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

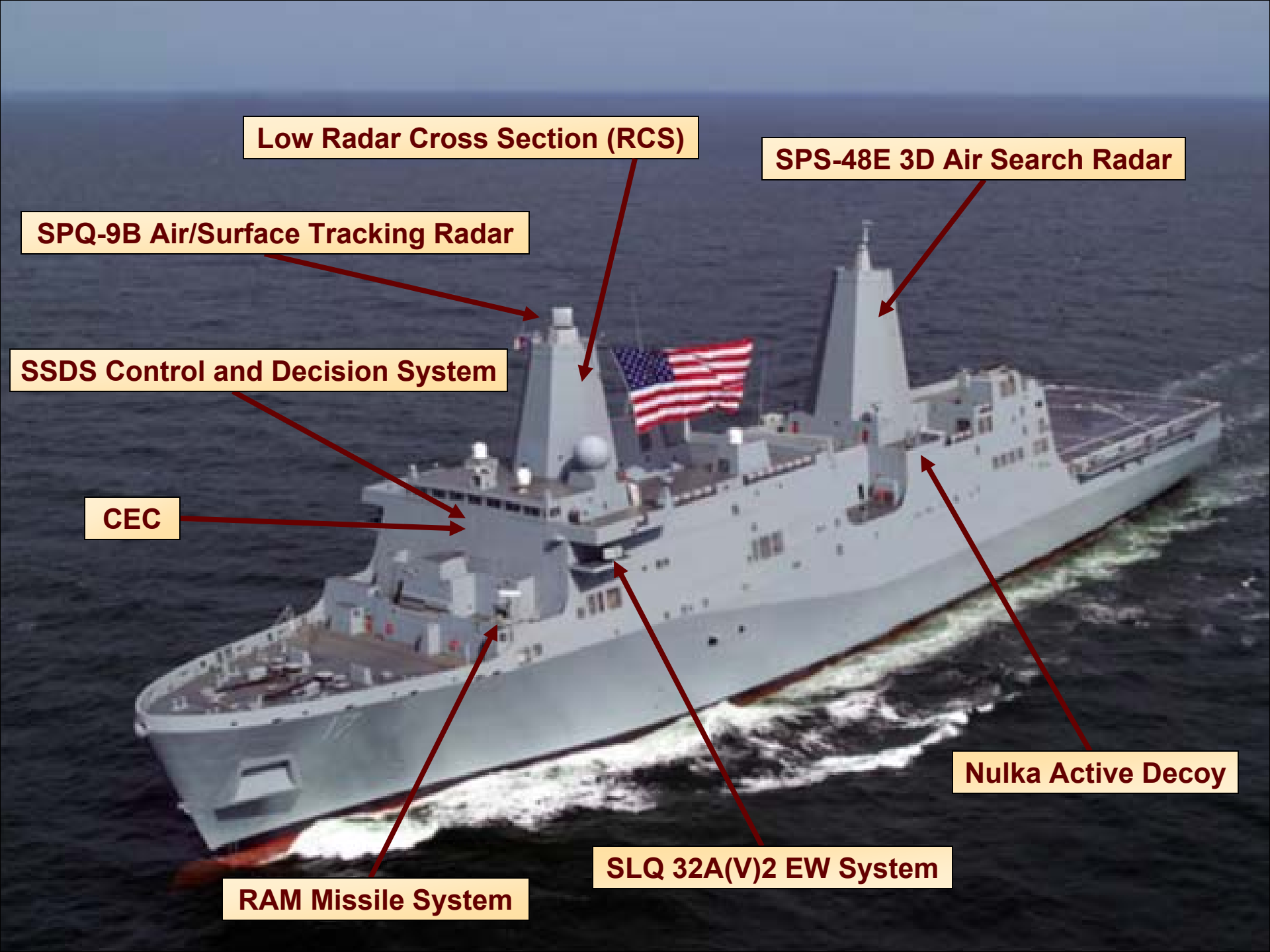
VV&A DATABASE OVERVIEW

- 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

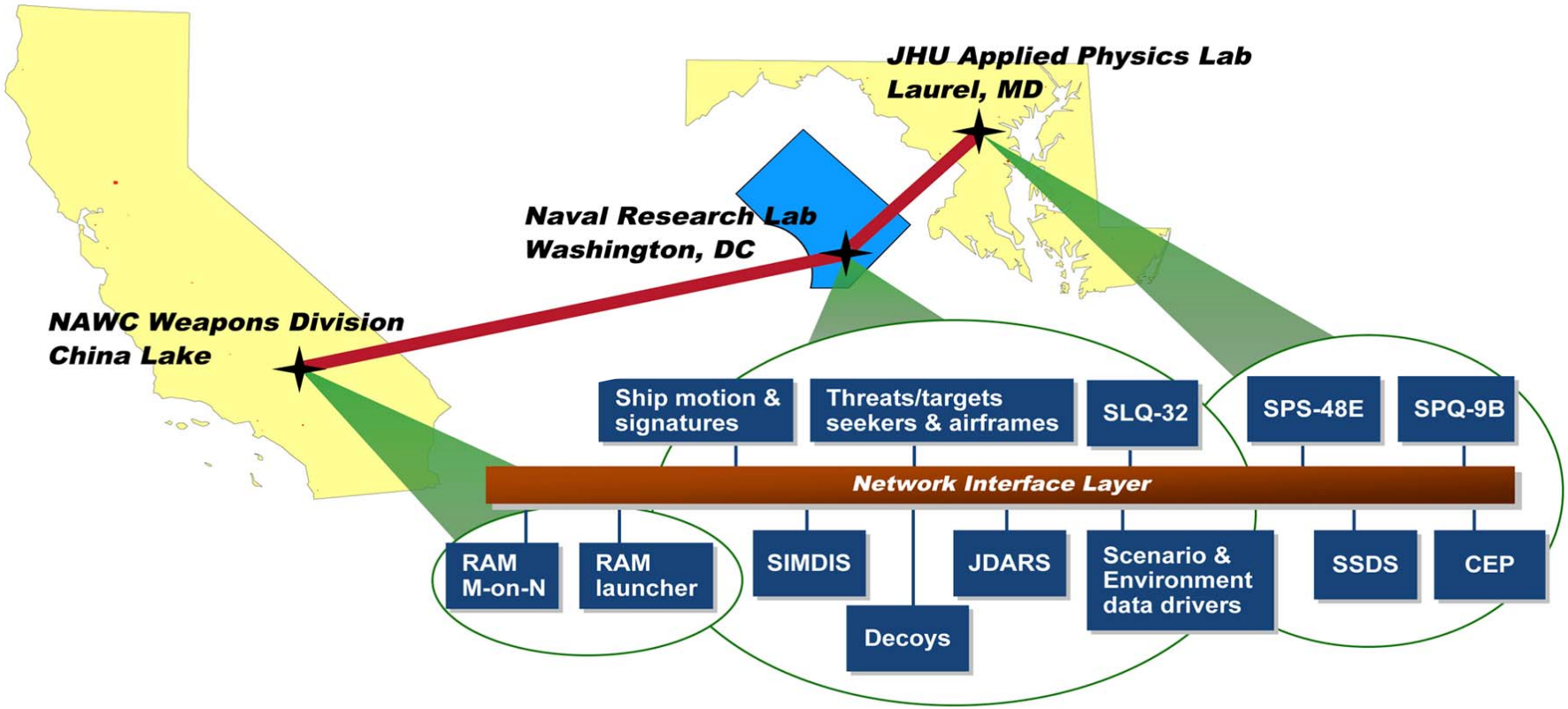

Low Radar Cross Section (RCS)
SPS-48E 3D Air Search Radar
SPQ-9B Air/Surface Tracking Radar
SSDS Control and Decision System
CEC
Nulka Active Decoy
SLQ 32A(V)2 EW System
RAM Missile System

