Test and Evaluation Connections with Systems Engineering

Beth Wilson, Raytheon
Steve Scukanec, Northrop Grumman
Industry Co-Chairs

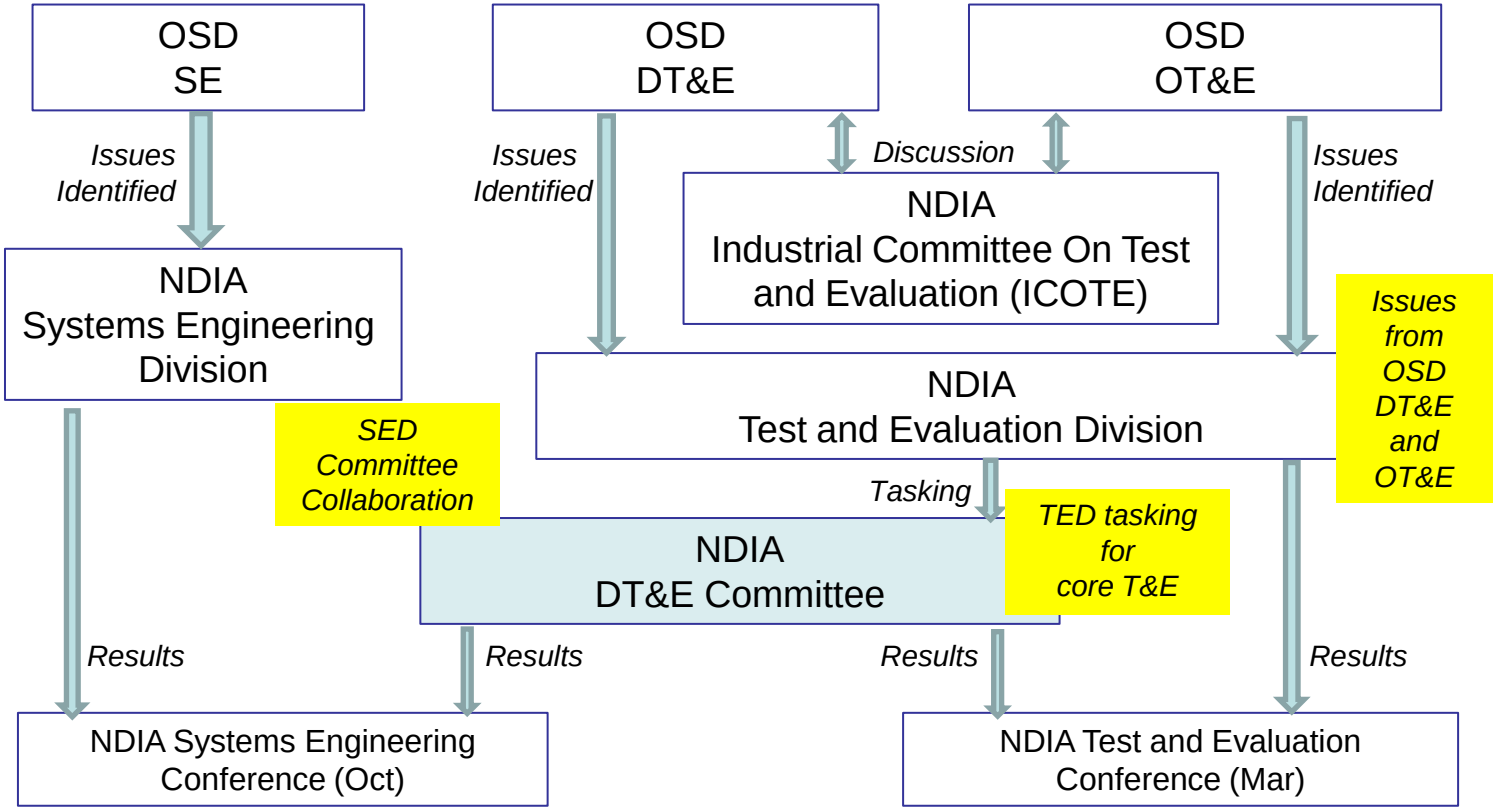
Topics

- **Overview of DT&E Committee**

- **NDIA DT&E Committee Focus for 2012**
  - Statistical Approaches for Test Optimization
  - Best Practices Model for Systems of Systems
  - Model Based Distributed Testing
  - Effectiveness Measures and Leading Indicators for Verification

