



LPD 17 PRA Testbed VV&A Database: A Disciplined Approach for VV&A

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9 March, 2006**



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 (PRA) 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

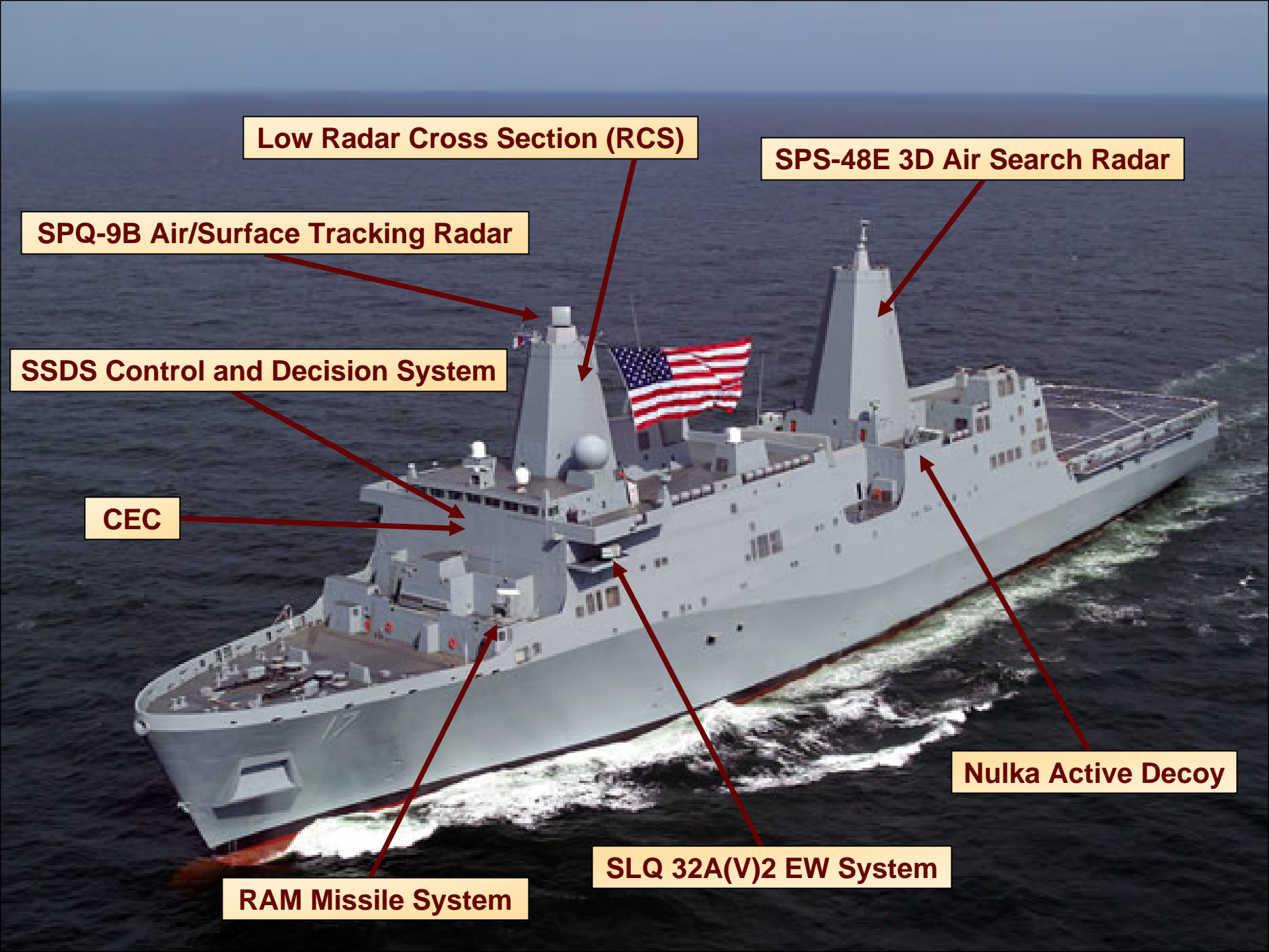
- An Example of Making VV&A Work
- **The Simulation**
 - LPD 17 San Antonio Ship Class
 - LPD 17 Combat System
 - PRA Requirement Definition
 - LPD 17 PRA Testbed Simulation
- **The Simulation Process**
 - Management, Technical Approach, Bound Problem Space, Defined Analysis Approach
- The VV&A Approach
- 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)

