nodes for embedding into platforms. (See Terry Tracy's MILCOM paper)
- To make robust Wireless Sensor networks, we are researching Disruption Tolerant Networking schemes.

Wireless Sensor Nodes

Future Evolution

Health Management Enterprise Information Flow

Raytheon
Integrated Defense Systems



Mission

Role of Logistics Planning in Mission Planning

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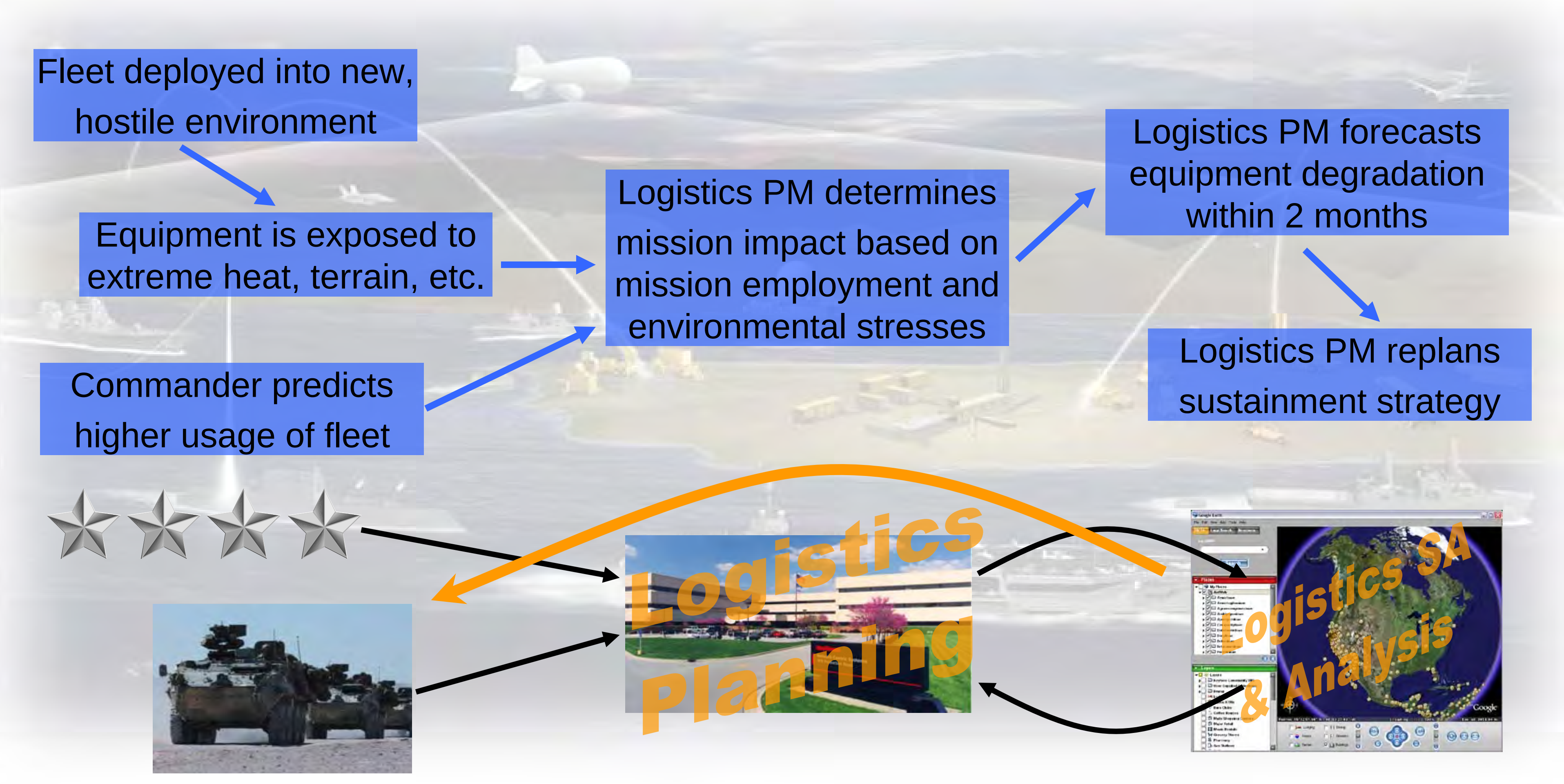
- **Background**: The program manager determines a maintenance strategy and schedule based on how his fleet will be employed.



Borrowing from Semantic Web Concepts

Raytheon
Integrated Defense Systems

- To enable fast and automated failure response, we need:
  – The ability to organize and aggregate large quantities of information so that they can be analyzed.
  – Interoperability via a common language framework. – Key

- An example of the future:
  – *Tom, a logistics planner, receives an alert about a potential failure.*
  – *His planning tool auto generates a list of repair strategies, with associated info about cost, schedule impacts, historical effectiveness, and resource needs.*
  – *The tool recommends a strategy providing the quickest repair.*
  – *Tom doesn't like this choice, since it involves some risk of unsuccessful repair.*
  – *Tom requests another option and inputs detailed requirements and goals.*
  – *The planning tool returns a recommendation for a more failsafe approach, which requires additional materials and changes to the repair schedule.*
  – *Tom selects this option and approves ordering of the needed materials.*

Conclusion

Raytheon
Integrated Defense Systems

- Raytheon is tackling the Mission Support problem space from a System of Systems approach.
- Through a DoDAF architecting process, we seek to understand key warfighter needs.
- We are modeling the architecture from a total system view, to integrate core PHM products into an end-to-end PHM solution.
  - Sensors and Prognostics algorithms to build equipment health status.
  - Total Asset Visibility to provide asset location and general status.
  - Integrated Information Management to organize the most relevant health status and asset information.

- Using a reference PHM Architecture, we can quickly deploy concept demos and new product solutions.
- The Prognostics and Health Management Enterprise enables us to maintain system performance for the long run.

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

11th Annual

NDIA System Engineering Conference

Enterprise Health Management Committee

Electronics Prognostics Technology Study

E-Prog Figure of Merit Application

23 October 2008

Briefing Topics

- The Background of NDIA Electronic Prognostics Studies
  - Why Electronic Prognostics
  - The Trail to The Current Application Study
  - NDIA Study Results
  - Some Electronic Prognostics Figures of Merit (FOM)
- Putting Numbers on the Figures of Merit
  - The Process for FOM Computation
  - The Results - Data, Analysis, Computation of FOM Values
- Application of the FOM Results to the Fleet
  - Air Force
  - DOD
- Next Steps

Why Electronics Prognostics

- Greater reliance on electronics and electrical based systems:
  - Navy – JSF, EMALS, AAG, Shipboard Weapons Loader, shipboard electric drive, Integrated Fight Through Power, ForceNet, linear motor elevators, etc.
  - Army – FCS Hybrid electric drive, soldier mounted electronics, MTRS, Net Centric Warfare, etc.
  - AF – JSF, F-22
- Enables users ability to operate and maintain increasingly sophisticated weapon systems
  - Prognostics provides advanced warning of deterioration as opposed to reporting failure
  - Potential to reduce downtime for unscheduled maintenance and reduce costly secondary damage associated with failures
  - Supports emerging distance support initiative
- Required technology to enable PHM, Performance Based Logistics, and Sense and Respond

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Legacy VS Prognostics Health Management (PHM) Summary of Expectations

	PHM Benefits
Maintainability	
MFHB CND	79-82% Improvement
MFHBME	13-14% Improvement
MFHBR	3% Improvement
MMH/FH	17-32% Improvement
Support Equipment	
QTY Weight (Lbs.) Volume (cu ft)	Reduction of 6-10%
Manpower	
QTY	Reduction of 46-52%
Logistics Footprint	
C17 Loads, Tons	Reduction of 2-17%
Safety	
Mishap Reduction	Reduction of 14-38
SGR	
SGR (Initial/Sustained)	10 to 14% Improvement
Airframe/OML Restoration	
Recurring Cost	$1.05B - $7.87B Cost Avoidance

The Trail To The Current Application Study

NDIA E-Prog I Workshop
(JSF 2004 Tasking)
Data to Enable Fielded Electronic Prognostics on JSF

→

NDIA E-Prog II Workshop
(2006 Tasking)
Needs and Gaps to Field Electronic Prognostics on Emerging And Legacy Systems

→

NDIA E-Prog III Working Group
(2007 Tasking)
Technology Programs to Field Electronic Prognostics on Emerging And Legacy Systems

Data List

19 Items of Contextual And Operational Data

Prognostics Needs

- High Power Devices
- Integrated Power Systems
- Avionics & Controls
- Radars
- Electric Drive

Development Programs

19 Technology & Tool Programs From 6.1 – 6.3
2 – 4 Year Duration

NDIA Study Results

Post E-Prog II Workshop Process

- All Gov't Task IPT
- Developer and User Focus - not S&T
- Defined in Real Prognostic Terms Based on Repair and Logistics Delay Times
  - Prognostic Horizon - How much longer will it work before failing?
  - Confidence factor - % confidence that the estimated Horizon is right

PROCESS

E-Prog II Workshop Defines Prognostic Needs to Support Legacy and Future Force → IPT Working Sessions Convert Needs to Topic Areas → Topic Areas assembled into Program Areas for Roadmapping and Acquisition Formatting

- Weapon System
- DoD Element
- RDT&E Level

- Weapon Type
- DoD Element
- RDT&E Level

- Topics for :
- MURI
- SBIR/STTR
- BAA

E-PROG R&D PROGRAM EXAMPLE 1

Prognostics for Power Supplies and Converters

Program Rationale: This program area addresses the need for prognostics for all types of electronic power supplies and power converters. Sensed parameters, sensor performance characteristics, sensor configuration (built into or added on to the device), data analysis algorithms, degree of smart sensing and integration with other electronic and electromechanical prognostic technologies are all a part of this effort. The Verification and Validation of the prognostic technology are included as part of this program.

Key Program Elements*:*

- Implementable prognostics for power supplies/converter.
- Transition of current SBIR technology to wider applications.
- Development of additional technology where needed.
- Incorporate in new designs and appended/integrated in current designs

Horizon: T = 100 hr; O = 1000 hr

Confidence: T = 90%; O =95%

S & T Category	Estimated Duration (Years)	Budgetary Man-Years
6.1 Basic Research	0	0
6.2 Applied Research	2	16
6.3 Advanced Technology Development	2	16
6.4 Advanced Component Development	1	8
Total	5	40

Table 20. E-PROG Program 19 Development Plan

NDIA Study Results

Program Breakout by R&D Category and Product Type

E-Prog Description	6.1 Basic Research	6.2 Applied Research	6.3 Tech Demo	6.4 Tech Application	Prod. Type
1. Physics of Failure Model for Gates, Devices and IC's	—	—			**M**
2. Electronics Prognostics for High Power Switching Electronics	—	—	—	—	**PT**
3. BIP Prognostics for Devices and Circuit Boards	—	—	—	—	**PT**
4. Electronics/electro-optical Prognostics for Tactical Sensor Systems	—	—	—	—	**PT**
5. Generic Environmental/Operational Parameter Monitoring Module for Electronic Prognostics		—	—	—	**H**
6. Electronic Prognostics for C4ISR Systems		—	—	—	**PT**
7. Maintenance Mode/Prognostic Interaction Design Tool		—	—	—	**T**
8. Interconnection Prognostic Technology	—	—	—	—	**PT**
9. Electronic Interconnection Prognostic Design Tools	—	—	—	—	**T**
10. Electronics Prognostics Financial Modeling Tool		—	—	—	**T**
11. Tool for Logistics Impact of E-Prog		—	—	—	**T**
12. Prognostics for HCI Electronics/Electro-Optics	—	—	—	—	**PT**
13. Prognostics for Redundant Electronic Systems	—	—	—	—	**PT**
14. Electronic Prognostics Design Tool for Environmentally Tolerant Electronics	—	—	—	—	**T**
15. Electronics Life Usage Assessment and Prognostics - Electronic Prognostics Life Usage System (E-Plus)	—	—	—	—	**PT**
16. Data Enterprise System - Module to LRU Tracking for Electronics Prognostics	—	—	—	—	**PT**
17. Electronic Prognostics Reasoner Engine applicable to Device through System	—	—	—	—	**PT**
18. Electronic System Level Prognostic and RUL Tool Set	—	—	—	—	**T**
19. Prognostics for Power Supplies and Converters		—	—	—	**PT**

M = Model, H = Hardware, PT = Prognostic Technology, T = Tool

NDIA Study Results
Road Map

Man Year Summary By FY

	FY1	FY2	FY3	FY4	FY5	FY6	FY7	FY8	Total
6.1 Total	41	45	26						112
6.2 Total	28	48	112	80	32				300
6.3 Total	0	20	20	72	88	60	8		268
6.4 Total	0	0	8	16	20	44	44	8	140
Totals	69	113	166	168	140	104	52	8	820

- **Nearly 70% of Program is 6.2 & 6.3 - only 14% of Program is 6.1**
- **Benefits of effort start to be realized in FY3**
- **Majority of effort is completed within 4 – 5 years**

Some Electronic Prognostics Figures of Merit

Potential Areas Where Electronics Prognostics Could Offer Significant Benefits to Advanced Military Systems

Benefit Area	FOM Metric
Total cost of ownership reduction	% Reduction in Support Cost, Material & Labor
Reduction of cost of false removals	% Reduction & Cost Savings on Spares & NFF/RTOK
Improved system availability	% Reduction in NFMC and Recovered Sorties

Putting Numbers on the Figures of Merit
The Process

- Select a Program for FOM Analysis
  - Fielded Air Force Fixed Wing (F/W) Aircraft
  - High Mission Electronics Content
  - Analysis of 50 Mb Support Data from Approximately Wing Size Sample
  - Analyzed a 2 Year Operational Period, Annualized Results

- The Analysis Approach
  - Calculate the Component Parameter Values
    - **Mission Aborts from Electronic Causes – Replacement Weapon Systems to Reestablish the Mission Rate**
    - **MMH for Electronics Maintenance – Reductions from Embedding E-Prog**
    - **Excess Spares Usage and Inventory – Due to lack of Embedded E-Prog**
    - **NFF/RTOK Rate –Material and Labor Cost due to lack of Embedded E-Prog**

  - Assemble the Component Parameter Values into The FOMs

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Putting Numbers on the Figures of Merit

Analysis of Expected Savings From Embedded Electronic Prognostics

Calculated Component Parameter Values

- **Mission Aborts from Electronic Causes**
  - **NMC Aborted Takeoffs + In-flight Aborted Missions = 55 (8%)**
    2 Additional A/C per Wing)
  - **NFMC Missions (Prior to Takeoff and In Flight) = 335 (47%)**

- **NFF/RTOK Rate – Related Material and Labor Cost**
  - **Total Maintenance = 33,000 MMH**
  - **Total Electronic Maintenance = 5,300 MMH (LRU Replacement) = 16% of Total MMH**
  - **NFF and FD/FI = 4,630 MMH (87% of Electronic MMH or 14% of Total MMH)**
  - **NFF / RTOK Rate 14-22% (18%Avg.) = Equivalent of 4 Electronic Systems in Pipeline**

Putting Numbers on the Figures of Merit

The Results

Component Parameter Values Assembled into FOM

Total cost of ownership reduction (Support Cost For Example W/S)	Reduction in Support Labor = 14% Reduction in Electronic Support Material =18% (4 electronic Systems per Wing)
Reduction of cost of false removals	Reduction & Cost Savings NFF/RTOK = 14% Reduction & Cost Savings on Spares = 18%
Improved system availability	Reduction in NMC = 8% (or 2 A/C per Wing) Reduction in NFMC = 47%

FOM Results Applied to the FW A/C Fleet (Est.)

USAF Tactical FW A/C (2006) ------------------- 2500
DOD Tactical FW A/C (2006) -------------------- 3700
(From 2006 DOD GAO Study)
Est. Avg Unit Cost --------------------------------- $ 40MM
Est. Avg Electronics Content -------------------- $ 8MM
DOD Electronics Maintainers FW A/C Est.---- 12,500
DOD Labor Cost@$45KPer --------------------- $ 560 Million
USAF is 30% -------------------------------------- $ 170 Million

Estimated Corporate Maintenance Indicators – USAF
(From 2006 DOD GAO Study)

Mission Capable Rate -------------------- 81%

NMC-Maintenance ---------------------- 15%

Abort Rate -------------------------------- 6%

Total cost of ownership reduction	**Reduction in Support Labor = 14% = $ 46 Million (USAF)** **Reduction in Electronic Support Material =18% = $ 101 Million (USAF)** **Reduction in Support Labor = 14% = $ 69 Million (DOD)** **Reduction in Electronic Support Material =18% = $ 150 Million (DOD)**
Reduction of cost of false removals	**Reduction & Cost Savings on Support Material =14% = $ 46 Million (USAF)** **Reduction & Cost Savings NFF/RTOK = 18%= $ 101 Million (USAF)** **Reduction & Cost Savings on Support Material =14% = $ 69 Million (DOD)** **Reduction & Cost Savings NFF/RTOK = 18%= $ 150 Million**
Improved system availability (DOD	**Reduction in NMC = 8% = $ 8 Billion (USAF)** **Reduction in NMC = 8% = $ 11.8 Billion (DOD)**

Recommended Next Steps

- **Expand Study to Classes of Weapon Systems**
  - **Select Best Payoff Classes (Troubled)**
  - **Prescribe Specific E-Prog Programs**
  - **Develop Specific Cost Benefit**
- **Develop Programs and Acquisition Strategy for the Prescribed E-Prog Technologies**
- **Execute Programs and Develop Technology Transition Plan**
- **Develop Metrics and Evaluate Results**
- **Repeat for Additional classes of Weapon Systems.**

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Customer Success Is Our Mission

11th NDIA SE Conference: Mission Analysis Impacts on Systems Engineering Fundamentals

John T McDonald & David W Rhodes
Raytheon IIS

22 October 2008

Raytheon
Customer Success Is Our Mission

Mission Analysis Impacts on Systems Engineering Fundamentals

Raytheon Information and Intelligence Systems (IIS)
John T McDonald
David W Rhodes

22 October 2008

Topics

- Disaster awaits
- Mission is the context for systems engineering
- Mission analysis – building the ‘right’ mission knowledge foundation
- Tools of the trade

Customer Success Is Our Mission

Disaster Awaits

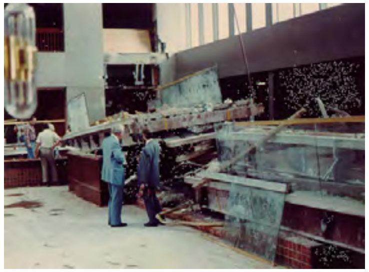
Hyatt Regency Walkway Collapse - 1981

Critical product components departed from design detail

Interface failures (connections)

Construction began before design was sufficiently mature

Moved from concept to design too quickly



117 people died

$140M cost (judgments alone)

Negative national press

Used beyond design limitations

Inspection for earlier significant failure limited due to scope issues

Communication failures

Key product ‘subsystems’ developed by subcontractor

Critical changes accepted via verbal approval

Mission Need Exceeded the Capability

What's Similar Between a Walkway and a Weapons System?

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- Mission should be pre-eminent in our planning and building
- Operational use will expand beyond existing design capability
- Communication too often lacks clarity, conciseness, rigor
- Prime hires others to provide piece parts for the solution
- Interfaces are high risk breakage points
- Right knowledge foundation is critical to downstream utility & quality
- Systems thinking is needed to 'rise above' limitations of scope perspectives
- Need for speed often overrides process discipline
- Disaster will strike if the foundation is not properly laid early in the game

What Impacts Are DoD Seeing Today?

- System complexity has grown dramatically since the early cold war
  - – Program schedules grew from 3 - 8 years to greater than 10 years
  - – Cost growth ranges from 45% to a staggering 100+%
- Of 11 major programs reviewed by the GAO, 8 had quality problems attributed to systems engineering deficiencies
- Insufficient systems engineering is applied early in the life cycle, compromising the foundation for initial requirements and architecture development
- Requirements are not always well-managed, including the effective translation from capabilities statements into executable requirements to achieve successful acquisition programs

Sources:

Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits of Future Air Force Acquisition, 2008 (ISBN: 0-309-11476-4)

Increased Focus on Requirements Oversight Needed to Improve DoD's Acquisition Environment and Weapon System Quality, February 2008 (GAO-08-294)

NDIA Task Report: Top 4 Systems Engineering Issues within DoD and Defense Industry, 26-27 July 2006

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How Can Mission Analysis Help?

- Sound understanding of the mission is necessary for building the right mission knowledge foundation
  - For solving the right problem and close mission capability gaps
  - For creating credible operations concept and alternative solution concepts, architectures, and requirements (pre-Milestone A through system development)
  - For aligning Government-Contractor goals

- Insufficient mission analysis
  - May find contractors selling what they have in their inventories instead of what is needed to solve the problem
  - May cause us to find out too late that while we meet stated requirements, we however do not meet mission needs

Mission Needs Are 'North Star' for Systems Engineering

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Mission is the Context for SE

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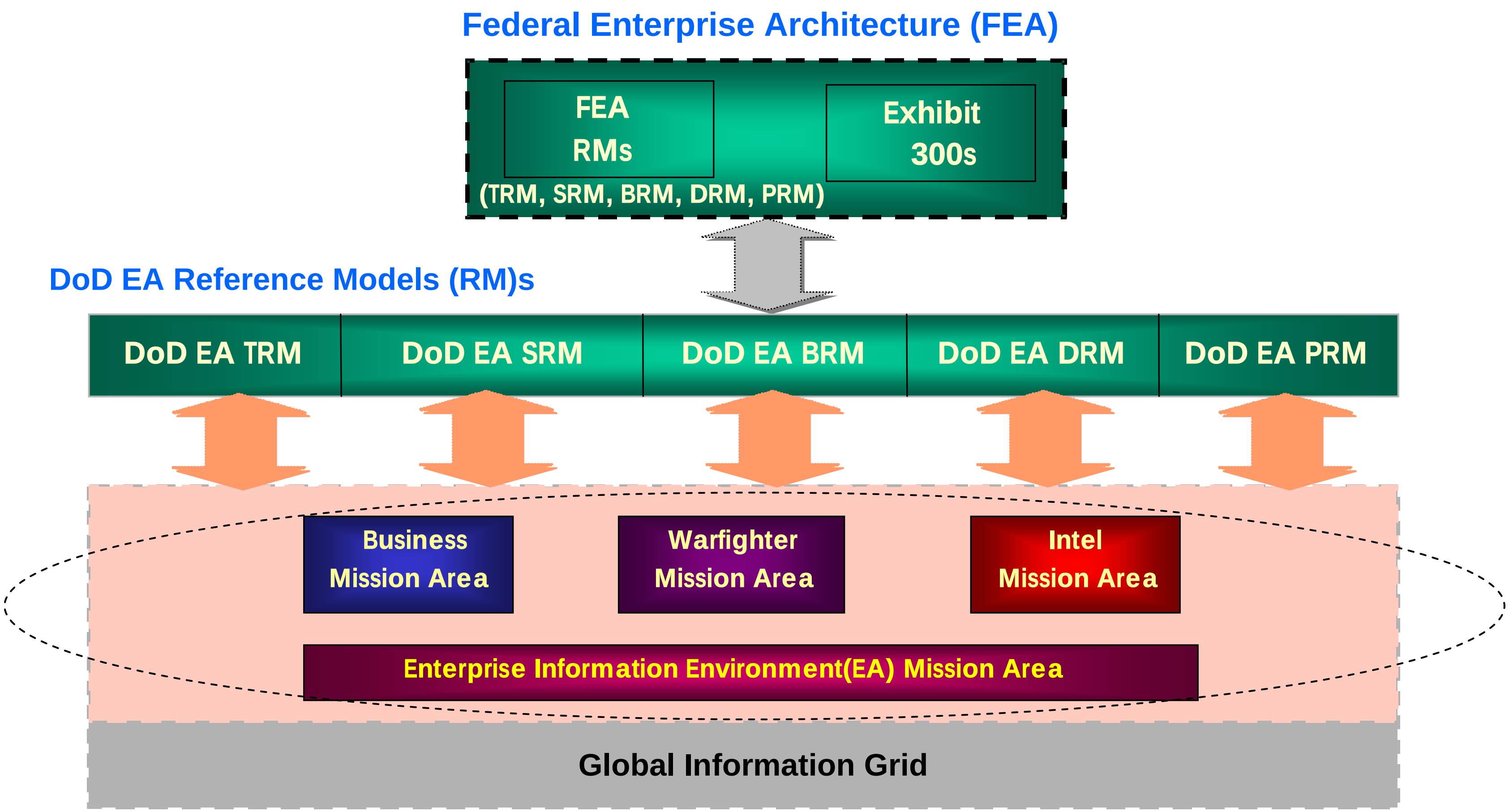
Customer Missions and Mission Need Statements



Think Mission 1st

Mission Need Statements Address Mission Capability Shortfalls

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- ***1. Administrative Information***
- ***2. Impact on Mission Areas***
- Briefly describe the impact of the capability shortfall or technological opportunity
- ***3. Needed Capability***
- Describe the functional capability needed or technological opportunity.
- ***4. Current and Planned Capability***
- ***5. Capability Shortfall***
- ***6. Impact of Not Approving the Mission Need***
- ***7. Benefits***
- ***8. Timeframe***
- ***9. Criticality***
- ***10. Long Range Resource Planning Estimate***

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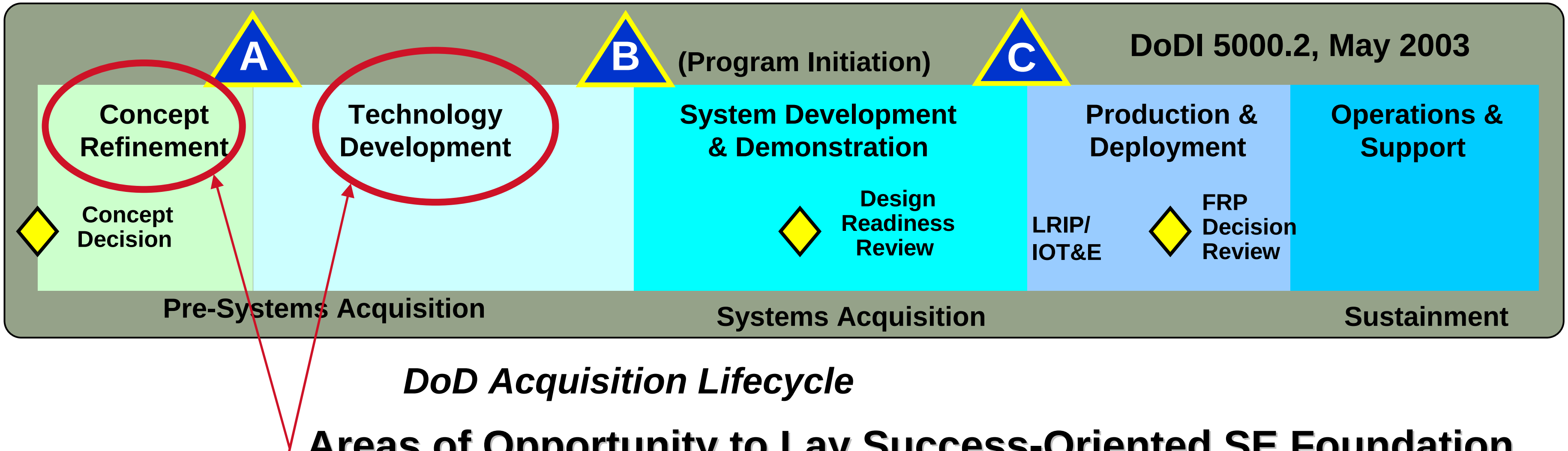
Mission Analysis – Building the ‘Right’ Mission Knowledge Foundation

JCIDS Phasing and 'Early' SE



DoD Acquisition Lifecycle

Areas of Opportunity to Lay Success-Oriented SE Foundation

- ***"Systems engineering is the overarching process that a program team applies to transition from a stated capability need to an operationally effective and suitable system" (***DoD 5000 series),
- Concept Refinement and Technology Development phases provide opportunities to work collaboratively with customers and other mission stakeholders to <u>understanding their needs and their environments</u>

Early SE is Required to Effectively Transform Capability Gaps into an Operationally Valid Mission Solution

Adapted from Raytheon SE Symposium presentation by Adrienne Rivera

Early Systems Engineering: Extending the Systems Engineering "V"

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Capture the Customer's Vision

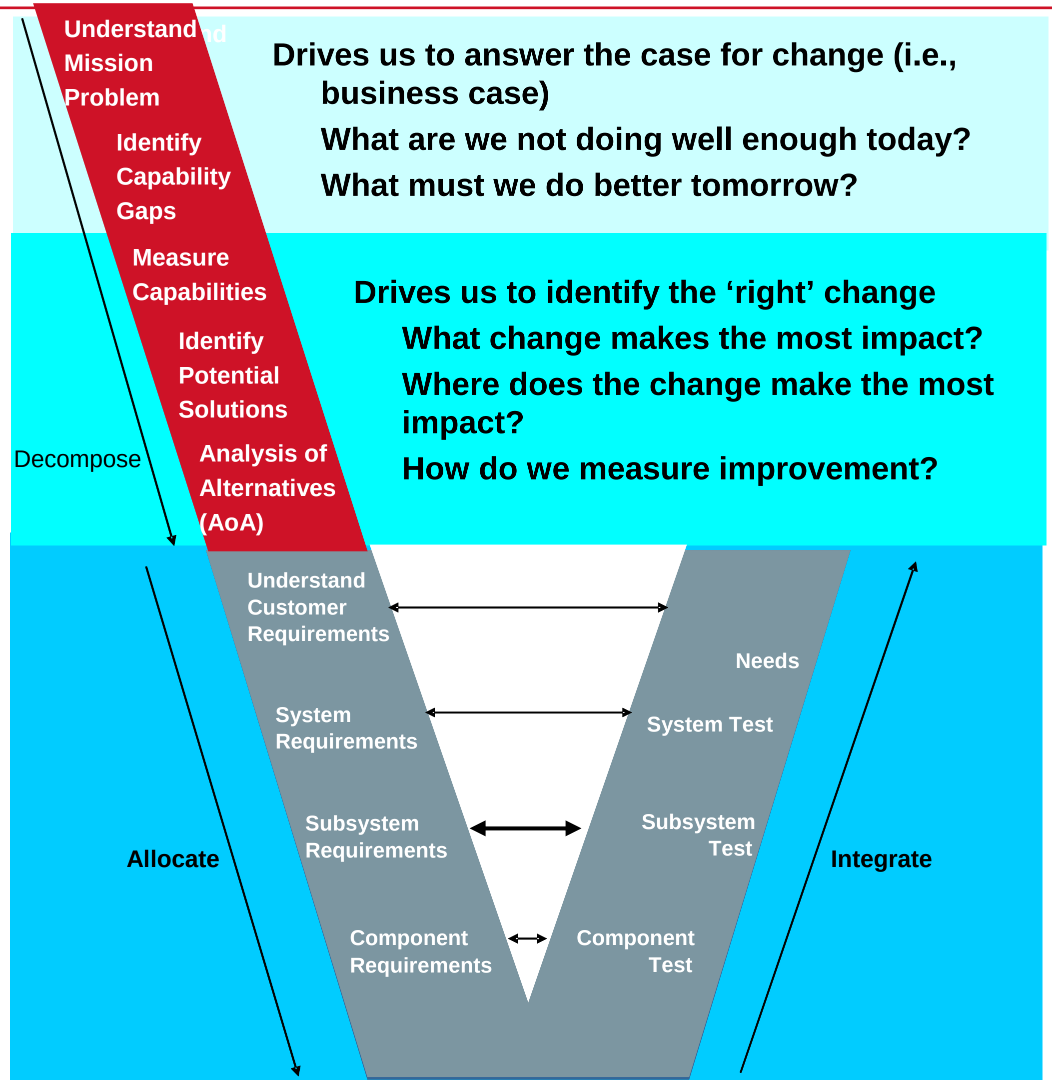
"Understand the problem"

"Define the need"

"Measure Capabilities"

"Assess Alternatives"

"Build this"



Extended 'V' Yields the Mission Context and Change Drivers

Adapted from Raytheon SE Symposium presentation by Adrienne Rivera

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Mission Analysis Implements Early SE

Milestones: Concept Definition ▲ — Milestone A ▲

JCIDS Capability Based Assessment → **Concept Refinement Phase**

DoD Lifecycle Phases: DoD Strategic Guidance | Joint Operations Concepts | Functional Area Analysis | Functional Needs Analysis | Functional Solution Analysis | Best Materiel Approach(es) | Analysis of Alternatives | Preferred System Concept

Mission Analysis Activities

Mission Capabilities Analysis

- Research Doctrine
- Identify Mission Areas
- Understand Current Mission CONOPS/Capabilities
- Analyze Mission Gaps
- Generate "As-Built" Architecture
- Analyze Constraints (DOTMLPF)
- Create Mission Needs Statement
- Assess Technology

Functional Solution Analysis

- Establish Mission Concept Characteristics
- Identify Candidate(s) Concept Capabilities
  - Non-Materiel and Materiel
- Write CONOPS for Candidate(s)
- Preliminary "To-Be" Mission Architecture
- Identify MOEs/MOPs
- Prepare Draft ICD/DCR

Concept Development

- Identify System Concept Trades
- Perform Mission Concept Analyses
- Write Advocacy CONOPS
- Develop System Architecture
- Identify KPPs
- Prepare Draft CDD
- Prepare Technology Strategy
- Analyze Cost-Benefit & Impacts

Enablers

Mission Capabilities Analysis:

- Raytheon's REAP process guideline
- Research documentation template
- Strategic intent template
- Quality Functional Deployment
- Zachman template
- Mission Concept Document template
- End-to-End Mission Level Simulation

Functional Solution Analysis:

- Raytheon's REAP process guideline
- DoDAF/MoDAF artifacts
- Mission Concept Document template
- End-to-End Mission Level Simulation

Concept Development:

- Raytheon's REAP process guideline
- DoDAF/MoDAF artifacts
- Man-in-the-Loop Simulations
- SW/HW-in-the-Loop Simulations

Mission Analysis is the Foundation Activity of Early SE

Adapted from Raytheon SE Symposium presentation by Adrienne Rivera

Tools of the Trade

Raytheon Enterprise Architecture Process (REAP) Overview

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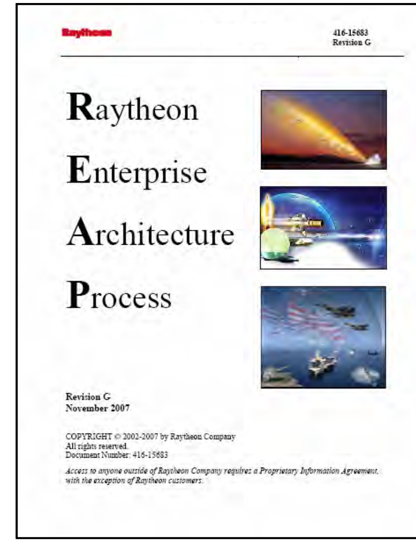
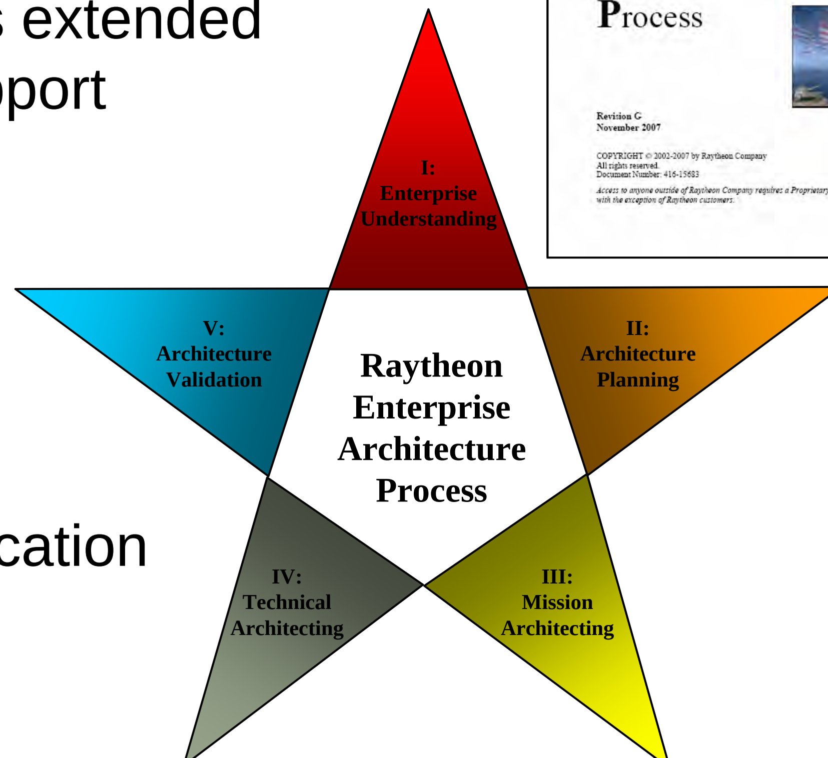
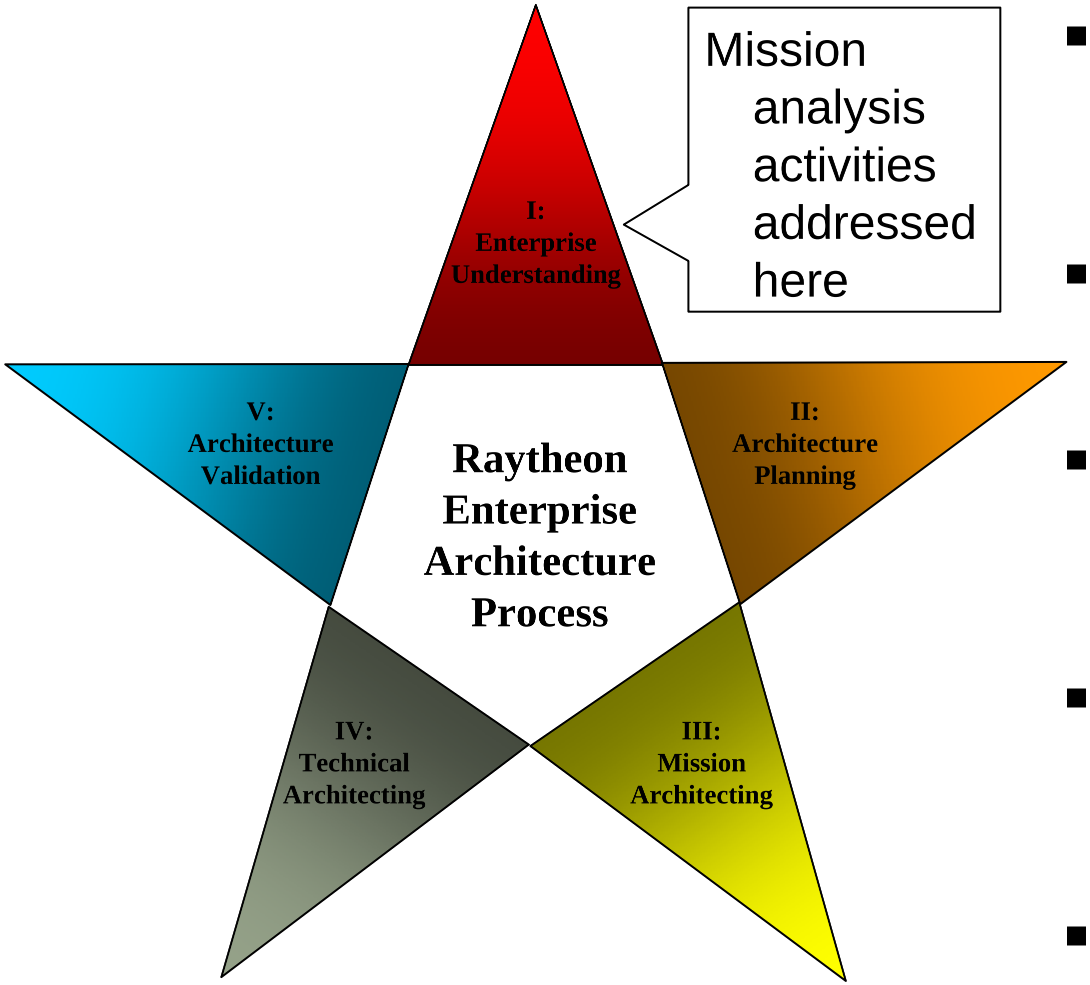
- Begins with understanding the mission and mission context
- A systems architecting process extended with enterprise architecting support
- A wrapper around established industry and government standards to "connect the dots"
- Reinforced through strict certification process





DODAF	FEAF	Zachman	TOGAF	ATAM®

REAP Activities



- **Enterprise Understanding**
  - Understand the Customer's problem, mission gaps, constraints, and context
- **Architecture Planning**
  - Define the REAP-guided work to the appropriate level
- **Mission Architecting**
  - Document the Mission and Operational Architecture…not the Technical Architecture
- **Technical Architecting**
  - Define the Technical Architecture solution from the Mission Architecture context
- **Architecture Validation**
  - Validate the content and utility of the architecture

Workshops, Mission Analysis, and Mission Experts

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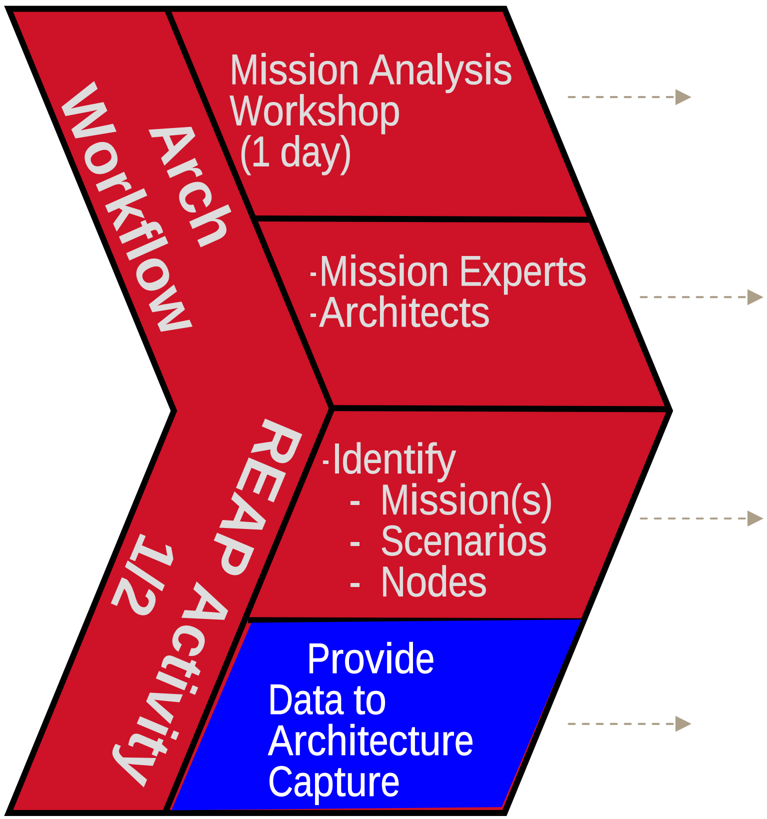

- Formalizes Mission Analysis phase for large, complex programs
- Pilots have shown that workshops are good approach
- Ensures strong alignment with Mission Experts
- Uses template for Data Capture (AV-2s, AV-1, QFDs, etc.)
- Captures mission definition, gaps, challenges, timeframe for target architecture
- Stakeholders may desire to validate output and identify any actions before proceeding to downstream activities

Mission Area Quality Functional Deployment (QFD) Template

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PACOM Fires Mission)	Relative importance to mission	Capability 1	Capability 2	Capability 3	Capability 4	Capability 5	Capability 6	Capability 7	Capability 8	Capability 9	Average Opportunity score	Weighted Score			
Scenario 1 (Use Case) - as is state											0	0			
Desire State															
Scenario 2 (Use Case) - as is state											0	0			
Desire State															
Scenario 3 (Use Case) - as is state											0	0			
Desire State															
Scenario 4 (Use Case) - as is state											0	0			
Desire State															
Scenario 5 (Use Case) - as is state											0	0			
Desire State															
Scenario 6 (Use Case) - as is state											0	0			
Desire State															
Scenario 7 (Use Case) - as is state											0	0			
Desire State															
Scenario 8 (Use Case) - as is state											0	0			
Desire State															
Scenario 9 (Use Case) - as is state											0	0			
Desire State											0	0			

1 is low correlation
10 is high correlation

Simple Tool to Correlate Mission Needs & Capabilities

Applied Mission Area QFD Example

Find, Fix, Track Individuals of Interest - As Is State Locating "JFC's Most Wanted People"	Relative importance to mission	SIGINT	IMINT	Video	HUMINT	MASINT	Multiple Intel Source Aggregation	KM/KD	Open Source Exploitation	Cyberspace Exploitation	Biometrics	Resource Management	Average Opportunity score	Weighted Score
Get Tip from Sources (Forces in Contact, Other Govt Agencies, LE, SOF, Open Source, Alliance Partners)	6	5	5	5	5	5	5	5	5	5	5	5	5	30
Desire State	6	8	8	8	8	8	8	8	8	8	8	8	8	48
Identify Target	9	4	4	4	4	4	4	4	4	4	4	4	4	36
Desire State	9	6	6	6	6	6	6	6	6	6	6	6	6	54
Confirm Target (in Probability Terms)	7	7	7	7	7	7	7	4	4	4	4	4	6	39
Desire State	7	7	7	7	7	7	7	7	7	7	7	7	7	49
Fix	6	4	4	4	4	4	4	0	0	0	0	0	2	13
Desire State	6	6	6	6	6	6	6	3	3	3	6	3	5	29
Track	7	8	8	8	8	8	8	8	8	8	8	8	8	56
Desire State	7	7	8	8	8	8	8	8	8	8	8	8	8	55
Gather Additional Situation Awareness Info As Needed	4	6	6	6	6	6	6	6	6	6	6	6	6	24
Desire State	4	6	6	6	6	6	6	6	6	6	6	6	6	24
Discern Intent	7	2	2	2	2	2	2	2	2	2	2	2	2	14
Desire State	7	8	8	8	8	8	8	8	8	8	8	8	8	56
Tag	5	3	3	3	3	3	3	3	3	3	3	3	3	15
Desire State	5	7	7	7	7	7	7	7	7	7	7	7	7	35

Identifies the Best 'Focus Area' Opportunities

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Mission Analysis Feeds Back to the Mission

- ***1. Administrative Information***
- ***2. Impact on Mission Areas***
- Briefly describe the impact of the capability shortfall or technological opportunity
- ***3. Needed Capability***
- Describe the functional capability needed or technological opportunity
- ***4. Current and Planned Capability***
- ***5. Capability Shortfall***
- ***6. Impact of Not Approving the Mission Need***
- ***7. Benefits***
- ***8. Timeframe***
- ***9. Criticality***
- ***10. Long Range Resource Planning Estimate***

Mission analysis activities and artifacts address items 2 thru 5

Acronyms

1) BRM – Business Reference Model
2) DOTMLPF – Doctrine, Organization, Training, Materiel, Leadership & education, Personnel, Facilities
3) DRM – Data Reference Model
4) FEA (Federal Enterprise Architecture)
5) PRM – Performance Reference Model
6) SRM – Service Component Reference Model,
7) TRM – Technical Reference Model
8) UJTL – Unified Joint Task List

Raytheon

Bio – John T McDonald

John T McDonald

(John_T_McDonald@raytheon.com)

- BS in Mathematics
- BS in Computer Science
- MS in Physics
- MS in Computer Science

Raytheon

- RTN Six Sigma Expert
- Raytheon Certified Architect
- Chief Engineer /Chief Architect IIS
- RTN Garland Site Council
- RTN IIS Technology Team
- University of Texas At Dallas Industry Advisory Board

Summary of Experience

John has close to 25 years of experience in Intelligence Community and DoD Software and Systems Engineering. John has served as lead and chief engineer on numerous systems and led an organization of aprox 100 SW Systems Engineers for over 7 years. John also lead the Object Technology Center at Garland for 5 years in the early and mid 90s.

John is currently the Chief Engineer and Chief Architect of IIS. John was a founding member of the RTN Architecture Review Board and formed a team that planned and realized the initial REAP (Raytheon Enterprise Architecture Process) which is the RTN wide architecture process and methodology.

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Bio – David W Rhodes

David W Rhodes

(dwrhodes@raytheon.com)

- BS in Computer Science
- MS in Systems Management
- DMSC/DAU Advance Program Managers Course
- PMI™ Project Management Professional

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- RTN Six Sigma Expert
- RTN IIS SE Council Co-chair
- Colorado State University Industry Advisory Council (ISTeC-IAC)

Summary of Experience

David Rhodes has worked at Raytheon Space Systems in Aurora, CO since 2001 and is currently the IIS Systems Engineering Council Co-chair and a member of the Raytheon corporate Systems Engineering & Technology Council. David has over 20 additional years in the aerospace industry performing in a variety of mission analysis, systems engineering, program management, and business development roles. David is a graduate of the DSMC Advanced Program Manager's Course and Systems Engineering Management course. David has an MS in Systems Management from the University of Southern California and a BS in Computer Science from the University of Maryland. David is also a member of the Industry Advisory Council for Colorado State University's Information Systems and Technology Center.

Innovation Cell
Engineering Solutions for Fleet Readiness Centers

William Birurakis
Senior Vice President, Engineering
Pioneering Decisive Solutions, Inc.
240-298-7124

Background

- The US Navy’s NAE has in it’s inventory slightly more than 3,700 aircraft (we had over 6500 in 1990). There are more than 90 T/M/S (type/model/series) aircraft in the Navy and US Marine Corps inventory.
- The NAE (both Navy & Marine Corps) fly more than 1.2 Million flight hours per year at a cost averaging a bit over $4,400 dollars per hour.
- From a sustainment standpoint, the cost to provide everything it takes to enable and provide this level of operations and associated maintenance, logistics and engineering exceeds $ 6 Billion dollars per year (not including new /replacement aircrafts and associated systems) and many thousands of highly skilled people of various skills

Challenge

- The Naval Aviation Enterprise (NAE) is under extreme pressure to achieve 'more Cost-Wise-Readiness'. This is a result of a clear understanding that the strain on our Navy / Marine Corps NAE during current times is extreme and that many of our aircraft, associated weapons systems, and the systems that support them are getting older and must be replaced and/or modernized. With this in mind, it is imperative that the Navy, and specifically the NAE, seek innovative ways to change the way things are done in order to achieve more 'effectiveness and efficiency' in a manner such that resource dollars can be freed up for modernization. The objective has to be to achieve exactly the right degree of readiness; i.e, not too much, not too little. The NAE 'is' in fact doing this.

Transformation to FRCs

- he Naval Aviation Enterprise (NAE) is transforming the way it performs its Depot and non-deployable Intermediate levels of maintenance by adopting the Fleet Readiness Center (FRC) concept. In fact, this initiative was a part of the Base Realignment And Closure (BRAC) process accomplished 2005.
- Per GAO analysis, the FRC initiative, if fully implemented in a successful manner, will provide the highest recurring cost saving of any of the 198 DoD BRAC 2005 initiatives (ref: GAO-rpt-159 dated Dec2007 see page 54).
- he FRC initiative, during it's first two years of implementation, has achieved it savings / cost avoidance targets and these have been reported to Navy leadership as well the GAO.
- hat said, the FY09 target increases dramatically and the FRC initiative will require significant efforts to actually 'do' all that is required.
-

Avionics Rapid Action Team

- ddressing the thinking and efforts of the NAE (Naval Aviation Enterprise) to improve the way we are 'providing timely engineering and logistics support' to aviation Fleet Readiness Centers that accomplish the level II and level III aviation maintenance that supports the Navy's operating aircraft and the associated weapon and support systems.
- he 'Imagineering' associated with the ARAT (Avionics - Rapid Action Team) is to deliver to the FRC's, 'expedited and focused engineering' based upon 'boots in the shop' and a direct and symbiotic relationship that changes the way we identify, then correct deficiencies including the alteration of the associated business and maintenance processes. This includes 'enhancing cost effectiveness', but also 'system performance' plus 'system reliability' or 'time-on-wing'.
- ey to this effort is the 'measurement' of what is or is not being accomplished as well as how the changes were made and can be replicated and sustained.

Exploration

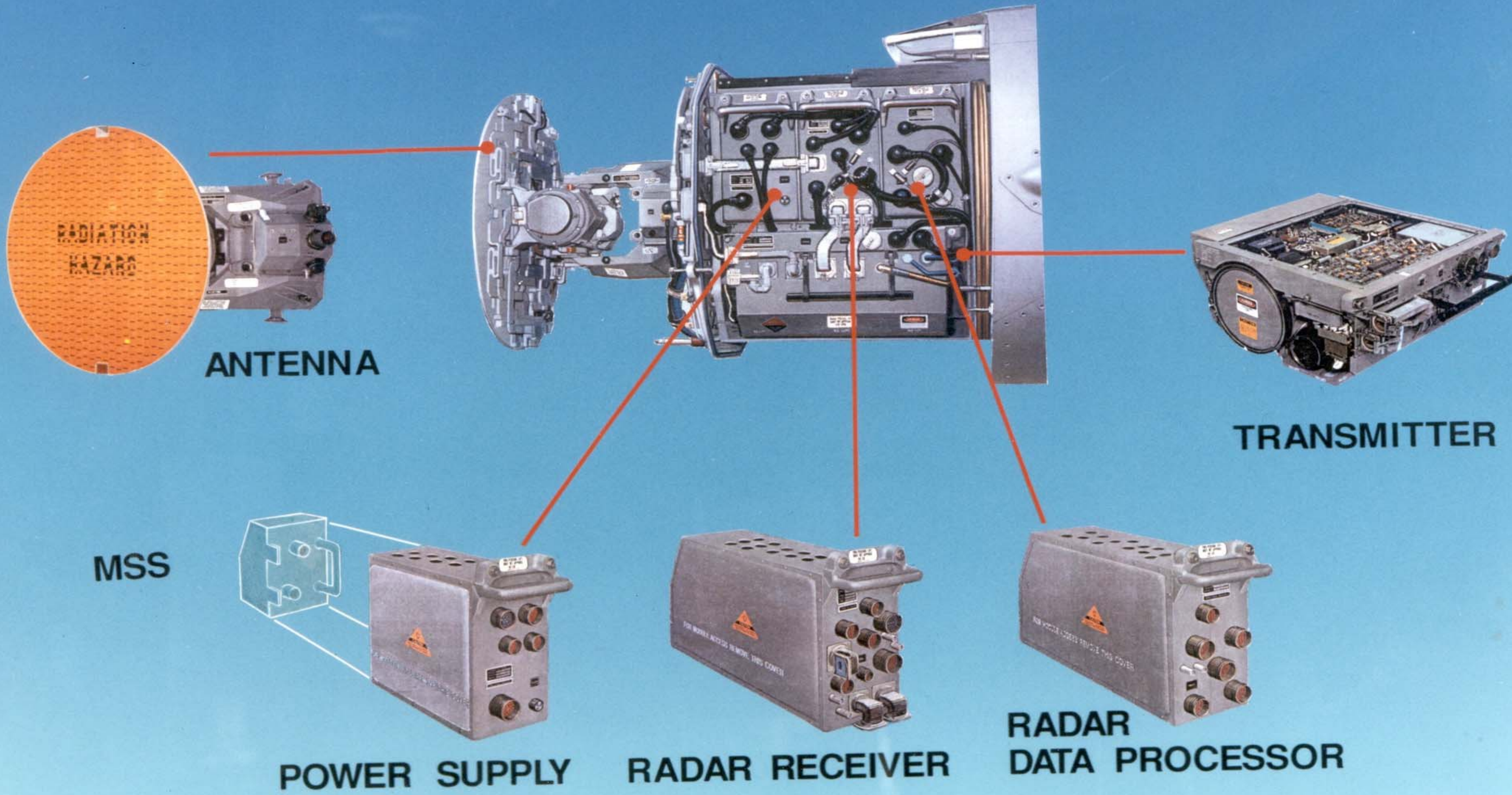
- ill provide an explanation of what has been achieved through ARAT at FRC West located at Lemoore California while working on FA-18 radar systems

- hile ARAT ‘is’ focused on specific achievements related to improvements in the domain of the FA-18 Hornet radar, the prime objective is to prove the hypothesis that improvements are possible to the methods the NAE uses to provide logistics, engineering and maintenance support.

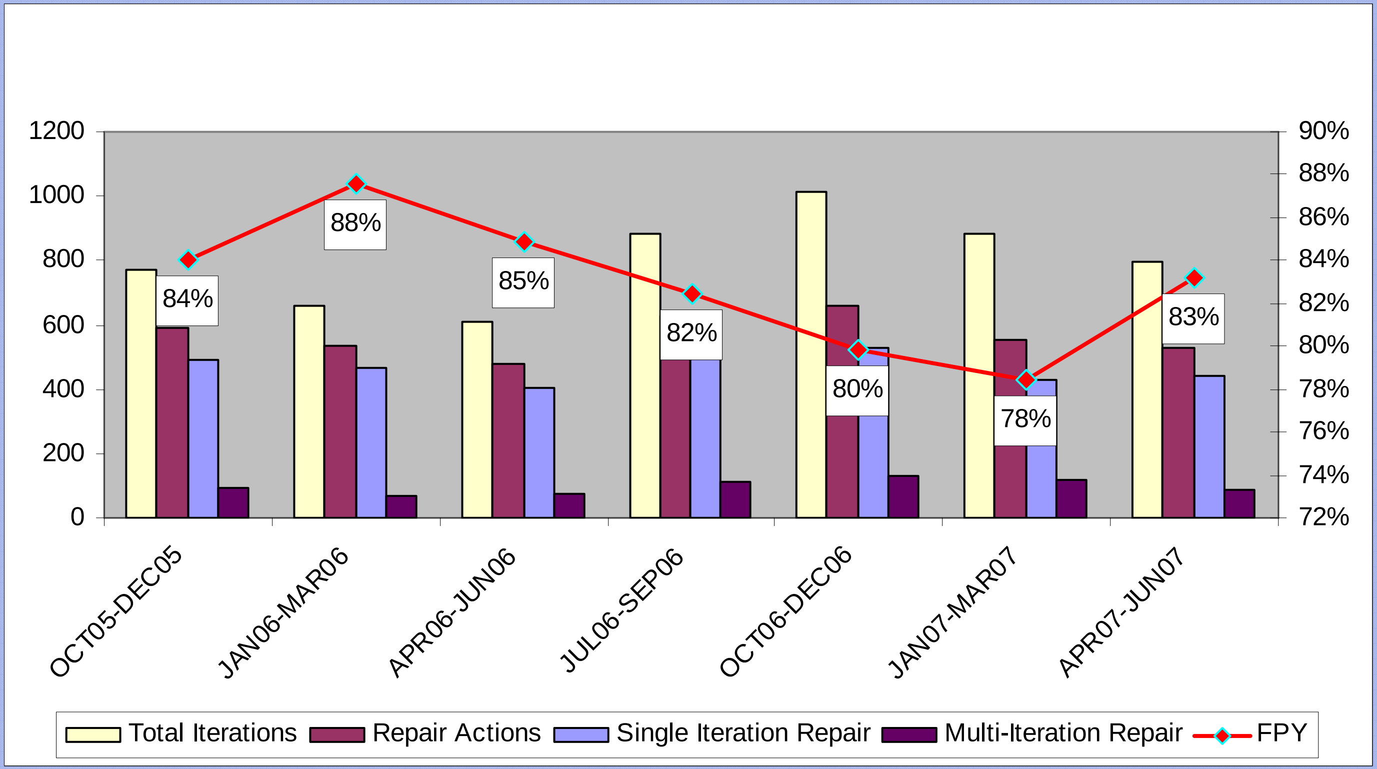
ARAT Innovation Cell Approach

- Innovation Cell was created to:
  - Identify/Solidify Objectives
  - Determine Appropriate Means of Measurements
  - Generate Approaches to meet Objectives
  - Measure Results
- Many areas covered for Objectives and were boiled down to two primary measure of effectiveness:
  - Time On Wing (TOW) & affects to RFT
  - Cost Avoidance /Savings

ARAT/COE Benefits


RADIATION
HAZARD
ANTENNA
TRANSMITTER
MSS
POWER SUPPLY
RADAR RECEIVER
RADAR
DATA PROCESSOR

First Pass Yields



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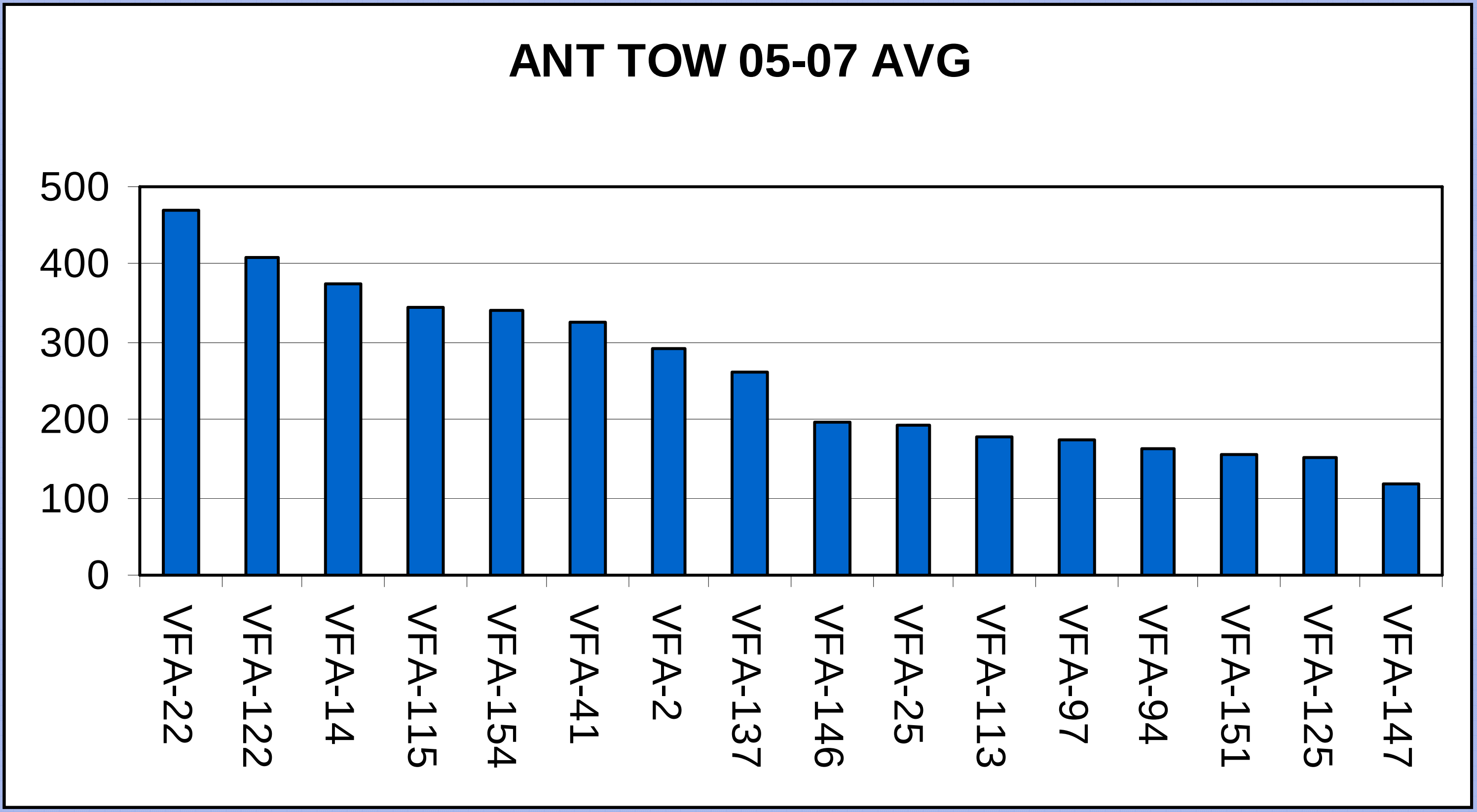
ANT Time On Wing Example



*FY-07 QTR2

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ANT Bad Actors example

SERNO	MHRS	IMAs
TFG857	341.1	11
PUV938	56.6	10
RLP327	103.4	8
SVG709	173.4	8
TAC756	159.3	8
PDR863	71	7
PUV887	58	7
QGR158	36.7	7
RLP349	58.7	7
SQW670	66.4	7
TNW153	203.9	7
TNW999	136.2	7
NUD579	198.7	6
RLP346	267.8	6
RTP388	139.5	6
SAZ461	79	6
QGR017	107.6	5
QXC129	76.1	5
REU307	23.6	5
RLP320	108.7	5
RLP328	178	5
SAZ475	440.9	5
SAZ512	22.1	5
TFG838	277	5
TFG868	57.2	5
TNW041	27.8	5
TNW050	49.8	5
TNW116	61.2	5
TNW229	19.3	5

Only Top ANT Bad Actor Serial Numbers are indicated in this slide.
Bad Actors = 13.1% of total ANT S/Ns processed, 33.6% of ANT IMAs, and 33.5% of ANT IMA MHRs.
Poor Performers = 22.6% of total ANT S/Ns processed, 31.3% of ANT IMAs, and 34.4% of ANT IMA MHRs.
Total = 35.7% of ANT S/Ns processed, 64.9% of ANT IMAs, and 67.9% of ANT MHRs.

MA Mean	2.461538	
MA Median	2	
Std Deviation	1.864651	
Bad Ac tors	#MA > Mean +1 Std Deviation	4.326189
Poor Performers	Mean + Std >= MA > Mean	Between 3 AND 4
R Population	MA <= Mean	<= 2

Group	#S/N	%S/N	#MA	%MA	#Mhrs	%Mhrs	
Bad Ac tors	29	13.1%	183	33.6%	3599	33.5%	greater than 4
Poor Performers	50	22.6%	170	31.3%	3698	34.4%	3 to 4
R Population	142	64.3%	191	35.1%	3452	32.1%	2 and below
Total	221	100%	544	100%	10749	100%	

ANT I-Level Repair Data 2005-QTR3 to 2007-QTR2

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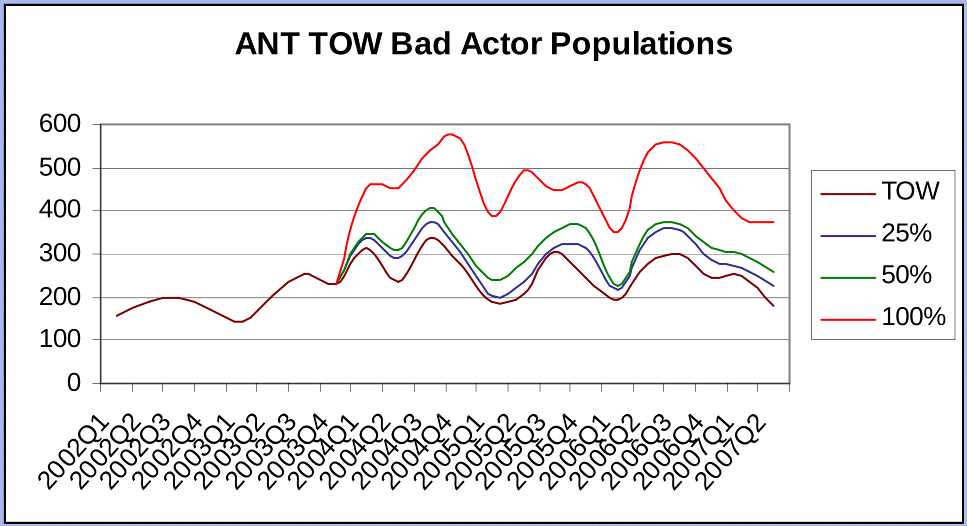
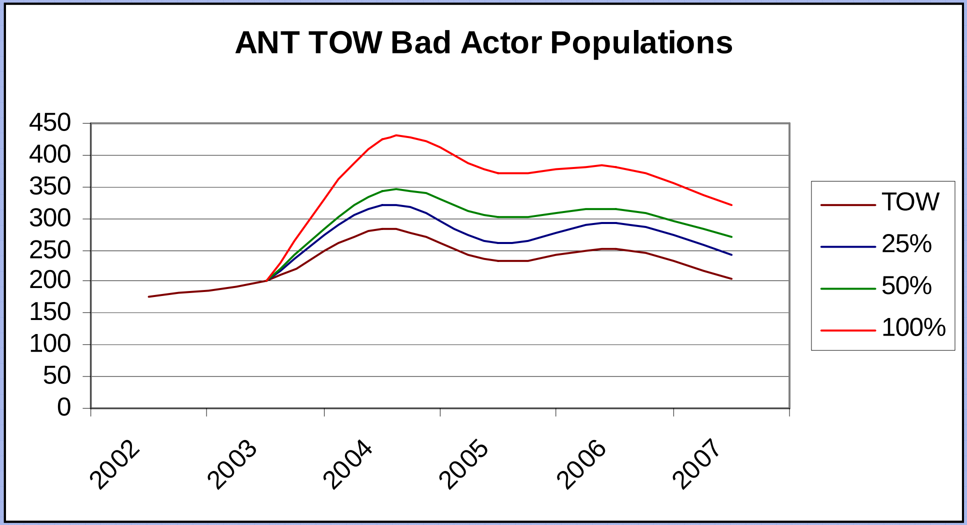
ANT Time On Wing (CONT)





ANT Bad Actor S/N were removed from Time on Wing calculations based on top 25% of ANT Bad Actor population and at the 50% and 100% populations from FY2004-FY2007 QTR2. FY2002-FY2003 was used for baseline comparison of trend.

***FY-07 QTR2**

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A799 Rates Unacceptable & Opportunity for EVHMS

- XMTRs: A799s + Reseat Actions = 51.4 % of IMAs.
- ANTs: A799s + Adjust/boresight/aligned Actions = 55.2 % of IMAs.
- RRs: A799s + Reseats + 2A9s alignments = 54.5 % of IMAs.
- R/Es: A799s + Reseats + 2A3s alignments = 69.4 % of IMAs.
- RDPs: A799s + Reseats = 51.2% of IMAs.
- PSUs: A799s + Reseats = 71 % of IMAs.
- CPSs: A799s + Reseats = 55.4 % of IMAs.

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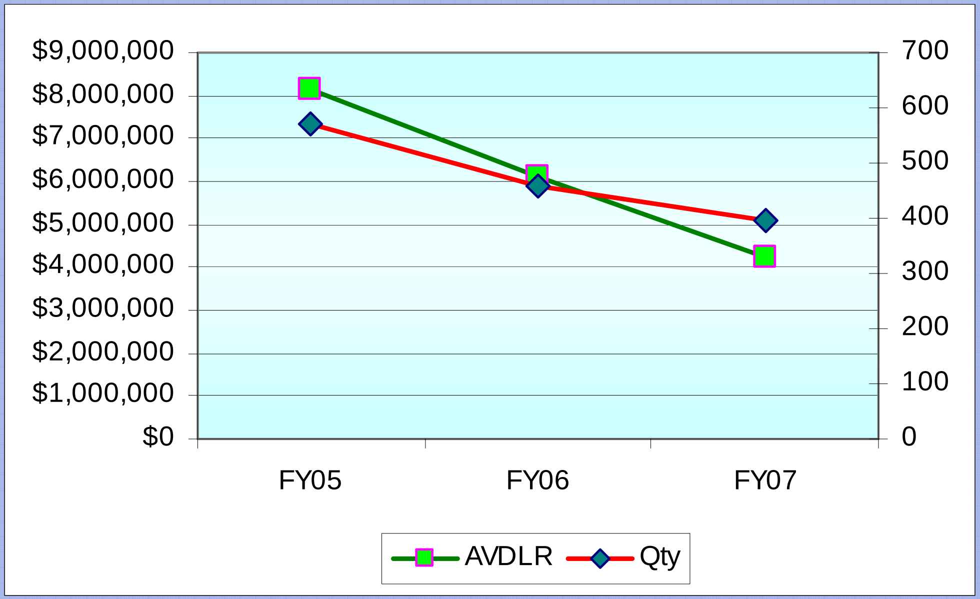
BCM Cost Savings

BCM Cost Summary

- FY07 AVDLR prices used in calculations
- Does not include R&R Support to other Sites



	What	Qty	AVDLR	MHRS	
FY05	**WRA**	**101**	**$3,570,179**	**5,695**	
	SRA	**471**	**$4,598,637**	**2,525**	**$8,168,816**
FY06	**WRA**	**56**	**$2,189,037**	**1,833**	
	SRA	**404**	**$3,936,383**	**2,866**	**$6,125,420**
FY07	**WRA**	**14**	**$586,879**	**301**	
	SRA	**383**	**$3,627,909**	**160**	**$4,214,788**

Data Source: DECKPLATE

Bad Actors Program

Bad Actors = Bad Eyes

Tx MQJ-618

- Number one Bad Actor transmitter in the fleet FY05-FY07
  - 24 Failures in two years
  - Reworked by artisans May 07
- Stayed in aircraft 11 months before failure
  - >260 transmit hours
  - Previous 5 maint. actions had a total of 11 operating hours

Example RR TNW-608

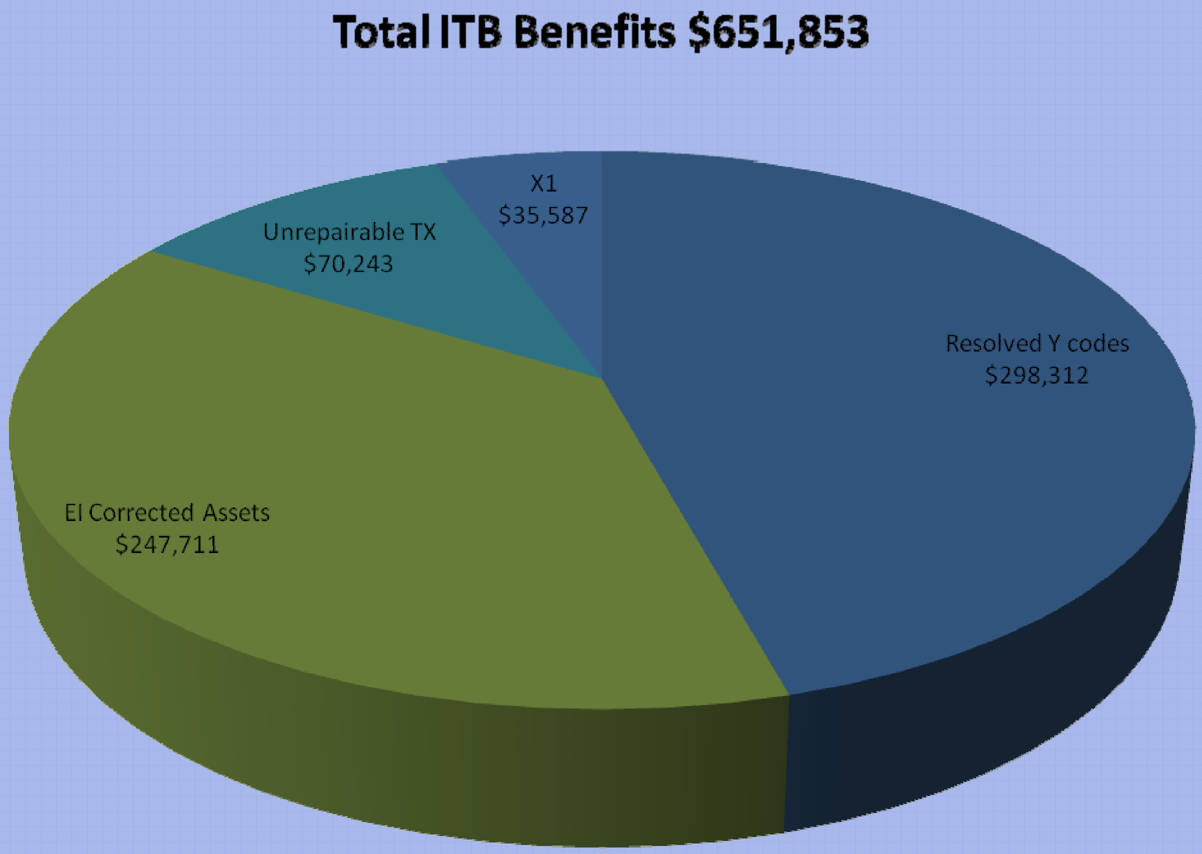
- **RR TNW 618**
- 23 effective Y-Codes (never stayed out)
- Reworked stayed out 11months
- $140,024.00 Cost avoidance by avoiding continuation of scenario.

Integrated Test Bench (ITB) Benefits FRC West Lemoore

ITB Uses

- Y-coded WRA’s (Repeat offenders for same fails).
- CASS TPS not available but supported by ITB.
- Data/Arithmetic problems undetected by CASS simulation.
- Bad Actor processing.
- CASS improvement through ITB test validation.

Integrated Test Bench Statistics: Total Cost Savings from 12/5/08.



FRC Mid Atlantic Critical EI

- EI Investigation
  - 1 yr from fleet intro of Spur Corrections (FST Lead Time). FRC East will be eliminating spurs from their RRs while in repair cycle.
  - RADAR Receiver Spur Root Cause Analysis (Troy Gordish). Local Oscillator failure mechanism.