DT&E Committee Background History and Accomplishments

Current Structure
Since 2010



DT&E Committee Focus: T&E initiatives aligned with SE, DT&E

Summary of DT&E Committee Efforts

	Topic	Activity
DT&E Committee	**DoD T&E Policy Study**	2006 – 2008: Workshops and Study Report Improving T&E in the DoD Acquisition Process
	Integrated Testing	2008 – 2010: Integrated Test Study NDIA presentations and tutorial ITEA journal article
	RFP Language for T&E	2010 – 2011: Comments for Update to OSD Guide Incorporating T&E into DoD Acquisition Contracts
	Test Optimization	**2012: Statistical Optimization Conference Thread**
SE Collaboration	**Software**	2009: SW T&E Summit Recommendations
	System of Systems	2010 – 2011: T&E for SoS Workshop and Initiatives **2012: Final Report on Best Practices Model**
	Modeling and Simulation	2011: Effective Use of M&S for T&E Use of M&S **2012: Distributed Model-Based Testing**
	Metrics	**2012: Leading Indicators for T&E**
	Architecture	**2012: T&E Perspective for Architecture views**

DoD T&E Policy Study

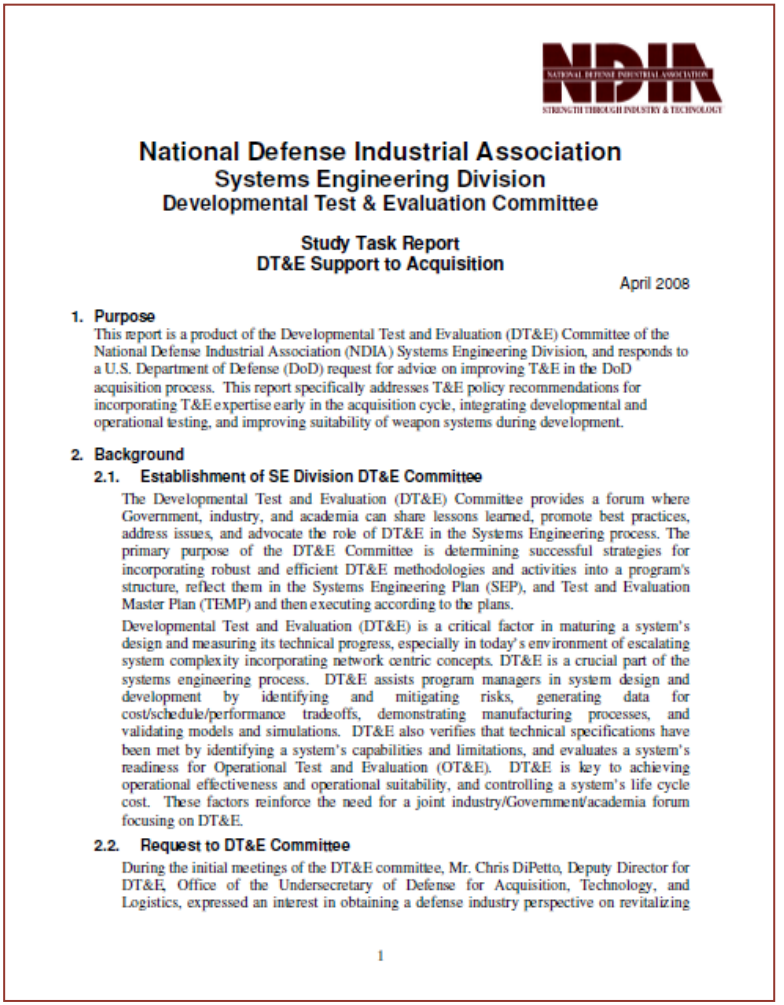
August 2006: DT&E Committee Kickoff

Policy Study:
"Improving T&E in the DoD Acquisition Process"
Industry T&E policy recommendations

Workshops:
August 2007
January 2008

Focus Areas:
1. Earlier contractor and tester involvement
2. Integrated DT/OT and DT operational relevance
3. Suitability

April 2008: Report Summarized Results:
10 Findings
15 Recommendations



National Defense Industrial Association
Systems Engineering Division
Developmental Test & Evaluation Committee

Study Task Report
DT&E Support to Acquisition

April 2008

1. Purpose

This report is a product of the Developmental Test and Evaluation (DT&E) Committee of the National Defense Industrial Association (NDIA) Systems Engineering Division, and responds to a U.S. Department of Defense (DoD) request for advice on improving T&E in the DoD acquisition process. This report specifically addresses T&E policy recommendations for incorporating T&E expertise early in the acquisition cycle, integrating developmental and operational testing, and improving suitability of weapon systems during development.

2. Background

2.1. Establishment of SE Division DT&E Committee

The Developmental Test and Evaluation (DT&E) Committee provides a forum where Government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate the role of DT&E in the Systems Engineering process. The primary purpose of the DT&E Committee is determining successful strategies for incorporating robust and efficient DT&E methodologies and activities into a program's structure, reflect them in the Systems Engineering Plan (SEP), and Test and Evaluation Master Plan (TEMP) and then executing according to the plans.