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



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

LPD 17 PRA TESTBED OVERVIEW

MANAGEMENT APPROACH:

Organization
Meetings
Documents
Schedule

TECHNICAL APPROACH:

Physics - Based
Non – Real Time
Distributed, RTI Solution
HLA Compliant
Spiral Development

SYSTEM OF SYSTEMS SOLUTION

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)

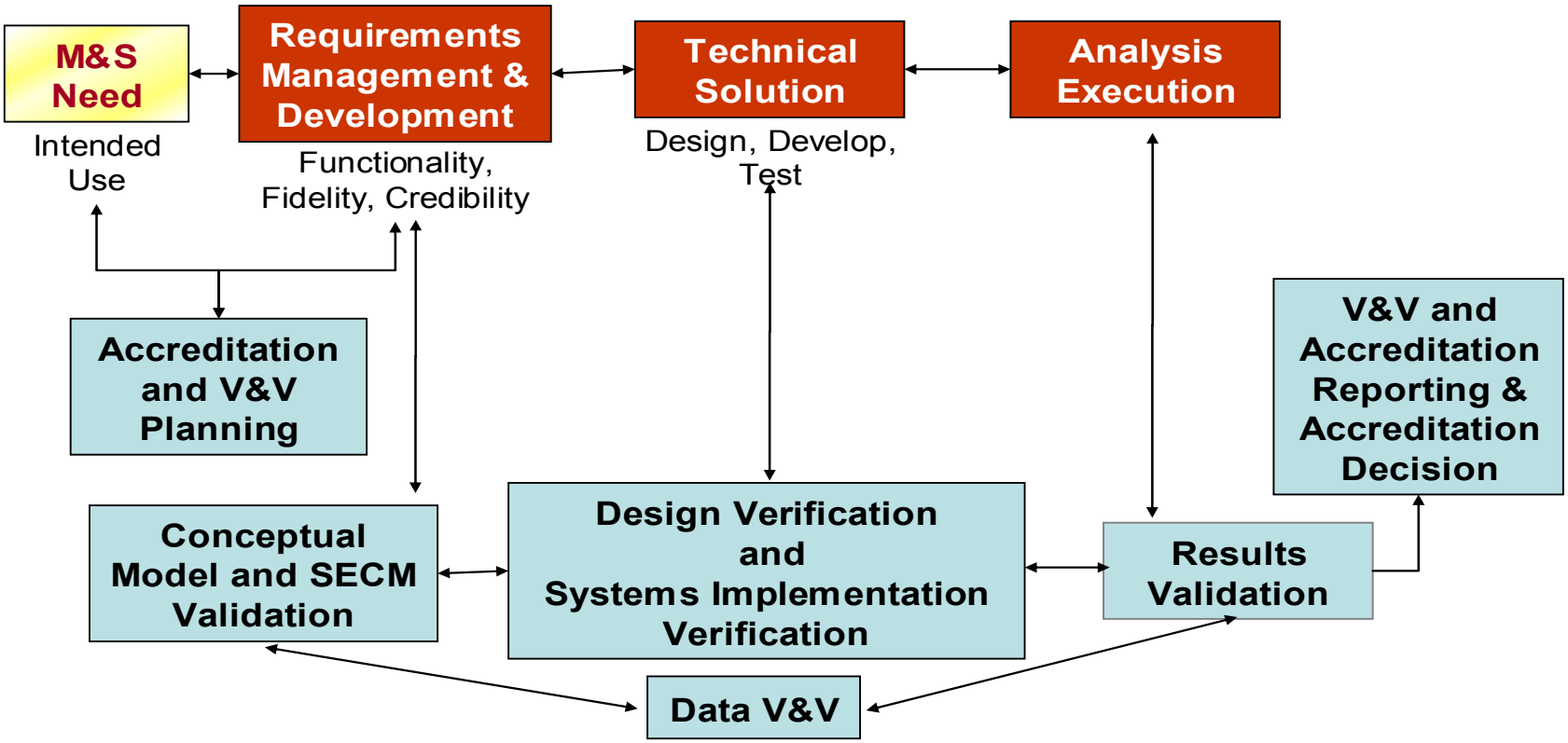
VV&A DATABASE OVERVIEW

- 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

AVW TECHNOLOGIES

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

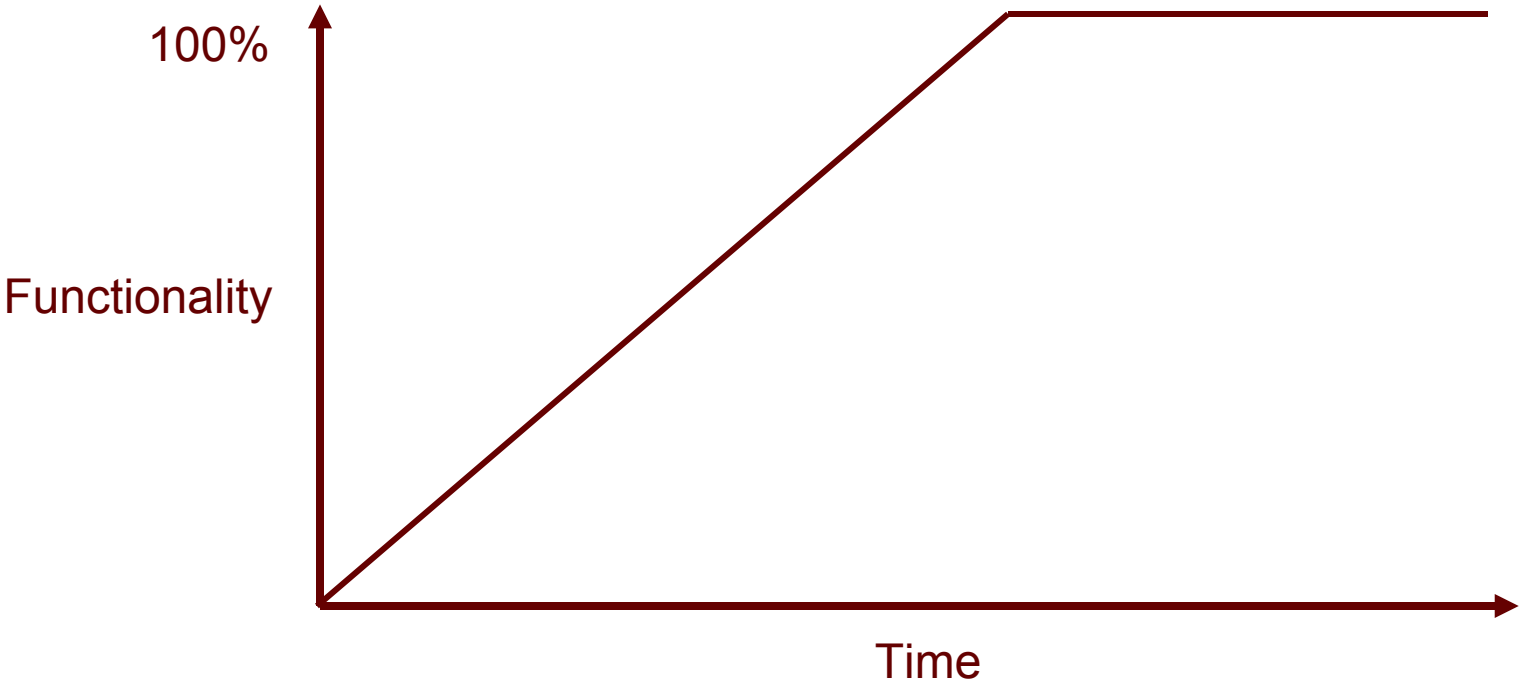