TOW Savings

Quantity to Quality based maintenance and benefits

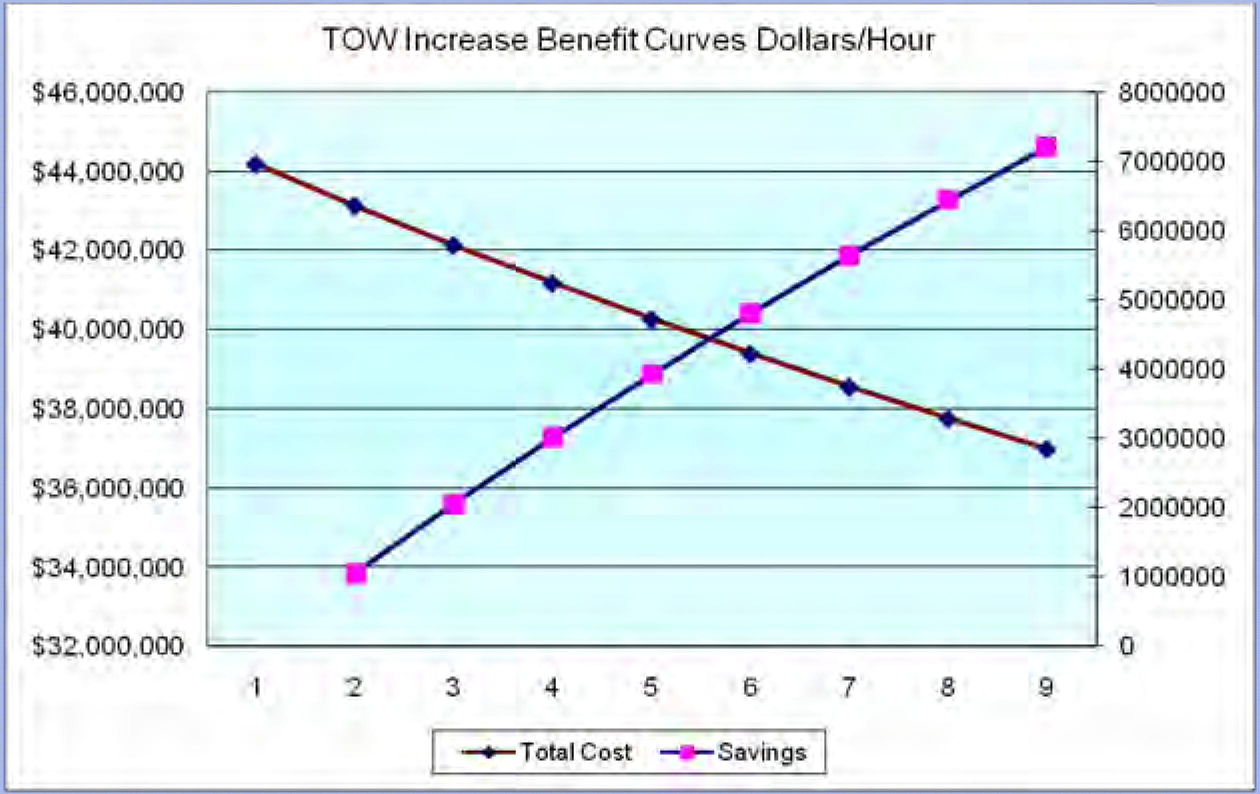
TOW Benefit

- TOW Cost = Total Cost of Repair = $44M
- TOW Increase = Reduction in Repairs
- Example = 100% Increase in TOW = 50% Reduction in annual cost of repair = $22M.

TOW Benefit

- Can maintenance practices change TOW
- Yes COE supported systems are running approx 20% higher TOW than rest of Fleet which yields approximately $2M/year savings
- COE supported systems are costing the fleet less from BCM interdiction savings and reduced cost based on higher TOW
- Y code removals, Bad Actor Program etc.

FRC TOW Increase Benefit about $1M/Hr



Pioneering Decisive Solutions, Inc.

Changing the Deployed Fleet Cost

- Can the COE and ARAT efforts change the cost of Fleet Repair
- Yes, thru local EI driven SW changes which improve Fleet Repair Capabilities

APPROACHES & Actions Taken

- **Incorporated Innovation Cell Findings**
- **Baselined TOW & Cost**
- **TOW Baseline**
  - **TOW completed**
  - **MTBD Lemoore Card Deck**
  - **Bad Actor Determination (By SN)**
    - **TOW**
    - **A799 (CND)**

APPROACHES & Actions Taken

- **Cost Baseline**
  - **Establish Cost/Repair/PN (in work)(in MYs)**
  - **WIP (in work) (MYs)**
  - **FPY (in work) (MYs)**
  - **BCM Interdiction (in work)($)**

APPROACHES & Immediate Actions for Effect

- **Bad Actor Elimination**
    - Remove small percentage for initial significant reduction
    - FRACAS (i.e., perform Root Cause Analysis)
- **Change SM&R Codes/ICRL**
    - Example Transmitter Auto BCM for Transmitter Chassis & 1A2 PSs
- **Instill process for History Cards**
    - **NAMP Change for ETI on MAFs (LT Penrod)**
- **Scrap Rate**
    - Investigate Scrap Rate from ARF
    - Hard Line Manufacturing (FRC)
    - Micro Min instructions and training
    - Potted Chip Removal & Card Trace Repair

APPROACHES & Immediate Actions for Effect

- **Training**
  - Teach SMEs how to read CASS digital code
  - Recommendation, CWO3 Daniels approach for troubleshooting publications
  - PMA-265 Training Initiatives
- **CND Reductions**
  - Supplier CNDs under investigation (Tom Henderson, Kevin Odel)
- **A799 Reductions**
  - Feedback to O-level
  - Feedback to SRA Repair
  - BOA ECT evaluation

APPROACHES & Actions Moderate Term

- **Cooperative FRACAS**
- **ADSR/Smart TPS**
- **Process Flow Modifications**
  - **Primary Highway**
  - **Rework Lane**
  - **Feedback Loop for Improvement**

The Way Its Supposed to Be

Bottom Line

Results:

-RE/RR/XMTR/ANT TOWs(MTBDs) have increased and FY08 levels are currently being calculated by FST. Expectations are in the range of 2-3 hrs/Radar = $2-3M FY09 targets another 4 hrs/radar=$8M *

-Cost Reductions in AVDLR from BCMI to date> $14M

-Radar COE is transitioning from Quantity Driven Repair to Quality Driven Repair Meeting Demand

-The approach utilized for Radar Transformation is now being utilized for other commodities.

-We are now looking into integration with and implementation of EVHMS

*calculations based on 2007 NAVICP AVDLR Costs

Questions?

8th Annual
NDIA Systems Conference
October, 2008
San Diego, California

Correlation of Types of Requirements to Verification Methods

Dr. William G. Bail
The MITRE Corporation

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Agenda

- Introduction
- Types of requirements
- Verification techniques
- Selecting techniques for requirements
- Examples
- Summary

Introduction

- When developing systems, it is a good idea to be able to show the customer that the system works
  - » Especially if you want to get paid
- Involves demonstration of compliance
  - » To all requirements, individually or in batches
  - » To the entire system, in operational environment with real-life operational scenarios
- Overall system “quality” needs to fit with customer’s range of acceptability, recognizing that trade-offs are usually made
- Need to construct a valid argument that system satisfies customer’s requirements, supported with sufficient objective evidence
  - » A requirement is verifiable if such an argument can be constructed
- This presentation examines some techniques for this proof

Qualities of requirements (1 of 2)

- IEEE Std 830-1993* defines nine qualities for requirements specifications
  - » *Complete* – All external behaviors are defined
  - » *Unambiguous* – Every requirement has one and only one interpretation
  - » *Correct* – Every requirement stated is one that software shall meet
  - » *Consistent* – No subset of requirements conflict with each other
  - » *Verifiable* – A cost-effective finite process exists to show that each requirement has been successfully implemented
  - » *Modifiable* – SRS structure and style are such that any changes to requirements can be made easily, completely, and consistently while retaining structure and style.

*** IEEE Recommended Practice for Software Requirements Specifications**

Qualities of requirements (2 of 2)

- IEEE Std 830-1993 qualities of requirements (cont'd)
  - » *Traceable* – Origin of each requirement is clear, and structure facilitates referencing each requirement within lower-level documentation
  - » *Ranked for importance* – Each requirement rated for criticality to system, based on negative impact should requirement not be implemented
  - » *Ranked for stability* – Each requirement rated for likelihood to change, based on changing expectations or level of uncertainty in its description

Agenda

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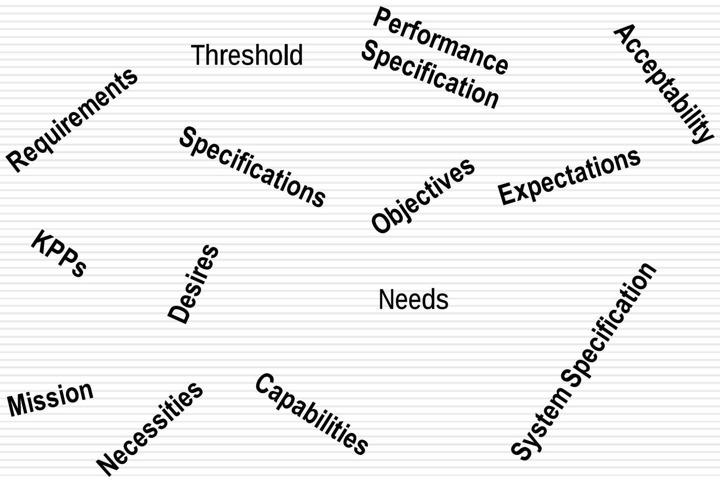
Requirement by any other name…

- We use many different words to refer to what we want to see in a system



- They all describe some desired attribute of the to-be-built system
- When developing a system for a customer, we need to prove that the system has the customer’s desired attributes
- We have various verification techniques to provide this proof

Differences among requirements

- There are many different types of requirements
  - Each type has different verification techniques that are suitable
- Planning for verification starts with defining the requirements
  - Important to define requirements such that they can be verified
  - A key IEEE quality attribute
- As requirements mature and acquire detail, more detail about how to verify them can be added
- Important to map requirements to the feasible verification techniques early
  - And mature these as development proceeds
- Good, complete, and unambiguous requirements inherently contain the information necessary for verification

Types of requirements

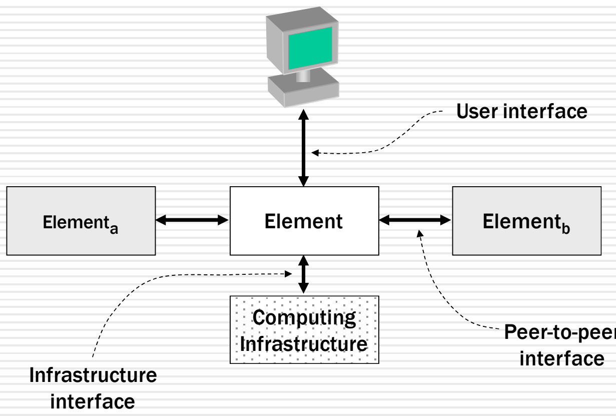
- **Requirements**
  - **Behavioral**
    - **Functional**
    - ***Trustworthiness***
      - ***Reliability***
      - ***Safety***
      - ***Availability***
      - ***Integrity of operation***
      - ***Protection of information***
    - **Interface**
    - **Temporal**
    - **Capacity**
    - **Resource utilization**
    - ***Usability***
      - ***Ease of learning***
      - ***Efficient to use***
      - ***Easy to remember***
      - ***Forgiving***
      - ***……***
  - ***Quality of construction***
    - ***Maintainability***
    - ***Portability***
    - ***Extensibility***
    - ***Reusability***
    - ***Integrity of construction***
  - **Implementation**
  - **Programmatic**
    - **Delivery Schedule**
    - **Cost**
    - **….**

Behavioral requirements *(page 1 of 5)*

- Those that express externally-visible actions / attributes / behaviors of the entity (component, subsystem, system, unit,…)
  - » Defined by *functional requirements / functional specifications*
- Verifiable by observing externally-visible responses from externally-applied stimuli
  - » (Potentially) measurable by testing
- Seven types
  - » Functional
  - » Interface
  - » Temporal
  - » Capacity
  - » Resource utilization
  - » Trustworthiness
  - » Usability

Behavioral requirements *(page 2 of 5)*

- *Functional* - Input-output behavior in terms of responses to stimuli
  - Simple I/O (stateless) – this input produces this output
  - State-based – the history of inputs defines the output
- *Interface* - characteristics of component's interfaces
  - Peer-to-peer
  - User interface
  - Computing infrastructure



Behavioral requirements *(page 3 of 5)*

- *Temporal* - establishing time characteristics of behaviors
  - *Speed* – rate at which events occur
  - *Latency* – aka delay – the time between initiation of a function and its completion
  - *Throughput* – number of items processed (volume) per unit time
- *Capacity* - amount of information that can be handled
  - System operation – *e.g.*, 25 simultaneous users
  - System data objects - e.g., a minimum of 20,000 employee records
- *Resource utilization* - limitations on resources available
  - Defined in terms of hardware and other items that provide resources to allow the system to operate
  - *e.g.*, memory usage (RAM, disk, flash,…), processor usage, communication line usage

Behavioral requirements *(page 4 of 5)*

- *Trustworthiness (dependability)* - degree of confidence in product's delivery of functions
  - Inherently qualitative – cannot be definitively proven but can be inferred based on evidence
  - Types
    - *Reliability* – probability of operation without failure for a specified time duration under specified operational environment (e.g., 0.001 failures/hr)
    - *Availability* – proportion of time a system is ready for use over a defined period of time (e.g., 0.9999999 over 1 year)
    - *Safety* – features that protect against actions that could lead to harm to humans or property
    - *Integrity of operation* – system features that protects against corruption during operation
    - *Protection of information – (confidentiality)* – features that protect against unauthorized disclosure of information

Behavioral requirements *(page 5 of 5)*

- *Usability* - the ease of system use by an operator
  - Two different flavors based interacting agent -- human or other systems
  - When applied to system-to-system interfaces
    - Deals with the complexity of the interfaces, their ease of implementation, and their efficiency of operation
  - When applied to human operators
    - Deals with the complexity of the interfaces relative to the how operators can operate with them, the ease of learning, and the efficiencies with which operators can exploit the services provided by the system.
  - Usability requirements cannot be directly verified
    - Involve inherently subjective behaviors that often have to be observed over time (e.g., via a usability analysis)

Quality of construction requirements

- Attributes of the product itself and its construction
- Deals with how product can be handled, not its operation
- Inherently qualitative – cannot definitively verify
- Often not directly observable or measurable
  - » Measures exist that provide insight into these qualities,
    - > Help to *infer* level of quality based on quantitative system attributes
  - » Direct measures generally do not exist
- Examples:
  - » *Portability* – ease with which component can be ported from one platform to another
  - » *Maintainability* – ease with which product can be fixed when defects are discovered
  - » *Extensibility* – ease with which product can be enhanced with new functionality

Implementation requirements *(page 1 of 2)*

- Restrictions placed on developers that limit design space and process (aka *implementation constraints, design constraints*)
  - *e.g.*, use of specific software components
  - *e.g.*, imposition of specific algorithms
  - *e.g.*, customer-mandated architectures (e.g., Joint Technical Architecture)
  - *e.g.*, imposition of certain development techniques
- Two general types:
  - *Product constraints* – restrictions on the product construction
    - *Design constraints* – restrictions on design styles that can be used
    - *Implementation constraints* – restrictions on coding or construction
  - *Process constraints* – restrictions on how the product is built

Implementation requirements *(page 2 of 2)*

- An implementation constraint to a system may be a requirement to a SW component within that system
- While these are required characteristics of development effort, they are not characteristics of the product's behavior
  - » But will likely affect behavior
- Examples
  - » Use of specific software components
  - » Imposition of specific algorithms
  - » Required use of specific designs (e.g., open systems)
    - > Technical architectures
  - » Imposition of specific coding styles
  - » Required application of specific techniques (*e.g.*, RMA)
  - » Required application of specific unit test coverage criteria

Programmatic requirements

- Terms and conditions imposed as a part of a contract exclusive of behavioral requirements
- Address development aspects of product
- Examples
  - » Costs
  - » Schedules
  - » Organizational structures
  - » Key people
  - » Locations
- While these are required characteristics of development effort, they are not characteristics of the product
  - » But they can directly affect the ability to achieve product characteristics (not enough time, not enough budget)

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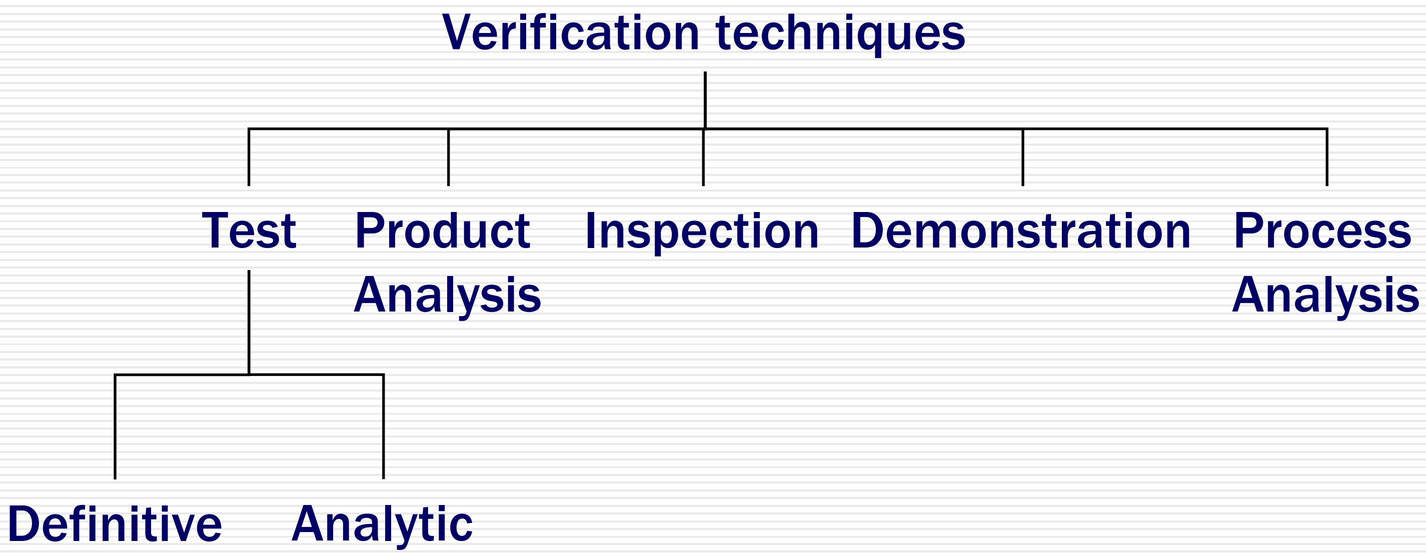
Requirements and verification

- Each and every requirement needs to be verified
  - » That is, need to be able to construct a valid argument that the requirement has been satisfied by the as-built system
  - » Argument needs to be supported with sufficient objective evidence
- A requirement is verifiable if such an argument can be constructed
- There are multiple techniques to construct these arguments
- Each type of requirement may require the application of multiple techniques to provide a full, sufficient argument
- When defined, each requirement must be correlated to the approach(s) to be used to verify that requirement
- Note that ALL requirements need to be verified
  - » Even if not behavioral

Verification techniques

- We define five types of verification techniques
  - » Test
  - » Product analysis
  - » Inspection
  - » Demonstration
  - » Process analysis



Verifying requirements – test

- With test, we execute the product, challenge with stimuli, and observe behavior (responses)
  - » Collect the responses
  - » Compare responses to desired responses (oracle) to determine degree of adherence
  - » Desired responses specified by the requirement statement
- Execution environment may include actual operational environment of product
  - » May also include simulations of other systems in the environment

Categories of test

- Two types of test based on the ability to determine conformance to requirements:
  - *Definitive*
    - Results are quantitative
    - Can be compared directly to the requirements
    - Results can be stated as pass/fail
  - *Analytic*
    - For requirements that cannot be definitively verified
      - Mathematical and other forms of analysis must be used to make an argument for compliance.
    - Test results from one or more tests may support an argument for either pass or fail, but do not provide an absolute determination of conformance.
    - Such arguments serve to establish the levels of trust that can be placed on the system's performance

Verifying requirements – product analysis

- Product is not executed (tested)
- System attributes evaluated analytically, often supported mathematically
  - » *e.g.*, RMA (Rate Monotonic Analysis)
  - » *e.g.*, architecture analysis
- Results used to create arguments of compliance for those requirements that are inherently non-deterministic
  - » dependability
  - » to establish levels of trust

Verifying requirements – demonstration

- Product is manipulated to demonstrate that it satisfies a quality of construction requirement
- Such requirements express certain attributes of the product but not how these attributes are achieved
- *e.g.*, portability
  - » A portability requirement states a desire to be able to rehost a product to a different computational environment with minimal effort and cost
  - » Usually achieved by imposing certain design constraints (modular architecture, low coupling, high cohesion)
    - > Perhaps separately stated as a design constraint
  - » To verify that the product is portable, a demonstration of rehosting the product from one computer to another may be performed.

Verifying requirements – inspection

- Visual examination of product, its documentation, and other associated artifacts to verify conformance to requirements
- Often used in conjunction with other techniques to complete argument
- Particularly useful for verifying adherence to design/implementation constraint requirements
  - » *e.g.*, a software component may be inspected to verify that makes no operating calls other than to a POSIX-standard interface

Verifying requirements – process analysis

- Analysis of the techniques and processes used by developers to determine if they are adhering to any required project standards and plans
  - » May involve examination of the various intermediate and final products as well as programmatic artifacts and records.

Agenda

- Introduction
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- ➡ Selecting techniques for requirements
- Examples
- Wrap-up

Verification approaches

Type of Requirement	Verification Approach					
	Definitive Testing	Analytic Testing	Analysis	Demon-stration	Inspection	Process Analysis
Behavioral						
Functional	√	√	√		√	
Interface	√				√	
Temporal	√	√	√		√	
Capacity	√	√	√		√	
Resource utilization	√	√	√		√	
Trustworthiness		√	√	√	√	
Usability		√	√			
Quality of construction				√	√	√
Implementation Constraints						
Product constraint					√	
Process constraint					√	√

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Example 1 - Reliability

- Requirement – "The system shall have a reliability of 60 days MTBF"
- Cannot verify definitively
- A test can suggest failure to comply but not compliance
- Techniques to be applied:
  - » Analytic testing – to observe failure rates
  - » Inspection - to verify built-in fault tolerance
  - » Analysis – to examine failure modes and their effects
- Steps for creating argument of compliance
  - » Define appropriate operational scenarios, agreed to by customer
  - » Define analysis technique for predicting reliability based on testing, including confidence level

Example 2 – Anti-tamper

- Requirement – "The system shall incorporate anti-tamper features"
  - » Vague – requirement needs to be clarified
- "The system shall be resistant to attacks on code integrity"
  - » Better…
- "The system shall detect, resist, and create a log of all attempts to change the code."
- Potential techniques to apply
  - » Definitive and analytic test – test altered code to verify detection
  - » Demonstration – show that code changes are detected at system load time
  - » Inspection – ensure that code check-sum is valid
  - » Process analysis – verify that safe processes being applied

Example 3 – Open modular system

- Requirement – "The system shall be an open, highly-modular system"
- Vague – requirement needs to be clarified
- "The system shall be designed with internal modules each of which is no larger than 50 KSLOC in size. The interfaces to these modules shall be documented and visible outside the system, and shall be easily replaceable."
- Potential techniques to apply
  - Inspection – verify that the modules are appropriately sized, and that their documentation is published
  - Demonstration – show that each module can be replaced by alternate modules with same interfaces with less than 1 week of effort.

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Wrap-up

- Planning for requirement verification must start early, at same time as requirements are defined
- Requirements must be written with the goal of ensuring that they can be verified effectively and efficiently
- Verification must be planned for all types of requirements, not just behavioral
- Techniques need to be selected appropriate to the type of requirement
- The quality of the requirement statement usually drives the effectiveness of the verification
  - » Too vague results in loss of confidence

NDIA - EHM Committee

Enterprise Health Management
Enabling Integrated Next Generation Decision Support

Joint Alliance and Common Reference Model
For Effective Vision to Transition

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23 October 2008 - update

Presented by Chris Reisig

Boeing

Integrated Diagnostics

Executive Summary

- **Common Vision:** **Pursuing enterprise transformation driving unprecedented level of value, affordability, supportability and availability**
- **Problem Statement:** **Enterprise Health Management , the key enabler is a complex integration challenge; Significant and Common barriers exist across stakeholders; Inefficient resource utilization across stakeholders; Not leveraging legacy transition opportunities with emerging programs/technologies; Need a paradigm shift**
- ***Proposed* Strategic Approach:** **Socialize the Common Vision for Enterprise Transformation; Provide a Focused Systems Engineering Process to execute against; Provide Common Reference Model for barrier identification, solutions, road mapping and resource alignment**
- **Desired outcome:**
  - **Actively drive a coalition approach towards 'doing business differently'**
  - **Provide proactive means to foster communication**
  - **Enhance resource alignment**
  - **Accelerate EHM/CBM benefit transition to the Warfighter**

Enterprise Health Management

"The capability to make intelligent, informed, appropriate decisions across the Enterprise about design, logistics, maintenance and operational actions based on Health Management Data or Information, available resources, acquisition strategy, and operational demand."

Next Generation Enterprise Health Management Decision Support Solution Targeting Unprecedented Value, Affordability and Continuous Improvement

Key Attributes Include….
EHM as a Design Element; Proactive Advisory Generation Based on Health State; Autonomic; Planned Maturation; Near Real Time Updates; No False Alarms

Approved for public release; distribution is unlimited

Common Programs & Initiatives

Shared Vision, Purpose & Barriers

Prognostics and Health Management

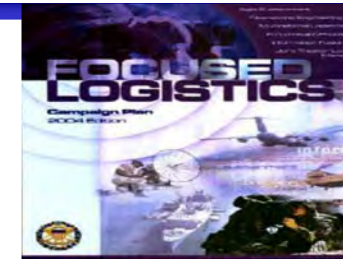
The capability to make intelligent, informed, appropriate decisions across the Enterprise about design, logistics, maintenance and operational actions based on HM information, available resources, acquisition strategy, and operational demand.

BUSINESS TRANSFORMATION

CBM+ is the application and *integration of appropriate processes, technologies and knowledge-based capabilities* to improve the *reliability and maintenance effectiveness of DoD systems and components*. At its core CBM+ is maintenance performed on evidence of need provided by Reliability-Centered Maintenance (RCM) analysis *and other enabling processes and technologies*.

AFSO21

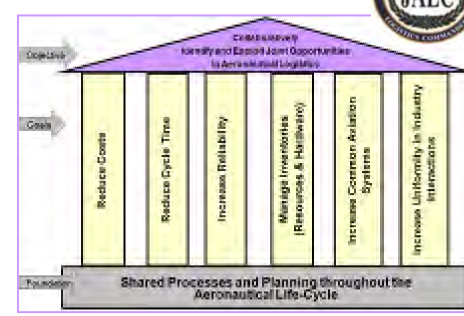
Air Force Smart Ops For The 21st Century



The proactive approach to managing fleet health

SLIM Mission Statement

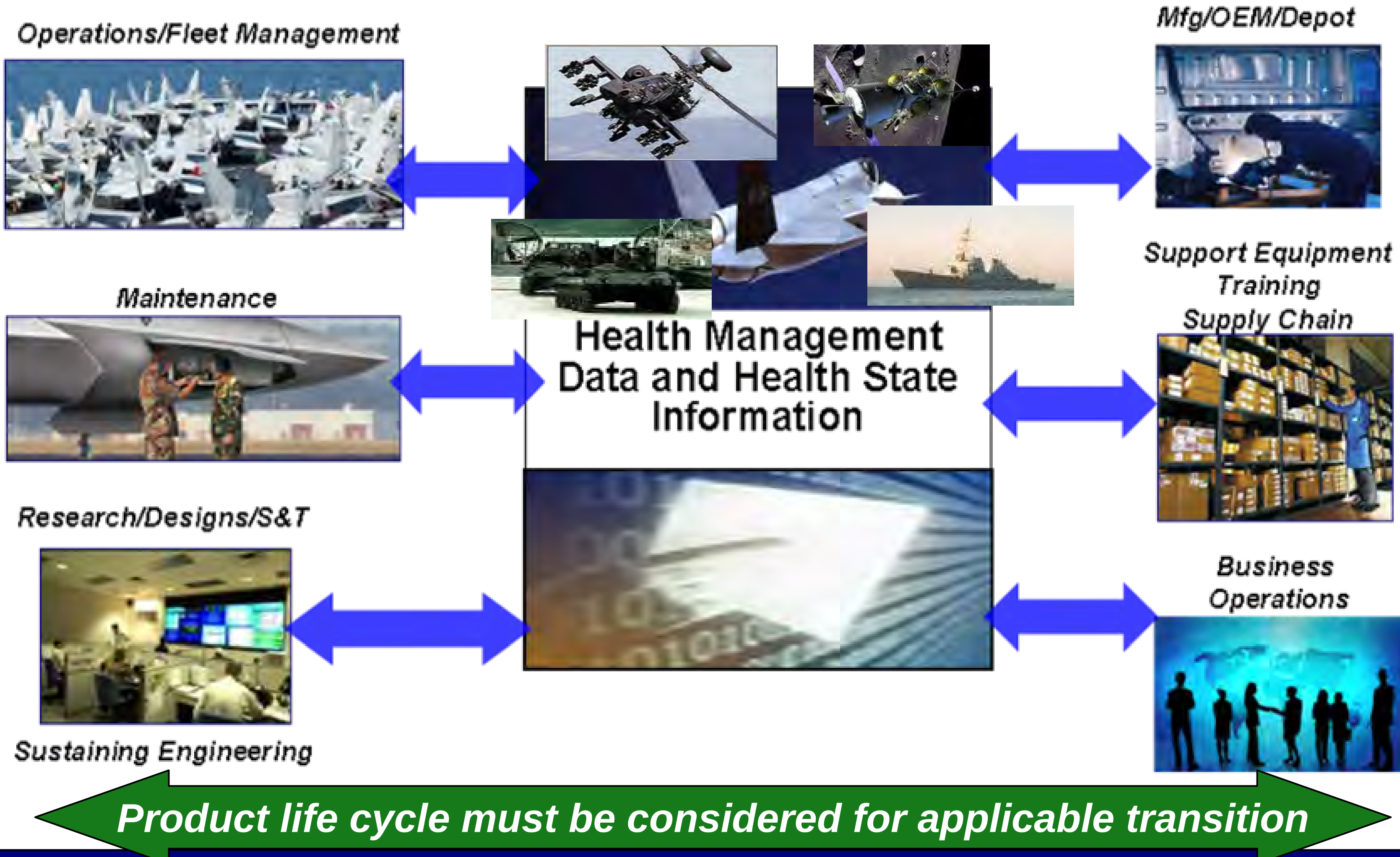
Integrate WSIP, CBM+, RCM/MSG-3, RAM, MFOQA, EAVI, and AIP efforts. Standardize engineering processes/tools associated with improving system performance monitoring and assessment leading to proactive weapon system management and product improvement throughout the system lifecycle.



Enterprise Health Management is the Common Denominator

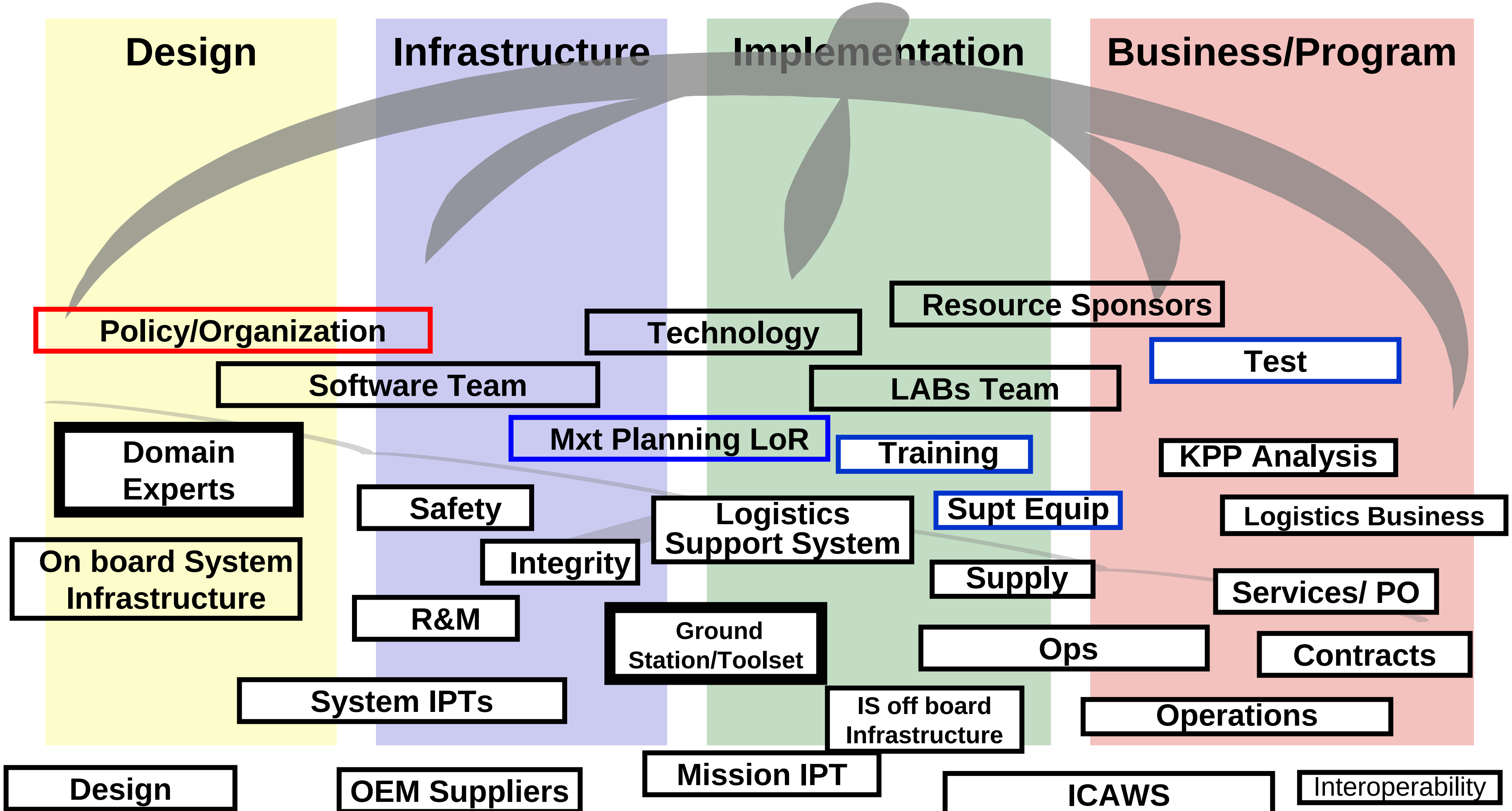
Approved for public release; distribution is unlimited

Enterprise Integrated Value Streams



Transformation Expected Across All Elements
Strong Commonality Across Platforms

Program IPT Integration Challenge



Responsibility is distributed across All domains; Need a integrated systems approach

Key Drivers for Change

- System supportability and affordability goals/vision difficult to meet without PHM/CBM+; Immature cost benefit models
- Contractor and Government organizational structures do not support health management as a new systems engineering "discipline"
- OEMs/Suppliers/IPTs not fully engaged
- Need system level architectural standards that integrate application of: smart sensors (e.g., IEEE 1451), condition monitoring (e.g., ISO 13374) and functional and global data and information exchange (e.g., MIMOSA OSA-CBM)
- PHM/CBM+ S&T roadmaps are not integrated across the Services, Agencies and domain IPTs --- this results in duplicate core efforts with minimal standardization, reuse and transition; Stakeholder resources not aligned to achieve vision effectively
- The stovepipe approach results in the "friction" factor of disparate capabilities across the enterprise value network—unsynchronized technologies will create interoperability problems, waste and non-value added activity

A Solution

Based on a broad depth of practical experience, observations & lessons learned across various industry CBM+/PHM/Autonomic Logistic initiatives — there is a need for a systemic transformation across the enterprise — to address common barriers and accelerate achieving the intended vision…

…a Joint Enterprise Health Management Alliance, a focused Systems Engineering Process and a Common Reference Model

The Bridge

Required for Efficiency and Effectiveness

Focused EHM Systems Engineering Process

Common Reference Model

Needs, Barriers, Expertise, Funding, Schedule, Data, Roadmaps

STAKEHOLDERS/SPONSORS

Policy & Requirements	**Technology Offices**	**OEM/Integrators**
Programs and Platforms	**Research Labs**	**Suppliers**
Warfighters	**Academia**	**Small Business**

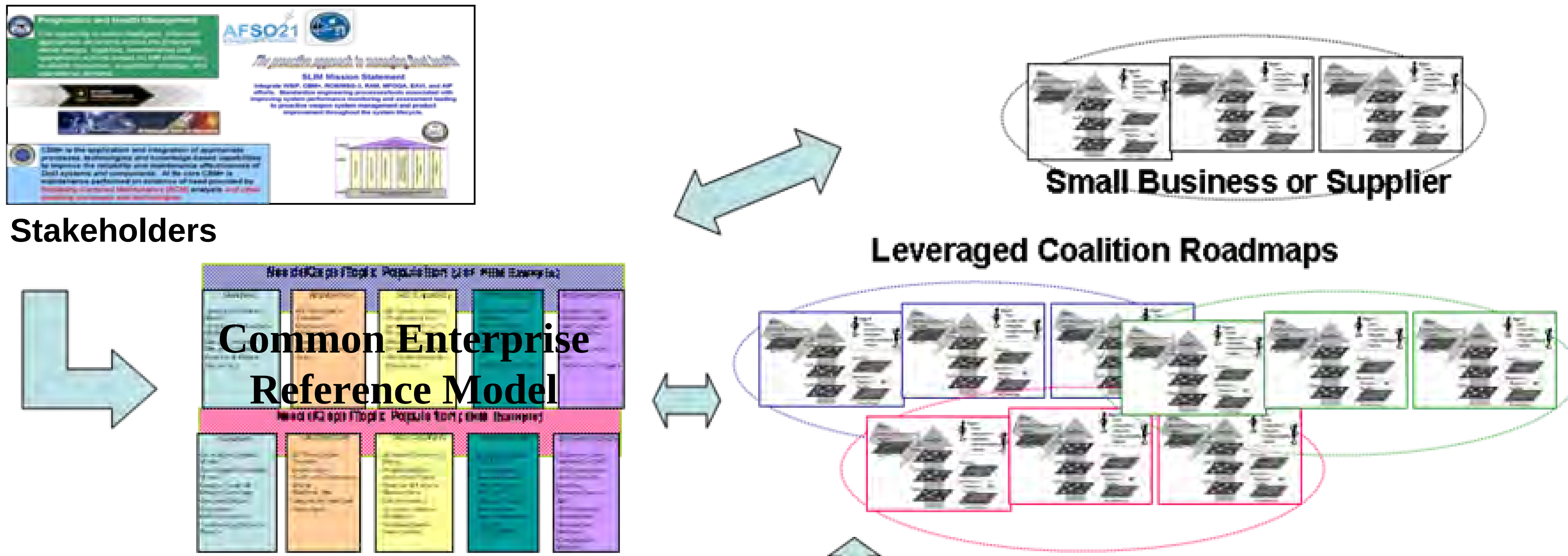
Moving Forward Effectively

- Drive a Coalition Alliance - *(Best of the Best)*
  - **Socialize needs, lessons learned, solutions, maturation & transition opportunities; Cop (Community of Practice)**
  - **Comprised of Stakeholders across sponsors, services, agencies, industry/small business, academia, and International**
  - **Drive prioritize needs, resource planning, future tasking, standards, education, policy & guidebook**
- Provide a focused Systems Engineering Process and Common Reference Model
  - **Enterprise solutions**
  - **Barrier and solution identification**
  - **Resource Alignment (Expertise, funding, data, schedule, transition path)**
  - **Integrated and dynamic roadmapping**
- Enhance Transition and Transformation
  - **Legacy platforms benefit from early transition opportunities**

Enhanced Transition through
a Common Approach, Awareness, and Knowledge

Strategic Objective Summary

Viable Transition with Resource Alignment



Resources:

Organizations | MANTECH | OSD | International

6.1 & 6.2 | SBIR | STTR | PEO Programs | Research | DARPA

Professional Organizations | IRAD | BAA | Other

Enhanced Transition through….

Alignment of Common Needs and Leveraging of Resources

Critical Path ID; Integrated Dynamic Roadmaps

Summary and Action

- Emerging or Legacy Programs can not effectively achieve the objective independently; Efficiency and affordably factors
- Common fundamental gaps and challenges exist across all stakeholders and value streams
- Need focused Systems Engineering process and Common Reference Model to achieve alignment of needs and resources

Leadership provide advocacy to engage and align key stakeholders

- Execute proposed strategy
- **NDIA Tasking**
  - Mature the common Reference Model and Systems Engineering process
- Forum to build the Joint Alliance
- Community of Practice (i.e. www.hmframework.org)

Common Reference Model and Framework Baseline

Detail

Common Reference Model

Business

This pillar addresses the business, program management aspects of the SE approach. Reference Cost Benefit, risk assessment, resources, data classification, verification needs, guidance, policies acquisition strategies, etc. Organizational structures; policies and acquisition strategies.

Architecture

This Pillar references the various architectures that must be understood or that may effect your solution. There are several on and off system, distribution, storage and utilization architectures. Applicable standards need to be realized.

S&T Capability

One must consider all the technologies required to achieve a transitionable solution. There may be dependencies, competing solutions, existing or leveraging solutions

Infrastructure

This pillar address the tools, labs, certification, testing required; external dependencies Implementation architectures and hosting architectures

Implementation

This pillar address the utilization, autonomics, human interface requirements, classification and security; policy changes; maturation path, transition path TRL/MRL strategy Data plans, how do you use it

System Engineering Process - Applied per Topic

Capability Needs/Gaps/ Barriers Identified Across Domains

EHM/CBM+ Top Level Vision Domain (population example only)

Business

- Models
  - Operational Case
  - Business Case
  - Cost Benefit
  - Trade-off
  - Safety/Engr trades
- Resource Alignment
- Organization
- Policies
- Data Mgt Plan
- Standards
- Requirements

Architecture

- On-Vehicle
- Off-system
- Distribution
- Software
- Utilization
- Downlink
- Recording
- Data Compression
- Throughput
- Standards/Rqts
- Data Format

S&T Capability

- Sensors
- Health State Methods
- Prognostics
- Decision Reasoning
- Enhancements to Existing

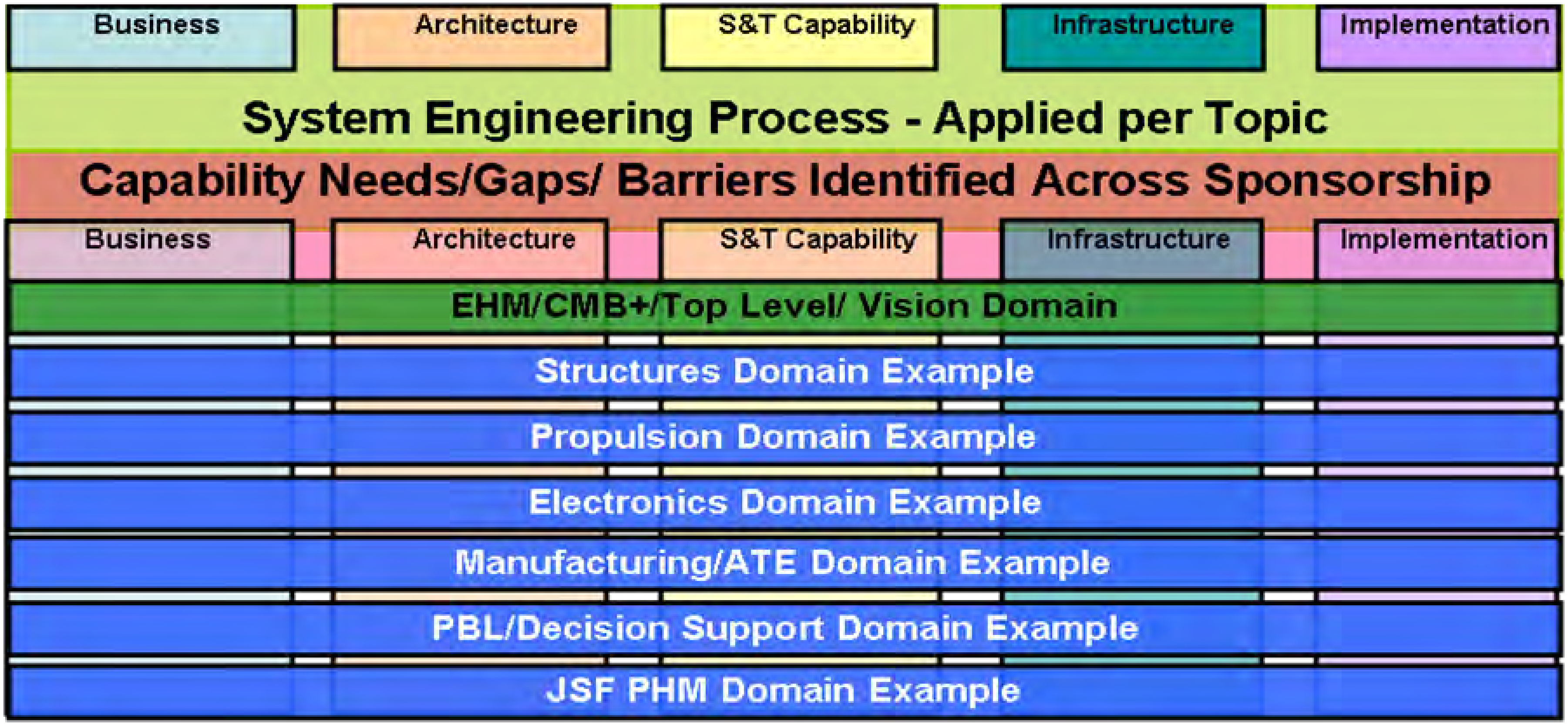
Infrastructure

- Platform Interface
- Logistics System Interface
- Ground Station Environment
- Test & Integration Toolset
- Data Mgt and Support
- ATE – Smart TPS

Implementation

- Maturation/Transition Path
- Process integration
- OPS Planning
- Tool Sets / Processes
- Tech Insertion
- Sustainment Decision Support
- Repository Solution
- Distribution
- Data update/Mgt
- Verification
- Certification

Multiple Domain Application



Model and Tools must be able to address Enterprise Level, Platform, System, Sub-system, Component, and Cross Stakeholder Utilization

Proposed Draft

NDIA Task Approach

NDIA Task Summary

The NDIA EHM Committee Task:

- **Validate and Enhance System Engineering Process (Definition and application)**
- **Evaluate and Test Common Reference Model**
  - **Test viability across Key domains (Enterprise, Platforms/Systems, and Stakeholders)**
  - **High Level EHM/CBM+ Gap/Needs Summary**
- **Conduct workshop with stakeholders**
  - **Application of "Overarching SE process" and Reference Model/Framework to specific domains (populate EHM/CBM+ Top Level Gaps)**
- **Provide a Task Final Report with Recommendations**
- **Products: Report; SE process Definitions for use; SE Recommendations; 1st Generation gaps towards achieving CBM+/EHM; High level gap/solution set and recommendations**

NDIA Task 1 Milestones

- Form Core Task Group – Jul/Aug 08
- Define Draft Tasking/Workshop – Aug 08
- Task meeting (Telecon/Virtual) – Sep 08
- Task meeting @ NDIA HQ – 1 Oct 08
- **Task meeting (Telecon/Virtual) – Early Nov 08**
- **Task meeting @ NDIA HQ – Early Dec 08**

- **Conduct Workshop – 28 - 30 Jan 09**
  - **New Orleans, LA**

NDIA Task 1 – Workshop agenda

- **NDIA Workshop**
  - **Jan 28 –30 2009**
  - **2-1/2 day event**
  - **New Orleans Sheraton**

Day 1	
0800	Welcome and Introductions
0830	NDIA task description •Executive Summary •Workshop Goals •Workshop product definition •Order of play •Logistics (facility) •Terms of Reference (What is EHM)
0900	"OSD vision" to which NDIA will contribute within this workshop
	Break
1030	Current State of DoD and Industry (presentations)
1030	•Policy
1200	Lunch
1300	•Program Perspective (emerging/legacy platform)
1430	Break
1500	•Top Level Stakeholder Visions (USAF/USN/USMC/NASA)
1630	Summary results of Day 1

NDIA Task 1 – Workshop agenda (Cont'd)

Day 2

0830 Review of day 1
- Refocus on WS goals and Products

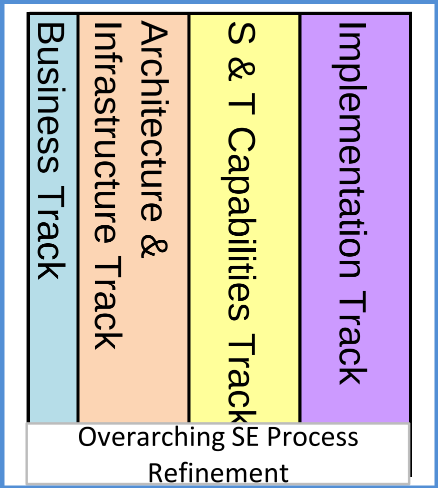
0900 Strawman EHM SE process description
- •Test Case overview
- •Q&A

1030 Break

1100 Breakout Sessions Introduction
- Discuss goals, test case(s), results & formats

1200 Lunch

1300 Breakout Sessions

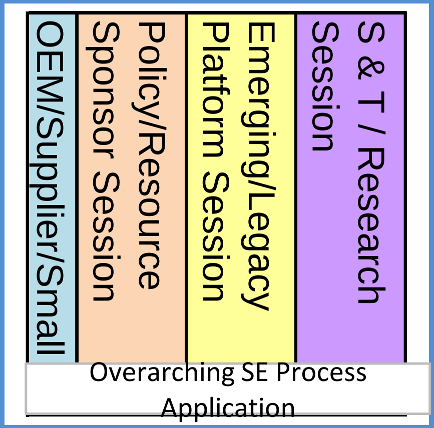


1600 Session Chair Outbrief

Day 3

0800 Breakout instructions / goals/ output def

0830 Breakout Sessions



1130 Lunch

1300 Wrap up
- Workshop Key outputs
- Action Items
- Final Report outline
- Schedule of remaining activities

1400 Conclude Workshop

Strategic Tasks - Not Covered by NDIA Task 1

….but will be covered under follow-on/separate venue

- Alliance Organization
- Tool Demonstrations
- Integrated Domain Application
- Policy Changes/Guidebook
- Defined Standards
- Resource Recommendations

Questions?

Prognostics Based Health Assessment System Approaches

Presented to:
National Defense Industrial Association
11th Annual Systems Engineering Conference
San Diego, California

Ron Newman
Director, Systems Engineering
Diagnostic and Prognostic Products and Services
VSE Corporation

October 23, 2008

VSE CORPORATION

VSE Corporate Overview

- Established in 1959
- Public company (NASDAQ:VSEC)
- Headquartered in Alexandria, Virginia
- ISO 9001:2000 registered
- Provides worldwide support through diversified engineering, technical, logistics, management, and information technology services to maintain and modernize equipment and systems
- Principal clients are agencies of the U.S. Government and other government prime contractors

Prognostics? What is That?

- Prognostics is an engineering discipline focused on predicting the future condition of a component and/or system of components.
- In most cases, prognostic approaches are based on the analysis of failure modes, detection of early signs of wear, and correlation of these signs with an aging profile (or model).
- Technical approaches to prognostics can be categorized broadly into reliability driven and conditioned based approaches.
- The VSE approach to Prognostics Based Health Assessment incorporates both reliability and condition based methodologies.

An Example of VSE's Prognostics Based Health Assessment Systems

- **F/A-18 Automated Maintenance Environment**
  - **Integration of system maintenance resources and configuration data and into an integrated system**
    - **Diagnostics •Prognostics • Health Management**
    - **Operator Debrief**
    - **IETMs**
    - **Life Usage Tracking**
    - **Asset • Configuration Management / Serial Number Tracking**
    - **Interfaces to Supply Chain and Maintenance Management Systems**

VSE AME Concept

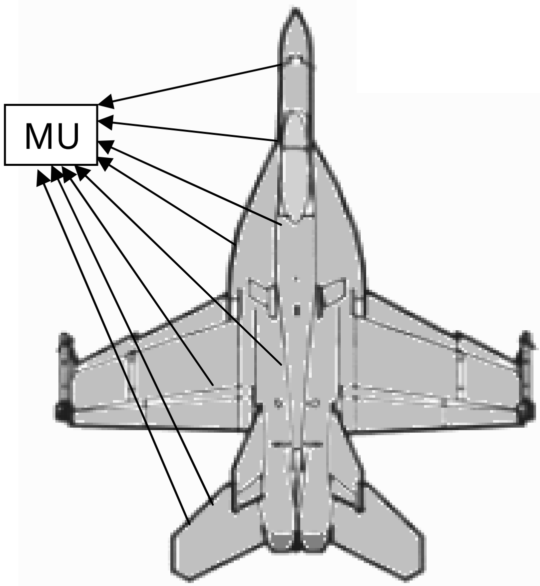
- AME is first instance of a geographically distributed information system that...
  - Supports strategic maintenance planning at
    - Headquarters
    - Each support level
    - Front line tactical maintenance operations
- Open system integrating framework
  - Software backplane that uniquely supports maintenance workflow and the Application Programming Interfaces (APIs) for plug-and-play software
  - Enables continuous use of “best of breed” COTS components
- Generalized APIs that are not system-specific

F/A-18 Sensors & Built-in Test (BIT) Provide Foundation

Each individual sub-system has it own diagnostics, BIT or health monitoring capability.

BIT is fully integrated digitally via the primary data bus.

The BIT data is recorded and stored. Data is available by a removable memory storage unit.



Mechanical, Pneumatics, Hydraulic, Engines, Structure, & Environment Systems are monitored via analog sensors.

The analog signals are converted to digital and used to verify, monitor, control and ensure optimum system performance.

All BIT, Go/No-Go, and self test data is transmitted via the data bus and recorded to the removable memory unit.

AME Work Flow

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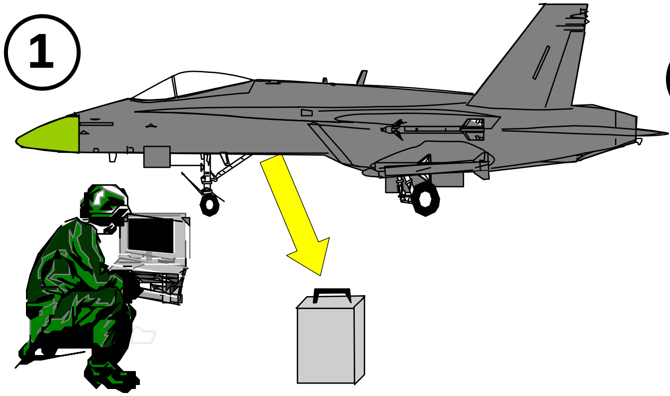
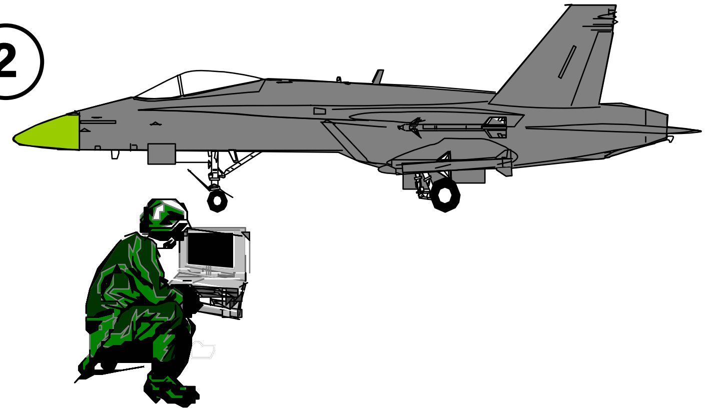
1



Pilot initiates data stripping.

2

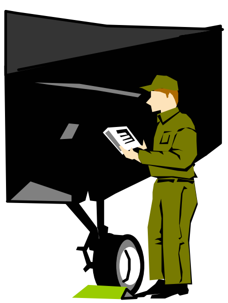


Pilot performs debrief.

3

Work Center Supervisor assign tasks.

4



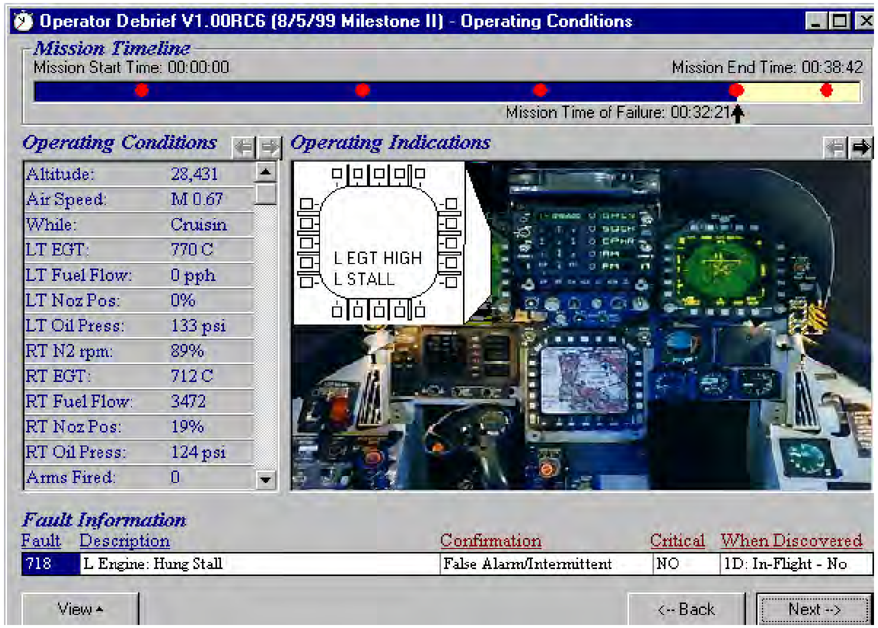
Technician performs repair procedure using IETM.

5

Materiel Control transfers item to Supply / I-level

Debrief Logs any Additional Discrepancies

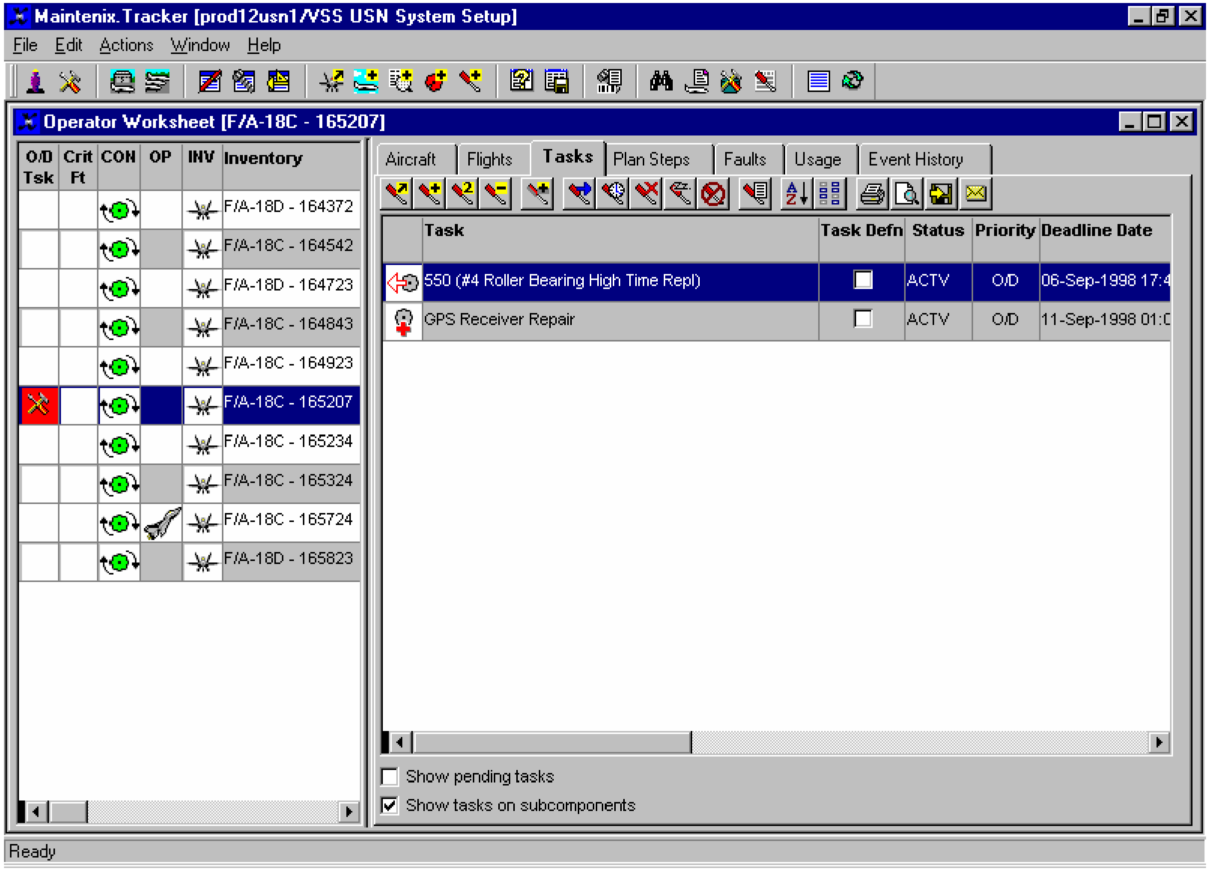
- The pilot reviews the faults identified by the expert system and adds any other discrepancies



- Maintenance tasks are passed to Maintenance Management Database

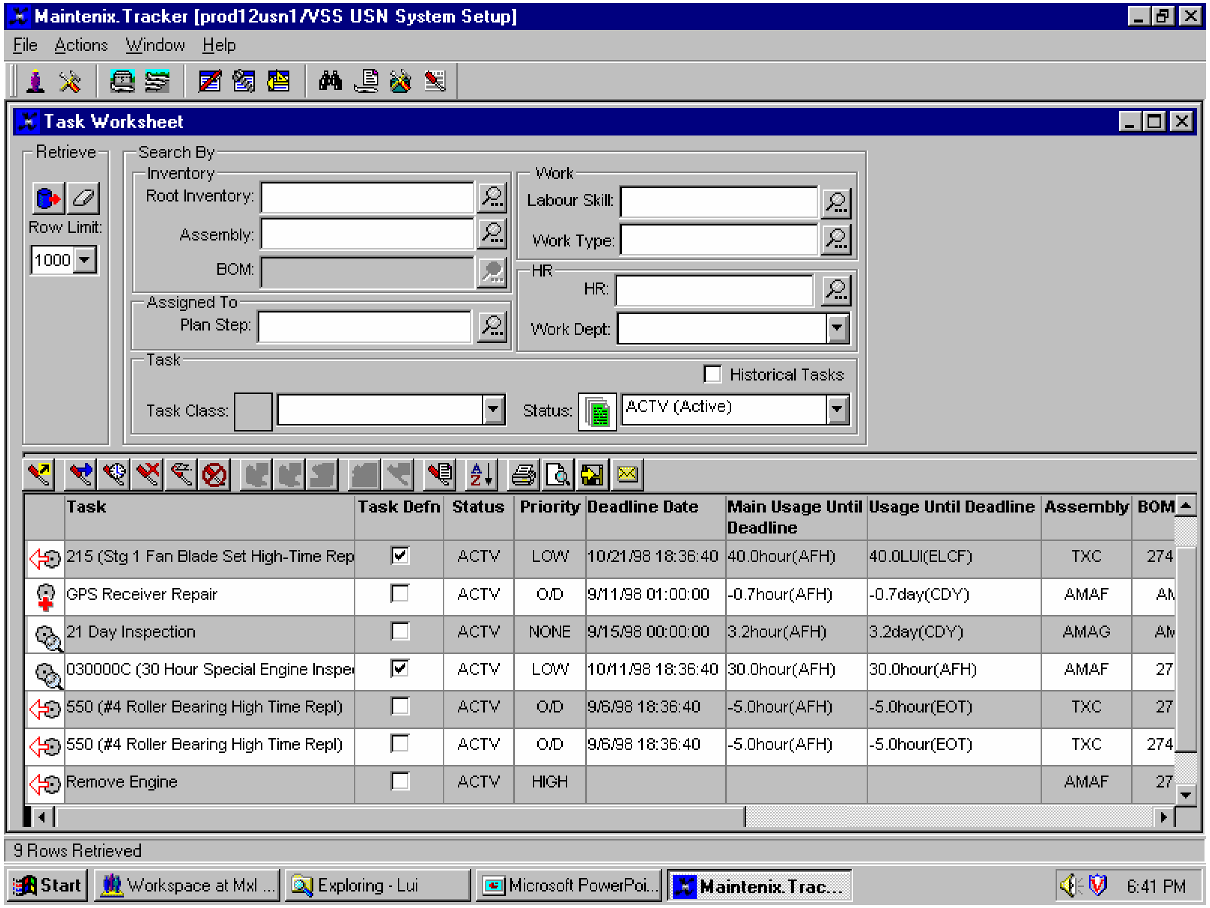
Maintenance Alerted to Aircraft Caution

- The aircraft is shown with overdue tasks
- The maintenance tasks are shown
  - Debrief task is to repair GPS receiver *(Condition Based)*
  - The LUI increase has caused an engine turbine to go 'high-time', requiring an engine removal *(Reliability Based)*



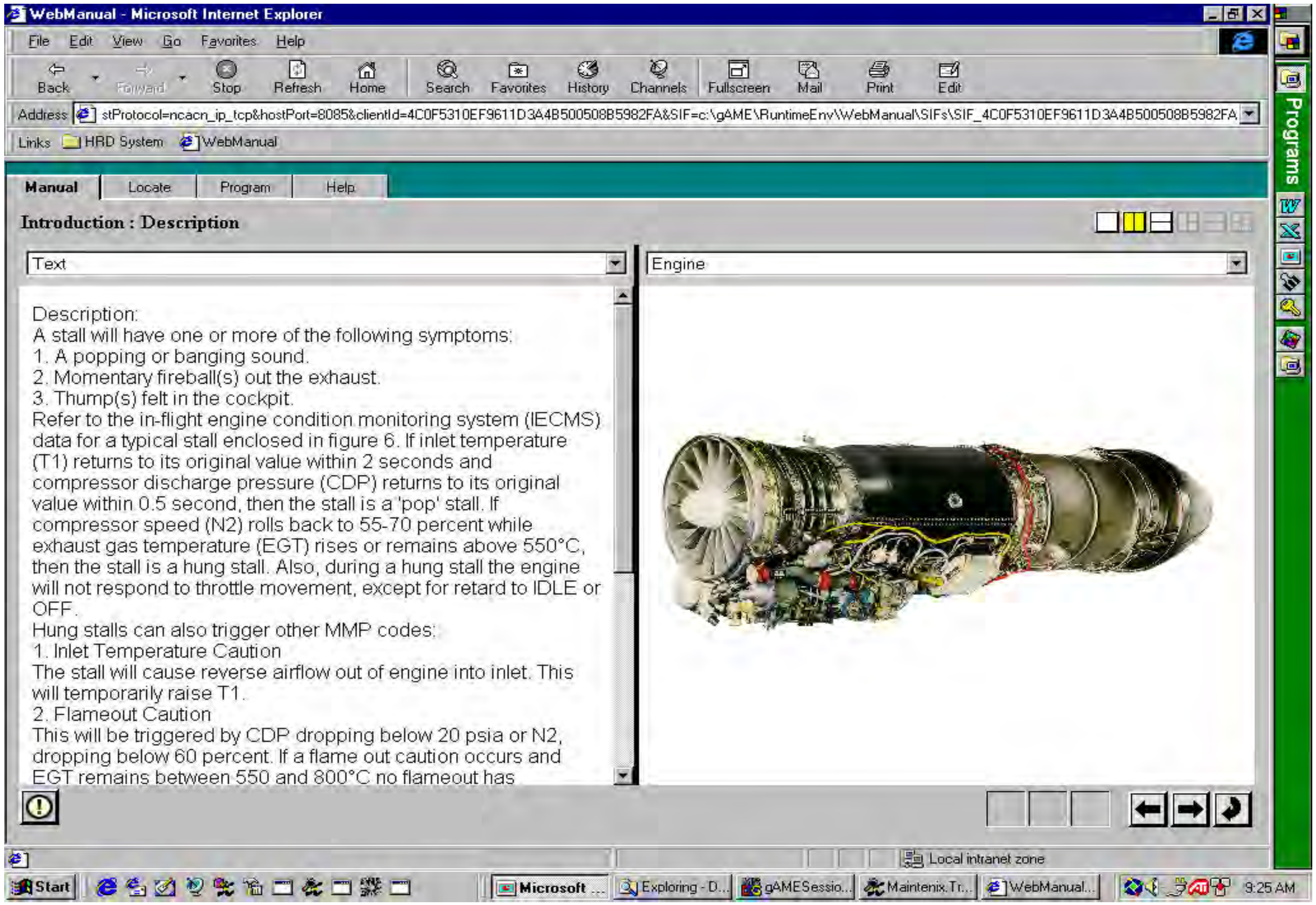
Identify Maintenance Tasks

- System shows all upcoming work for the squadron to Maintenance Control
  - Work can be sorted to facilitate planning
- Maintenance Control initiates maintenance actions based on the identified tasks



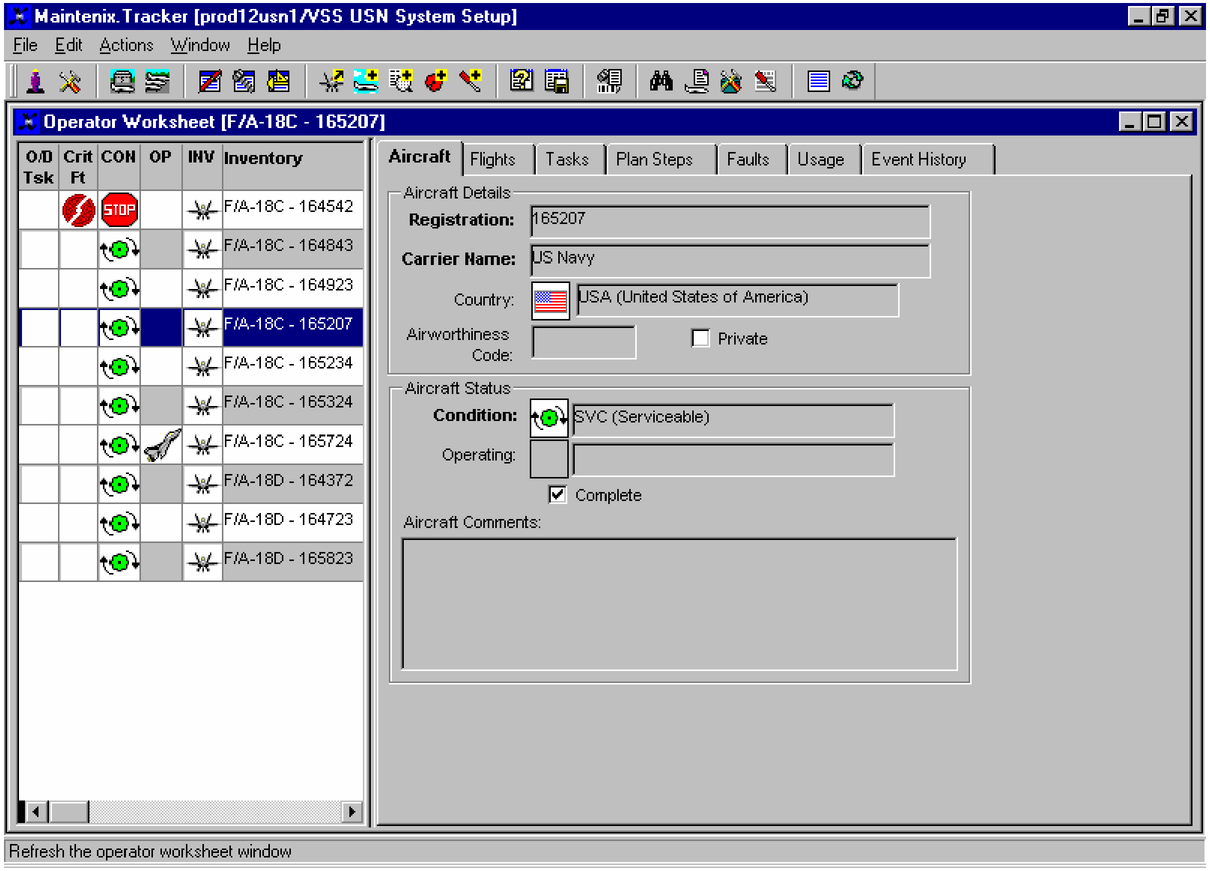
Execute Maintenance Tasks

- The maintainer takes the PEDD/PMA out to the aircraft and uses the IETMs while executing the maintenance tasks



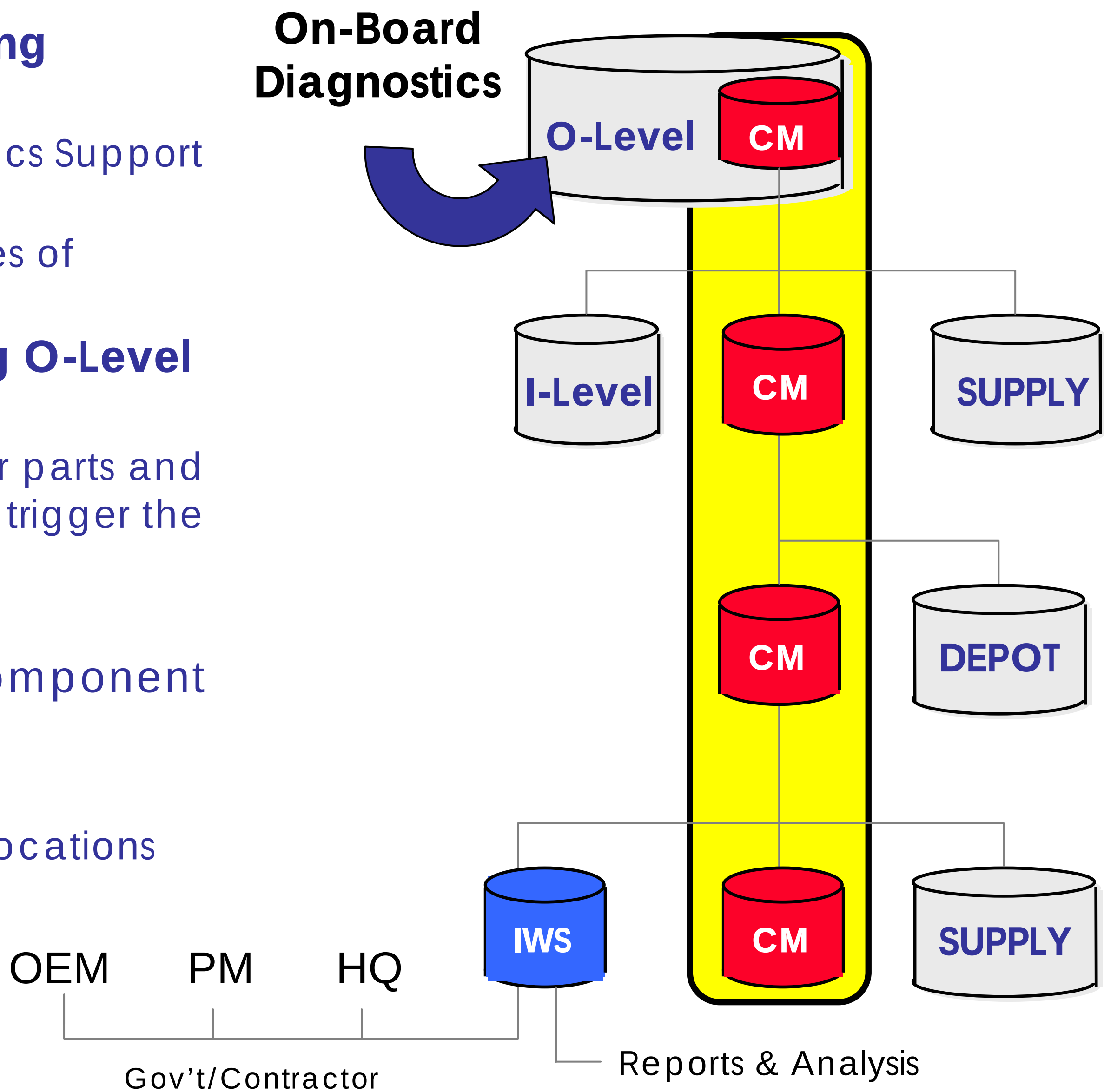
Aircraft Status is updated

- The PEDD/PMA upload installed the new engine in the aircraft logset
- The Status Board now shows the aircraft as ready to fly