Developmental Test and Evaluation (DT&E) is a critical factor in maturing a system's design and measuring its technical progress, especially in today's environment of escalating system complexity incorporating network centric concepts. DT&E is a crucial part of the systems engineering process. DT&E assists program managers in system design and development by identifying and mitigating risks, generating data for cost/schedule/performance tradeoffs, demonstrating manufacturing processes, and validating models and simulations. DT&E also verifies that technical specifications have been met by identifying a system's capabilities and limitations, and evaluates a system's readiness for Operational Test and Evaluation (OT&E). DT&E is key to achieving operational effectiveness and operational suitability, and controlling a system's life cycle cost. These factors reinforce the need for a joint industry/Government/academia forum focusing on DT&E.

2.2. Request to DT&E Committee

During the initial meetings of the DT&E committee, Mr. Chris DiPetto, Deputy Director for DT&E, Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics, expressed an interest in obtaining a defense industry perspective on revitalizing

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2006-2008

Integrated Testing (CT/DT/OT) Implementation Framework

NDIA Test and Evaluation Conference
Paper #7847

Walking the Line with Title 10: Implementation Strategies for Integrated Testing

NDIA Systems Engineering Conference
Paper #8848

Integrated Testing: We Can Do It

NDIA Test and Evaluation Conference
Paper #9565

Erasing the Line with Title 10: Best Practices in Integrated Testing

Beth Wilson
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Principal Engineering Fellow, Raytheon Company

Darlene Mosser-Kerner
Government Chair NDIA System Engineering Division, DT&E Committee
OUSD(AT&L)/Developmental Test and Evaluation

Tom Wissink
Industry Co-Chair NDIA System Engineering Division, DT&E Committee
Director of Integration, Test & Evaluation, Lockheed Martin Corporate Engineering & Technology

NDIA T&E Conference Mar 2010

2009 ITEA Journal

Integrating Test and Evaluation (September issue)

ITEA Journal 2009; 30: 375–380

Integrated Testing: A Necessity, Not Just an Option

Beth Wilson, Ph.D.
Raytheon Company, Sudbury, Massachusetts

Department of Defense policy states that developmental and operational test activities need to be integrated whenever possible to improve overall test and evaluation efficiency with increased emphasis on operational relevance. The National Defense Industrial Association Systems Engineering Division Developmental Test and Evaluation Committee has been evaluating existing integrated testing policies, methods, and practices to identify an implementation framework with best practices for sharing data, involving developmental test and operational test stakeholders in integrated test planning, and collaboratively executing an integrated test program. Barriers to integrated testing were identified looking at the cultural constraints placed on planning, people, and data. While the definitions and mandates are recent, the practice of integrated testing is not new. The framework described focuses on existing policy and captures best practices.

Key words: Collaborative planning; collaborative execution; shared data; DT&E; CT&E; Army News; Air Force contractor support; resource planning

NDIA Systems Engineering Conference
Paper #8818

Integrated Testing: Tutorial

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Darlene Mosser-Kerner
Government Chair NDIA System Engineering Division, DT&E Committee
Developmental Test & Evaluation
OUSD(AT&L)/Systems & Software Engineering

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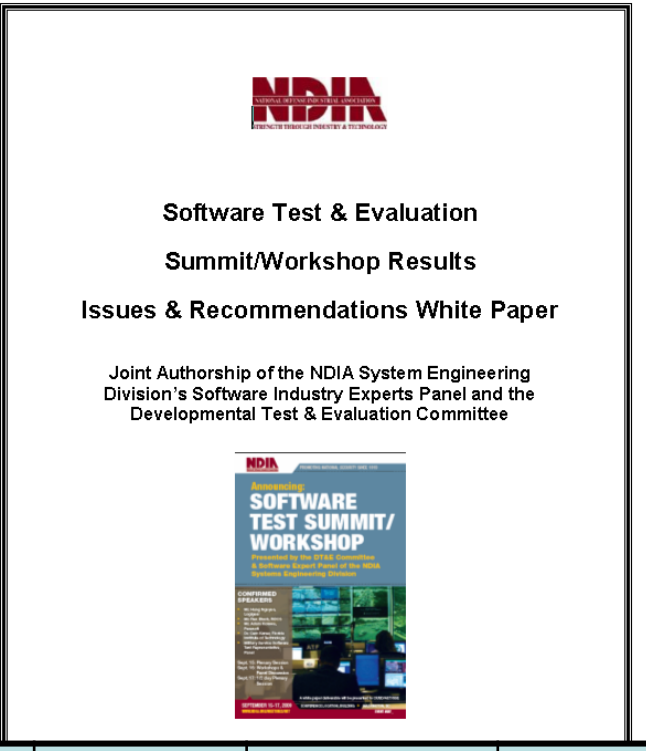
NDIA SE Conference Oct 2009