SPS-48E 3D Air Search Radar

SPQ-9B Air/Surface Tracking Radar

SSDS Control and Decision System

CEC

Nulka Active Decoy

RAM Missile System

SLQ 32A(V)2 EW System



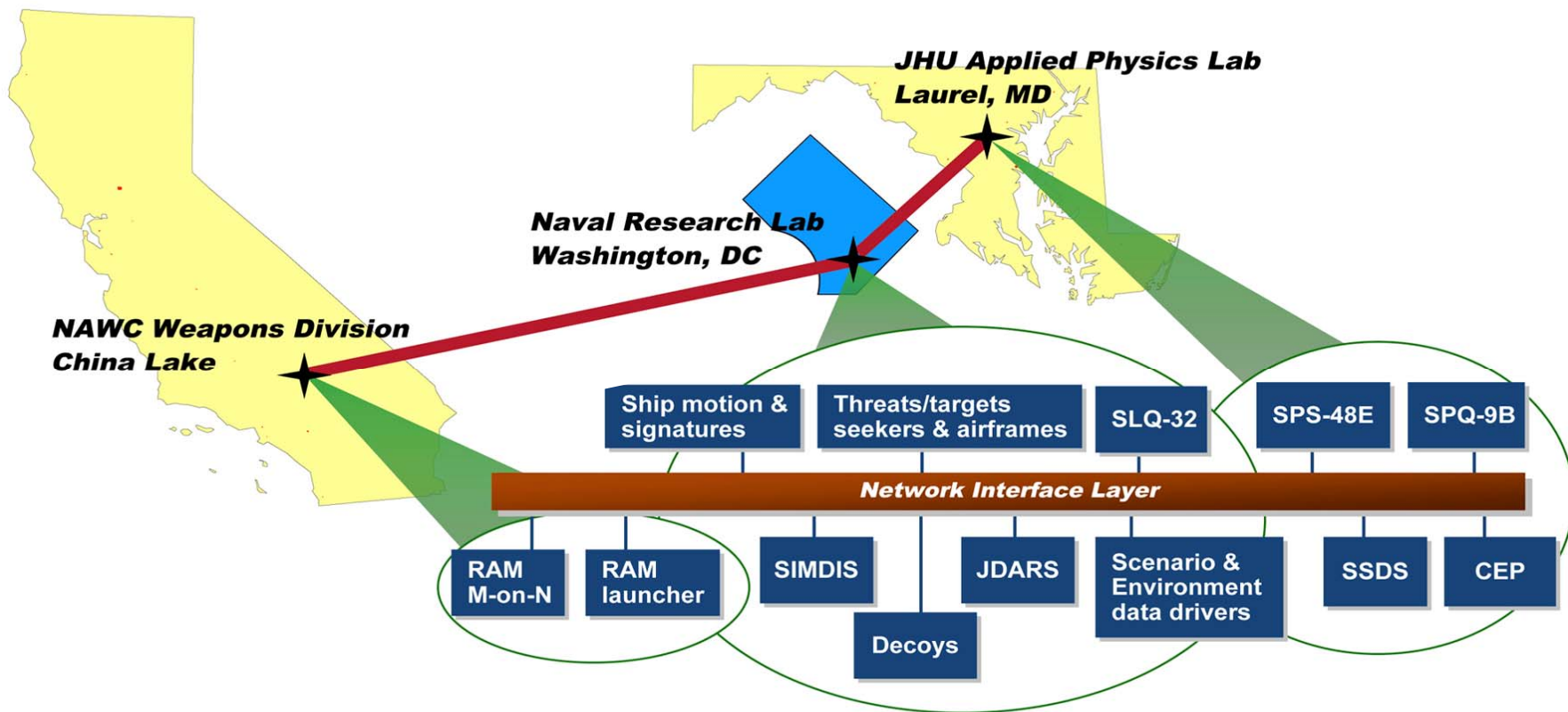
BACKGROUND – P_{RA}

OBJECTIVE: ASSESS LPD 17's P_{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_{RA} as the primary Measure of Effectiveness (MOE) to assess ship combat system suites.
- P_{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_{RA}.



