VV&A DATABASE OVERVIEW

• An Example of Making VV&A Work
• The Simulation
• The Simulation Development Process
• The VV&A Approach
• The VV&A Process
• The VV&A Database
VV&A DATABASE OVERVIEW

• An Example of Making VV&A Work
  – Have Completed Build 2 of the 4 Build LPD 17
    Probability of Raid Annihilation (P_RA) Testbed
  – Have Successfully Integrated the VV&A Process
    into the Development Cycle
  – The Documentation is Tracked via a Relational
    Database

• Describe the Simulation
• Describe the Simulation Process
• Describe the VV&A Approach
• Describe the VV&A Process
• Describe the VV&A Database
VV&A DATABASE OVERVIEW

• An Example of Making VV&A Work

• The Simulation
  – LPD 17 San Antonio Ship Class
  – LPD 17 Combat System
  – PRA Requirement Definition
  – LPD 17 PRA Testbed Simulation

• The Simulation Process
  – Management, Technical Approach, Bound Problem Space, Defined Analysis Approach

• The VV&A Approach
• The VV&A Process
• The VV&A Database
• Relational Database Tables
LPD 17 CAPABILITIES

• The LPD 17 capabilities include:
  – State-of-the-art command and control suite
  – Advanced ship survivability features that enhance its ability to operate in the unforgiving littoral environment (low radar cross section)
  – Substantially increased landing force vehicle lift capacity (23,600 square feet of vehicle storage space),
  – Large flight deck (land 2 MV-22 or 4 CH-46) and well deck (holds 2 Landing Craft Air Cushion {LCAC})

• The LPD 17 is the first amphibious ship designed to accommodate the Marine Corps’ “mobility triad”
  – Expeditionary Fighting Vehicle (EFV)
  – LCAC
  – MV-22 Osprey tilt rotor aircraft.

OUR FOCUS WILL BE ON THE COMBAT SYSTEM
Low Radar Cross Section (RCS)

SPQ-9B Air/Surface Tracking Radar

SSDS Control and Decision System

CEC

SPS-48E 3D Air Search Radar

Nulka Active Decoy

RAM Missile System

SLQ 32A(V)2 EW System
BACKGROUND – $P_{\text{RA}}$

OBJECTIVE: ASSESS LPD 17’s $P_{\text{RA}}$ (ABILITY TO DEFEND ITSELF AGAINST INCOMING MISSILES)

- CNO’s Anti-Air Warfare Capstone Requirements Document mandated the ship self defense capability for specific ship classes and established the $P_{\text{RA}}$ as the primary Measure of Effectiveness (MOE) to assess ship combat system suites.

- $P_{\text{RA}}$ is defined as the ability of a particular stand-alone ship, as an integrated system, to detect, control, engage, and defeat a specified raid of anti-ship cruise missile (ASCM) threats with a specified level of probability in the operational environment.

- The LPD 17 class is the first U.S. naval ship class required to demonstrate its ability to defeat specific ASCM threats to achieve a specified $P_{\text{RA}}$. 
Geographically Distributed Federation of Tactical HWIL, Tactical SWIL and Digital Physics Based Models
LPD 17 PRA TESTBED OVERVIEW

MANAGEMENT APPROACH:
- Organization
- Meetings
- Documents
- Schedule

BOUND THE PROBLEM:
- Testbed Requirements
- Fidelity
- Ship Configuration
- Environment
- Threat Types

BOUND THE ANALYSIS:
- Finite Number of Runs
  (Geographic Location
  Ship Configuration
  Season, Time of Day
  Threat Types)

TECHNICAL APPROACH:
- Physics - Based
- Non - Real Time
- Distributed, RTI Solution
- HLA Compliant
- Spiral Development

SYSTEM OF SYSTEMS SOLUTION
An Example of Making VV&A Work
The Simulation
The Simulation Process
The VV&A Approach
  - Set up Process with Defined V&V Checks
  - Leverage off of Previous Accreditation Packages, Focus on Implementation in the Testbed Simulation
  - Integrate V&V into the Simulation Spiral Development
  - Have a Dedicated V&V Team to Relieve Pressure from Developers
The VV&A Process
The VV&A Database
4 PHASES of V&V AND CHECKS

• As Defined in the DOD M&S Recommended Practices Guide (RPG)

• 1. Conceptual Model (and SECM) Validation
  – Conceptual Model – Testbed Design and Architecture
  – SECM – System Engineering Conceptual Model Document

• 2., 3. Functional Design and System Verification
  – Combine Functional Design Verification Step with The System Verification Step
  – Verify Data within the Models