2008-2010

Software Test and Evaluation Software Summit



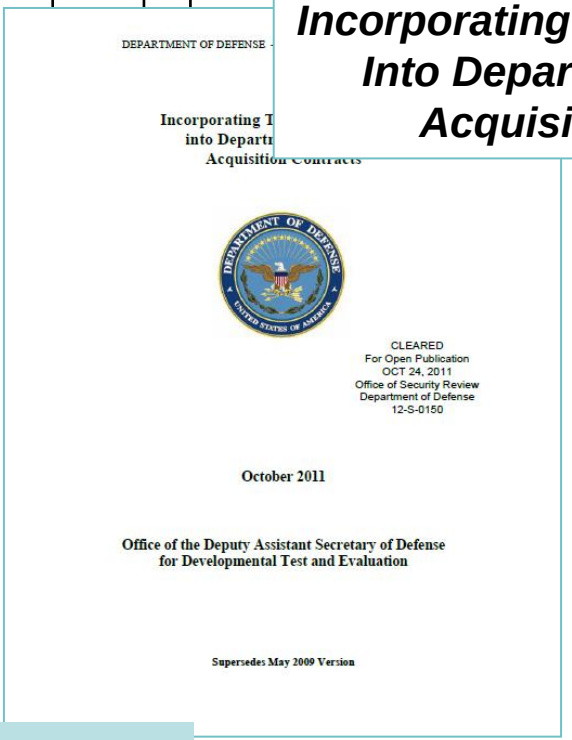
RFP Language	How Much Testing is Enough?	Lifecycle and End-to-End Software T&E	Changing Paradigms
Training & Competency Model			
Policy, Guidance, and Standards			
Tools, Automation, Methodologies, Process			

2009

RFP Language

Industry #	Master #	Reviewer	Line #	Comment and Rationale	Recommended Input	A/R/P

Industry Comments for Update:
Incorporating Test and Evaluation Into Department of Defense Acquisition Contracts


DEPARTMENT OF DEFENSE

Incorporating T
into Departr
Acquisition Contracts

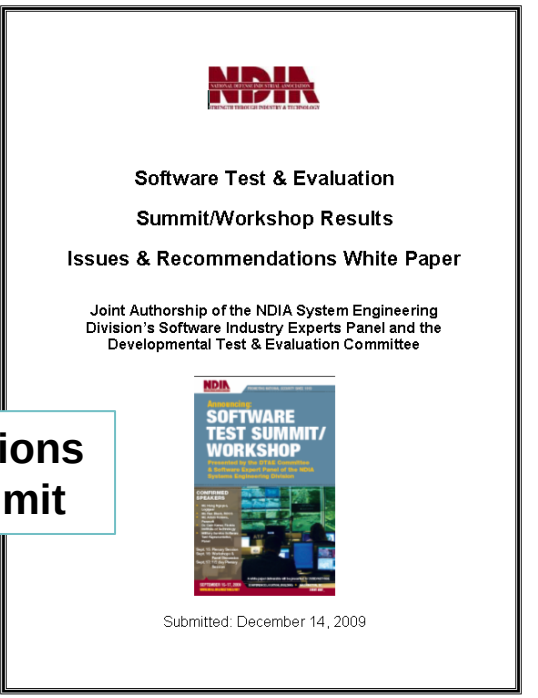
CLEARED
For Open Publication
OCT 24, 2011
Office of Security Review
Department of Defense
12-S-0150

October 2011

Office of the Deputy Assistant Secretary of Defense
for Developmental Test and Evaluation

Supersedes May 2009 Version

Recommendations from SW Summit


Software Test & Evaluation

Summit/Workshop Results

Issues & Recommendations White Paper

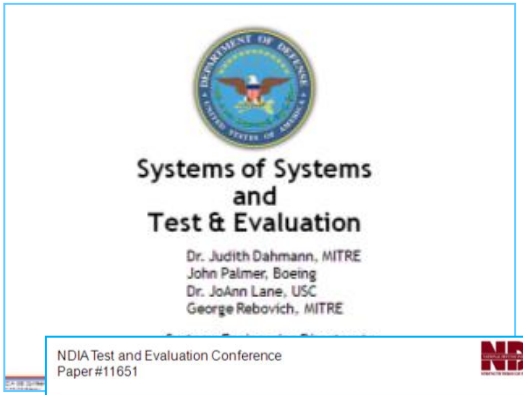
Joint Authorship of the NDIA System Engineering Division's Software Industry Experts Panel and the Developmental Test & Evaluation Committee