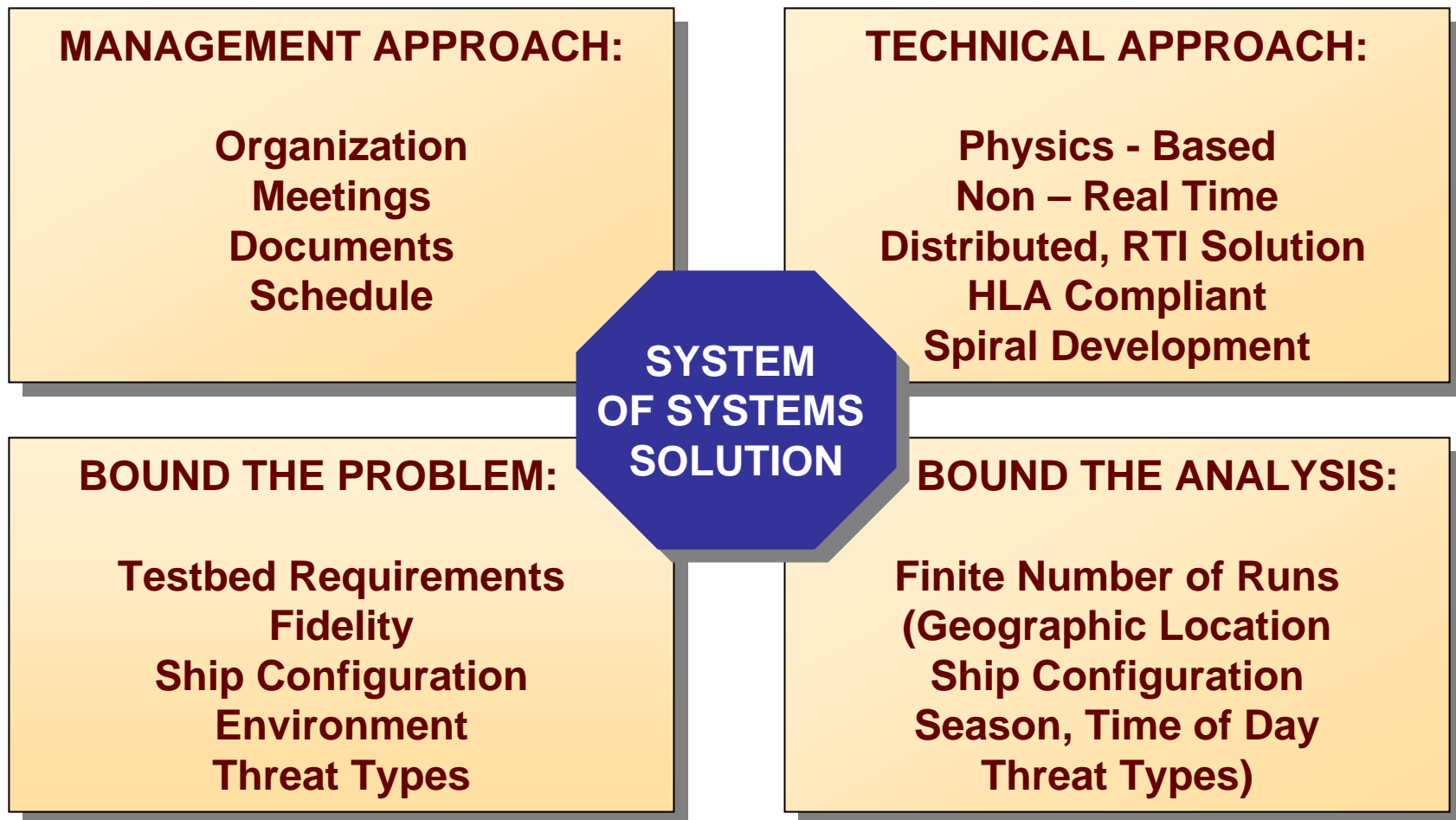
LPD 17 PRA TESTBED



**Geographically Distributed Federation of Tactical HWIL,
Tactical SWIL and Digital Physics Based Models**



LPD 17 P_{RA} TESTBED OVERVIEW





VV&A DATABASE OVERVIEW

- 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

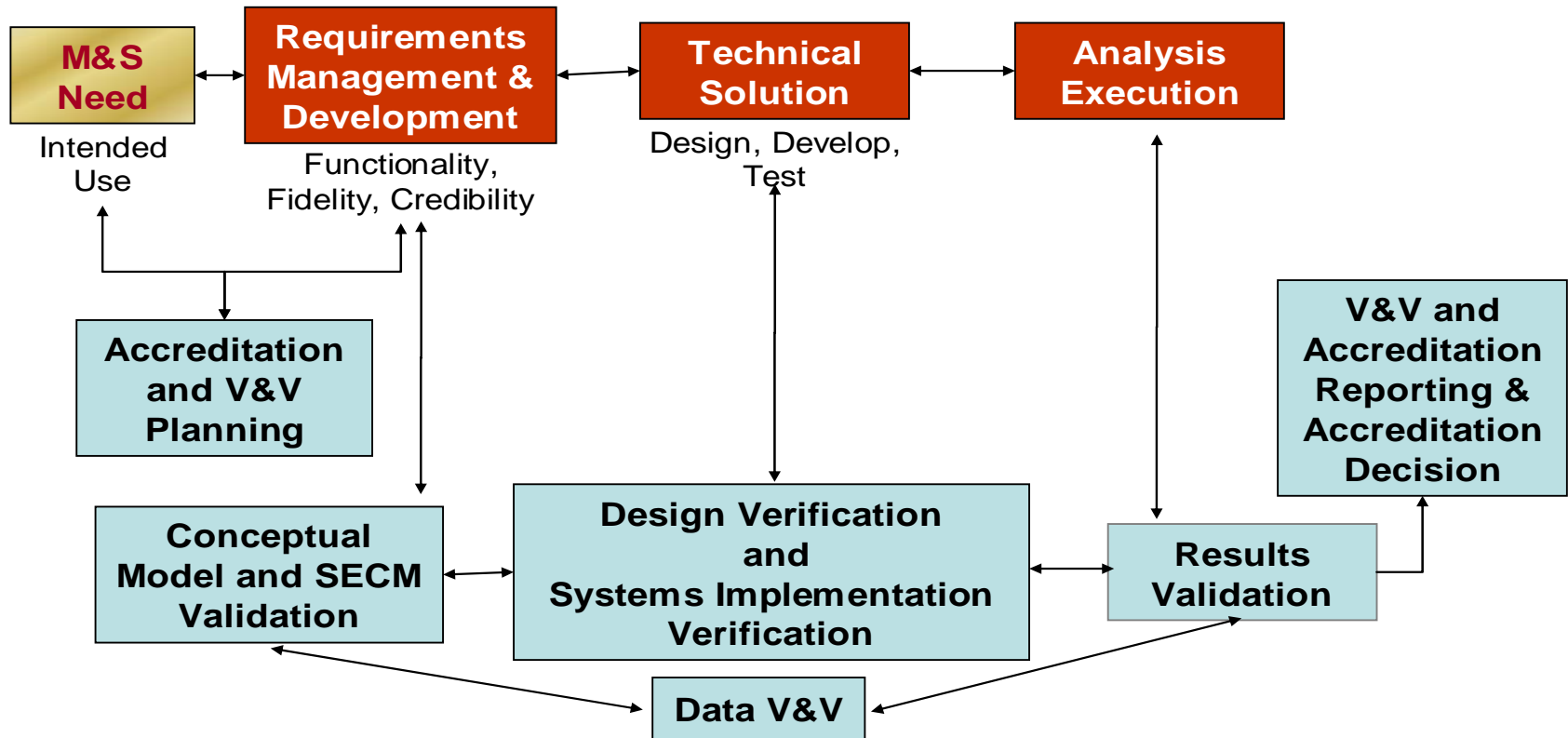


4 PHASES of V&V AND CHECKS

