Non-Technical Obstacles to Effective M&S Connectivity in Support of T&E

Panel Chair: Mr. John Illgen
Northrop Grumman Simulation Technologies
Introduction

- Greetings
- Introduction of Panel Members
  - John Illgen, Northrop Grumman
  - Dr. Paul Deitz, ARL
  - Mr. Rick Cozby, DTC
  - Mr. Jack Sheehan, FCSCTO
  - Mr. Augie Ponturiero, Northrop Grumman
A Changing Landscape

- **Capabilities-Based Acquisition**
  - Warfighter-focused
  - New thought processes on WHY, WHAT, and HOW to develop new Systems/Families of Systems/Systems of Systems

- **New Systems/Families of Systems “Born Joint”**
  - Services working together at all levels to bring capabilities to the Warfighters

- **Funding Constraints**
  - New Developments vs Current Operations Support
  - Using more Virtual and Constructive entities for testing
    - M&S more significant in Test and Evaluation
The Effect

- Increased cooperation between Services and DoD Agencies at all levels
- Multi-Service and Joint Testing
  - OSD-driven – “Testing in a Joint Environment Roadmap”
    - What is the impact to Service Acquisition efforts?
- PM, T&E, Warfighters must work together across Service boundaries to field new systems
  - T&E communities need to understand one another first!
- T&E Communities forging closer working relationships
  - Different priorities
  - “Cultural” and “Language” differences
Today’s Discussion

- Look at the Non-Technical issues affecting T&E
- T&E Communities forging closer working relationships
  - Different priorities
  - “Cultural” and “Language” differences
- Multi-Service and Joint Testing
  - OSD-driven – “Testing in a Joint Environment Roadmap”
    - What is the impact to Service Acquisition efforts?
- PMs, T&E, Warfighters must work together across Service boundaries to field new systems
  - First Step: T&E Communities must work together and speak the same language
Non-Technical Factors Affecting T&E Interoperability

Mr. Augustine J. Ponturiero
Northrop Grumman Simulation Technologies
The Problem: How to clarify Lifecycle issues in a T&E context?

**Tactical Use Case:**
Example for IP03: Conduct Network Operations

**M&S**
Evaluation Matrix and Decomposition of COI C MOE
UA CIC
UE/JTF CIC
Seven Levels, Four Operators

1.3
1.4

1. Index: Location
2. Mission & Time
3. Functions, Performance & Effects
4. Tasks, Operations & Employment
5. Missions
6. Forces
7. BLUFOR OPFOR

**JROCM 080-02**
IP-1: BATTLE COMMAND WAR MOOTW Involving Use/Employment Of Forces; Forcible Entry; Strikes; Raids

**DoD 5000.1**
HOMELAND DEFENSE: NATIONAL LAND DEFENSE; NATIONAL MARITIME DEFENSE; MILITARY ASSISTANCE FOR CIVIL DISTURBANCES; SECURITY ASSISTANCE; UNCONVENTIONAL WARFARE; LINE OF COMMUNICATIONS PROTECTION; COMBATTING TERRORISM; HOMELAND SECURITY

**VIDEO**
PEACE ENFORCEMENT PEACEKEEPING OPERATIONS SECURITY COOPERATION ACTIVITIES NATION ASSISTANCE: SECURITY ASSISTANCE; HUMAN & CIV ASSISTANCE; ARMS CONTROL; MILITARY CONTACTS

**MILITARY CONTACTS**
MULTI-NATIONAL EX, TR, ED

**TRADOC**
Functional Areas
Joint Interoperability

**JTEM**
Use Cases
3CE
Warfighter Requirements

**GIG**
Future Upgrades

**PPBS**
Development Plans

**C3T**

**Contractor**

**AFICE**

**ATIC**

**Object Models**

**SV’s**
M&S Instrumentation

**Testing**

**Future**

**Threats**

**Analysis Of Alternatives**

**FCS**

**RDECOM**

**JSBE**

**PREFERENCES**

**Fiscal “Realities”**

**Netrworks**

**Tasks**

**DEP**

**UAMBL**

**ENTITIES**

**MOCs**

**NCIE**

**TRADOC**

**Programs**

**DoD 5000.1**

**Joint Interoperability**
Challenges

- Systems of Systems (SOS)/Families of Systems (FOS)
  - Network Enabled Systems
  - Network Centric Enterprise Services
  - Global Information Grid
  - Joint Command and Control (JC2)
  - Multi-National Information Sharing

