Warfare Systems Engineering Challenges and Test and Evaluation Approaches

Presented to:

Presented by:
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Outline of Presentation:
DoN T&E Challenges & Strategies
NAVSEA Core T&E Functions
NAVSEA T&E Initiatives
(Integration, Interoperability, M&S, Undersea Tracking Ranges and T&E capabilities, Human Capital Strategy)

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Challenges

• The growing need for the large scale joint and dynamic test environment of the future, e.g. Net Centric Warfare, FoS/S, coalition operations.

• The increasing technological complexity and tightly integrated interoperability across weapons systems.

• Current information and accounting systems do not provide adequate visibility of T&E events and costs to maintain and improve process and capability.

Strategies

• The Joint Capability Integration Development Requirement and the budget process needs to be better synchronized to reduce unanticipated cost changes.

• The use of combined Integrated DT/OT is one of the successful “innovative” T&E approaches by Navy program managers to cut testing costs.

• Increased use of M&S can reduce Acquisition programs costs and improve the value of DT and OT data.

• The return of M&S across programs can be enhanced through investments in common infrastructure, policies, and standards and reuse.
Navy T&E Initiatives

Navy T&E Board of Directors
- Established by DASN/RDA
- RADM Landay (co-chair) and COTF (co-chair), OPNAV N091 (Exec Sec), PEOs, N1, N4, N6, N8, SYSCOMs, MCOTEA and CFFC
- Strategic Priorities
  - Establish governance
  - Inventory the domain
  - Define metrics
  - Create value by optimizing resource utilization

- N43 Range Contribution to Readiness Effort
- PEO T&E Forum
  - Coordinates T&E actions across PEOs
  - Identify opportunities for efficiencies
- PEO Ships T&E Working Group
- NAVSEA Warfare Center T&E Working Group
  - Representatives from each WC division
  - Forum for:
    - WC leadership in joint initiatives
    - Knowledge sharing, synergy/efficiency initiatives
    - Recommendations for T&E policy formulation
    - Coordination of NAVSEA T&E action items

Renewed focus and attention on T&E
DoN Integrated Testing Strategies

• FY07 Nat'l Defense Authorization Act, Sect 231. directed USD and DOT&E to review DOD policies and practices on T&E.

• Integrated testing major theme
  – Goal: early detection & correction of program deficiencies

• Navy Proposed Draft DoD IT definition: Integrated testing is the collaborative planning and collaborative execution of test phases and events to provide data in support of independent analysis, evaluation and reporting by all stakeholders (government, contractor, operational test communities).

• PM identifies program as “Integrated Test” program
  • Establishes a test team to collaboratively create and manage the TEMP
  • Identify test parameters, data, and resources required for development of DT/ OT test plans, and certifications, to optimize test data collection while minimizing test resource required.

• MDA provide formal direction establishing the Test Team in the program's first ADM

• Contractor full participation in the IT planning and execution included in RFP and contract.
NAVSEA T&E Initiatives In Support of DoN Directives

• Implement Integrated T&E Strategies
  – Combined DT/OT
  – Synergy DT/OT with Fleet Training Events

• Implement Interoperability T&E
  – Distributed Engineering Plant
  – Joint T&E Distributed Engineering Plant
  – Coalition T&E
  – Integral Fire 07

• Promote Consolidated T&E Capability
  – Undersea Tracking Range Collaboration and Roadmap Development
  – Synthetic Environments to Enhance ASW Operational Effectiveness
  – Test Assets & M&S
  – T&E Human Capital Strategy

• Establish Strategies for Transformational T&E
  – Establish Rapid Response CREW T&E
  – Establish M&S Accreditation Process
  – Establish Open Architecture T&E
Virtual SYSCOM Sea Trial Collaboration Team

- NAVSEA, NAVAIR, and SPAWAR, with support from NWDC
- Share knowledge of the SYSCOMs’ Experimentation processes, tools and venues

3rd Fleet conducted a Sea Trial Symposium for Sea Shield Experimentation

- Identified Fleet Warfighting gaps
- Aligned and prioritized experimentation documented in STIMS
- Use experimentation to fix the short term gaps
- Provide representation to the STESG

NAVSEA develops initiatives to rapidly solve gaps and cost

- Provide Engineering review of initiatives and gaps
- Provide operation & system architecture views

PEO PM’s provide DT & OT event activity to NWDC

NWDC vet experiments through SYSCOM’s prior to Fleet Collaborative Team action*

- Support Sea Trial Information Management System (STIMS)

Sea Strike - 2nd fleet - NAVAIR
Sea Shield - 3rd Fleet - NAVSEA
Forcenet - NETWARCOM - SPAWAR
Sea Base - 2nd Fleet - NAVAIR
Distributed Engineering Plant Overview (NSWCDD)