- **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

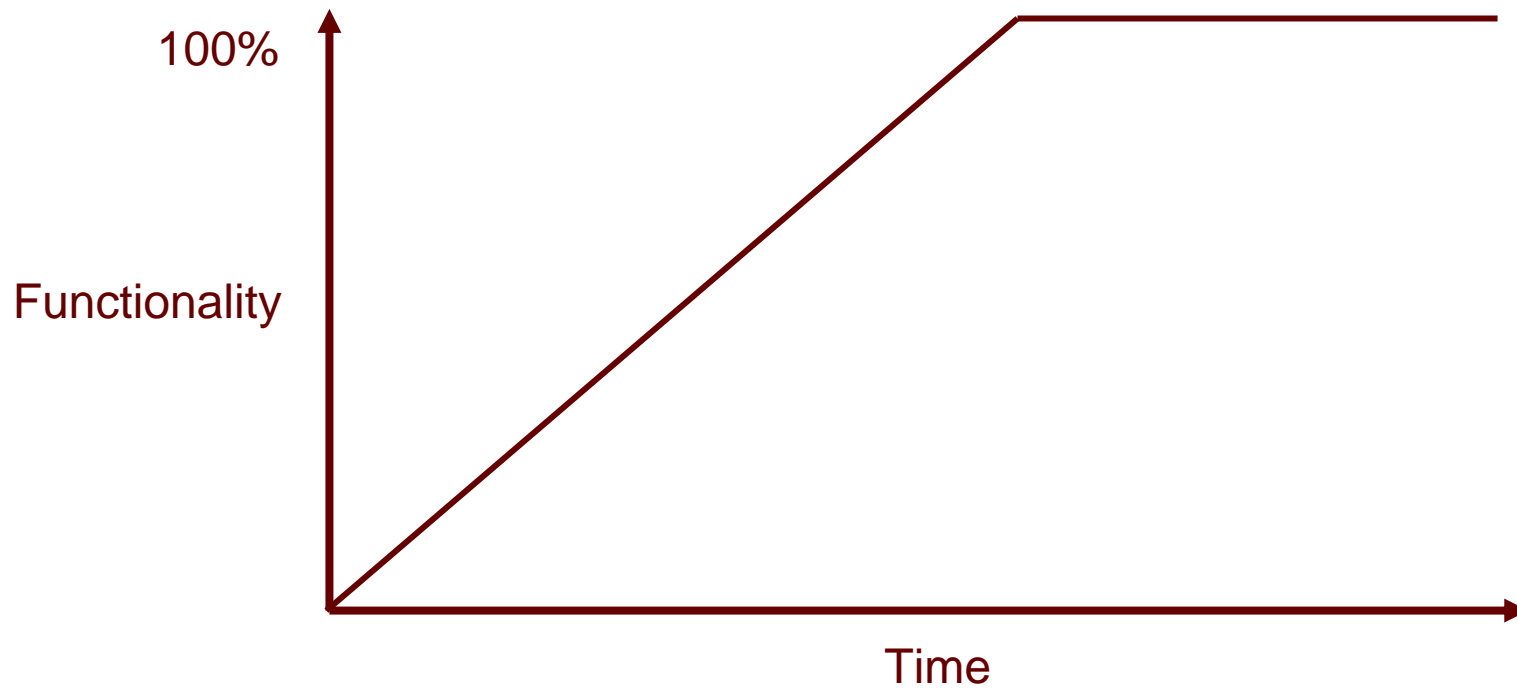


V&V AND MODEL DEVELOPMENT

- **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**



DEVELOPMENT TIMELINE





LPD 17 P_{RA} 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

VV&A

Integration

Test Planning

SIMULATION CONTROL PANELS (SCP)