AME Vertical Integration

- **Integrated environment linking maintenance and OEMs**
  - Accurate feedback to Logistics Support re: fleet status
  - Rapid and accurate deliveries of Maintenance Plan updates
- **Total Asset Visibility including O-Level activities**
  - PM can 'see' the demand for parts and other resources and properly trigger the Supply Chain
- **Modular components**
  - Can rapidly install on a component by component basis
- **Deployable**
  - Can fully operate in remote locations with no operational impact
  - 24/7 Global User Support

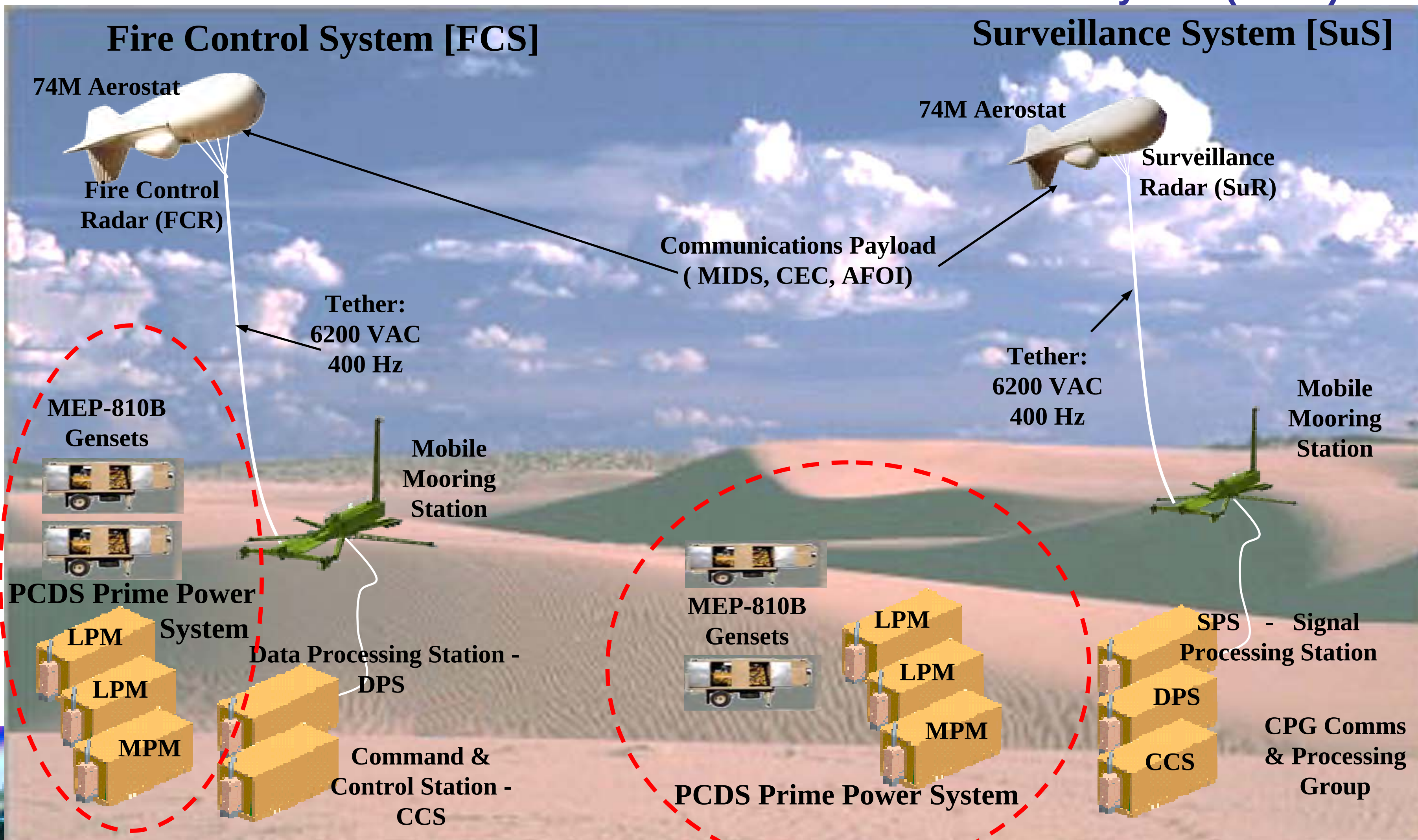


AME Benefits

- **Increased Operational Availability**
  - IT-related improvements have increased F/A-18 Readiness by 8%
  - Significantly improved understanding of current status
  - Improved maintenance efficiency via comprehensive and accurate diagnostics
  - Ability to capture and use status information for maintenance and supply actions
  - Improved supply chain management based on knowledge of in-field demand for resources
  - Provides timely & accurate data for logistics analysis
- **At Reduced Cost**
  - More than $1B cost savings over the past decade
  - More efficient maintenance labor execution
  - Improved asset utilization
  - Significantly fewer good or unknown items floating through supply

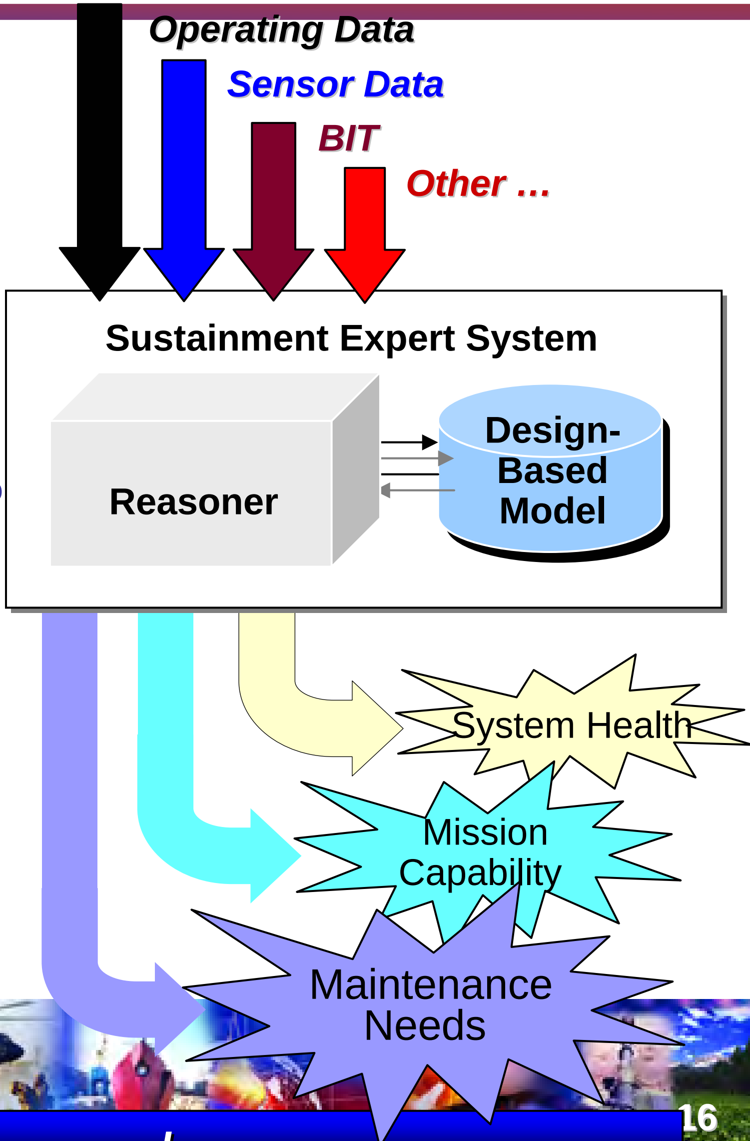
Another Example of VSE's Prognostics Based Health Assessment Systems

Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS)



Prognostics Framework Reasoning

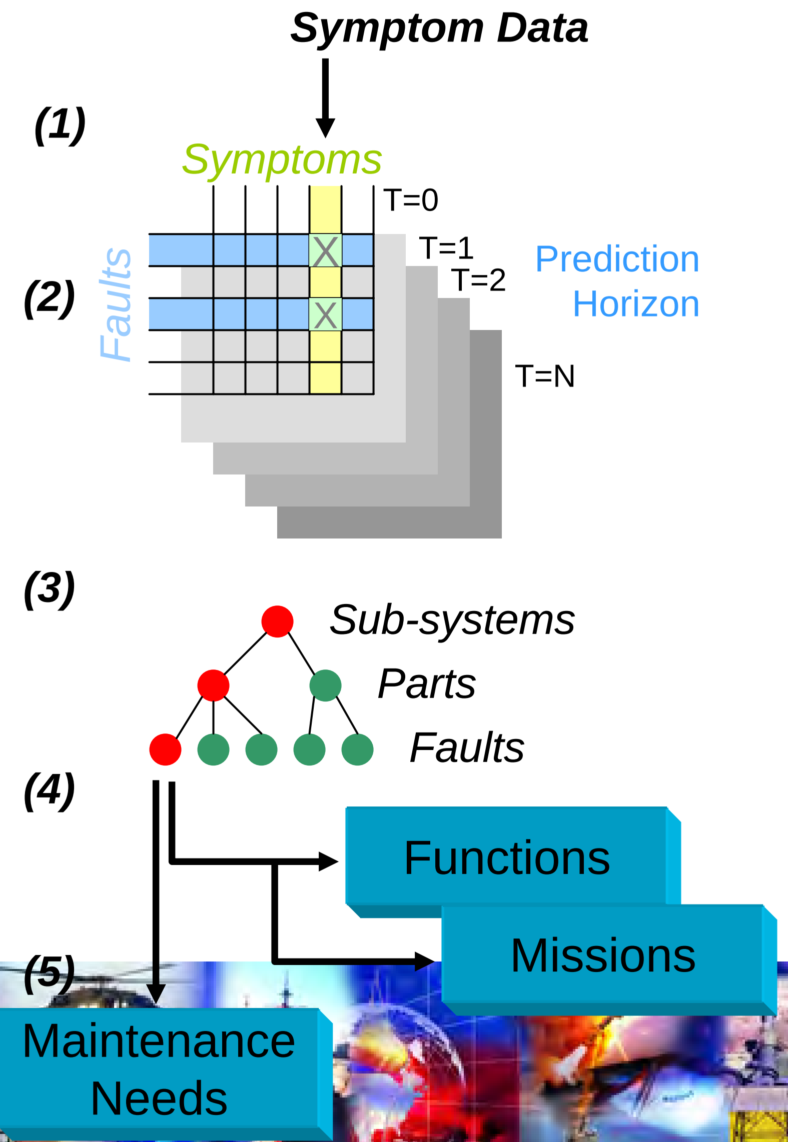
- **Expert System using Model-Based Reasoning**
  - Uses design-based model for diagnostics/prognostics
  - Is deterministic model using "first principles" of design
  - Reasons by dynamically interpreting the inference of data
  - Reads streams of data from variety of sources
  - ☑ Interprets sensors, built-in test and operational data; to assess system health, predict, detect and isolate faults
  - ☑ Results in health monitoring, diagnostics ***and*** prognostics
  - ☑ Can be embedded (on-line, real-time) or off-line
  - ☑ Can be used on existing or new systems
  - ☑ Replaces traditional fault/logic tree



An Information Driven Approach

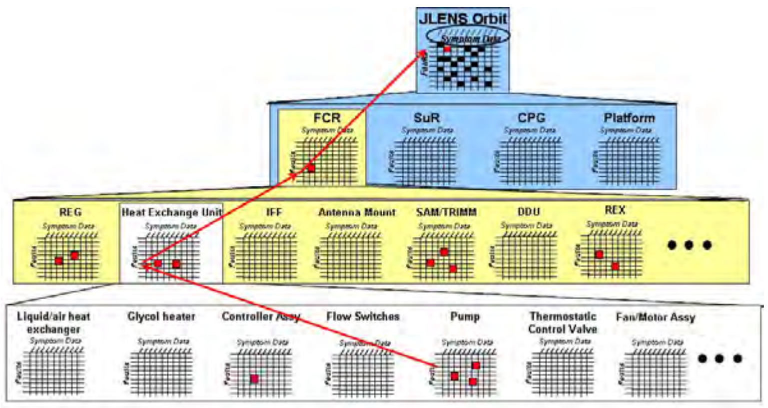
Achieving Design-Base Comprehension

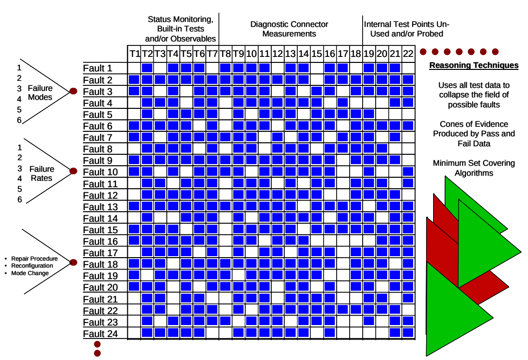
1. **Accept operational data, sensor, BIT and parametric data as symptoms**
2. **Apply reasoning algorithms to predict & diagnose the implication of out of tolerance symptoms on each future time point defined in the model**
3. **Identify the components and sub-systems affected by predicted failures - sub-system health**
4. **Identify the functions and missions affected by predicted failures - mission readiness**
5. **Identify the repair actions needed - anticipatory maintenance**

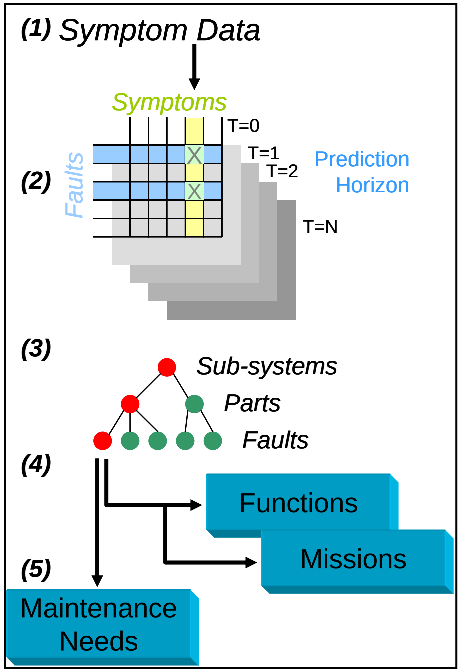


Diagnostic/Prognostic Reasoning

- **Build a System Model to reflect system hierarchy**
- **Map fault propagation and test coverage in a Fault/Symptom matrix**
- **Correlate actual test data with faults across system hierarchy *(Intelligent Reasoner)***







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System Model Scope

DESIGN DATA

- Definition of Parts, Faults, Failure Modes, Failure Rates, Tests, Interconnectivity and Test Coverage

SYSTEM DATA MANAGEMENT

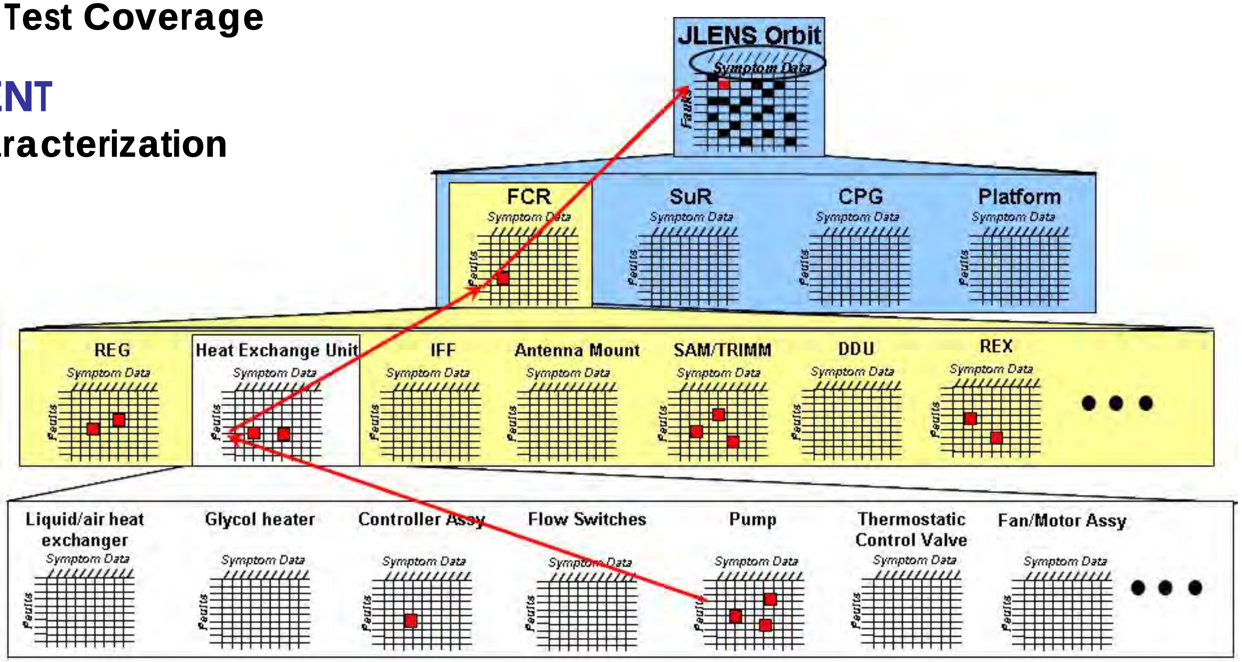
- Input Data Definition & Characterization
- Prediction Horizons

TEST/SENSOR DATA

- BIT Inputs & Mapping
- Sensor Data & Mapping

HEALTH MANAGEMENT

- Detection Algorithms
- Diagnostic Coverage
- System Stress Factors
- Prediction Algorithms
- Fault Criticality
- Input Data Processing & Filtering
- Confidence Factors



MISSION SUPPORT

- Mission Profile
- Function Correlation to Mission Phases
- Function Criticality to Mission
- Immediate Operator Actions

MAINTENANCE SUPPORT

- Repair Item Definition
- Combinations of Repair Items
- Repair Actions (IETM Interface)
- Parts Ordering Data
- PMCS Triggering and Tracking

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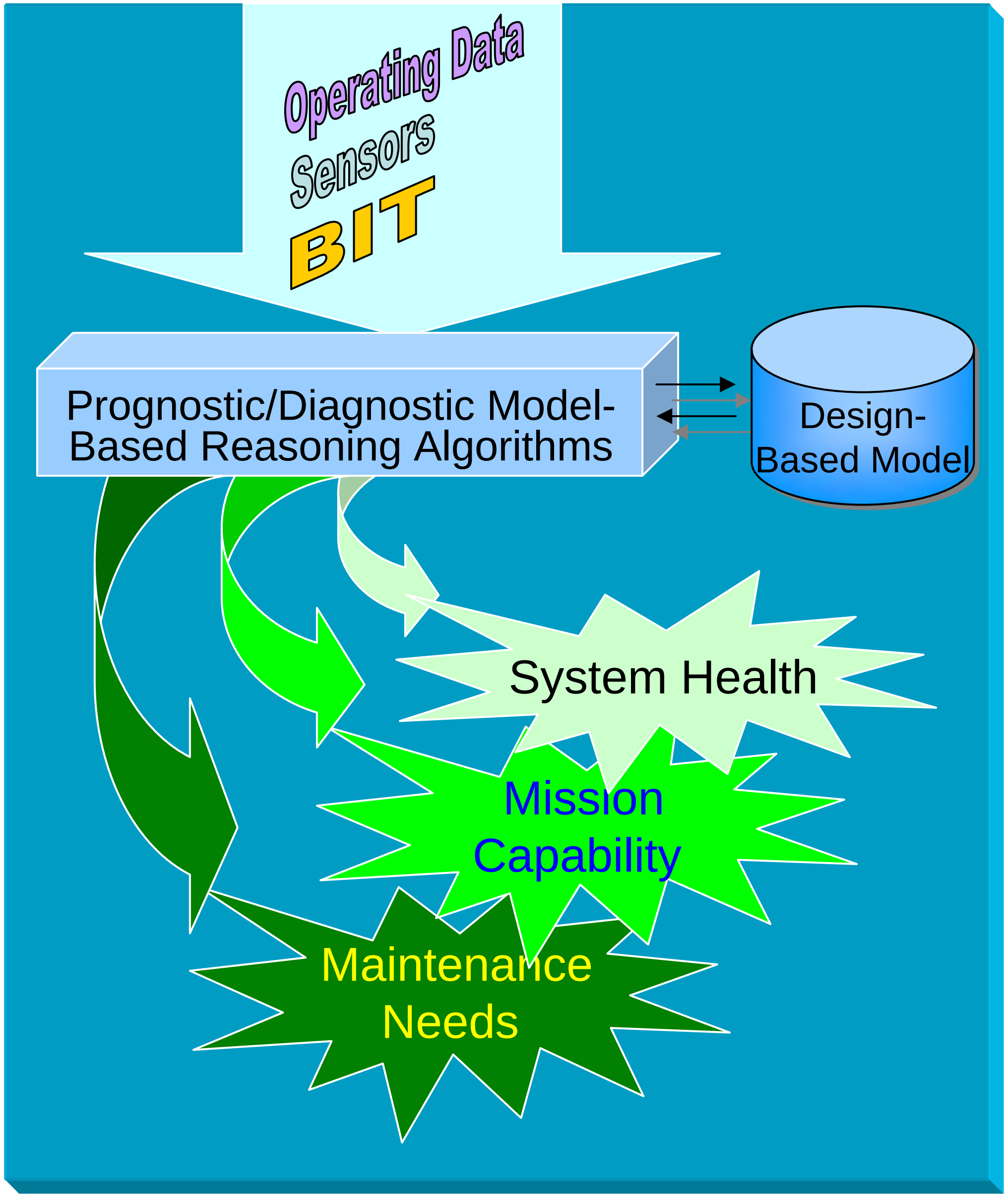
Diagnostic/Prognostic Reasoning

- Model-based reasoner maximizes the information gained from sensors and built-in test
- Diagnostic / Prognostic Reasoner
  - Identifies stress and wear factors
  - Detects and interprets anomalies
  - Determines mission capability
  - Serial Number Tracking - Determines remaining useful life of each item
  - Performs condition-based prognostics



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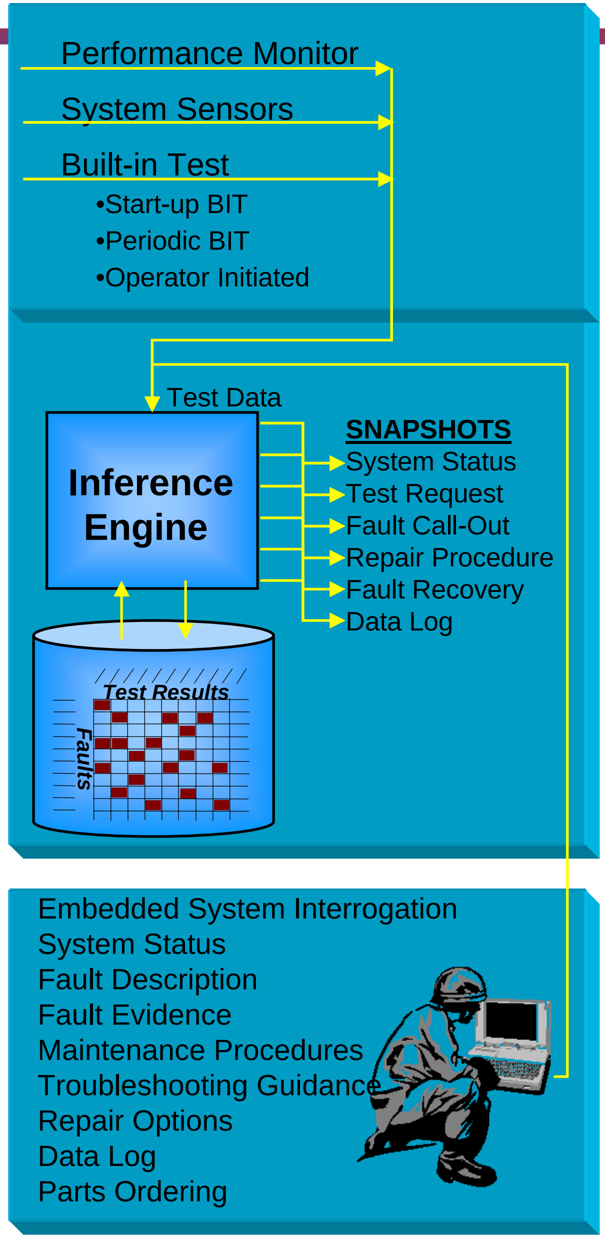
"Dynamic" Diagnostic Capability

- **Test Results can be input**
  - **... in any order**
    - no pre-set sequence
  - **... from any source**
    - operator observations, test instruments, data bus, data file, built-in test, automatic test equipment, system panels & displays, etc.
  - **... as many as test source(s) can provide**
    - not restricted to one-at-a-time to traverse fault tree
    - zeroes-in on cause of fault(s)

- **Can identify multiple faults**
  - ... Diagnostic trees follow single-fault assumption

- **Will always zero in on fault**
  - ... Never leaves the technician hanging

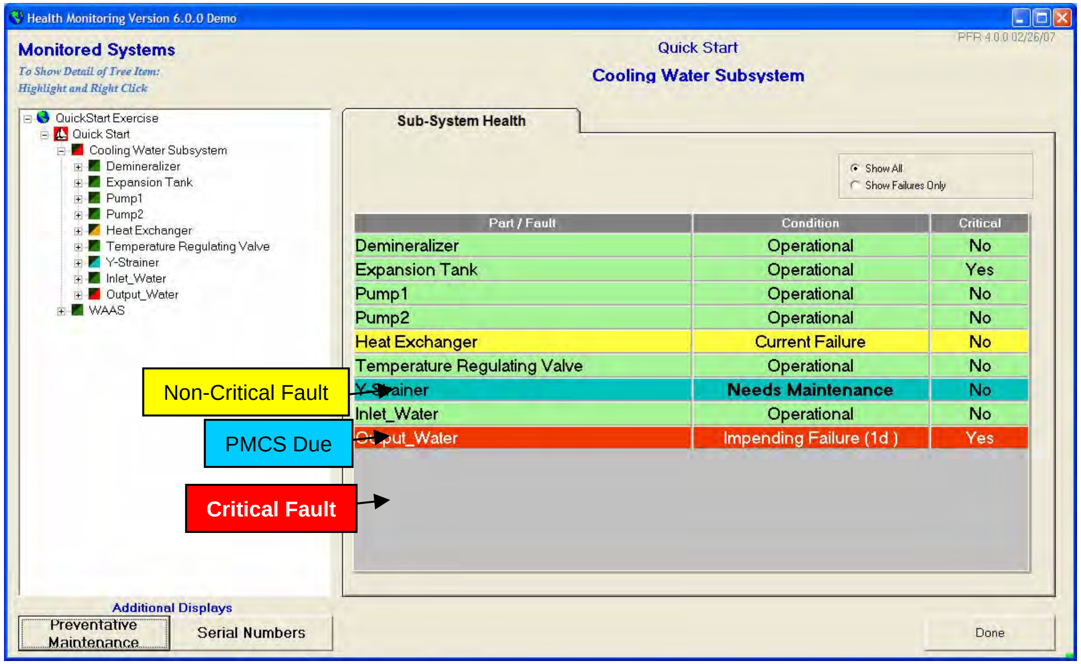
- **Only requests tests of diagnostic significance**
  - ... Based upon snapshot of current fault possibilities



Prognostics Based Health Assessment Functionality

- **Integrates diagnostic/prognostic results into a Health Management System**

- **Makes maximum use of existing Sensor/BIT data**
- **Provides Prognostics Analysis/Reasoning**
  - Degradation of signals/measurements over time
  - Depletion of consumable items
  - Accumulates wear factors
  - Engineering correlations
  - Tracks preventive maintenance based on time/wear/use
  - Serial number tracking
  - Remaining Useful Life



- **Allows for integration of 3rd party prediction techniques**

- **Compiles, interprets and displays trend data**

- **Creates multiple log files**

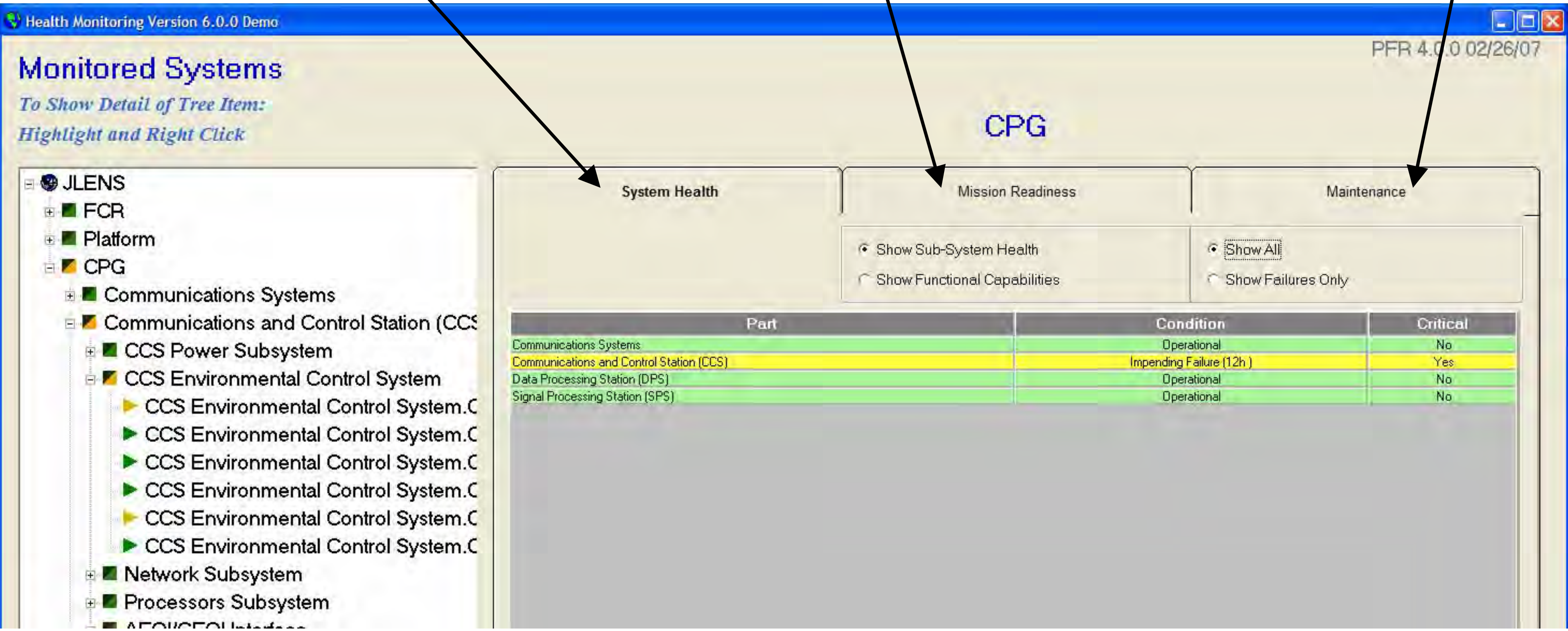
- **Links to maintenance systems (IETM, PMCS, Supply) based on specific fault**

3 Views into Health Data

Operator – Am I OK? If not, why not? What do I do?

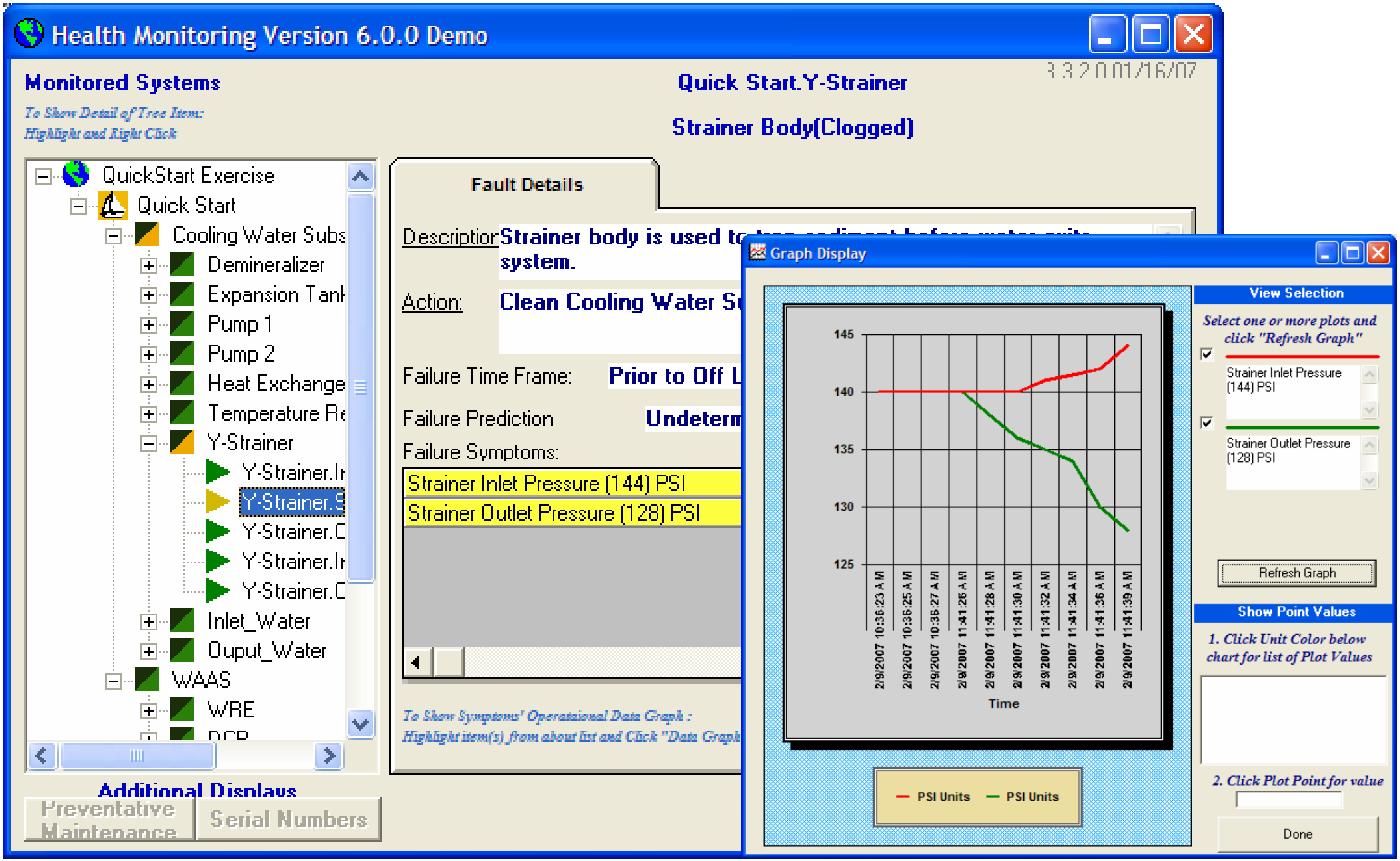
Mission Commander – Will this system make it through mission without failure? Which of my systems will make it through the mission?

Maintainer – What repairs need to be made? What spares do I need to make the repairs? What are the repair procedures? What PMCS is currently due?



Operator View - Real-Time Status Monitoring & Health Assessment

- **Drill down the hierarchical model to get the level of detail desired.**



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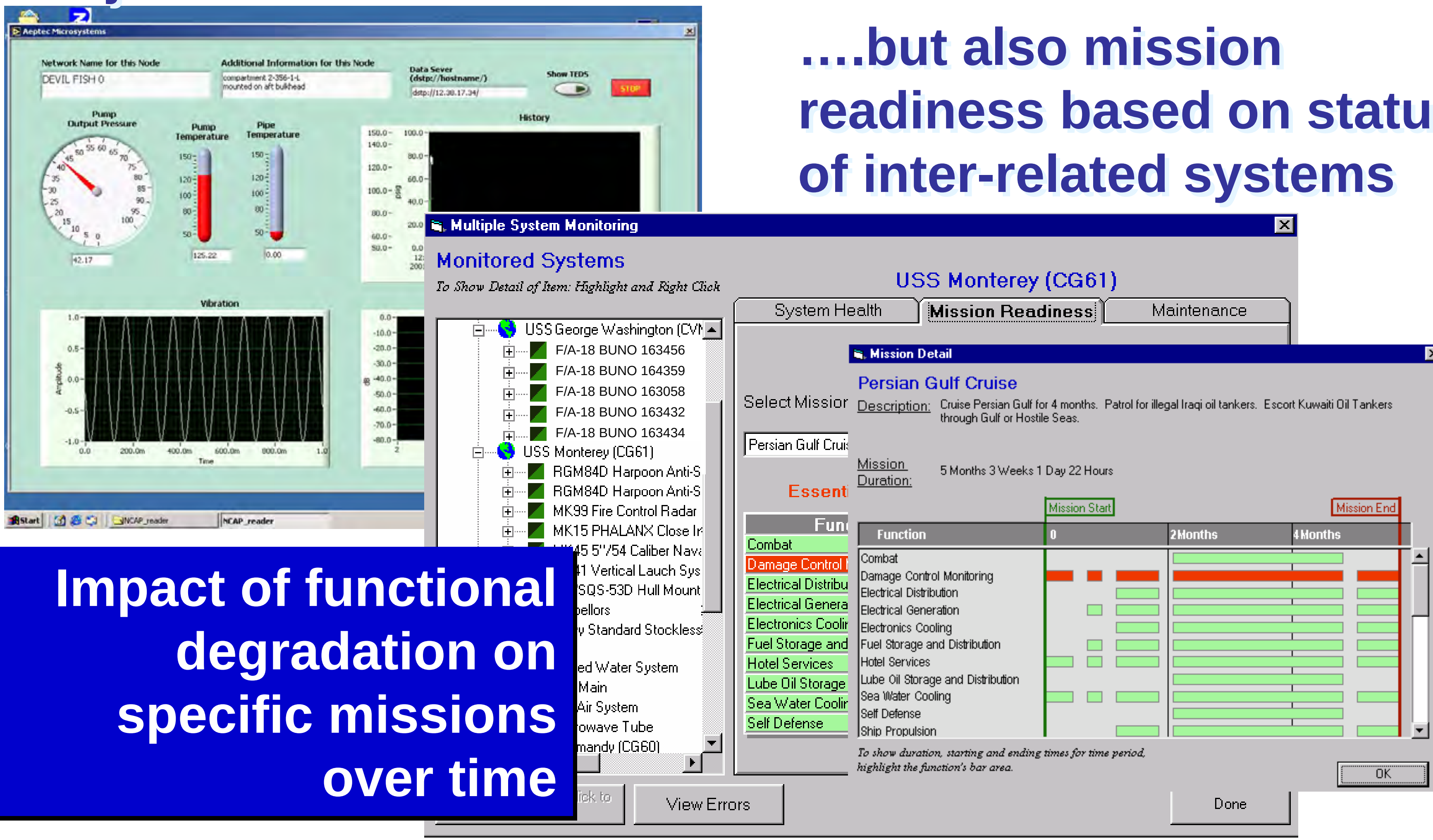
Mission Commander View

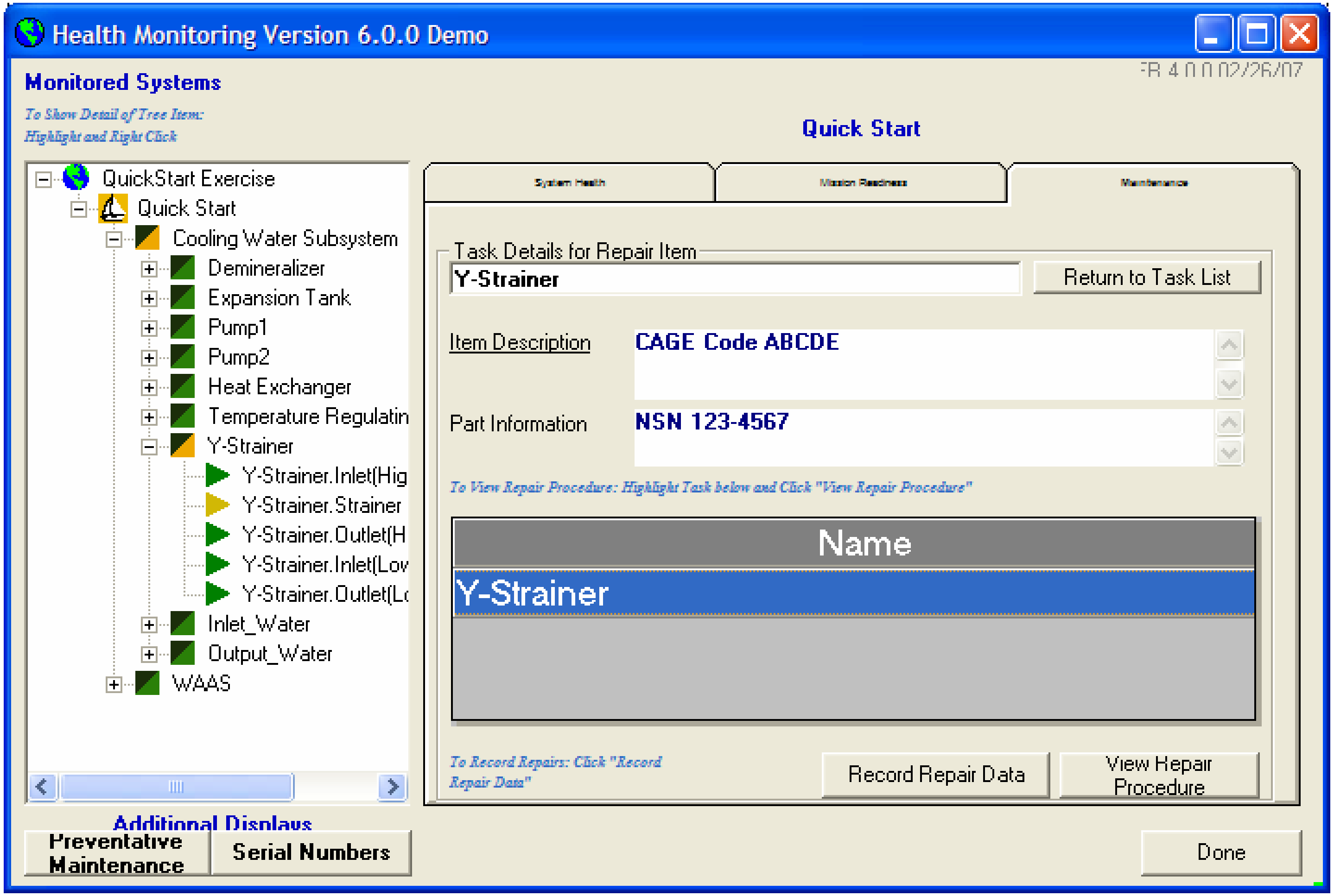
Not just sensor data…..

….but also mission readiness based on status of inter-related systems

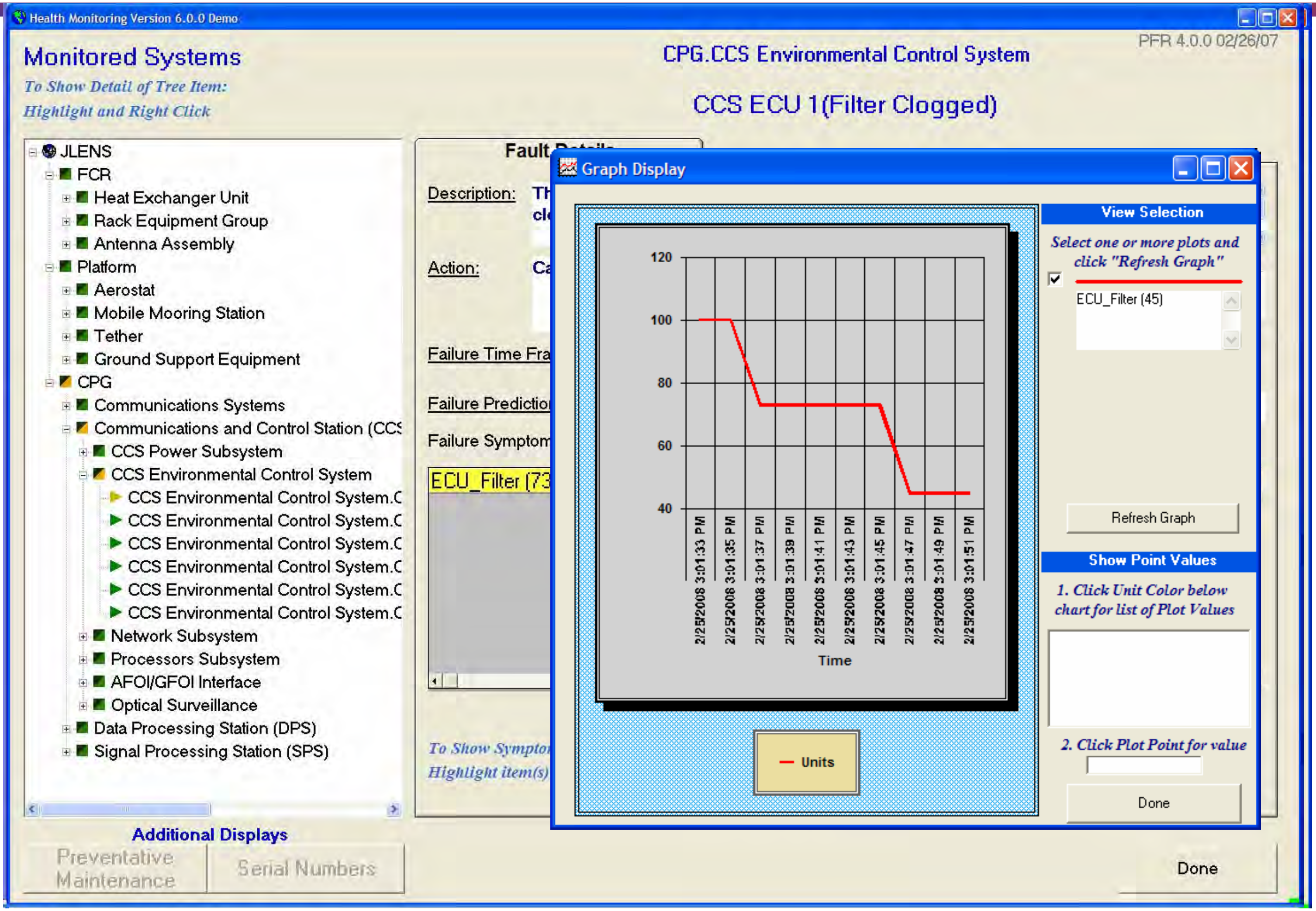


Impact of functional degradation on specific missions over time

Maintainer View



System Capability (SYSCAP)



•SYSCAP displays system status based on the hierarchical breakout of the system:

- System
- Prime Item
- Critical Item
- LRU
- Fault
- Failure Mode

•At each level, appropriate information is displayed.

•Operator can drill-down to investigate health

HMS displays and interaction were demonstrated at Early User Assessment in March 2008

Additional Features

- Preventive Maintenance
- Maintenance and repair procedures linked to fault enunciation
  - Model can launch IETM to specific repair procedure for fault
- Serial Number Tracking
- Interface to Parts Ordering
- Data Logging
- Validate Sensor Data
  - Missing or invalid data
  - Valid sensor ranges

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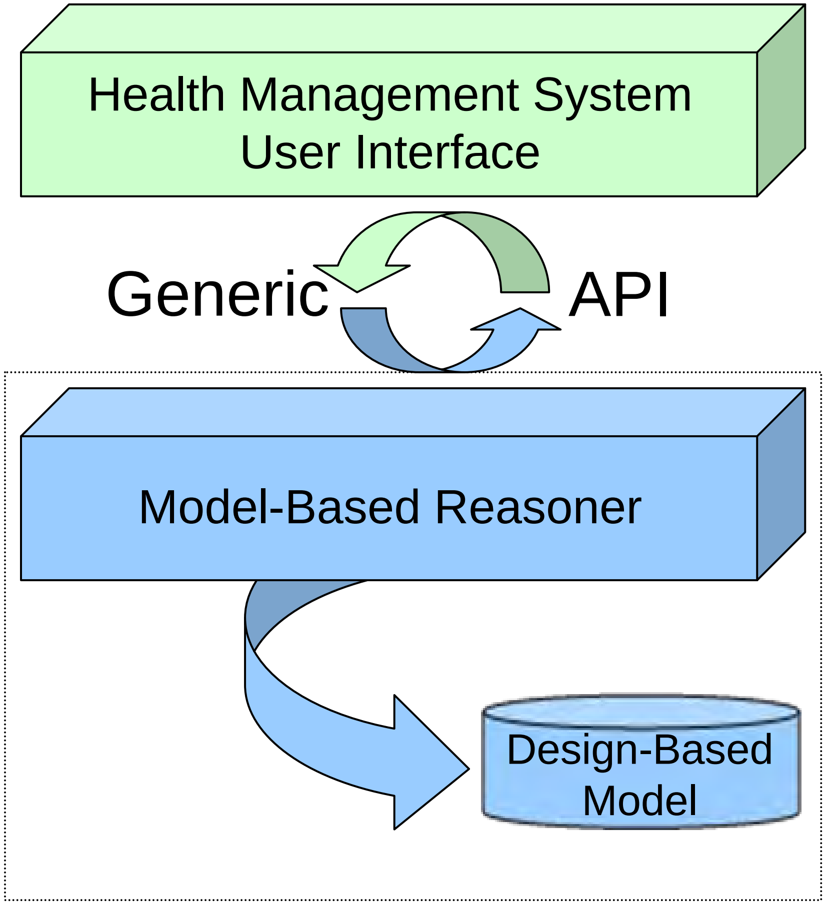
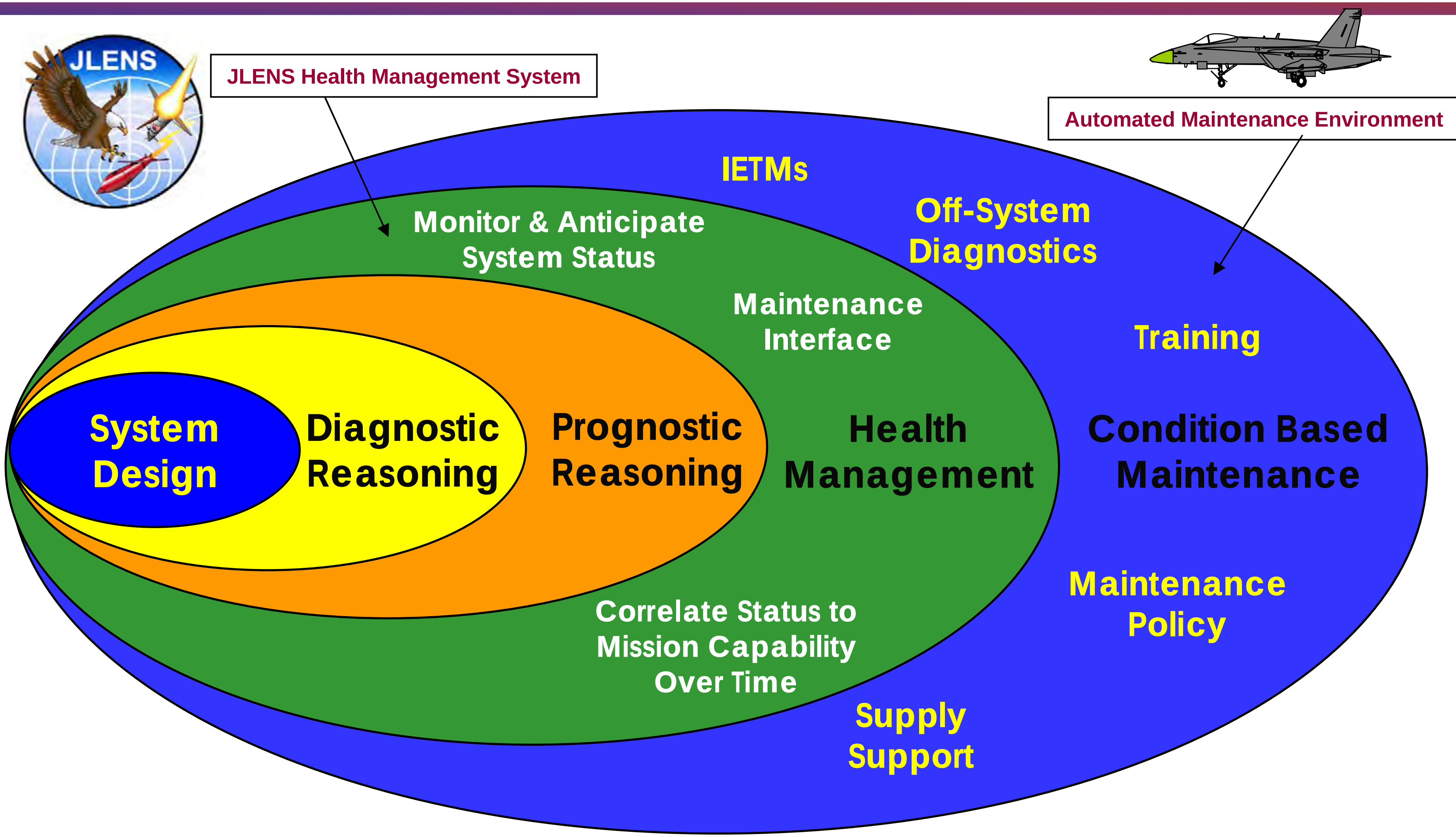
Software Architecture of the Health Management System

- Run-Time Software designed for embedded applications
- C Code that can be cross-compiled to any platform
- Implementation Strategy:
  - Centralized
  - Distributed
  - Hierarchical
- Software functions serve as building blocks
  - Integrate building blocks to build desired functionality
  - Design User Interface as desired or use existing
  - Well-documented API



Layers of CBM +



Design-Based Comprehension of System Condition is the Most Fundamental Enabler of CBM+

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Other VSE Diagnostics/Prognostics Based Programs

- Navy SPS-48E Radar
- C-130 Gunship
- A-10/KC-135 Turbine Engine Monitoring System
- Kiowa Warrior Mast Mounted Sight
- Seawolf Ship Control System
- Avitronics Radar Warning Receiver
- NASA Remote Power Controller
- F-16 Universal Data Acquisition System
- Navy Total Ship Monitoring (TSM) Program
- Navy Battle Group Automated Maintenance Environment Program
- FAA Wide Area Augmentation System

VSE Capabilities: Total Implementation Support

- Tailorable to any platform or system
- VSE has the capability and experience to bring all of the resources together to forge a PRACTICAL, EXPEDIENT and, COST EFFECTIVE solution:
  - Requirements Analysis/Implementation Strategy
  - Integration & Middleware
  - Legacy Data Capture
  - Development of System Diagnostic/Prognostic Models
  - Installation & Fielding
  - Training
  - Fleet Support Team

VSE CORPORATION

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Enhanced Systems Engineering - Starting Programs Right

NDIA 11th Annual Systems Engineering Conference

October 23, 2008

Ceasar D. Sharper
Systems and Software Engineering/Enterprise Development
Office of the Deputy Under Secretary of Defense
(Acquisition & Technology)

Outline

Enhanced Systems Engineering (SE)

- SE Context: Background / Framework
- Early SE: "… right activities at the right time …"
  - Materiel Solution Analysis Phase
  - Technology Development Phase
- Emphasis on SE ".. the right time in the right way"
  - Competitive Prototyping
  - SE Design Consideration - Reliability, Availability, and Maintainability
  - Preliminary Design Review (PDR)

"Implementing the right activities at the right time in the right way"

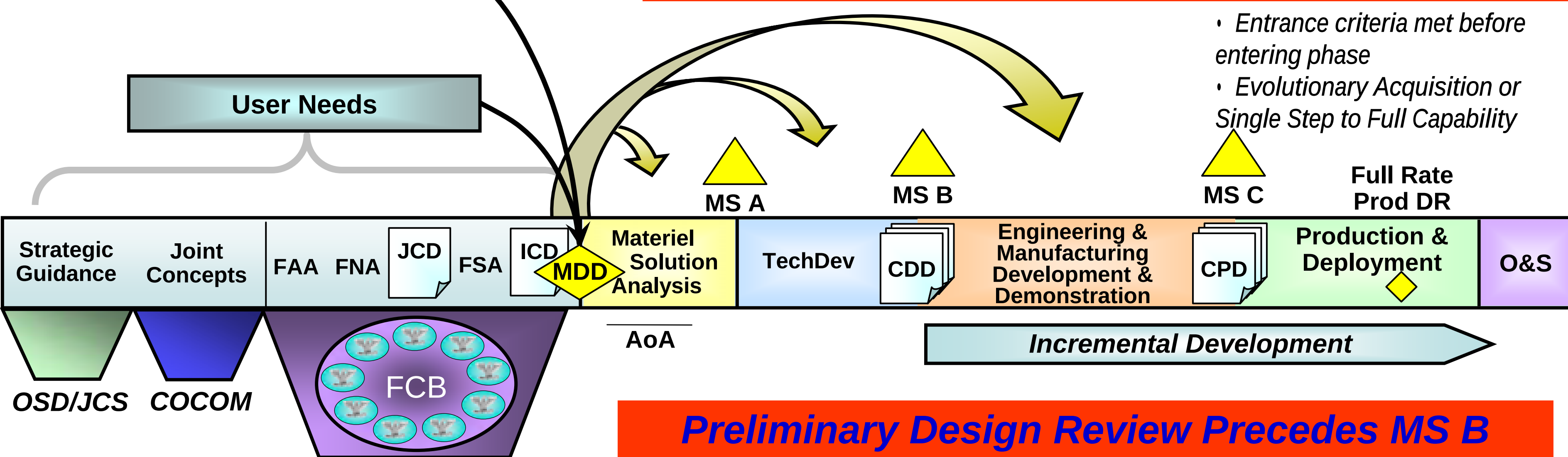
Background
Program Roles & Activities

	Project Manager	Systems Engineer
Stakeholder Management	Primary	Support
Planning	Primary	Support
Cost Management	Primary	Support
Schedule Management	Primary	Support
Configuration Management	Primary	Support
Contract Management	Primary	Support
Concept Selection	Shared	Shared
Architecture Development	Support	Primary
Requirements Baseline	Support	Primary
Technical Risk Management	Support	Primary
Interface Control	Support	Primary
Integration	Support	Primary
Verification	Support	Primary
Validation	Shared	Shared

"Proposed DoDI 5000.02 Changes" Framework for Enhanced SE

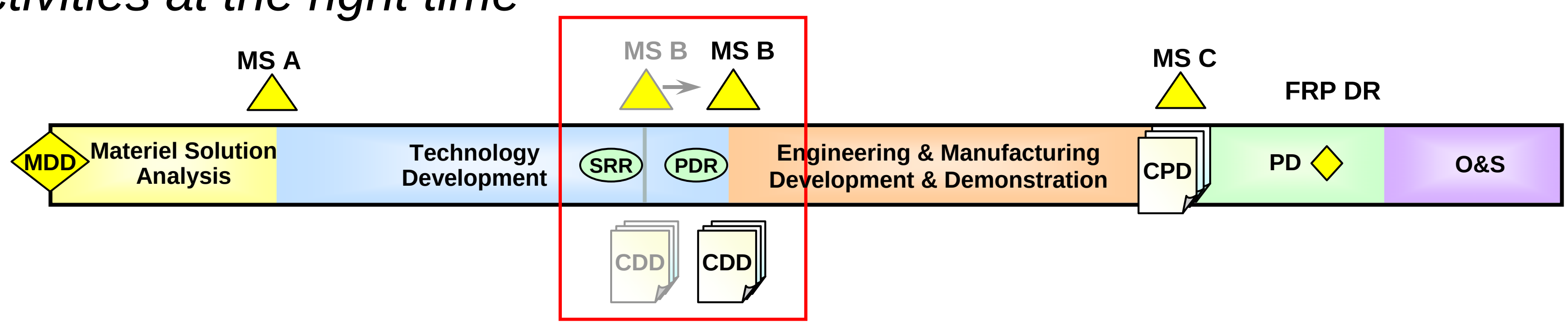
Materiel Development Decision precedes entry into any phase of the acquisition system

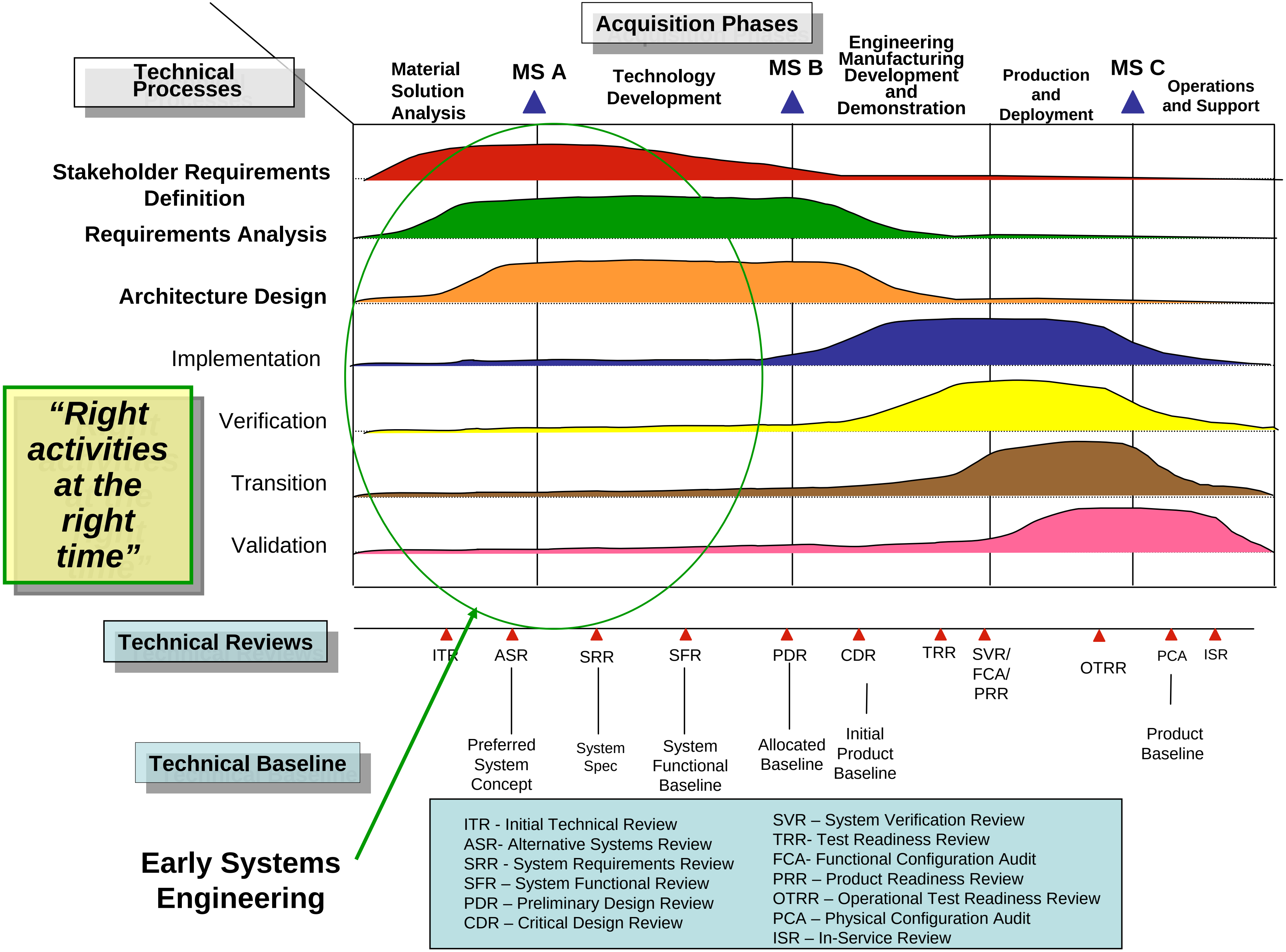
- *Entrance criteria met before entering phase*
- *Evolutionary Acquisition or Single Step to Full Capability*



Preliminary Design Review Precedes MS B

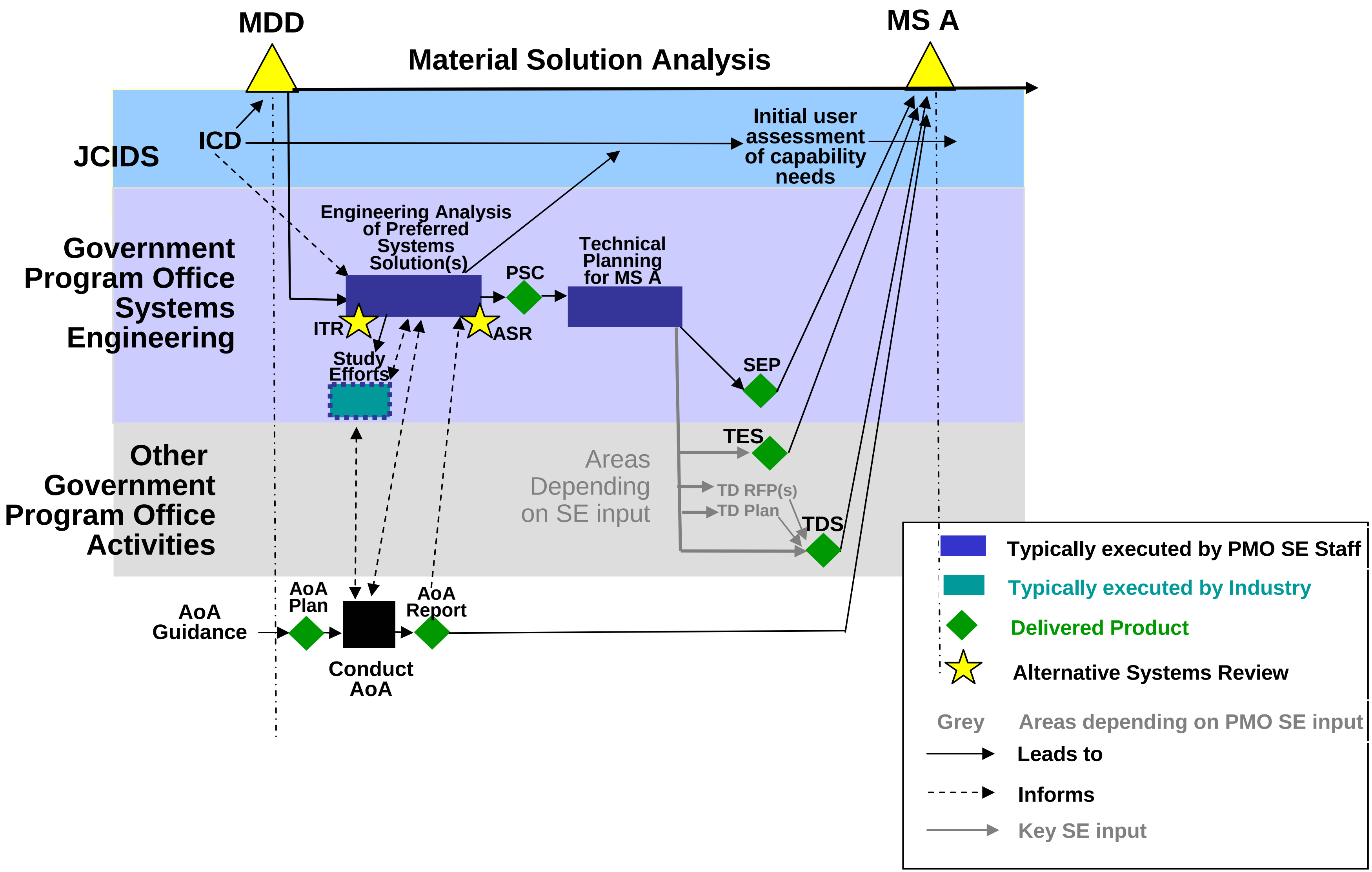
"Right activities at the right time"





Acquisition Phases
Technical Processes
Material Solution Analysis
MS A
Technology Development
MS B
Engineering Manufacturing Development and Demonstration
Production and Deployment
MS C
Operations and Support
Stakeholder Requirements Definition
Requirements Analysis
Architecture Design
Implementation
Verification
Transition
Validation
“Right activities at the right time”
Technical Reviews
ITR
ASR
SRR
SFR
PDR
CDR
TRR
SVR/ FCA/ PRR
OTRR
PCA
ISR
Technical Baseline
Preferred System Concept
System Spec
System Functional Baseline
Allocated Baseline
Initial Product Baseline
Product Baseline
Early Systems Engineering
ITR - Initial Technical Review
ASR- Alternative Systems Review
SRR - System Requirements Review
SFR – System Functional Review
PDR – Preliminary Design Review
CDR – Critical Design Review
SVR – System Verification Review
TRR- Test Readiness Review
FCA- Functional Configuration Audit
PRR – Product Readiness Review
OTRR – Operational Test Readiness Review
PCA – Physical Configuration Audit
ISR – In-Service Review

Materiel Solution Analysis Phase



SE Activities During MSA Phase

Systems Engineering Processes/Documents/Plans

- Key Technical Processes
- Systems Engineering Plan (SEP)
- Test and Evaluation Strategy (TES)
- Analysis of Alternatives (AOA)
- Input to the Technology Development Strategy
- Input to the Cost Estimate

Assessments

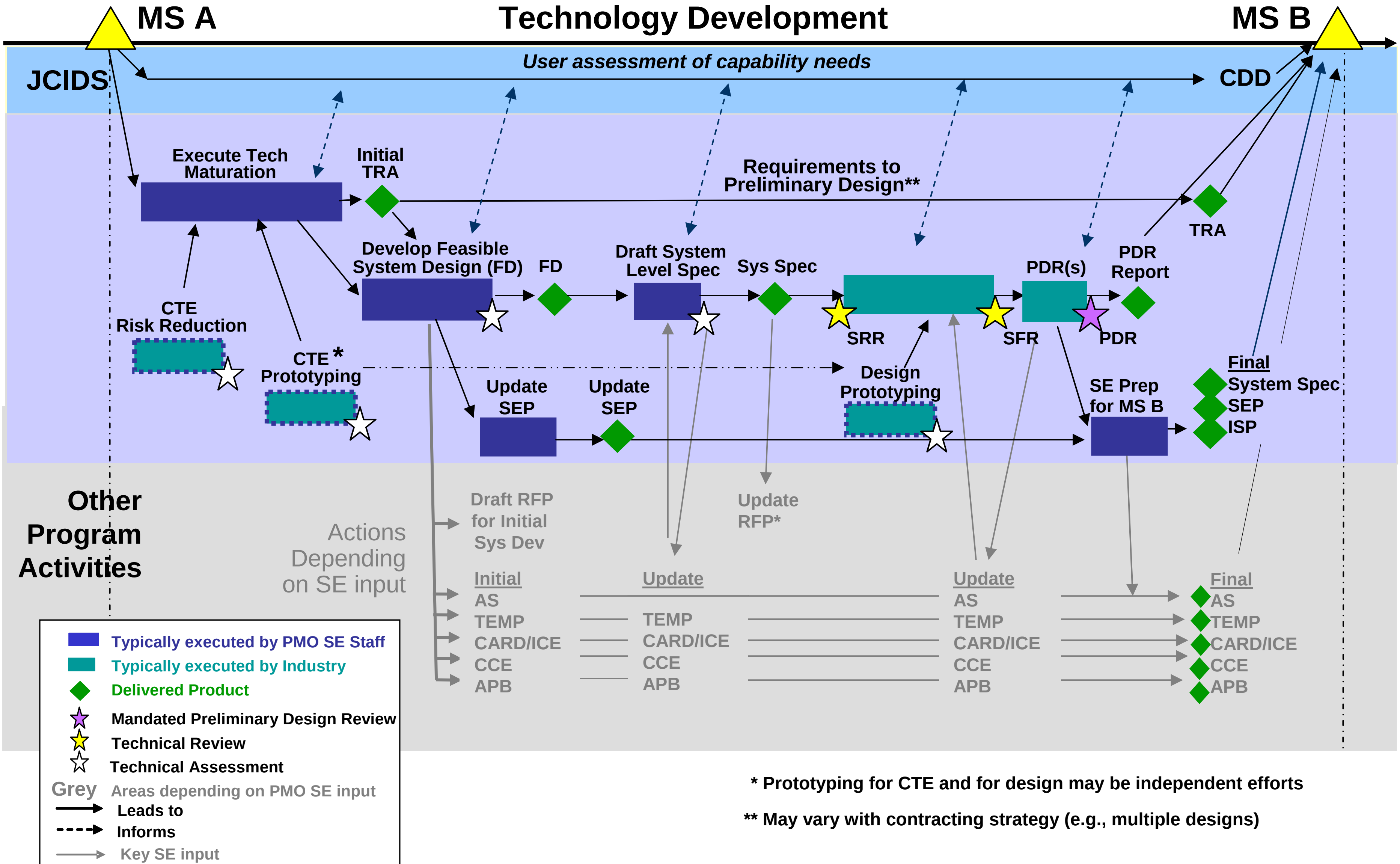
- Program Support Review (PSR)

Technical Reviews

- Initial Technical Review (ITR)
- Alternative System Review (ASR)

SE COP **(**https://acc.dau.mil/TechRevChklst**).**

Technology Development Phase



* Prototyping for CTE and for design may be independent efforts

** May vary with contracting strategy (e.g., multiple designs)

SE Activities During TD Phase

Systems Engineering Processes/Documents/Plans

- Key Technical Processes
- Competitive Prototyping
- Technology Maturation
- Test and Evaluation Master Plan (TEMP)
- Cost Analysis Requirements Description (CARD)
- Input to the Acquisition Program Baseline (APB)

Assessments

- Technology Readiness Assessment (TRA)
- Program Support Review (PSR)

Technical Reviews

- Systems Requirements Review (SRR)
- Systems Functional Review (SFR)
- Preliminary Design Review (PDR)

Prototyping and Competition
"… in the right way"

"Evolutionary acquisition requires . . . Technology development preceding initiation of an increment shall continue until the required level of maturity is achieved, prototypes of the system or key system elements are produced, and a preliminary design is completed. . . ."

"The TDS and associated funding shall provide for two or more competing teams producing prototypes of the system and/or key system elements prior to, or through, Milestone B. The prototypes shall be representative platforms reflecting the maturity of technologies and integrated system performance consistent with expected capability."

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

ACQUISITION, TECHNOLOGY AND LOGISTICS

19 SEP 2007

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.

Competitive Prototyping "Done in the Right Way"

- Need to know earlier on what will make the program successful and prototype that (i.e. challenges)
- Decide what is important – cost, integration, technology, etc – and determine how to measure / assess success
- Cost in prototyping should be a factor but the not dominant decision point
- Get domain experts to assist in determining what needs to be prototyped
- Do proof of concept but also to fill in the other holes
- Achieved at any level – system or key system elements (sub-system, assembly, or component)
- Prototype the critical path items first
- Need to spend money smartly up front – get smart at low burn rate

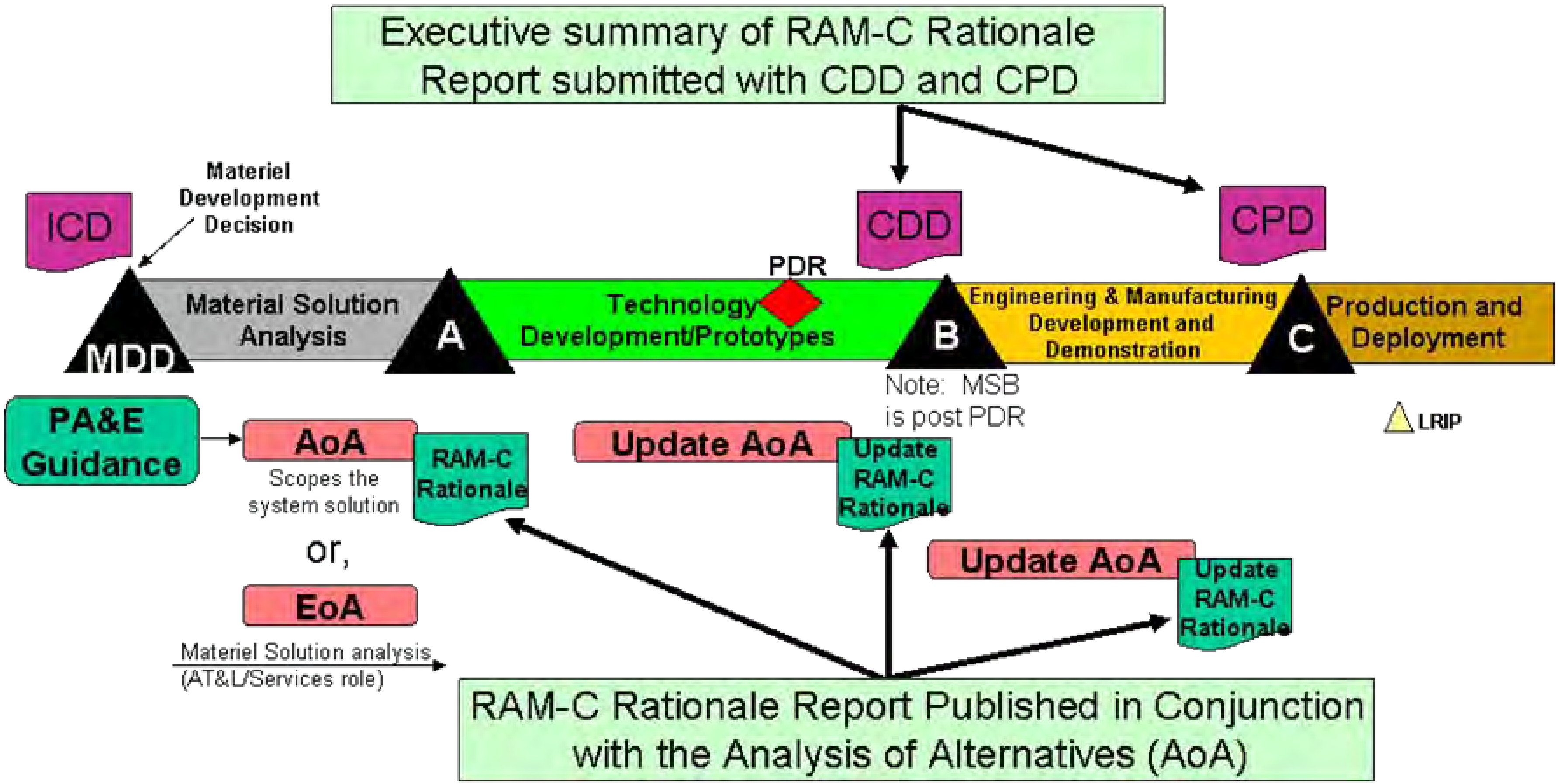
Enhanced Systems Engineering
SE Design Consideration - RAM

Reliability, Availability, & Maintainability (RAM)

- Defense Science Board Report on DT&E (dtd May 08) recommended to improve RAM
- DoD Working Group formed to implement recommendations
- Reliability, Availability, and Maintainability Policy (dtd 21 Jul 08); Directs Components to set policy actions to ensure:
  - Collaboration in the establishment of RAM requirements
  - Development contracts and acquisition plans evaluate RAM during system design
  - Maturation of RAM throughout the acquisition life cycle
  - Use of contract incentives to achieve RAM goals

(http://www.acq.osd.mil/sse/dte/docs/USD-ATLMemeo-RAM-Policy-21Jul08.pdf)

Implementing RAM-C
"... right activities at the right time ..."