Submitted: December 14, 2009

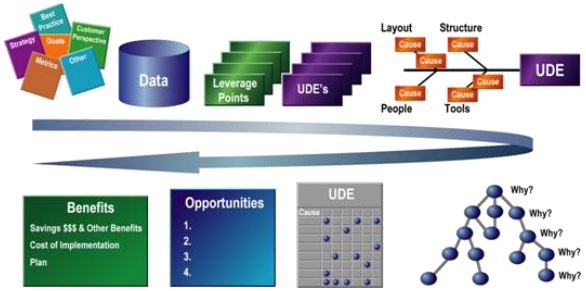
2010-2011

Test and Evaluation for Systems of Systems

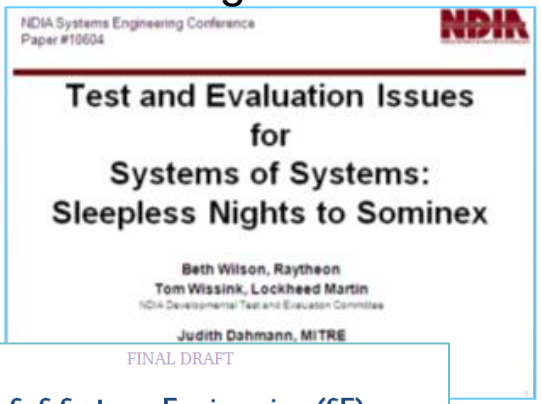
2009: "Sleepless Nights" List of Issues

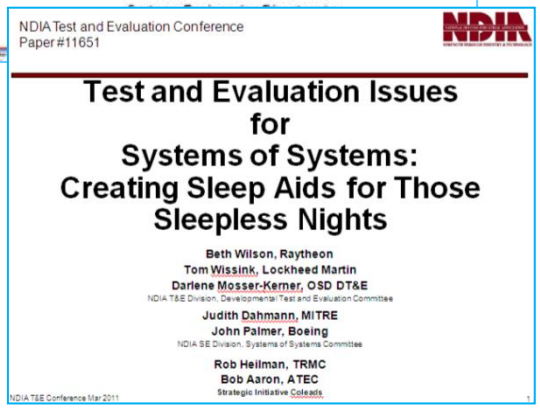


2010: Workshop

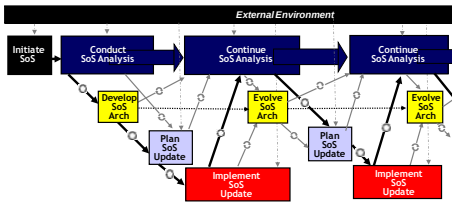


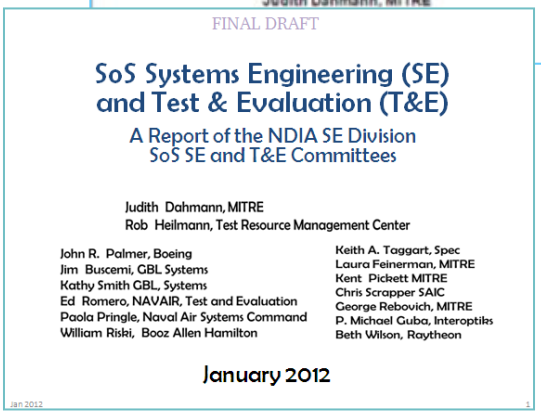
2010: "Sominex" Resulting Initiatives





2011: Best Practices Wave Model

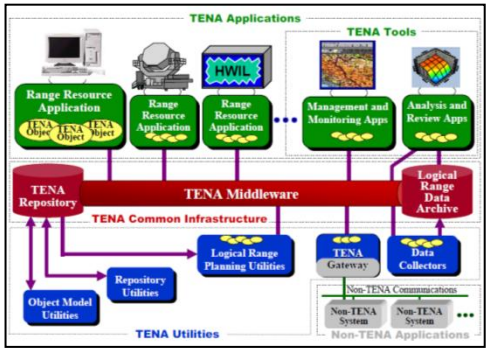


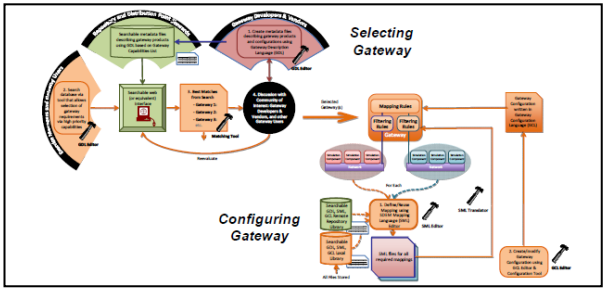


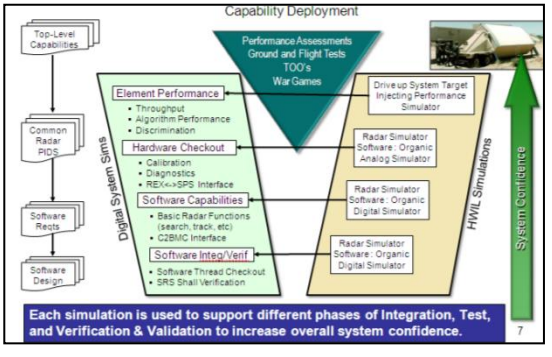
2012: Final Report

2009-2012

Effective Use of Modeling and Simulation for Test and Evaluation







Joint Meeting in August 2011

- Distributed Testing, the Joint Mission Environment Test Capability (JMETC) and the Test and Training Enabling Architecture (TENA)
- DoD M&S Community of Interest Data Management Working Group
- LVC Architecture Roadmap Implementation (LVCAR-I) Gateways Effort Applicability to T&E
- OSD T&E Working Group
- Raytheon Presentation on M&S for T&E
- Potential Topics for November AMSWG Meeting