- The Distributed Engineering Plant (DEP)
  - Critical element of the Navy's response to Battle Force Interoperability
  - Formed by Federating Combat System Sites Dispersed Around the United States
  - HITL CS suite to evaluate how systems interact with CEC and TADIL environments
  - All ship baselines require DEP evaluations prior to deployment
  - A High-Fidelity, Shore-Based distributed Force Test bed
  - Demonstrated utility for industry participation
  - Demonstrated utility for industry participation
  - Established foundation for and compatible with JDEP
- Primary mission to provide Shore-based Force-level testing of deploying CSGs/ESGs.
  - Force Interoperability Assessment
- The mission has evolved to support the entire acquisition cycle.
  - Force-Level Performance
  - Prototype Evaluation
  - Developmental Systems
  - Force Problem Resolution

DEP Goal is to Enable Navy Acquisition Decisions Based on Sound Force System Engineering
Navy Joint and Coalition Interoperability Challenge

Coalition Distributed Testing (2007) 8 MTMD Nations

------ C/DIT Testing ------

Phase 2 (2005)
Fix developing Implementation of MIL STD 6016C
- Patriot
- AEGIS
- E-2C

Phase 3&4 (2006/7) – IABM
Testing in Joint Engineering Environment

- UK
- Germany
- Netherlands
- Italy
- Australia
- US
- Spain
- UK AWACS
- PATRIOT
- TAOM
- SSDS
- AEGIS (2)
- ACDS
- E-2C
- F-18

SIAP Pathfinders and Connectivity:
Systems Interface Description (SV-1)

Joint Test Env.: (2001) Joint I/O
Capabilities & Limitations (4 Joint Nodes)

Navy DEP - HWIL for Deployers (13 Nodes)

Joint, Distributed Engineering finds problems early, reduces costs, and improves interoperability: the “Force Multiplier” for the 1,000-ship Navy.
Integral Fire 07
(AF-ICE, USJFCOM J89, SIMAF, JMTC, JC2 JCAS, JTEM, NSWC DN)

**Description:** establish a Joint persistent test environment to support Joint Command and Control (JC2), Joint Close Air Support (JCAS) Assessment for USJFCOM; and Air Force Secretary on the Warfighter Warfighter Forwarder (WWF) integration

**Objectives:**
- Conduct a technical assessment of JCAS in response to real time requests.
- Evaluate Methods and Processes C2 airspace de-confliction between Army NLOS and Net enabled weapon (NEW) (Air Force and Navy).
- Machine to Machine re-tasking of strike platforms and NEW from the Air Operations Center (AOC).

**JSIC JC2 JCAS:** Assess data exchange between AF/Army, Marine, and SOF Terminal Air Controller digital ground kits to coordinate Close Air Support

**LVC JME Infrastructure**
T&E Facility Examples
Ocean & Coastal Ranges and Facilities

Pacific Northwest Range Complex
Narragansett Bay Shallow Water Test Facility
Potomac River Test Range
Surface Combat Systems Center
Combatant Craft Division
South Florida Test Facility
Atlantic Undersea Test and Evaluation Center

Southern California Offshore Range
PMRF

Pacific Missile Range Facility

Fleet Ranges
T&E Ranges
T&E/w MRTFB Components

Gulf of Mexico Coastal Test Range
Initiative: Undersea Ranges Consolidation & Collaboration (NUWCKPT, NPT)

Portable Range Programs Reduced
From 12 to 5
Cost Avoidance ~$3M

One Contract for Upgrades at 2 Ranges
Cost Avoidance ~$9M

Eliminating Overlap

USW T&E and Training
Ranges Master Plan

Identifying & Leveraging
Common Systems

Assess Using IMPASS (Gun Firing) System
for Portable Surface Ship Radiated Noise Measurements

Inventoryed East Coast Range
Cable given to KPT’s Nanoose
Range for Repair
Cost Savings $800K

Collaboration

Pinger Consolidation Across
Warfare Centers
Cost Savings = $150K/yr

Common Equipment

Reduce Cost

Sponsors: NRO
Partners: PMA205, SCORE, PMRF,
LMC/L3/Mariapro

Leveraging Existing Systems Future Multi-use Cost Savings TBD
Undersea Tracking Range Roadmap

- Comprehensive roadmap of USW tracking range requirements (T&E & Training)
- Held UTR T&E requirements forum with PEO’s, COTF, FFC
- Provides investment guidance for near, mid, and long term
- Identifies shortfalls or gaps in resources and shared approaches to USW ranges technology
- Completed Phase 1, conducting Phase 2
- Documents efforts required for the current ranges out to FY20.
- Proposes potential technologies and range architecture
Initiative: White Sands Missile Range (WSMR) Desert Ship Upgrade

- Transitioned 20-40 year old specialized Fire Control System (FCS) equipment to an Aegis Open Architecture FCS and COTS based approach.
- Supports current and future Integrated Fire Control (IFC) tests to demonstrate Naval and Joint Capabilities
- Reduces overall Desert Ship system maintenance cost
- OA and COTS approach reduces future upgrade costs
Potential Future IFC Test Configurations

The Cooperative Engagement Capability (CEC) Land Mobile Unit (LMU) is connected to Desert Ship Aegis OA FCS via the White Sands Missile Range (WSMR) Technical Support Network. There are numerous connection points through the entire range where the CEC LMU may be connected.