- Missions and Scenarios Paradigm Shift
  - Transform from forces-based, materiel-centric Cold War to capabilities-based, mission centric asymmetric-warfare posture

- Joint Focus

What is the “force multiplier?”
How do we define it?
Non-Technical Factors
T&E Community Issues

- “Ad Hoc” Processes
  - Rely on individuals, not processes, to successfully complete events

- Common Tools
  - Few
  - Not used effectively
  - Gap in tools available for collaboration and communication

- Not familiar with other Services
- No effective Network Engineering Process
- Insufficient process maturity to be “repeatable”

Must make a Cultural Change within the T&E Community
A Cultural Change

- Joint vice Service focused testing
- Shared Models and Simulations
  - “Users won’t use the model correctly and it will reflect badly on me/us…”
- Improved understanding of Joint Test environment including Network and Security strengths and limitations
  - Navy = Air Force = Army = Marines
- Improved community-wide methods and processes
  - JTEM is taking the first steps
  - Sustainable, Repeatable, Consistent, Understandable results
  - Operations and Acquisitions context
The Benefit:
Better Info to Decision-Makers, Faster

- Operational and Acquisition Leadership
- Better analysis of alternatives for acquisition decisions
- Clearer understanding of test results across T&E and Operations Spectrum
- Shared data and information – faster analysis and recommendations
- Virtual Environment for testing
- Capability-based assessment of system
- Examination of proposed systems from a Doctrine/Operations/Training perspective early in development.
- Common “language”, data, and processes between Acquisition, T&E, and Ops Communities
- Common understanding between Acquisition, Ops, and T&E Communities
Capabilities-Based Development
The Missions and Means Framework

- The LINK between the Military Decision Making Process and the domain of DOTMLPF solutions
- A WARFIGHTER-FOCUSED STRUCTURE for rigorous, complete, and detailed analysis in crucial evaluation programs
- An ORGANIZING PRINCIPLE for requirements, test planning, and evaluation
Application of the Missions and Means Framework to Distributed Testing: Some Results From A Test

Mr. Richard S. Cozby
Chief, Technology Management Division
HQ, U.S. Army Developmental Test Command
Distributed Test Event-5/Multi-Service Distributed Event

Event: August 2005
Mission Context: A Company Mounted Operation Supported by Platoon Dismounted Forces in an Urban Environment

**Step 1:** Alpha Team (2 ICV & 1 MCS PLTs) moves along AXIS BLUE. Enemy dismount force is detected by A TM’s Class II UAV in town. ICV PLT identifies enemy flank, and formulates & disseminates plan to all Soldiers. MCS PLT moves to SBF position. ICV PLT moves to secure locations & deploys Class I UAV, SUGV, and T-UGS. ICV PLT dismounts and attacks with direct fire & movement; deploys U-UGS. ICVs & weapons squads provide supporting LOS fires. MCS PLT provides supporting BLOS fires.

**Step 2:** Enemy force in town is defeated or captured. ICV PLT secures objective, and consolidates & reorganizes. Dismount PLT LDR transmits situation report & requests MEDEVAC support. MCS PLT covers dismount movement to ICV remount locations. ICV PLT quickly remounts ICVs. ICV PLT LDR updates SA for all Soldiers. MCS Class II UAV detects and identifies another dismounted force. Alpha Team continues attack along AXIS BLUE.
Event Joint Mission Context

Reachback

Army UAVs

Navy E-2C

AWACS

JTAC

JSTARS

FORCES

FAC-A

F-15

F-16

F-18

SA-6

SA-8

STRYKER

AEGIS Cruiser

AEA Assets

TARGET

Reachback
Event Analysis Framework

- Use Joint Tactical Tasks to define the operation
- Decompose the tasks to understand component-level influences
- Instrument the components to measure their activities
- Synthesize the tasks as a manifestation of component interactions
Event Analysis Methodology