LEVERAGE PREVIOUS VV&A

- 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

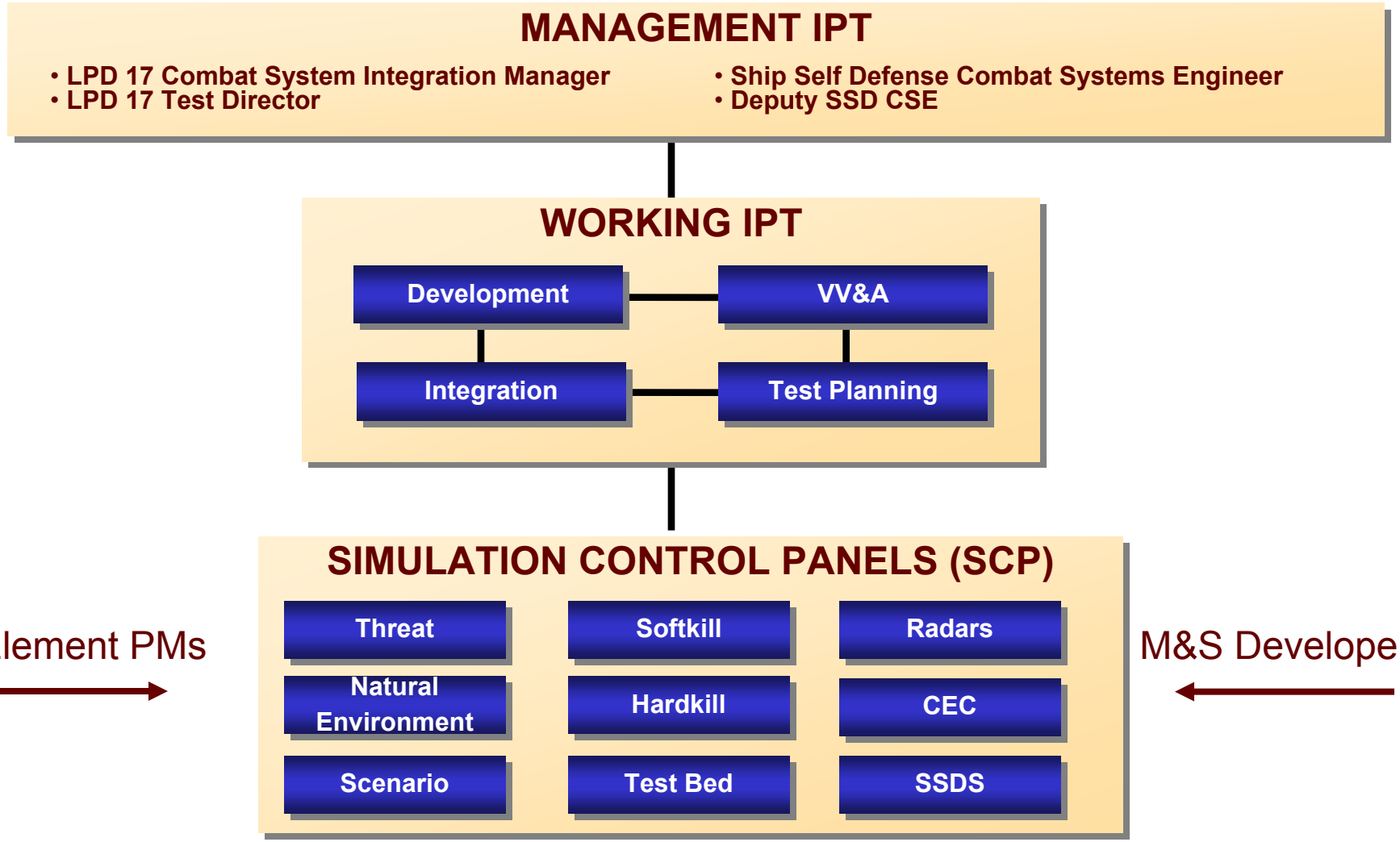
V&V AND MODEL DEVELOPMENT

- 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



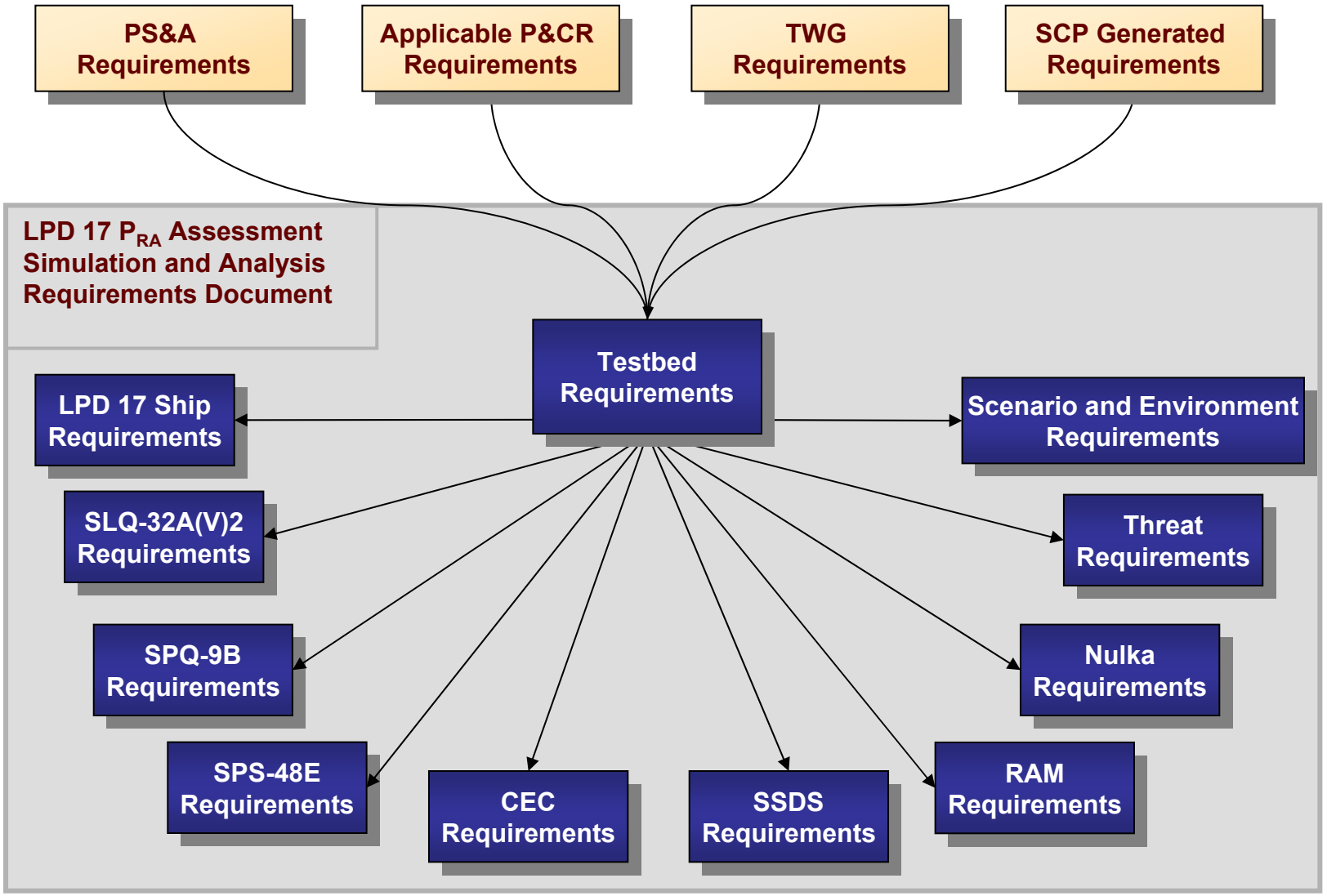
VV&A ORGANIZATION

- 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

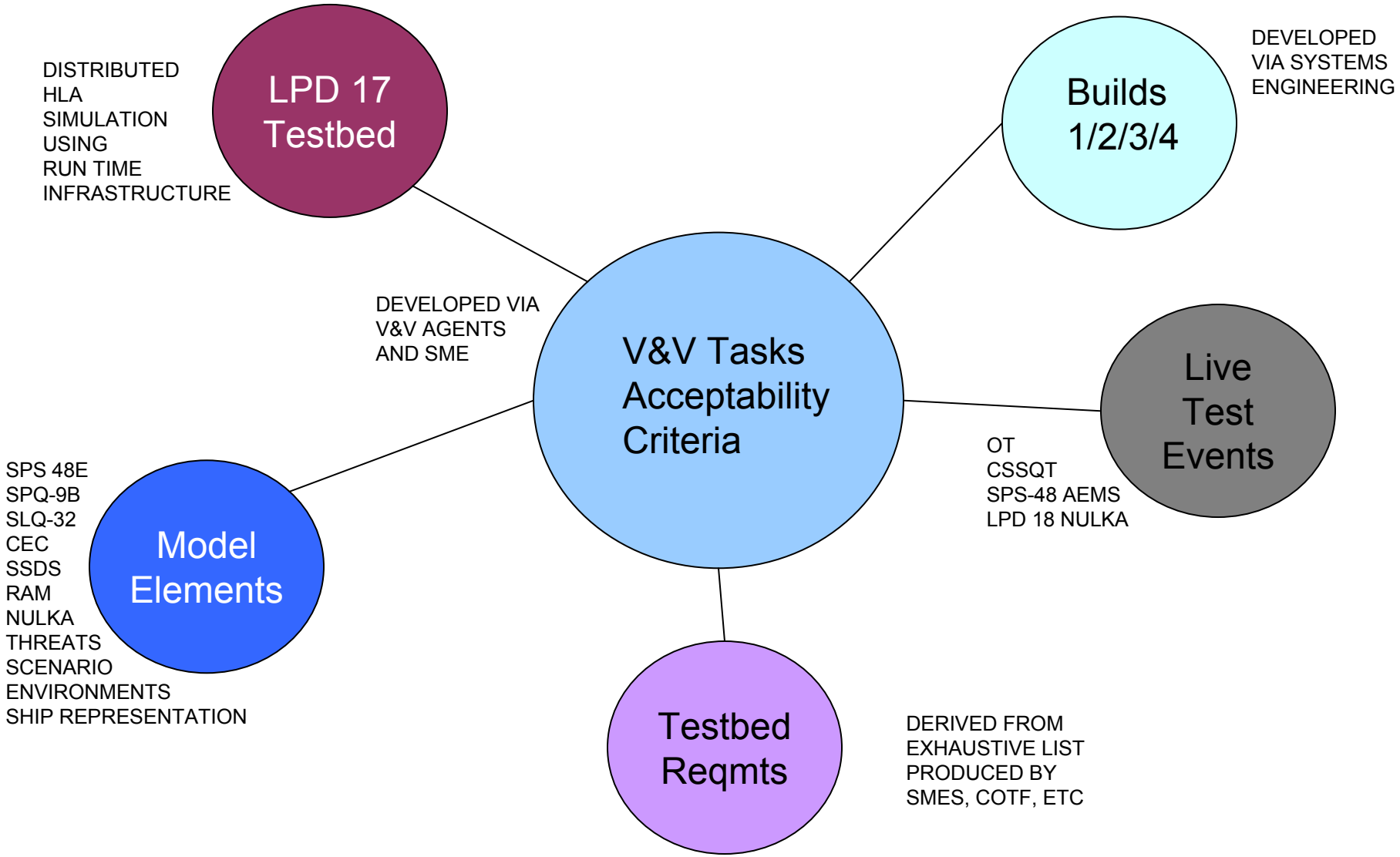
VV&A DATABASE OVERVIEW

- 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

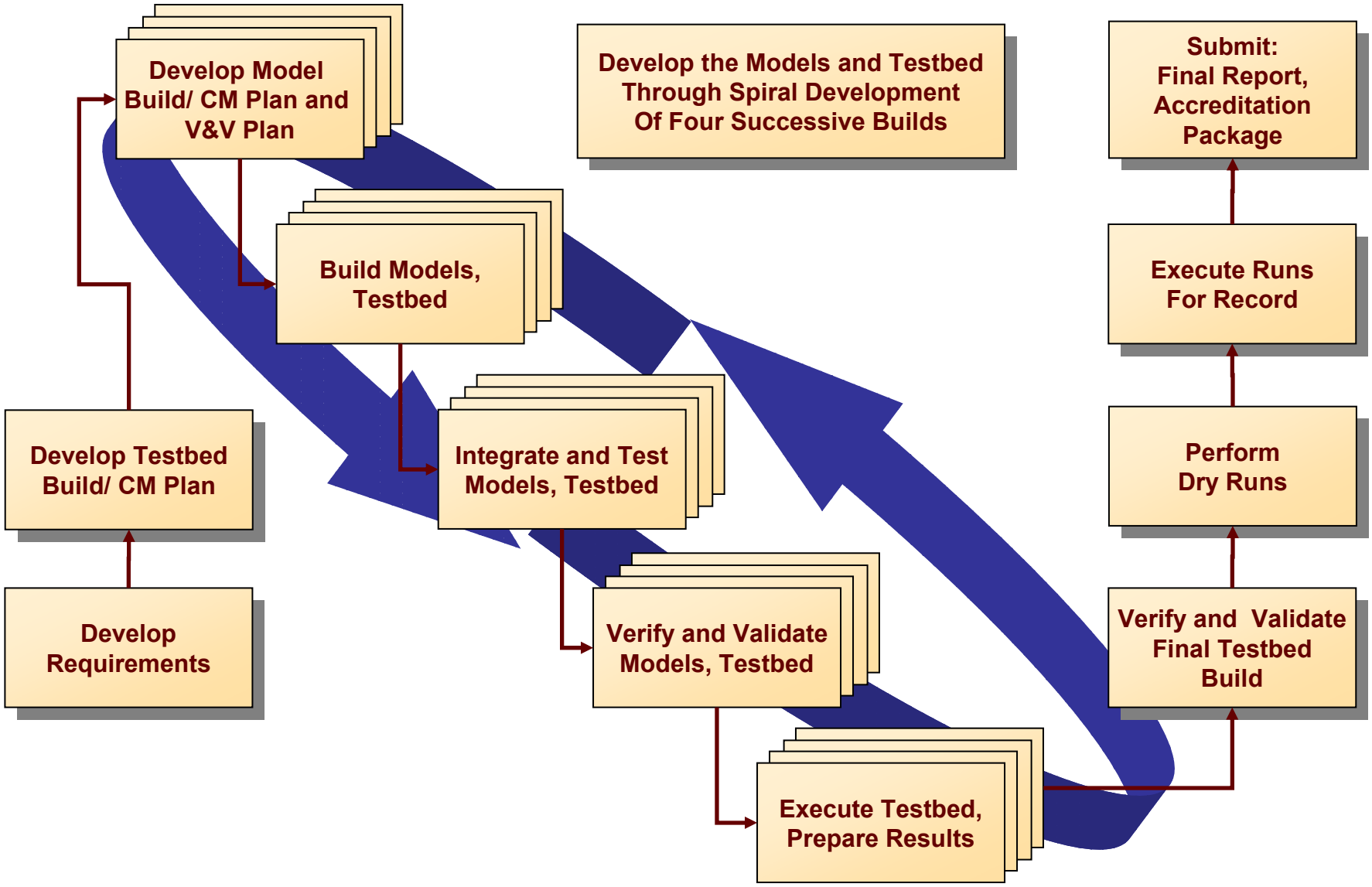
TESTBED REQUIREMENTS FLOW



DATABASE: VV&A TASKS AND ACCEPTABILITY CRITERIA VIEW

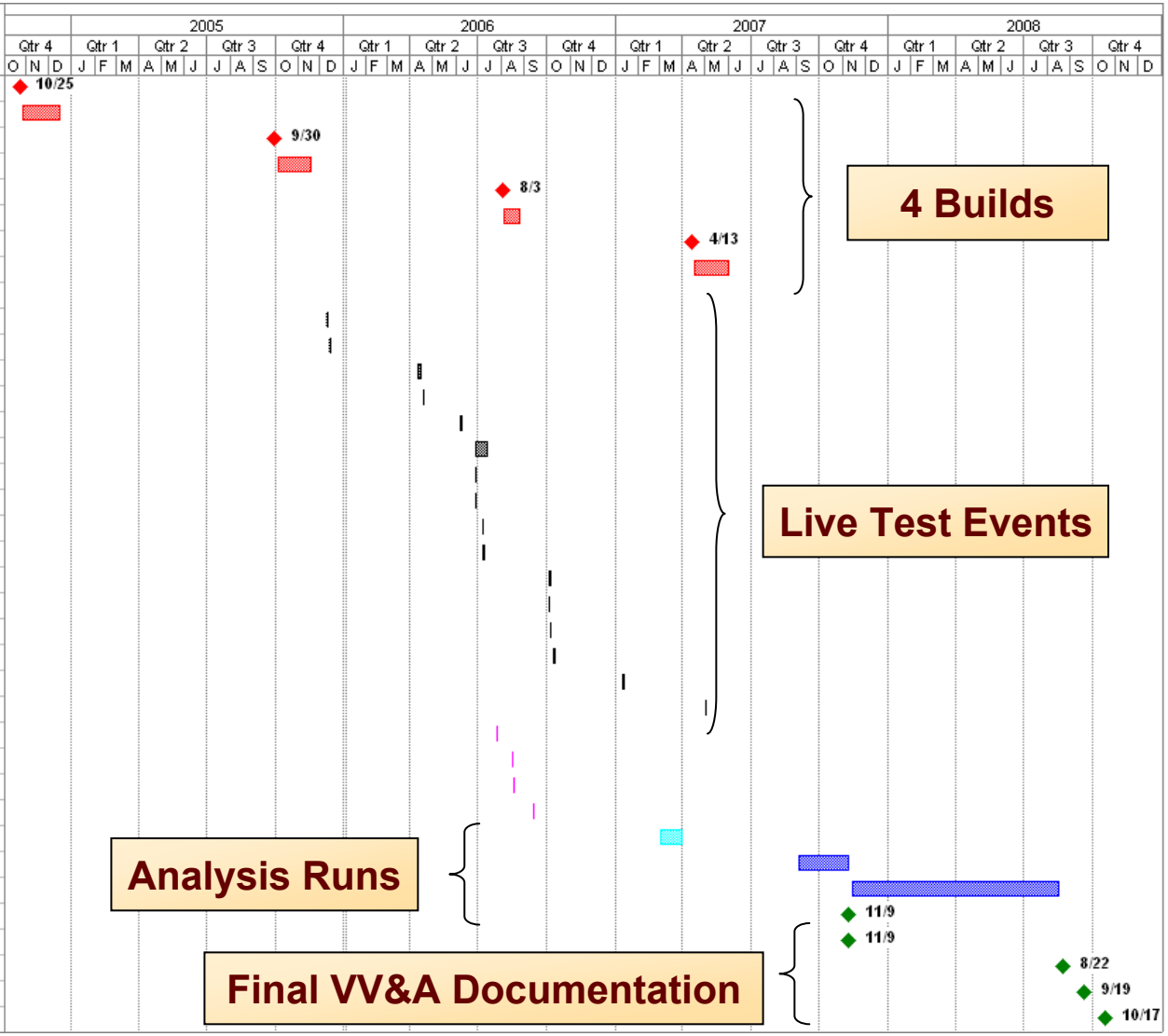


TESTBED SPIRAL DEVELOPMENT