• 4. Results Validation
  – Use Live Test Data to Validate Testbed Performance

• Data Verification
  – Defined as Environmental, Scenario, and FOM Data
LPD 17 PRA M&S AND VV&A PROCESSES
4 PHASES of V&V - STEP 1

• Conceptual Model and SECM Validation
  – Conceptual Model Validation
    • Review Individual Models Ability to Satisfy Requirements
    • Review Model’s Role, Interactions Within the Testbed
  – System Engineer Conceptual Model Validation
    • Review Universal Modeling Language Representation
    • Review Input, Output Flows For Each Model
  – Trace Requirements to Models, Model Elements
4 PHASES of V&V - STEP 2/3

- Functional Design and System Verification (Partial Listing)
  - HW Architectural Design Review
  - Design Review of Rehosted Tactical Code
  - Algorithm and Structure Control Flow
  - Evaluate Interfaces
  - Model Input/Output Visualization
  - Model Element Black Box Functionality
  - SME Model to Testbed Input/Output Comparison
  - Verify Input Data/Output Data as Appropriate
  - Trace Requirements into Design
  - Model Performance Compliance
4 PHASES of V&V - STEP 4

• Results Validation
  – Display Model Execution
  – Model Output Data – Format and Fidelity
  – Operationally Test Model for Proper Operation
  – SME Comparison of Model to Actual System
  – Test Federation Requirements
  – Validate Model Output Using Real-World Input Data
  – Trace Requirements to Model Performance
  – Model Performance Compliance
4 PHASES of V&V

- **Data Verification**
  - Assess Environmental Data
    - Verify Transformation/ Data Consistency
    - Verify/ Validate Data and Metadata
    - Verify/ Validate Initialization Data
  - Assess Scenario Data
    - Verify Transformation/ Data Consistency
    - Verify/ Validate Scenario Data Set
    - Verify/ Validate Data and Metadata
  - Assess FOM Data
    - Graphical Comparison
    - Verify Object Attributes and Structure
    - Verify Interaction Parameters and Data Types
LEVERAGE PREVIOUS VV&A

- Review Model’s Previous Accreditation Package
  - For Model Credibility
  - For Applicability to Testbed
- VV&A Team Focus
  - The Model as it is Used Within the Testbed
  - Integration of the Model Within the Testbed
  - Model Interfaces Within the Testbed
V&V AND MODEL DEVELOPMENT

• LPD 17 PRA Testbed Spiral Development Approach
  – Four Builds Over 3 Years
  – Increasing Functionality Within Each Build

• V&V Integration
  – Identify V&V Checks That Can Be Performed During the Builds
  – Perform Checks at the Completion of Each Build
LPD 17 PRA ORGANIZATION

MANAGEMENT IPT
- LPD 17 Combat System Integration Manager
- LPD 17 Test Director
- Ship Self Defense Combat Systems Engineer
- Deputy SSD CSE

WORKING IPT
- Development
- Integration
- VV&A
- Test Planning

SIMULATION CONTROL PANELS (SCP)
- Threat
- Natural Environment
- Scenario
- Softkill
- Hardkill
- Radars
- CEC
- Test Bed
- SSDS

CS Element PMs

M&S Developers
VV&A ORGANIZATION

• Separate Team From Developers
  – Experienced in Combat Systems and Ship Operations
  – Knowledgeable in Verification and Validation Process

• V&V Philosophy
  – V&V Team Perform the V&V Checks (with Assistance of the Developers as Necessary)
  – V&V Checks Performed During Each Build as the Testbed Functionality Permits
  – V&V Team Generates the Documentation
  – Minimizes the Workload on the Developers
VV&A DATABASE OVERVIEW

• An Example of Making VV&A Work
• The Simulation
• The Simulation Process
• The VV&A Approach
• The VV&A Process
  – Requirements is the Foundation,
    (there are over 1600 for this Federation)
  – Arrange Requirements under Models, Builds
  – Assign V&V Checks, Acceptability Criteria to Each Requirement
  – Perform V&V During Each Build
  – Generate V&V Reports
• Describe the VV&A Database
DISTRIBUTED HLA SIMULATION USING RUN TIME INFRASTRUCTURE