WSMR provides various overland test environments:
- Desert
- Mountain
Initiative: AAW SSD T&E Enterprise

- PEO IWS Initiative to apply an enterprise approach to program T&E strategies
- Integrates SDTS and Lead ship at-sea test events, and $P_{ra}$ Testbed across combat system variants
  - Applicable to LPD 17, LHA 6, DDG 1000, CVN 78, LCS
  - SSDS, RAM, ESSM
- Eliminates duplication and optimizes testing; element TEMP(s) still supported

Potential savings of $240 Million, and reduction of 38 missiles
WAF-SM MTT Value to the Warfighter

- Real Torpedo Hardware in the loop and latest weapon software
- High fidelity threat models, CMs, and high fidelity tactically significant environments
- An excellent test bed to preview, and test Combat Control and APB Weapon System and HSI improvements prior to costly at-sea firings
- Proven HLA connectivity
- Leverage the latest exploitation for training in the employment of the latest torpedoes in operationally relevant scenarios. Used as part of SCC training since Oct 2004. Utilized for mission-specific Pre-Deployment Training
ASSESSING WORKFORCE HEALTH

Measure TC Health by Knowledge Area (KA) (e.g. Test & Evaluation)

Gap Assessment

ASSESSING WORKLOAD DEMAND

Assign Workload by Technical Capability (TC)

Yields

WORKFORCE SHAPING ACTIONS

Hire Or Redeploy based on TC& KA Health

Develop by 5VM Career Path (e.g. Test & Evaluation)

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## Counter IED Device Testing
(NSWC Corona, Dahlgren, NAVEODTECHDIV, PMS408)

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<tr>
<th>Tasking</th>
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<tr>
<td>Assessment of effectiveness of CREW systems for dismounted troops, wheeled vehicles, and riverine patrol boats.</td>
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<tr>
<td>• Quick Reaction Mounted &amp; Dismounted CREW - Counter Remote Control Improvised Explosive Device Electronic Warfare</td>
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<th>Challenges</th>
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<td>• Compressed acquisition process requires demanding OPTEMPO.</td>
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<td>• Transform process for assessment of NAVY weapons systems for assessment of systems used in ground combat environment to counter asymmetric threat – IED’s.</td>
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<th>Accomplishments</th>
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<td>• On-site at Yuma Proving Grounds Az, for data collection, analysis &amp; operator support</td>
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<td>• Author Effectiveness reports</td>
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<td>• Testified as SME at source selection board Feb 07.</td>
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M&S Initiative: Envisioned Roadmap Towards M&S of the Full Ship Shock Trial

- **Business Strategies**
  - Uncoupled simulators of shock load.
  - Global energy equations (include fragment energy).

- **M&S Technologies**
  - Structure Dynamics Under Shock /Blast load.
    - Beam-column, Pipe-structure connection, Bolted joints.
    - Shock transmission across joints.
  - Fracture & fragment Modeling
    - Integrated UNDEX whipping resistance assessment model.
  - Fluid-Structure Interface
    - CFD Modeling of blast intrusion.
    - CFD cavitation interaction with structure.
    - Adaptive FEB for fluid structures.
  - Numerical Models
    - Non-reflecting B.C.’s
    - Peak pressure, total impulse sensitivity calibration.
    - Alternate T&E to support critical gaps.
  - T&E Engineering
    - Fast transient response instrumentation.
    - Pseudo velocity shock spectrum.
    - High speed actuator for shock testing, Multi-axis transducers.
  - FSST
    - Certify LSDYNA, ABAQUS, NASTRAN, DYSMAS.. in accordance with specified capabilities and limitations.
    - Collaborative investment on most critical enablers.
    - End to end coupled M&S with imbedded beam analogy, joint analogy, cavitation load analogy, fragment energy balance models.

- **Basic Science of Material**
  - Visco-elastic, non-linear, non-isotropic, strain rate-stress constitutive models.
  - Composite failure models, fracture mechanics.
Future of NAVSEA T&E

Mature Test Evaluation & Analysis Competency

• Support Navy T&E BOD integrated investment strategies
• Create end-to-end transparency in demand signals, improve execution capacity and efficiency, reduce cost of execution and ultimate deliverables, and improve customer satisfaction

Enable System Engineering To Support Acquisition via Integrated Strategic Planning

• Emphasize enterprise integrated solutions versus platform or singular domain focus across PEO T&E Directors, HQ & Warfare Centers T&E Executive activities
• Enable Navy T&E in a Joint Environment
• Enable Affordable T&E of Open Architecture Systems