Threat

Softkill

Radars

Natural Environment

Hardkill

CEC

Scenario

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

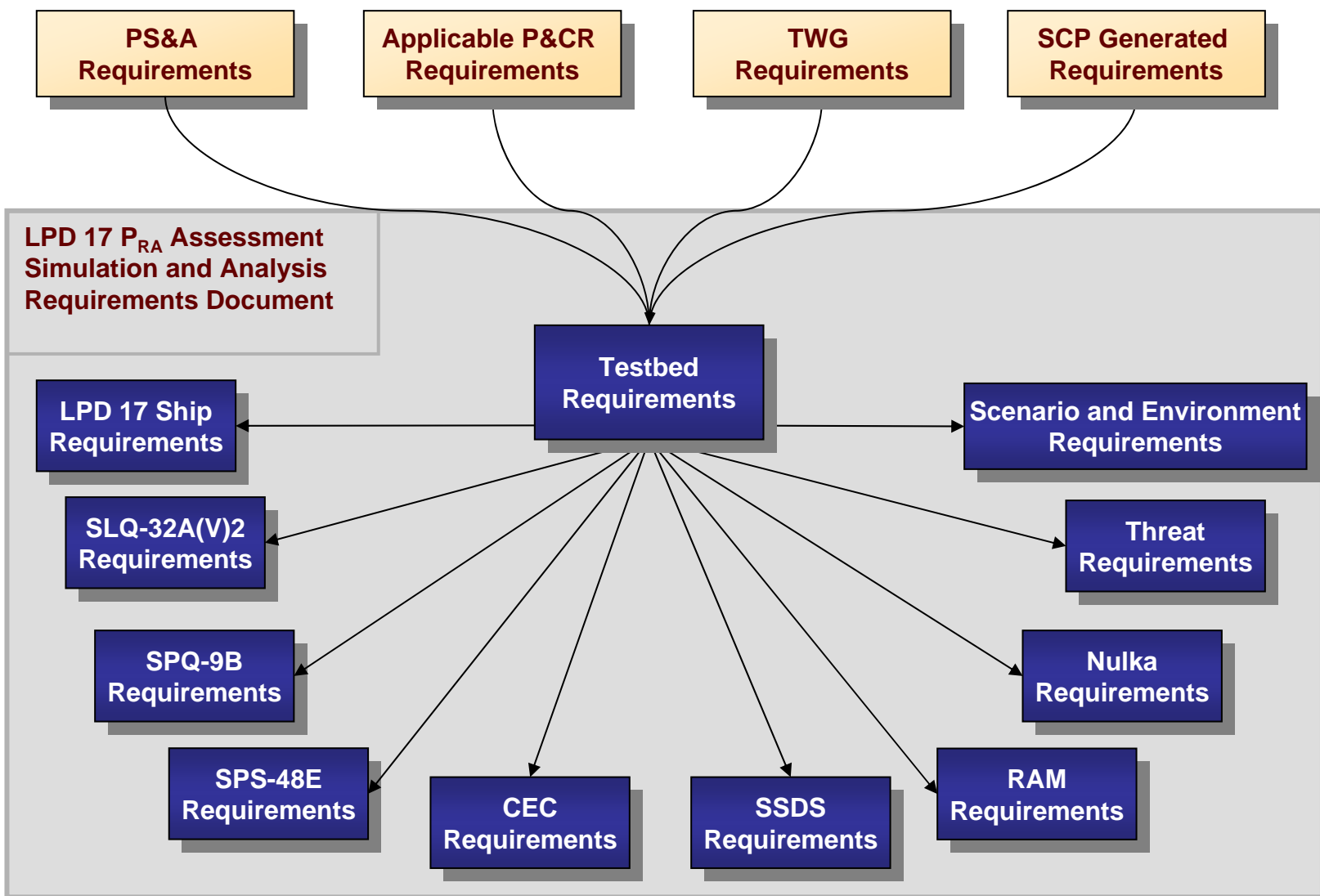


VV&A DATABASE OVERVIEW

- 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

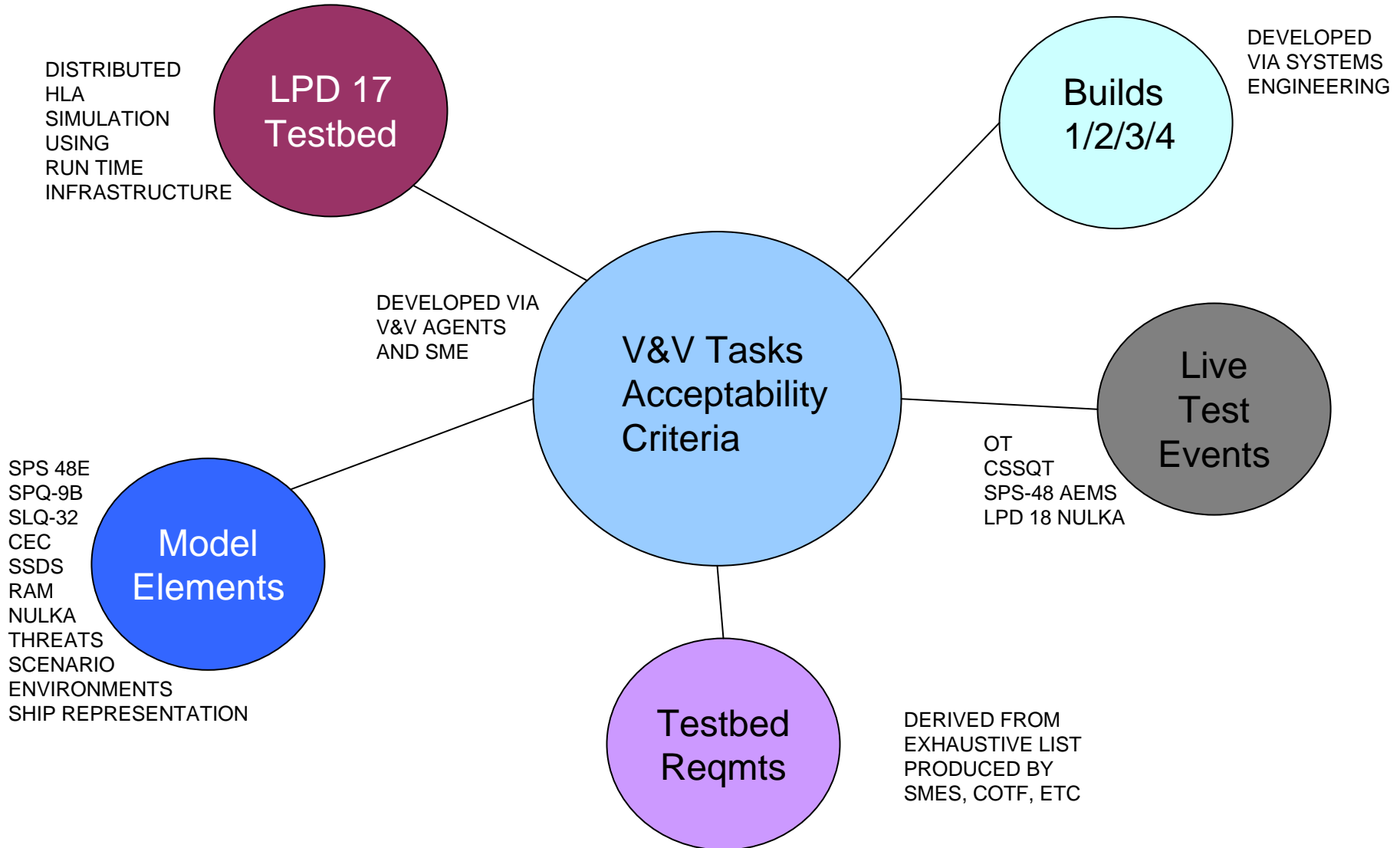


TESTBED REQUIREMENTS FLOW



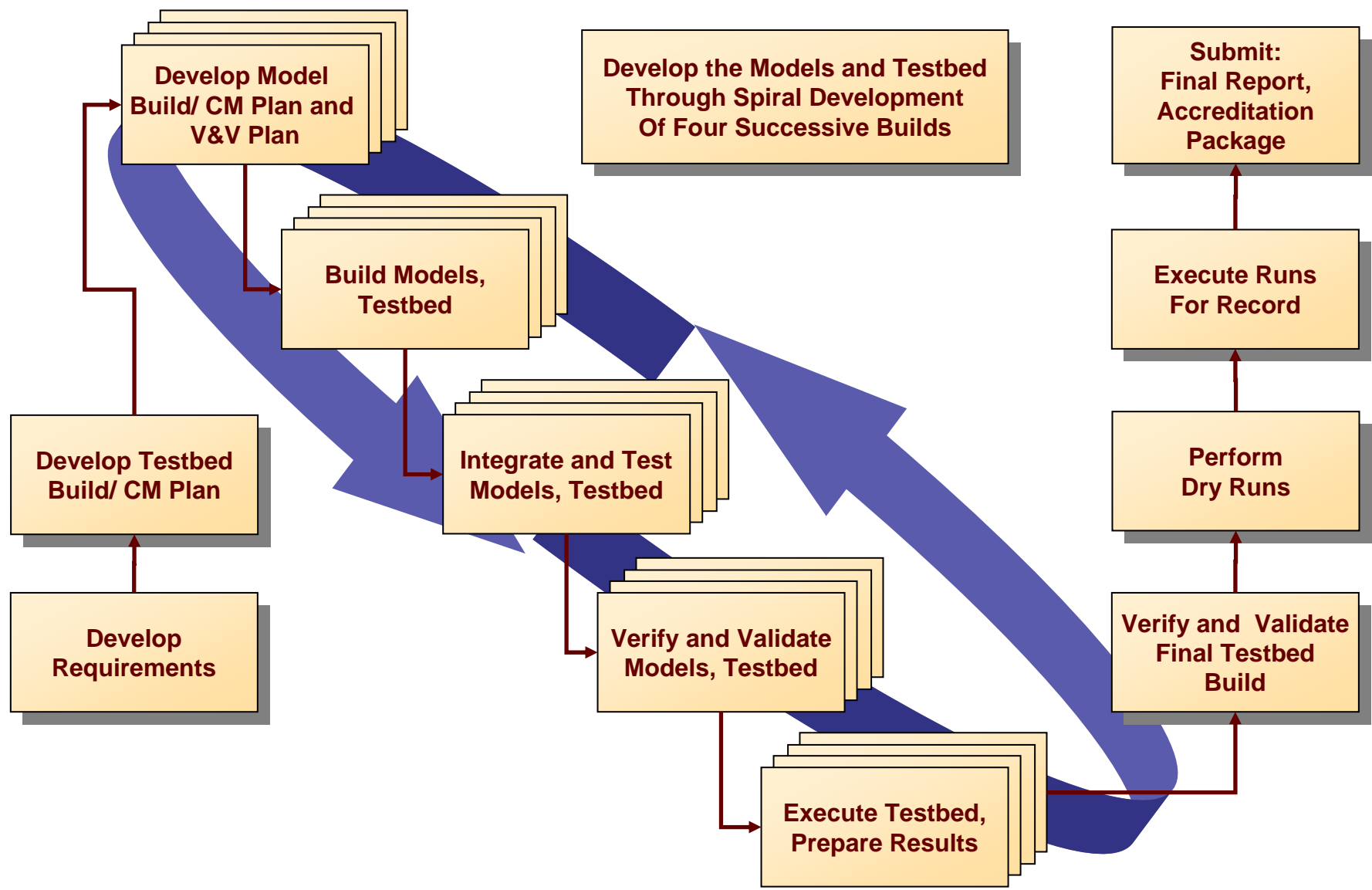