NDIA DT&E Committee Focus for 2012

DT&E Committee Focus 2012

Activity	Plans for 2012	Status/Plans
Scientific Test and Analysis Techniques **STAT for T&E Thread at SE Conf**	Examples of effective use of statistical approaches for test optimization (including DOE) for an implementation framework	-Tutorial on statistical methods - Case study track: effective use - Panel: implementation -Synthesis workshop: draft white paper
System of Systems **Best Practices Model for T&E**	Finalize best practices model to define a framework for SoS test and evaluation	*Collaboration with SoS Committee* - Presented at T&E Conference - Final report submitted to SED
Modeling &Simulation **Distributed Model-Based Testing**	Focus on distributed testing in support of integrated testing using government models	*Collaboration with M&S Committee* Joint meeting: August 21, 2012
Metrics **Leading Indicators for T&E**	Expand the 2011 focus to include requirements verification information as additional leading indicators	*Collaboration with System Performance Measurement WG* October workshop
Architecture WG	*Added since Dec 2011*	*Collaboration with Architecture WG* Determine T&E perspective for DoDAF views and architecture visualization
NDIA SE Conf	DT&E tracks	Joint M&S, Joint SoS, Statistical Test Optimization

DT&E
Statistical Test Optimization

Activity	Plans for 2012	Status/Plans
Scientific Test and Analysis Techniques **STAT for T&E Thread at SE Conf**	Examples of effective use of statistical approaches for test optimization (including DOE) for an implementation framework	-Tutorial on statistical methods - Case study track: effective use - Panel: implementation - Draft white paper

Conduct a summit/workshop thread
(Similar to SW Test event in 2009)
-Tutorials on Monday 10/22
- Presentations on Wednesday 10/24
- Synthesis Panel on Wednesday 10/24

SE Conference Thread October 2012

Define an implementation framework
(Similar to Integrated Testing effort in 2009)
- Define attributes of successful application
- Identify framework for implementation
- Provide amalgamation of success examples

T&E Conference Paper February 2012

Modeling & Simulation Collaboration Distributed Testing

Activity	Plans for 2012	Status/Plans
Modeling &Simulation **Distributed** **Model-Based Testing**	Focus on distributed testing in support of integrated testing using government models	*Collaboration with M&S Committee* Joint meeting: August 21, 2012

Joint Meeting August 2012

SE Conference Joint Track October 2012

Benefits:

- Find integration issues earlier
- Test to learn in 'safe' environment
- Protect proprietary information
- Facilitate DT to OT transition
- Increase performance testing range in operating environments
- Support end to end studies throughout the program

Barriers:

- Security
- Lack of persistent network
- Early consideration of technical issues
- Perceived value
- Disconnect between the communities (M&S and T&E)

Recommendations:

- Harmonize the standards for M&S and Test for the life cycle perspective (HLA, TENA, Metadata)
- Create a framework for reusing and repurposing M&S through the product model
- Establish M&S as part of statistical test design
  - Determine what tests are conducted to acquire data for model validation.
  - Fewer test events with better models.
- Recommend the use of M&S to do I&T
- Recommend establishment of JMETC as a persistent node for industry to engage in MBDI&T

Systems of Systems Collaboration Best Practices Model for T&E

Activity	Plans for 2012	Status/Plans
System of Systems Best Practices Model for T&E	Finalize best practices model to define a framework for SoS test and evaluation	*Collaboration with SoS Committee* - Presented at T&E Conference - Final report submitted to SED