Implementing RAM-C
"… in the right way"

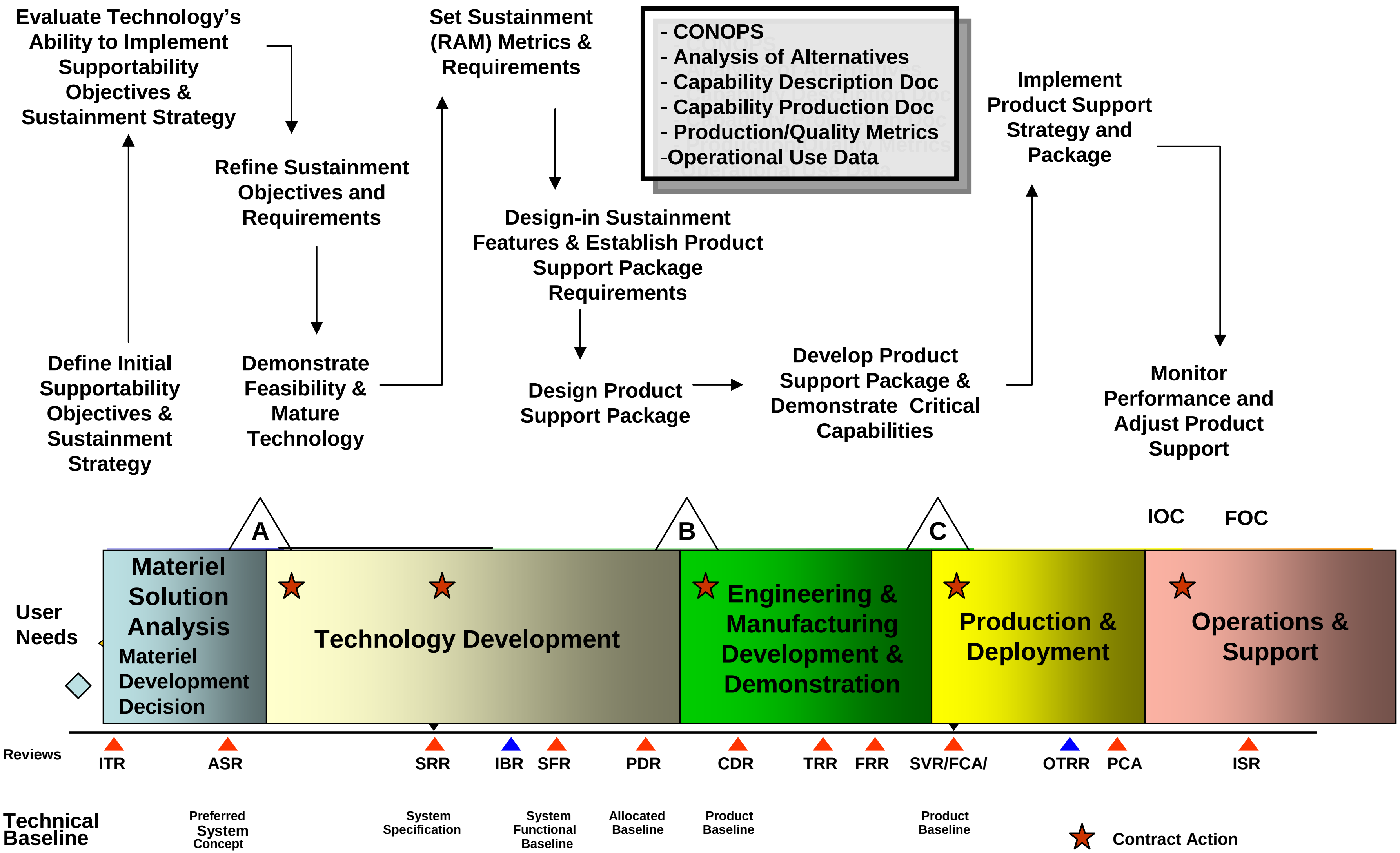
SE Design consideration "… in the right way"

- Template for Reliability Contract Language
  - Sections C, L, and M
  - Guidance on Performance Incentives for Reliability
- GEIA-STD-0009, Reliability Program Standard for Systems Design, Development, and Manufacturing
- RAM Planning Template by each Technical Review
- Evaluation Criteria (Reliability Program Detailed Scorecard) to assess a program
- Early T&E Involvement in RFP Development
- DoD Reliability, Availability, Maintainability and Cost Rationale Report Manual, October XX, 2008

(http://www.acq.osd.mil/sse/dte/spec-studies.html)

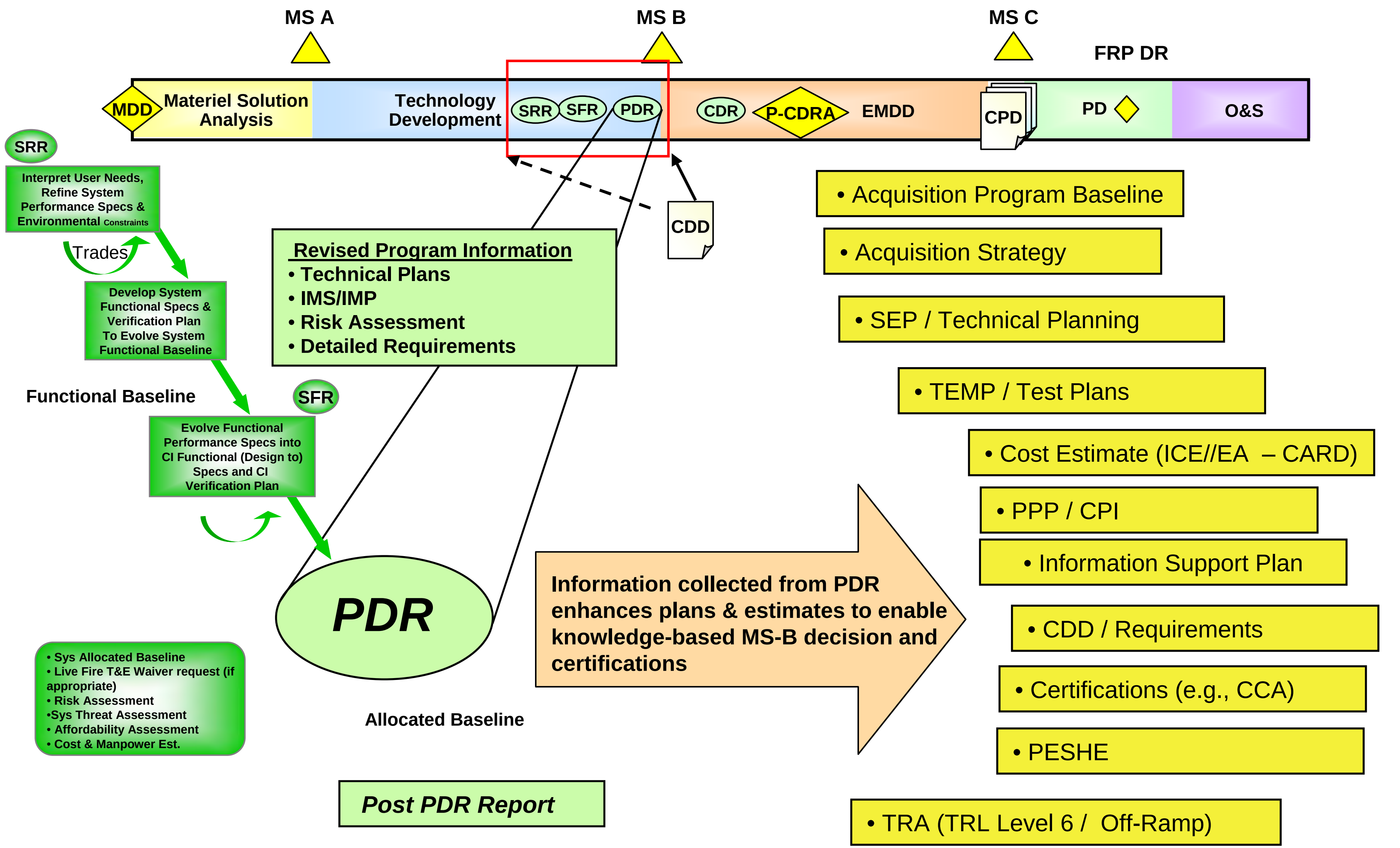
"Having performance is important,
but not as important in most cases, as having reliability"

Life Cycle Logistics Flow (RAM)



RAM included in Systems Engineering Tech Reviews

Enhanced Role of PDR



PDR – "… in the right way"

- Certification and Accreditation activities scoped and identified
- Configuration Management Plan and procedures scoped and implemented
- Integrated Master Schedule showing Critical Path through Critical Design Review
- Software Development Plan scoped and documented at the Configuration Item level
- FMECA scheduled to support System Hazard Analysis
- Modeling and Simulation role in testing and life cycle planning scoped
- Representative mission profiles finalized

PDR – "… in the right way"

(Continued)

- Engineering data requirements needed from testing identified
- Data element identification procedures established – IDE procedures established
- Test Verification Matrix covering subsystem allocations
- Physical properties (i.e., weight, power, cooling, etc.) allocated to subsystems
- Human Systems Integration design standards flowed to subsystems
- R&M diagnostics addressed in design allocations
- Interface Control Documents between subsystems completed

PDR Report to MDA

DRAFT PDR Report Guidance to require the following:

- A comprehensive list of the systems engineering products that make up the Allocated Baseline, per the PDR review,
- A list of the participants in the review. including the independent (of the program) chair, applicable technical authorities, independent subject matter experts, membership of the Technical Review Board, and other key stakeholders,
- A summary of the Action Items and their closure status/plan
- A resulting risk assessment using a PDR risk assessment checklist and readiness to commit to full detail design,
- A recommendation from the PDR as to the approval of the program's system Allocated Baseline to support detail design.

Proposed Source: DAG para 4.3.2.4.2.3

Enhanced SE Provides key information for the MS B Decision

Enhanced SE contributes to key MS B prerequisites

- Acquisition Strategy (including core logistics analysis/source of repair; cooperative opportunity; etc.)
- Independent Cost Estimate
- Cost Analysis Requirements Description (CARD)
- Manpower estimate
- Acquisition Program Baseline
- Analysis of Alternatives
- System Threat Assessment
- Technology Readiness Assessment (TRA)
- Affordability Assessment
- Selected Acquisition Report (SAR)
- SEP, TEMP, Program Protection Plan, and PESHE
- Clinger-Cohan Act compliance

Enhanced SE Summary

Enhanced Systems Engineering is the lynchpin to start programs right!

- Early SE in support of MDD, MS A, and B
- SE activities in support of Technical Reviews and essential program planning efforts
- Implementing SE ….in the right way
  - Competitive Prototyping
  - Reliability, Availability, Maintainability – Cost implementation

"Implementing the right activities at the right time in the right way"

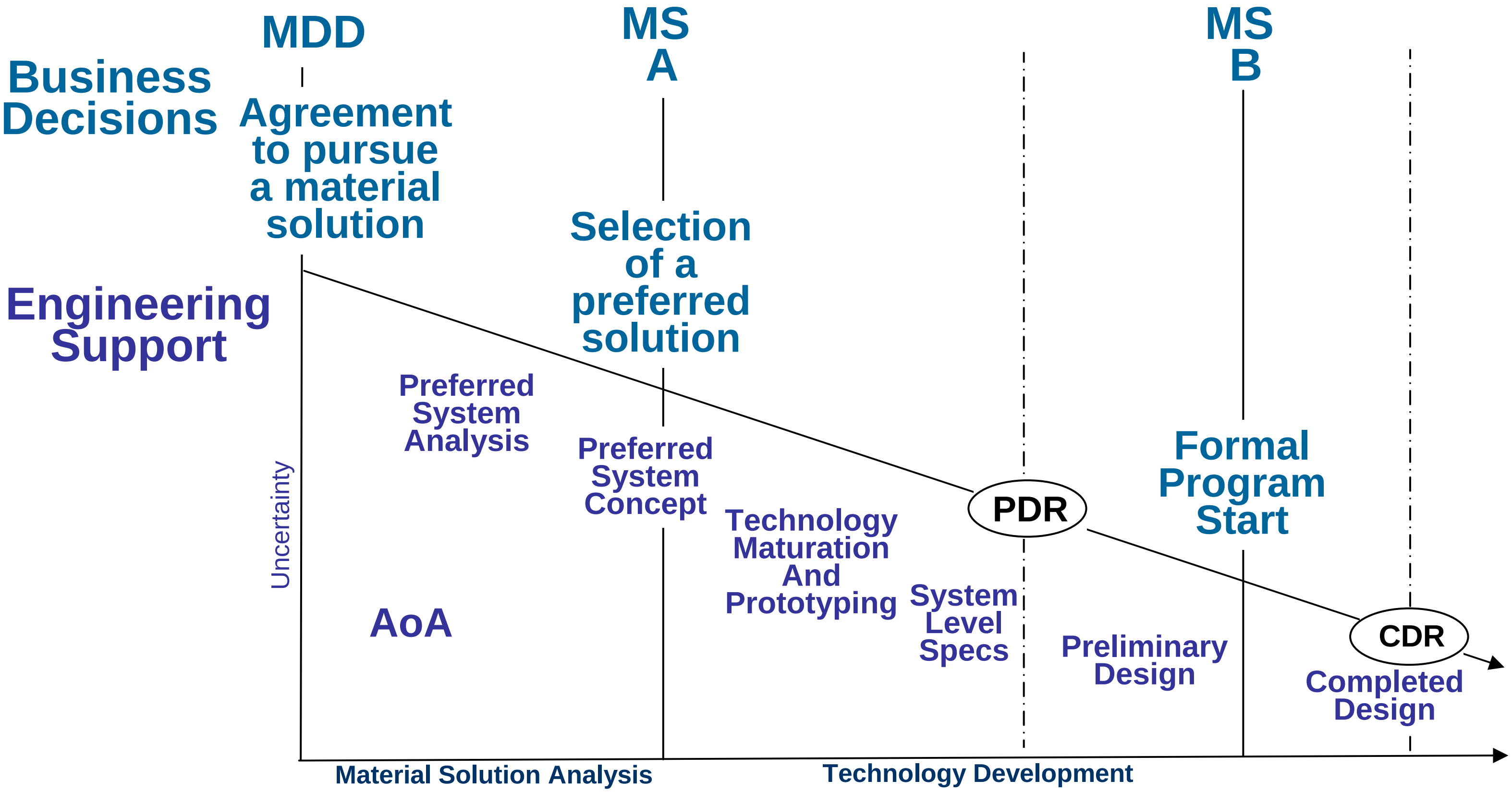
Defense Acquisition Guidebook (DAG) (http://akss.dau.mil/dag/)
The Systems Engineering Community of Practice (https://acc.dau.mil/CommunityBrowser.aspx?id=17608);

Backup

RAM Improvement Efforts

- Some RAM Pitfalls to avoid when executing a sound systems engineering process include:
  - Inadequate planning for reliability and maintainability
  - Failure to identify mission context or intended use profile when stating RAM requirements
  - Failure to design-in reliability early
  - Reliance on predictions instead of design analysis
  - Inadequate lover level testing
  - Lack of proper planning, managing, and executing reliability growth activities, and
  - Lack of reliability incentives

SE Provides a Technical Foundation for Acquisition

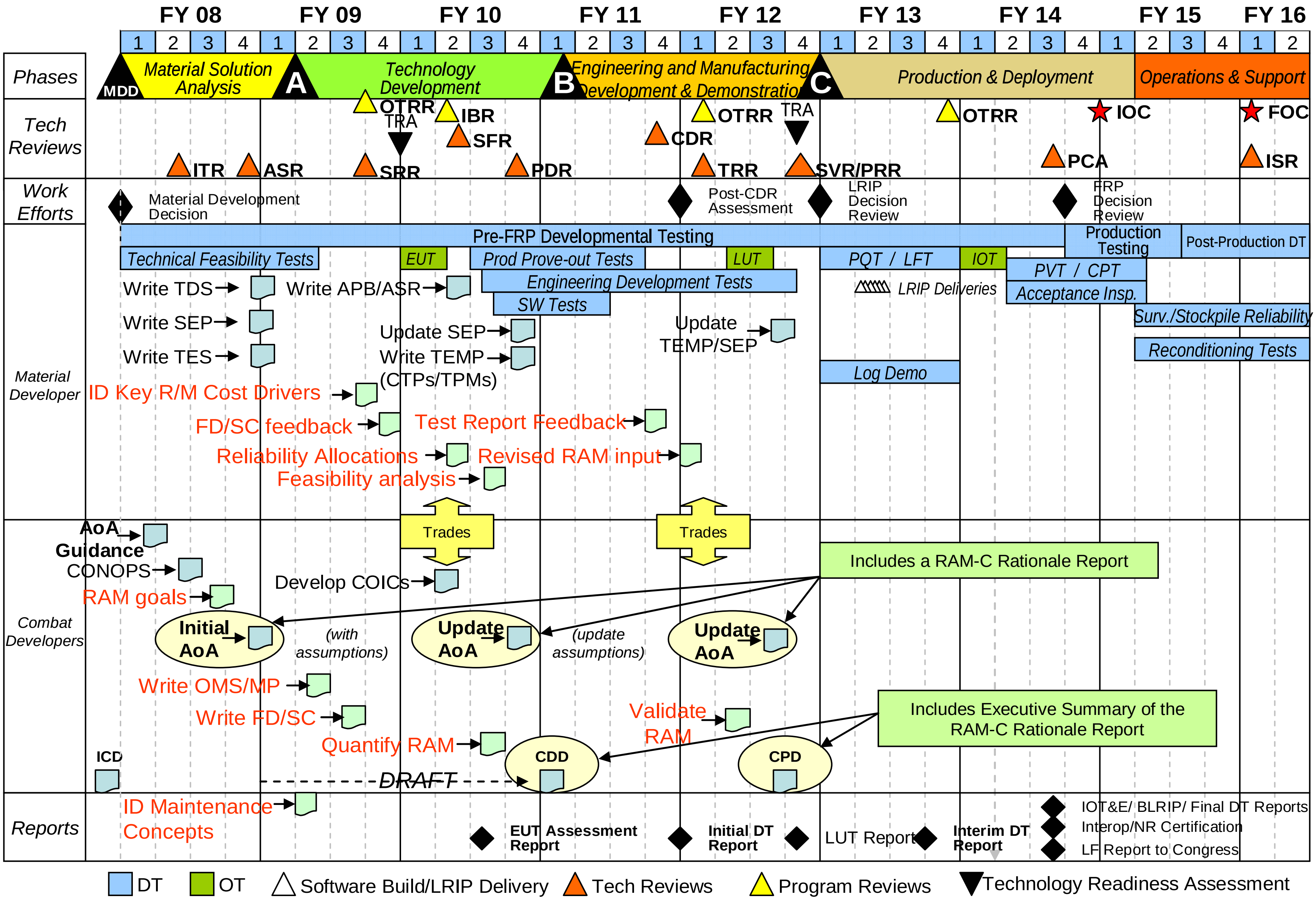


National Research Council

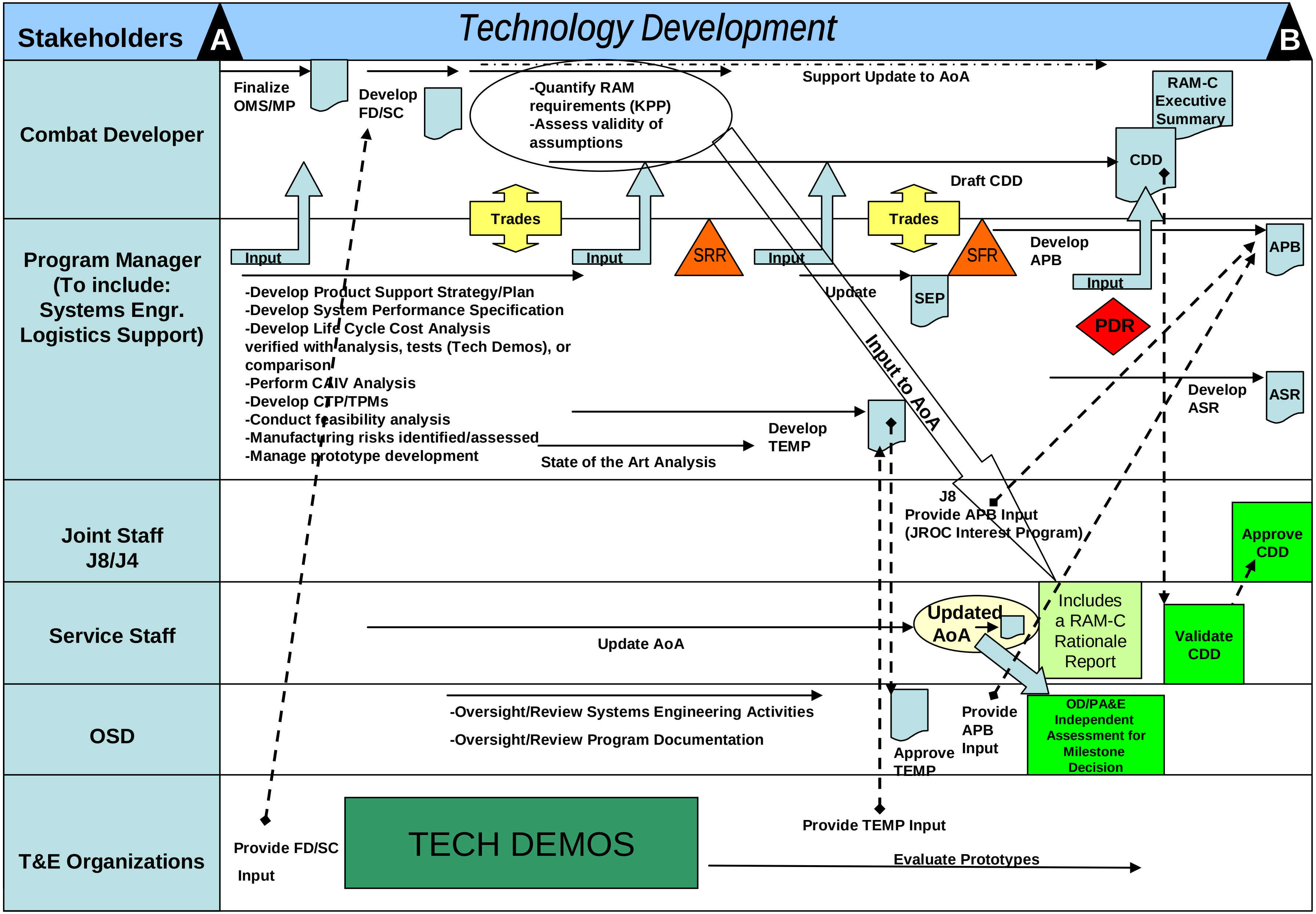
"Pre-Milestone A and Early-Phase Systems Engineering"
Jan 2008

Systems Engineering is most effective when it initiated early to start a program right!

RAM-C Activities



Pre-Milestone B Sustainment Requirement Process



Applying Business Process Modeling to Develop Systems Engineering Guidance for New DoD Acquisition Regulations

NDIA Systems Engineering Conference
San Diego - October 2008

Dr. Judith Dahmann
Aumber Bhatti
The MITRE Corporation

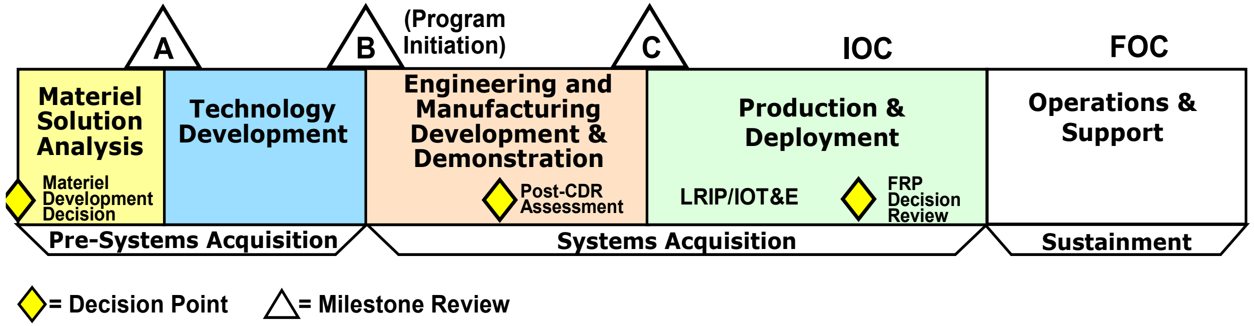
Background

- Recognized need for enhanced SE early in the acquisition process to provide robust technical foundation for acquisition success
- DoD acquisition regulations (DoD 5000) changes address more structure in early phases of acquisition
- Defense Acquisition Guide (DAG) updates to address the changes in acquisition regulation
- A Business Process Model of DoD 5000 and SE Guidance has been constructed to provide technical support to this process

Acquisition is a complex process requiring systems thinking and SE analysis like other complex systems

DoD Acquisition Regulations and Guidance

Regulations
DoDI 5000.02



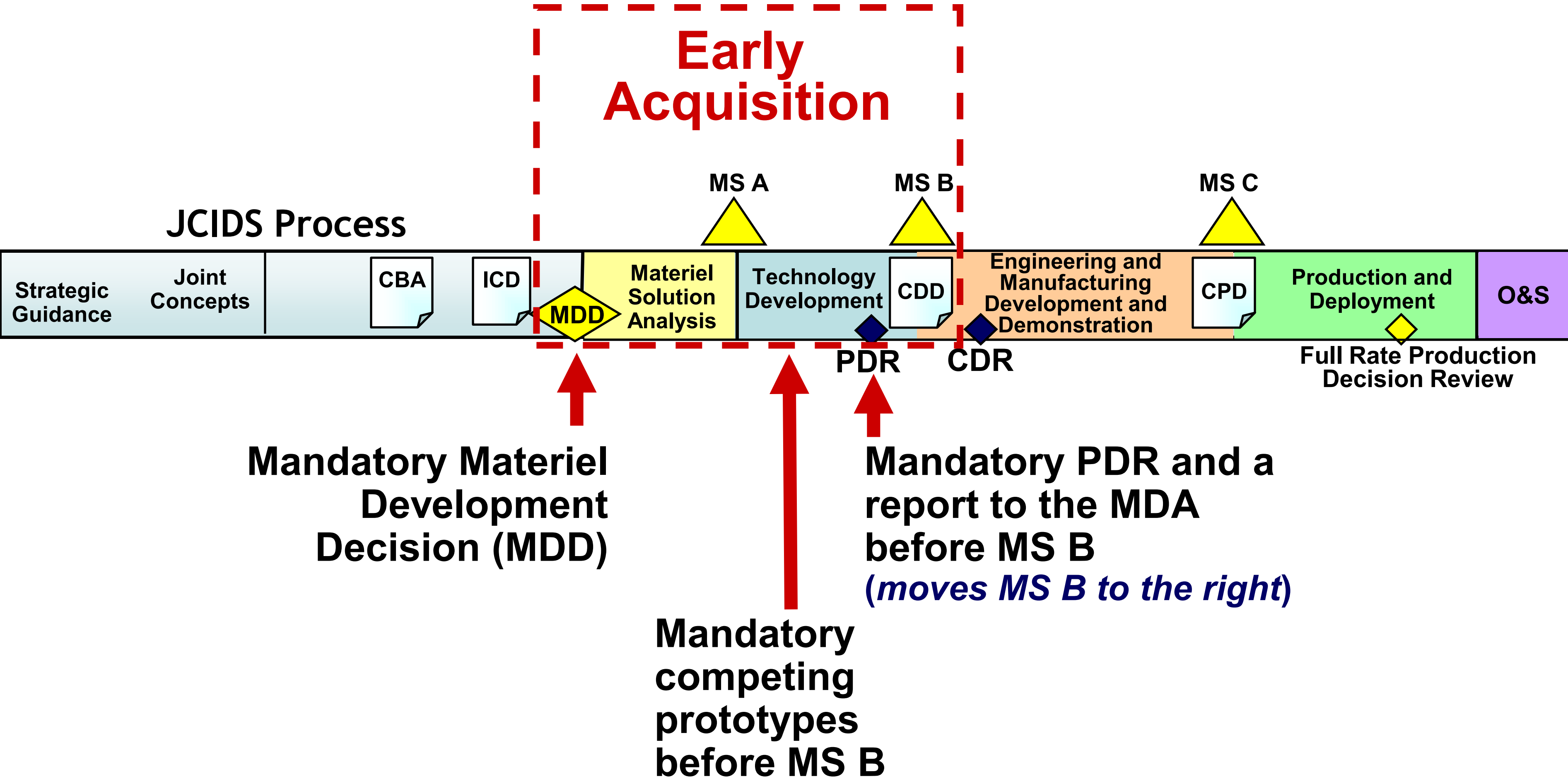
Guidance
Defense Acquisition Guide

Ch	Topics
1	Decision Support Systems
2	Acquisition Strategy
3	Affordability & Life-Cycle Estimates
4	Systems Engineering
5	Life Cycle Logistics
6	Human Systems Integration
7	IT & NSS
8	Intelligence
9	Test & Evaluation
10	Assessments and Reporting
11	Program Management

Focus of current activity

Context is worth 50 IQ Points

Draft Early Acquisition Policy Changes*



Coordination Draft, DoDI 5000.02

Why is this hard?

- Very little experience with current pre- Milestone B SE guidance
  - Makes it difficult to know what to ‘adjust’ given changes
- The current DAG guidance is voluminous
  - Online resource with over 500 printed pages of information without hotlinks
- Limited understanding about the interdependencies among the guidance provided to the program office from different perspectives
  - Any added SE guidance will compete attention from already over burdened program office
- Consequently, it was important to understand how SE fits into the context of early acquisition
  - What is the relationship between SE and guidance for other areas

Need a structured approach to understanding how SE fits into larger context

Why Business Process Modeling?

- Business process modeling (BPM) rapidly articulates processes and relationships
  - Supports communication and common understanding among stakeholders
  - Provides a means for understanding relationships among concurrent stakeholder activities
- Information to update the DAG is closely aligned to information for the pilot model; efficient leveraging of effort
- Objective is to support understanding of how SE fits into the larger context of DoD 5000 and guidance
- An BPM model has been developed to address SE guidance in context of regulations and other guidance 'lanes' addressing
  - Proposed DoD 5000
  - SE guidance (draft updates to DAG Chapter 4)
  - Relationships between SE guidance and 5000 and guidance in other DAG chapters (limited)

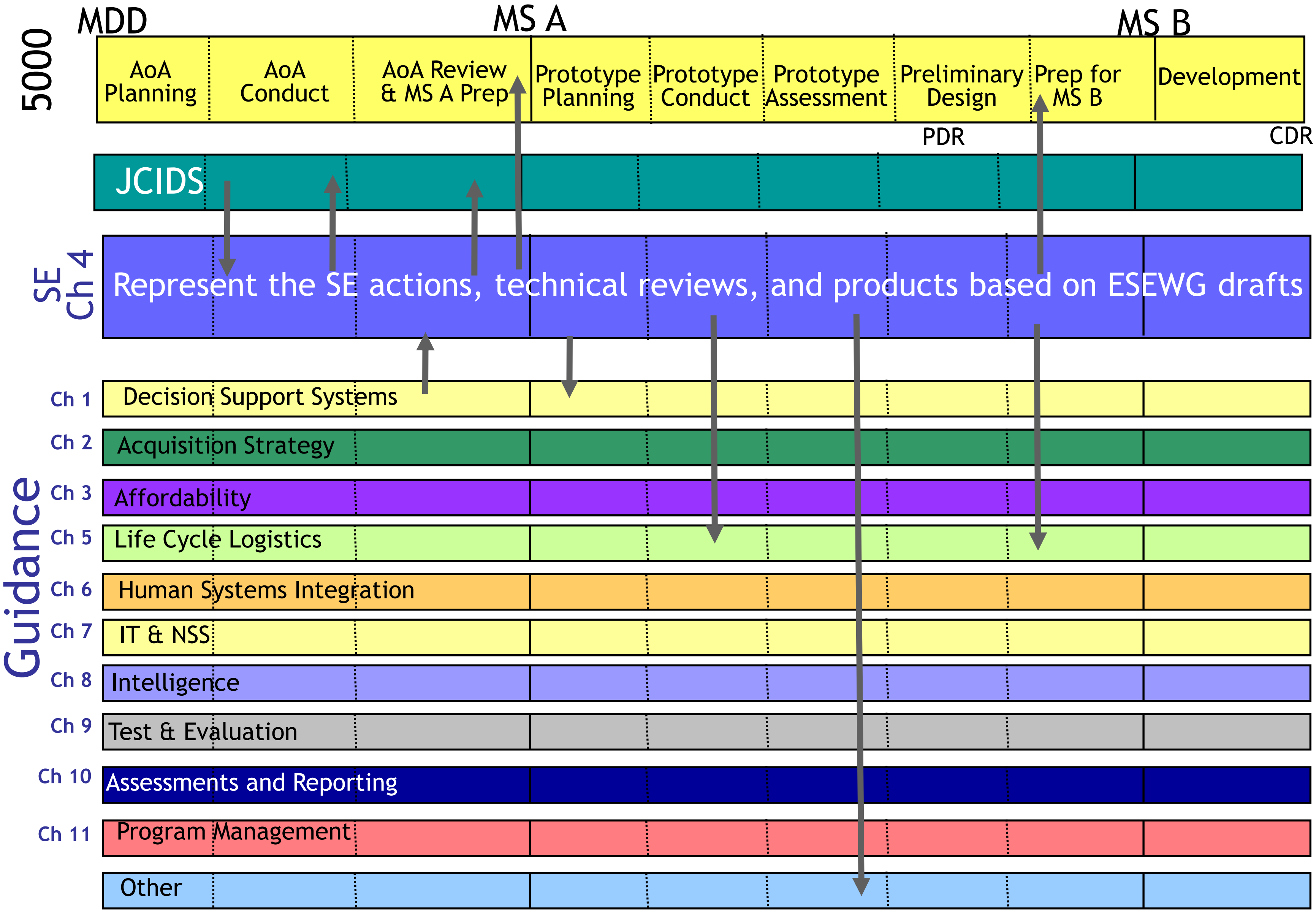
Model provides a framework to articulate the role and relationship of early SE

Approach

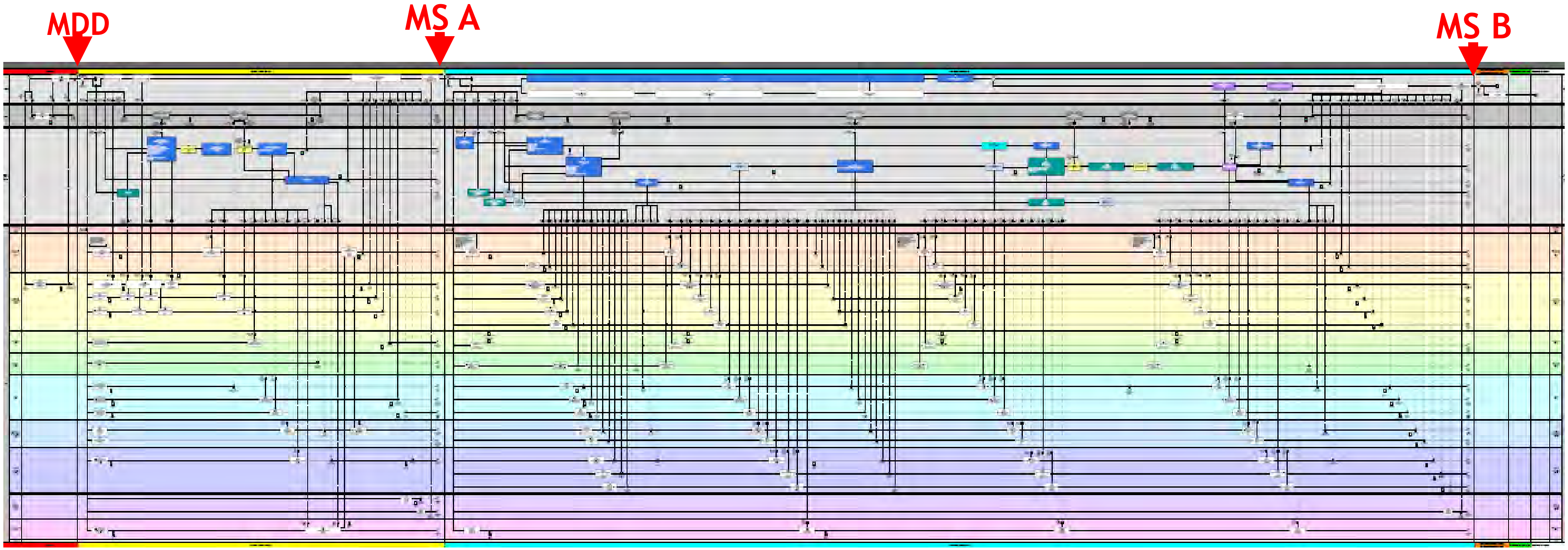
- Iterative approach to building, reviewing, applying the model
  - Begin with a 'first pass' rapid development based on the current 5000 documentation using 'surrogate' subject matter expert (SME)
  - Review 'first pass' model with SMEs
  - Update (second pass), review and revise
  - Conduct an initial assessment, review and revise in collaboration with stakeholders
- Use model as a framework for enterprise level exchanges

Version 1.0 if the model is in place and in use
Work in progress

Notional Initial Model Layout



Birdseye View of the Model



Best viewed as 4’ x 10’ version

Model provides a way to visualize MDD to MS B

Results (1 of 2)

- Clear description of
  - Key elements of new DoD 5000
    - Provided a abstracted view of complex process
    - Understand and communicate the changes
  - Relationship among the guidance across the DAG chapters particularly with respect to systems engineering
    - Identified activities at different points in the process
    - Helped to frame questions about relationships
  - Focus for SE Guidance during early phases of acquisition process including
    - SE actions during each phase
    - Expected input from other processes
    - Expected outputs to other processes
    - Time criticality of information exchanges

Model provides a framework to look at issues across various guidance lanes

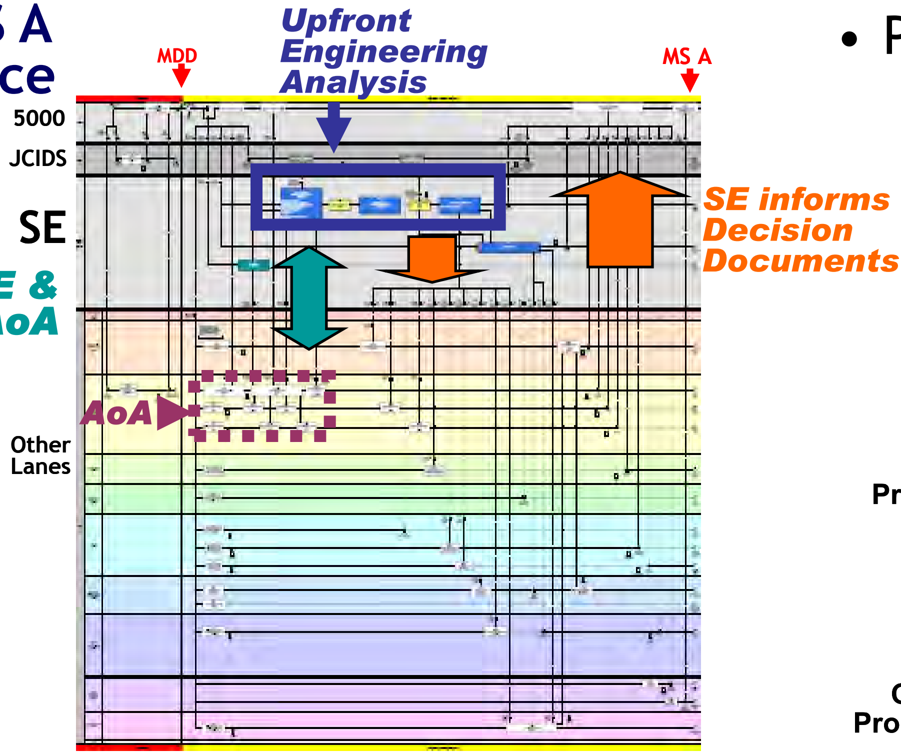
Results (2 of 2)

- Provides a framework for ‘enterprise’ discussion
  - Showing the numerous guidance ‘lanes’ and where they provide guidance to an acquisition program
  - Identifying issues in aligning guidance with changes in policy
  - Establishing SE relationships with other guidance ‘lanes’
    - Identifying and managing interrelationships
    - Understanding the need and timing for information sharing across ‘lanes’
  - Demonstrating SE contributions to acquisition process and work in other lanes
    - Measuring the impact of earlier interactions
    - Contributing to knowledge base of all ‘lanes’ throughout the process

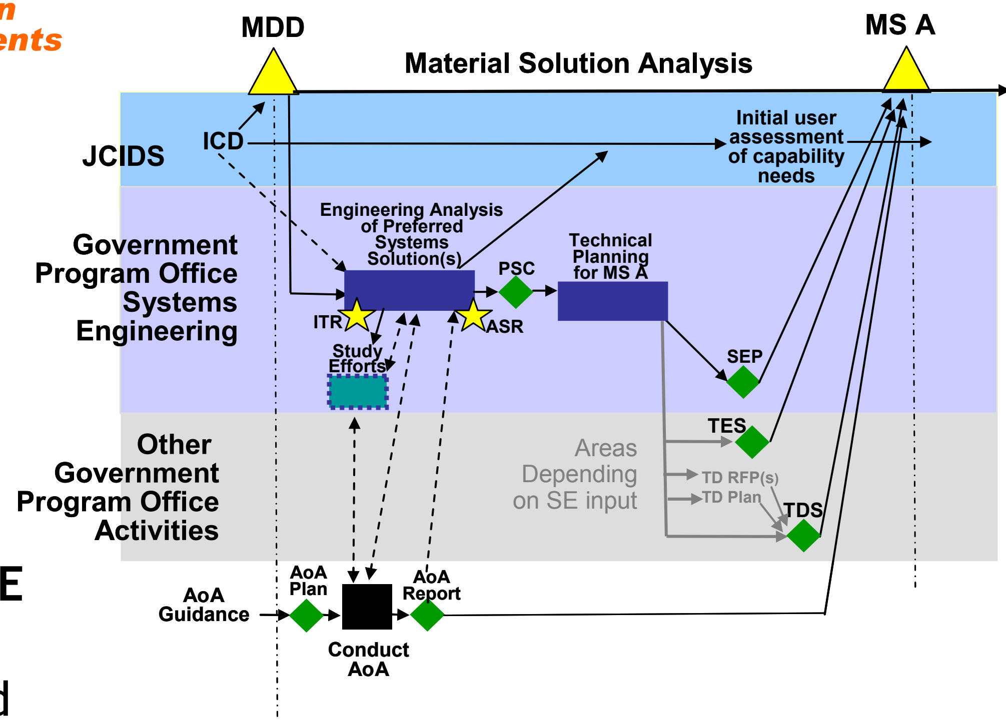
Model provides a framework to articulate the role and contributions of early SE

Example: Best Practices for MDD to MS A

MDD to MS A Slice



- Provided basis for DAG SE guidance on
  - Key SE Activities
  - Impact on program planning

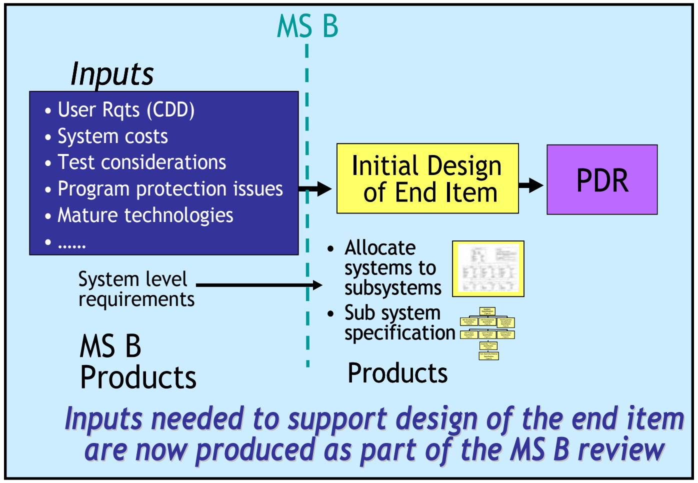


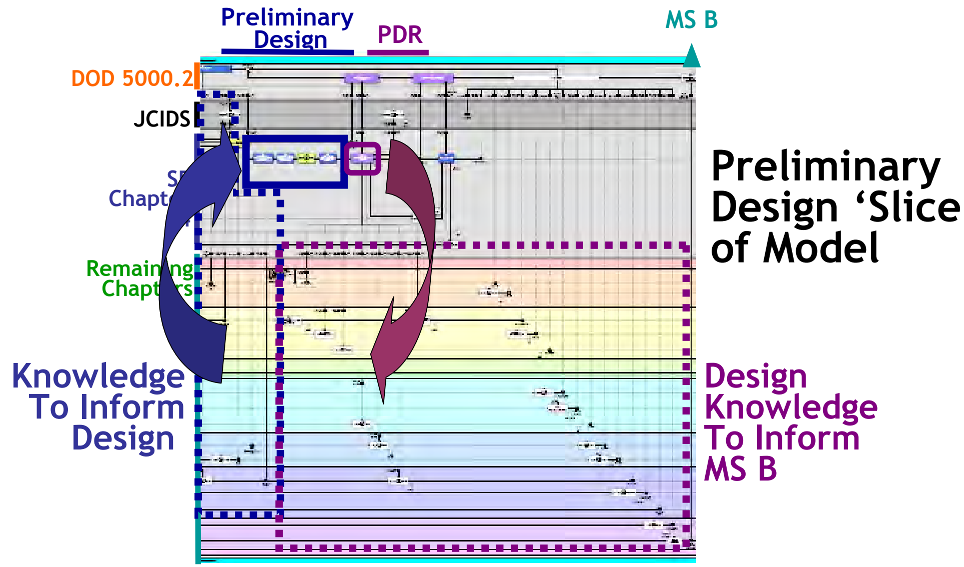
- **Critical role for early program office SE**
  - Advise and review AoA
  - Engineering analysis of recommended solution for TDS technical planning

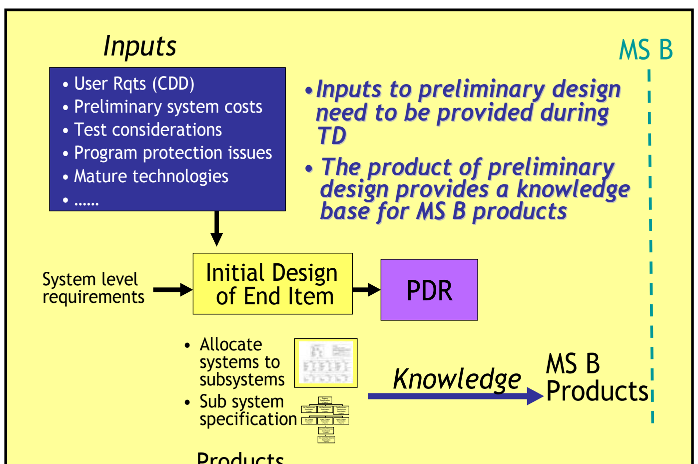
Key SE Activities, Events and Products and Their Support to Program Planning

Example: Moving Milestone B to follow PDR

- PDR has been an SE event; change impacts a range of considerations outside of SE







- **Model provided a framework for enterprise level discussion**
- **Identified key inputs needed prior to preliminary design including**
  - User requirements, cost constraints, critical technologies, critical protection items

Topic of a July workshop to address the impact of the change across the guidance lanes (e.g. DAG Chapters)

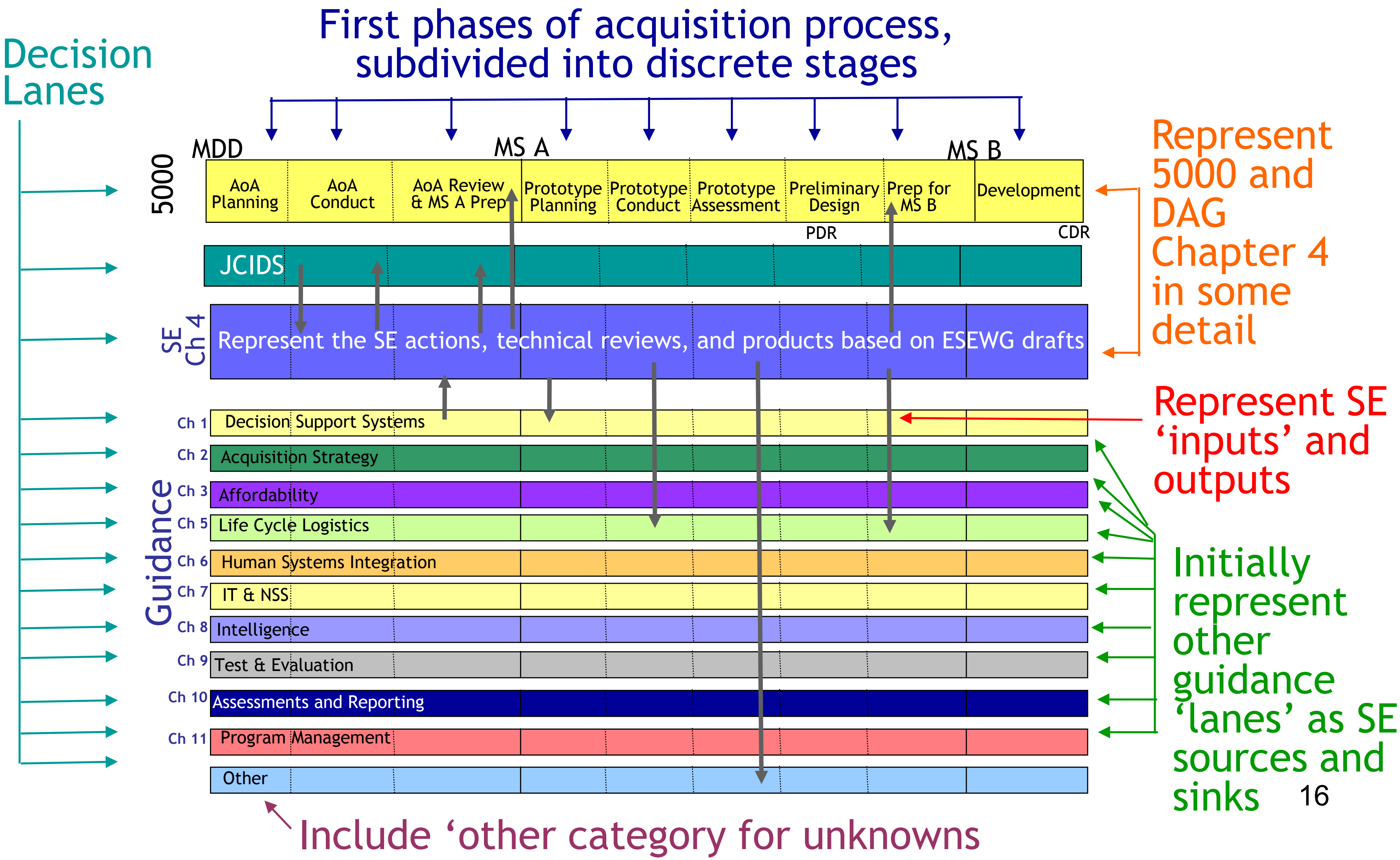
In Sum….

- Use of BPM as a tool for examining acquisition policy and guidance demonstrated the value of systems thinking and structured analysis of what is in effect a complex system
- Follow-on possibilities
  - Extend model to expand description of other lanes and their interrelationships, or add other concurrent activity (e.g. OSD oversight activities)
  - Animate model to understand concurrency, dynamics, and synchronization
  - Add notional resources (manpower, time) for analysis
  - Extend to focus on information as a basis for streamlining ‘documentation’ across the acquisition process
  - Others….

Model provides a framework for examining issues within SE and between SE and other aspects of acquisition

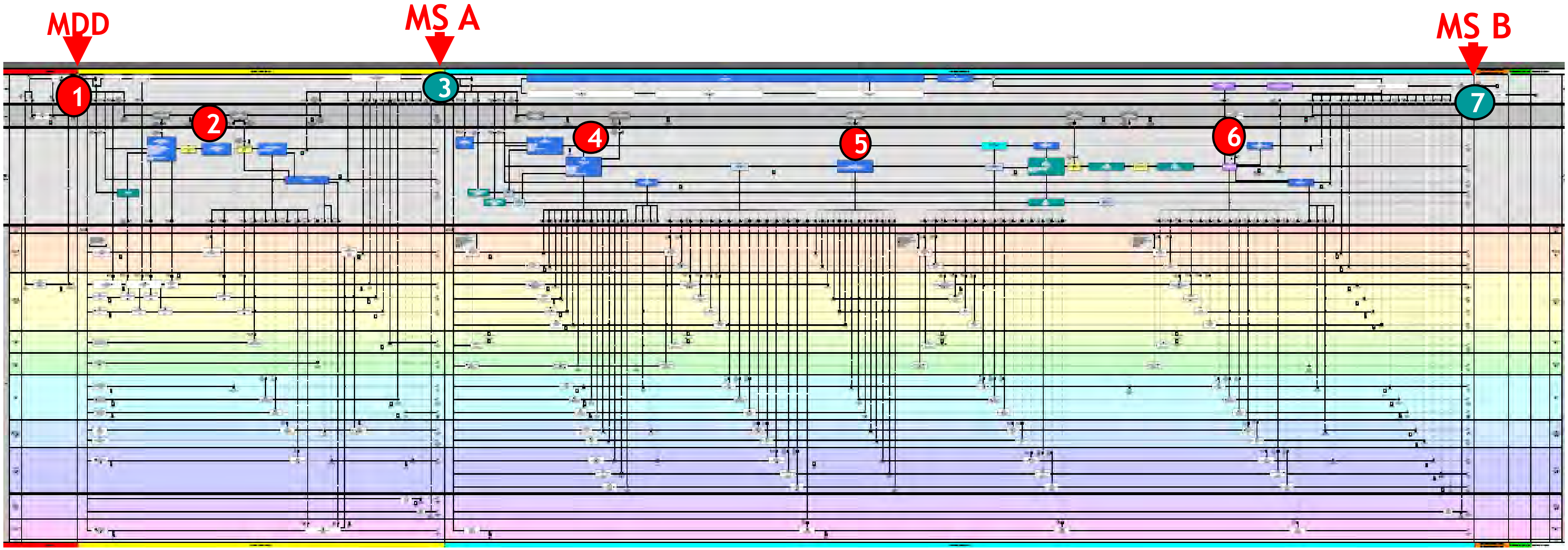
Backup

Initial Model Scope Concept: Focus on Early SE



Birdseye View of the Model

- Progress is being made in developing DAG chapter 4



Best viewed as 4’ x 10’ version

Pilot effort has been initiated to explore use of business process modeling to examine relationship and alignment of regulations and SE guidance

ACQUISITION & TECHNOLOGY

THE WILL TO CHANGE

NDIA 11th Systems Engineering Conference
Executive Panel

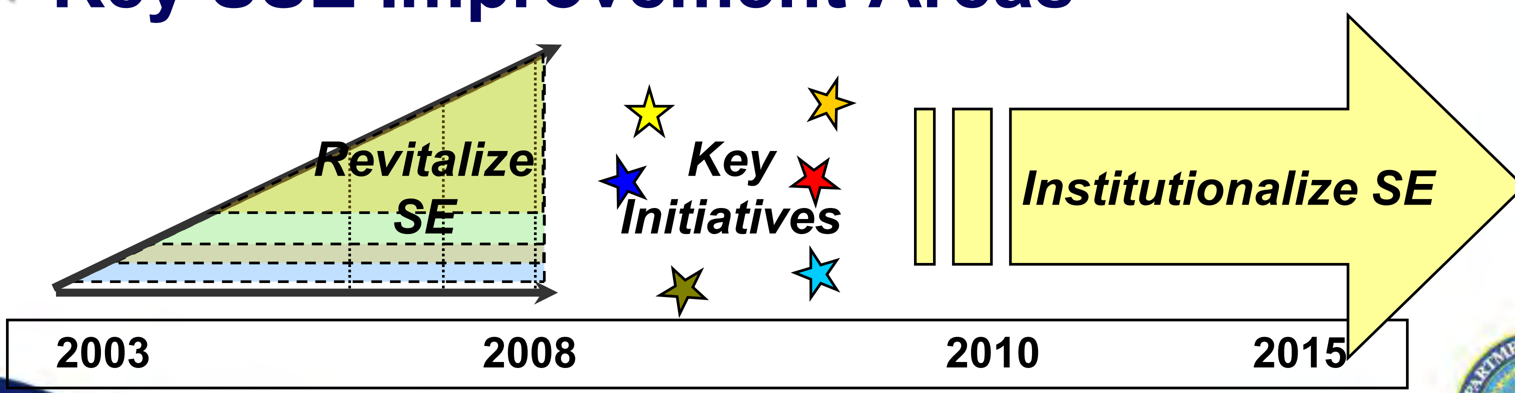
Kristen Baldwin

Deputy Director, Software Engineering and System Assurance (SSA)
Office of the Deputy Under Secretary of Defense
(Acquisition and Technology)

October 21, 2008

SSE Way Forward

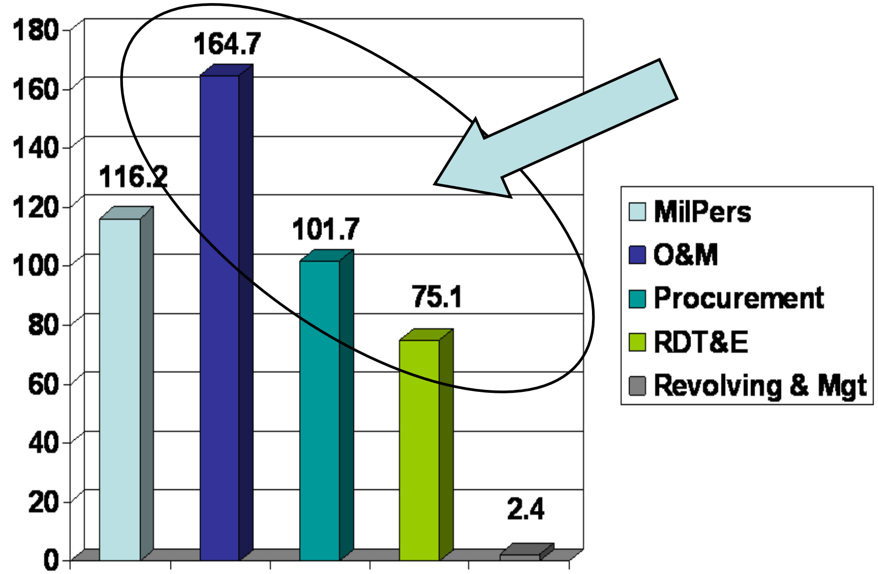
- Reality, and opportunity
- OSD SSE Strategy
  - Enhanced SE Pre-MS A/B
  - Human capital strategy for SE
  - SE research
- Key SSE Improvement Areas



Reality and the Opportunity

- Acquisition cost growth over 11 years*:
  - Estimation changes: $201B
  - Engineering changes: $147B
  - Schedule changes: $70B

**SAR data FY 1995–2005*



*National Defense Budget for FY 2008 (aka Green Book), March 2007, page 29.

With 72% of O&S costs established pre-Milestone A, Systems Engineering plays a critical role ensuring capabilities are translated into executable requirements and feasible programs

OSD SE Strategy

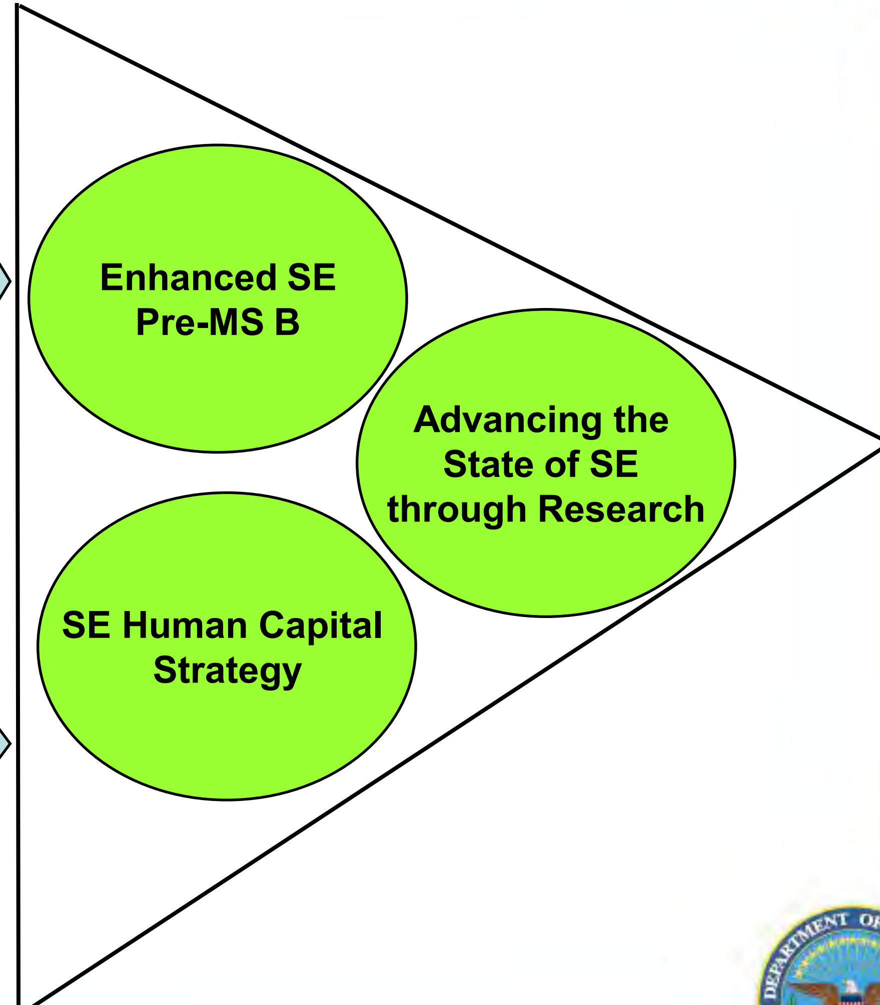
NRC Study Recommendations

- Treat Milestones A/B as critical; ensure completion
- Deliver needed # of trained SEs
- Perform pre-MS A analysis; include stakeholders
- Implement Component development planning

Systemic Analysis Recommendations*

- Implement Achievable Acquisition Strategy and Planning
- Enhance Gate Review Decision Process
- Enhance Staff Capabilities

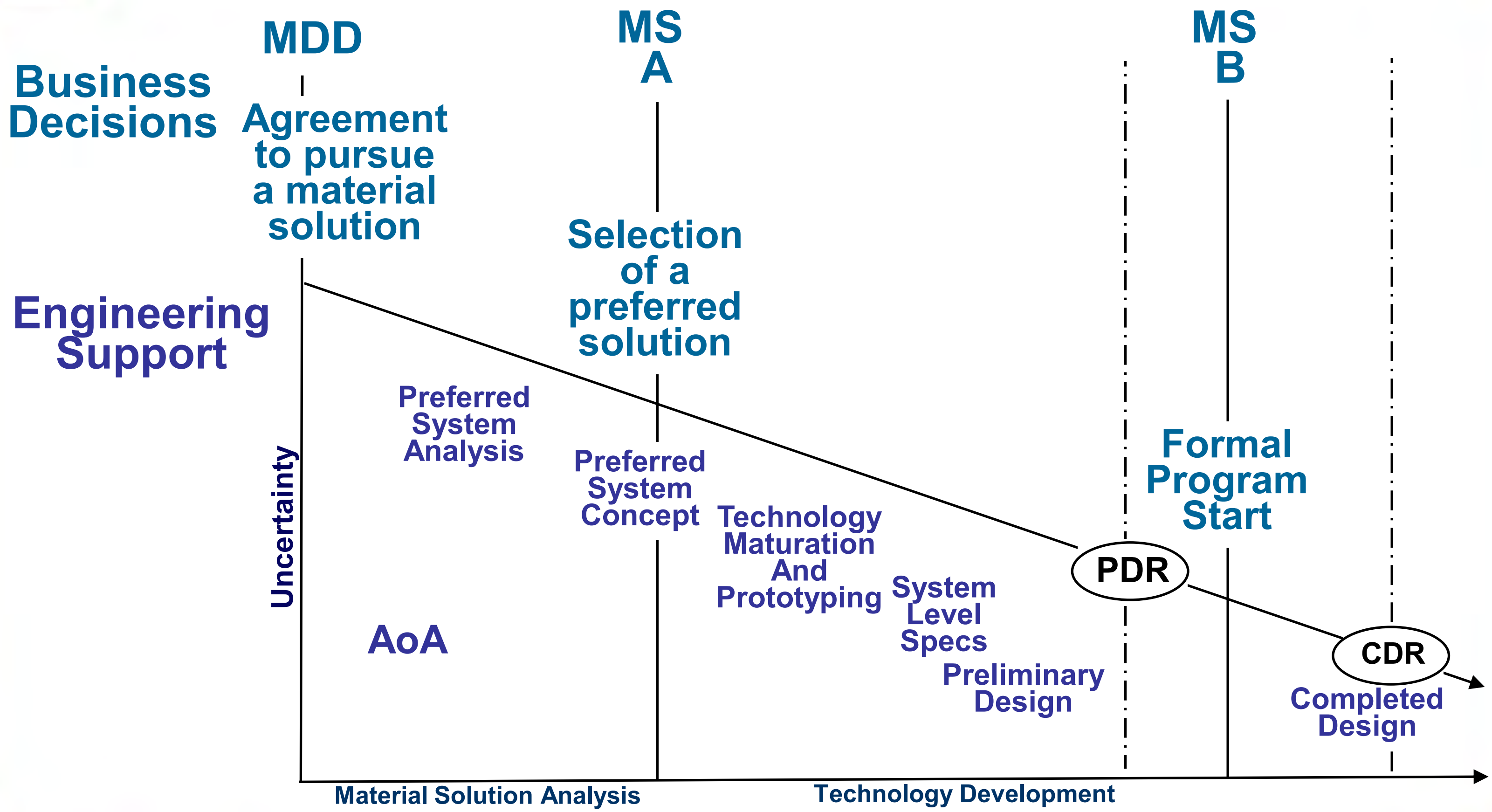
**Based on 3700 Program Assessment findings from 40 Programs Support Reviews*



Enhanced Systems Engineering

- Policy and Guidance Updates
  - DoD 5000 update
  - Acquisition Guidance Model
  - Early SE engagement with programs
  - Program Support Reviews (PSRs) Pre-MS A/B
  - Risk Reduction activities (e.g. Technical Risk assessment in AoAs, Competitive Prototyping)
  - SE Technical Reviews - Informed Trades for Feasible Solutions
- Developmental Test & Evaluation
  - Integrated DT/OT
  - Updated T&E Strategy at MS A

Improve Knowledge through Technical Foundation



Systems Engineering is effective when it informs, and is informed by, other Acquisition process owners.

SE Human Capital Strategy

- SE core competency assessment effort; completion - Spring 2009
- Program Systems Engineer career path
- FY08 NDAA Section 852: DoD Acquisition Workforce Development Fund - $300M per year across DoD
  - SE and T&E initiatives to recruit, retain and train the workforce
- DoD Human Capital Initiative - Published Annex for SPRDE, PQM and T&E
- Partnership with INCOSE SE Certification Program
  - Aligned with Defense Acquisition Guidance
- Software Engineering (SwE) Human Capital Initiatives
  - DoD Acquisition Workforce SwE Competencies
  - Graduate SwE reference curriculum

Systems Engineering Research

- Awarded SE Research UARC
  - University Affiliated Research Center (UARC)
  - Led by Stevens Institute of Technology and its principal partner, University of Southern California
- SSE and NSA UARC Funds
  - Lead, coordinate, and harmonize SE research
  - Improve SE methods, processes, and tools (MPTs) in support of DoD challenges
- Opportunity for DoD and Industry investment
  - Advance the state of Systems Engineering
  - Nurture and grow graduate-level systems engineering academic and research programs

Key OSD SE Improvement Areas

Transcending DoD Acquisition

- **System/Software Engineering Integration**
  - Framework to highlight key process, workforce, and tools to recognize key role software plays in our systems
- **Systems of Systems Engineering**
  - *DoD SoS SE Guide* defines core elements of SoS SE, application of SE processes, and emerging principals
- **Manufacturing and Reliability**
  - OSD and Component implementation of reliability best practices, throughout the lifecycle – July 08 Policy Memo
  - Assessing Manufacturing Risk & Readiness at key decision points
- **System Assurance and Program Protection**
  - *NDIA Engineering for Assurance Guidebook* integrates security into Systems Engineering to focus on protecting our programs from malicious tampering and network threats

Always Our Focus

The Mission:
Delivering Timely and Affordable Capabilities to the Warfighter

The Defense Acquisition Community
126,033 Government and Military Certified Professionals
500,000+ Defense Industry Personnel

For More Information: Tues Afternoon 1

Tuesday, October 21, 2008
Session C - 1:30-3:15pm
Track 1 SE Effectiveness – Bayview III
7099 DoD's Systems and Software Engineering Revitalization Efforts—An Update, Nicholas (Nic) Torelli
7153 Systems Engineering Plan (SEP) and Systems Engineering Management Plan (SEMP) Unification, Chet Bracuto
Track 2 T&E in SE – Bayview II
7100 Implementation of the 2007 Developmental Test & Evaluation Defense Science Board Results, Chris DiPetto
7101 Test and Evaluation Value Metrics at Acquisition Decision Points, Darlene Mosser-Kerner
Track 3 Program Management – Bayview I
7096 New Acquisition Policy and Its Impact on Defense Systems Engineering, Sharon Vannucci
Track 5 M&S – Mission II
7172 Execution of the Acquisition M&S Master Plan - A Progress Report, James Hollenbach & Michael Truelove
Track 8 Software – Palm II
7137 DoD Software Engineering and System Assurance, Kristen Baldwin

For More Information: Tues Afternoon 2

Tuesday, October 21, 2008
Session D - 3:30-5:15pm
Track 1 SE Effectiveness – Bayview III
7089 Systems of Systems: Update on the DoD Systems of Systems SE Guide and Future Direction, Dr. Judith Dahmann
6986 Technology Readiness Assessments for Systems of Systems, Dr. Jay Mandelbaum
Track 2 T&E in SE – Bayview II
7103 New Test and Evaluation Master Plan Guidance, Darlene Mosser-Kerner
6996 Modeling & Simulation in the Test & Evaluation Master Plan, Michael Truelove
Track 5 M&S – Mission II
7175 LVC Architecture Roadmap - A Path Forward for Distributed Simulation, James Hollenbach

For More Information: Wed Morning

Wednesday, October 22, 2008
Session A - 8-9:45am
Track 3 Program Management – Bayview I
7438 The Incremental Commitment Model and Competitive Prototyping, Dr. Barry Boehm
Track 4 Program Management – Mission I
7721 Systemic Analysis and Developing System Issues, Peter Nolte
7720 Systemic Root Cause Task Group Results, Dave Castellano
Systemic Root Cause Task Group Recommendations Implementation, Nicholas Torelli
Track 8 Software – Palm II
7114 Building the Next Generation of Software Engineers – Benchmarking Graduate Education, Dr. Art Pyster
7135 Improving Work Breakdown Structure (WBS) Guidance for Weapons Systems with Substantial Software Content, Christopher Miller
Session B – 10:15am-Noon
Track 1 SE Effectiveness – Bayview III
7436 A Process Decision Table for Integrated Systems and Software Engineering, Dr. Barry Boehm

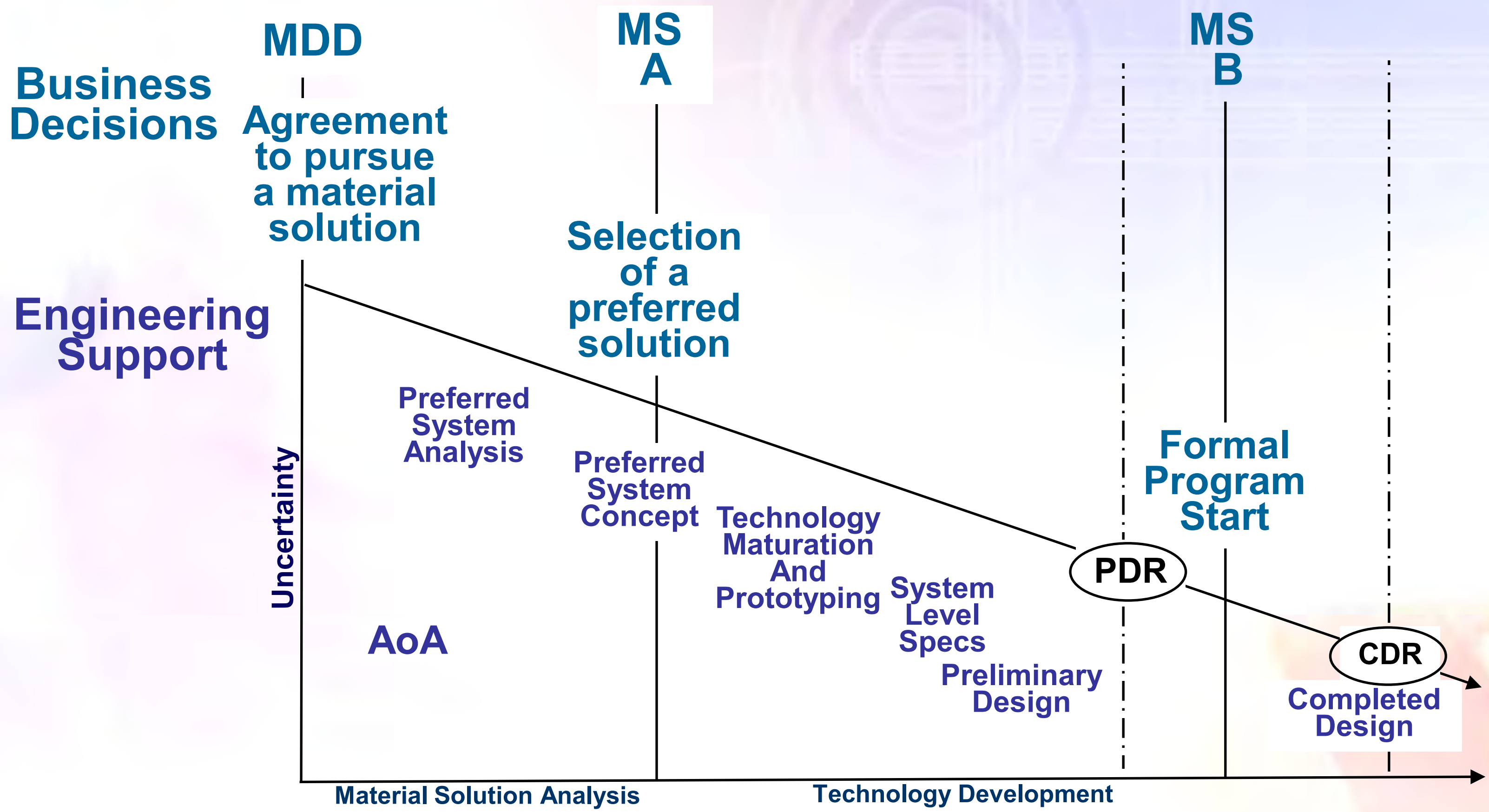
For More Information: Wed Afternoon

Session C - 1:30-3:15pm
Track 1 SE Effectiveness – Bayview III
6878 Reduction of Total Ownership Costs (R-TOC) and Value Engineering in the Defense System's Life Cycle, Chet Bracuto & Dr. Danny Reed
Track 2 Best Practices & Standardization – Bayview II
6888 Value Engineering: Enhance DMSMS Solutions, Dr. Jay Mandelbaum
7761 Applying Business Process Modeling to Develop Systems Engineering Guidance for New DoD Acquisition Regulations, Dr. Judith Dahmann
Track 3 Program Management – Bayview I
7344 Complex System Development Program Assessments and Support: A Forensics Perspective, Dr. Dinesh Verma
Session D - 3:30-5:15pm
Track 1 SE Effectiveness – Bayview III
7204 Advancing Systems Engineering Practice within the Department of Defense: Overview of DoD's Newest University Affiliated Research Center (UARC), Sharon Vannucci & Dennis Barnabe
Track 5 M&S – Mission II
7174 Virtual Battlespace Center for Systems Engineering, James Hollenbach

For More Information: Thurs Morning

Thursday, October 23, 2008
Session A - 8-9:45 am
Track 1 SE Effectiveness – Bayview III
7697 Enhancing Systems Engineering in the Department of Defense, Ceasar Sharper
Track 2 Best Practices & Standardization – Bayview II
7179 Integration of Systems and Software Engineering: Implications from Standards and Models Applied to DoDs' Acquisition Programs, Donald Gantzer
Session B - 10:15am-Noon
Track 5 Education & Training – Mission II
7094 Development and Validation of a Systems Engineering Competency Model, Dr. Don Gelosh

Improve Knowledge through Technical Foundation



Systems Engineering is effective when it informs, and is informed by, other Acquisition process owners.