TESTBED SCHEDULE

ID	Task Name	Start	Finish
1	Model Build 1	Mon 10/25/04	Mon 10/25/04
2	Testbed Build 1	Tue 10/26/04	Wed 12/15/04
3	Model Build 2	Fri 9/30/05	Fri 9/30/05
4	Testbed Build 2	Mon 10/3/05	Wed 11/16/05
5	Model Build 3	Thu 8/3/06	Thu 8/3/06
6	Testbed Build 3	Fri 8/4/06	Thu 8/24/06
7	Model Build 4	Fri 4/13/07	Fri 4/13/07
8	Testbed Build 4/Final	Mon 4/16/07	Thu 5/31/07
9			
10	SSDS TE #1	Thu 12/8/05	Sat 12/10/05
11	SPS-48E Characterization Testing	Mon 12/12/05	Tue 12/13/05
12	SSDS TE #2	Mon 4/10/06	Fri 4/14/06
13	SESEF/SEMCIP	Mon 4/17/06	Wed 4/19/06
14	SSDS DTE TE #3	Mon 6/5/06	Thu 6/8/06
15	CSSQT UW	Tue 6/27/06	Wed 7/12/06
16	A/C Trackex	Mon 6/26/06	Mon 6/26/06
17	DT/DTE	Tue 6/27/06	Tue 6/27/06
18	MSLEX (BQM 34)	Wed 7/5/06	Thu 7/6/06
19	RCSR Measurement	Thu 7/6/06	Sat 7/8/06
20	SSDS TE #4	Mon 10/2/06	Thu 10/5/06
21	A/C Trackex	Mon 10/2/06	Tue 10/3/06
22	DTE	Wed 10/4/06	Thu 10/5/06
23	DT/OT Firings	Mon 10/9/06	Thu 10/12/06
24	SSDS DTE TE #5	Mon 1/8/07	Thu 1/11/07
25	RCSR Validation	Mon 4/30/07	Tue 5/1/07
26	SDTS OP 1	Tue 7/25/06	Tue 7/25/06
27	SDTS OP 2	Tue 8/15/06	Tue 8/15/06
28	SDTS OP 3	Thu 8/17/06	Thu 8/17/06
29	SDTS OP 4	Tue 9/12/06	Tue 9/12/06
30	LPD 18 Nulka	Thu 3/1/07	Sat 3/31/07
31	Dry Runs	Mon 9/3/07	Fri 11/9/07
32	Analysis Runs	Mon 11/12/07	Fri 8/15/08