NDIA » Divisions » Divisions » **Systems Engineering**

Email to a Friend

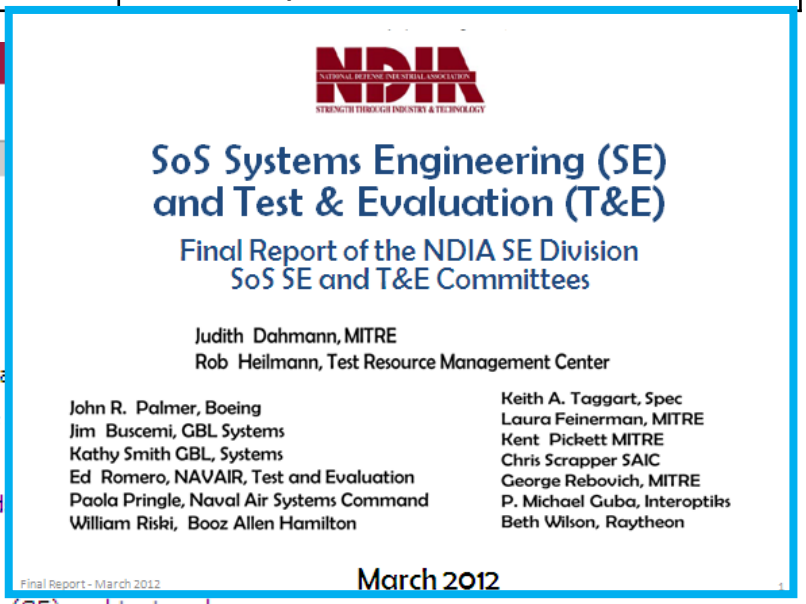
Studies & Publications

Systems Engineering Division

Studies & Publications

- Survey to Access the Relationships Between Systems Engineering Fa
  Success
  Introduction and Overview of Survey (pdf of survey is at the end of
  Link to Access Survey
- DoD/Industry Quality Assurance Council Meeting, Mr. Michael Shield
- SoS SE and TE NDIA Final Report, March 2012

  This report presents an approach to integrated systems engineering (SE) and test and evaluation (T&E) for SoS based on work underway by the National Defense Industry Association Systems Engineering Division Systems of Systems and Developmental Test and Evaluation Committees. The report focuses on how to approach T&E for SoS given the challenges of large scale SoS development as a continuous improvement process that provides information on capabilities and limitations for end users and feedback to the SoS and system SE teams toward SoS evolution.



This Track

Metrics Collaboration
Leading Indicators for T&E

Activity	Plans for 2012	Status/Plans
Metrics **Leading Indicators for T&E**	Expand the 2011 focus to include requirements verification information as additional leading indicators	*Collaboration with System Performance Measurement WG* October workshop

System Development Performance Measurement

National Defense Industrial Association
Systems Engineering Division

Practical Software and Systems Measurement

Working Group Report
System Development Performance Measurement
October 2011

Introduction

An issue often cited in studies and reports[1] is the ineffective use of measures and predictive leading indicators to proactively plan and manage the successful acquisition and execution of defense programs. This is reflected as one of the top NDIA systems engineering issues needing to be addressed[2]:

Technical decision makers do not have the right information & insight at the right time to support informed & proactive decision making or may not act on all the technical information available to ensure effective & efficient program planning, management & execution.

In September 2010, the NDIA Systems Engineering Division and Practical Software and Systems Measurement (PSM) sponsored a working group to consider these issues and provide recommendations on a set of information needs, leading indicators, and measures for use by both acquirers and suppliers to obtain better insight into program status and risks to aid ongoing communication and to provide input to decision-making at key program milestones and decision points. This task builds upon prior measurement initiatives and consensus guidance (e.g., PSM, the International Council on Systems Engineering (INCOSE), academia), while integrating experience and practices from adopters as a next logical step in maturing common approaches for systems engineering measurement. The task team used the measurement approach described in the PSM guidance (see PSM in Appendix B) and leveraged the content from the Systems Engineering Leading Indicators Guide (see SELI in Appendix B) as a foundation to identify and define a small set of leading indicators that are very useful on most programs during the Technology Development (TD) and the Engineering and Manufacturing Development (EMD) phases. Though this product is targeted primarily at the NDIA aerospace and defense markets, the results may be broadly applicable into other domains.

Working group objectives included:

- Identify a set of leading indicators that provide insight into technical performance at major decision points for managing programs quantitatively across their life cycle, with emphasis on Technology Development (TD) and Engineering Manufacturing and Development (EMD) phases.
- Build upon objective measures in common practice in industry, government, and accepted standards. Do not define new measures unless currently available measures are inadequate to address the information needs.
- Select objective measures based on essential attributes (e.g., relevance, completeness, timeliness, simplicity, cost effectiveness, repeatability, and accuracy).
- Measures should be commonly and readily available, with minimal additional effort needed for data collection and analysis.

[1] Refer to Appendix B for a summary of key studies and reports related to obtaining greater objective insight into program performance issues.
[2] Top Systems Engineering Issues in U.S. Defense Industry. NDIA Systems Engineering Division, September 2010. www.ndia.org/Divisions/Divisions/SystemsEngineering/Documents/Studies/Top%20SE%20Issues%202010%20Report%20v11%20FINAL.pdf

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Follow-on workshop with System Performance Measurement WG
Focus on other information needs not addressed in first report