DEPARTMENT OF DEFENSE MERIT
Materials of Evolving Regulatory Interest Team

Emerging Contaminants (EC) Directorate

www.denix.osd.mil/MERIT

Maintaining Strategic Advantage by Learning to Surf in San Diego

Your Surfing Instructor is
Shannon E. Cunniff
Director, Emerging Contaminants
ODUSD (I&E)

NDIA Systems Engineering Conference Oct 2008

Today's Surfing Lesson

- Understand the Ocean
- Read Today's Conditions
- Proactively Paddle or

  Miss the Wave
- Sustain your Ride!

Lesson One

Understand the Ocean

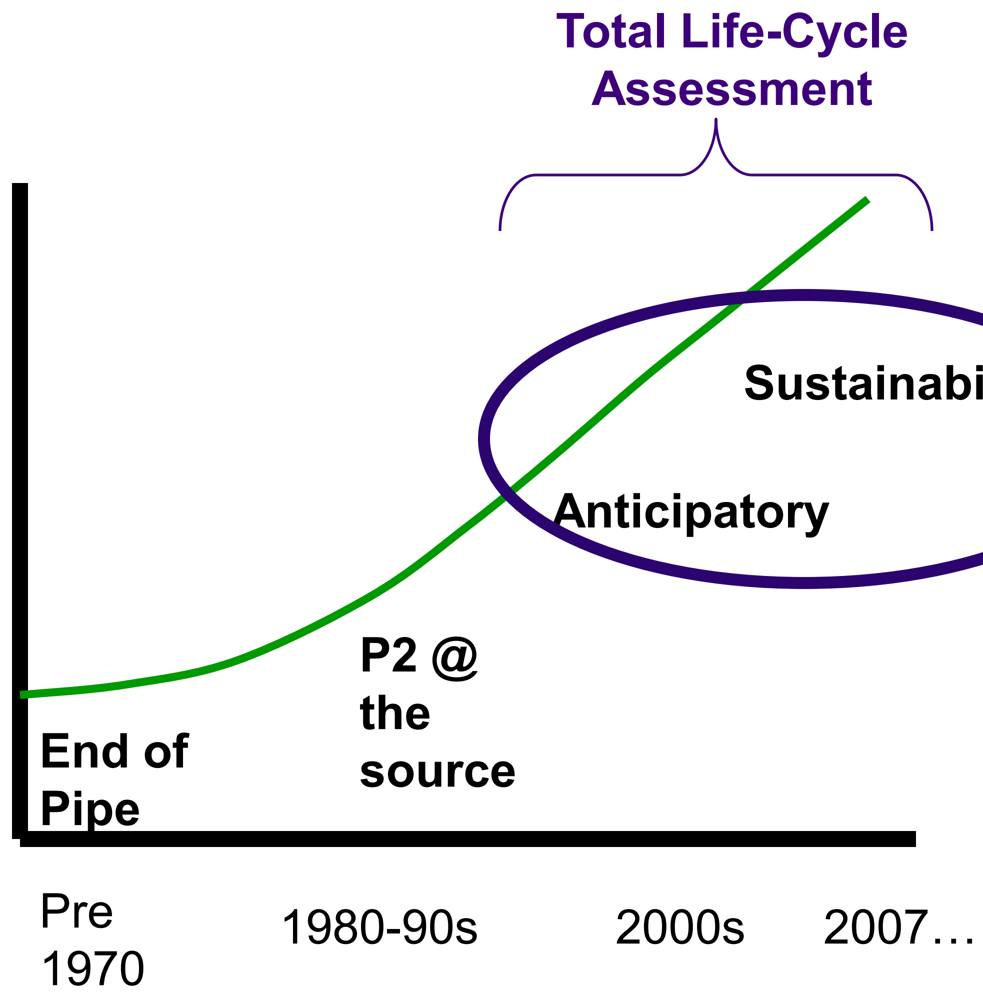
Trends

- **Economic strength / growth**
  - » Energy costs increasing
  - » Environmental liabilities
  - » Discretionary spending shrinking
  - » Frustration with ATL spending & timeliness

- **Legal**
  - »Regulations, Treaties
  - »EO 13423
  - »Regional Agreements

Evolve to remain relevant and ready to meet these challenges.

Progression of Environmental Practice



National Chemical Risk Mgmt Trends

Use of Precautionary Principle

» Must understand health & environmental effects before using chemicals

Chemical Management and Green Chemistry

» E.U. REACH, EO 13423, U.S. ChAMP, likely Toxic Substances Control Act reforms

Biomonitoring – What's showing up in humans?

» Center for Disease Control's national biomonitoring & Calif. voluntary program

Evolving Risk Assessment Process

» Increasing transparency…showing uncertainty range
» Identifying science gaps early and filling gaps via research
» Shift from animal dose/response →toxicogenomics with human cells
» Use of computational sciences
» Application of Age-Dependent Adjustment Factor (ADAF)

RoHS and Lead – A Cautionary Tale (continued)

- **One RoHS Goal: Eliminate Lead from Electronics**
- **Aeronautical/Aerospace Applications Constitute ~ 1% of Worldwide Electronics Usage**
  - DoD a fraction
- **Lead-free Circuit Boards Are In Our Supply Chain**
  - Where? What is the impact on mission-critical applications?
- **Initiatives Underway at DoD to Address These Unintended Consequences**
  - All are expensive (time-consuming)
  - All are *re*-active (vice *pro*-active)

Lesson Two

Read Today's Conditions

REACH – Basic Background

Main Objectives

- Reduce risk from chemicals
- Share information on chemicals affects
- Encourage substitution to safer substances
- Authorize or restrict the use of high concern chemicals
- 2009-2018 Progressive implementation based on quantity & hazard

Directly Affects

- Importers to EU & EU based manufacturers to be responsible for assessing the health and environmental effects of every substance
- Importers to EU & EU based manufacturers to transmit information to downstream users
- Downstream users to apply risk management measures

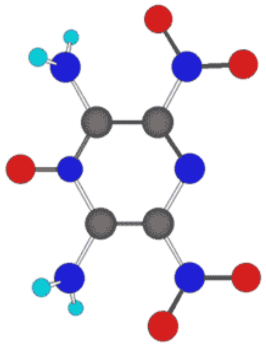
REACH – Basic Background (con't)

- **Requires Manufacturers and Importers to Register Listed Chemicals, which Raises Issues About:**
  - DoD's status and role are complex and unclear
  - Impact to DoD's suppliers (both in and into EU)
  - Proprietary, business confidential and national security info

- **First Impacts to DoD**
  - If by November 30, 2008, if some party has not registered those High Production Chemicals that DoD uses, its possible that then DoD may start feeling the effects of REACH.

REACH: Generating Emerging Contaminants for the Next 10 Years

What is an Emerging Contaminant?



- **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

Defense Exemptions are Possible, Not Guaranteed

- **Specific cases…certain substances…necessary…Defense.**
- **Treaty of Lisbon 2007- EU greater say on Defense matters**
- **Not EU-wide -- Country by Country Exemption -- 30 Countries**
- **Labor intensive to get**
- **Likely to Require Some Proof of Military Uniqueness and Lack of Substitutes**
- **US not an EU Member State**
  - DoD not obligated to comply with EU laws
  - Sovereignty issues
  - SoFA / Bi-Lateral agreements
- **However, for EU Nations**
  - Compliance is mandatory
  - May be subject to sanctions for non-enforcement within their borders

DoD & Defense Industries: Stormy Seas?

- **Potential for Release of Sensitive Information**
  - Required disclosures could reveal sensitive material formulations
- **Foreign Military Sales**
  - US may not have access to needed maintenance or logistic supports in EU
  - Competitive advantage to EU if US suppliers do not comply
- **NATO Interoperability/Unknown Performance Factors**
  - EU military may not be able to use US systems, maintenance procedures, or logistic supports
- **Overseas Maintenance and Base Operations**
  - Chemicals required by for maintenance may not be available
  - May not be able to import articles made with or containing some chemicals
- **Cost and Availability**
  - Diverging defense & commercial sectors: Possible problems with availability of parts and materials
- **Compatibility Issues & Pressure to Expand Qualified Products Lists**
  - RDT&E of substitutes -- alternatives that meet military specs
  - Unknowing acceptance of alternatives
- **Complicated and varying MOD requirements for Defense Exemptions**

REACH … a Surfboard?

- **Knowledge Management Benefits Other DoD Interests and Activities**
  - Inform material selection to avoid late change orders
  - Lifecycle cost reductions
  - EO 13423's chemical risk management goals
  - Strategic materials identification for National Defense Stockpile decision making

EU 1st Round SVHC & DoD Chemicals of Interest

FOR IMMEDIATE CONCERN	
Sodium dichromate	Large potential impact since it is used in many conversion coatings and primers repaint of all DoD aircraft skins, although less than first suspected on F-16s; much will depend on which products have been qualified. May also be used in chromate washes prior to vehicle painting. In many formulations, zinc chromate, barium chromate, strontium chromate or other chromates can be used instead. <**Sodium dichromate dihydrate** was 'screened' in '07 because it showed up on an NTP list. There were **57 items in HMIRS** most were reagent grade for lab use and a number of photo developer cleaning applications.>
Cadmium (Cd) – containing products	Restrictions on Cd use for vehicles come into effect **June 1, 2009** (aircraft exempted for now) includes fasteners and bolts. DoD may not be able to obtain Cd-plated components, even if allowed to use them; major impacts to repair and overhaul can be expected for trucks, for example, since few qualified alternatives (ZnNi plate, Al coatings), especially for fasteners.
Asbestos	Used for some turbine engine washers, gaskets. Existing items can be used, but not replaced, with asbestos.

OTHER CHEMICALS/USE OVERVIEW	CAS / EC Numbers	Reason	Recently Compiled DoD Information
Anthracene is used in the manufacture of pyrotechnics and as a component of black smoke	120-12-7 / 204-371-1	PBT	May be of concern since it is used in dyes (flares and markers) **HMIRS – 37 products; MIDAS – 32 items**
4,4'-Diaminodiphenylmethane is used as a hardener in epoxy resins and adhesives as well as in some construction coatings	101-77-9 / 202-974-4	CMR	Could become a big issue as DoD uses many adhesives (chemistry to be identified) **HMIRS – 253 products, curing and hardening agents, adhesive film**
Cobalt dichloride's widespread uses include the production gas masks, self indicating silica gels, flux for magnesium refining (notably when recycling scrap material), as a solid lubricant, a metal drier in air-drying coatings and a drying agent in paints, lacquers, varnishes and printing inks; in the production of non-ferrous metals and electroplating processes	7646-79-9 / 231-589-4	CMR	**HMIRS – 215 products; MIDAS – 113 items**

Lesson Three

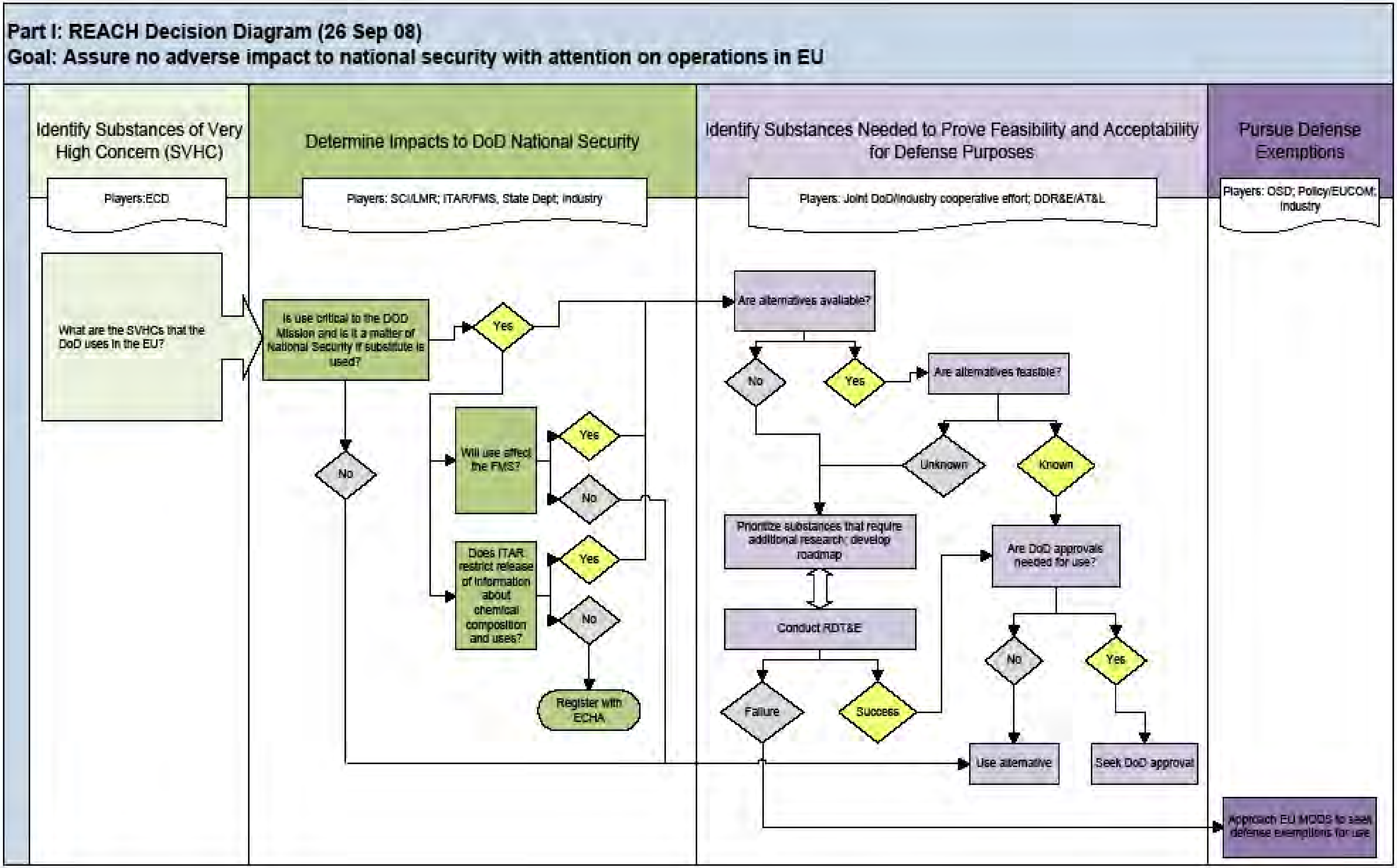
Proactively Paddle or Miss the Wave

Steps for Catching the REACH Wave: What DOD & its Suppliers Can Do

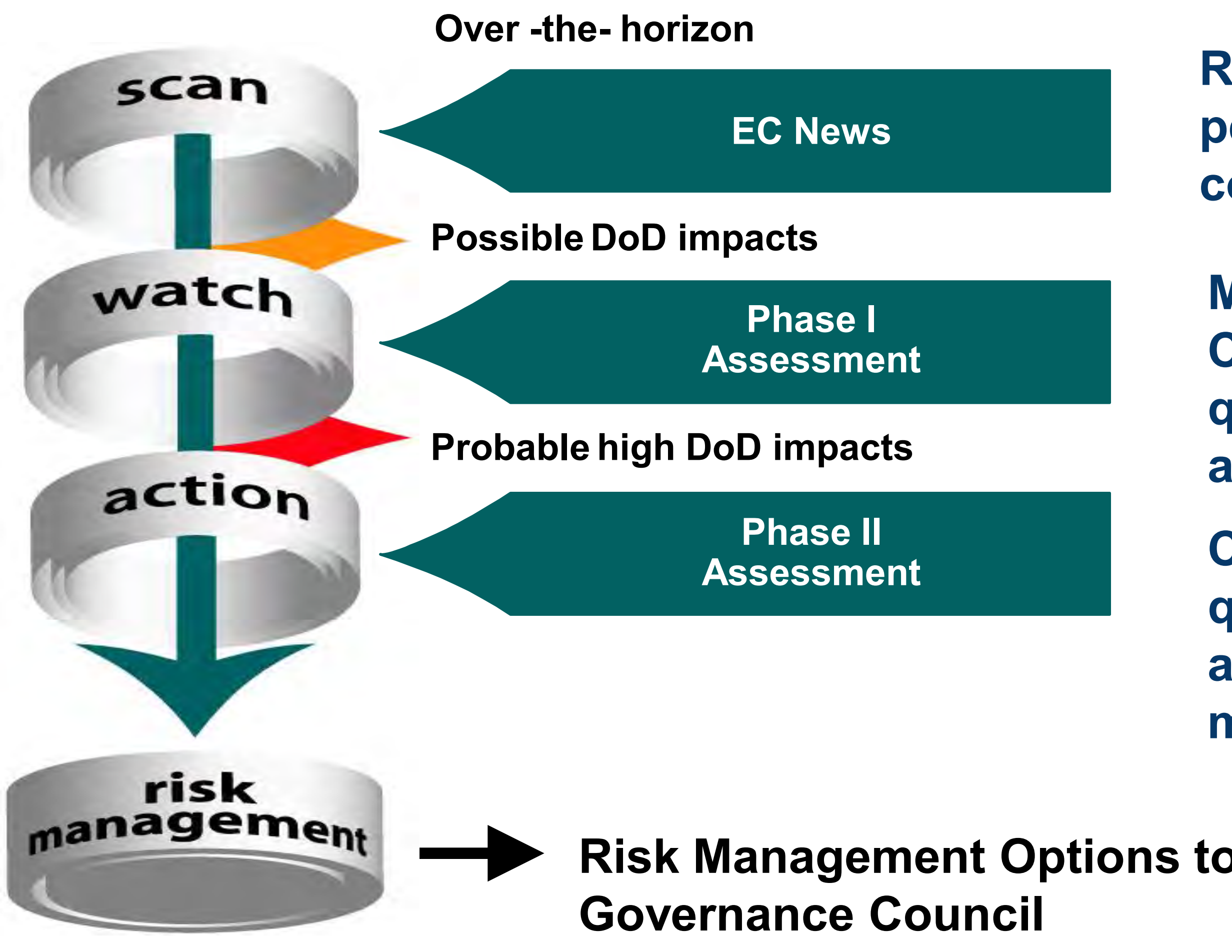
- **Identify Strategic Materials/Chemicals and Identify Needs for Defense Exemptions Early**
- **Coordinate Research Plans to Look For and Evaluate Substitutes**
- **Accelerate & Expand Substitution Efforts**
- **Improve Visibility into Supply Chain**
  - Materials used
  - Chemicals required for O&M
- **Improve Knowledge Management and Information Sharing**
  - E.g., Uses of proposed SVHCs to ensure those uses authorized

DoD's Emerging Contaminants Directorate Can Help You

REACH and EC


Part I: REACH Decision Diagram (26 Sep 08)
Goal: Assure no adverse impact to national security with attention on operations in EU
Identify Substances of Very High Concern (SVHC)
Determine Impacts to DoD National Security
Identify Substances Needed to Prove Feasibility and Acceptability for Defense Purposes
Pursue Defense Exemptions
Players:ECD
Players: SCI/LMR; ITAR/FMS, State Dept; industry
Players: Joint DoD/industry cooperative effort; DDR&E/AT&L
Players: OSD; Policy/EUCOM; industry
What are the SVHCs that the DoD uses in the EU?
Is use critical to the DOD Mission and is it a matter of National Security if substitute is used?
Yes
No
Will use affect the FMS?
Yes
No
Does ITAR restrict release of information about chemical composition and uses?
Yes
No
Register with ECHA
Are alternatives available?
No
Yes
Are alternatives feasible?
Unknown
Known
Prioritize substances that require additional research; develop roadmap
Conduct RDT&E
Failure
Success
Are DoD approvals needed for use?
No
Yes
Use alternative
Seek DoD approval
Approach EU MODS to seek defense exemptions for use

EC "Scan-Watch-Action" Process

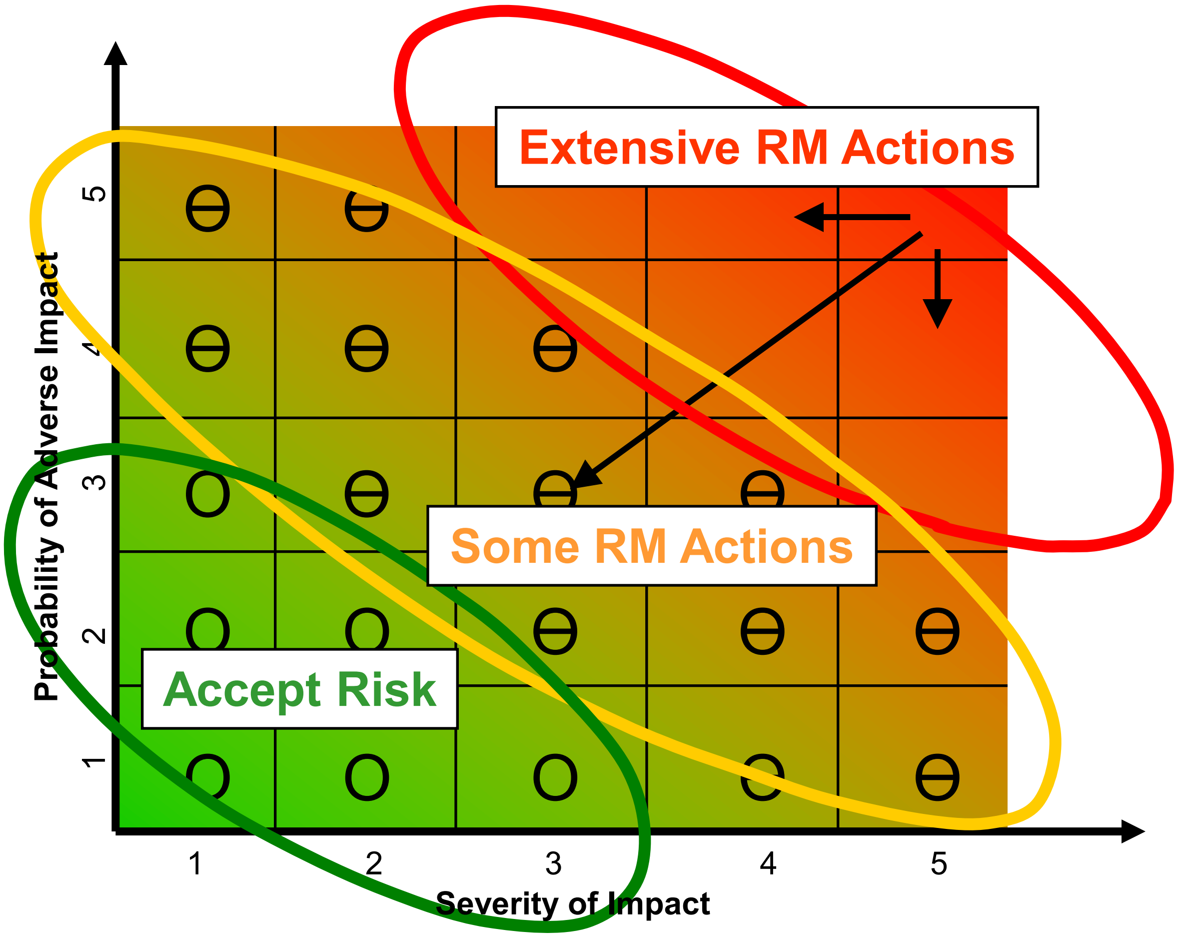


Review literature, periodicals, regulatory communications, etc.

Monitor events; Conduct Phase I qualitative impact assessment

Conduct Phase II quantitative impact assessment with risk management options

Integrated Risk Management



- Define the negative influences on the enterprise in question.
- Identify strategic risk management options to lower severe risks.
- Measure progress by quantifying risk reduction of actions taken.

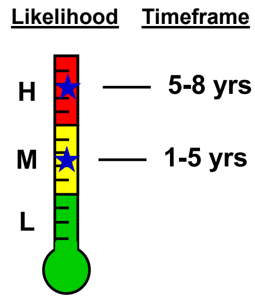
Hex Chromium Phase I Impact Assessment

Completed July 2007

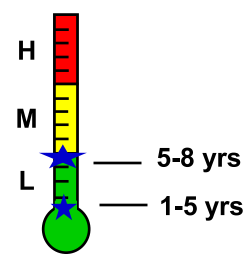
Hexavalent chromium is used in DoD weapons systems due to its useful metal finishing properties. Chromium compounds enhance hardness, increase adhesion as paint primers, and provide corrosion protection. Undergoing IRIS reassessment and CAL/EPA is developing drinking water public health goal.

<u>Likelihood of Toxicity Value/ Regulatory Change</u>

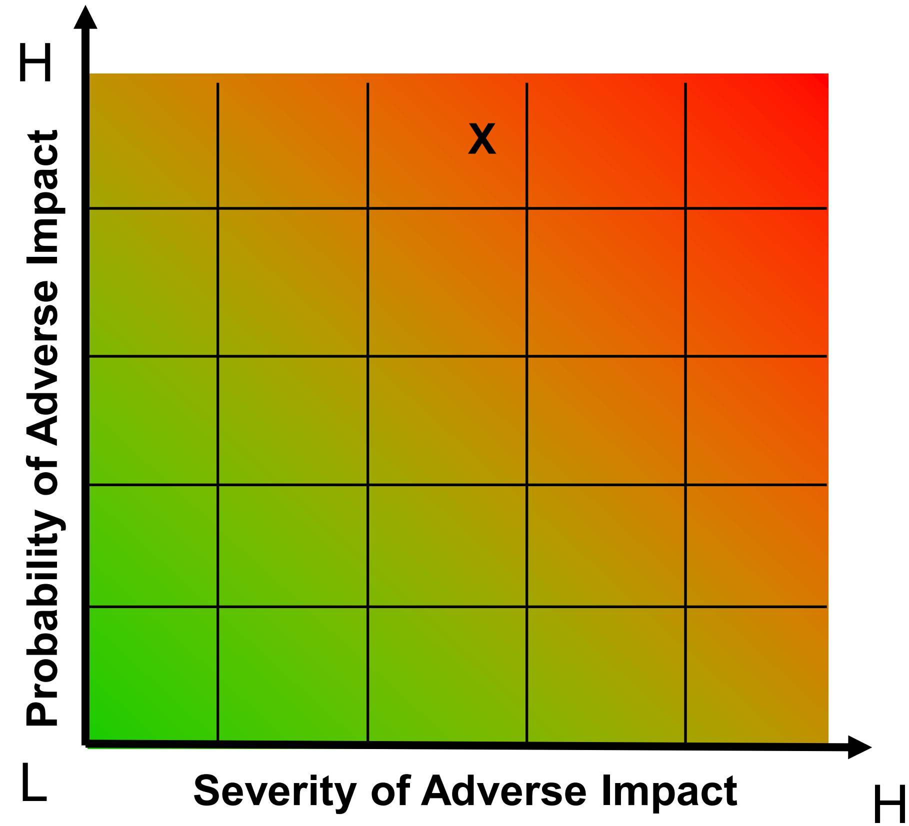
1. **Likelihood that the USEPA will revise the IRIS toxicity benchmarks for Hex Chrome**



2. **Likelihood that OSHA will revise the occupational exposure standards for Hex Chrome**



Note: California may establish a Public Health Goal before USEPA finalizes its IRIS value or reassesses the federal MCL.



ES&H **POMD of Assets**

Readiness & Training **X Cleanup**

Acquisition/RDT&E

DoD Action List

- Perchlorate
- Royal Demolition eXplosive (RDX)
- Trichloroethylene (TCE)
- Hexavalent Chromium
- Naphthalene
- Beryllium
- Sulfur Hexafluoride (SF6)

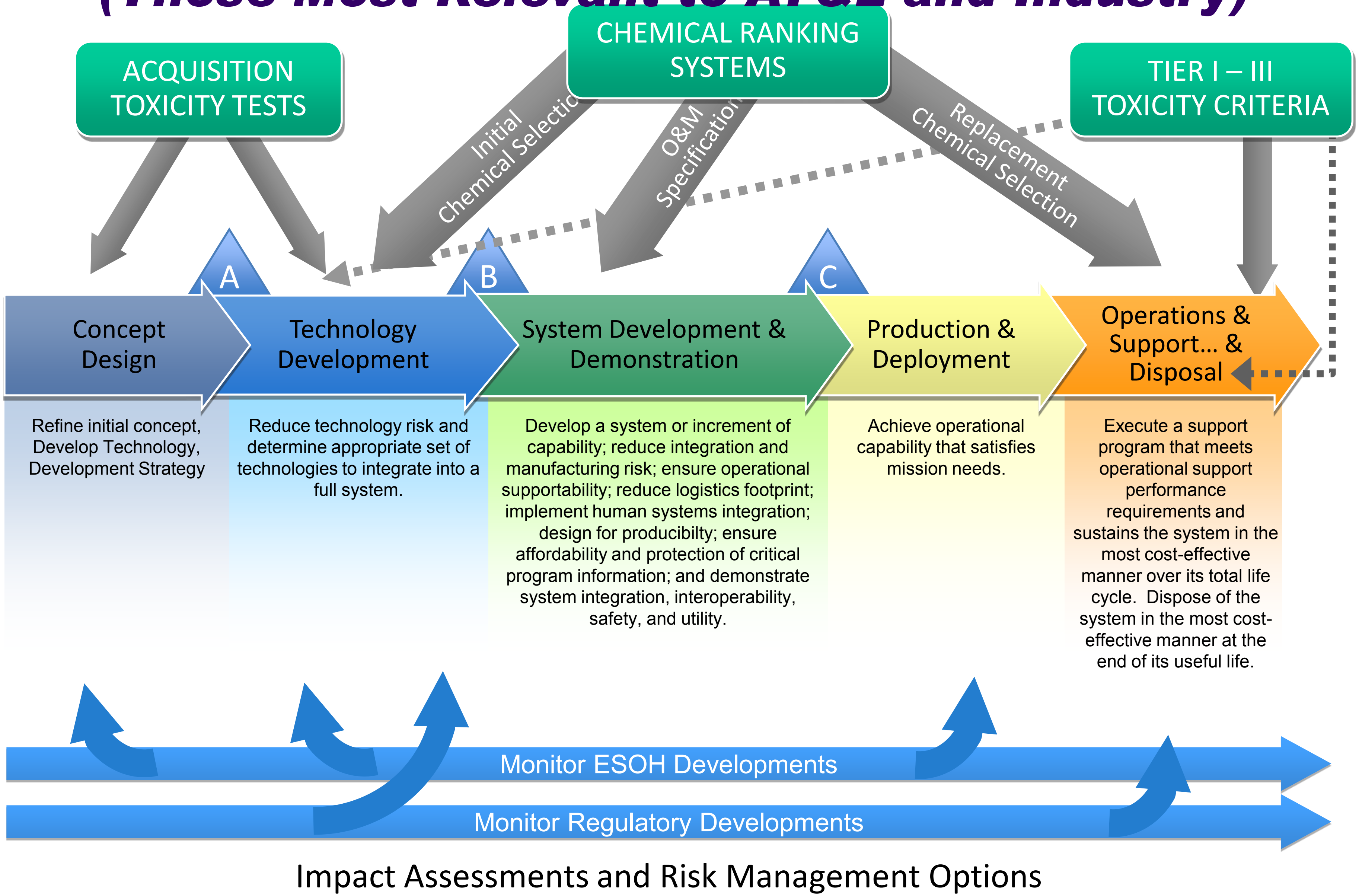
Note: Some risk management actions underway including research on toxicity, substitutes, & treatment.

DoD Watch List

- ✓ Tungsten
- ✓ Tetrachloroethylene (PCE)
- ✓ Dioxins
- ✓ 1,4-Dioxane
- • Nanomaterials
- ✓ Perfluorooctyl sulfonate (PFOS)
- ✓ Di-nitrotoluenes (DNT)
- ✓ Lead (Added 3-07)
- ✓ Nickel (Added 3-07)
- • Cerium (Added 7-07)
- • Cobalt (Added 7-07)
- • Cadmium (Added 12-07)
- • Manganese (Added 12-07)
- ✓ Perfluorooctanoic acid (PFOA) (Downgraded from Action List 9/08)

✓ = Phase I Impact assessments completed

The Products (Those Most Relevant to AT&L and Industry)



Emerging Contaminants Public Web Site: https://www.denix.osd.mil/MERIT

EC PORTAL: www.ecportalinfo.org

Working on More Powerful Ways to

Collect, Disseminate, and Share Information & Experiences

Lesson Four

Sustain Your Ride

Address Emerging Contaminants Early!

Proactive vs. Reactive Actions

Early EC ID & Risk Management Actions →

- **Health Impacts**
- **Cleanup Costs**
- **Compliance Costs**
- **Readiness Impacts**
- **Platform/Facilities Life Cycle Costs**

$$$

Small Investment

$$$

Large Benefits

Sustainability Fosters DoD's Mission

Sustainability Fosters DoD's Mission

- **Strengthens Operational Capacity**
  - Meet current and future training, testing, and other mission requirements by sustaining land, air, and water resources
- **Lessens Costs**
  - Minimize impacts and total ownership costs of systems, materiel, facilities, and operations
- **Enhances Well-Being**
  - Of our Soldiers, civilians, families, neighbors and communities
- **Links the Future to the Present**
  - Fosters identification of user needs and anticipation of future challenges

- ✓ **Disciplined People**
  - ✓ Act with Understanding
  - ✓ Broadened temporal & areal scales
- ✓ **Disciplined Thought**
  - ✓ Broadened System Boundaries
  - ✓ Risk-based Approaches
  - ✓ Life-cycle, Ownership of the risk, Risk taker pays
  - ✓ Moving beyond compliance
- ✓ **Disciplined Action**
  - ✓ Greater Accountability

- ✓ **Distinctive Impact**
- ✓ **Superior Performance for the Mission**
- ✓ **Enhanced Endurance**
- ✓ **Strategic & Economic Advantage**

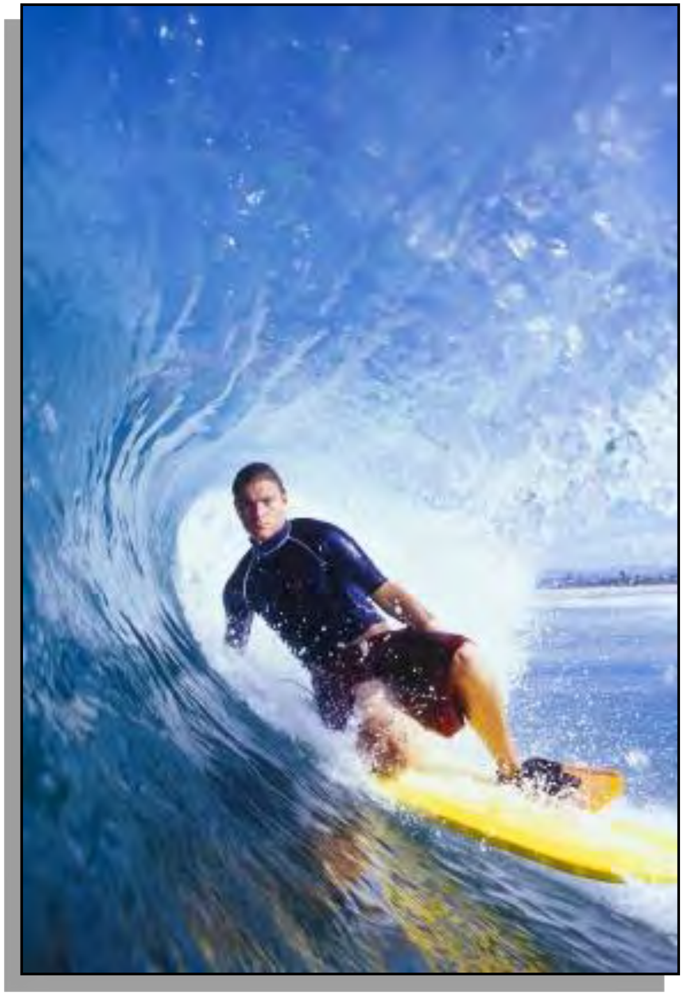
Sustainability is about Building Greatness to Last

Surfing Lesson Main Points

- **Understand the Ocean: New Paradigms Forcing Change**
  - Budget
  - Agility needed to maintain strategic advantage
- **Read Today's Conditions**
  - REACH is just the beginning…its going to get more complicated in a world economy and supply network
- **Proactively Paddle or Miss the Wave**
  - Requires new thinking: Proactive targeted investments before regulatory action
  - EC providing advance warning and tools to help
- **Sustain your Ride!**
  - Potential large payback
  - Protects people, mission and assets

Take Home Message

Either stay ahead of the curve…………..



Or wipe out…………..

Questions & Discussion

Hexavalent Chromium

- Hexavalent chromium is a metal that is used for coatings in aircraft and other vehicles to provide a hard, wear-resistant surface, and in paints to prevent corrosion of the base metal

- The Permissible Exposure Limit (PEL) was recently lowered by the Occupational Safety and Health Administration (OSHA)
- European environmental regulations have effectively banned the use of hexavalent chromium on vehicles and electrical equipment. Many automobile, military parts and electronics manufacturers are adopting European or other stringent standards for all of their products

Hex Chromium Phase I Impact Assessment Findings

- ♦ **Environment, Safety, and Health (ES&H)**
  - High risk because it is a known inhalation carcinogen—CrVI is also a suspected oral carcinogen that poses noncancer risks. May be more stringently regulated due to new toxicity testing results. Significant cost and effort required to monitor and manage worker exposure if standards are lowered.
- ■ **Readiness and Training**
  - Low risk due to the possibility of reduced availability of ranges/firing points as a result of new regulations is considered small.
- ▲ **Acquisition/Research, Development, Testing, and Evaluation (RDT&E)**
  - High risk because over 2,300 munitions items contain CrVI. Aircraft demolition and shipwrecking also releases CrVI. Emerging regulatory constraints may increase life-cycle costs and restrict testing/development of new technologies.
- ● **Production, Operations, Maintenance & Disposal (POMD) of DoD Assets**
  - High risk as new CrVI toxicity values would impact some routine anti-corrosion inspection and painting processes. Waste handling and disposal burdens would increase as would permitting and reporting for many DoD industrial operations.
- ✕ **Cleanup Program**
  - High risk as cleanups at 200-250 DoD sites may be affected. Very likely will have to re-examine closed sites for possible re-evaluation.

➢ Recommendation: **Phase II Impact Assessment in process/RMOs under development.**

Beryllium

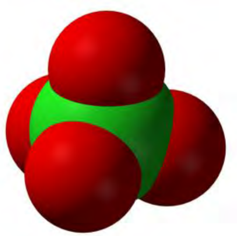
- Beryllium is a steel-gray, naturally occurring metal found in rock, coal, soil and volcanic ash
- It is used to make specialty ceramics for electrical and high-technology applications such as x-ray machines, spaceships and aircraft, missile guidance systems, and computers
- OSHA's exposure limit is 2 micrograms/cubic meter of air. Under the Clean Air Act, EPA restricts the amount of beryllium that can be released into the air

Naphthalene

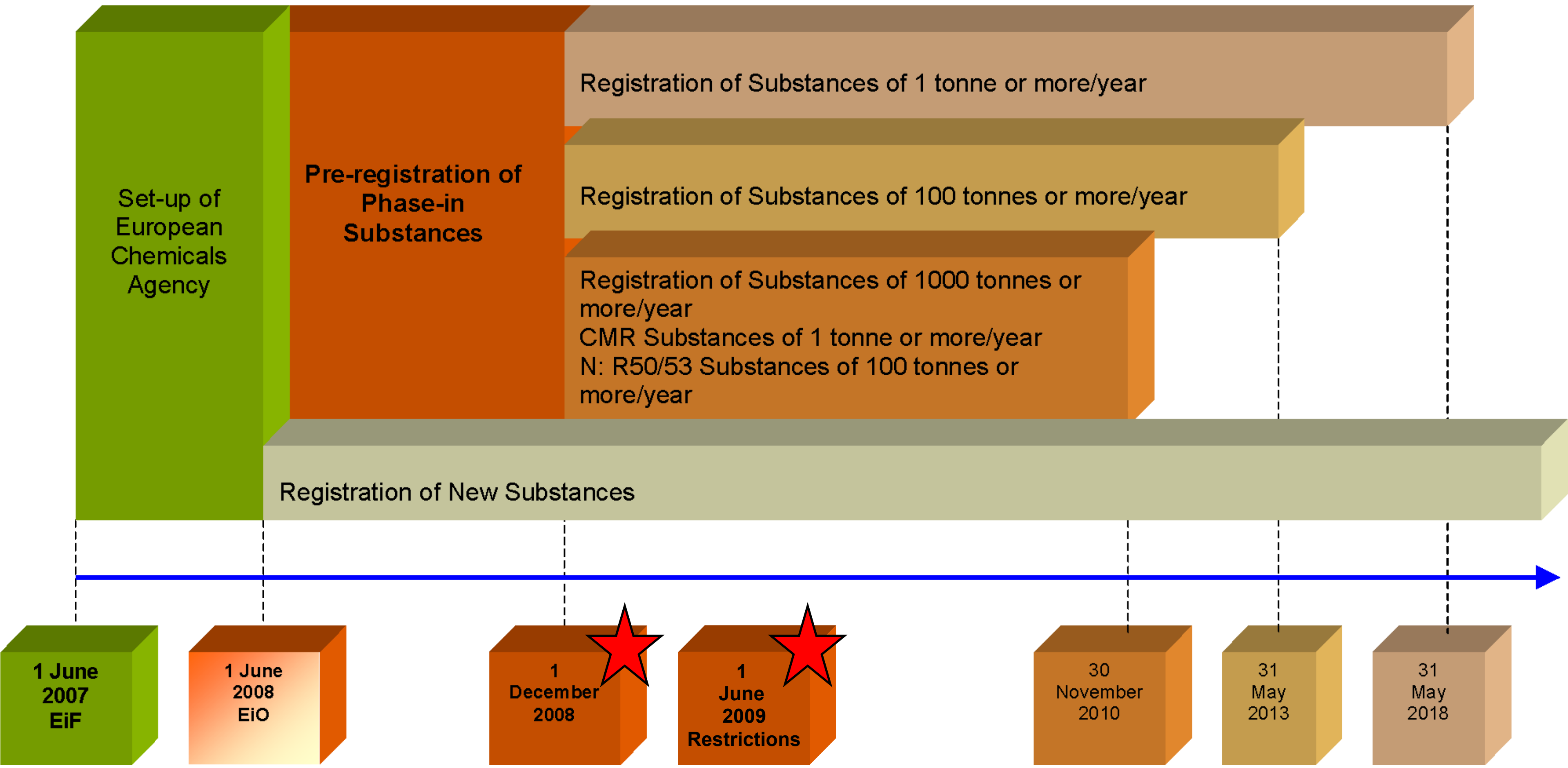
- Naphthalene is a natural constituent of petroleum and jet fuel used by the military. It also appears as a white solid in pesticides (e.g., mothballs)
- Naphthalene is classified by the National Toxicology Program as *reasonably anticipated to be a human carcinogen*
- EPA is evaluating potential regulatory changes
- There are potentially significant impacts on health and DoD operations, especially fuel handling
- Further engineering controls, personal protective equipment, air monitoring, and medical tracking may follow
- DoD complies with current environmental and occupational health regulations
- DoD is testing jet fuel samples and evaluating potential impacts on DoD related to possible changes in regulatory status

Perchlorate

- Perchlorate is a salt with properties that make it the safest, most efficient, stable and reliable propellant oxidizer available
- DoD relies on perchlorate for rocket and missile propellants, pyrotechnics and flares, but is relying on it less and less for munitions
- Perchlorate was detected — generally at levels below EPA's benchmark of 24 parts per billion — in drinking water sources in at least 34 states
- Several states such as California are considering or have recently developed public health goals or other regulatory requirements



REACH – Timeline and Phases



Focus First on substances with <u>high volumes</u> and those of <u>greatest concern.</u>

NDIA 11th Annual Systems Engineering Conference

ESTABLISHNG A SYSTEM OF SYSTEMS SYSTEMS ENGINEERING ORGANIZATION IN THE ARMY

ROSS R. GUCKERT
Assistant Deputy for Acquisition and Systems Integration
Assistant Secretary of the Army for Acquisition, Logistics and Technology
Ross.Guckert@us.army.mil
21 October 2008

Challenges for the Army

- No System of Systems (SoS) Systems Engineering capability at the Enterprise level
  - Stove-pipe product development
  - Many interdependencies
  - Path from Current to Future?
  - SE critical to LandWarNet Battle Command and operational GWOT rotations
- No "Integrator" for Brigade Combat Teams (BCTs) and support Brigades
- Institutionalizing Reliability Programs

Army systems are becoming more interdependent and required operational capability is not provided by a single system, but rather a combination of systems

ASA(ALT) SoS SE Organization

MISSION

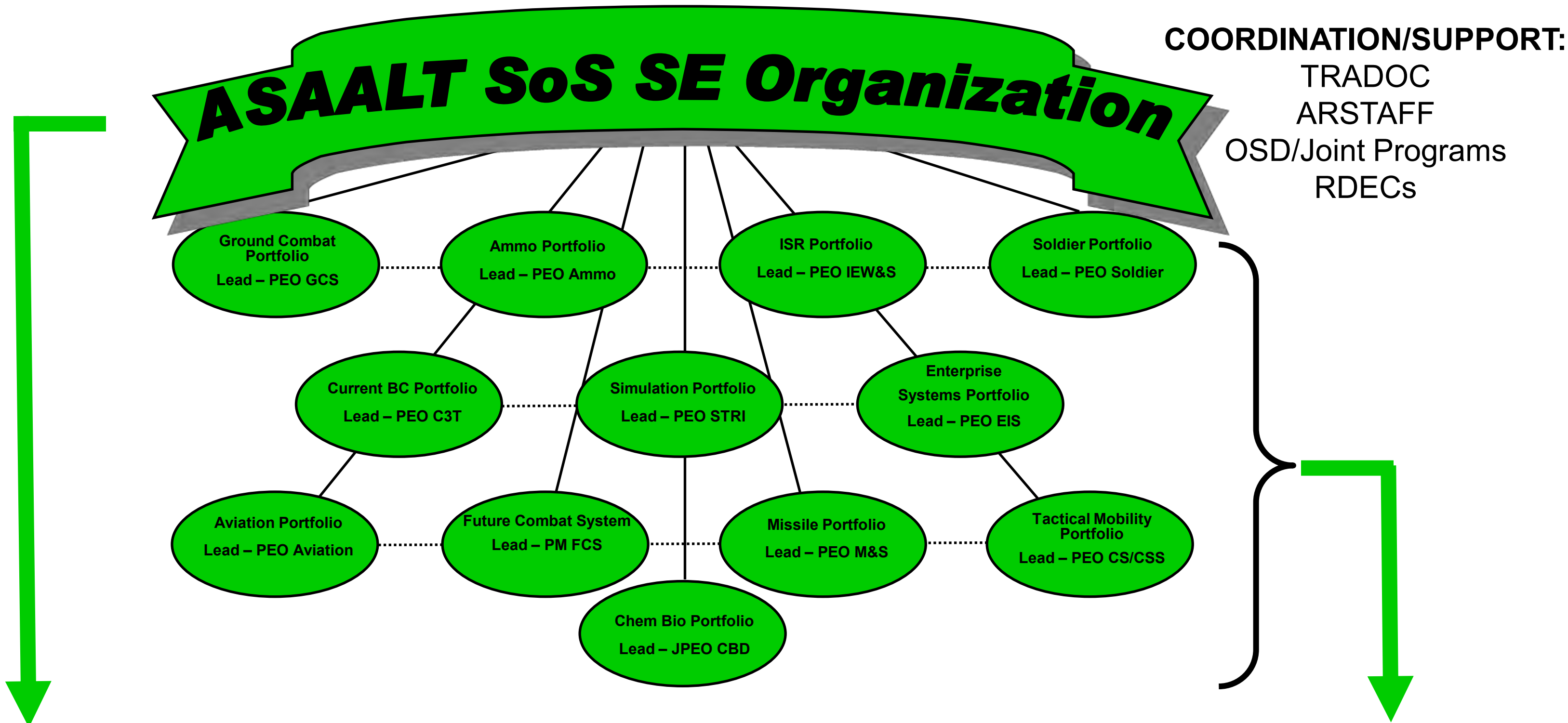
Provide Systems Engineering capability at System of Systems level across the Army enterprise to deliver integrated and interoperable weapon systems that provide optimized and affordable capability

FUNCTIONS

- Develop, evolve, and maintain a detailed, interoperable SoS design baseline - Enterprise Systems Architecture
- Address technical, operational and cost aspects to frame issues for decision making
- Leverage experimentation and M&S tools as part of engineering analysis/operational assessment
- Establish and evolve an SoS vision over time, and translate into capability attributes
- Translate emerging requirements into implied system attributes for technology insertion solutions
- Lead targeted technical assessments to enable cost/capability trades within and across system boundaries
- Maintain visibility into individual system architectures, specifications & performance
- Coordinate technically with SEs in related programs (Army, Joint)

ASA (AL&T)

SoS SE and PEO Relationship



ASA (AL&T) SoS Systems Engineering
- Policy
- Oversight
- Enterprise level system architectures
- Enterprise level analysis, evaluations, trade studies – End-to-end performance
- Synchronize enterprise level development
- Identify and resolve cross-portfolio issues

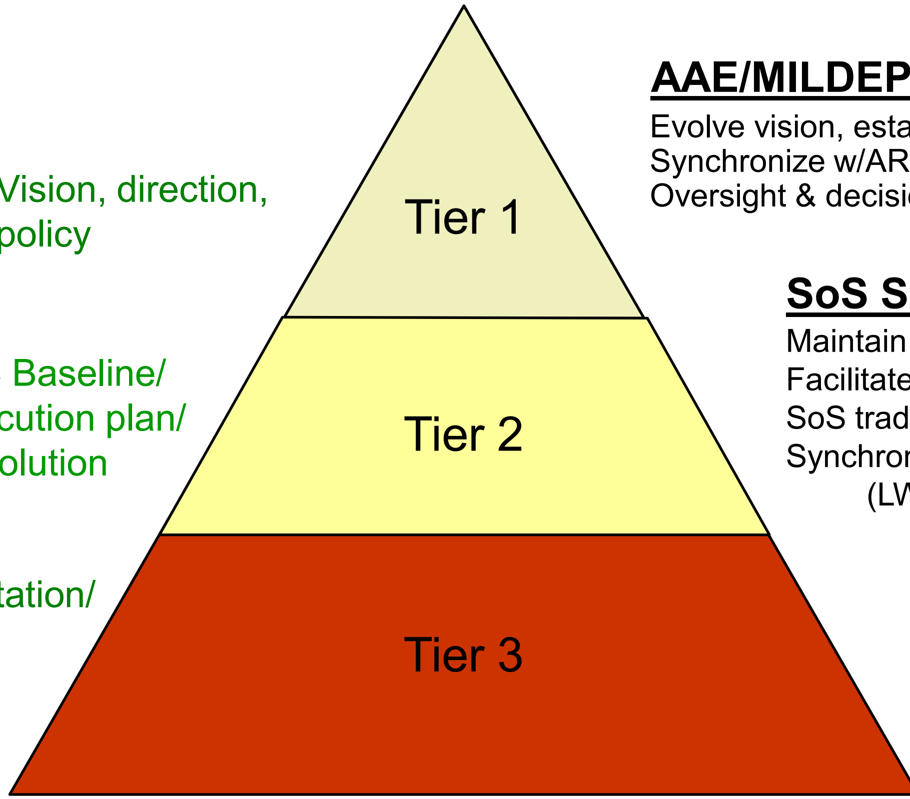
PEO Portfolio SoS Engineering
- Oversight of POR
- Portfolio level architecture (to include cross-portfolio requirements)
- Portfolio level analysis, evaluations, and trade studies
- SoS responsibilities - Works to resolve cross-domain issues
- PEO - Lead
- RDEC, FFRDC, SETA - Support

SoS SE Governance

Vision, direction, policy

SoS Baseline/ Execution plan/ Resolution

Implementation/ Execution



AAE/MILDEP/DASA(A&SM)

Evolve vision, establish policy
Synchronize w/ARSTAFF Leadership
Oversight & decisions

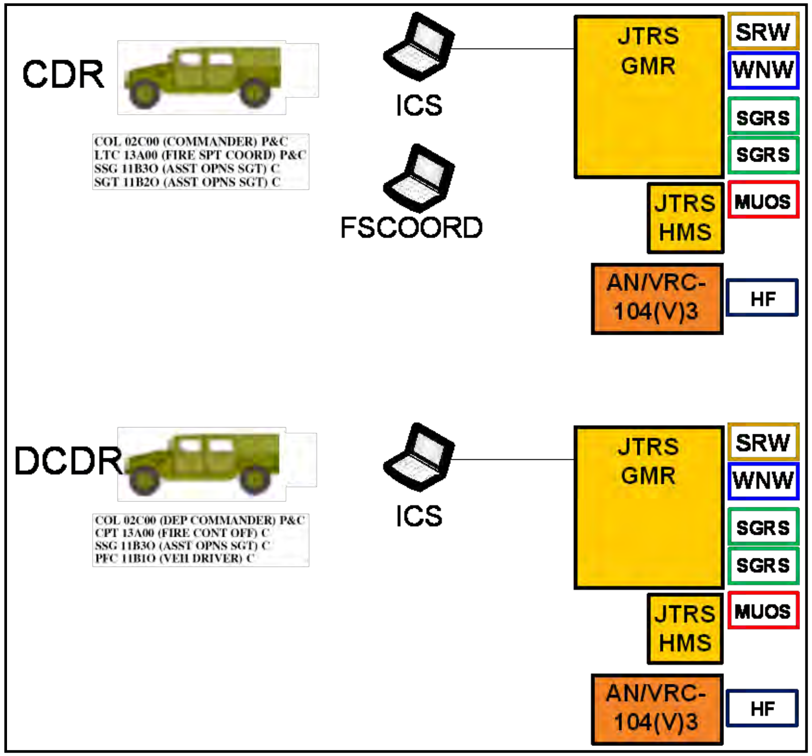
SoS SE Org

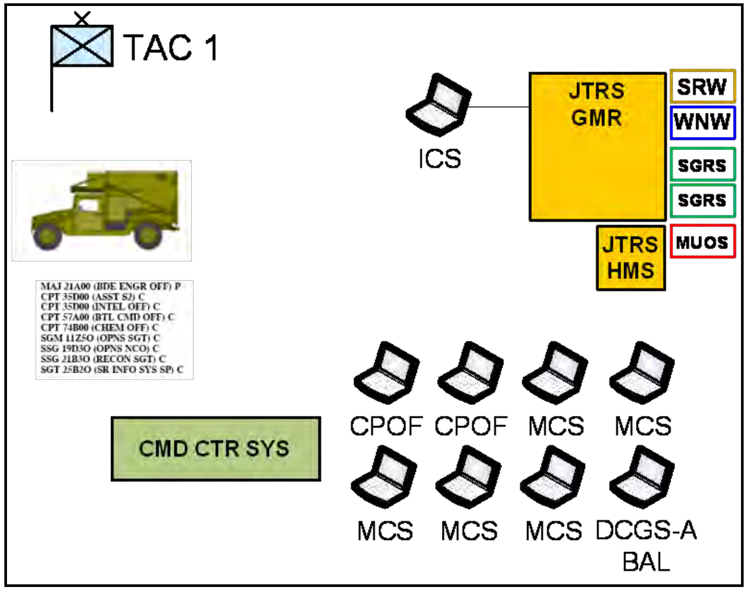
Maintain Enterprise Systems Arch
Facilitate cross-portfolio issue resolution
SoS trade studies/engineering analysis
Synchronize enterprise level development (LWN, SWB, C2 Conv, UBC)

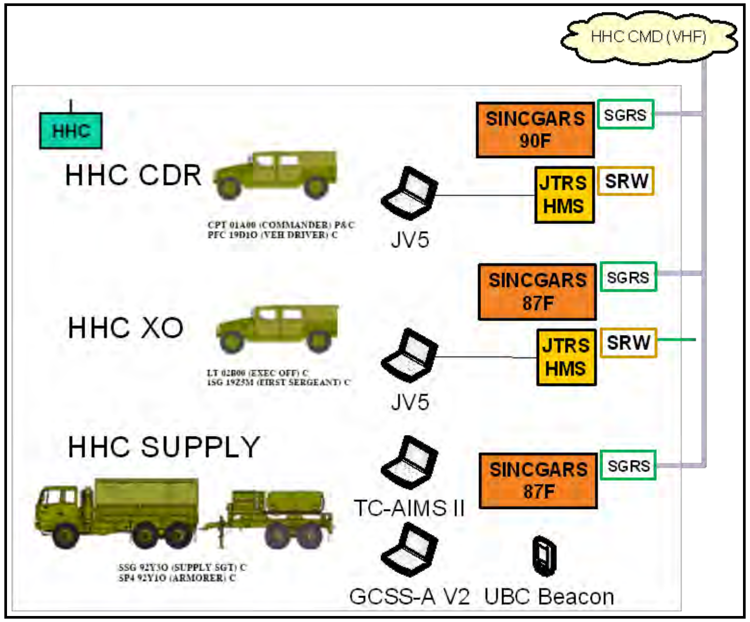
PEOs

Technical Execution/Implementation
SoS Eng & Arch
Support trades

Example: IBCT Snapshots







Synchronization with LandWarNet

LWN/BC Capability Set Management Process

"Capability Set Life-Cycle"

What can be provided when at affordable price?
- SoS Engineering Analysis/Trades
- SoS Synchronization
- Technical Feasibility
- Inform decisions
- "Bang for the Buck"

DEFINE & DEVELOP

STEP 1 CABILITY NEEDS ANALYSIS

G3 — PRIORITIZE CAPABILITY NEEDS

G3 — ESTABLISH CAPABILITY SET PARAMETERS (OPN, TECH, FISCAL)

R-7 Years

FOCUS ON CAPABILITY SEGMENTS — STEP 4

STEP 2 INTEGRATE ARCHITECTURES

STEP3 Fiscal Analysis

SCREEN & ID SOLUTION SET

Does Capability Set stand up to Oper Analysis?
- Exercise Cap Set through Oper Analysis - leverage analytic tool suite
- Adjust to changes (funding, rqmt, force changes, etc.)
- Assess changes on SoS perf & synchronization
- Re-assess "Bang for the Buck"

REFINE

...NT FOR CHANGE ENVIRONMENT

...EW TECHNOLOGY, ONS/JUONS, FORCE SIZING)

PRODUCE / PRIORITIZE COAS

SOSE ANALYSIS OF CAPABILITY SETS

Understood Operational Effects Through Operational Analysis (M&S)

SELECT CAPABILITY SET COA — LWN GOSC — R-36 months

BOIP Lock

"80% Solution"

APPROVE

Approve "Baseline" CAP. SET 15-16 FOR REFINEMENT — LWN GOSC — R-6 Years

STEP5 Develop "BASELINE" INTEGRATED CAPABILITY SET

SYNCH

Near Term Trades

"Good Idea" Cut-Off

APPROVE Final CAPABILITY SET Synched w ARFORGEN — LWN GOSC — R-18 Months

MTOE Lock

ONS/JUONS

STEP7 SYNCH CAPABILITY SET Testing & Certification

Force Validation Conference
Army Sourcing Conferences
Army Equipping Conferences

Begin Reset

SWB Go / No Go

Issue MTOE

FIELD

ARFORGEN RESET SCHEDULE

Army Reliability Initiatives

Army Reliability Policy

- Mandates development and demonstration of a mid-SDD reliability test threshold for all pre-Milestone B programs with a JPD of JROC Interest[1]:
  - Default value is 70% of CDD reliability requirement
  - Must be demonstrated with at least 50% statistical confidence by end of the first full-up, system-level developmental test event of SDD
  - Threshold value must be approved as a part of the TEMP, and recorded in the SDD contract and APB at Milestone B
  - Requires review of material developer's reliability case documentation
    - AMSAA and AEC to apply Reliability Scorecard
- ATEC to perform threshold assessment, and lead IPR in event of a breach:
  - PEO/PM develops corrective action plan
  - AEC performs assessment of PM's plan and projected reliability
  - AMSAA/AEC estimates ownership cost impacts
  - TRADOC assesses utility of system given current reliability maturity level
  - ATEC CG provides recommendation to ASA(ALT) thru Army T&E Executive, with PEO coordination in advance

ASA(ALT) policy expands the Army's current T&E mission

1. Per CJCSI 3170.01F, JROC "Interest" refers to programs that have a potentially significant impact on joint warfighting.

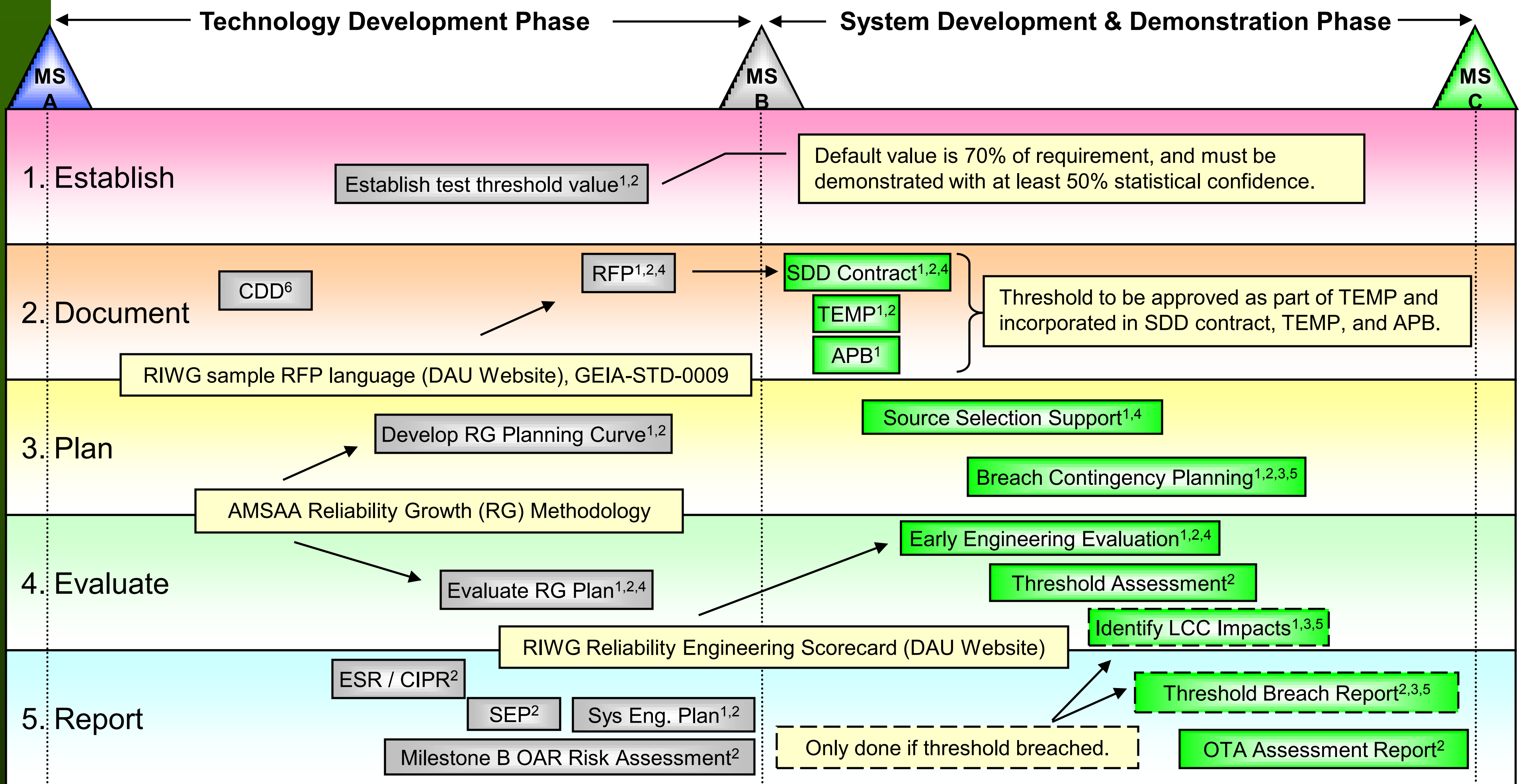
Army RAM Improvement Initiatives

(AAE Memo, 4 Sep 08)

- Army PM Charters to explicitly include RAM focus
- APB to include an increased RAM scope and hold PEOs & PMs accountable
- ASARC (& other reviews) to be modified to focus on RAM
- Reliability expertise & POCs within ASA(ALT) SOS Engineering Organization
- RAM emphasis in future capabilities documents & acquisition contracts
- Improve RAM training provided to Army acquisition & logistics workforces
- Sponsor RAM workshops & conferences, including latest RAM improvement initiatives
- Encourage use of GEIA-STD-0009 (Reliability Stnd for Design, Devel. & Manufac.)
- Apply Reliability Scorecard early to evaluate progress in the development process

ASA (AL&T)

5-Step Army Policy Implementation Plan



- **Key players**: 1 PEO/PM, 2 AEC-RAM, 3 AEC-ILS, 4 AMSAA - Reliability Branch, 5 AMSAA - Resource Studies Branch, and 6 TRADOC.
- **Documentation**: Currently developing an ATEC guide on this implementation plan and associated reliability growth planning processes.
- **Reference**: ASA(ALT) Memorandum, Dated 6 December 2007, Subject: Reliability of U.S. Army Materiel Systems.
- **GEIA**: Government Electronics and Information Technology Association.

Summary

- The Army is modernizing & transforming
- The Army must organize for success
- SoS Systems Engineering plays a pivotal role

Questions?

Back-Up

LWN/BC Governance

Concept for Transformed SoS Governance

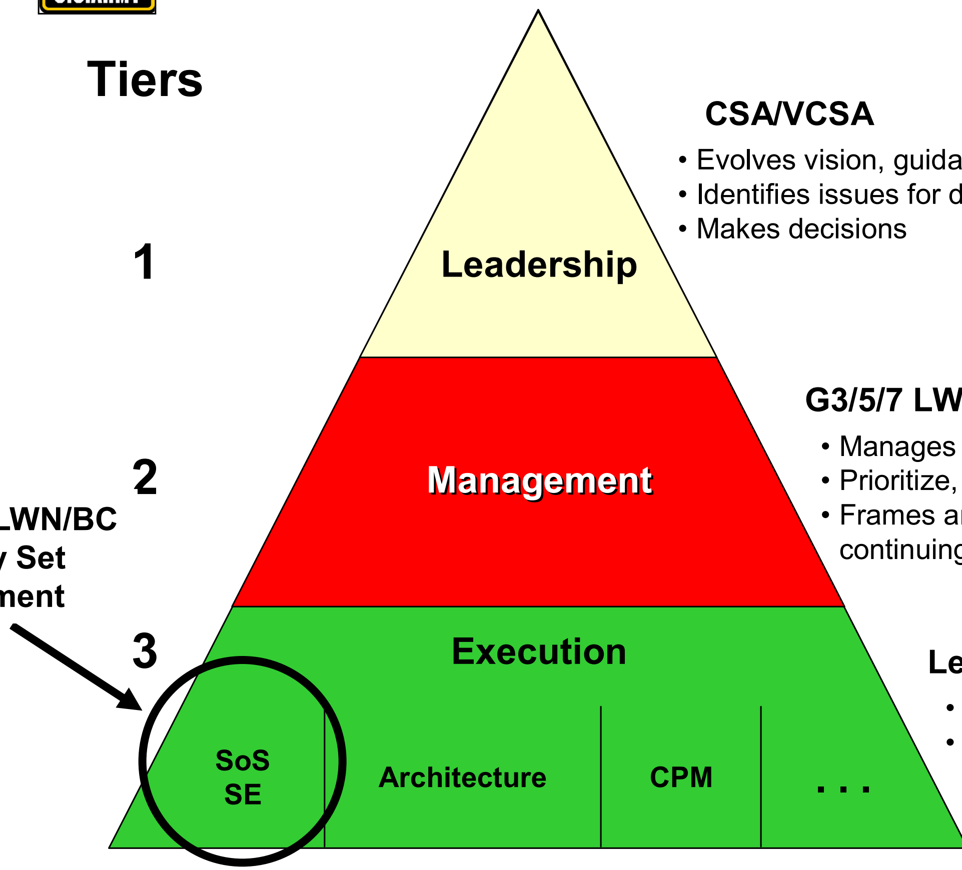
Tiers

1

2

3

Supporting LWN/BC Capability Set Development



CSA/VCSA
- Evolves vision, guidance and directions
- Identifies issues for decision making
- Makes decisions

G3/5/7 LWN/BC Lead
- Manages decision making process
- Prioritize, synchronize, integrate
- Frames and coordinates ad hoc and continuing task execution

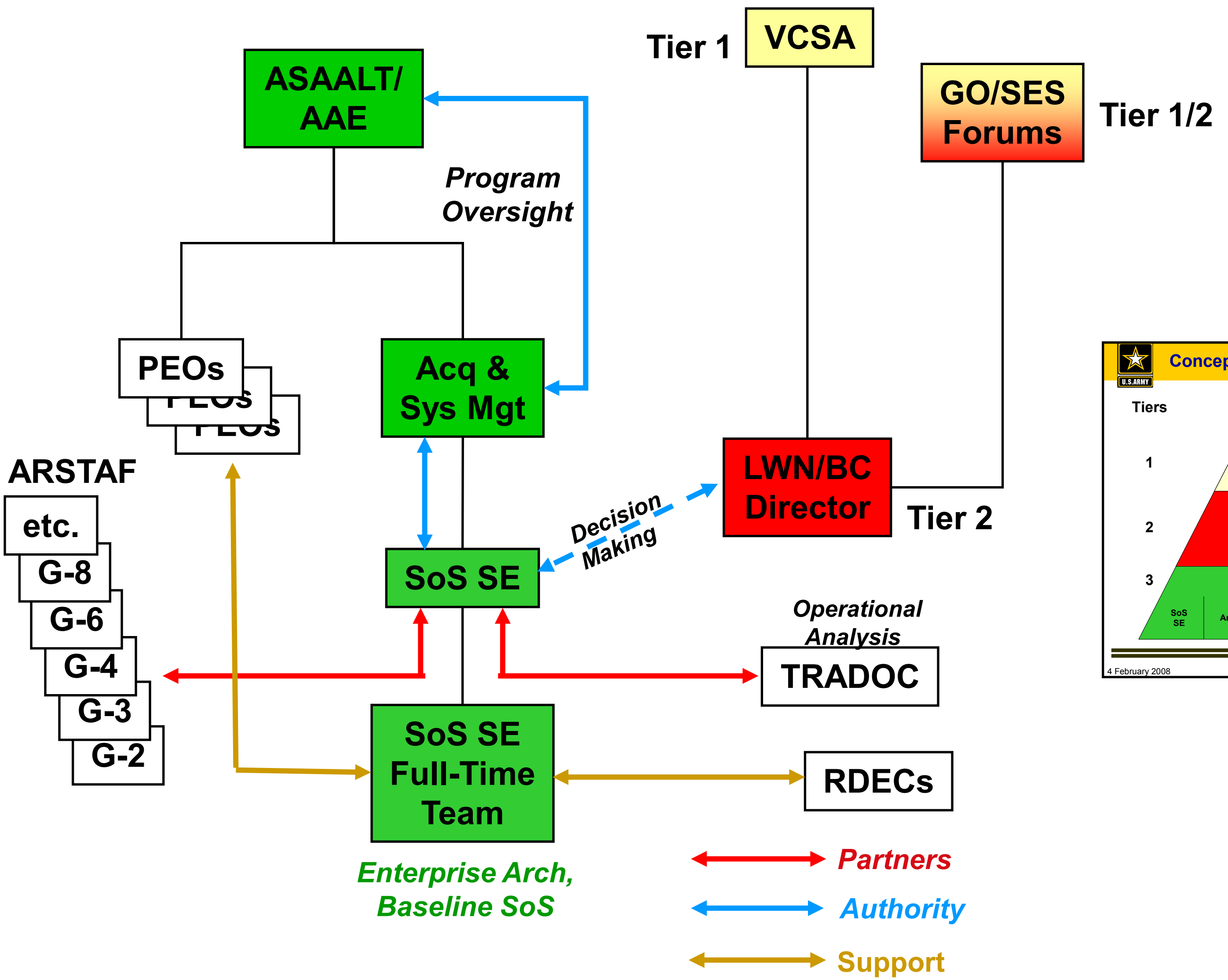
Leads for All SoS Process
- Executes tasks
- Collaborates among SoS Processes

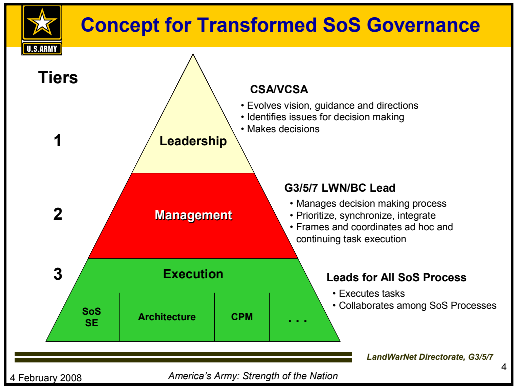
LandWarNet Directorate, G3/5/7

4 February 2008 *America's Army: Strength of the Nation* 4

ASA (AL&T)

LWN/BC & SoS SE Synchronization





UNCLASSIFIED

Generating Force Process Transformation

- **The success of the LandWarNet strategy is reliant on the transformation of current Generating Force processes, policies and procedures.**
- **The adoption of a System of Systems Engineering Approach is the first critical step in the transformation process.**
- **Concurrently, other processes must adapt to enable the System of System approach. The Generating Force processes identified for transformation include:**

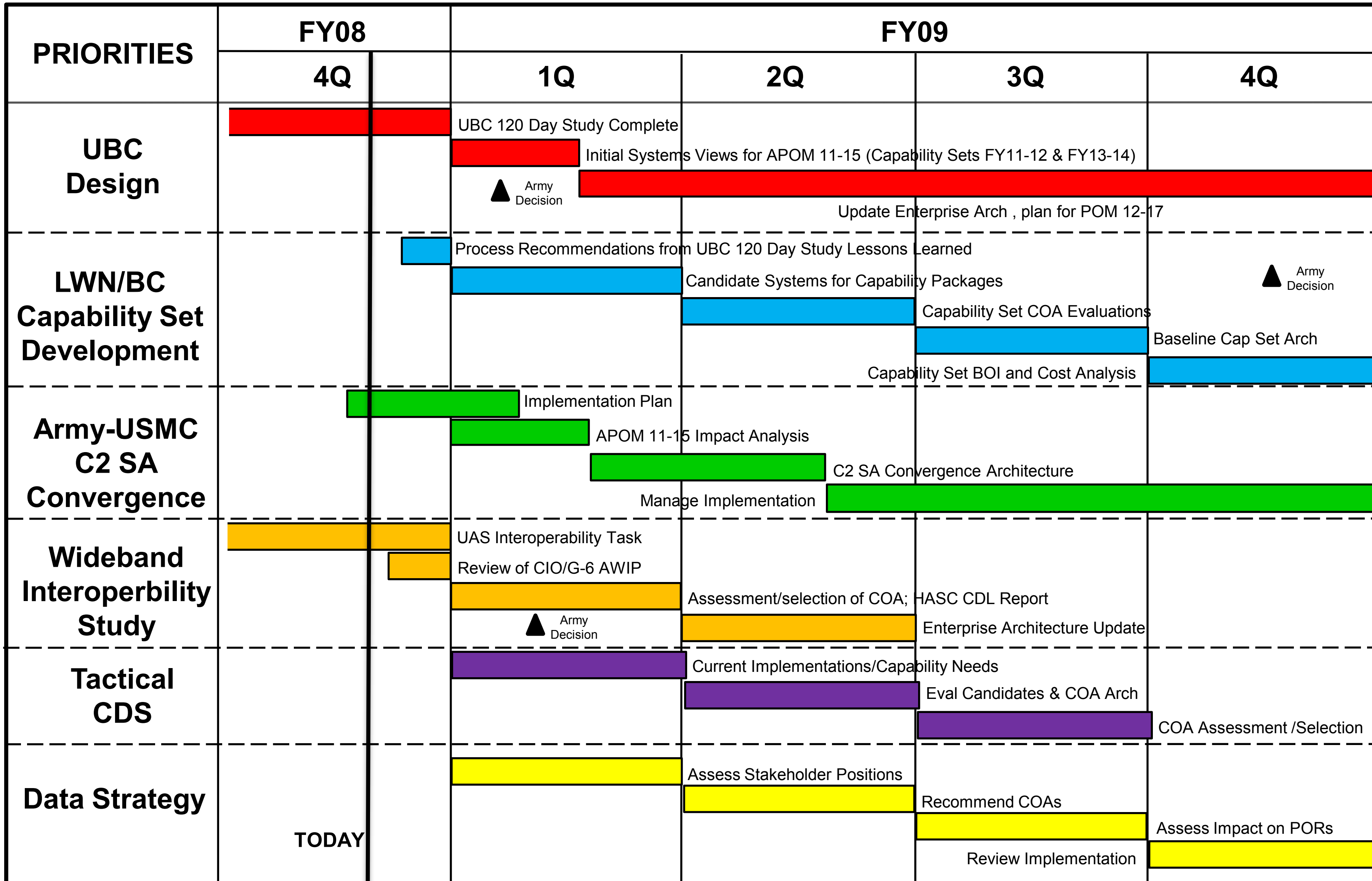
ASA(ALT) SoS SE

- Engineering
- Architectures
- Configuration Management
- Portfolio Management
- Capabilities / Requirement Validation
- Force Integration & Documentation (TO&E, BOIP)
- Operational Analysis (M&S)
- Programming
- Testing & Certification
- Information Assurance
- Fielding Capability Sets
- Acquisition
- *Prioritization (DARPL/ARFORGEN)

To achieve synchronization:
Must determine critical deliverables
ID organizational Interdependence
Target key decision points (strategic and operational)

ASA (AL&T)

Overview of SoS SE Activities - FY09



TORs Being Developed for Each Activity

Headquarters U.S. Air Force

Integrity - Service - Excellence

USAF Systems Engineering

Presentation to the NDIA Systems & Software Engineering Conference
21 Oct 2008

U.S. AIR FORCE

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

Agenda

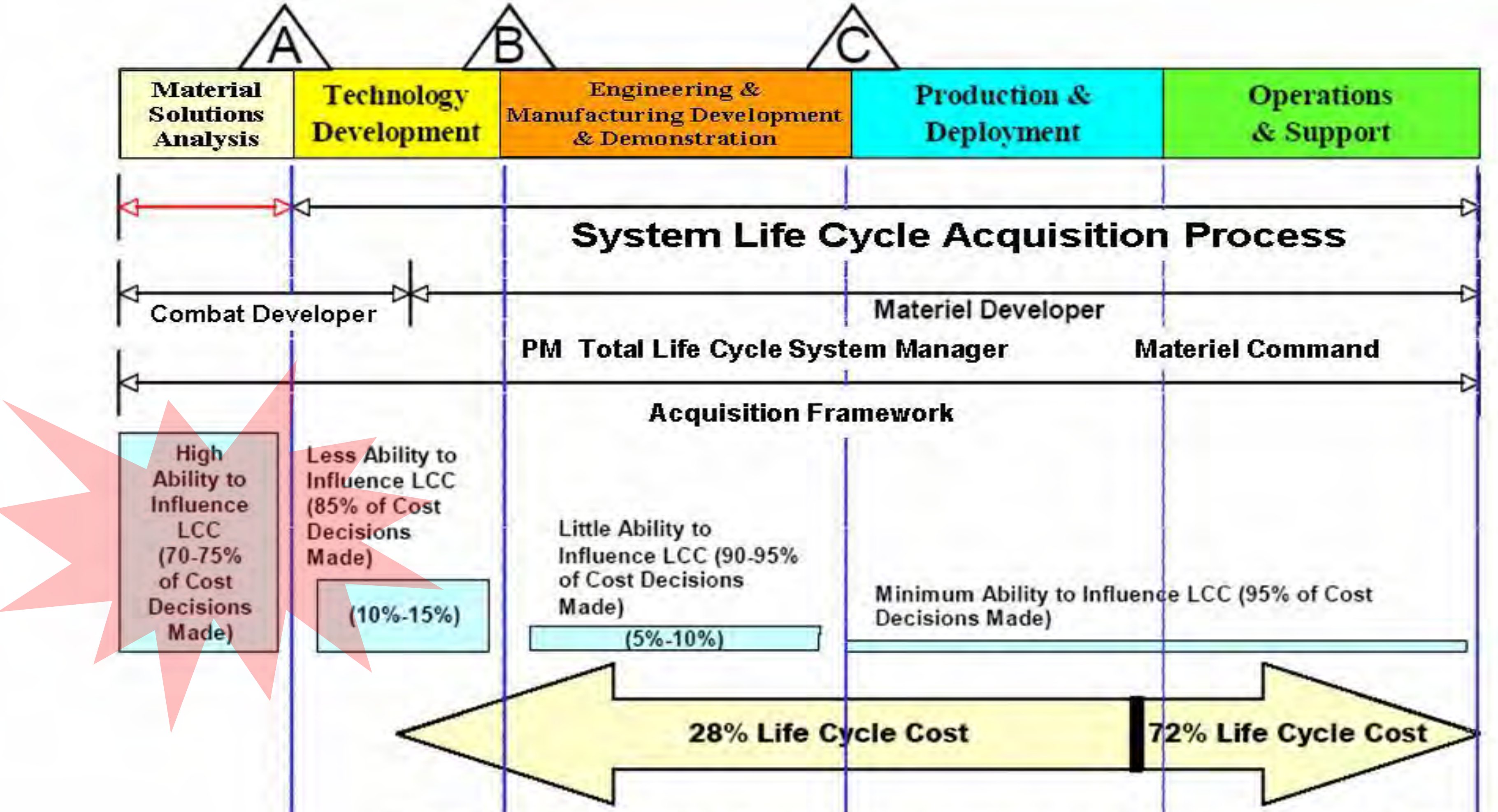
- AF Systems Engineering (SE) Revitalization
- AF Early SE Defined
- AF Early SE Initiatives
- Early SE Workforce Considerations

AF SE Revitalization

- **Accomplishments**
  - Published first AF Instruction on Systems Engineering (Jul 07)
  - Approved first-ever software development guide
  - Approved AF life cycle prototyping policy
  - Approved SE plan (SEP) policy and streamlined staffing by 80%
  - Developed integration readiness assessment tool and implementing during AF ACAT 1C program support reviews
  - Funded interface management program for CSB support (FY10 POM initiative)
  - Established concept development SE plan (ConSEP) and concept spec (CCTD) for space pre-A systems engineering
  - Established AFIT SE Graduate Program and SE Masters' Degree Programs
  - Co-sponsored NRC Study to define 25-yr AF STEM requirements

- **Initiatives**
  - Updating AF Scientist & Engineer Strategic Plan (goal 3 focused on system & software / specialty engineers for pre and post-A materiel development)
  - Developing standardized program support reviews for all AF programs
  - Collapsing discrete S&T and engineering polices to form seamless Research, Development, & Engineering Policy
  - Standardizing pre-A ConSEP and CCTD policy & processes across the AF

"AF Supports NRC Early SE Recommendations"



Adapted from "Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits for Future Air Force Systems Acquisition," Air Force Studies Board, National Research Council of the National Academies, Washington DC, 2008. Original publication: Andrews, Richard, "An Overview of Acquisition Logistics," Defense Acquisition University, Fort Belvoir, VA, 2003.