33	Draft V&V Report	Fri 11/9/07	Fri 11/9/07
34	Preliminary DT Accreditation	Fri 11/9/07	Fri 11/9/07
35	Final V&V Report	Fri 8/22/08	Fri 8/22/08
36	Final DT Accreditation	Fri 9/19/08	Fri 9/19/08
37	OT Recommendation to COTF	Fri 10/17/08	Fri 10/17/08



VV&A DATABASE OVERVIEW

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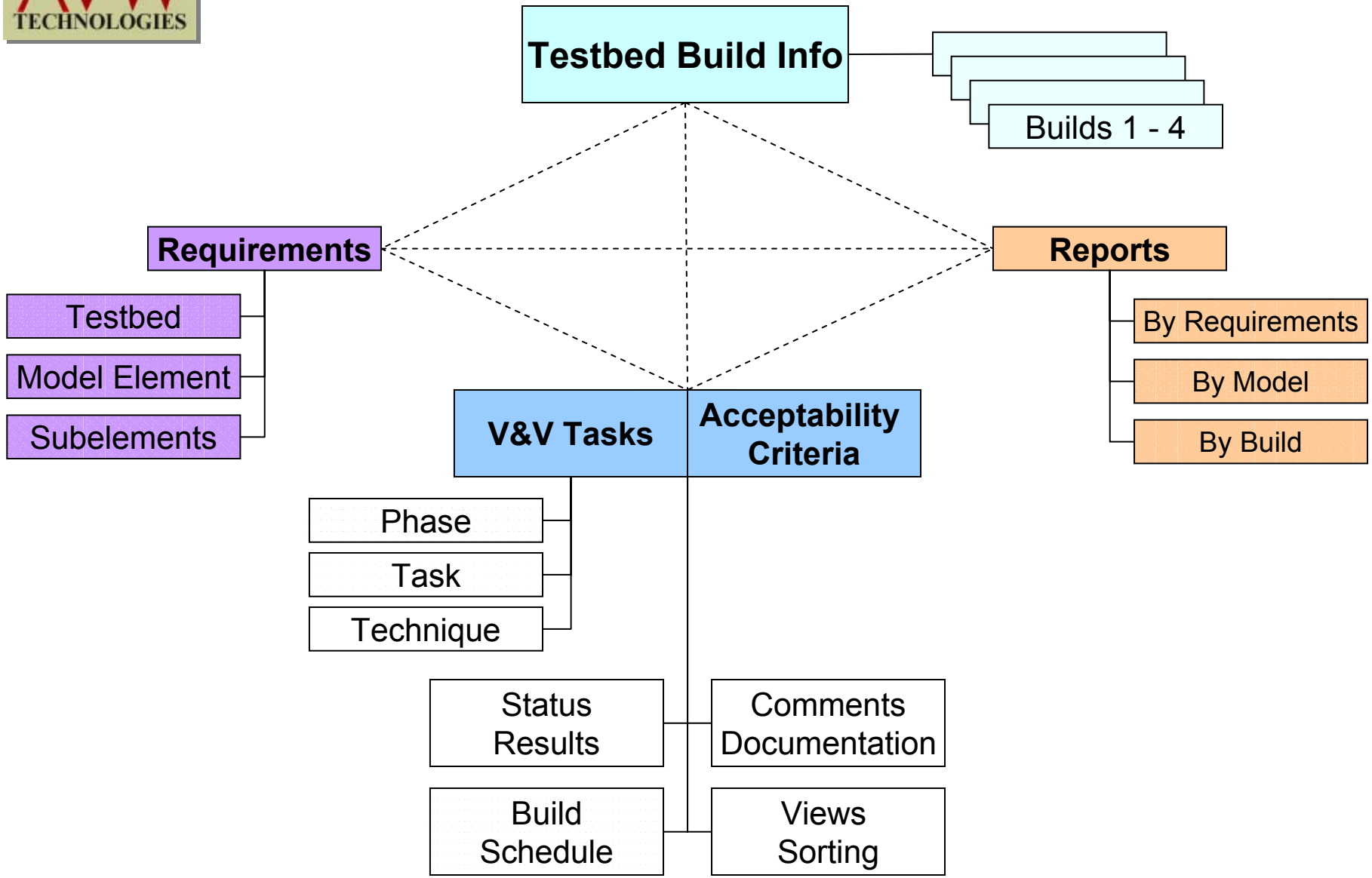
- The VV&A Approach
- The VV&A Process
- **The VV&A Database**
  - **Relational Database Tables**
  - **User Interface**
  - **Database Reports That can be Generated**
  - **Program is Easily Modified, Updated.**
  - **Data, Reports is Property of the Customer**