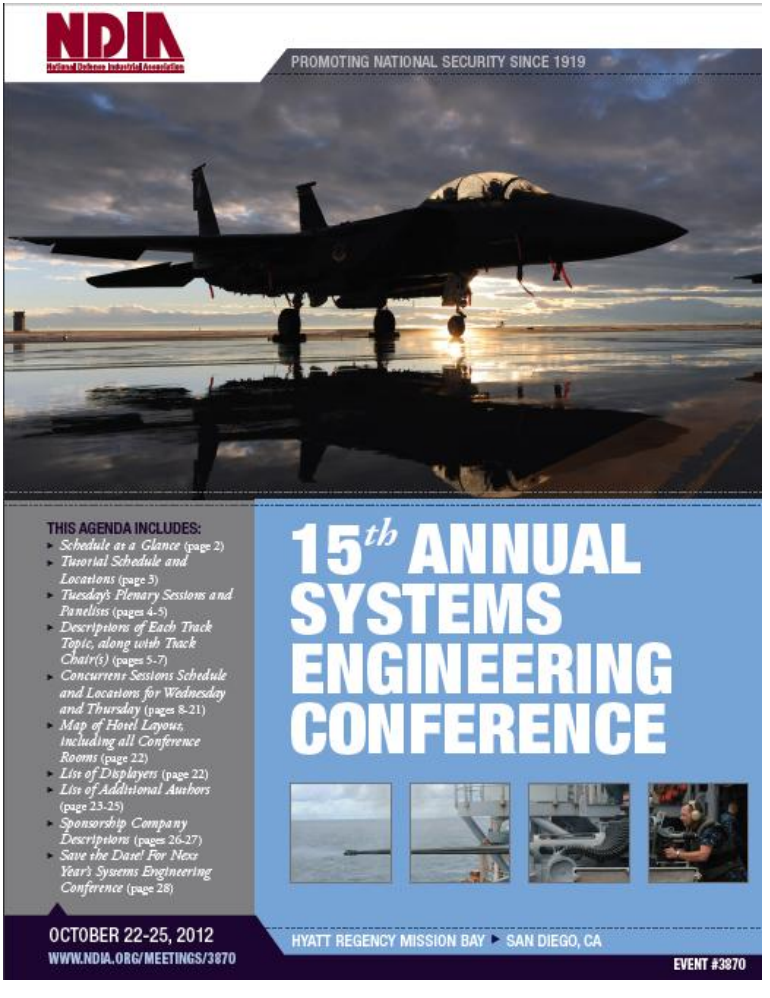
Table 1. Information Needs

Highest Priority Information Needs (drivers for measures considered by breakout teams)	Other Information Needs (not considered by breakout teams)
• Requirements	• Testability
• Interfaces	• Requirements Verification and Validation
• Architecture	• Defects and Errors
• Staffing and Skills	• System Assurance
• Technical Performance	• Process Compliance
• Technology Maturity	• Work Product Progress
• Affordability	• Facilities and Equipment
• Risk Management	• Change Backlog
• Manufacturability	• Review Action Item Closure

Follow-on Workshop
October 22, 2012

http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Documents/Studies/NDIA%20System%20Develpopment%20Performance%20Measurement%20Report.pdf

NDIA DT&E Committee
SE Conference October 2012



TEST & EVALUATION

Session Chairs: Dr. Beth Wilson & Mr. Steve Scukanec

The Test and Evaluation track address the entire continuum of test and evaluation from early planning to operational testing. The overall track includes a joint focus on distributed model based test and evaluation strategies, a joint focus on best practices for test and evaluation applied to Systems of Systems capabilities, and a focus on the effective use of scientific test and analysis techniques to implement statistical test optimization.

STATISTICAL TEST OPTIMIZATION

Session Chairs: Dr. Neal Mackertich & Dr. Beth Wilson

The Statistical Test Optimization track focuses on effective use of scientific test and analysis techniques for test design and optimization. The track will begin with real examples of test optimization leading to a synthesis panel where we will capture an understanding of best practices in this area and build an integrated route forward for increasing implementation maturity.

SYSTEM OF SYSTEMS/TEST & EVALUATION

Session Chairs: Dr. Beth Wilson & Mr. John Palmer

The joint Test and Evaluation for System of Systems track is one of the collaboration efforts in the NDIA Systems Engineering Division. The focus is to investigate best practices that can be applied to testing our SoS capabilities.

TEST & EVALUATION/MODELING & SIMULATION

Session Chairs: Ms. Louisa Guise & Dr. James Coolahan

The joint Test and Evaluation for Modeling and Simulation track is one of the collaboration efforts in the NDIA Systems Engineering Division. The focus is to investigate modeling best practices that can leverage to effectively test systems.

Summary

- **DT&E Committee in Test and Evaluation Division**
- **Continue Collaboration in Systems Engineering Division**
- **Joint Effort in 2012**
  - **Systems of Systems**: Best Practices
  - **Modeling and Simulation**: Model Based Distributed Testing
  - **System Effectiveness**: Measures and Leading Indicators
  - **Architecture**: Views for Successful Systems Integration
- **DT&E Presence at SE Conference**
  - Track on Test and Evaluation
  - Track on Statistical Test Optimization
  - Joint Track with Systems of Systems
  - Joint Track with Modeling and Simulation
- **Will Continue Collaboration with SE in 2013**