DATABASE: VV&A TASKS AND ACCEPTABILITY CRITERIA VIEW



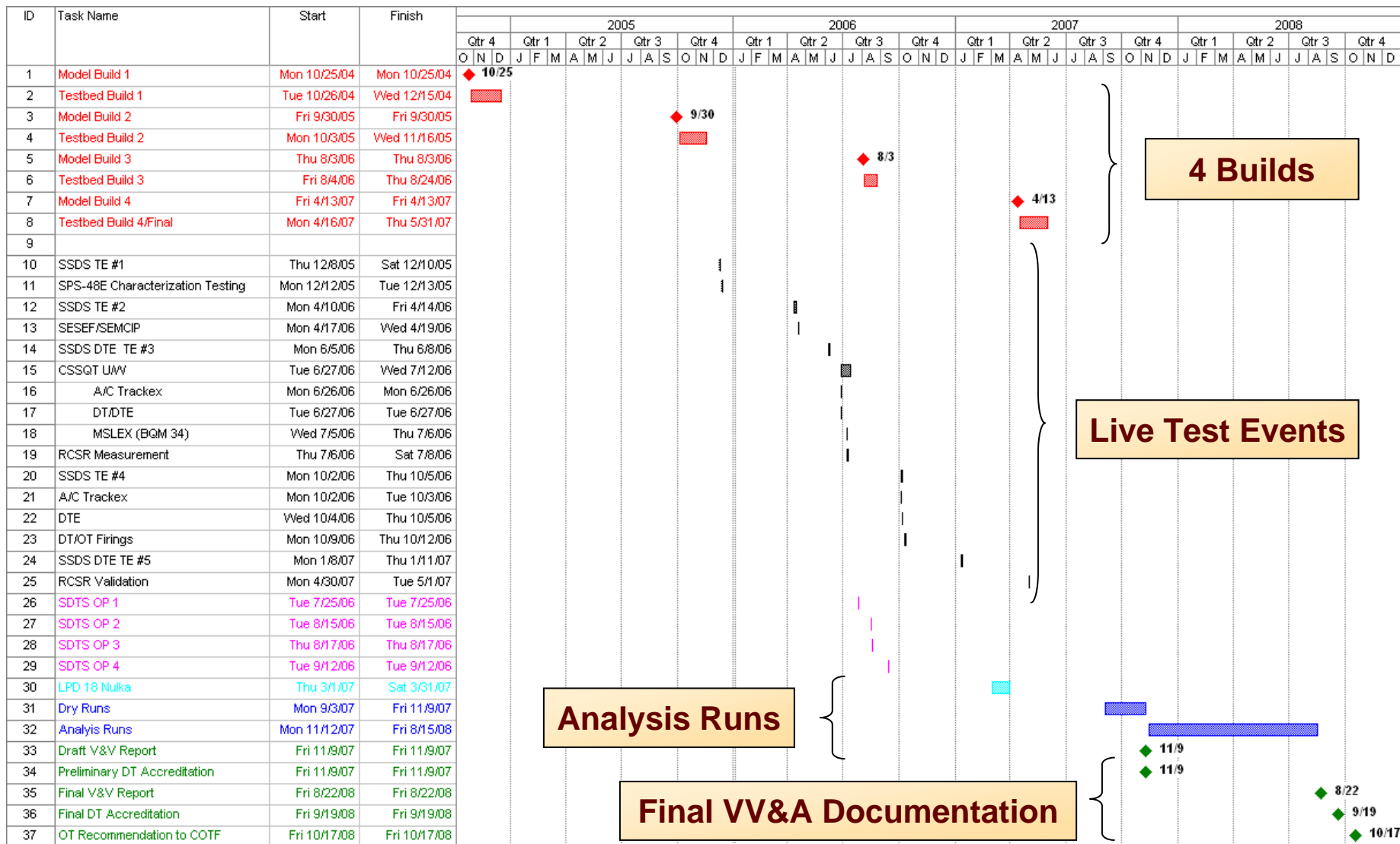


TESTBED SPIRAL DEVELOPMENT





TESTBED SCHEDULE





VV&A DATABASE OVERVIEW

- An Example of Making VV&A Work
- The Simulation
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- 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