LPD 17 Testbed

DEVELOPED VIA SYSTEMS ENGINEERING

V&V Tasks Acceptability Criteria

DEVELOPED VIA V&V AGENTS AND SME

Builds 1/2/3/4

OT CSSQT SPS-48 AEMS LPD 18 NULKA

Live Test Events

DERIVED FROM EXHAUSTIVE LIST PRODUCED BY SMES, COTF, ETC

Model Elements

SPS 48E SPQ-9B SLQ-32 CEC SSDS RAM NULKA THREATS SCENARIO ENVIRONMENTS SHIP REPRESENTATION

Testbed Reqmts

SPS 48 AEMS LPD 18 NULKA

Testbed Reqmts

LPD 17 Testbed

V&V Tasks Acceptability Criteria

Live Test Events

Builds 1/2/3/4

DISTRIBUTED HLA SIMULATION USING RUN TIME INFRASTRUCTURE
TESTBED SPIRAL DEVELOPMENT

1. Develop Requirements
2. Develop Model Build/ CM Plan and V&V Plan
3. Build Models, Testbed
4. Develop the Models and Testbed Through Spiral Development Of Four Successive Builds
5. Integrate and Test Models, Testbed
6. Verify and Validate Models, Testbed
7. Execute Testbed, Prepare Results
8. Perform Dry Runs
9. Execute Runs For Record
10. Submit: Final Report, Accreditation Package
11. Submit: Final Report, Accreditation Package
12. Develop Testbed Build/ CM Plan
13. Develop the Models and Testbed Through Spiral Development Of Four Successive Builds
14. Execute Testbed, Prepare Results
15. Perform Dry Runs
16. Submit: Final Report, Accreditation Package
17. Submit: Final Report, Accreditation Package
# Testbed Schedule

## 4 Builds

- **Testbed Build 1**: Mon 1/23/06 - Wed 1/25/06
- **Testbed Build 2**: Mon 1/30/06 - Wed 2/1/06
- **Testbed Build 3**: Mon 2/6/06 - Wed 2/8/06
- **Testbed Build 4/Final**: Mon 2/13/06 - Wed 2/15/06

## Live Test Events

## Analysis Runs

## Final VV&A Documentation
VV&A DATABASE OVERVIEW

• An Example of Making VV&A Work
• The Simulation
• The Simulation Process
• The VV&A Approach
• The VV&A Process
• The VV&A Database
  – Relational Database Tables
  – User Interface
  – Database Reports That can be Generated
  – Program is Easily Modified, Updated.
  – Data, Reports is Property of the Customer
LPD 17 PRA VV&A DATABASE

- Maps Requirements to Testbed/Models/ Model Elements
- Maps Requirements to Builds
- Maps V&V Activities to Requirements/ Testbed/Elements/ Subelements/ Builds
- Tracks Completion of V&V Activities
- Includes Comments/ Results/ V&V Documents
- The Database is Capable of Printing a Variety of Documents for VV&A Reports, etc.
- Uses Live Test Events for Validation
AVW VV&A DATABASE

- Microsoft Access/VBA Relational Database
  - User Friendly, Uncomplicated and Customizable
  - Low costs in License and Tech Support
  - NMCI Compatible
- Supports process standardization
  - Consistent with M&S Instructions
  - Buy in from COTF, DOT&E
- Inherent flexibility of a database
  - Reports standardization
  - Query for specific or tailored reports
- Assists COTF and PM
  - Provides quick, easy access to all information requested
  - Provides single source for requirements traceability to all VV&A efforts
  - Manages associations from requirements to development to VV&A
V&V CHECK SCREEN
ACCEPTABILITY CRITERIA SCREEN
### LPD 17 PRA - VVA Database

**SL0-32.1.2**

**Expected Functionality:**
- Build 1
- Build 2
- Build 3
- Build 4

**Requirement Acceptability Criteria:**
- All criteria for this requirement have not been confirmed.

**Reconciliation:**
- 1. Verify that the VICO-AC data file is provided to the chip module and being sent to the VICO via the 10PHP system and that input data is being accepted.

**Comment:**
- 1. Bility of the chip module input test the VICO.

**SL0-32.1.5**

**Expected Functionality:**
- Build 1
- Build 2
- Build 3
- Build 4

**Requirement Acceptability Criteria:**
- All criteria for this requirement have not been confirmed.

**Reconciliation:**
- 2. Verify, test, and confirm that the VICO-AC data file is provided to the VICO via the 10PHP system and that input data is being accepted.

**Comment:**
- 1. Bility of the chip module input test the VICO.

**SL0-32.2**

**Expected Functionality:**
- Build 1
- Build 2
- Build 3
- Build 4

**Requirement Acceptability Criteria:**
- All criteria for this requirement have not been confirmed.

**Reconciliation:**
- 1. Verify that the VICO-AC data file is provided to the VICO via the 10PHP system and that input data is being accepted.