U.S. AIR FORCE

AF Early SE Defined

Material Solutions Analysis			Technology Development
Pre-AoA Concept(s) SE	***AoA SoS Concept(s) SE***	***Pre-Program Requirements SE***	***Traditional Design Systems SE***
• "Big A" trades	• Refine mat'l concepts	• System requirements	• Preliminary design
• Use SE to - Mature requirements - Determine tech needs - Develop mat'l concept	• Use SE to - Inform requirements - Refine tech needs - Refine concepts	• Use SE to - Define requirements - Develop tech roadmaps - Describe system	• Use SE to - Trace requirements - Assess technology - Describe design
• Lab, Product Centers, MAJCOMs & Industry	• MAJCOM-Led AoA Team	• Product Center XR or Program Office	• Program Office

Concept Spec (CCTD) → *Spec* →

ConSEP → *SEP* →

AF Instruction for Life Cycle SE (AFI 63-1201) →

AF Early SE Initiatives

- **Programs**
  - Increased pre-program engineering & analysis by 39% (+$37M/yr) in FY10 POM
  - Increased pre-program prototyping by 26% (+$10M/yr) in FY10 POM
- **Policy & Process**
  - Approved CCTD guide and directing ConSEPs / CCTDs for all pre-program concept development in lab and product centers
  - Directed prototypes IAW OSD policy (expect to see in FY11 or 12 POM)
  - Multiple AFSO21 process initiatives (capability planning & tech assessment)
- **People**
  - Established AF Technology Transition Office to oversee BA-4 policy & programs
  - Increased pre-program AF civilian engineers at MAJCOMs by 5%
  - Identifying military engineers from AF military plus up (316K to 330K)
  - Designating level III SPRDE-PSE Chief Engineer positions in pre-program developmental planning offices at product centers, in addition to program offices
  - Designating level III SPRDE-SE Chief Engineer positions in AF Research Lab
  - Updating S&E Strategic Plan to address early SE and specialty engineering competencies

Early SE Workforce Considerations

- The numbers of "illities" specialists to adequately contribute to early SE (RAM, manufacturing, ESOH, HSI, etc) will have to be addressed
- Requirements officers, lab technologists, and product center developers should all have SE training (unlike post-A development, pre-A planning is a team sport)
- Offices doing early SE should be staffed by a seasoned & experienced workforce
- Early SE work priorities should be set at the 4-star level and not relegated to the early SE staff to guess (in this phase, everything can be chased)
- Critical acquisition positions (CAP) should be considered for concept developers outside of established program offices (for continuity and leadership)
- Writing, reviewing & approving early SE concept specs (CCTDs) will require new or adapted skills (or at least a revitalization of old ones)
- Pre-program prototyping will require integration risk and EMDD skills

U.S. AIR FORCE

Integrity - Service - Excellence

Systems Engineering and Capability Portfolio Management *(JNO Approach)*

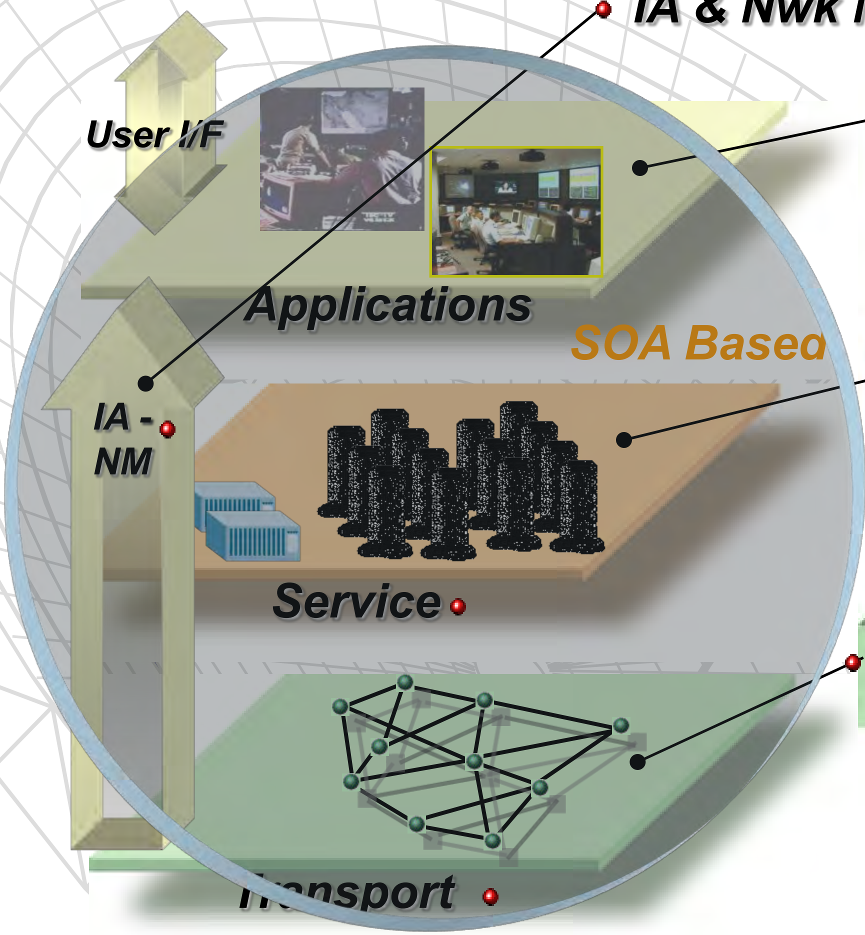
21 October 2008

NDIA Systems Engineering Conference

People throughout the trusted, dependable and ubiquitous network are empowered by their ability to access information and recognized for the inputs they provide.

Build, Populate, Protect

Information & the GIG - Layered Perspective



IA & Nwk Mgmt are critical components

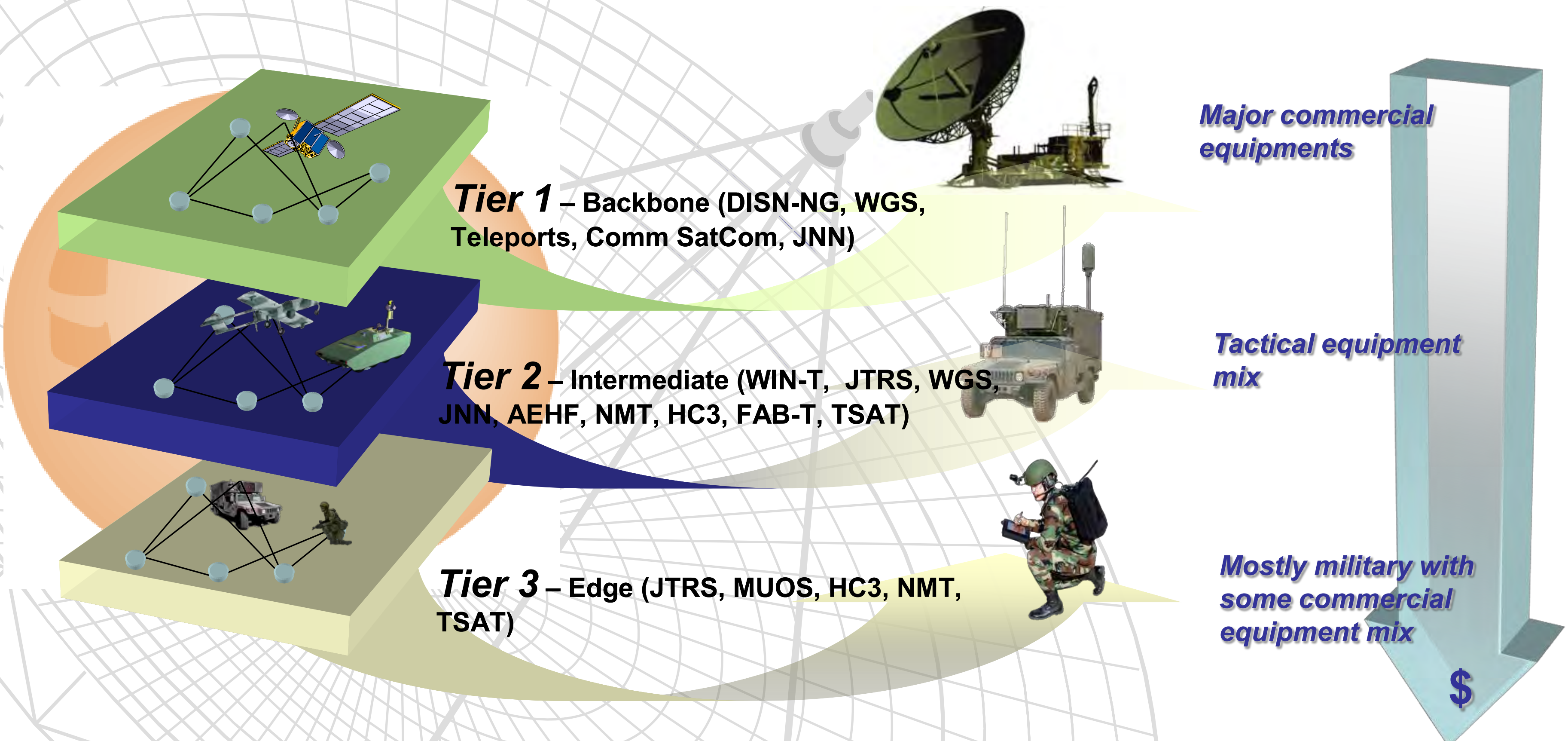
- ✓ Loosely coupled applications based upon SOA/SLA
- ✓ Enabled applications are highly adaptive and flexible

- ✓ Defined data strategy – attributes set by applications
- ✓ XML driven by DoD directives
- ✓ SOA enterprise environment with managed services

- ✓ IP based with QoS established by applications
- ✓ Multi-media for highly available communications

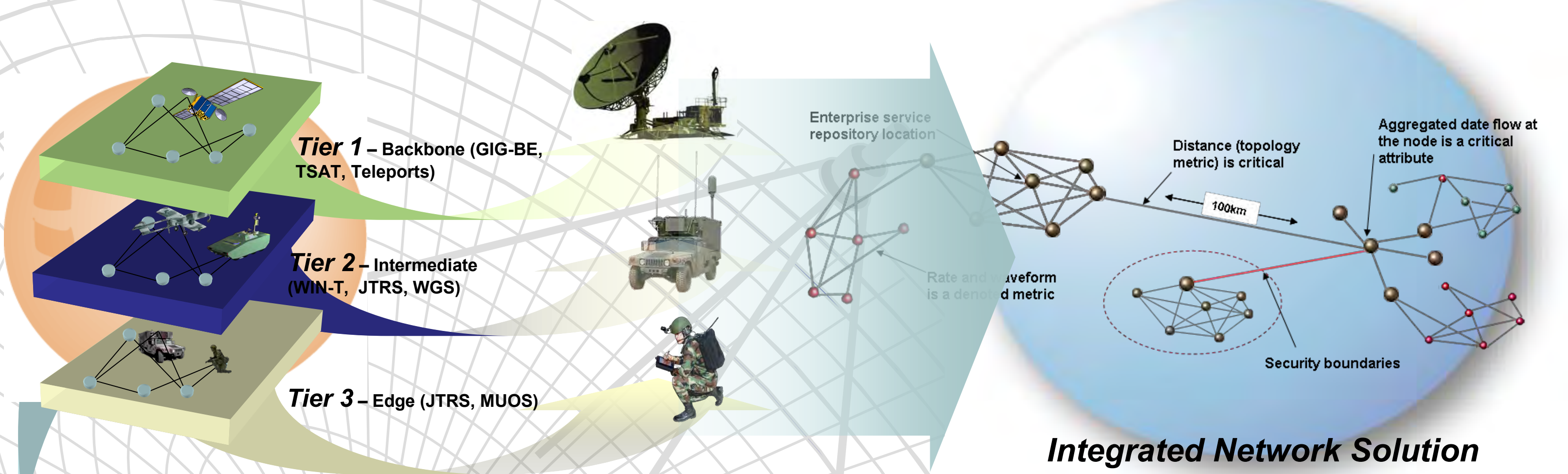
Assured information (data) access is the critical concept – the user sets the information access requirements

Global Information Grid (GIG) Transport Tiers



- GIG is an IP unified network having a BLACK routing and switching basis – tiered in many respects as commercial networks; with cost significantly increasing towards the edge

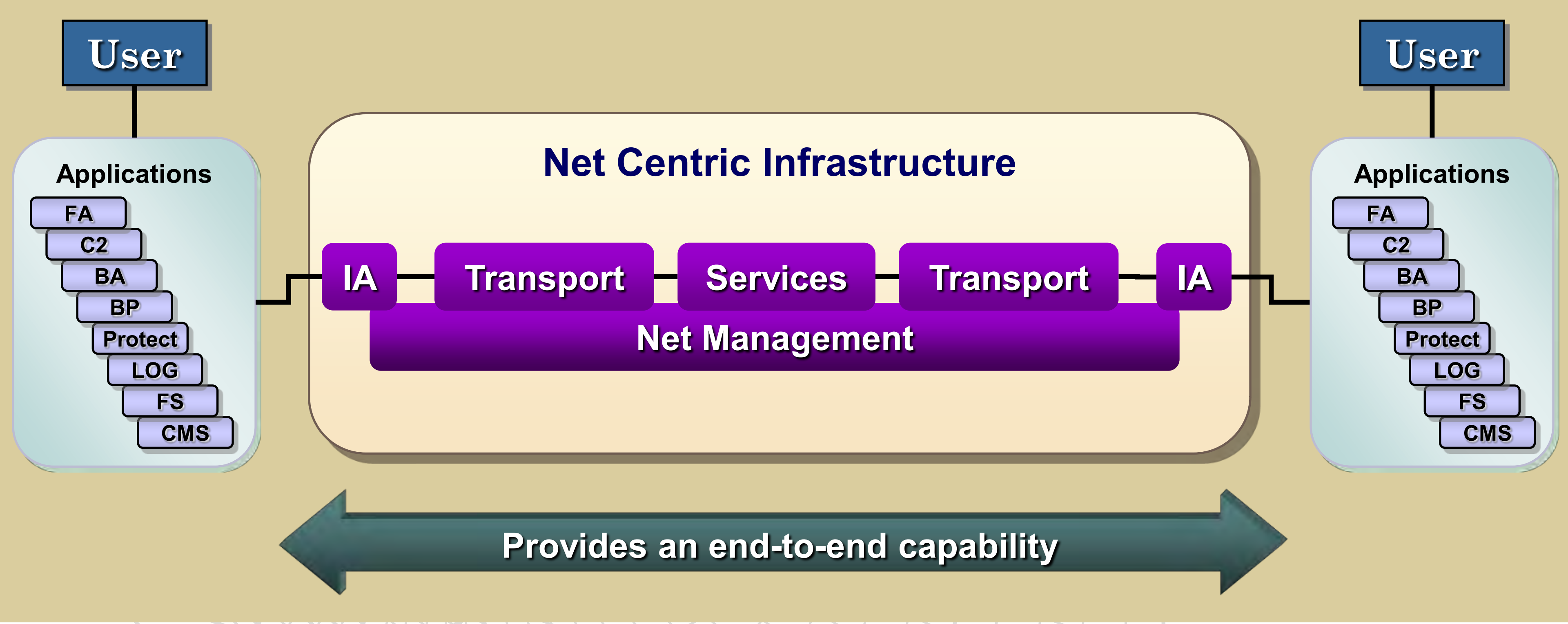
Incomplete Network Solution - Losing Sight of the Network
Network Topology Relationships



- **Understanding the entire network is critical so to not compromise a cost and warfighter effective solution (Interoperability)**
- **Forcing the core and tactical edge networks to be addressed an integrated structure**
- **Network and Enterprise programs are NOT independent**
- **Network is part of the GIG – requires relationship to the services and applications, BUT information (data) is the critical element**
- **Interoperability with more than a single Service element or a partial force – total force including the all Services and coalition forces**

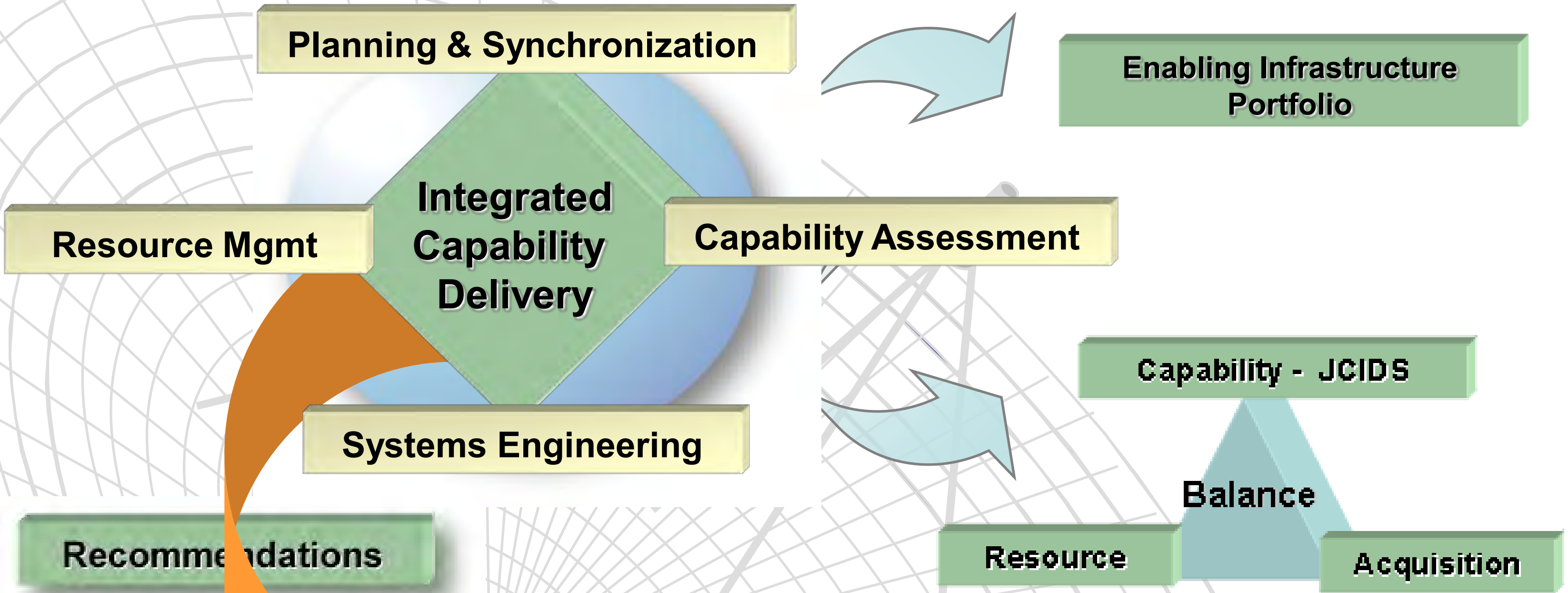
Mission

Conduct portfolio management of enabling programs and capabilities--develop material and non-material solutions to ensure timely, synchronized, and integrated delivery of Net-Centric capabilities



NC portfolio is an enabling infrastructure for other Capability Portfolios

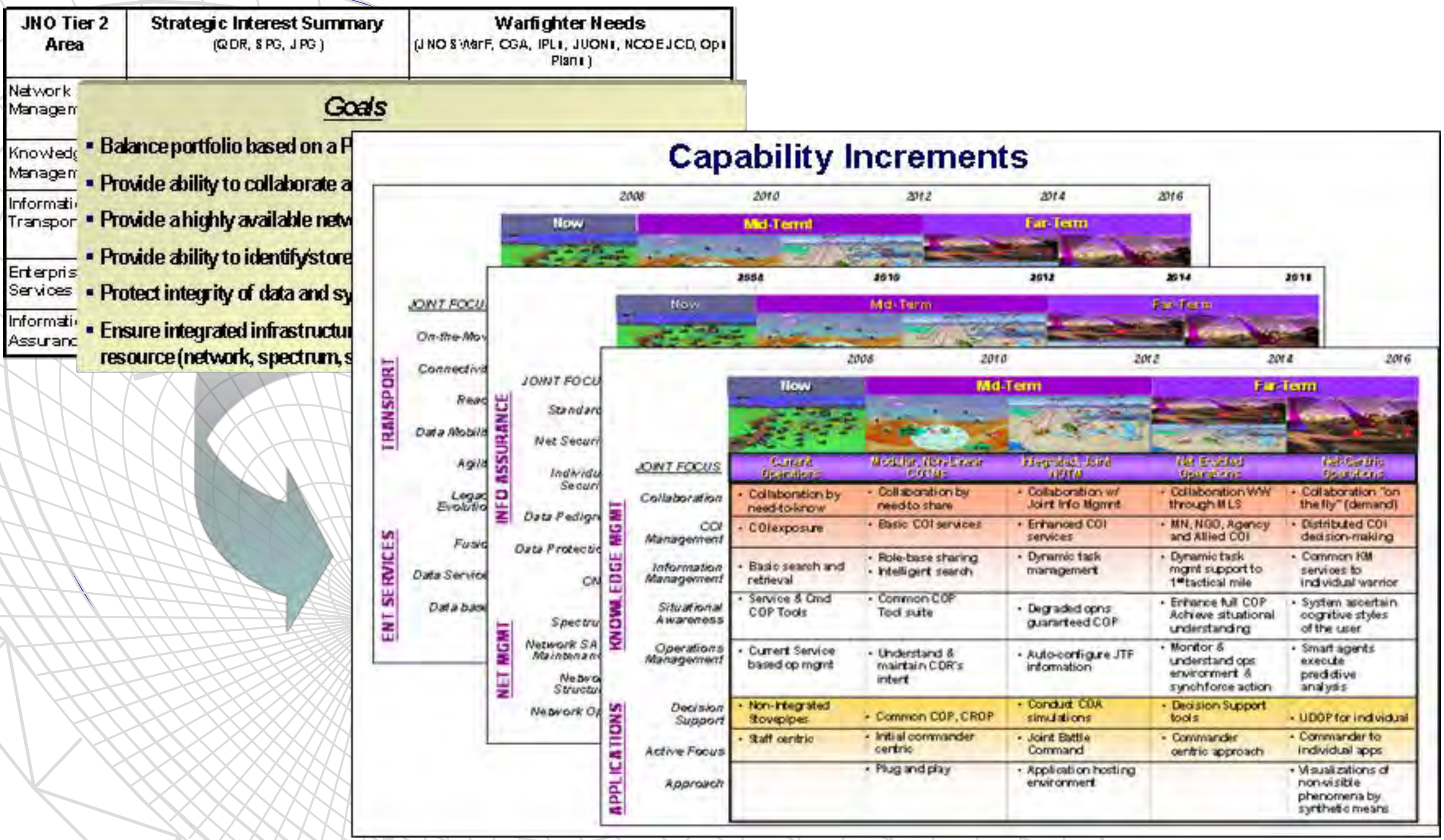
JNO (NC) CPM Roles & Responsibilities



- JNO CPM is executing four areas of responsibility
- Resource Management and Capability Assessment are focus for PR/POM actions
- System tools and Acquisition are being worked

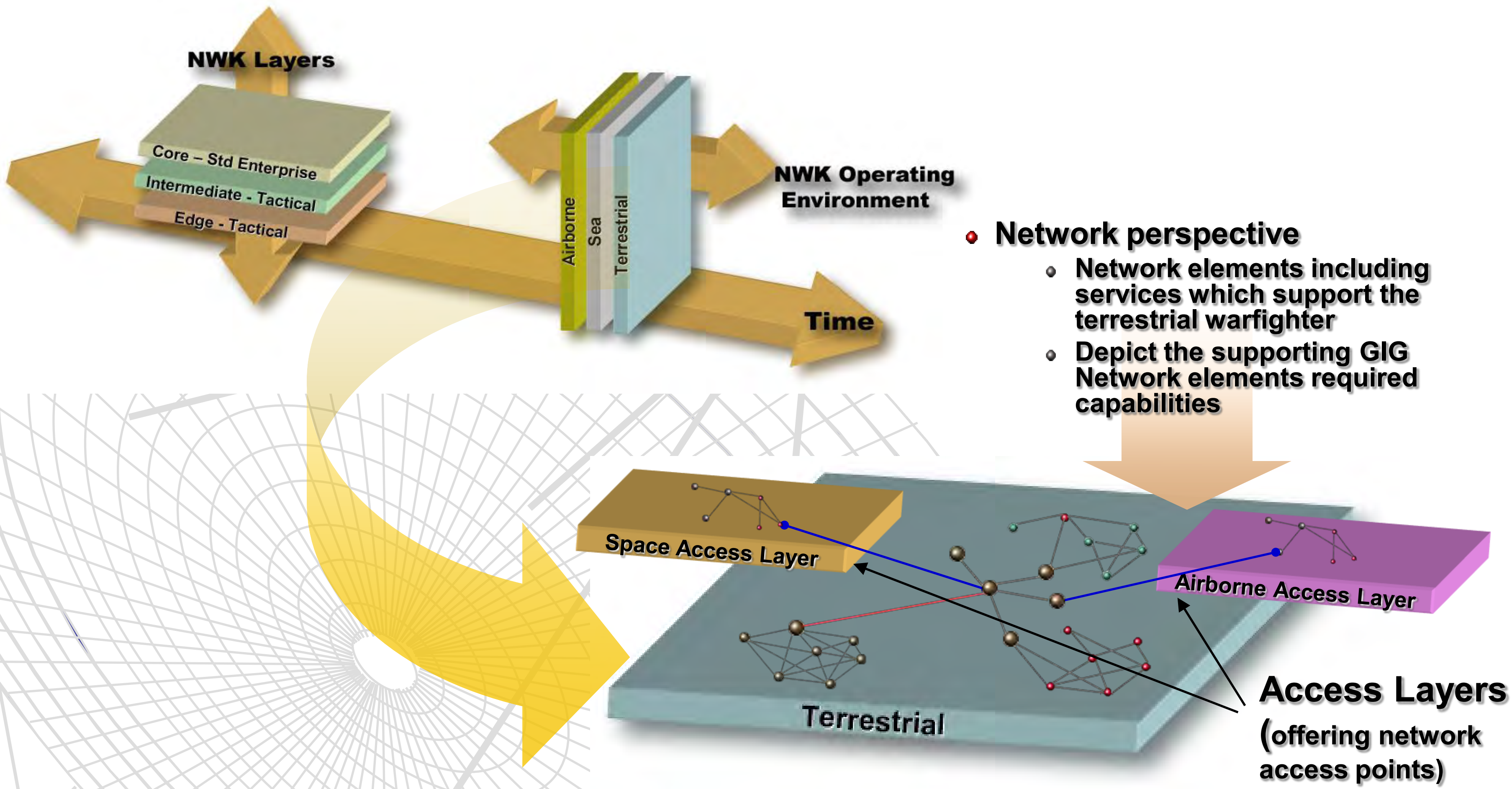
Use JNO portfolio management to improve synchronization, interoperability & integration -- balance cost, schedule, & performance (risk) across the portfolio

Capability Increments



- Defines Near-, Mid-, and Far-Term capability deliveries
- Capability Increments will be approved via the FCB and SWarF

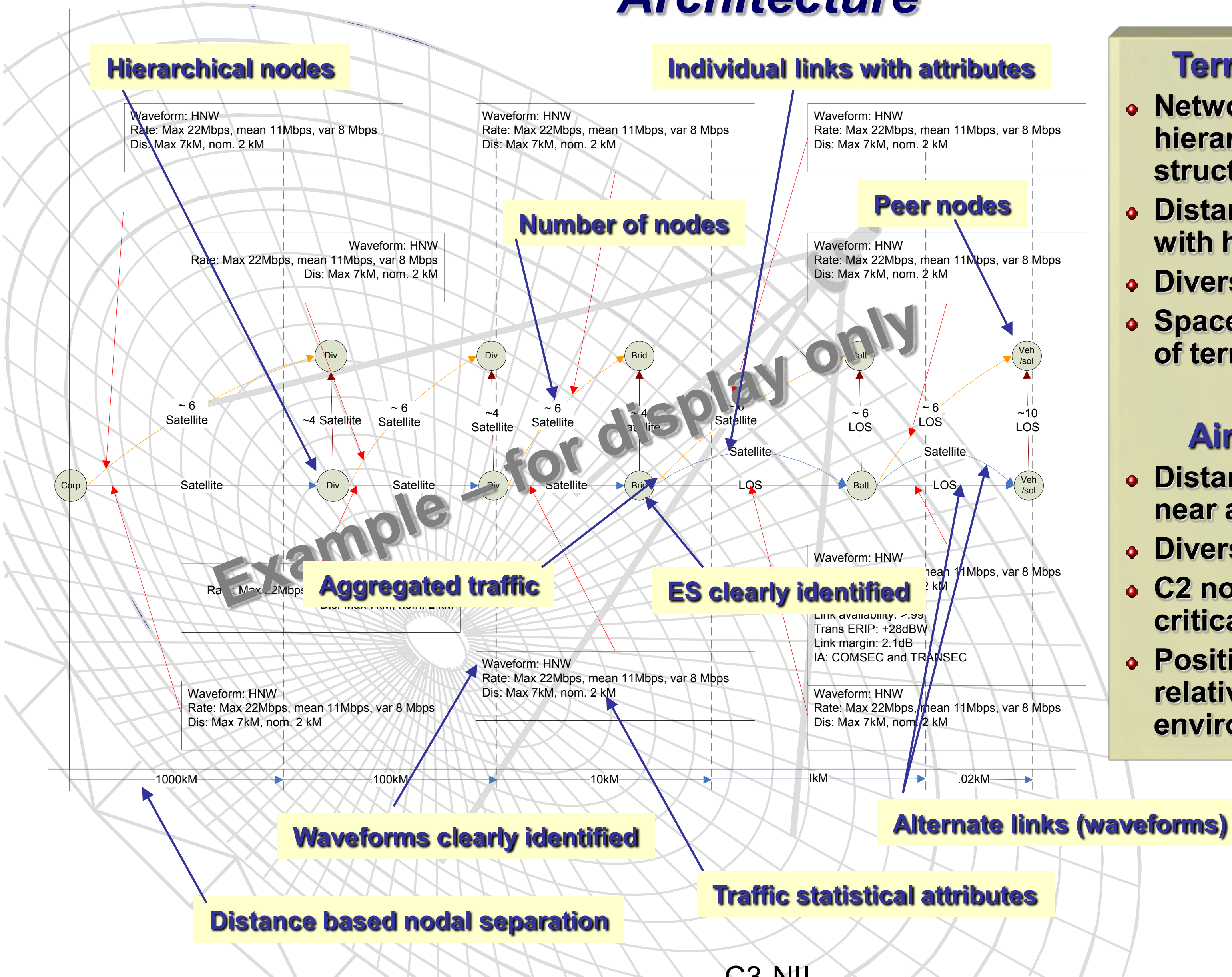
Network Architecture Perspectives



- Network perspective
  - Network elements including services which support the terrestrial warfighter
  - Depict the supporting GIG Network elements required capabilities

- Understanding the network framework (architecture topology) is essential to determining the ability to meet the warfighter capability demands and optimizing the investment
- The space and airborne access layers are not necessary networks but offer the networks an alternate media means not available within the nwk physical domain

The Characteristics of a Terrestrial Tactical Network Architecture



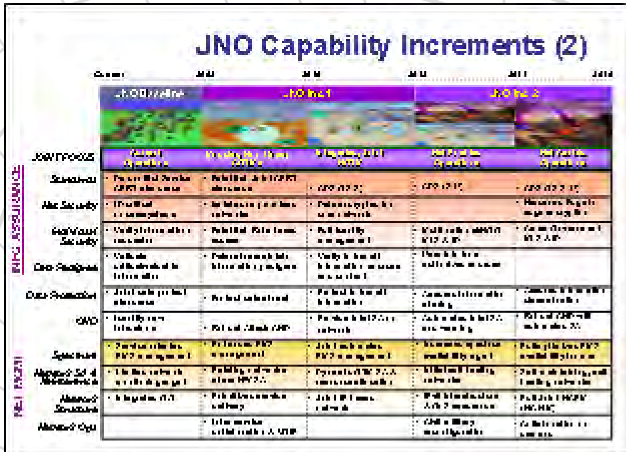
Terrestrial NWK

- Network is hierarchical in structure
- Distance is critical with hierarch topology
- Diversity is key
- Space is an extension of terrestrial

Airborne Nwk

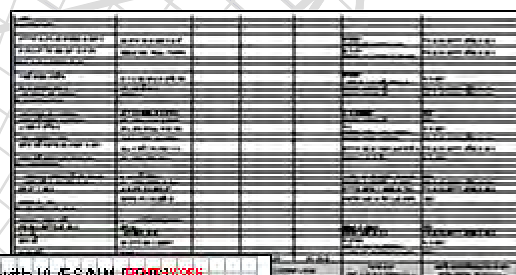
- Distance is in terms of near and far
- Diversity is important
- C2 nodes with ES are critical
- Position in air space relative to permissive environment is key

Assessment and Framework

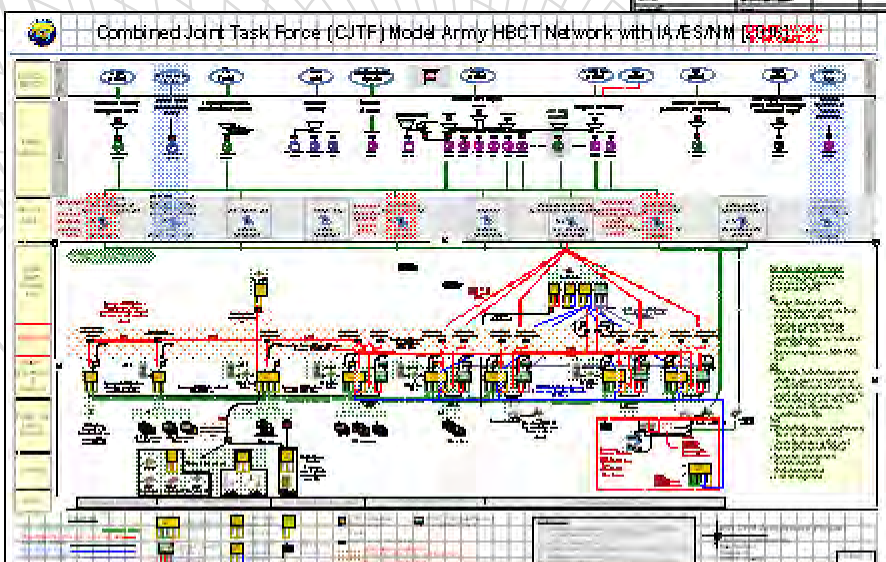


Capability Delivery Increments (CDI): **Describes desired Capability Delivery over time**

- **Derived from JROC-approved sources (JIC, JCD)**
- **Parsed into evolutionary Increments of capability**



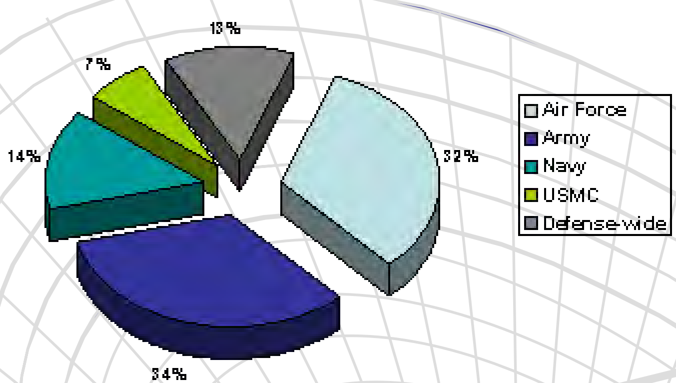
Quantified CDI w/Metrics: **enables the technical analysis of the portfolio**



Architecture Views: **Describe the POR capability available**

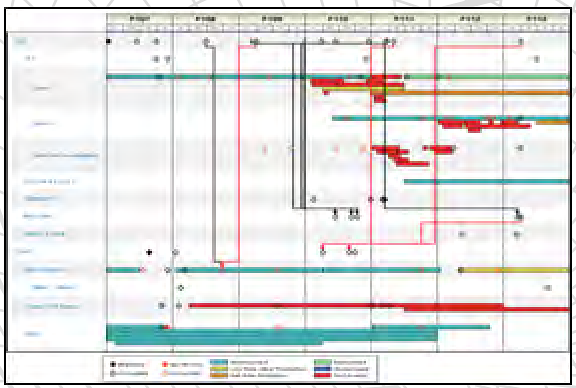
- **Derived from JCIDS documents**
- **Overlays of ES, NM, IA**
- **Assembled into evolutionary architectures by Increments**

Specific Assessment and Analysis Aspects



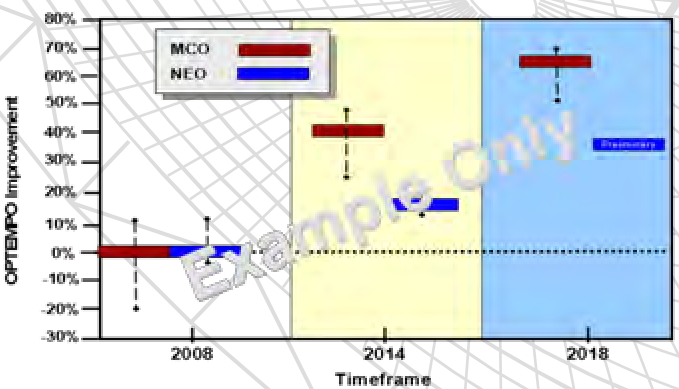
Portfolio Financial Profile: **boundary and baseline for resource analysis and optimization**

- **286 Program Elements (whole or partial)**
- **$160B total over FY08-13 (RDT&E+Proc+O&M)**



Integrated Master Schedule: **analysis of program, interdependencies, and synchronization issues**

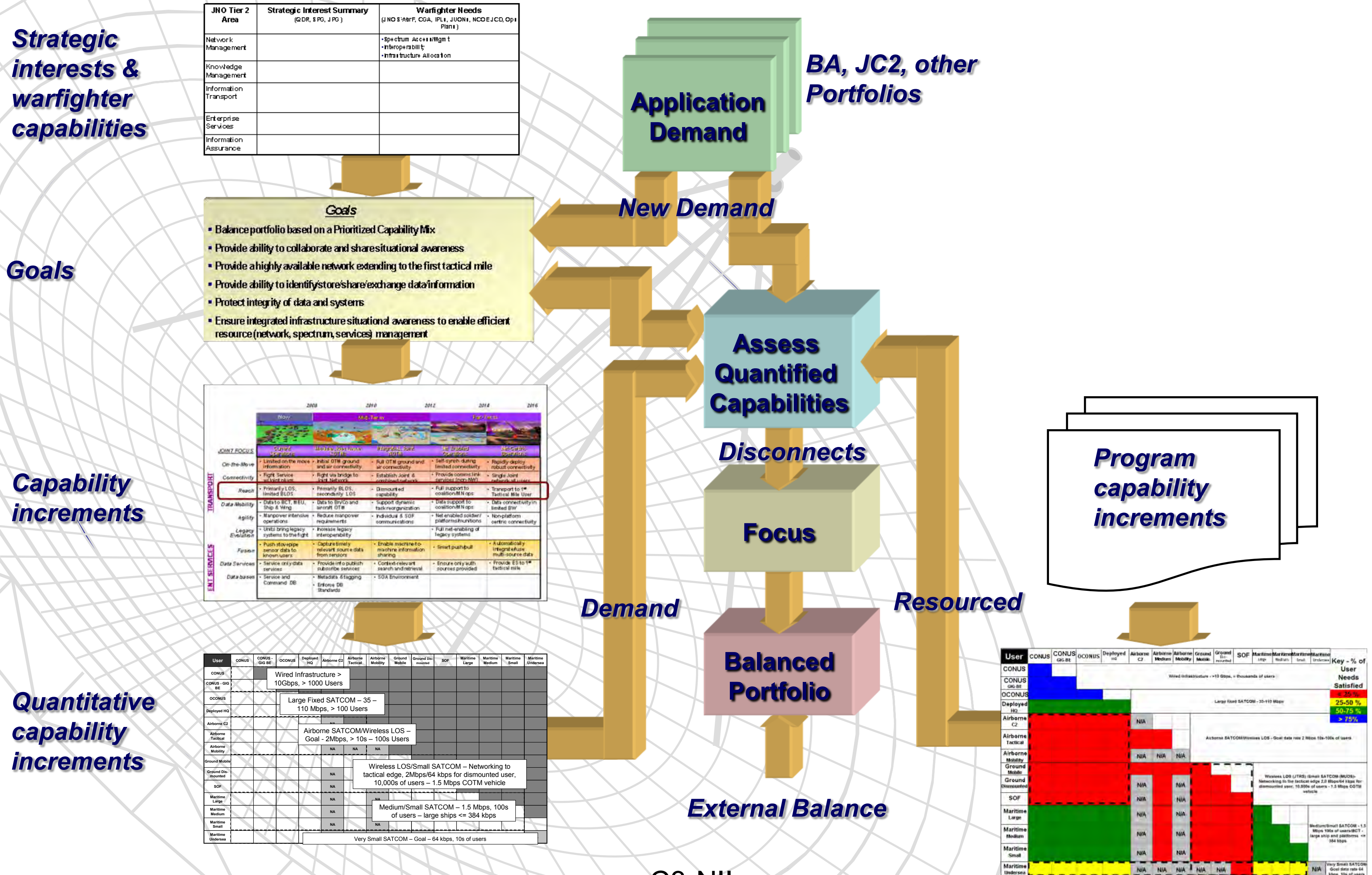
- **Provides support to:**
  - **Architecture Development**
  - **Program and cross portfolio analysis**
  - **POM focus teams**



Ops Impact Analysis: **quantifies impact of portfolio changes on ops effectiveness**

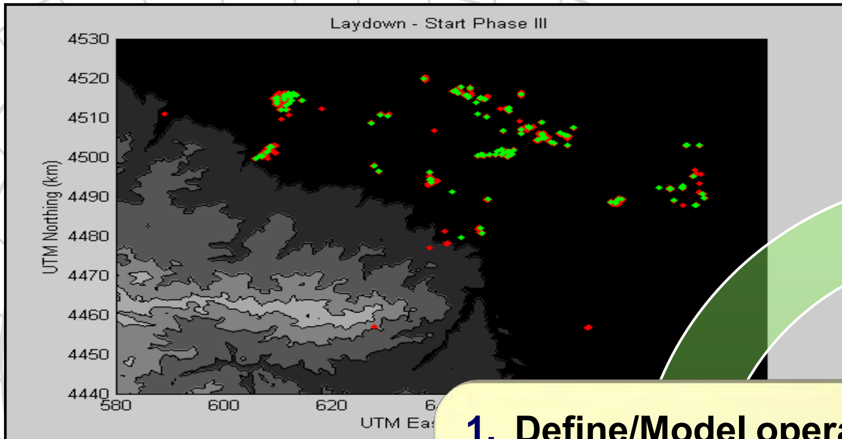
- **OPTEMPO**
- **Lethality**
- **Survivability**

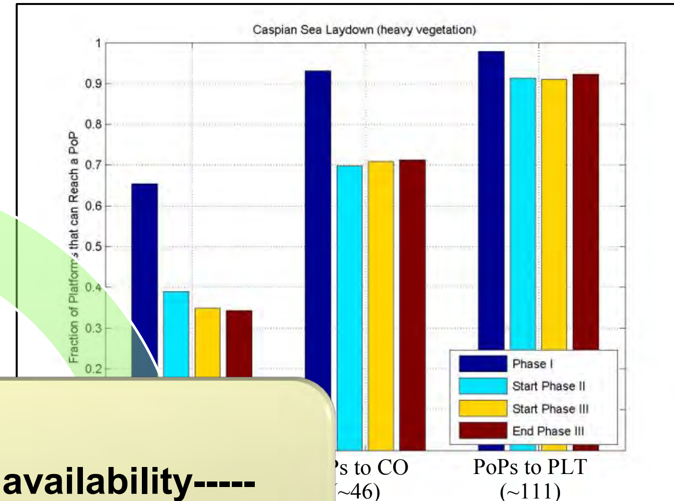
Balancing the Portfolio – Resource Process

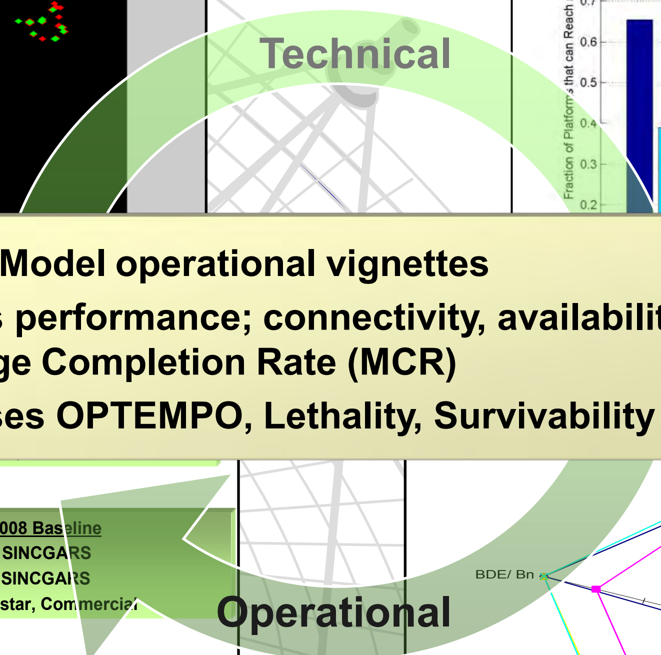


Analysis Example

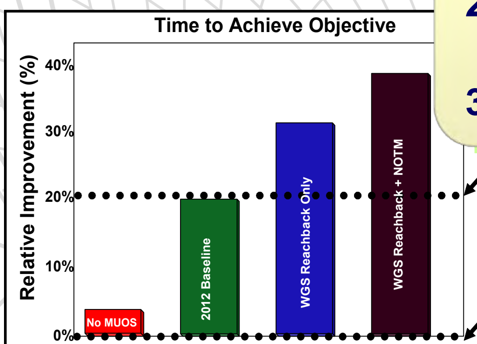
-- # of BDE SATCOM terminals required to connect the edge --



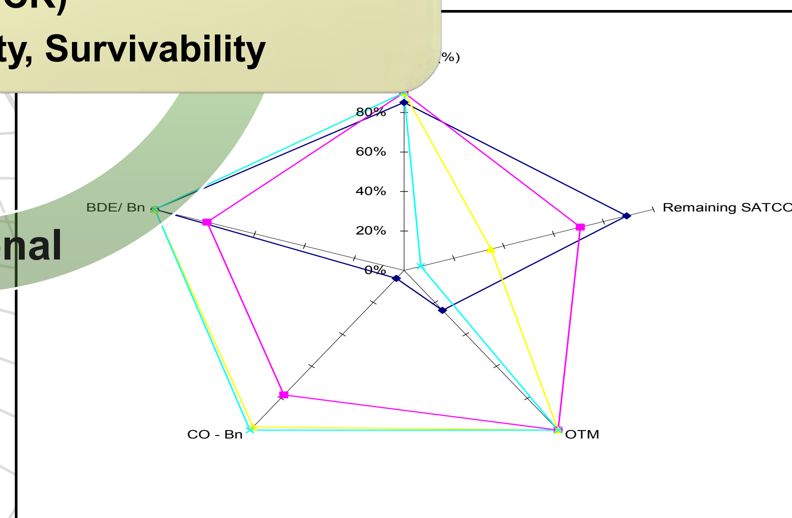




1. **Define/Model operational vignettes**
2. **Assess performance; connectivity, availability----- Message Completion Rate (MCR)**
3. **Assesses OPTEMPO, Lethality, Survivability**



2008 Baseline
- 3-BDE: EPLRS, SINCGARS
- 1-RCT: EPLRS, SINCGARS
- DSCS, UFO, Milstar, Commercial



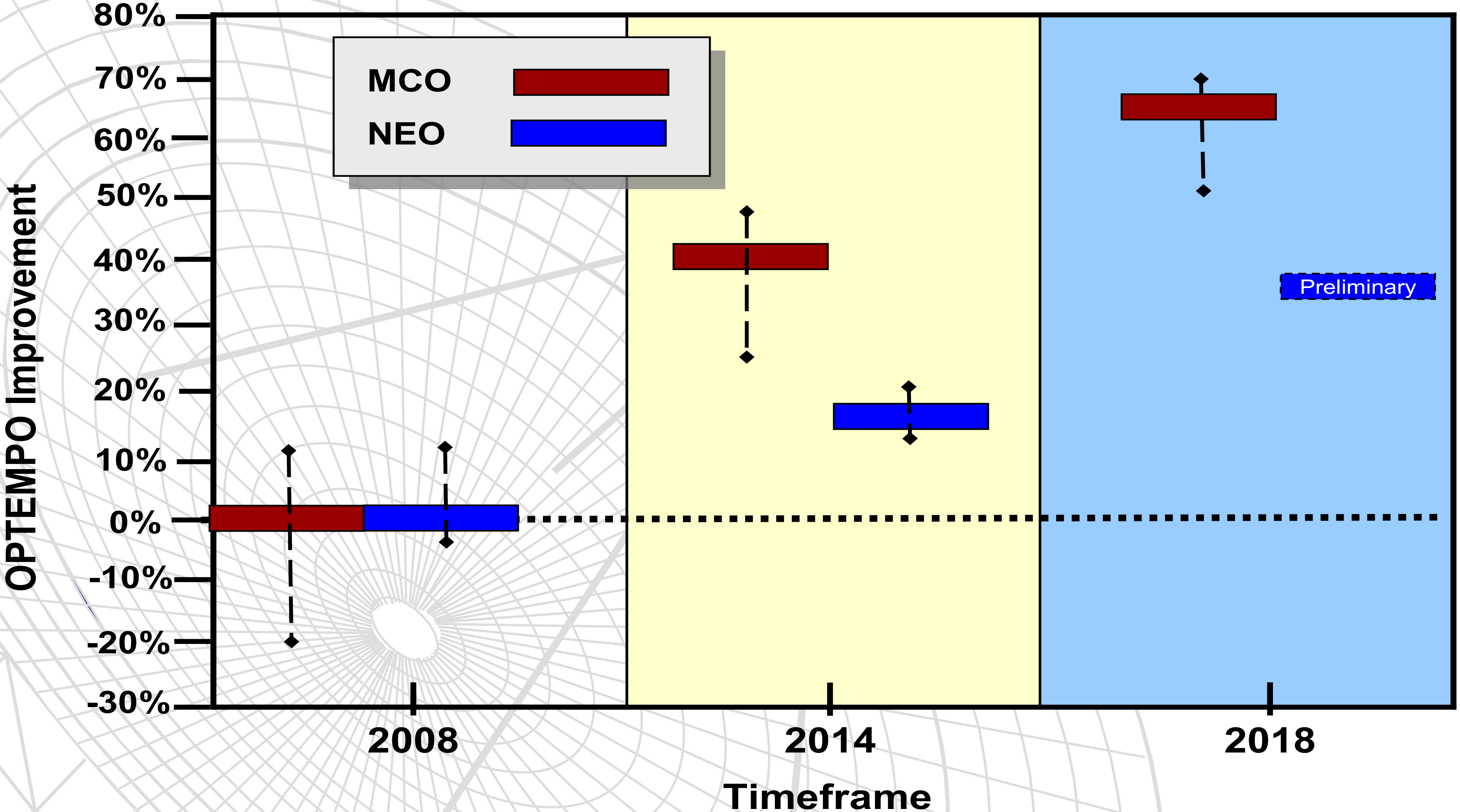
- **Based on MCO-3 Phase IIIb combined amphibious/ground assault—designed to relieve stress on broader campaign**
- **Additional analysis for other MCO scenarios and impact of cyber/space attack planned for 2007—per DSD draft guidance**

JNO recommendations increase Warfighting effectiveness

Connectivity, Message Completion Rate, OPTEMPO, Lethality and Survivability

Ops Impact Analysis Results

Benign Threat Environment

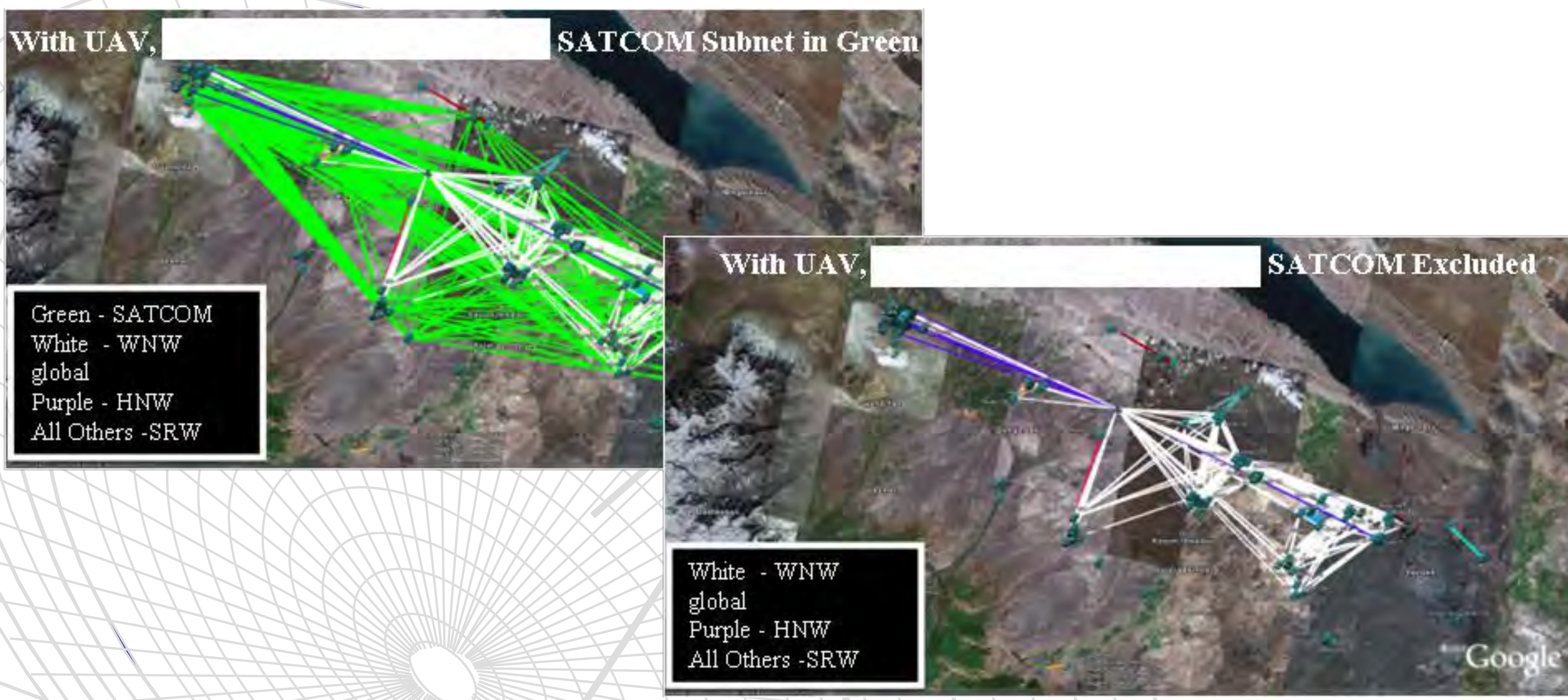


- Network equipped forces have significantly improved OPTEMPO
- Good Situational Awareness (SA) & Battle Command (BC) result in predictable outcome

MCO: Major Combat Operation
NEO: Non-Combat Evacuation Operation

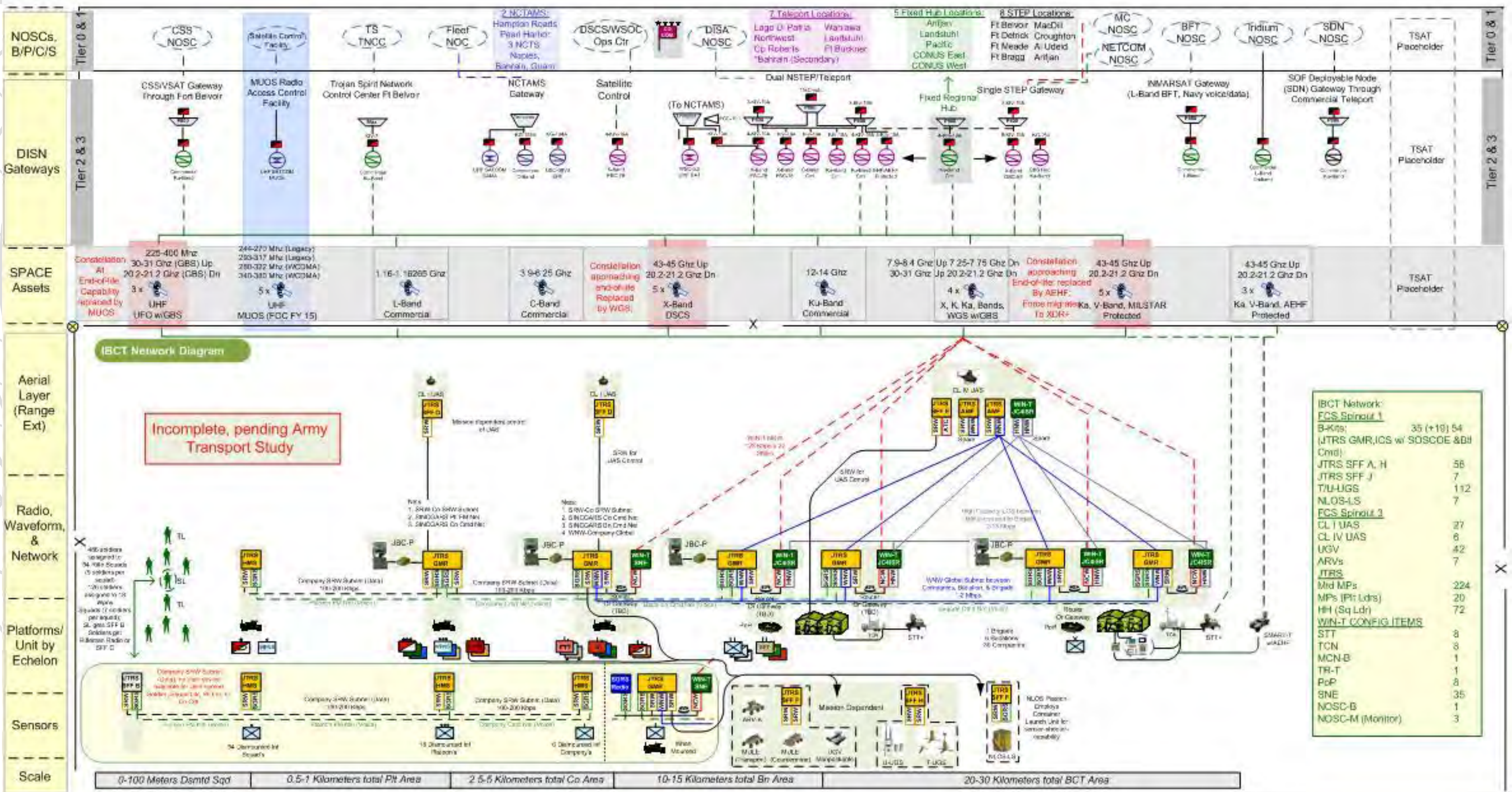
Network Performance Analysis

(CERDEC Tool)



- **Allows quick turnaround studies with numerous excursions feasible**
- **Provides Message Completion Rates and other Network characteristics**
- **Used as feeder to higher fidelity models (e.g., OPNET) and provides means of visualizing / analyzing high fidelity models**

Example Army IBCT Network



Expanded View of JTRS-WIN-T Connectivity by Waveform with Aerial Layer Applied and FCS Spinout Items From Soldier to Brigade Main

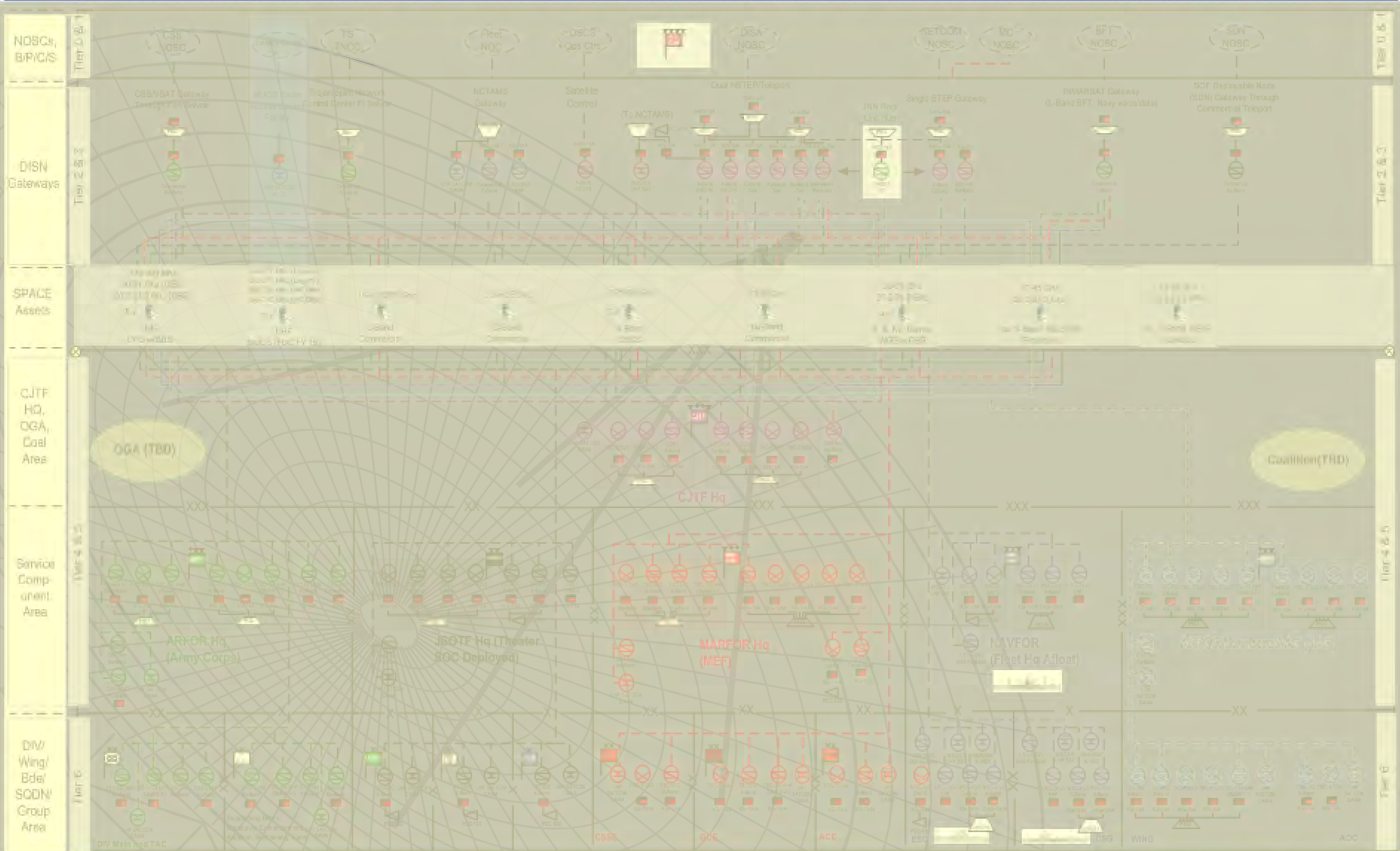
Summary

- NC Portfolio balances the three building processes – capabilities, acquisition and resources
- NC Portfolio employs a Systems Engineering based portfolio management approach
  - Achieves a quantitative analytical position based upon warfigther based capability increments
  - Places the capabilities into a network topology architectural framework which is used to offer contextual structure to the capability implementations
  - Quantitative demand and supply concepts are used to evaluate the gaps and overlaps in capabilities
- Implementation / program solutions developed from the evaluation assessment are used to determine the right investments
- Continual analytical assessments for the three building processes is done using a combination of network topology architectures, QCDI, and modeling tools
  - Network and enterprise services performance are evaluated quantitatively
  - Specific metrics include OPTEMPO, lethality and survivability derived from operational models / scenarios

Backup

Combined Joint Task Force (CJTF) Model [2012]

DRAFT – WORK IN PROGRESS



Legend

- Purple-Joint
- Green-Army
- Red-Marine
- Dark Blue-Navy
- Light Blue-Air Force
- Black-Special Operations

LOS/Tropo Radio System
Wideband Satellite Terminal
Narrowband Satellite Terminal
Multiplexers
Satellite
Major HQs
Crypto Hardware

Note: LOS lines were not drawn to reduce clutter

References:

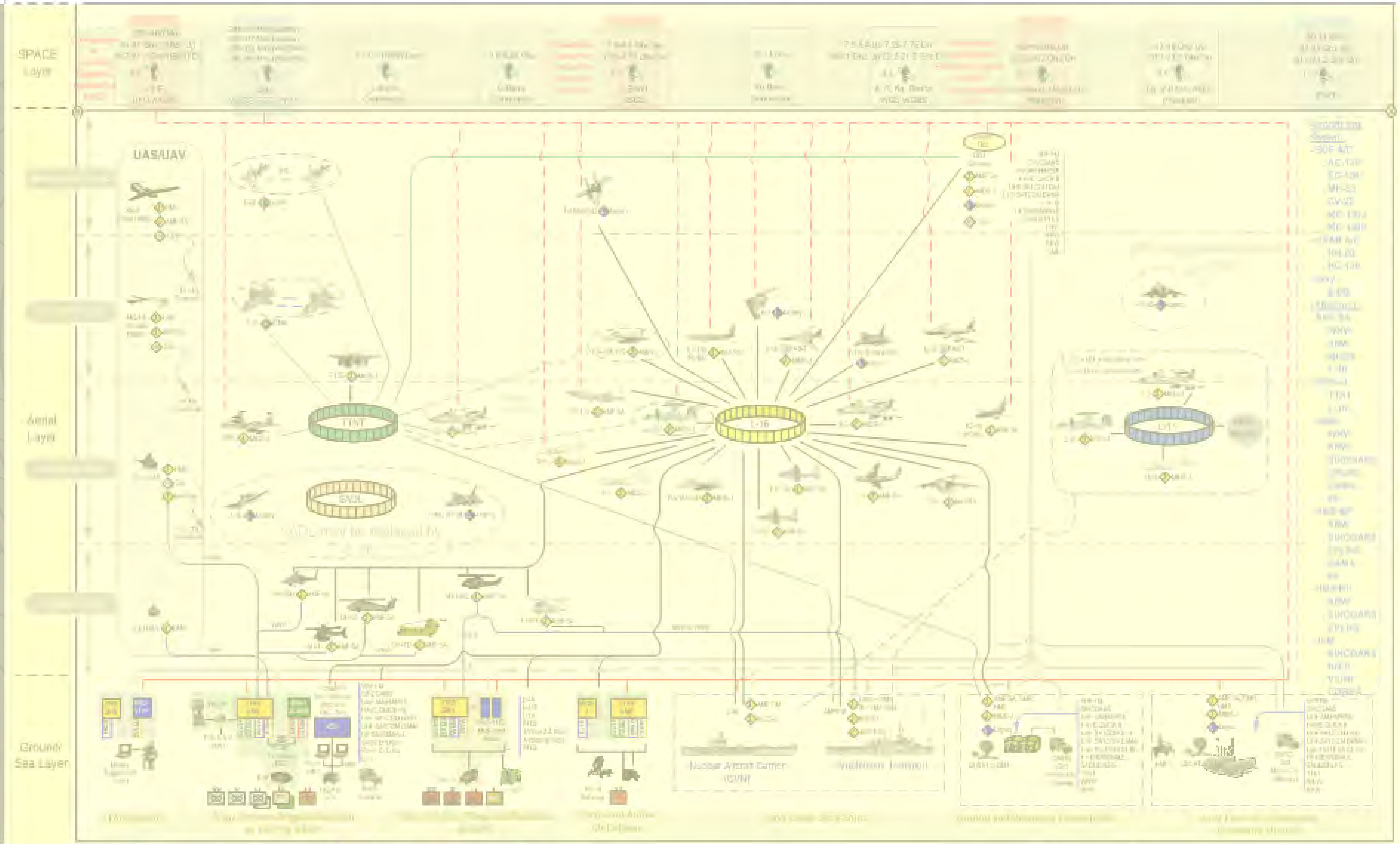
1. Operational Area Network Version 4.5, CJCSM 6231
2. Tactical Networks for Ground Forces Study
3. JCS Publication 6-02, 3.0
4. AIMD Modular Force Operational Architecture 2/16/2006
5. Landwarnet Evolution Version 7.0
6. AIMD Horseblankets HBCT, IBCT, SBCT 12/5/2006

JNO CPM Architecture Product

Title: CJTF Top Level Architecture
Date: 5/31/2007
Version: 0.7
R. Conway

Combined Joint Task Force (CJTF) Model Joint Airborne Network [2016]

DRAFT – WORK IN PROGRESS



Legend

- Black-L-16 Data Link
- Red-NB/WB SATCOM
- Gray-IP JAN Backbone LOS
- Blue-SRW/WNW LOS
- Green-TTNT LOS

Note: To minimize clutter, all connectivity lines are not shown.

JTRS GMR

0-10,000 Ft Alt.