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

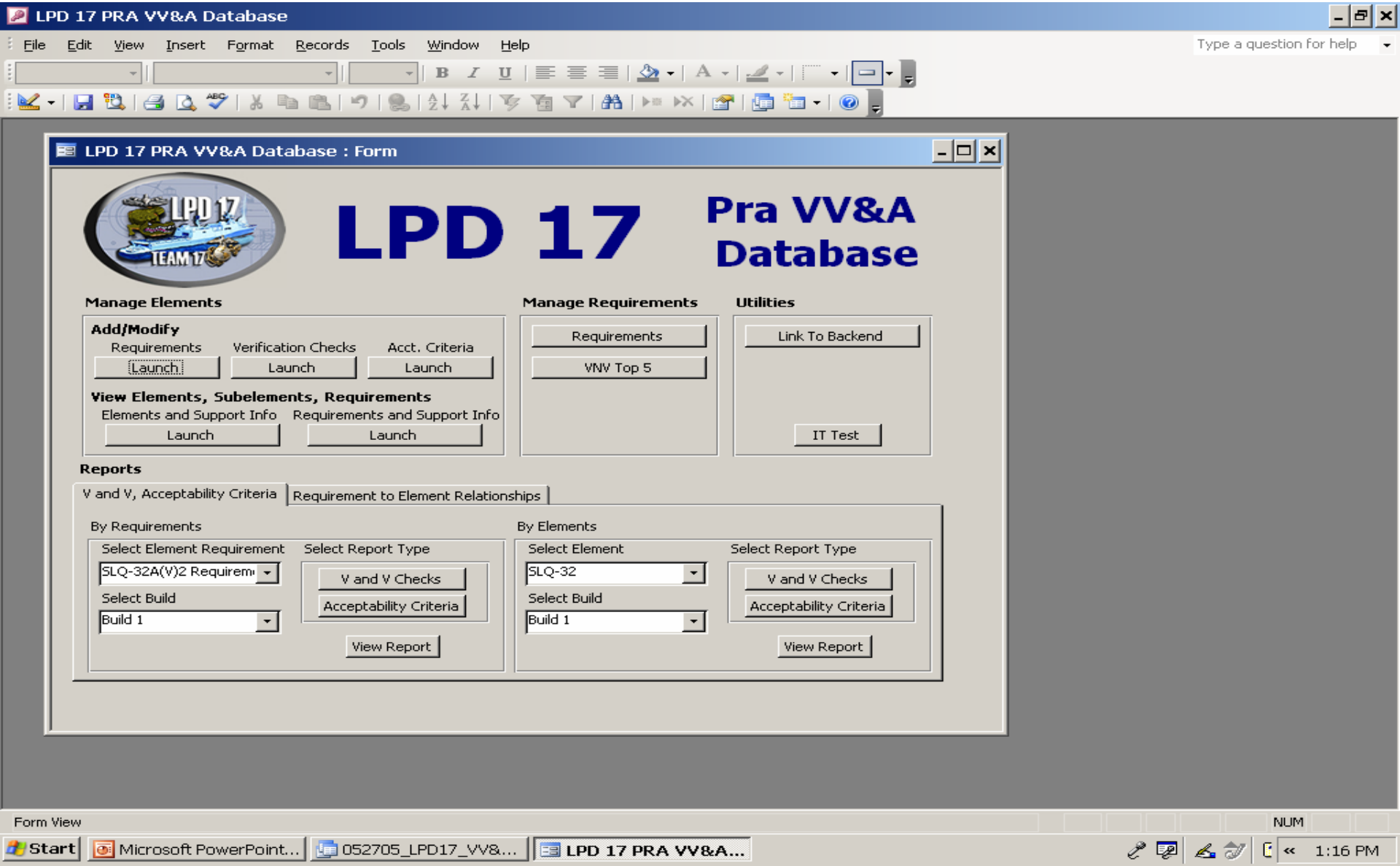
AVW VV&A DATABASE ARCHITECTURE



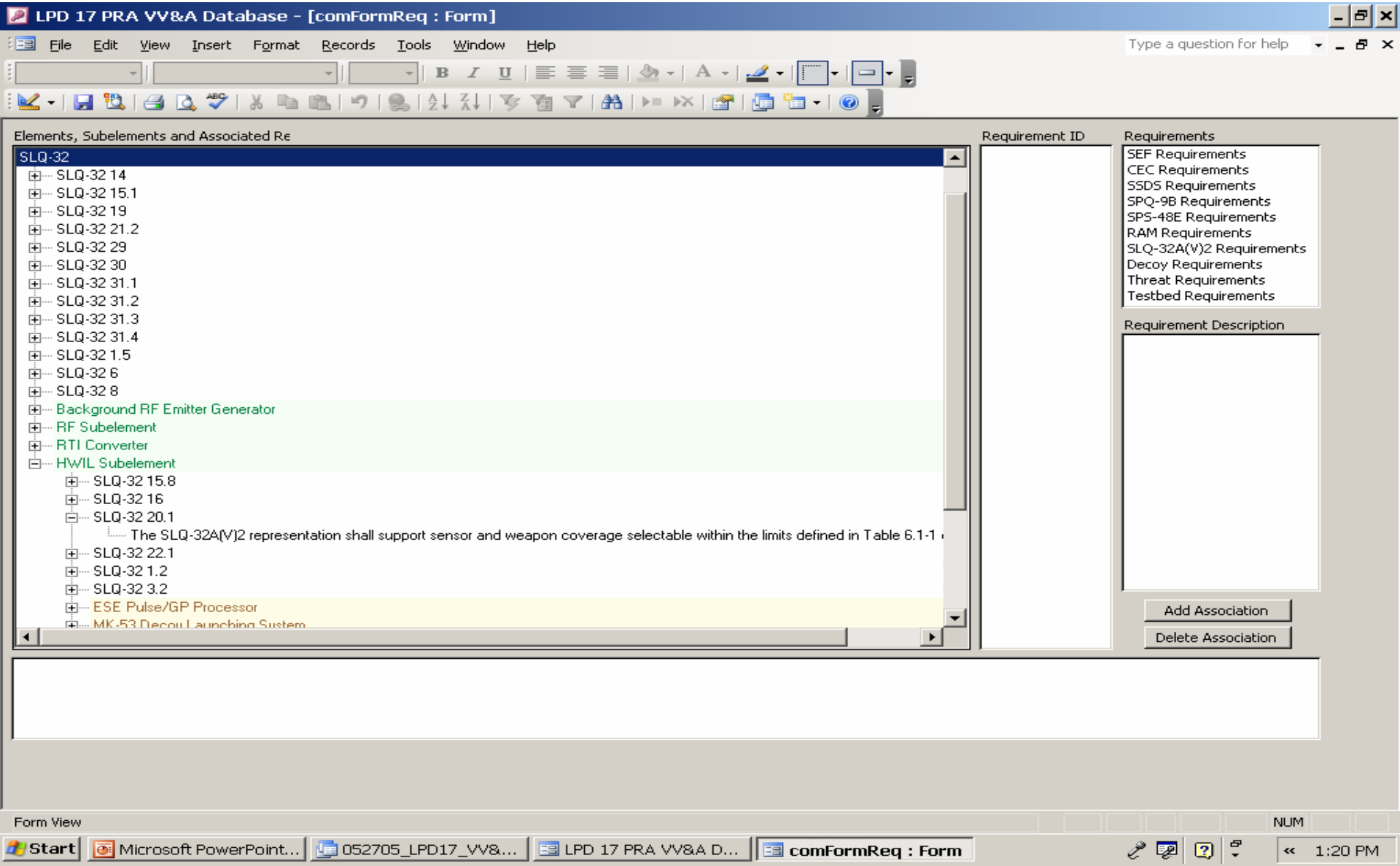
AVW VV&A DATABASE