**Comment:**
- 1. Bility of the chip module input test the VICO.
DECOY MODEL BUILD 2 REPORT

Monday, December 12, 2005

LPD 17 PRA – VV&A Database
Decoy Requirements Build 2
Verification & Validation Checks and Acceptability Criteria

Verification & Validation Status:
3(7%) of 46 Decoy Requirements validated. 3(1%) of 510 Decoy Requirements Verification & Validation checks validated.

Acceptability Criteria Status:
3(7%) of 46 Decoy Requirements meet Acceptability Criteria. 3(3%) of 106 Decoy Requirements Acceptability Criteria met.

The Decoy representations shall be capable of incorporating various types of environmental factors regarding radar, ES, and IR performance.

<table>
<thead>
<tr>
<th>Decoy 1.1 Requirement V&amp;V Checks</th>
<th>All checks for this Requirement have not been confirmed.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element:</strong></td>
<td><strong>Phase:</strong> Threat/Decoys : EW Decoys</td>
</tr>
<tr>
<td><strong>Technique:</strong></td>
<td>1. SECM/CM Validate</td>
</tr>
<tr>
<td><strong>Task:</strong></td>
<td>Traceability Assessment</td>
</tr>
<tr>
<td><strong>Investigated in:</strong></td>
<td>Trace Requirements to Elements</td>
</tr>
<tr>
<td><strong>Status:</strong></td>
<td>Status 2/16/05 - Deferred to Builds 2/3.</td>
</tr>
<tr>
<td><strong>Intended:</strong></td>
<td>Trace Requirements to the Elements and Subelements.</td>
</tr>
<tr>
<td><strong>Comment:</strong></td>
<td>Status 2/16/05 - Deferred to Builds 2/3.</td>
</tr>
<tr>
<td><strong>Unconfirmed</strong></td>
<td></td>
</tr>
</tbody>
</table>

| **Element:**                      | **Phase:** Threat/Decoys : EW Decoys                  |
| **Technique:**                    | 1. SECM/CM Validate                                   |
| **Task:**                         | Review                                               |
| **Investigated in:**              | Conceptual Model Validation                           |
| **Status:**                       | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Intended:**                     | Evaluate the conceptual model to confirm it captures the attributes and behaviors to meet the requirement. |
| **Comment:**                      | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Unconfirmed**                   |                                                        |

| **Element:**                      | **Phase:** Threat/Decoys : EW Decoys                  |
| **Technique:**                    | 1. SECM/CM Validate                                   |
| **Task:**                         | SECM Validation                                       |
| **Investigated in:**              |                                                        |
| **Status:**                       | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Intended:**                     | Evaluate the SECM to confirm it captures the attributes and behaviors to meet the requirement. |
| **Comment:**                      | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Unconfirmed**                   |                                                        |

| **Element:**                      | **Phase:** Threat/Decoys : EW Decoys                  |
| **Technique:**                    | 2. Fct Design Sys Verif                               |
| **Task:**                         | Traceability Assessment                               |
| **Investigated in:**              | Trace Requirements into Design                        |
| **Status:**                       | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Intended:**                     | Trace Requirements into the design and into the SW code and the HW. |
| **Comment:**                      | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Unconfirmed**                   |                                                        |

| **Element:**                      | **Phase:** Threat/Decoys : EW Decoys                  |
| **Technique:**                    | 3. Results Validation                                |
| **Task:**                         | Traceability Assessment                               |
| **Investigated in:**              | Trace Requirements to Model Performance               |
| **Status:**                       | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Intended:**                     | Trace requirements from design and systems implementation to the output. |
| **Comment:**                      | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Unconfirmed**                   |                                                        |

| **Element:**                      | **Phase:** Threat/Decoys : EW Decoys                  |
| **Technique:**                    | 2. Fct Design Sys Verif                               |
| **Task:**                         | Functional Test                                       |
| **Investigated in:**              | Models/ Submodel Black Box Functionality              |
| **Status:**                       | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Intended:**                     | Black box testing, evaluating the accuracy of the output to input test data. |
| **Comment:**                      | Status 2/16/05 - Deferred to Builds 2/3.              |
| **Unconfirmed**                   |                                                        |
SUMMARY

- A Disciplined Approach
  - Defined Management, Technical Framework
  - Consistent with M&S Guidance
- A Developed, Working Database
  - Little Cost to Adapt to a New Program
- Experienced Personnel
  - Understand the Process and the Potential Pitfalls
- Process Proven on a Complex Program
  - The Database and System Guides the Development and the V&V of the Simulation
  - An Accepted Process by COTF (Accreditation Authority) and DOT&E
BACKUP SLIDES