**ANALYSIS PRODUCTS**

- Baseline analysis methodology for assessment of Joint Tasks
- Baseline set of Joint Task Measures associated with each Service Level Task (NTA, ART, AFT, MCTL)
  - Quantitative Data Examples
    - ART 1.4.3 - M3 - Time to make initial assessment of attacks after TOT
    - NTA 3.2.2 – M2 – Minutes after target ID to complete attack
    - AFT 2.1.1 – M1 – Time from the desired timing for lethal force to cause desired effects
- System level measures for respective service test objectives

**MULTI-SERVICE JOINT TASK COMMON ANALYSIS METHODOLOGY**

- Requirements
- Analysis
- Mission Accomplishment
  - Joint Tasks (i.e. JCAS, JFIRES, JSEAD)
- Service Level Tasks (ART, NTA, AFT, MCTL)
- Multi-Service Test Data

Highly Qualitative Measures

Highly Quantitative Measures

Mission Analysis
## Results and Areas for Improvement

- Demonstrated ability to execute a distributed L/V/C event with existing capabilities.
- Conducted system testing in the context of a Joint mission.
- Gained experience with multi-Service performance report generation using multiple tools.
- Gained experience in reporting complex Joint thread exercises with diverse data formats.

<table>
<thead>
<tr>
<th>Areas Requiring Improvement</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>1 Ability to determine system contributions to the accomplishment of a Joint task.</td>
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<td>2 Ability to evaluate individual test item performance in L/V/C events.</td>
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<td>3 Ability to test multiple items in a Joint environment simultaneously and accomplish all test objectives.</td>
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<td>4 Ability to sufficiently gather, process, and analyze data (one set) from distributed L/V/C events.</td>
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<td>5 Determine capabilities and limitations associated with legacy systems in Joint L/V/C events.</td>
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<tr>
<td>6 Integrate across a variety of environment models and coordinate systems.</td>
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<tr>
<td>7 Assess and integrate multiple threat representations in a distributed L/V/C environment</td>
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Getting Organized to Perform Evaluation

Dr. Paul H. Deitz
Director (A)
Human Research & Engineering Directorate,
U.S. Army Research Laboratory
Military Operations and Warfighting

Require Capability

Provide Capability

DOTMLPF* Solutions

Define

Enable

Research, Experimentation

Life Cycle

Acquisition, Test & Evaluation

Logistics, Sustainment

Readiness, Training

Analysis, Demonstration

Tactics, Fielding

Mode 1: Deliberate Planning

Mode 2: Crisis Response

Vugraph Happy Talk!

* DOTMLPF: Doctrine, Organization, Training, Materiel, Leader Development, Personnel, Facilities
Military Operations and Warfighting

Provide Capability

Require Capability

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Define

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Mode 1:
Deliberate Planning

Mode 2:
Crisis Response

Vugraph Unhappy Talk!

* DOTMLPF: Doctrine, Organization, Training, Materiel, Leader Development, Personnel, Facilities
"Just got to get organized. We've got to get organized."

Jonathan Winters (Officer Norman Jones) to Ben Blue

§Metro-Goldwyn-Mayer, Inc., 1966
Observe, Exercise, Measure, Test

Calculate, Model, Represent, Simulate

Abstraction

Repeted VV&A Process

Single, Unified Abstraction

Where “E” Resides

Where “T” Resides

Knowledge Formation

Sift, Filter, Analyze, Evaluate

Decision Making

Where “M&S” Reside
The Example:
Ballistic Live Fire Example - 1985

Mission Utility
Level 4
- Operational Testing*
  - O₃₄ Operator

Functional Capabilities
Level 3
- Developmental Testing*
  - O₂₃ Operator

Post-Event Components
Level 2
- Developmental Testing*
  - O₁₂ Operator

Interaction Conditions
Level 1
* And/Or Modeling & Simulation

The Example:
Ballistic Live Fire Example - 1985
## Direct Fire Validation

<table>
<thead>
<tr>
<th>Shot</th>
<th>Threat</th>
<th>Perf or Non-Perf</th>
<th>Number of Components</th>
<th>Personnel Casualties</th>
<th>System Evaluation Metrics</th>
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<td>Threat F</td>
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### Performance Criteria