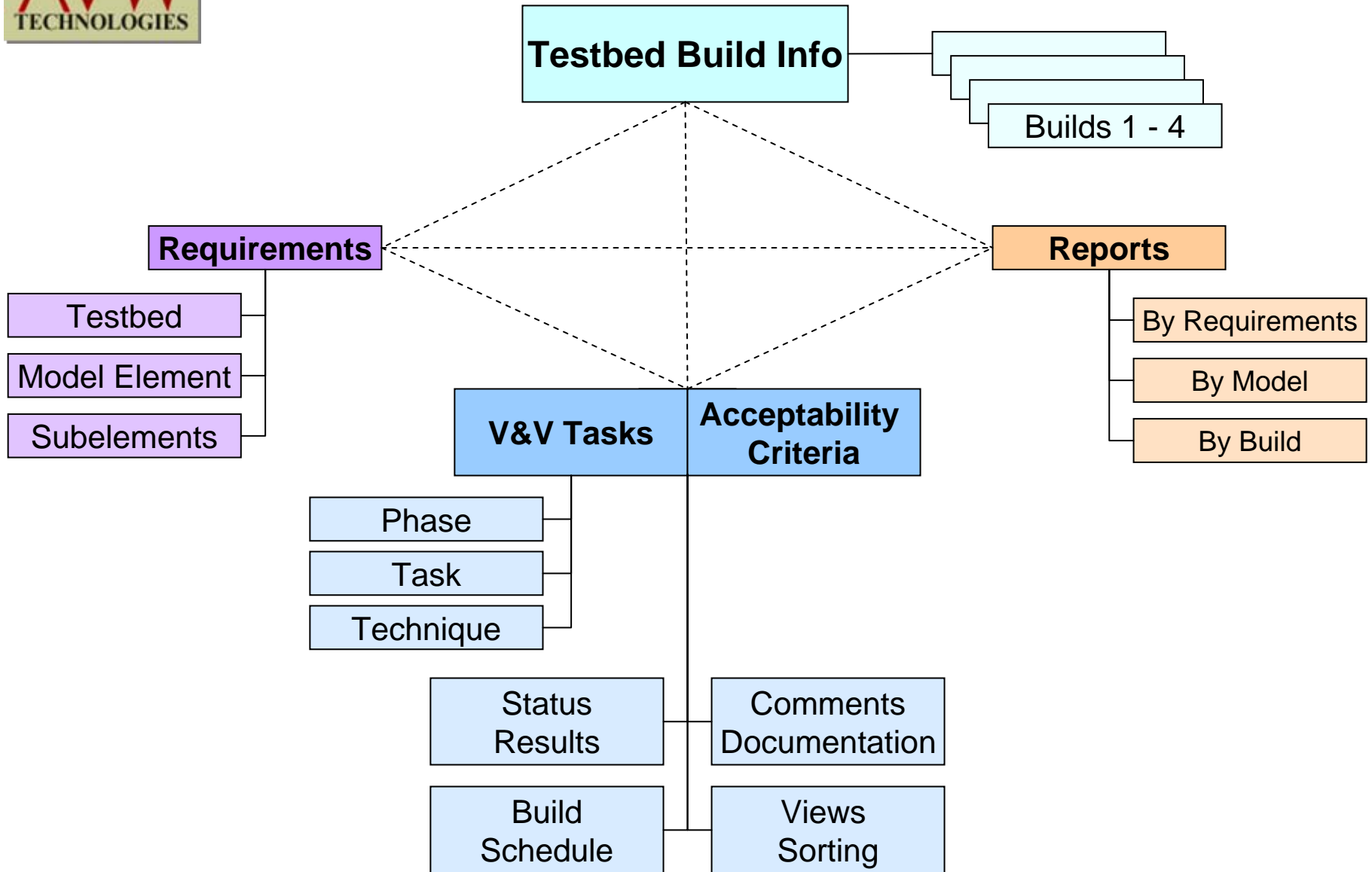


LPD 17 PRA VV&A DATABASE

- **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 ARCHITECTURE





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




DATABASE FRONT PAGE

LPD 17 PRA VV&A Database

File Edit View Insert Format Records Tools Window Help

Type a question for help

LPD 17 PRA VV&A Database : Form



LPD 17 Pra VV&A Database

Manage Elements

Add/Modify

Requirements Verification Checks Acct. Criteria

Launch Launch Launch

View Elements, Subelements, Requirements

Elements and Support Info Requirements and Support Info

Launch Launch

Manage Requirements

Requirements

VNV Top 5

Utilities

Link To Backend

IT Test

Reports

V and V, Acceptability Criteria Requirement to Element Relationships

By Requirements

Select Element Requirement Select Report Type

SLQ-32A(V)2 Requirement V and V Checks

Select Build Acceptability Criteria

Build 1 View Report

By Elements

Select Element Select Report Type

SLQ-32 V and V Checks

Select Build Acceptability Criteria

Build 1 View Report

Form View

NUM

Start Microsoft PowerPoint... 052705_LPD17_VV&... LPD 17 PRA VV&A...

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REQUIREMENTS SCREEN

LPD 17 PRA VV&A Database - [comFormReq : Form]

File Edit View Insert Format Records Tools Window Help

Type a question for help

Elements, Subelements and Associated Re

- SLQ-32
 - SLQ-32 14
 - SLQ-32 15.1
 - SLQ-32 19
 - SLQ-32 21.2
 - SLQ-32 29
 - SLQ-32 30
 - SLQ-32 31.1
 - SLQ-32 31.2
 - SLQ-32 31.3
 - SLQ-32 31.4
 - SLQ-32 1.5
 - SLQ-32 6
 - SLQ-32 8
 - Background RF Emitter Generator
 - RF Subelement
 - RTI Converter
 - HWIL Subelement
 - SLQ-32 15.8
 - SLQ-32 16
 - SLQ-32 20.1
 - The SLQ-32A(V)2 representation shall support sensor and weapon coverage selectable within the limits defined in Table 6.1-1
 - SLQ-32 22.1
 - SLQ-32 1.2
 - SLQ-32 3.2
 - ESE Pulse/GP Processor
 - MK-53 Decoy Launching System

Requirement ID

Requirements

- SEF Requirements
- CEC Requirements
- SSDS Requirements
- SPQ-9B Requirements
- SPS-48E Requirements
- RAM Requirements
- SLQ-32A(V)2 Requirements
- Decoy Requirements
- Threat Requirements
- Testbed Requirements

Requirement Description

Add Association

Delete Association

Form View

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NUM

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V&V CHECK SCREEN

LPD 17 PRA VV&A Database - [comFormGroup : Form]

File Edit View Insert Format Records Tools Window Help

Type a question for help

Elements, Subelements and Associated Requirements

- SSDS
- SLQ-32
 - SLQ-32 14
 - SLQ-32 15.1
 - SLQ-32 19
 - SLQ-32 21.2
 - SLQ-32 29
 - SLQ-32 30
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 - Background RF Emitter Generator
 - RF Subelement
 - RTI Converter
 - HWIL Subelement
 - SLQ-32 15.8
 - SLQ-32 16
 - SLQ-32 20.1

The SLQ-32A(V)2 representation shall support sensor and weapon coverage sel

- 1. SECM/CM Validate ~ Traceability Assessment ~ Trace Requirements to
- 1. SECM/CM Validate ~ Review ~ Conceptual Model Validation
- 1. SECM/CM Validate ~ Review ~ SECM Validation
- 2. Fct Design Sys Verif ~ Traceability Assessment ~ Trace Requirements in

Phases:
1. SECM/CM Validate
2. Fct Design Sys Verif
3. Data V&V
4. Results Validation

Technique:
Review
Hardware Verification

Task:
Algorithms and Structure
Algorithms and Structure Control Flow
Data Input and Transformation
Evaluate Algorithms and Internal Structure
Functionality and Input/Output
Hardwired Data Algorithms and Structure
HW Architectural Design
Interface

Comments:

Functional Design Elements in Group:

Requirement Group

Is In Group: Y

Current Groups:

Flag With Issue: 1 2 3 4

New Group Add to Group Delete from Group Save Build Info Refresh Tree



ACCEPTABILITY CRITERIA SCREEN

LPD 17 PRA VV&A Database - [comFormAccCrit : Form]

File Edit View Insert Format Records Tools Window Help

Type a question for help

Elements, Subelements and Associated Requirements - with Associated Verification Checks and Acceptability Criteria

- SLQ-32 6
- SLQ-32 8
- Background RF Emitter Generator
- RF Subelement
- RTI Converter
- HWIL Subelement
 - HWIL Subelement Acceptability Criteria
 - SLQ-32 15.8
 - SLQ-32 16
 - SLQ-32 20.1
 - The SLQ-32A(V)2 representation shall support sensor and weapon coverage selectable within the limits defined in Table 6.1-1 of the P&CR.
 - SLQ-32 20.1 Verification Checks
 - 1. SECM/CM Validate ~ Traceability Assessment ~ Trace Requirements to Elements
 - 1. SECM/CM Validate ~ Review ~ Conceptual Model Validation
 - 1. SECM/CM Validate ~ Review ~ SECM Validation
 - 2. Fct Design Sys Verif ~ Traceability Assessment ~ Trace Requirements into Design
 - SLQ-32 20.1 Acceptability Criteria
 - 1. The SLQ-32 federate shall have the same sensor coverage limits as the SLQ-32: A. Azimuth - 360 degrees B. Elevation - classified C. Maneuverability - classified
 - SLQ-32 22.1
 - SLQ-32 1.2

SLQ-32 20.1 Acceptability Criteria 1

The SLQ-32 federate shall have the same sensor coverage limits as the SLQ-32: A. Azimuth - 360 degrees B. Elevation - classified C. Maneuverability - classified D. Track capacity - classified

Comments:

This is a repeat from the RF subelement. It may need to be deleted from here.