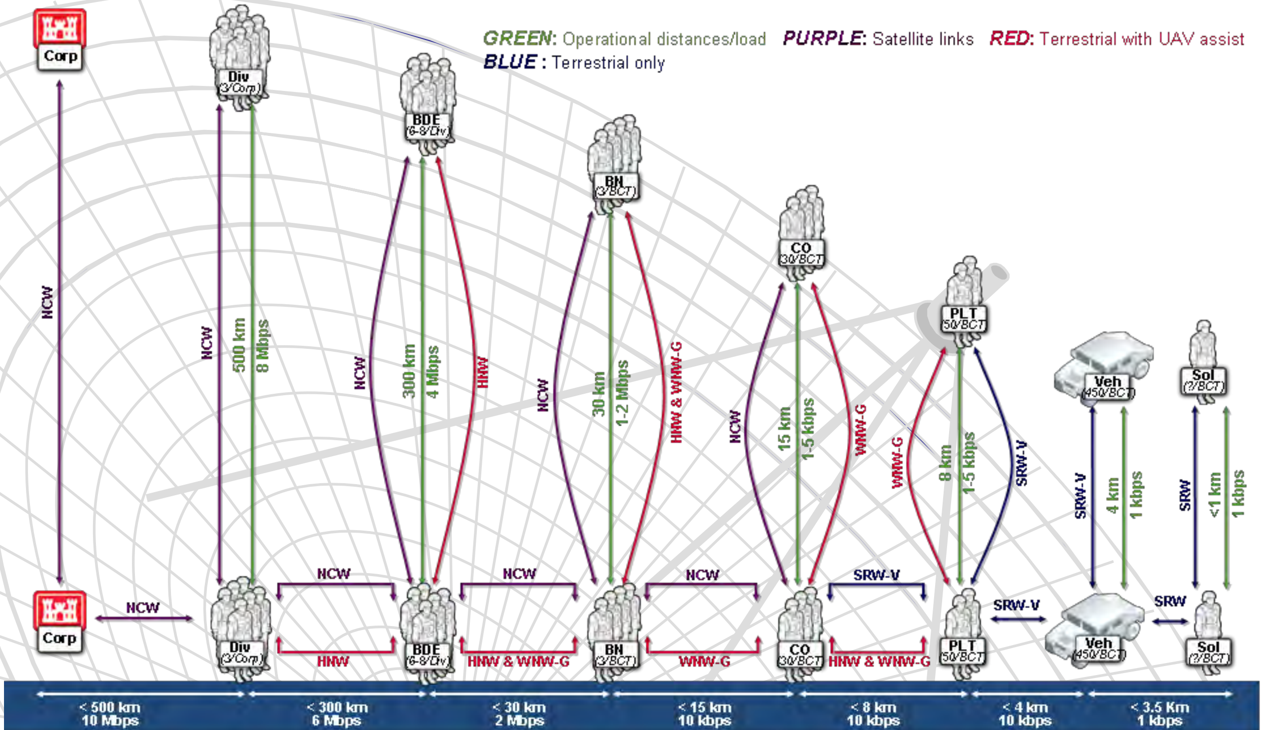
References:

1. Deployable Comms Concept of Employment, Sep 2005
2. JACC OV 2/3
3. AOC Wpns Sys, USQ-163 ISP, 31 July 2006
4. TDC Presentation, February 2007
5. Air Force Doctrine Document (AFDD) 2, 17 Feb 2000
6. Tactical Wireless Joint Network (TWJN) v.1, 30 Apr 2007
7. Objective Gateway CONOPS Ver 1, 25 May 2006
8. TRD, ASOC Gateway Ver 0, 30 April 2007
9. Air Force Roadmap 2006-2025, June 2006
10. Joint Terminal Engineering Office, NS4R, SATCOM Systems Roadmap, Spring (07), PB 08
11. OPNAV N58 Capability Case Analysis (CCA), Oct 2007

JNO CPM Architecture Product

Title: Joint Airborne Network 2016
Date: 10/27/2007
Version: 0.9
MITRE/R. Conway

High Level Topology View



Operational distances will likely be much lower in heavily foliated or urban environments
Loading represents the traffic generated by each transmitter (*e.g., total load for a PLT of 44 members would be 3.4 kbps x 44 = 150 kbps*)
Does not include direct, raw ISR feeds

- Architectural structure sets the assessment and analysis context
- The network topology offers analysis of the links, ES and IA aspects

Terrestrial Network

- Network is hierarchical in structure
- Distance is critical with hierarch topology (node-to-node – peer-to-peer)
- Link diversity is critical
- Space and UAVs are an extension of terrestrial – these are access points (or layers)
- Significant work is need to insure the right balance exists between LOS, space and UAV
- Throughout the implementation consideration: performance, cost, schedule and risk need careful assessment

JNO Increments to Focus Team Solutions

	2004 JNO Baseline	2008 Transition 1	2010 JNO Incr 1	2012 Transition 2	2014 JNO Incr 2 (2016)
JOINT FOCUS	Current Operations	Modular, Non-Linear, COTM	Integrated, Joint, COTM-NOTM	Net-enabled Operations	Net-Centric Operations
TRANSPORT	• Fight Service with Joint Plugs • Limited on the move data • Manpower intensive • Primarily LOS, limited BLOS • Data to Brigade, MEU, Ship, Wing	• Fight via bridge to Joint network • Increase legacy interoperability • Initial OTM ground and air connectivity • Reduced manpower • Primarily BLOS, secondarily LOS • Data to Bn/Co level	• Joint / combined network • Full on the move ground and air • Operate in Austere Environment • Support dynamic task reorganization • Dismounted capability	• Net-enabled soldier/ platforms/munitions • Self-synchronization during limited connectivity • Fully support Joint/coalition/MN operations • Provide comms link services (non-NW)	• One Network • Transport to 1st Tactical Mile user • Guaranteed delivery of data • No longer platform-centric • Global data access • Enhanced CES
ENTERPRISE SERVICES	• Best Effort Routing; bridged voice • Svc command DB • Push stovepipe sensor data	• Initial CES • Metadata & tagging • Federated Portals • Enforce DB standards	• SOA environment • Enhanced COI formation • Machine-to-machine info sharing	• Full integration of all CES (joint/service) • Service coreography to dynamic tasks • Smart push/pull	• Automatically integrate/fuse multi-source data • ES to Tactical edge
INFORMATION ASSURANCE	• De-conflict Service CERT org stds • Joint data protection standards	• Isolate compromised • Joint CERT standards • Role-based access • Robust CND; detection & response to attacks	• CDS (TS-S) • Protected & assured in-transit • Identity management • COI Security	• Multi-national MLS • CDS (S-U) • Assured sharing	• Hardened edge-to-edge encryption • Assured info dissemination • CDS (TS-S-U)

Pre-decisional draft

Components

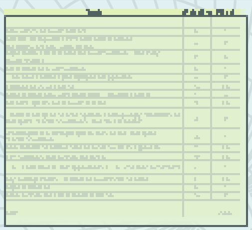
GDF, PDM, Directed

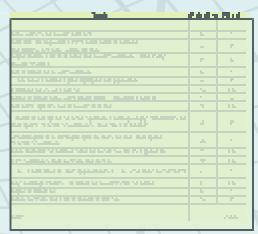
Focus Teams

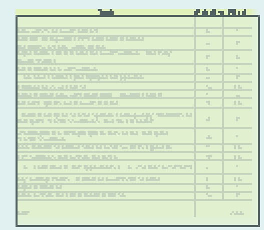
Gaps / Over Laps

Near Term — Time → **Mid Term** **Far Term**

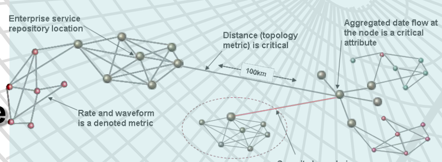
Quantitative Capabilities

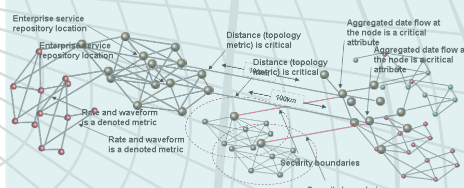


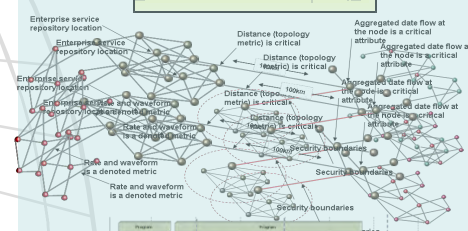




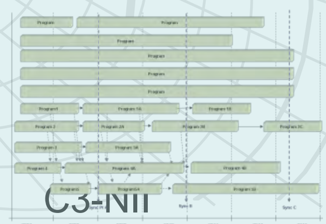
Network Architecture

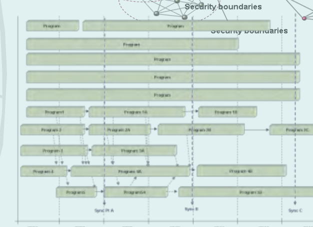






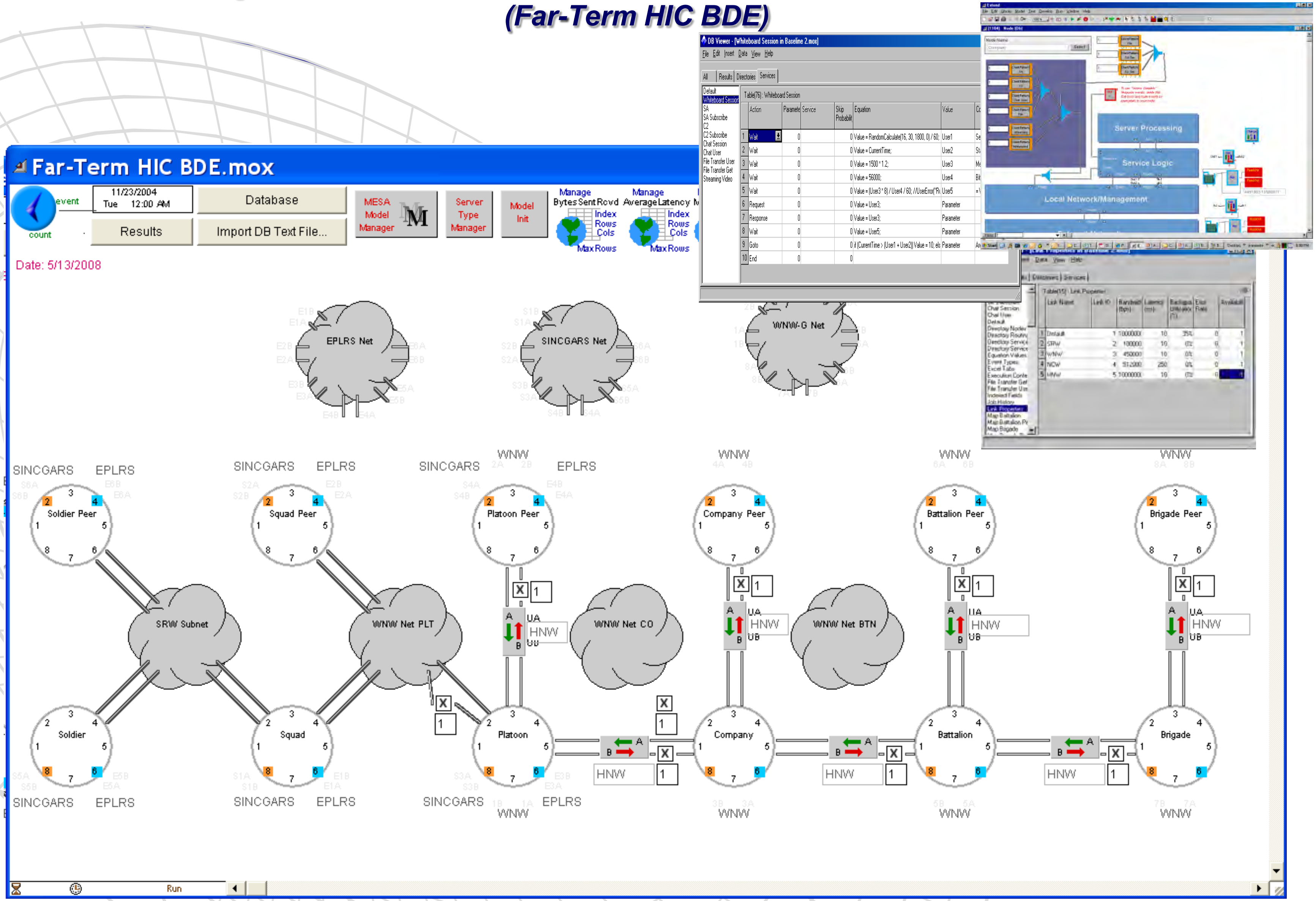
Integrated Schedule



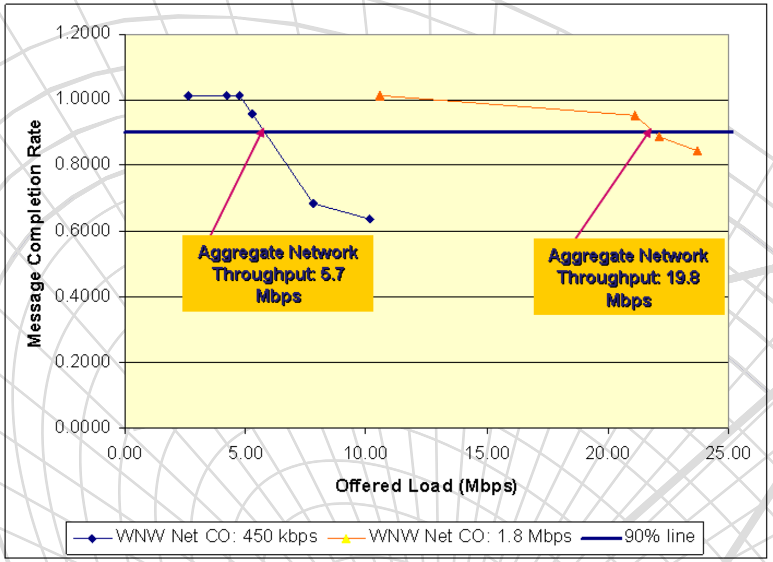


Simplified Traffic Network Model Structure

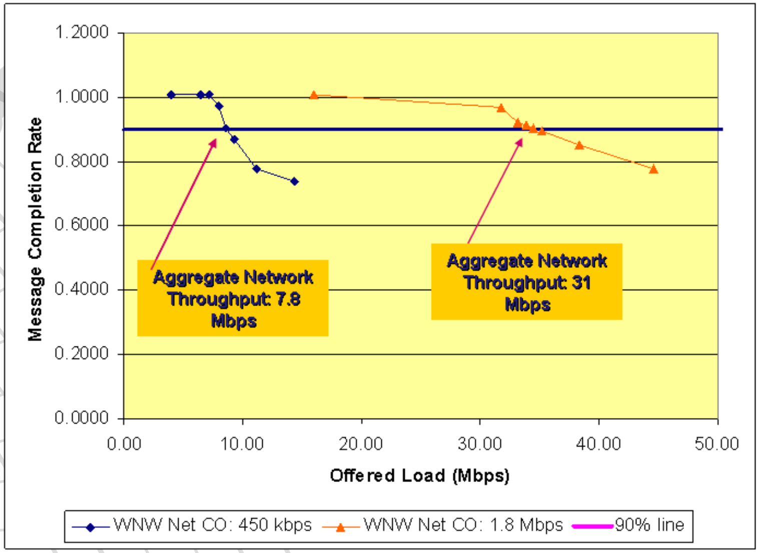
(Far-Term HIC BDE)



ES Network Location –Throughput and Cost



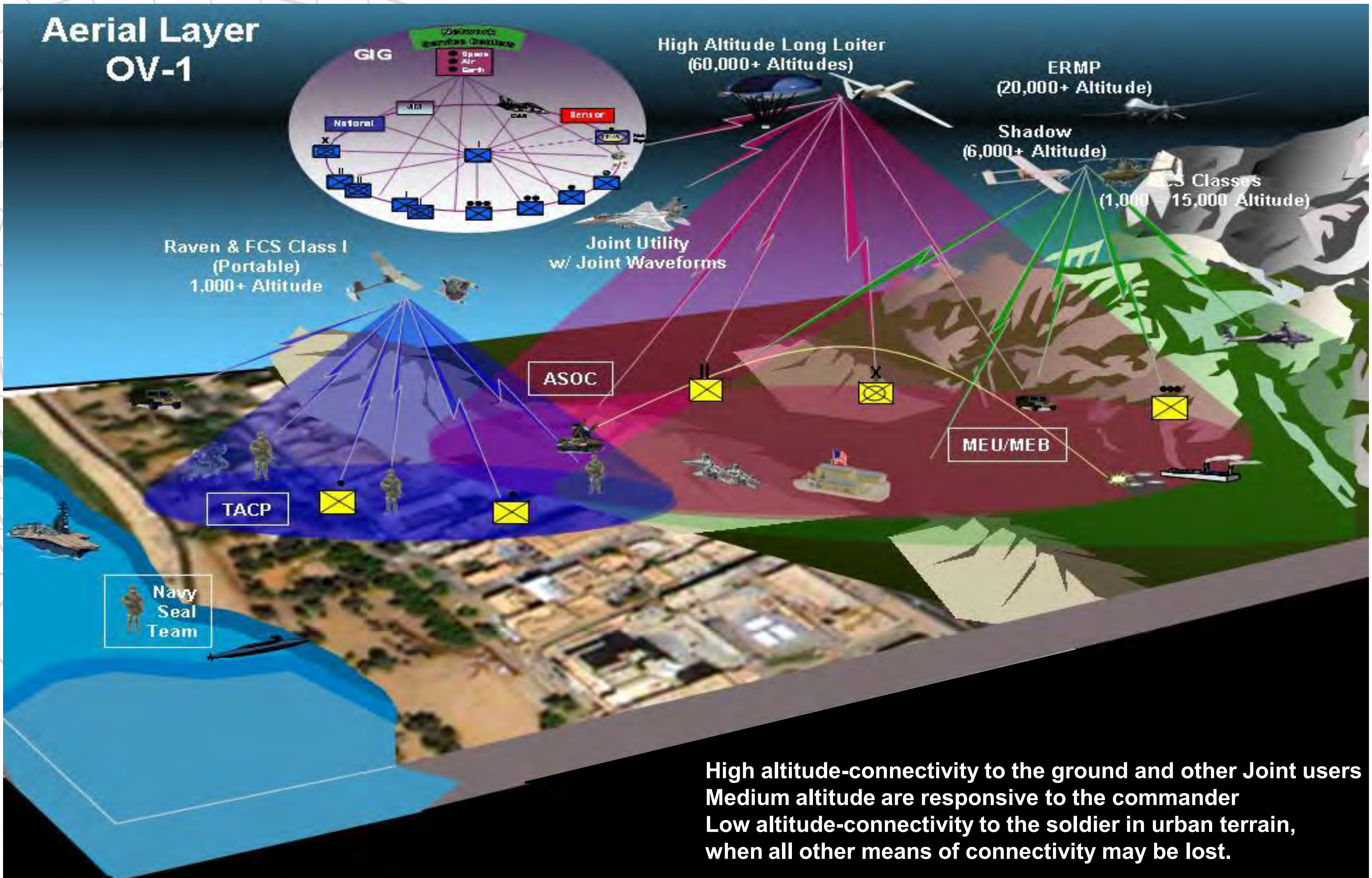
Configuration 1: Total throughput achievable versus message completion rate for the mid-term, high-intensity conflict configuration with Enterprise Servers at the BDE level



Configuration 2: Total throughput achievable as a function of offered traffic load for the far-term, high-intensity conflict configuration with Enterprise Servers at the CO level

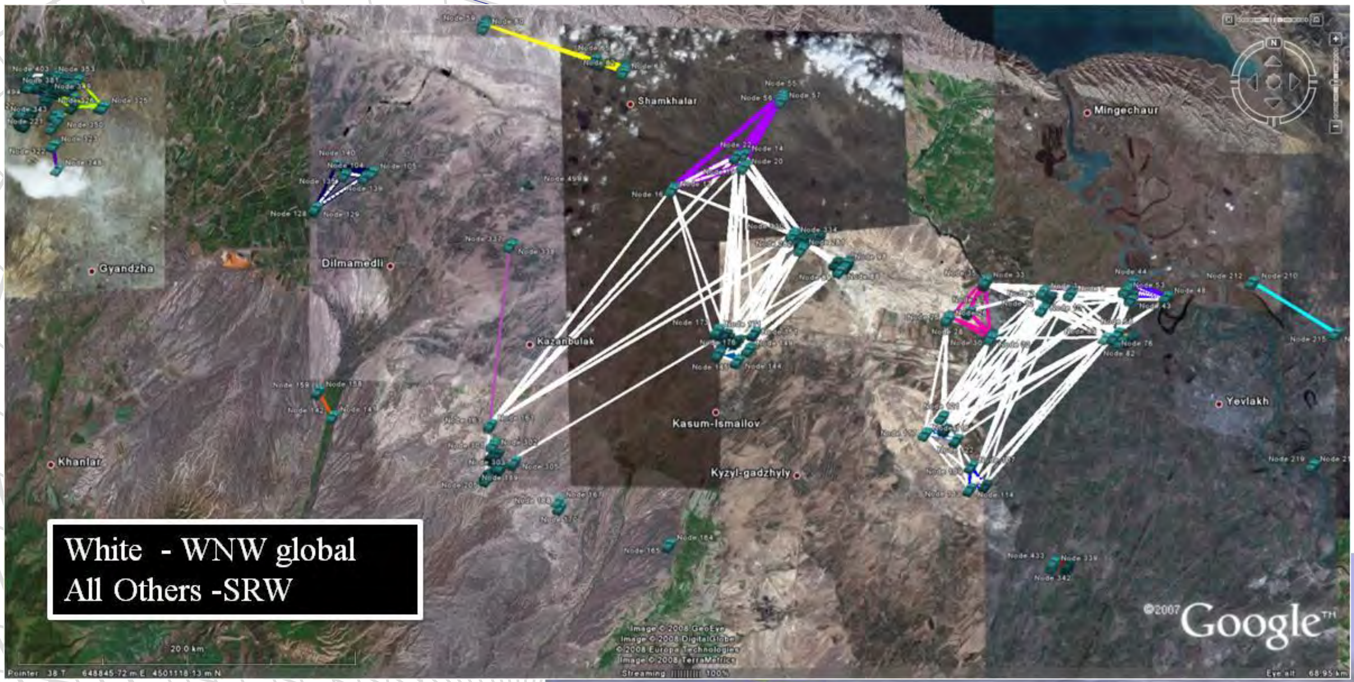
- **The location of the ES may have potentially significant effects on the network performance and more importantly on the effective network throughput**
- **The balance of ES cost vs the lower level network cost is an important aspect which is being currently assessed**

Operational View – OV-1 (U)



UNCLASSIFIED (U)

Without Satellite Connectivity



Standard View

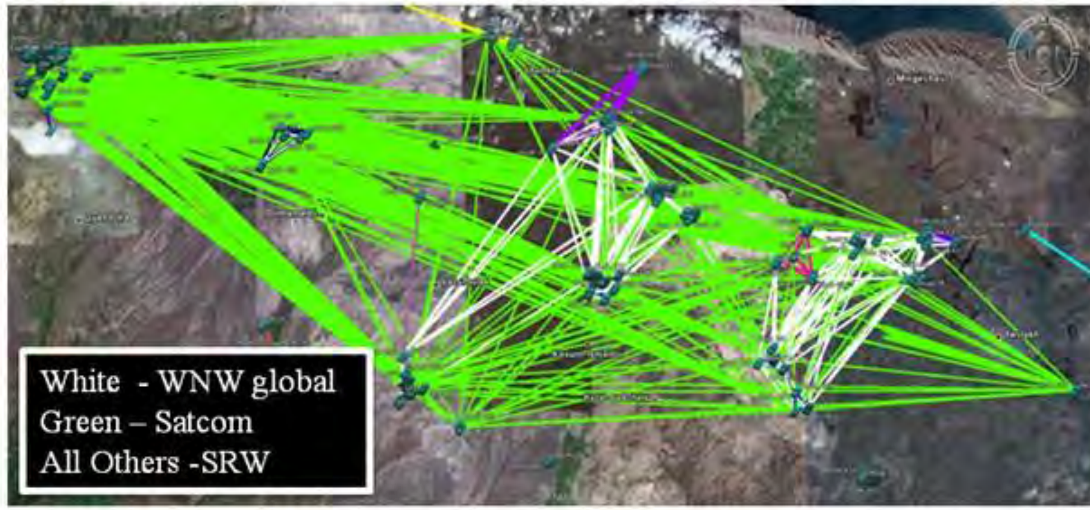
Slant View

Network Topology

- SRW subnets are tightly clumped, good connectivity.
- Global WNW subnet connects some SRW subnets but is fragmented.
- SATCOM terminal in each SRW subnet connects those without Global WNW connectivity.

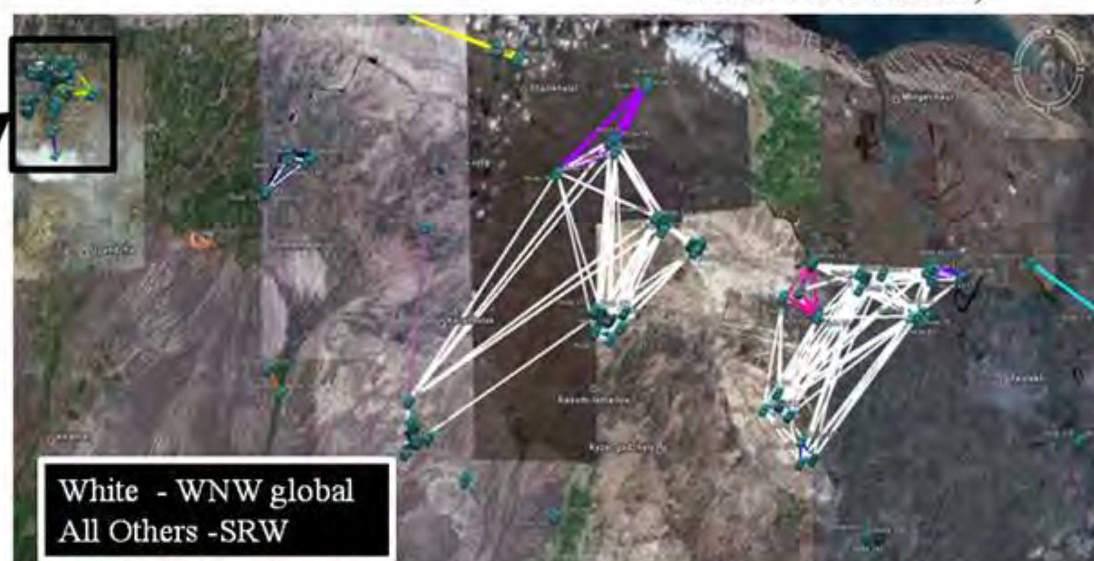
TNGF BCT

SATCOM Subnet in Green)

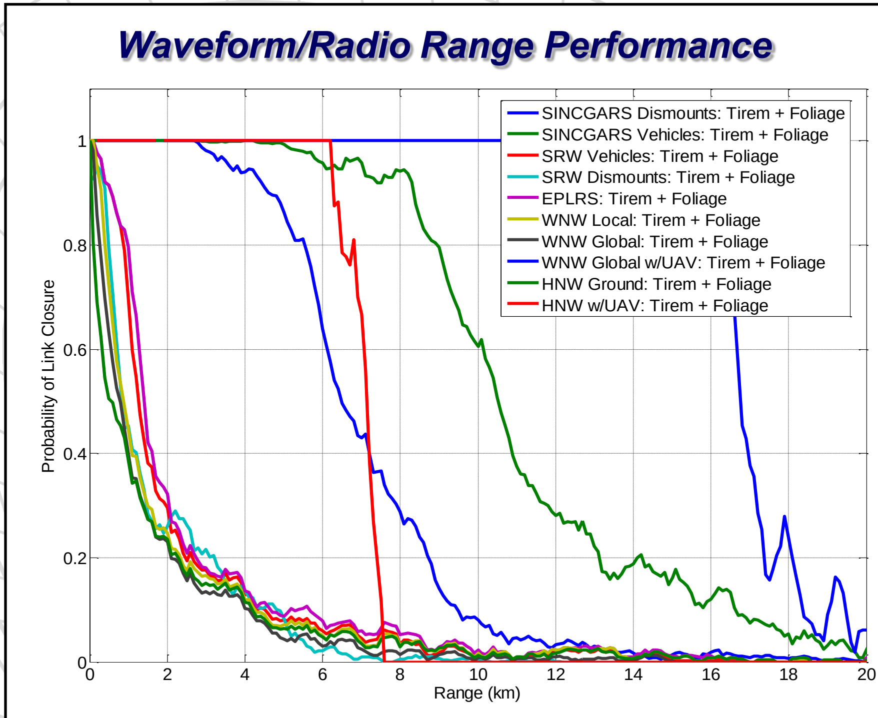


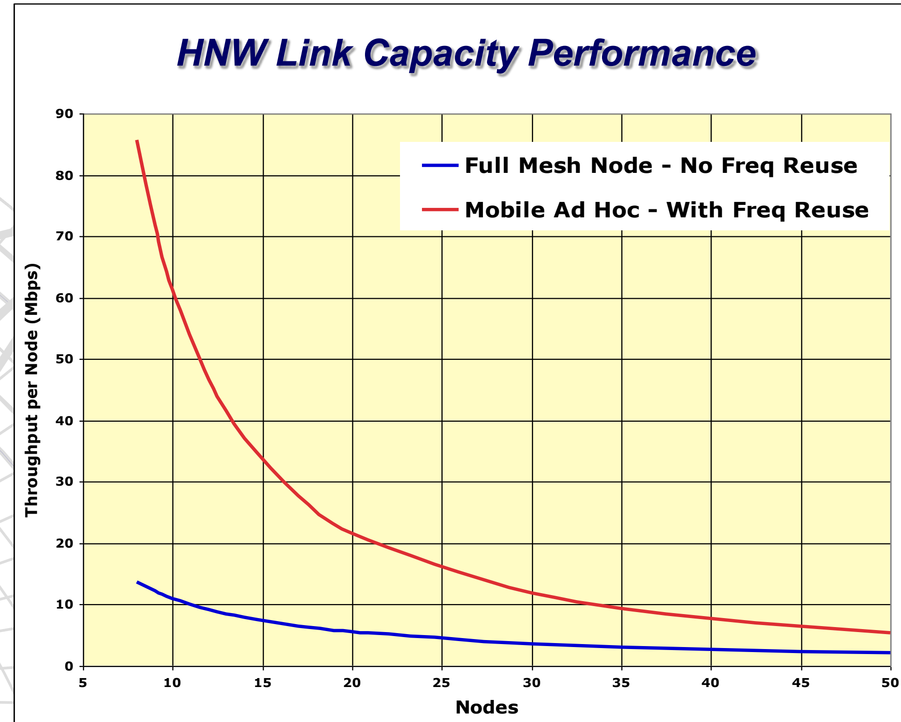
TNGF BCT

SATCOM Excluded)



Range and Capacity Analysis



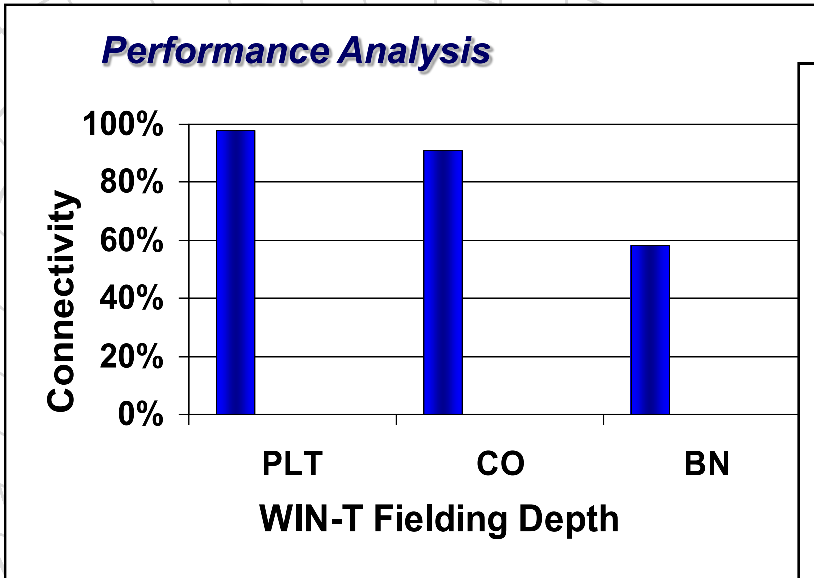


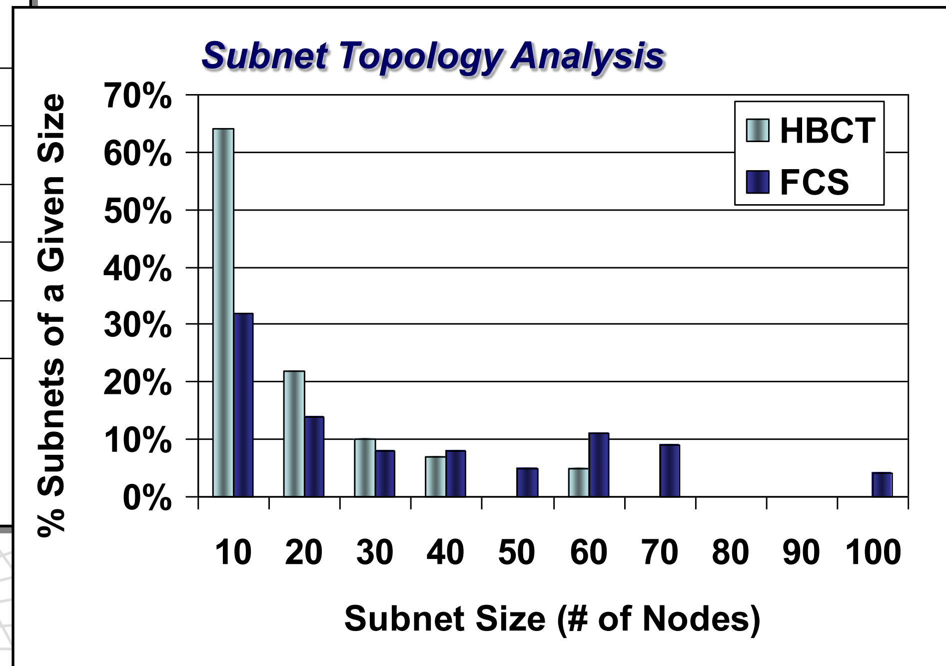
- Compute link closer and capacity for given network laydown, terrain, and vegetation
- Waveform performance analysis feeds Network performance analysis

NOTES
Masts are 7 meters for HNW
UAVs at low altitude (FCS CL IV altitude used in PM FCS BCT analyses)
Assume 80-90% confidence

C3-NII

Representative Results



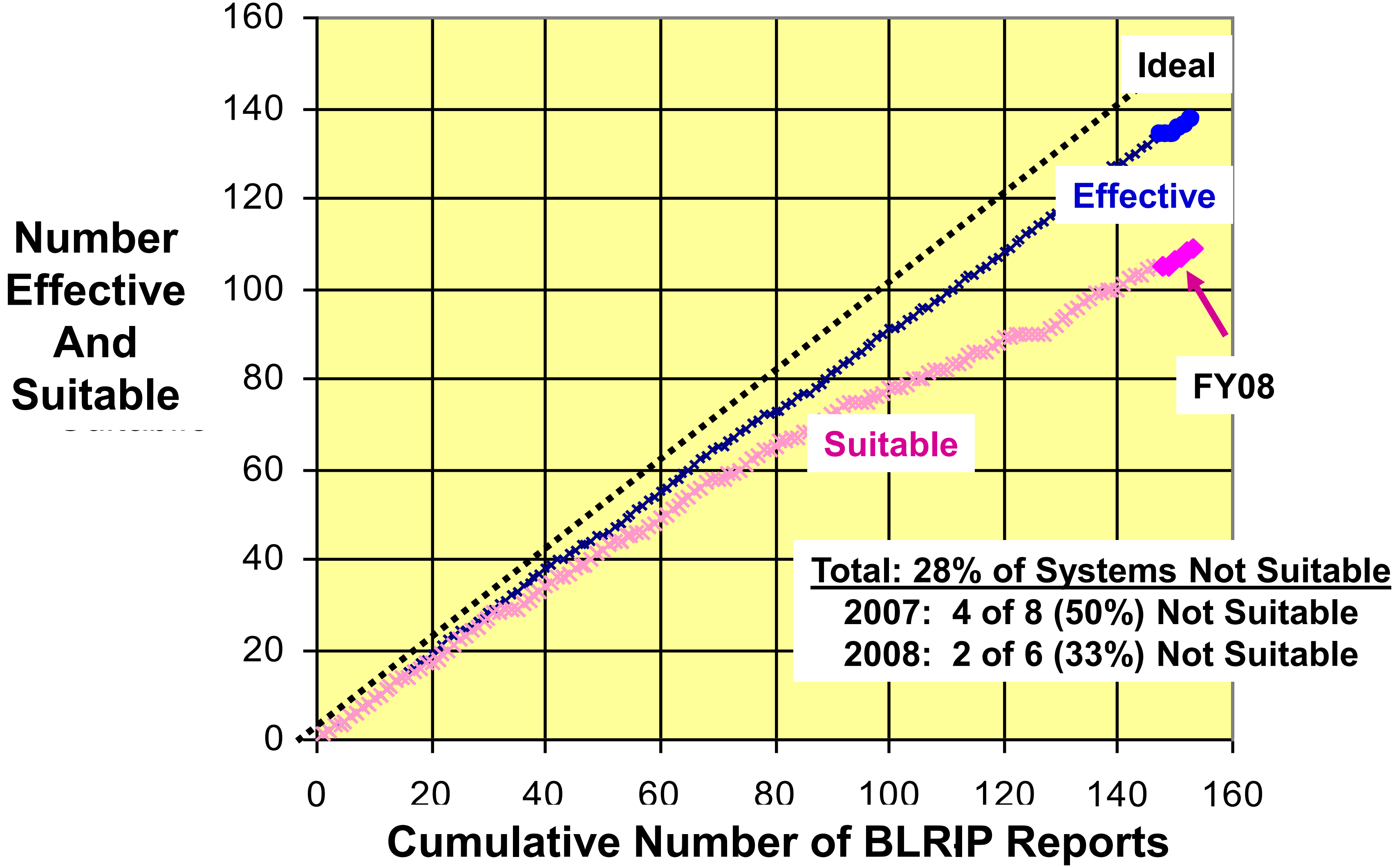


- WIN-T connects Ad Hoc subnets into an integrated network
- More than 70% of mobile AD Hoc networks are less than 30 nodes
- Reorganization of subnets may allow all to fall below 50 nodes

OPERATIONAL TEST AND EVALUATION • DIRECTOR •

KEY TO WEAPONS THAT WORK

Cumulative IOT&E Results Through FY 2008



DSB DT&E Taskforce Main Conclusion

May 2008

- " . . . the single most important step necessary to correct high suitability failure rates is to ensure programs are formulated to execute a viable systems engineering strategy from the beginning, including a robust reliability, availability, and maintainability (RAM) program, as an integral part of design and development. No amount of testing will compensate for deficiencies in RAM program formulation."

Section 231 Report to Congress
Core T&E Principles

1. T&E should concentrate on measuring improvements to mission capability and operational support based on user needs;

2. T&E programs should experiment . . . . learn and understand the strengths and weaknesses of a system and its components, and the effect on operational capabilities and limitations;

3. DT and OT activities should be integrated;

4. T&E should begin early, be more operationally realistic, and continue through the entire system life-cycle;

5. Evaluation should be conducted in the mission context expected at time of fielding to the user . . . in terms of operational significance;

6. Evaluations should include a comparison against current mission capabilities;

7. Evaluations should take into account all available data and information;

8. T&E should exploit the benefits of appropriate M&S.

New Acquisition/T&E Policies

McQueary/Finley Memo on Assessment of Op Test Readiness
(21 May 2007)

- The DUSD(A&T) shall conduct an independent Assessment of Operational Test Readiness (AOTR) for all ACAT ID programs and special interest programs designated by the USD(AT&L)

- The CAE shall consider the results of the AOTR prior to making a determination of materiel system readiness for IOT&E.

New Acquisition/T&E Policies

Young Memo on Competitive Prototyping (19 Sep 2007)

- All acquisition strategies requiring USD (AT&L) approval must be formulated to include competitive, technically mature prototyping through MS B.

New Acquisition/T&E Policies

Young-McQueary T&E Policy Letter - (22 Dec 2007)

- DT and OT test activities shall be integrated and seamless
- Evaluations shall include a comparison with current mission capabilities
- T&E should assess improvements to mission capability and operational support based on user needs
- To more effectively integrate DT and OT, evaluations shall take into account all available and relevant data and information, including contractor data
- Operational evaluators will continue to fulfill their statutory roles in providing assessments of operational effectiveness, operational suitability, and survivability to the Milestone Decision Authority
- To realize the benefits of modeling and simulation, T&E will be conducted in a continuum of live, virtual, and constructive environments.

New Acquisition/T&E Policies

McQueary-Finley Memo on Reliability Improvement WG
(15 Feb 2008)

- Ensure programs are formulated to execute a viable systems engineering strategy, including a RAM growth program.
- Ensure government organizations reconstitute a cadre of experienced T&E and RAM personnel.
- Implement mandated integrated DT and OT, including the sharing and access to all appropriate contractor and government data and the use of operationally representative environments in early testing.

New Acquisition/T&E Policies

McQueary-Finley Memo defining Integrated Testing (May 2008)

- “Integrated testing is the collaborative planning and collaborative execution of test phases and events to provide shared data in support of independent analysis, and evaluation.”

New Acquisition/T&E Policies

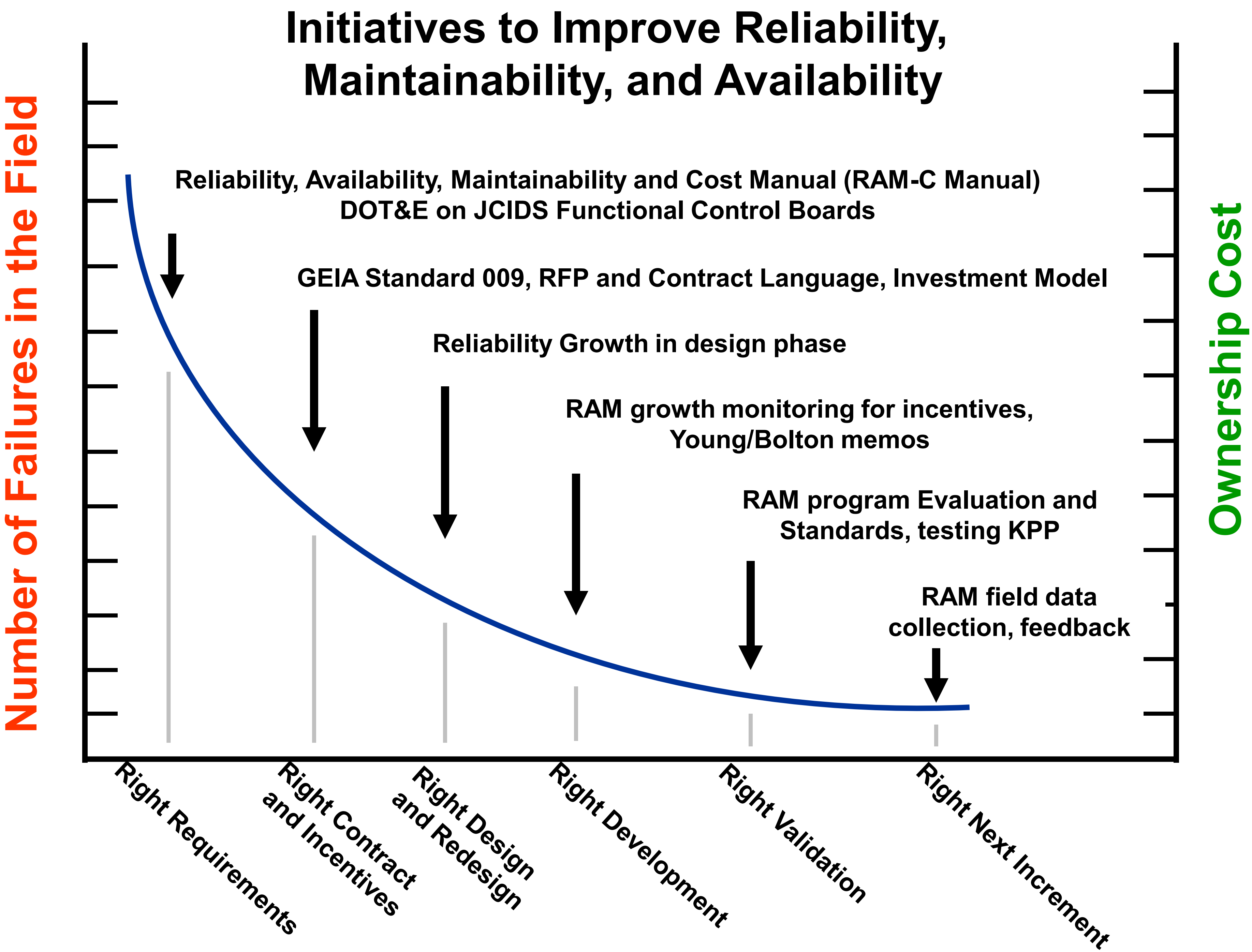
Young Memo on RAM Policy (July 2008)

- The Service Secretaries are directed to establish Service policy to do the following:
  - Effective collaboration between the requirements and acquisition communities
  - Development contracts and acquisition plans must evaluate RAM during system design.
  - Evaluate the maturation of RAM through each phase of the acquisition life cycle.

Senior Leadership Buy-In of New Reliability/T&E Policies

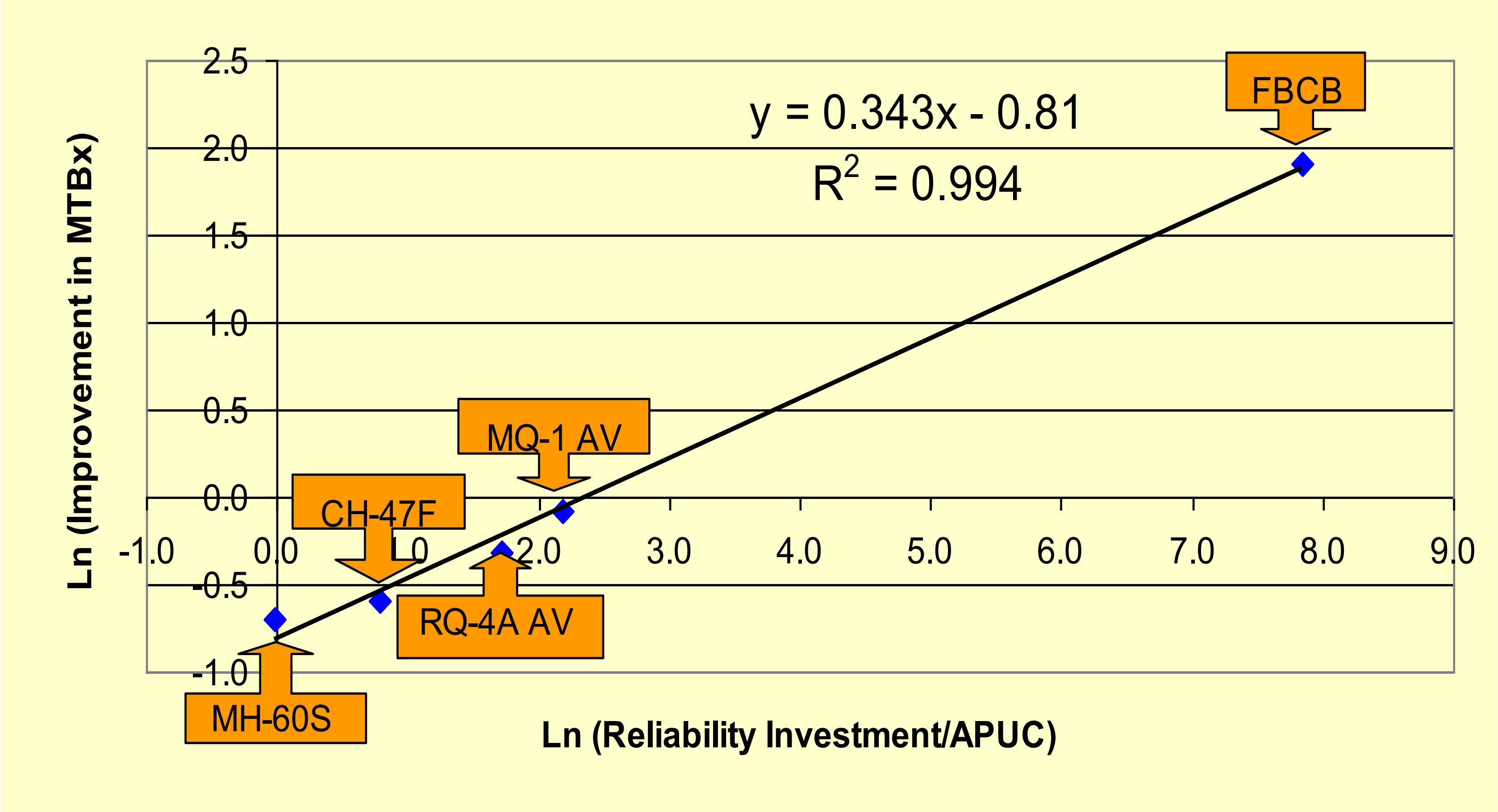
"Having performance is important, but not as important in most cases, as having reliability."

- Hon. Donald Winters, Secretary of the Navy (Sept 3, 2008)

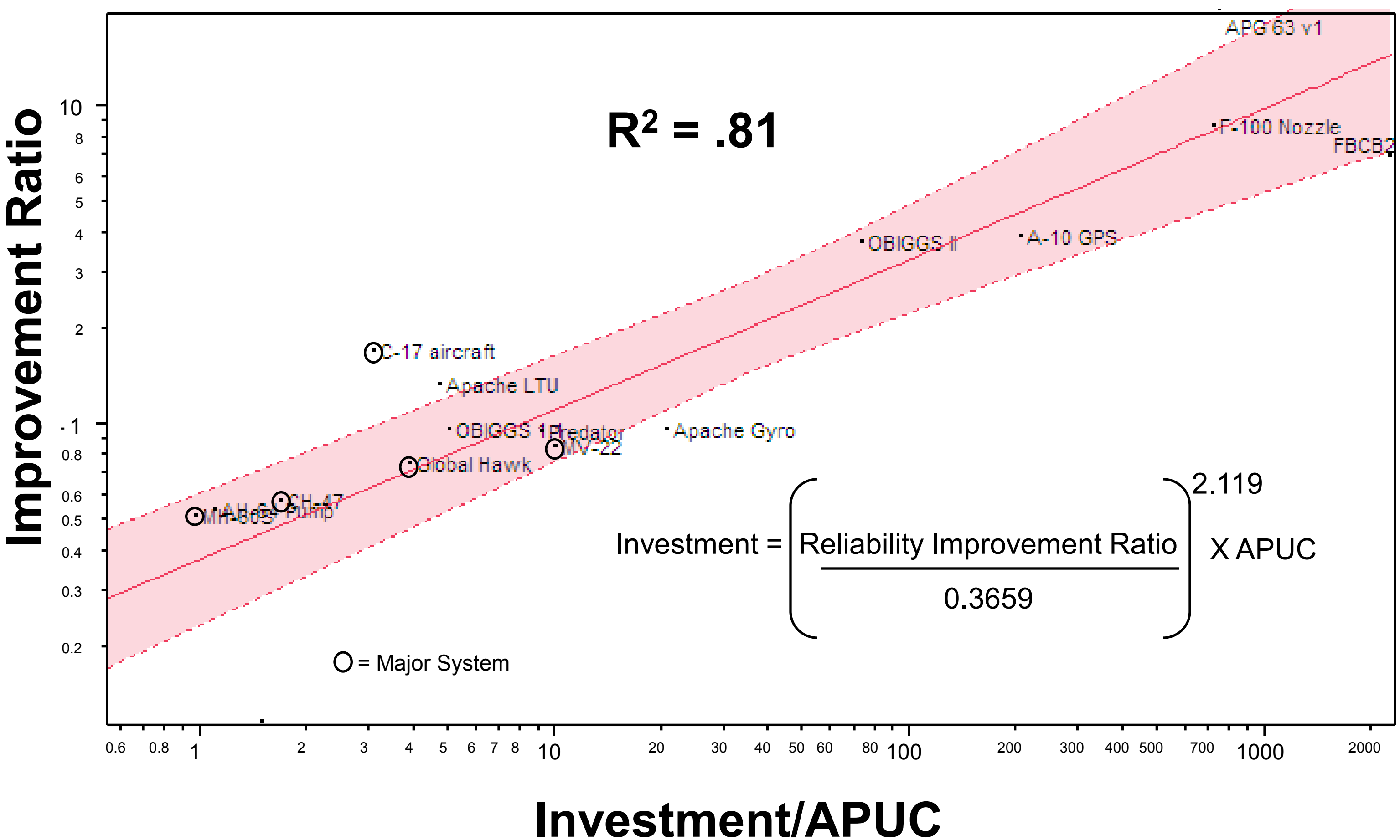

Initiatives to Improve Reliability, Maintainability, and Availability
Number of Failures in the Field
Ownership Cost
Reliability, Availability, Maintainability and Cost Manual (RAM-C Manual)
DOT&E on JCIDS Functional Control Boards
GEIA Standard 009, RFP and Contract Language, Investment Model
Reliability Growth in design phase
RAM growth monitoring for incentives, Young/Bolton memos
RAM program Evaluation and Standards, testing KPP
RAM field data collection, feedback
Right Requirements
Right Contract and Incentives
Right Design and Redesign
Right Development
Right Validation
Right Next Increment

Phase I: Empirical Research

Reliability Improvement vs. Investment

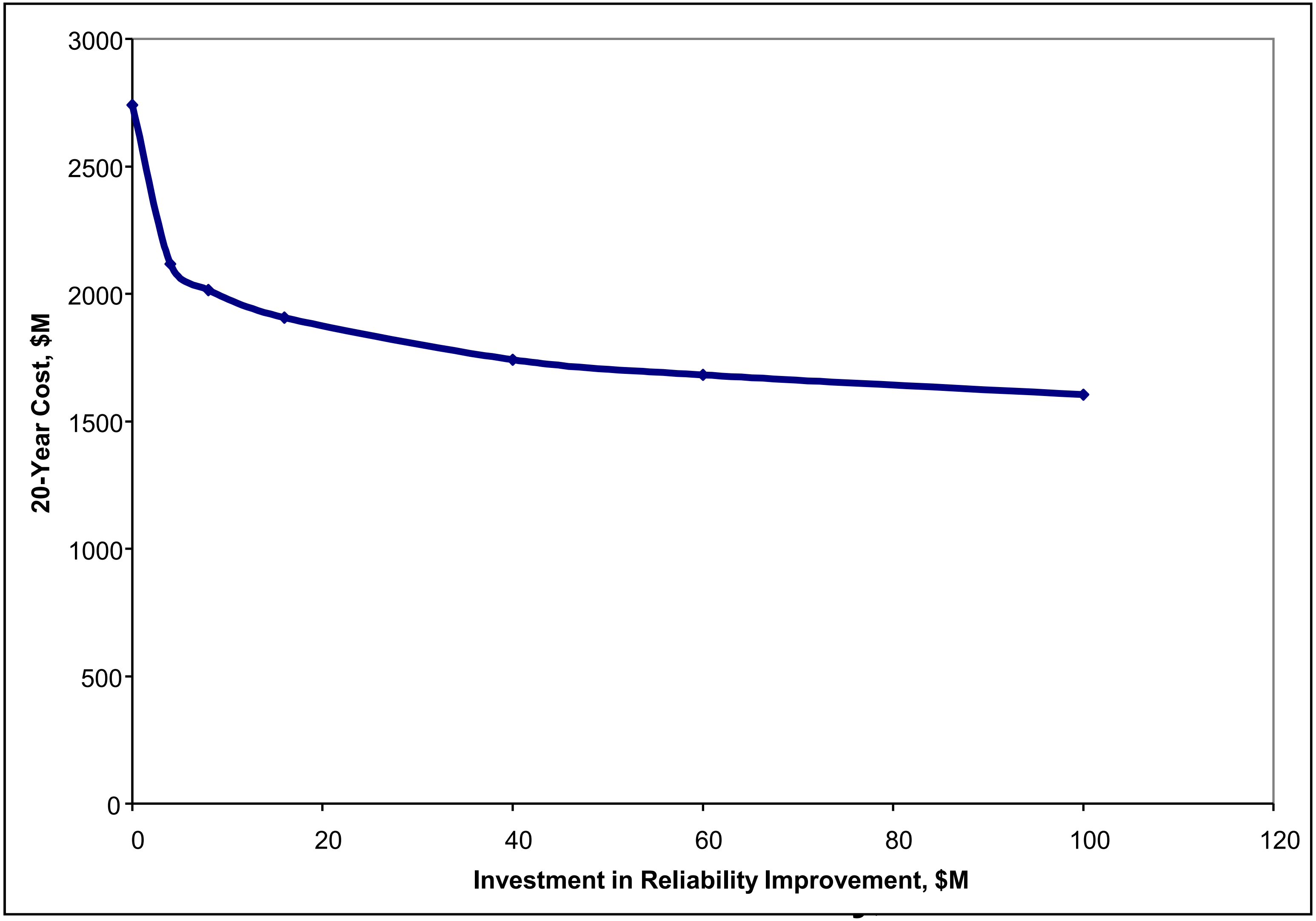


Phase IIA (Basic Model)



Phase III: Notional Example

Effect of Reliability Investment on System Cost (UAV)



Update on Revisions to MIL-STD-882

NDIA 11th Annual Systems Engineering Conference
System Safety – ESOH & HSI Session 3C4
San Diego, CA

Robert E. Smith, CSP

October 22, 2008

Contents

- Introduction
- MIL-STD-882 history
- Purpose of revision
- Highlight of changes
- Coordination process
- Conclusion

Introduction

- MIL-STD-882 is DoD's standard practice for system safety
- Considered the system safety "bible" for DoD Acquisition Programs
- Identifies system safety practices for both the program manager and contractor
- In existence since 1969 and has been revised several times
- Last revision (MIL-STD-882D) occurred Feb 2000

MIL-STD-882 History[1]

- MIL-STD-882 - July 1969
  - First DoD system safety standard
  - System safety program became mandatory on all DoD-procured products and systems
- MIL-STD-882A - June 1977
  - Centered on the concept of risk acceptance as a criterion for system safety programs
  - Required introduction of hazard probability and established categories for frequency of occurrence to accommodate the long-standing hazard severity categories
- MIL-STD-882B - 30 March 1984
  - Continued evolution of detailed guidance in both engineering and management requirement
  - More emphasis on facilities and off-the-shelf acquisition was added, and software was addressed in some detail for the first time

[1] Clifton Ericson II, *A Short History of System Safety*, Journal of System Safety, May-June 2006.

MIL-STD-882 History[1] (cont)

- MIL-STD-882B, Notice 1 - 1 July 1987
  - Expanded software tasks and the scope of the treatment of software by system safety
- MIL-STD-882C - 19 Jan 1993
  - Integrated the hazard and software system safety efforts
  - Individual software tasks were removed
  - Safety analysis would include identifying the hardware and software tasks together in a system
- MIL-STD-882C, Notice 1 - 19 Jan 1996
  - Corrected some errors and revised the Data Item Descriptions
- MIL-STD-882D - 10 Feb 2000
  - Under the Military Specifications and Standards Report (MSSR) initiative, MIL-STD-882D was considered important to continue, as long as it was converted to a performance-based standard practice – *what you want vs. how to do it*
  - Task descriptions removed

Average time between revisions: ~ 8 yrs

Purpose of Revision

- Initial drivers:
  - Government and Industry wanted to bring back the Task Descriptions from MIL-STD-882C to make them readily available for call out in contract documents
  - Align with current OSD Acquisition Systems Engineering policy changes
- Subsequent drivers:
  - Adjust the organizational arrangement of information to clarify the basic elements of a system safety program and the process flow among them
  - New tasks
  - Support DoD strategic plans and goals

Highlight of Changes

- Update will be referred to as MIL-STD-882D, Revision 1
- Subtitle added to emphasize ESOH integration into Systems Engineering
  - "ESOH Risk Management Methodology for Systems Engineering"
- Standardized definitions
- Rewrote task descriptions to clarify and dissociate from each other
  - 100-series tasks - program management and control
  - 200-series tasks - design and integration
  - 300-series tasks - design
  - 400-series tasks - compliance and verification
- Emphasized the identification and derivation of applicable ESOH technical requirements
- Added Hazardous Material Management Process (HMMP) task

Highlight of Changes (cont)

- Matrix description updated
  - For severity, dollar value on losses increased for today's program dollars and logarithmic progression applied
  - For probability, finite period of time or cycles added; "Eliminated" level added
  - Matrix rearranged to have ascending severity on x-axis
    - » Mishap risk assessment values and categories unchanged, but graphically looks different than current matrix
- More emphasis on:
  - Establishing a collaborative ESOH effort using the system safety process
  - Providing coordinated ESOH input to systems engineering to maximize performance by minimizing the environmental "footprint" of the system and improving safety of personnel and the system itself
- "Appendix A - Guidance for Implementation of an ESOH Effort" has been updated
  - Additional detail on hazard definitions and assessing top level mishaps
  - Software safety techniques and principles reintroduced

Coordination Process

- DoD ACQ ESOH IPT
  - 882 Working Group complete IPT recommended draft
  - Review and comments
  - Resolution of comments
  - Provide the IPTs recommended Draft to SAF/AQRE
- NDIA SE Division
  - Review and comments
  - Resolution of comments
- Formal DoD Coordination
  - Standardization community

Current Estimated Completion Date: Mid 2009

Conclusion

- Clarifies terminology, incorporates current policy and defines task descriptions to improve system safety practices
- Strengthens integration across Environment, Safety, and Occupational Health and into Systems Engineering during the acquisition process
- Improves consistency of system safety practices between programs

Questions?

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703-412-7661
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MIL-STD-882D, Rev 1 – Severity Categories

TABLE 1. Severity Categories

Severity Category	Severity Level	Environment, Safety, and Occupational Health Mishap Result Criteria
Catastrophic	I	Could result in death, permanent total disability, loss exceeding $10M, or irreversible significant environmental impact.
Critical	II	Could result in permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, loss exceeding $1M but less than $10M, or reversible significant environmental impact.
Marginal	III	Could result in injury or occupational illness resulting in 10 or more lost work days, loss exceeding $100K but less than $1M, or reversible moderate environmental impact.
Negligible	IV	Could result in injury or illness resulting in less than 10 lost work days, loss less than $100K, or minimal environmental impact.

Dollar value on losses changed:

- ***Increased for today's program dollars***
- ***Logarithmic progression applied***

Current MIL-STD-882D Definition

MIL-STD-882D, Rev 1 – Probability Levels

TABLE 2. Probability Levels

Probability Name	Probability Level	Description*
Frequent	A	Likely to be experienced several times by a system within a 12 month period; a probability of occurrence greater than 10^{-1} over 12 months.
Probable	B	Likely to be experienced by a system within a 12 month period; a probability of occurrence less than 10^{-1} but greater than 10^{-2} over 12 months.
Occasional	C	May be experienced by a system within a 12 month period; a probability of occurrence less than 10^{-2} but greater than 10^{-3} over 12 months.
Remote	D	Unlikely, but possible to be experienced by a system within a 12 month period; a probability of occurrence less than 10^{-3} but greater than 10^{-6} over 12 months.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced by a system within a 12 month period; a probability of occurrence of less than 10^{-6} over 12 months.
Eliminated	F	Incapable of occurrence. This category is used when potential hazards are identified and later eliminated.

- ***Finite period of time or cycles added to description***
- ***“Eliminated” level added***

Current MIL-STD-882D Definition

MIL-STD-882D, Rev 1 – Risk Matrix

TABLE 3. ESOH Risk Assessment Values

		Severity			
		Negligible IV	Marginal III	Critical II	Catastrophic I
Probability	Frequent (A)	13	7	3	1
	Probable (B)	16	9	5	2
	Occasional (C)	18	11	6	4
	Remote (D)	19	14	10	8
	Improbable (E)	20	17	15	12
	Eliminated	21			

TABLE 4. Risk Categories

Risk Assessment Value	Risk Category	Risk Acceptance Level
1 – 5	High	In accordance with DoD policy
6 – 9	Serious	
10 – 17	Medium	
18 – 20	Low	
21	N/A (eliminated)	

- ***Matrix rearranged to have ascending severity on x-axis***
- ***Risk assessment values and categories unchanged***

Current MIL-STD-882D Definition

Backups

MIL-STD-882 Eight Mandatory System Safety Steps

1. Document the system safety approach
2. Identify ESOH hazards
3. Assess the risk
4. Identify risk mitigation measures
5. Reduce risk to an acceptable level
6. Verify risk reduction
7. Review hazards and accept risk by appropriate authority
8. Track ESOH hazards, their resolution, and residual risk throughout the system lifecycle

Current MIL-STD-882D Severity Definitions

TABLE A-I. **Suggested mishap severity categories.**

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

Current MIL-STD-882D Probability Definitions

TABLE A-II. **Suggested mishap probability levels.**

Description*	Level	Specific Individual Item	Fleet or Inventory**
Frequent	A	Likely to occur often in the life of an item, with a probability of occurrence greater than 10^{-1} in that life.	Continuously experienced.
Probable	B	Will occur several times in the life of an item, with a probability of occurrence less than 10^{-1} but greater than 10^{-2} in that life.	Will occur frequently.
Occasional	C	Likely to occur some time in the life of an item, with a probability of occurrence less than 10^{-2} but greater than 10^{-3} in that life.	Will occur several times.
Remote	D	Unlikely but possible to occur in the life of an item, with a probability of occurrence less than 10^{-3} but greater than 10^{-6} in that life.	Unlikely, but can reasonably be expected to occur.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced, with a probability of occurrence less than 10^{-6} in that life.	Unlikely to occur, but possible.

*Definitions of descriptive words may have to be modified based on quantity of items involved.

**The expected size of the fleet or inventory should be defined prior to accomplishing an assessment of the system.

Current MIL-STD-882D Risk Assessment Matrix

TABLE A-III. **Example mishap risk assessment values.**

SEVERITY PROBABILITY	Catastrophic	Critical	Marginal	Negligible
Frequent	1	3	7	13
Probable	2	5	9	16
Occasional	4	6	11	18
Remote	8	10	14	19
Improbable	12	15	17	20

TABLE A-IV. **Example mishap risk categories and mishap risk acceptance levels.**

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

*Representative mishap risk acceptance levels are shown in the above table. Mishap risk acceptance is discussed in paragraph A.4.4.7. The using organization must be consulted by the corresponding levels of program management prior to mishap risk acceptance.

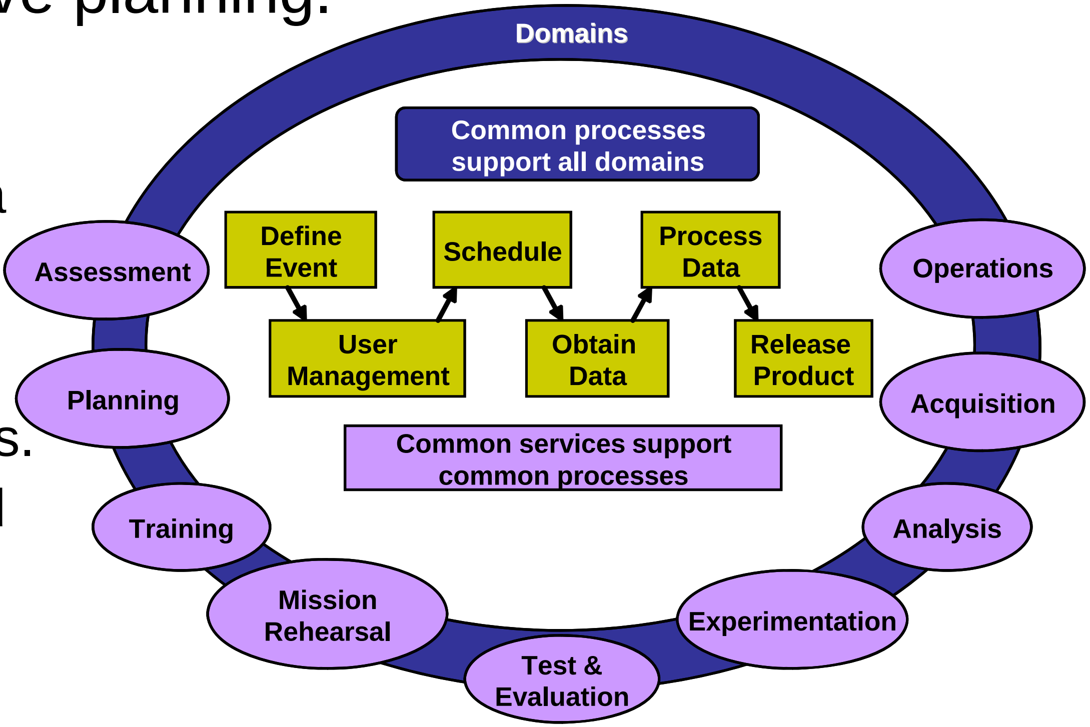
Joint Rapid Scenario Generation (JRSG)
Systems Engineering
October 2008

Mr. Ralph O'Connell
US Joint Forces Command
Joint Capability Development (J8)
Senior Systems Engineer

JRSG Problem Statement

Generation of scenario data sets do not support operational requirements for near real time mission rehearsal, course of action analysis, and adaptive planning.

- The increasing use of complex M&S applications requires data with greater fidelity with a rapid production time.
- There are common capability gaps that transcend all domains.
- Combined, Joint, Services, and Agencies (C/J/S/A) are developing independent improvements to their scenario generation capabilities.



JRSG Activity Model & Domain Support

No one in is responsible for orchestrating the DoD enterprise solution.

Scenario generation expenses reported in FY07 are **>$400M***

Department of Defense M&S Budget in FY08 is **~$11B****

*Source: JRSG Evaluation of Alternatives Survey

**Source: Dan Cuda, Mike Frieders, IDA CARD

JRSG Systems Engineering Objective and Constraints

Objective: Integrate existing Combined, Joint, Service, and Agency (C/J/S/A) scenario generation capabilities into an enterprise solution that can rapidly translate authoritative data into a set of initialization products that support mission critical timelines.