- **Perforations**
  - ≥ 50%
  - ≥ 5% & < 50%
  - > 0% & < 5%
  - = 0%

- **Component Criteria**
  - ≥ 80%
  - ≥ 50% & < 80%
  - > 50%

- **Personnel Criteria**
  - ≤ 1/2 Crew member
  - > 1/2 & ≤ 1 Crew member
  - > 1 Crew member

### Discrete Distribution

- ≥ 50%
- ≥ 5% & < 50%
- > 0% & < 5%
- = 0%

The MMF: Old

1. Interactions, Effects

2. Components, Forces

3. Functions, Capabilities

4. Tasks, Operations

5. Index: Location & Time

6. Context: Environment (Military, Civil, Physical, etc.)

7. BlueFor Purpose: Why = Mission

Circa 2002

O1,2

O2,3

O3,4

O4,1

BLUFOR

O1,2

O2,3

O3,4

O4,1
Missions and Means Framework

11 Fundamental Elements:

7. OWNFOR Why = Purpose, Mission

7. OPFOR Why = Purpose, Mission

7. Why, Wherefore, to What End
Missions and Means Framework

11 Fundamental Elements: Seven Levels, Four Operators

6. Context, Environment (Military, Civil, Physical, etc.)

7. OWNFOR Why = Purpose, Mission

7. OPFOR Why = Purpose, Mission

6. Under What Circumstances
Missions and Means Framework

11 Fundamental Elements:  Seven Levels, Four Operators

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5. Index: Location & Time

5. When and Where
4. Activity-centric, named with a Verb, “Do What”

“The Playbook”
Missions and Means Framework

Architecture defines how Parts are assembled into Packages
Capabilities are relationships between Parts and Packages
MMF and FCS

Mr. Jack Sheehan
Chief Engineer, Combined Test Organization
PM UA
Systems of System Engineering

INPUTS
- SoS SRR 2004 (1Q)
- SoS SFR 2005 (4Q)
- SoS PDR 2008 (4Q)
- SoS CDR 2010 (4Q)

Verification
- Army Operational Validation
- Final Industrial Capability Assessment Complete
- Production Readiness Reviews (PRR)
- Demonstrates SoS Compliance to Specs

System of System Specification
- Prime Item & CI Development Specs
- Preliminary Design
- CI / CSCIs
- Component Verification
- Build
- TRR’s Proceed Testing
- Integrate DT&E / LFT&E
- Verify Performance Compliance to Specs
- SoS Level DT&E / LFT&E
- Demonstrate SoS Compliance to Specs

Planning
- System of System Verification
- System Integration Verification
- Subsystem Integration Verification
- Integrated DT&E / LFT&E
- Verify Performance Compliance to Specs

Analysis and Simulation
- System of System Verification
- System Integration Verification
- Subsystem Integration Verification
- Individual CI / CSCI Verification

Test
- SoS PDR 2008 (4Q)
- SoS PDR 2010 (4Q)
- EMRL 2 @ SoS CDR
- EMRL 1 @ SoS PDR
- TEST, Lab, and Field

Build
- Fabricate, Assemble, Code to “build to” Documentation

Legend:
- Current Status of Completion

*Dates In FY
- April 03 ORD, Jan 05 Update
- Develop System Functional Specs into PID’s / PCD’s and CI Functional (design to) Specs
- Evolve CI Functional Specs into Product (build to) Documentation
- Concurrent Engineering Approach consists of a series of four Engineering Iterations (EI’s), four Capability Maturity Reviews and four Engineering Maturity Reviews
- TRR’s Proceed Testing
- System of System Engineering

AS Of 21Jun05 FCS Review to DAB
Chains versus Networks

Chain
Too brittle, simple pattern, simple control, scaled
“business end” most poorly connected, hard to reconfigure or change flow

Network
Very robust, complex pattern, complex control, scale free
“business end” best connected, natural to reconfigure or change flow
The FCS BCT Integrates With Army Enterprise System Into the GIG

Integrated Warfighting
Platforms: Lethality / Survivability enhanced by underlying network layers
Sensing Systems: motion, visual, audible, etc. ISR: Eyes and Ears of the Commander

BC Applications: assimilate info
BC: C2 logic and reasoning based on information

System Services: Common Net-Centric Infrastructure SOSCOE: Tactical Net-Centric Middleware

Transport Systems: networked communications
Networked Communications: comms backbone and omms subnets from GIG to/from ground sensors

Standards: Common Net-Centric technical standards
Includes DoD guidance, policy, and direction
a-MIND™§ - “Automated Mission Relevant Situational Awareness”

Operational Architecture/Operational Use Case Definition

Operational Use Cases Dependencies on Services Service Layer – Virtual Translator

Infostructure Used to Provide Services

What is done?