Build Info 1 2 3 4 Modify Verification Check Modify Acceptability Criteria Utility

Investigated: Update

Functionality: Update

Toggle Check Edit Comment

Delete Check New Line

Add Criteria

Accept Cancel

Toggle Criteria Delete Criteria

Edit Criteria New Line

Edit Comment New Line

Form View

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DATABASE FRONT PAGE

LPD 17 PRA VV&A Database

File Edit View Insert Format Records Tools Window Help

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LPD 17 Pra VV&A Database

Manage Elements

Add/Modify

Requirements Verification Checks Acct. Criteria

Launch Launch Launch

View Elements, Subelements, Requirements

Elements and Support Info Requirements and Support Info

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Reports

V and V, Acceptability Criteria Requirement to Element Relationships

By Requirements

Select Element Requirement Select Report Type

SLQ-32A(V)2 Requirement V and V Checks

Select Build Acceptability Criteria

Build 1 View Report

By Elements

Select Element Select Report Type

SLQ-32 V and V Checks

Select Build Acceptability Criteria

Build 1 View Report

Form View

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ACCEPTABILITY CRITERIA REPORT

LPD 17 PRA VV&A Database - [v2reqAccCritDetails : Report]

File Edit View Tools Window Help

Type a question for help

Close Setup

Build 3

LPD 17 PRA - VVA Database



Acceptability Criteria: 0(0%) of 119 SLQ-32A(V)2 Requirements Acceptability Criteria met.
 SLQ-32A(V)2 Requirements: 0(0%) of 79 SLQ-32A(V)2 Requirements meet Acceptability Criteria.

SLQ-32 1.2 Expected Functionality: Build 1 Build 2 Build 3 Build 4 Investigated In: Build 1 Build 2 Build 3 Build 4
 The representation shall be capable of incorporating Sea State 3 dependent ship motion.

Requirement Acceptability Criteria: All Criteria for this requirement have not been confirmed. Investigated In: Build 1: Build 2: Build 3: Build 4:

Unconfirmed 1. Verify that the SLQ-32 federator shall use the ship motion and heading as an input to the ESE via the ships cyclone, and that this input is used in the computation of the SLQ-32 performance.
 Comment: Kevin, how is the ship motion input used by the ESE?

Unconfirmed 1. Verify that the SLQ-32 federator shall use the ship motion and heading as an input to the WSC-6 EMI model, and then access the backup table to assess the degradability of the WSC-6 EMI to the SLQ-32 performance.
 Comment: Kevin, I am using the ship motion requirements to look at the EMI model.

SLQ-32 1.5 Expected Functionality: Build 1 Build 2 Build 3 Build 4 Investigated In: Build 1 Build 2 Build 3 Build 4
 The representation shall be capable of Chaff/NULKA Impactor ES capability.

Requirement Acceptability Criteria: All Criteria for this requirement have not been confirmed. Investigated In: Build 1: Build 2: Build 3: Build 4:

Unconfirmed 2. Verify that the NULKA mode 1 affects the SLQ-32 mode 1 in the same manner as the NULKA affects the SLQ-32 in the actual outcome as using the LPD 18 NULKA setting - A. Comparing the NULKA signal that is received by the IFM and DF receiver to the SLQ-32 mode 1. B. Comparing the NULKA signal that is processed by the ES processor to the SLQ-32 mode 1.
 Comment: Kevin, do you agree with this acceptability criteria?

SLQ-32 2 Expected Functionality: Build 1 Build 2 Build 3 Build 4 Investigated In: Build 1 Build 2 Build 3 Build 4
 All output provided by the representation shall be in a format suitable to reconstruct the run including simulation version number and input file parameters.

Requirement Acceptability Criteria: All Criteria for this requirement have not been confirmed. Investigated In: Build 1: Build 2: Build 3: Build 4:

Unconfirmed 1. Verify that the SLQ-32 federator outputs shall be in a format suitable to reconstruct the run to include: A. Scenario files for the background emitters. B. DX from the ESE. C. SLQ-32 SDS data collected using HLA Results. E. Version number and input file parameters.

Page: 1

Ready

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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.

Decoy 1.1

Expected Functionality: Build 1: [P] Build 2: [P] Build 3: [F] Build 4: []

Investigated in: Build 1: [] Build 2: [X] Build 3: [X] Build 4: []

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

Decoy 1.1 Requirement V&V Checks

All checks for this Requirement have not been confirmed.

	Element:	Phase:	Technique:	Task:	Investigated In:			
					Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	Threat/Decoys : EW Decoys	1. SECMCM Validate	Traceability Assessment	Trace Requirements to Elements	[]	[X]	[X]	[]
Intent:	Trace Requirements to the Elements and Subelements.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	1. SECMCM Validate	Review	Conceptual Model Validation	[]	[X]	[X]	[]
Intent:	Evaluate the conceptual model to confirm it captures the attributes and behaviors to meet the requirements.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	1. SECMCM Validate	Review	SECM Validation	[]	[X]	[X]	[]
Intent:	Evaluate the SECM to confirm it captures the attributes and behaviors to meet the requirements.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	2. Fct Design Sys Verif	Traceability Assessment	Trace Requirements into Design	[]	[X]	[X]	[]
Intent:	Trace Requirements into the design and into the SW code and the HW.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	4. Results Validation	Traceability Assessment	Trace Requirements to Model Performance	[]	[X]	[X]	[]
Intent:	Trace requirements from design and systems implementation to the output.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							
Unconfirmed	Threat/Decoys : EW Decoys	2. Fct Design Sys Verif	Functional Test	Model/ Submodel Black Box Functionality	[]	[X]	[X]	[]
Intent:	Black box testing. evaluating the accuracy of the output to input test data.							
Comment:	Status 2/16/05 - Deferred to Builds 2/3.							



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