Constraints:

- Comply with Net-Centric Data Strategy (NCDS) and Universal Core (UC) data schema
- Utilize Net-Centric Enterprise Services (NCES)
- Synchronize capability development with Net-Enabled Combat Capability (NECC) and the Command and Control (C2) Domain Core data schema
- Evolve best of breed C/J/S/A capabilities
- Adhere to Information Assurance policy

JRSG Systems Engineering Approach

Establish JRSG Community of Interest (COI)

↓

Determine JRSG Demonstration Objectives

- Integrate existing capabilities as enterprise solution
- Determine Combatant Command priority data sharing needs

↓

Demonstrate JRSG Service Oriented Architecture (SOA)

Geospatial Data Discovery

- Map Metadata to GSIP
- Build Message Broker
- Deploy Agents

Order of Battle Data Discovery/Delivery

- Map OOB to JC3IEDM
- Build Message Broker
- Invoke GFM DI Service

JRSG Community of Interest (COI)

US Special Operations Command

Joint Chiefs Of Staff

US Joint Forces Command

National Geospatial Intelligence Agency

DISA
Defense Information Systems Agency
Department of Defense

US Navy

US Army

Simulation to C4I Interoperability

Topographic Engineering Center

National Simulation Center

US Air Force

US Marine Corps

Program Executive Office Simulation Training, Instrumentation

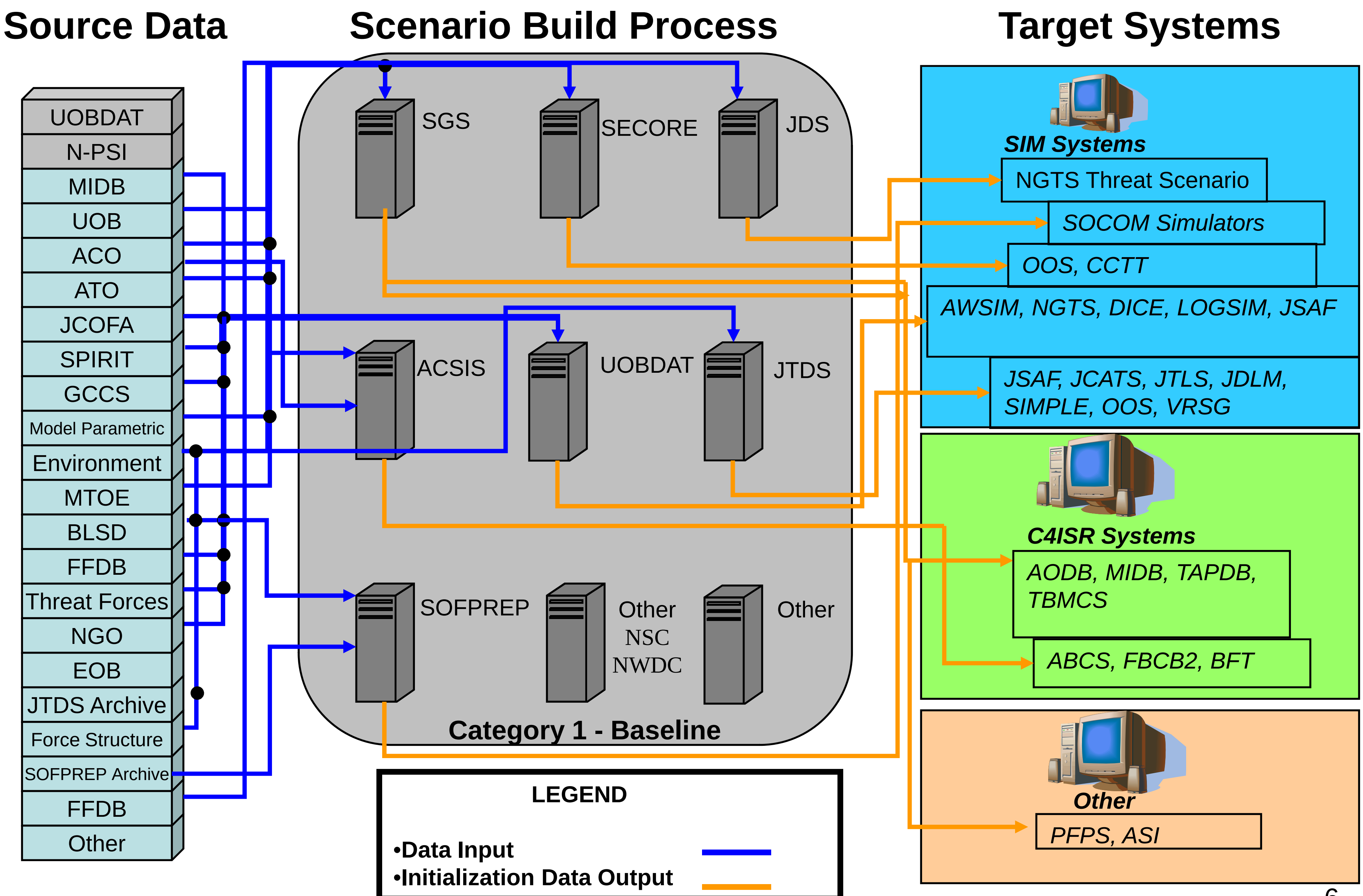
Synthetic Environment Core

Air Force Research Lab

Air Force Agency For Modeling & Simulation

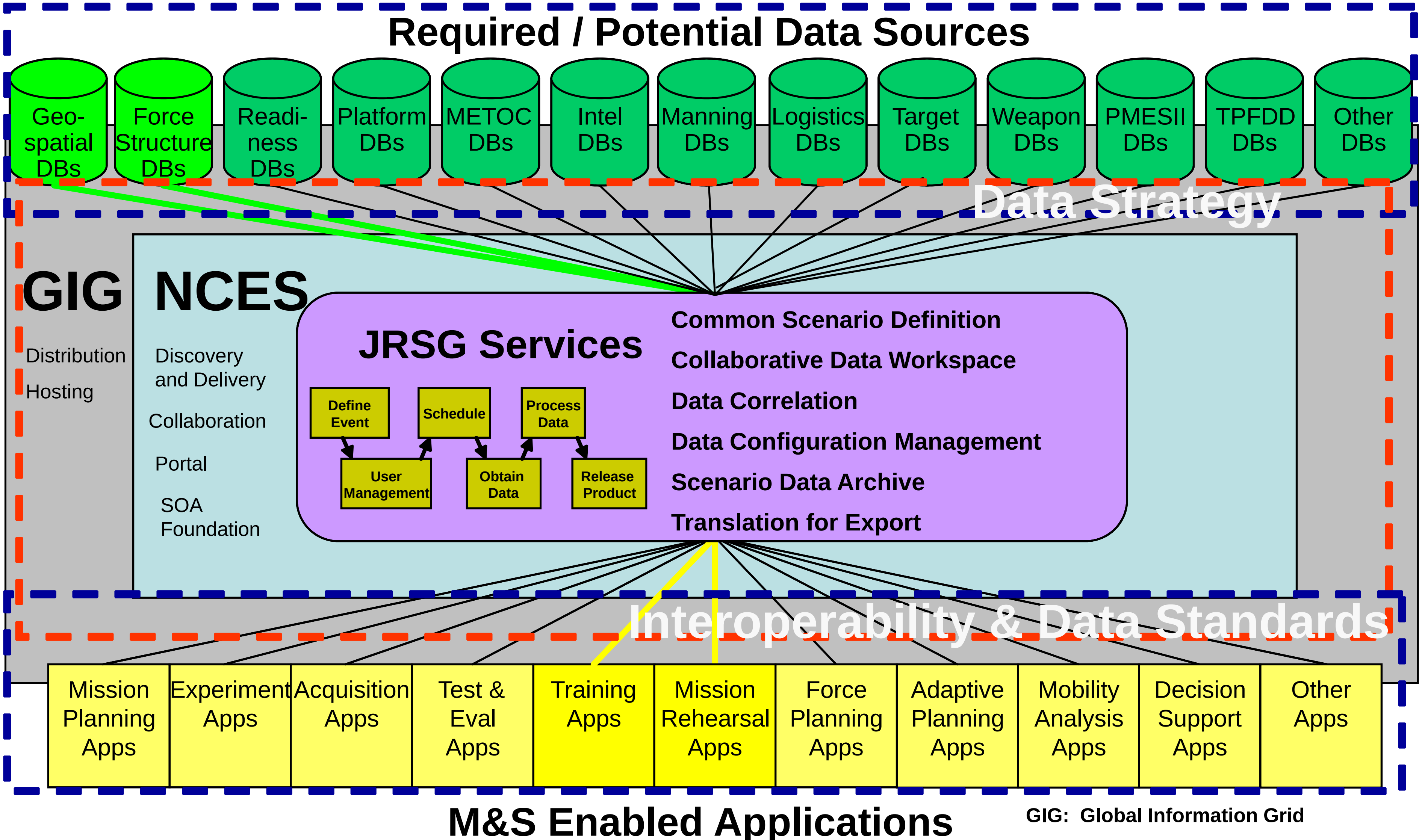
Naval Aviation System Master Plan

Notional "As-Is" Baseline Capability



Conceptual JRSG "To Be" Architecture

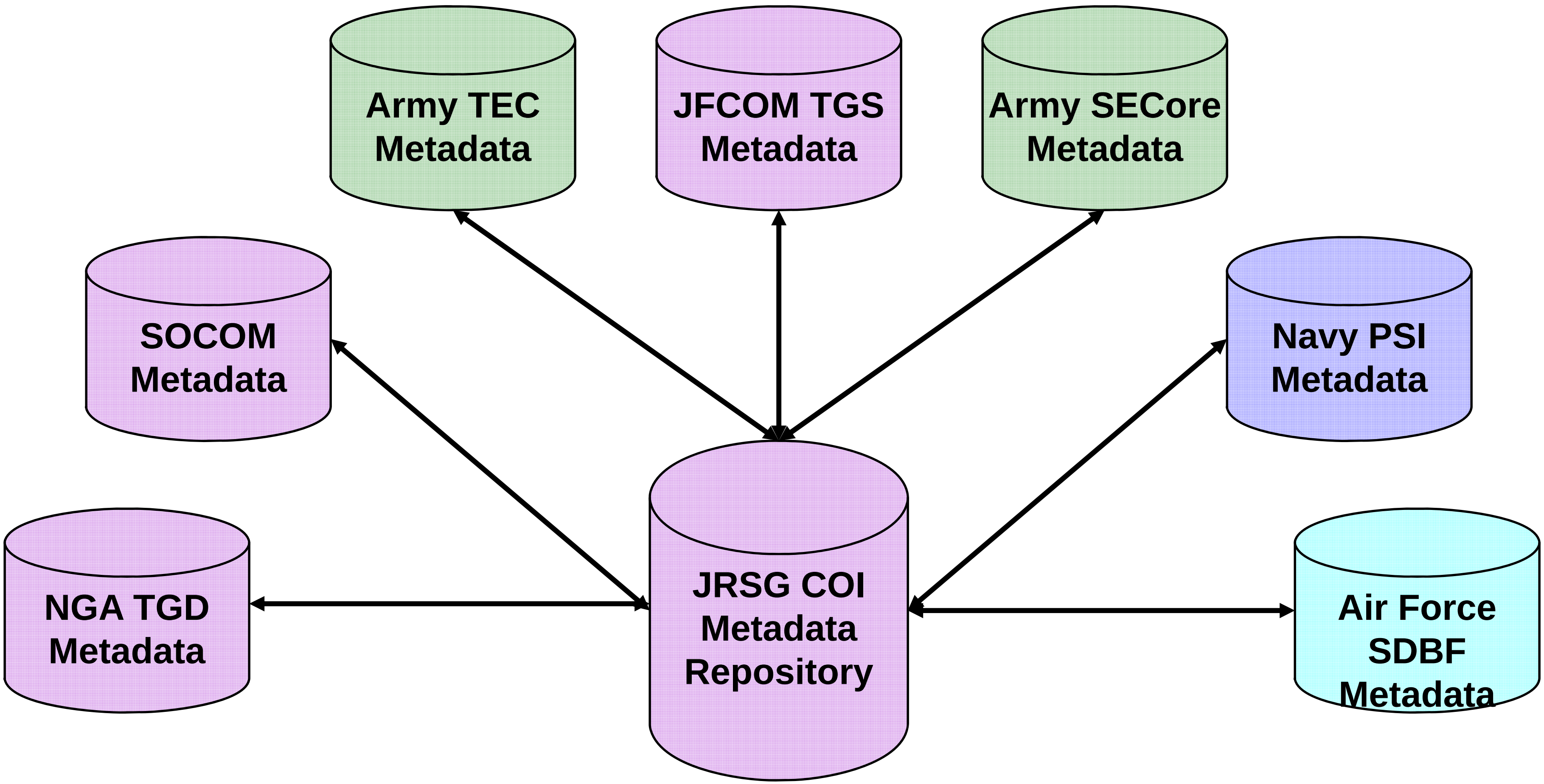
FOCUSED ON PROVIDING LVC FUTURE IMMERSIVE TRAINING ENVIRONMENT



GIG: Global Information Grid

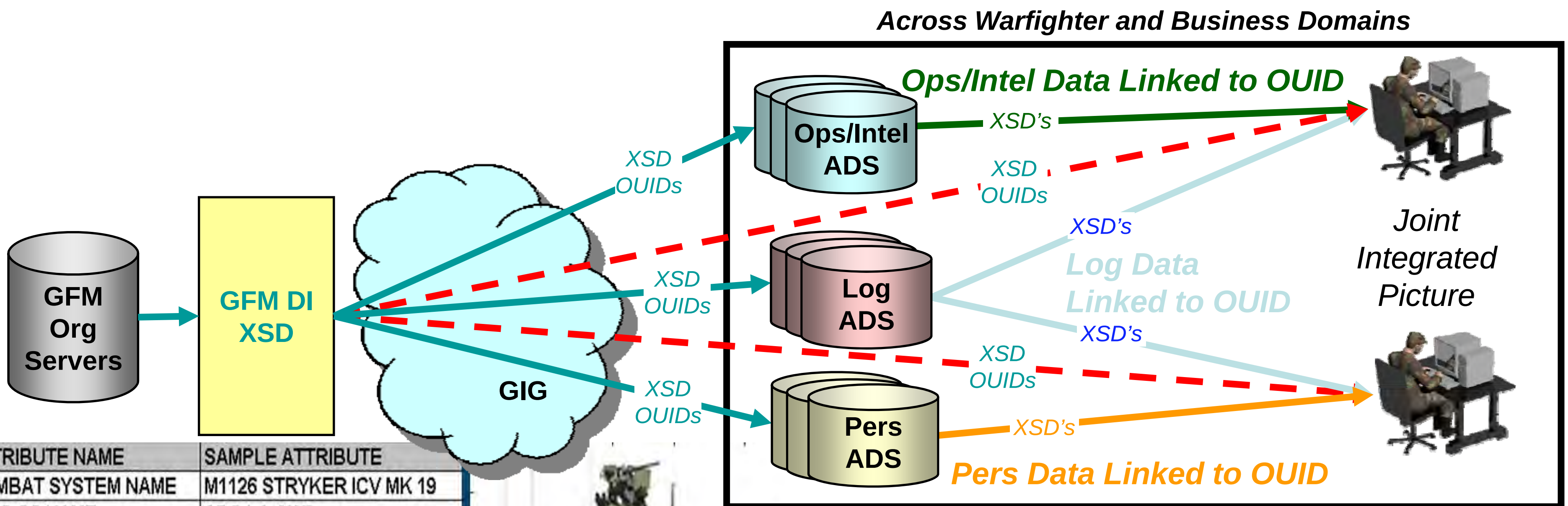
NCES: Net-Centric Enterprise Services

JRSG COI Geospatial Metadata Mapping



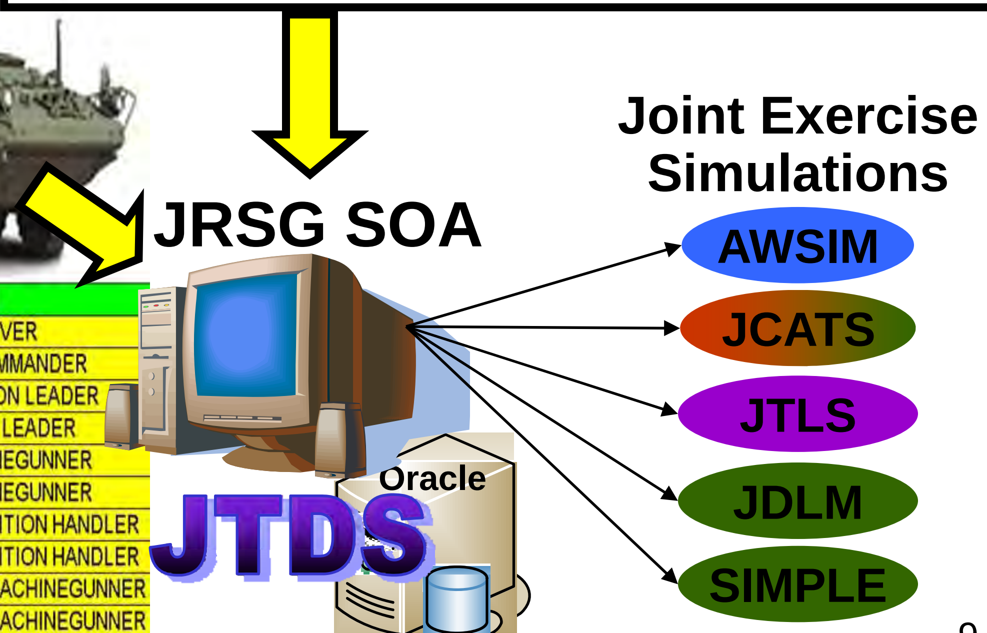
All JRSG COI geospatial discovery metadata mapped to GEOINT Structure Implementation Profile (GSIP) standard metadata exchange model.

Order of Battle Scenario Generation Data

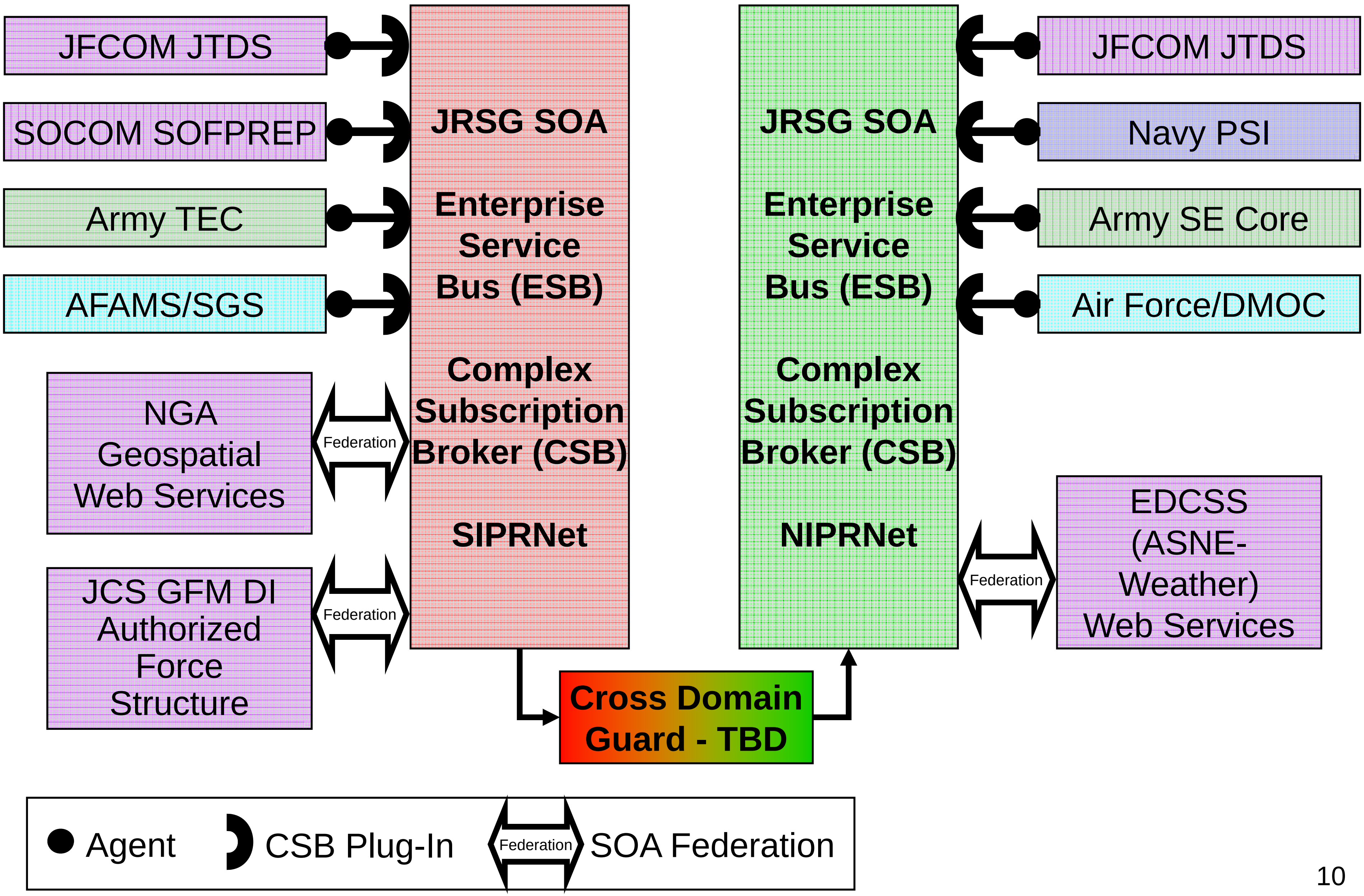


ATTRIBUTE NAME	SAMPLE ATTRIBUTE
COMBAT SYSTEM NAME	M1126 STRYKER ICV MK 19
JTLS CS NAME	APC-LA-OW2
ENUMERATION	1/1/225/2/5/18/0
ROLE	PL-1-A-4-2 ACR
BUMPER NUMBER	A-16
URN	123456
LIN/TAMC	J22626
WEAPON LIN	M92362
FSC	2320
NIIN	14818575
PARENT UNIT	1-A-4-2 ACF
NET TYPE	COMMAND
NET	PLT 1-A BN
COMMUNICATION DEV	SINGARS
NET POS	0
NET TYPE	COMMAND
COMMUNICATION DEV	EPLARS
NET	CO A BN1
NET POS	2
LOCATION	LAT/LON

SYSTEM CLASS	M STATUS	GRADE	MOS	BILLET
US CREWMAN RIFLE	C	E4	11B10	IAV DRIVER
US CREWMAN RIFLE	C	E5	11B20	IAV COMMANDER
US CBT OFFICER	P	O2	11A00	PLATOON LEADER
US CBT NCO	P	E6	11B30	SQUAD LEADER
US M240G	P	E4	11B10	MACHINEGUNNER
US M240G	P	E4	11B10	MACHINEGUNNER
US ASST GUNNER	P	E3	11B10	AMMUNITION HANDLER
US ASST GUNNER	P	E3	11B10	AMMUNITION HANDLER
US ASST GUNNER	P	E3	11B10	ASST MACHINEGUNNER
US ASST GUNNER	P	E3	11B10	ASST MACHINEGUNNER
US FO	P	E5	13F20	FORWARD OBSERVER



JRSG SOA Pilot Operational Nodes



USJFCOM – IBM

Cooperative Research and Development Agreement

Joint Force Operations

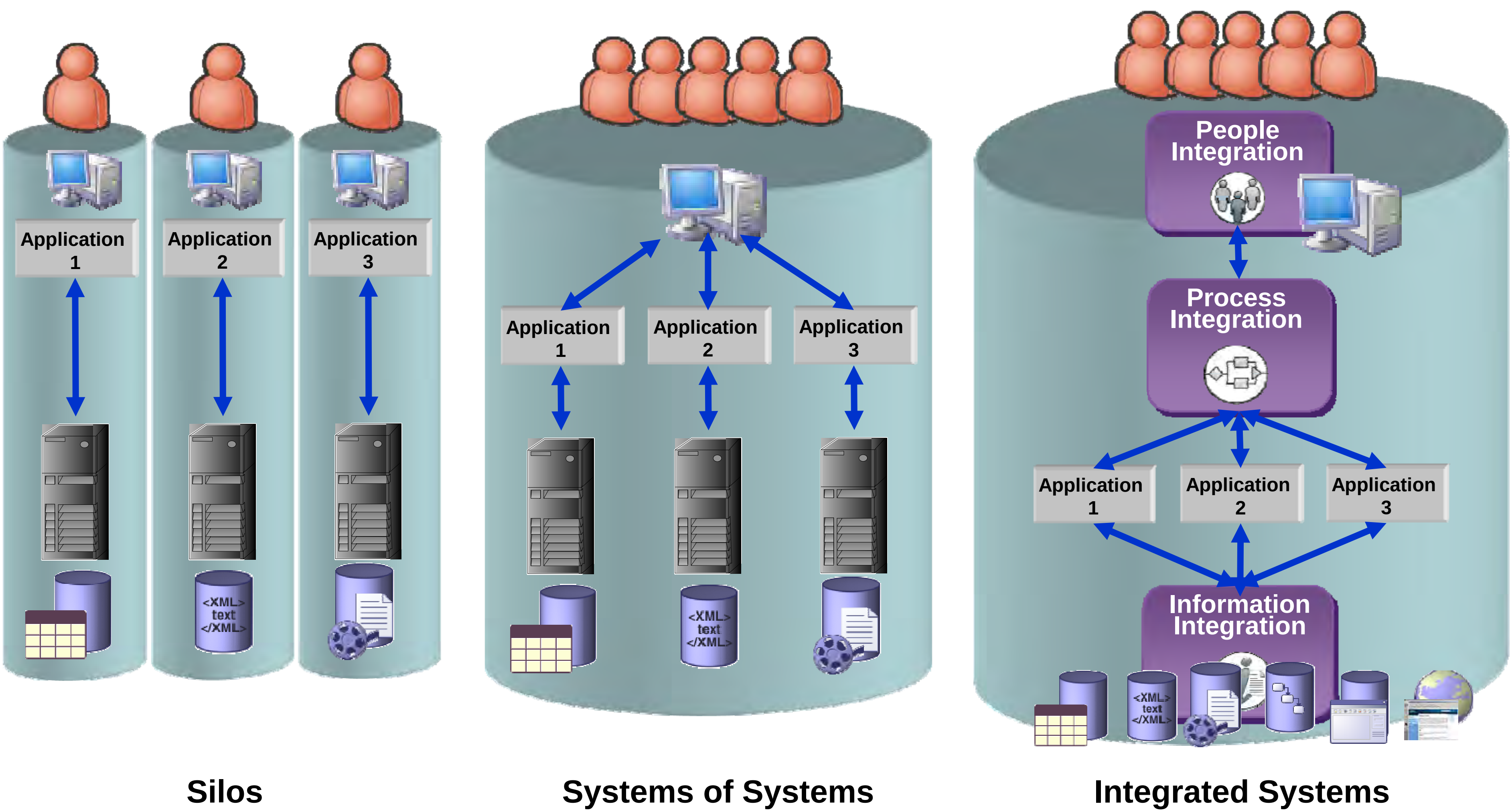
Service Oriented Architecture (SOA)

Applying SOA

9 October 2008

Paul Giangarra
IBM Distinguished Engineer
Office of the CTO, IBM Federal

The Path to Integrated Systems



What is (and isn't) SOA?

SOA is…

- Service Oriented Architecture
- A way of thinking
- A means of aligning Business with Information Technology
- An architectural style for the design of business applications in terms of flexible, reusable, loosely coupled service assets

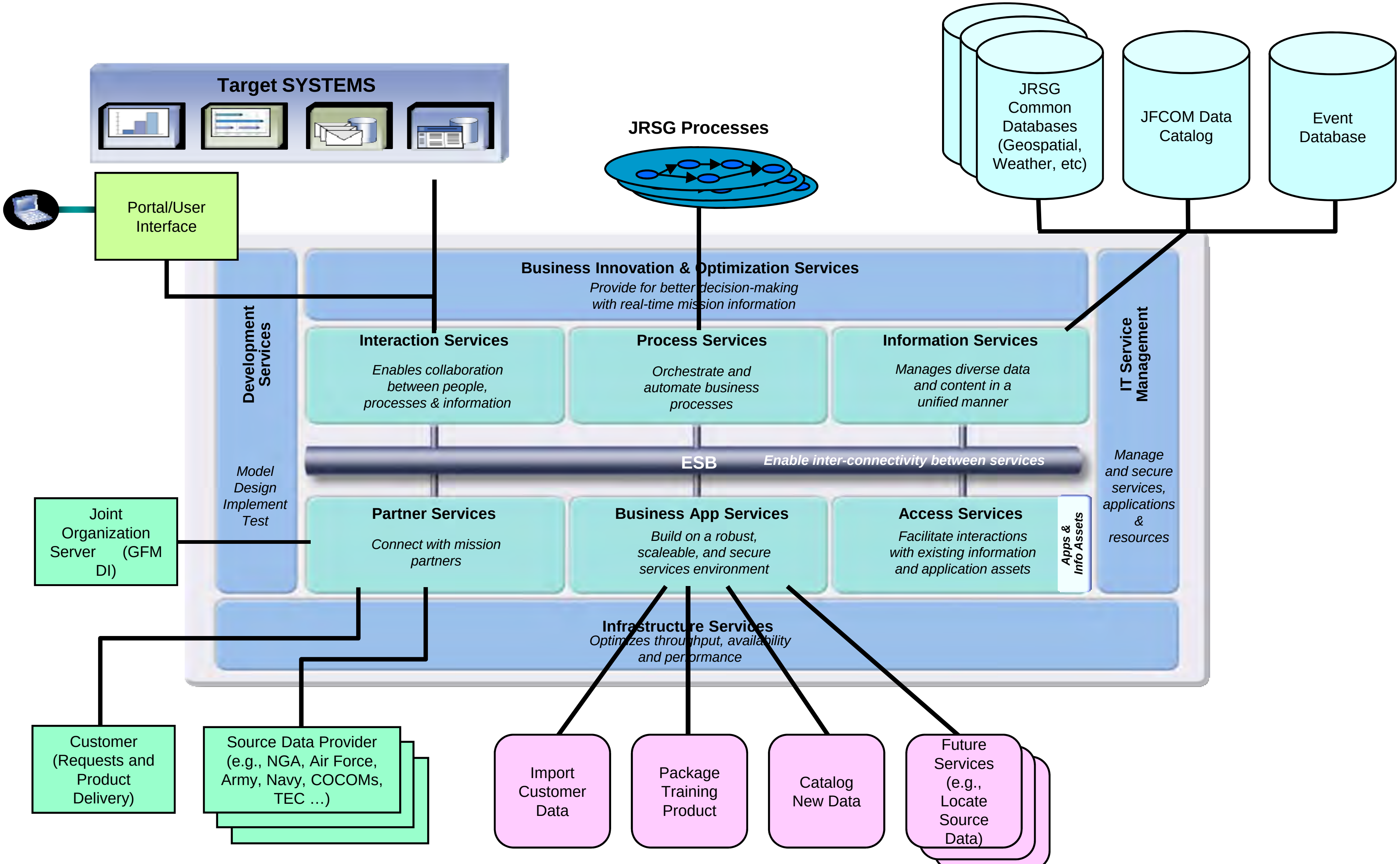
SOA is <u>not</u>…

- A standard
- A specification
- A programming model
- A platform

The SOA Journey

SOA Briefings	Business Pilot Workshop	Architecture & Design	Pilot & Prototype	
Build Common Understanding of SOA	Define First Project and SOA Roadmap	Develop Architecture & Implementation Road Map	Demonstrate SOA Production Feasibility	Objective
• SOA Overview • SOA Mission Value • SOA Best Practices • SOA Implementation	• SOA Assessment • Business Process Map • SOA Reference Arch. • SOA Framework • SOA Governance	• Architecture Principles • Architecture Decisions • Integration Framework • Pilot Project Plan	• Create Code • Create Documentation • Establish Governance	Agenda
• Handouts • IBM SOA Position • SOA Compass Book	• Strategic Roadmap • Project Plan • Service Description • Mission Value	• Technical Architecture • Definition of Phases • Business Case	• Production ready Code • Technology Proof Point • Metrics • Center of Excellence	Deliverables

Joint Rapid Scenario Generation SOA Reference Architecture



Information Lifecycle: The "Problem" Space

Collection

(task/post)

Satellite

Newsfeeds

Radar

UAV

Weather

…

Analyze

(process)

Complex image analysis

Add some meta data

GPS metadata, target analysis

GPS metadata

GPS metadata

…

Generically steps:

- Cleanse, transform, resolve, combine (federation), structure, tag, index
- Choreograph the analysis process
- Requires deterministic E2E responsiveness

Disseminate

(use)

Complex Subscription Broker fits here

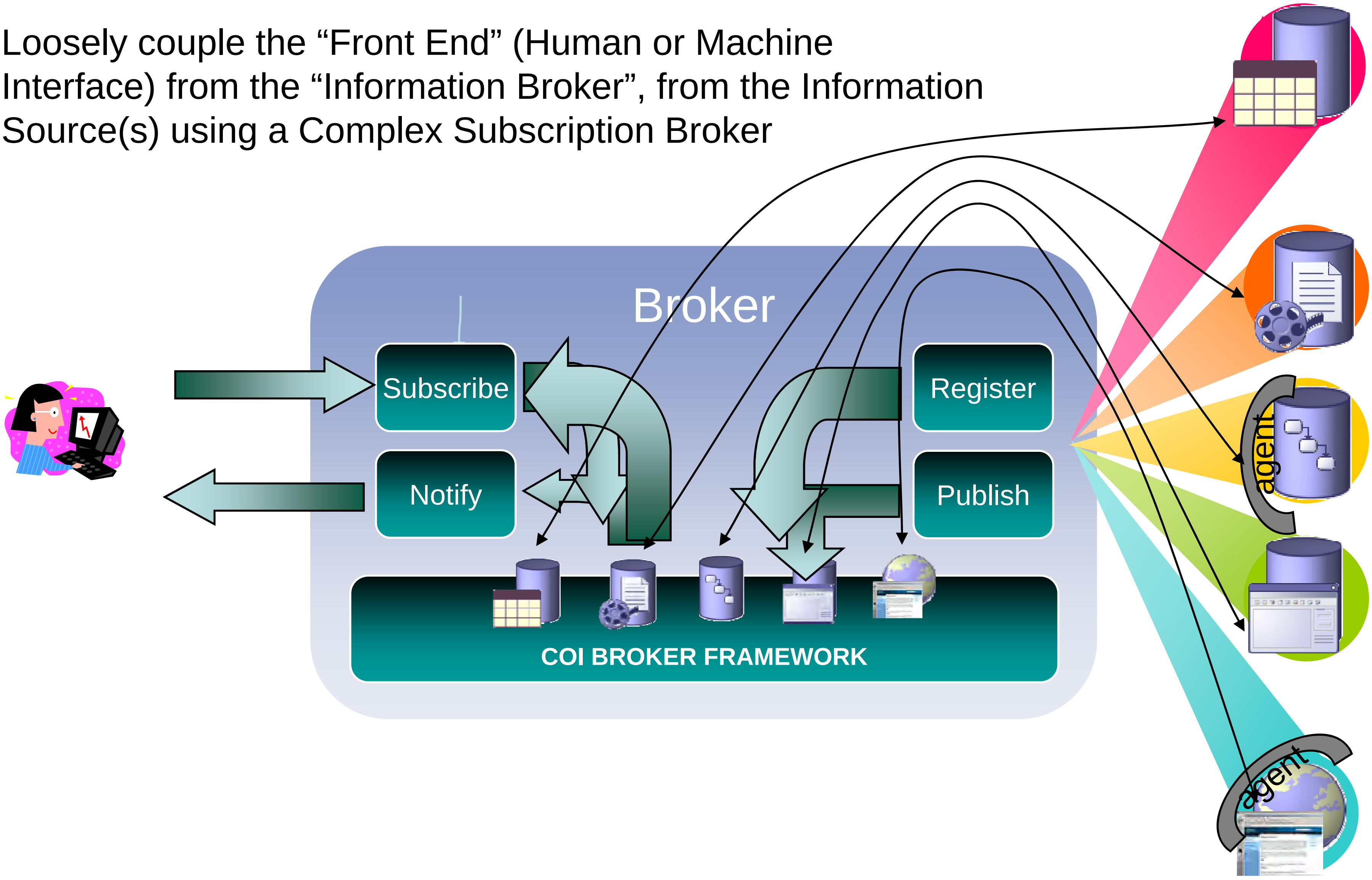
Decouple UI from final information "fusion" and filtering

Community based pub/sub

Example communities: jet fighters, bomber pilots, AWACs, AOC (various roles), ….

Key Architectural Decision

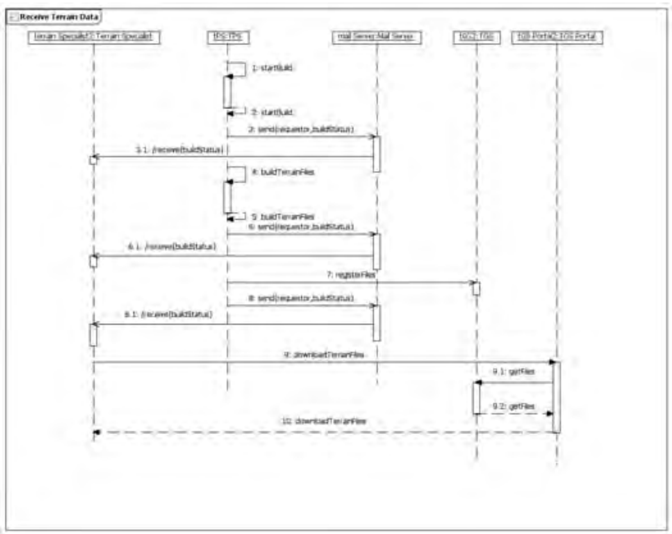
Loosely couple the "Front End" (Human or Machine Interface) from the "Information Broker", from the Information Source(s) using a Complex Subscription Broker

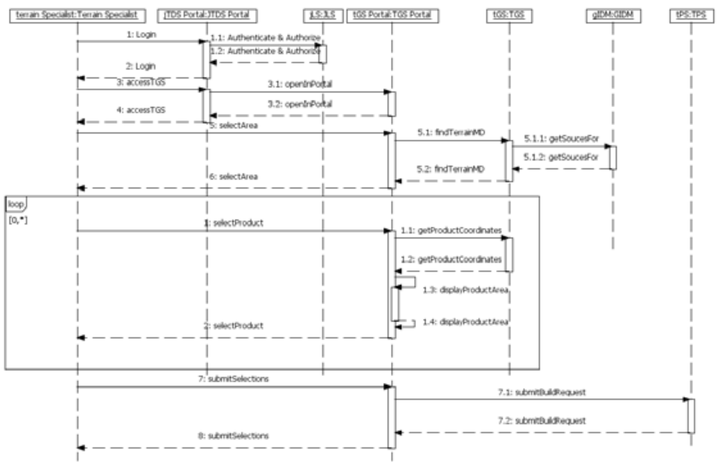


Use Cases to Validate Design Assertions

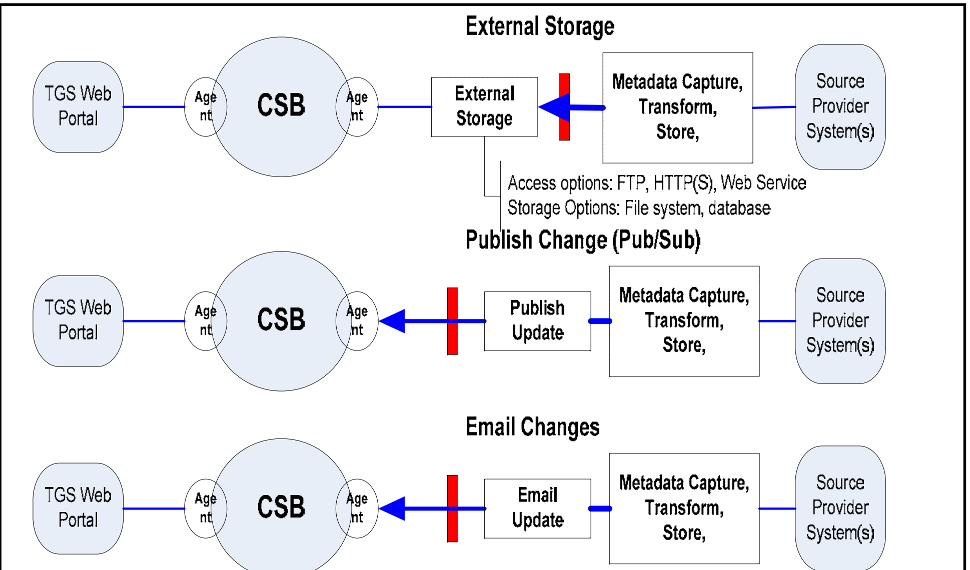
- Publish Terrain Metadata
- Search for and Request Terrain Data
- Receive Terrain Data

(Sample) Sequence Diagrams Created to document the use cases:





To Push or Pull: Architectural Alternatives



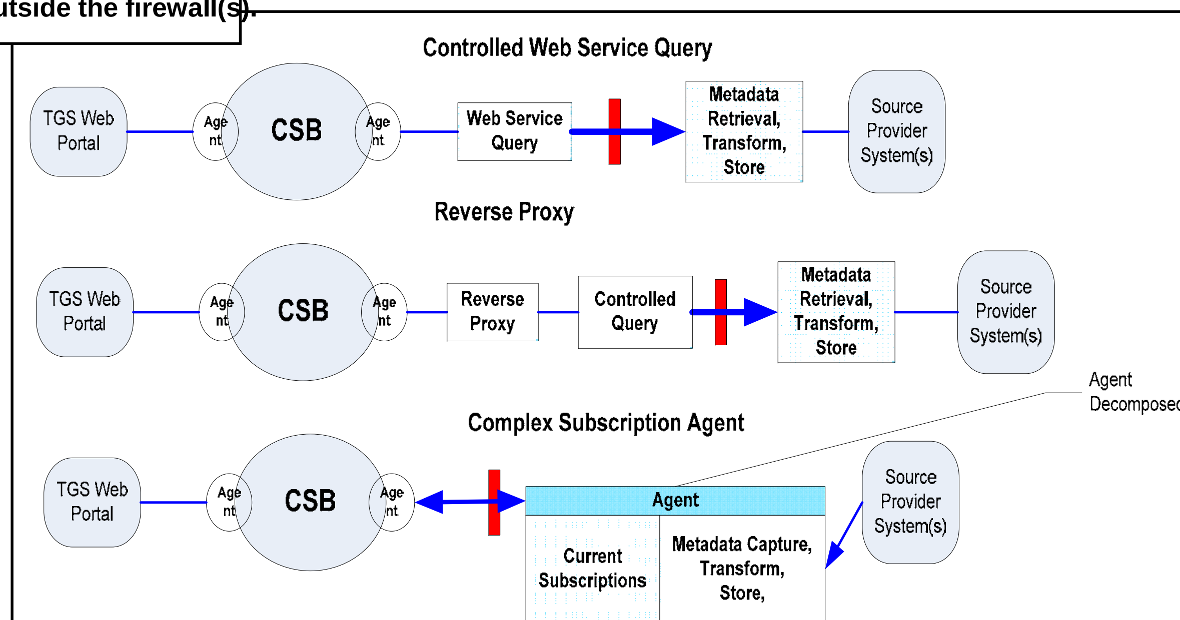
Push Options: Source Provider pushes the metadata outside the firewall(s).

Functional Requirements

- Detect change in Metadata
- Retrieve updated metadata (can be entire catalog at first)
- Transform local metadata structure to a common format
- Store common format metadata (if needed)
- Expose metadata to search

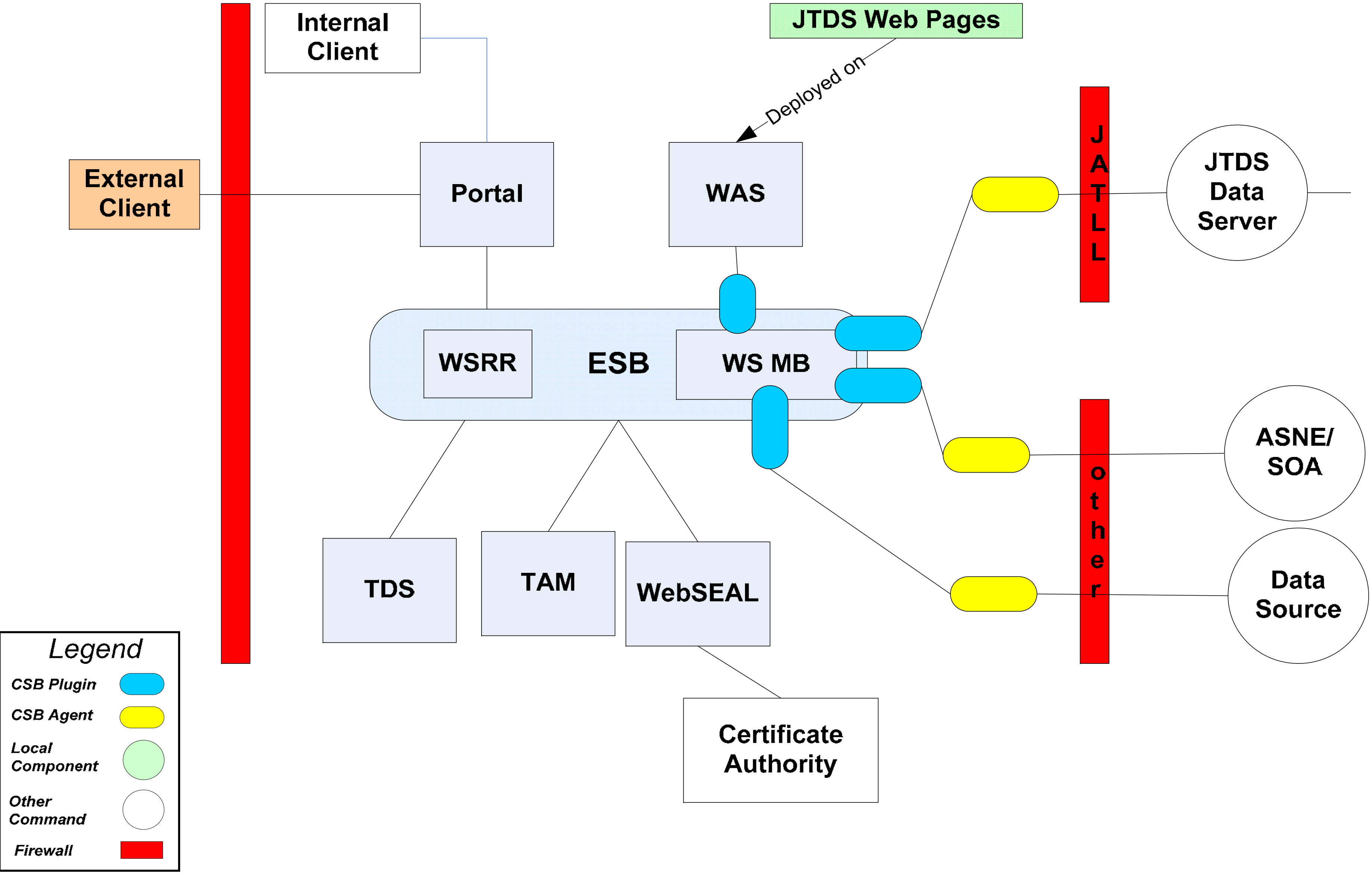
Nonfunctional Requirements (will vary by site)

- Requires minimal work to install, configure and manage on the source provider's part
- Adheres to IA constraints
  - IA: Transparency of exposed metadata
  - IA: Controlled queries
  - IA: Controlled ports/protocols
- Satisfy agreed to SLAs
- Sources are geographically distributed
- Source provider systems may not always be accessible
- Extensible / flexible
- Open Architecture, Standards Based



Pull Options: Source responds to metadata requests

Logical (Network & Product) Architecture



Examples of What is Coming Next

- Finalize Security Model & Design
- Finalize the Data Model
- Design, Develop, Test & Deploy the Components and Infrastructure
- Governance
- Possibly Look at Alternative Interface Options

- Demonstrate the Results
- Determine the Next Steps/Spirals

- Document What We Learned

QUESTIONS??????

ESOH Challenges in Commissioning an Aircraft Carrier

Doug Parrish

Booz Allen Hamilton

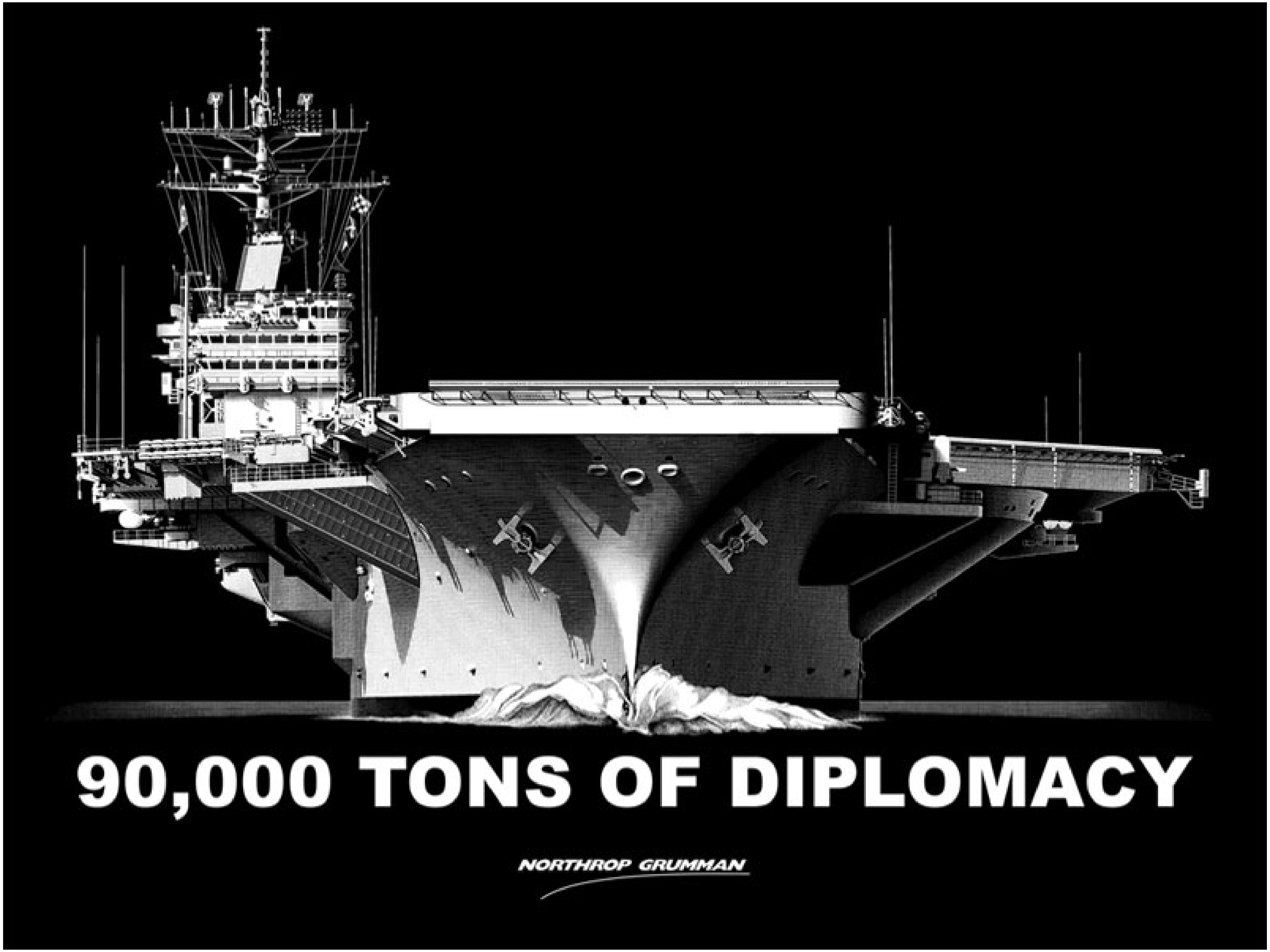
11th Systems Engineering Conference

Summary

- Complex operational environment.
- Manning challenges.
- Design/Contract challenges.
- Equipment challenges.
- ESOH challenges.
- Hazardous Materials
- Safety Equipment
- Training

USS CONSTELLATION (exCV-64)

NGNN Aircraft Carriers



Complex Operational Environment

- **Busy place. NGNN has 1000+ cranes, many forklifts, 3 shifts of operation, 19k+ employees.**
  - **COMMERCIAL YARD!**
- **Carrier takes 5 years to build. Some crew there ~2 years prior to commissioning, phased manning.**
- **Carrier build ~$5.5B + outfitting + modernization. ~ 50M manhours.**

NIMITZ Class (CVN-68)

- Builder: Newport News Shipbuilding Co, NGNN/NGSB
- CVN-68 Deployed: May 3, 1975.
- Unit Cost: ~ $4.5B each, + planes & supplies.
- Propulsion: 2 nuclear reactors, 4 shafts.
- Length: 1,092 ft
- Beam: 134 ft
- Flight Deck Width: 252 ft
- Displacement: ~ 97k tons (88k metric tons) full load.
- Speed: 30+ knots (34.5+ mph).
- Crew: Ship's Company: 3,200 - Air Wing: 2,480.
- Aircraft: 85

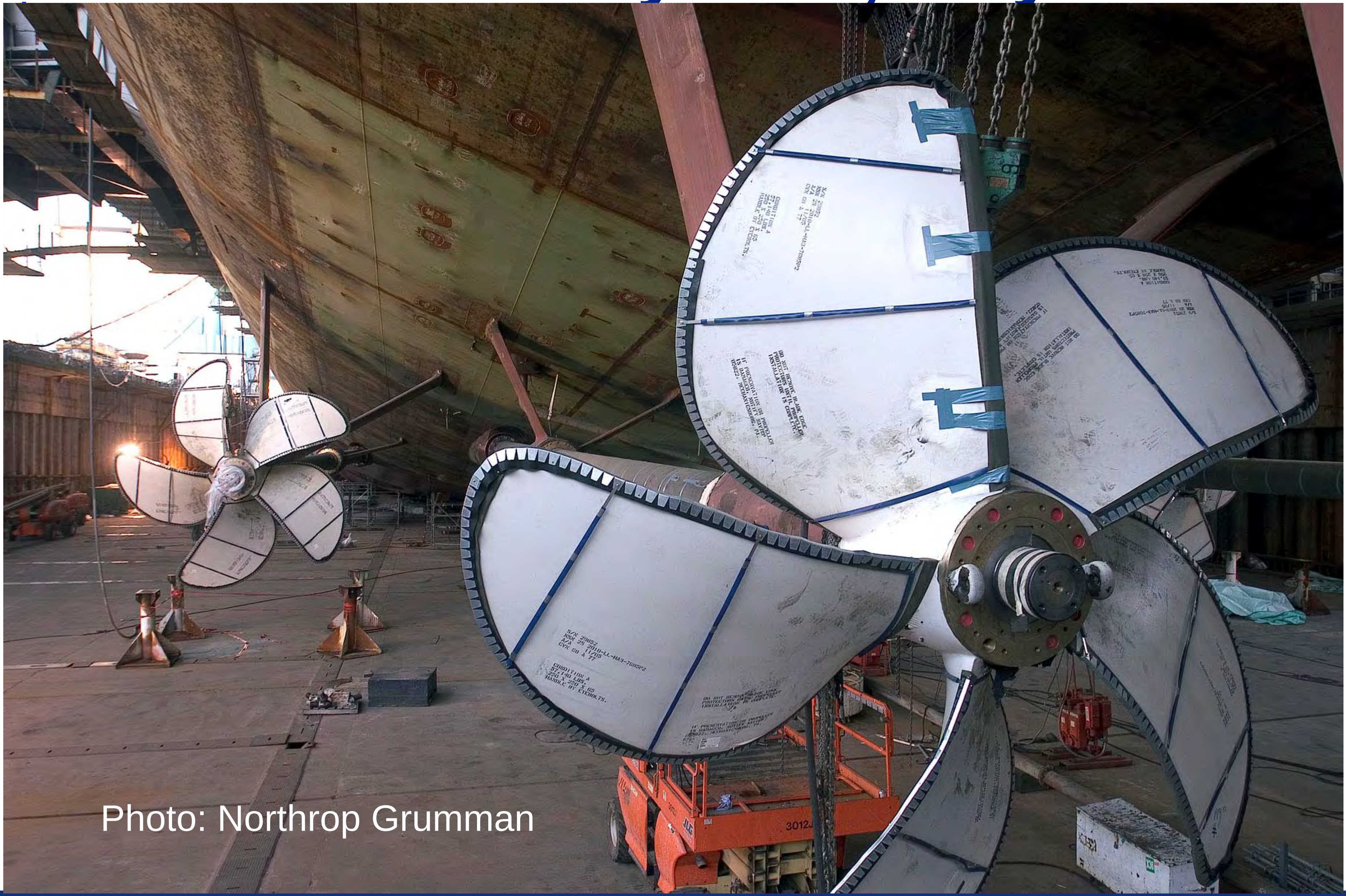
KITTY HAWK, NIMITZ AND STENNIS- Intended Area of Use = Complex Operational Environment

Design/Contract Challenges

- 1970s Design.
  - Little changed from first NIMITZ design.
  - Shipalts/mods not normally done at yard, wait on PSA/SRA.
  - "As designed/built" to pass INSURV/Navy Acceptance Trials, then many items ripped out/replaced at SRA.
    - » Wet Chemistry Photolab.
  - FORD design ~complete, little Fleet input.
    - » Too late to input ESOH problems now/not in contract.

BUSH, 2nd with new bulbous bow

BUSH in drydock, May06



Superlifts: Upper Bow, Island

Photos: Northrop Grumman

BUSH in drydock, Sep06

Photo: Northrop Grumman

PCU BUSH Christening, Oct 7, 2006

Manning Challenges

- Few people initially. Everyone has multiple jobs.
- As Safety Dept and rest man up, most are not trained for primary and collateral duties.
- First ship or carrier tour for many.
- Safety Dept = TAD bodies.

Schedule

- Keel laid: Sep 03
- First crew onboard: Jun 06
- 25% ~Dec 06
- 50% ~ Jun 07
- 75% ~ Jan 08
- Light off reactor Jul 08
- Crew moveaboard Aug 08
- Builder's Trials Oct 08
- Navy Acceptance Trials Dec 08
- Commissioning Jan 09
- SRA/PSA Mar 09
- Workups/FCT late 09
- First Cruise late 2010

The Ship

- BUSH Contract awarded January 26, 2001.
- Seven-year construction timeframe.
- 47,000 tons of structural steel and about a million pounds of aluminum
- Modular construction process forms large individual units of the ship much like interlocking building blocks
- Units welded together to form a module or superlift weighing up to 900 tons.


603
VMFA-323
VFA-137
NE
202
210
400
402
407
414
300
503
704
02
03


304

The Ship

- **Top speed 30+ knots.**
- **2 nuclear reactors, operate 20+ years without refueling.**
- **~50 years lifespan.**
- **Three two-inch diameter arresting wires on the flight deck bring an airplane going 150 MPH to a stop in < 400 ft.**

ESOH Challenges During Construction

Equipment Challenges

- Buy initial outfitting items, no gear comes with the job.
- AELs are wrong.
- Supply Dept undermanned, no HAZMAT program.
- RPPO untrained.
- Byzantine supply system (not standard methodology).

ESOH Challenges

- Getting people to wear PPE.
- Constant training challenges- new people, new equipment, new systems, complex operations.
- Commercial yards have their own rules- some are arbitrary.
- Navy DOES NOT OWN THE SHIP, DOES NOT OWN THE YARD.
  - Barge, rented offices, Huntington Hall.


Street View
More...
Map
Satellite
Terrain
50th St
49th St
47th St
46th St
45th St
44th St
43rd St
42nd St
41st St
38th St
37th St
36th St
35th St
34th St
33rd St
32nd St
31st St
30th St
29th St
28th St
Hines Ave
Warwick Blvd
Washington Ave
Huntington Ave
West Ave
60
351
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ESOH Challenges

- **Shipyard owns emergency (med, spill, fire, envm) response until move-aboard.**
- **While working aboard, follow yard rules- if we know/understand them.**
- **SUPSHIP is intermediary.**

HAZMAT Challenges

- One BM2/9595 for first year (Jul06-Dec07).
- No AUL, limited visibility on ordering.
- SERVMART provides HAZMAT- which may be fine for shore offices but not usable onboard.
- Safety Dept BM1/SK1 9595- late arrivals (Mar08).
- Have/use HAZMAT before program in place.
  - Training, Hazcomm standard, PPE, disposal.

Safety Equipment Not Available Until Crew Moveaboard

- **Just Prior To Builder's Trials**
- **195 List/Exclusion Items:**
  - **EEBDs & SCBAs.**
  - **Bull's Eyes, CCOLs, SIB.**
  - **Fire fighting equipment.**
  - **Ladder chains.**
  - **Nonskid decks.**
  - **Deck coverings & deck markings.**
  - **Warning Labels/SOPS/Operator Placards.**

Training Challenges

- **Many new, unique, untried systems.**
- **Navy crew doesn't own systems, yard does initially.**
- **Vendor prepares maintenance + training pubs- often late in the game.**
- **Crew must be trained/prepared for ATG Crew Certification, Builders and Navy Acceptance Trials.**

Recommendations

- **Standardize and implement consistent, timely SSWGs and allow changes to contract and design early in design cycle.**
- **More fleet/user community involvement, earlier- and USE their suggestions.**
- **Make and use passdown/lessons learned.**
- **More SUPSHIP oversight during all phases of build process.**

CVN-78 Plan

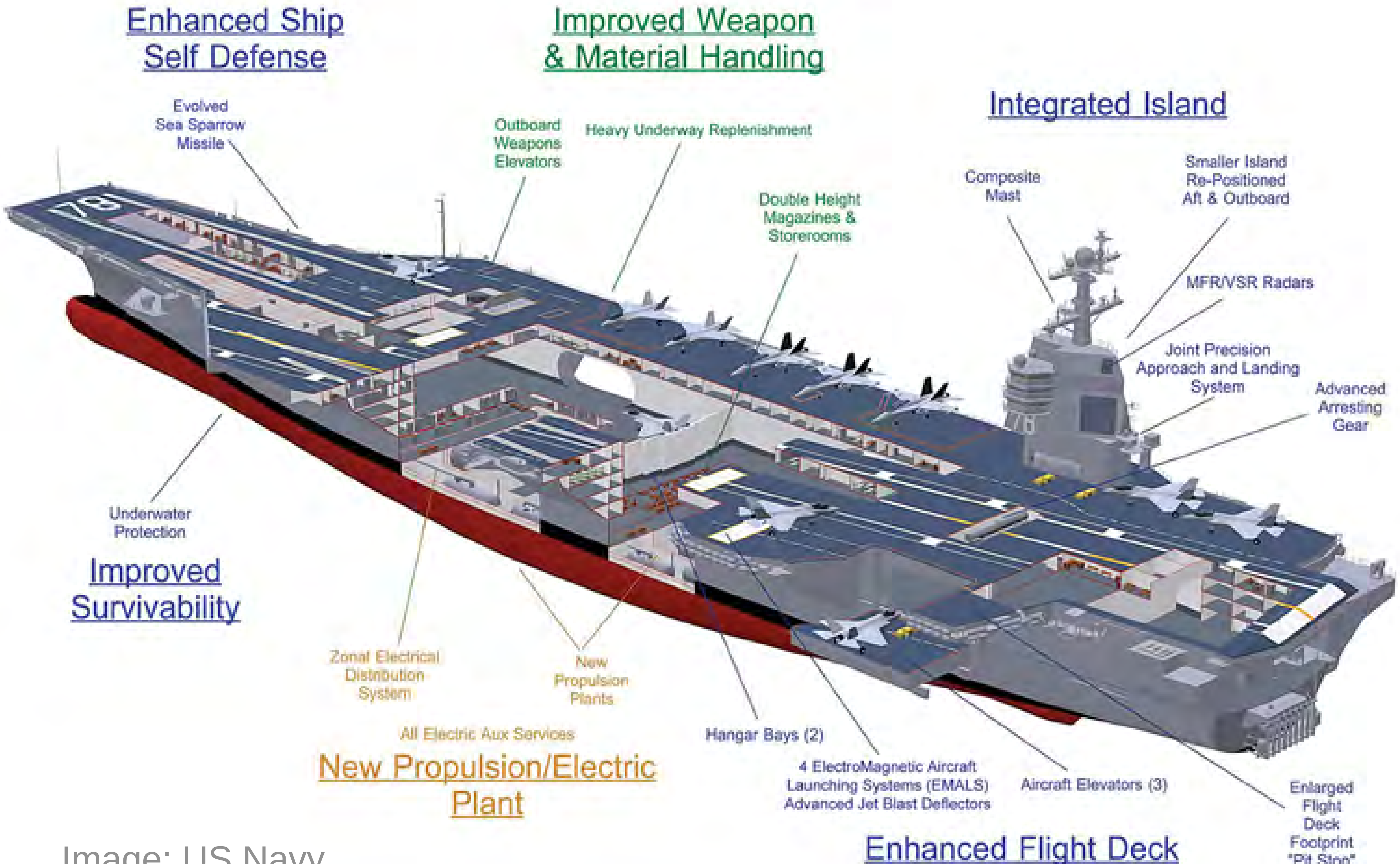

Image: US Navy

Summary

- Complex operational environment.
- Manning challenges.
- Design/Contract challenges.
- Equipment challenges.
- ESOH challenges.
- Hazardous Materials
- Safety Equipment
- Training

ESOH Challenges In Commissioning an Aircraft Carrier

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NDIA 11th Annual Systems Engineering Conference
Chief Engineer Panel

21 October 2008

Mr. Carl R. Siel, Jr.
ASN(RDA) Chief Systems Engineer
carl.siel@navy.mil

NAVAL SYSTEMS

RDA CHIEF SYSTEMS ENGINEER

SHIPS AND AIRCRAFTCARRIERS

SUBMARINES

AIRCRAFT

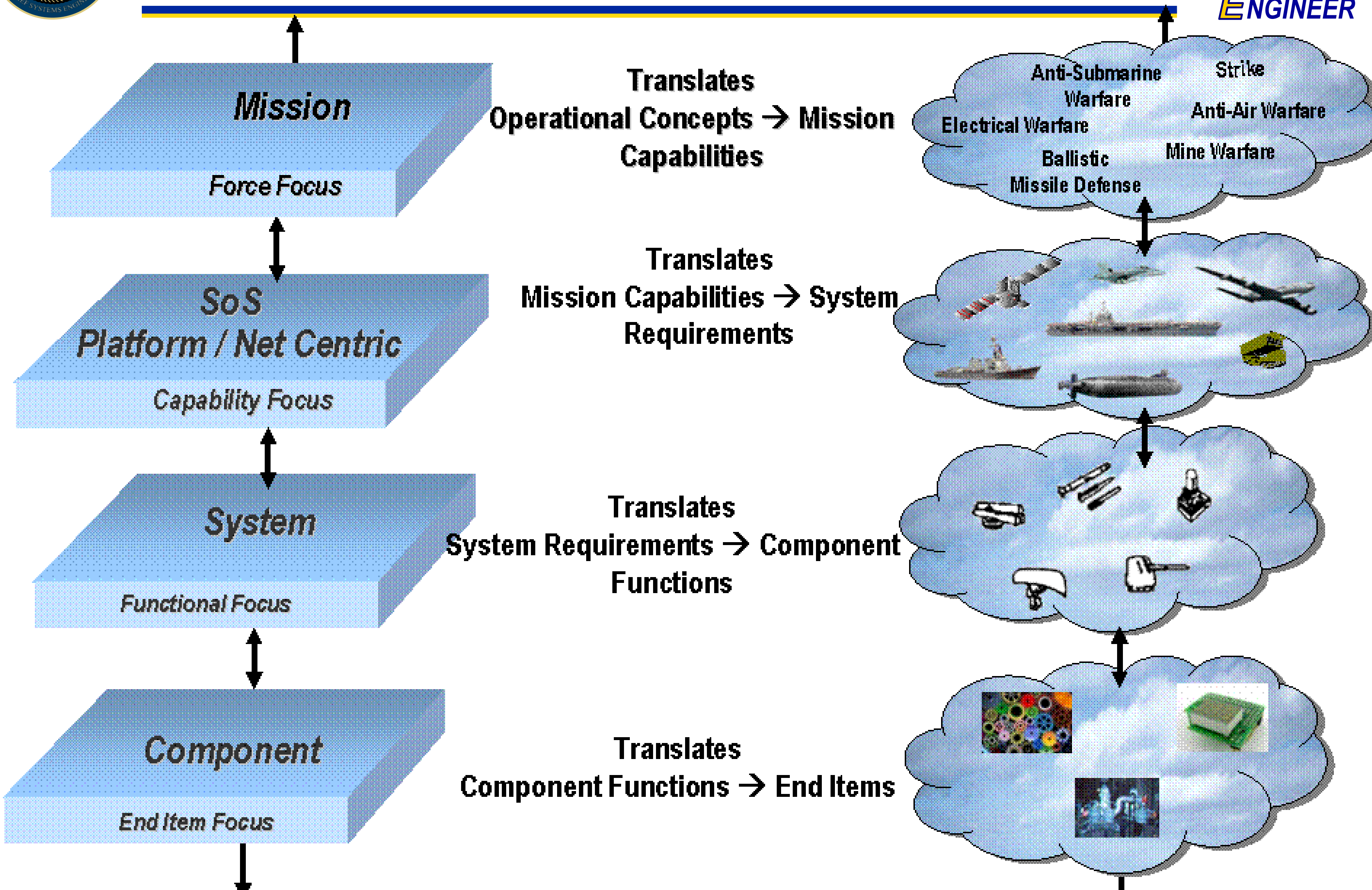
C4ISR SYSTEMS

WEAPON SYSTEMS

LAND VEHICLES

Naval Engineering of Systems

RDA CHIEF SYSTEMS ENGINEER



Discussion Topics

- Requiring and Acquiring Alignment
  - Program Health
- Net-Centric Integration and Interoperability
- System Engineering Processes
- SE Human Resources
- Software Process Improvement

DoN Acquisition Governance

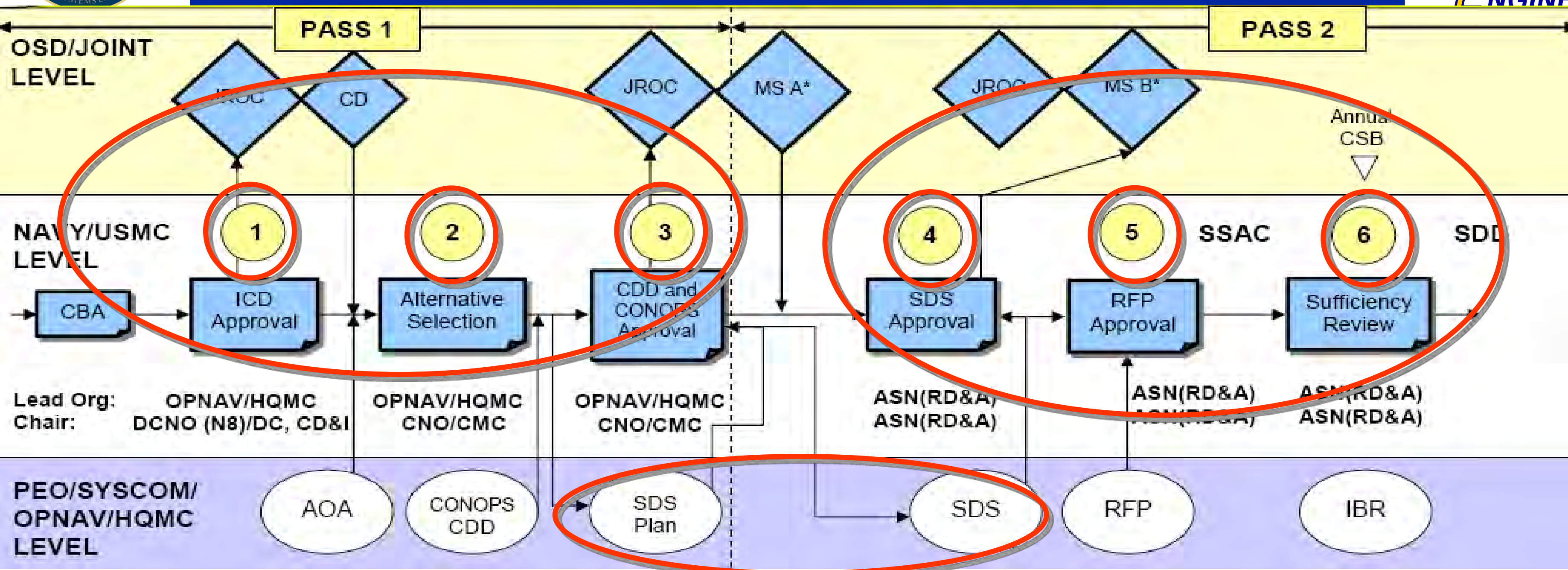
RDA CHIEF SYSTEMS ENGINEER

- The Secretary of the Navy
  - Comprehensive review of the Acquisition process
  - Challenges in Program Planning and Execution.
- Enhance the Acquisition Governance process
  - Inject Early Senior Leadership
  - Continuous Engagement and Transparency
- Increase discipline during each phase of Program Maturity
- Codified by SECNAVNOTE on 26 February 2008

"Two Pass / Six Gate"

DoN Acquisition Governance

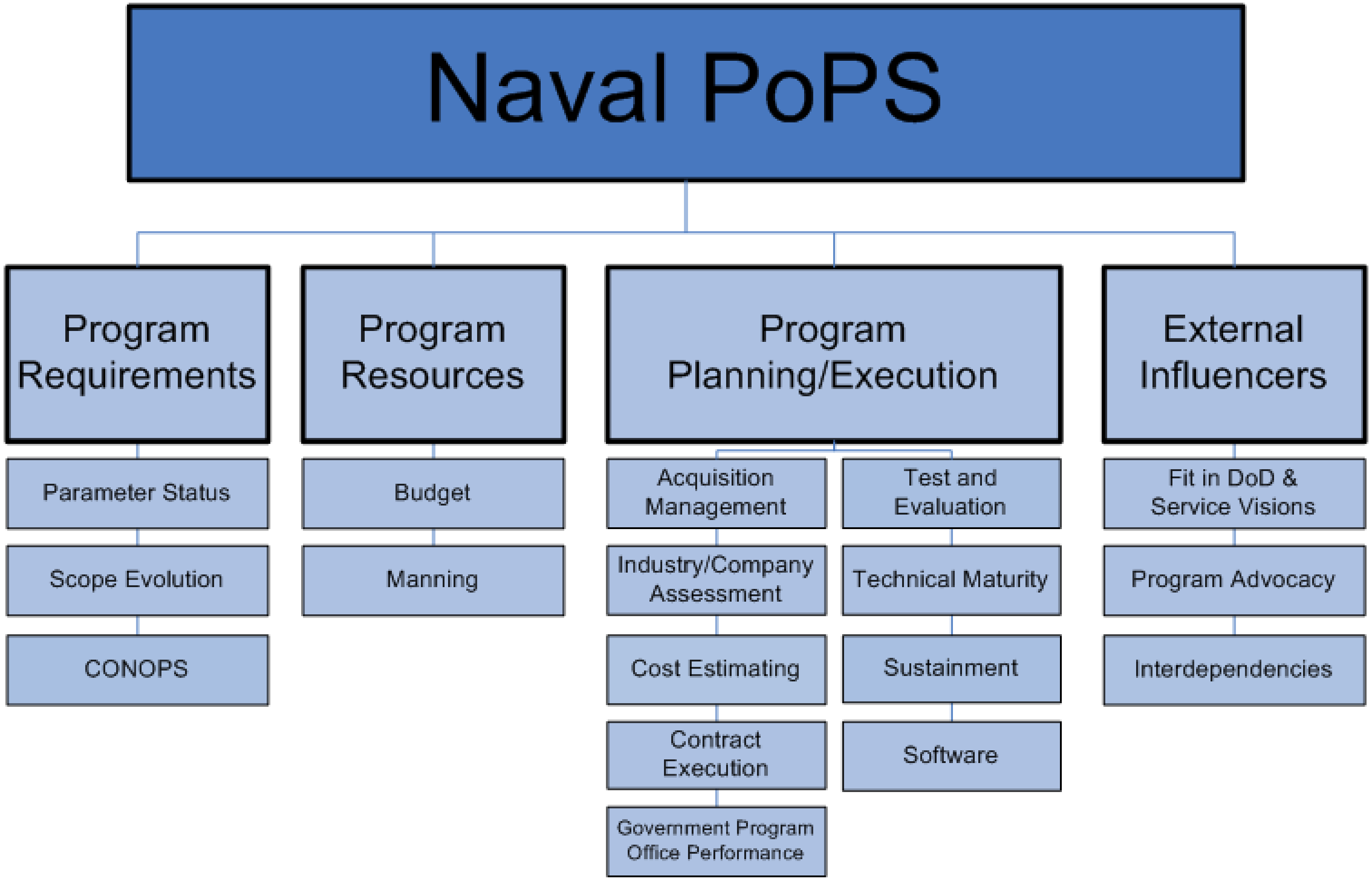
RDA CHIEF SYSTEMS ENGINEER



- First Pass - Requirements Establishment
- Second Pass - Acquisition Execution
- Gates - Reviews to Assess Readiness to Proceed
- System Design Specification - Capability and Performance Expectations

Naval Probability of Program Success (PoPS)

RDA CHIEF SYSTEMS ENGINEER



Net-Centric Integration and Interoperability Engineering Management

RDA CHIEF SYSTEMS ENGINEER

- Transform DoDAF to support System Engineering
  - Standard Architecture Data Element Reference Guide
    - Jointly issued by ASNRDA and DON CIO
  - Naval Enterprise Architecture Hierarchy
    - Approved by DON CIO
  - Structured Content and Format to retain and use DODAF Products
- Manage the planning, development, testing, and fielding of Net-Centric capabilities
  - Use Information Support Plans to refine System and Mission evolutions.
  - Net Ready Key Performance Parameter in terms that can be Tested
  - Large Scale Capability Evaluations to assess System and Mission performance

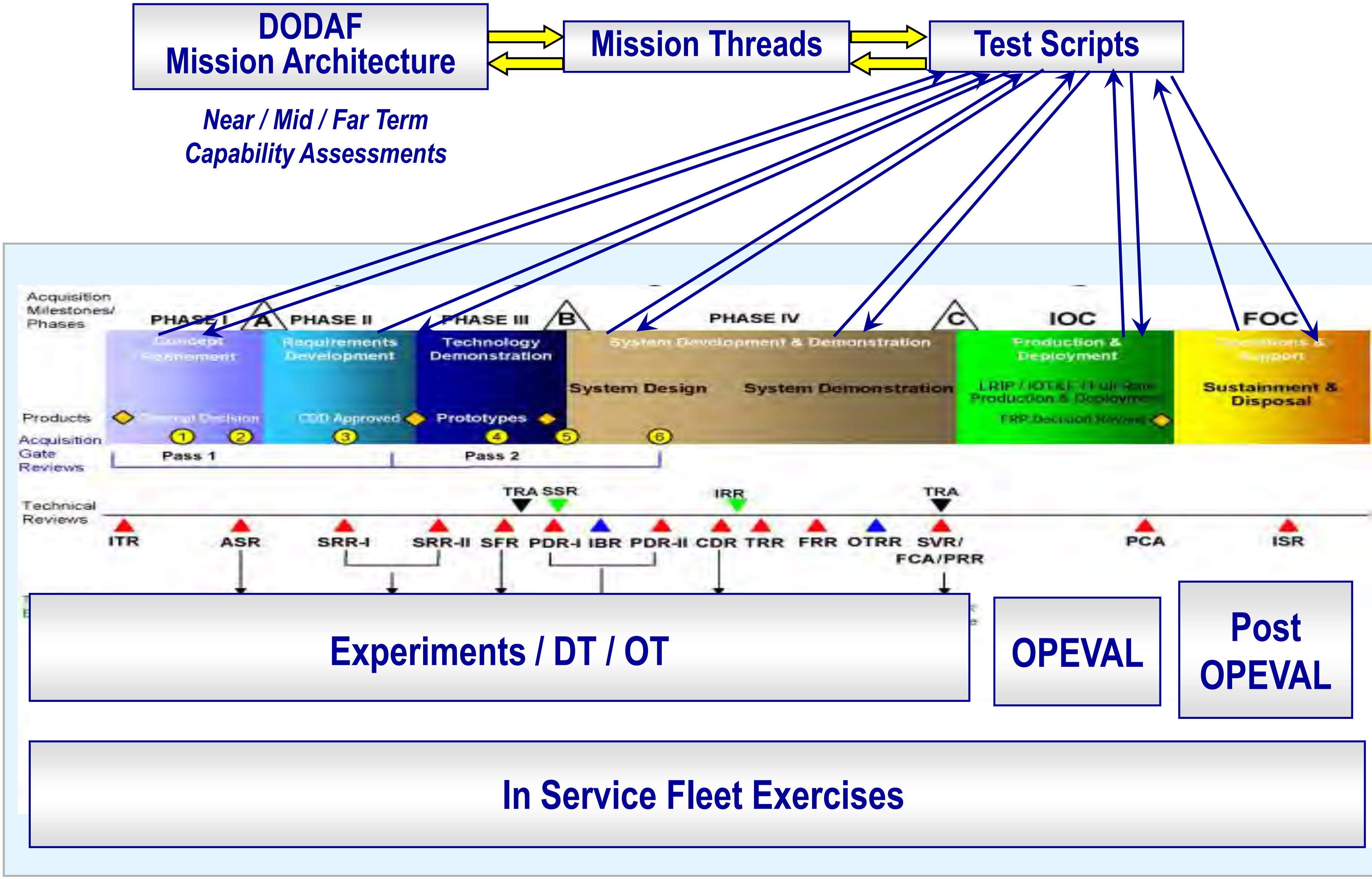
System Engineering Processes

RDA CHIEF SYSTEMS ENGINEER

- "Lead Systems Integrator"
  - Determine the Governments role at the Mission, Net-Centric, Platform, System, and Component Levels
- Naval SOS Eng Guidebook
  - Issued in 2006
  - To be updated to better support Mission Chief Engineer efforts
- System Engineering Technical Review (SETR) Process
  - ASNRDA Policy - Execute a common SETR Process
  - Ensure Breadth of Technical Functions Infused
- Large Scale Capability Evaluations

Large Scale Capability Evaluations
Mission – SoS - System

RDA CHIEF SYSTEMS ENGINEER



SE Human Competency Management

RDA CHIEF SYSTEMS ENGINEER

- Care for those we have
  - Principal DASN for Acquisition Workforce
  - On Site MS in System Engineering via NPS Embedded Faculty
    - NAVAIR Pax River
    - NAVSEA Dahlgren, Port Hueneme, Newport, and Carderock
  - Refine KSA's, Education, Training, and Job Experiences
- "Fill the Tub"
  - Undergraduate Candidates through Co-Opting, Internships, Scholarships
- "Prime the Pump"
  - K-12 use of STEM

Software Process Improvement

RDA CHIEF SYSTEMS ENGINEER

- ASNRDA Issued Software Process Improvement Policy and Guidebook
  - Software Acquisition Management (SAM)
  - Software Systems Engineering (SSE)
  - Software Development Techniques (SWDT)
  - Business Implications (BI)
  - Human Resources (HR)
- Software Acquisition Training and Education Working Group with DAU, OSD, and Services
  - Program Management and SPRDE initial focus
- Quality, Objective Evidence for Assuring SW
  - Vulnerabilities, Malicious Code, Security

NAVAL SYSTEMS

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SHIPS AND AIRCRAFTCARRIERS

SUBMARINES

AIRCRAFT

C4ISR SYSTEMS

WEAPON SYSTEMS

LAND VEHICLES