How it’s done.

What is used?

a-MIND Technology automates dependency understanding enabling analysis of Mission Impact of Infostructure Disruptions

- Proven ability to integrate COTS products
- Unique integration and analysis framework – patent filings

§ Mission Impact Management (MIM) Solution a Product of Northrop Grumman-Patent Pending
Dependencies
Map and view relationships within tiers . . .
Dependencies

... and between tiers
New M&S Requirements Module

- Requirements Modules Established Around the Front-Face of “the Cube”
- M&S Module is intended to enhance the integration and utilization of M&S across all aspects of the program.
- M&S Team is responsible for the application of M&S from “Cradle-to-Grave” and “Top-to-Bottom”

Multi-disciplined Teams including LSI, PM UA & TRADOC
Simple Tree – UGV Example
Panel Summary

Mr. John Illgen
Northrop Grumman Simulation Technologies
Conclusions

- T&E and M&S have evolved and are managed asynchronously
  - Adequate evaluation for today’s complex SoSs in a Joint context requires extensive complimentary Test/M&S detailed planning and execution
- Lack of common processes inhibits M&S sharing in the T&E community
  - No standard “Standard” to assess M&S ability
    - What is a “High Fidelity Model”? 
  - No common processes for using/sharing M&S
- Common understanding through common languages, methods, and processes are crucial to achieving full T&E community integration
Path Ahead

- Crawl before Walking
  - Develop a common understanding of what “Warfighter focused T&E” means to each Service and DoD Agency
  - Develop common language and practices for M&S use in T&E
  - Understand Service/Agency strengths and weaknesses in M&S in a T&E context

- Community-wide Methods and Processes (M&P)
  - Standard M&P for T&E across all Services and DoD Agencies
  - Links M&S use within DoD T&E communities
  - Good news: JTEM is making progress in this area
Path Ahead

- Incorporate MMF as a community-wide T&E Process
  - Global organizing schema covering both the mission definition and mission execution
  - Common understanding of T&E in Warfighter context
  - Without a global organizing schema covering both the mission definition and mission execution sides of the problem, the many pieces cannot be properly defined, instantiated, linked and executed
The Problem:
How to clarify Lifecycle issues in a T&E context?

**MMF SOLVES THE PROBLEM**
Points of Contact

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  - augustine.ponturiero@ngc.com
Questions?
2. Entity-centric, named with a Noun “By Whom”
“The Players”
11 Fundamental Elements:

- 7. OWNFOR Why = Purpose, Mission
- 7. OPFOR Why = Purpose, Mission
- 6. Context, Environment (Military, Civil, Physical, etc.)
- 5. Index: Location & Time
- 4. Tasks, Operations
- 3. Functions, Capabilities
- 2. Components, Forces
- 7. Mission

1. The (shared) Slings-and-Arrows of Outrageous Fortune -- Science

3. Condition-dependent “How Well” -- Engineering
Missions and Means Framework

11 Fundamental Elements:

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5. Index: Location & Time

1. Interactions, Effects

2. Components, Forces

3. Functions, Capabilities

4. Tasks, Operations

7. Mission

Bottom-up, Causal, Time-forward execution and adjudication of outcomes
Missions and Means Framework

11 Fundamental Elements:

- Seven Levels, Four Operators

6. Context, Environment (Military, Civil, Physical, etc.)

7. OWNFOR Why = Purpose, Mission

BLUFOR

- 7. Mission
- 4. Tasks, Operations
- 3. Functions, Capabilities
- 2. Components, Forces

O1,2, O3,4

OPFOR

- 7. Mission
- 4. Tasks, Operations
- 3. Functions, Capabilities
- 2. Components, Forces

O2,3, O4,1

5. Index: Location & Time

Top-Down, Concurrent Synthesis and Decision Making
Architecture defines how Parts are assembled into Packages

Capabilities are relationships between Parts and Packages