- 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

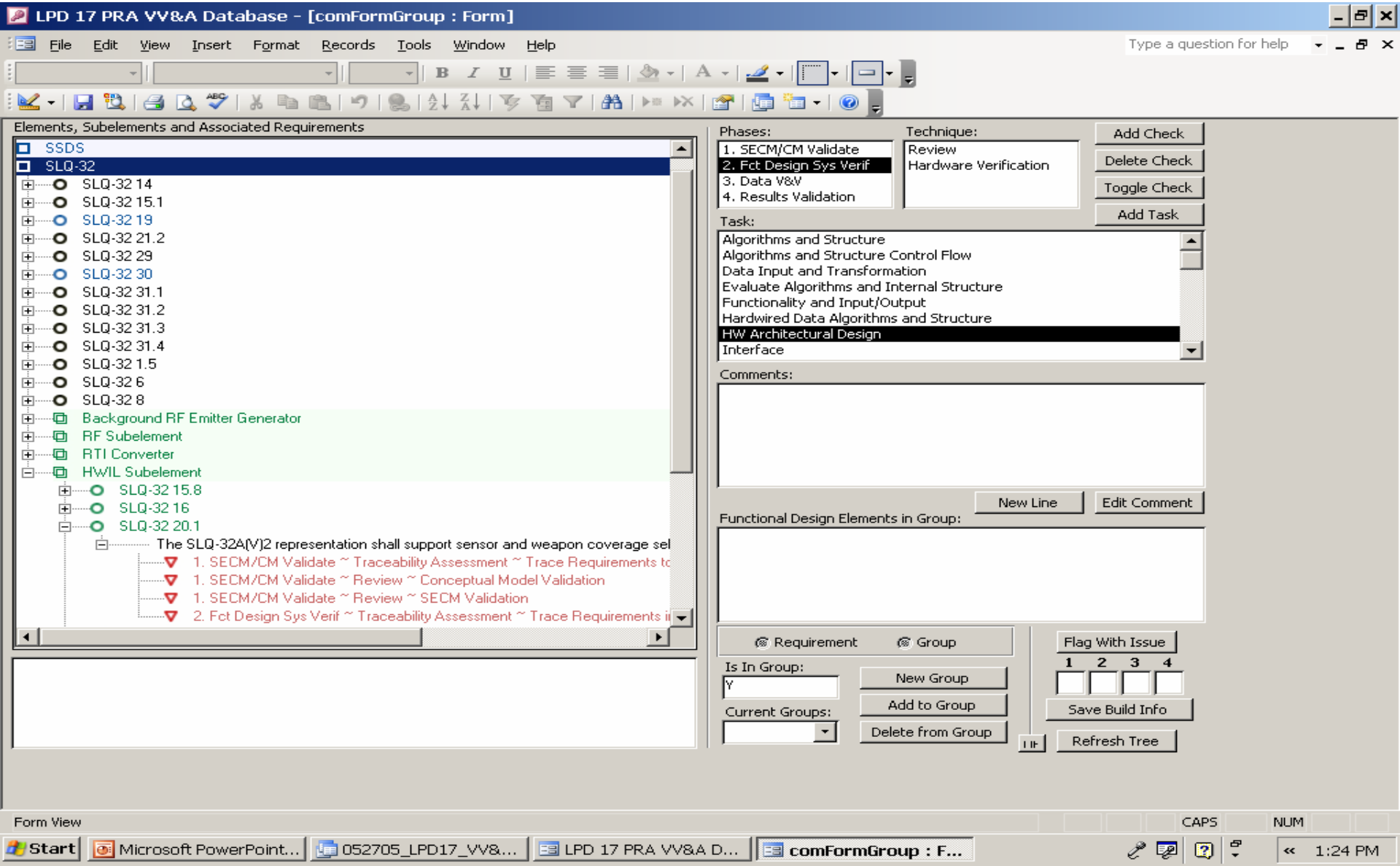
DATABASE FRONT PAGE



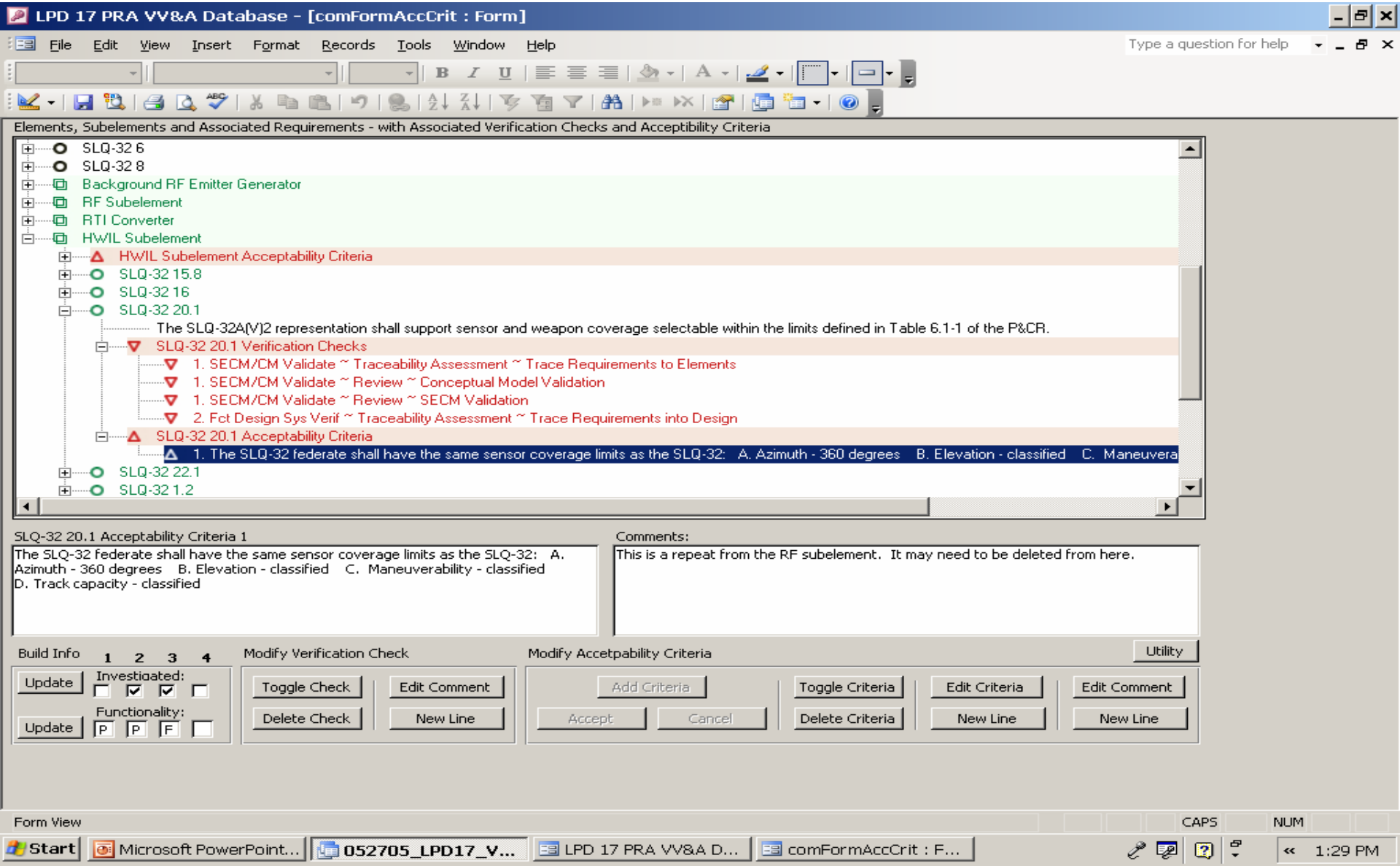
REQUIREMENTS SCREEN



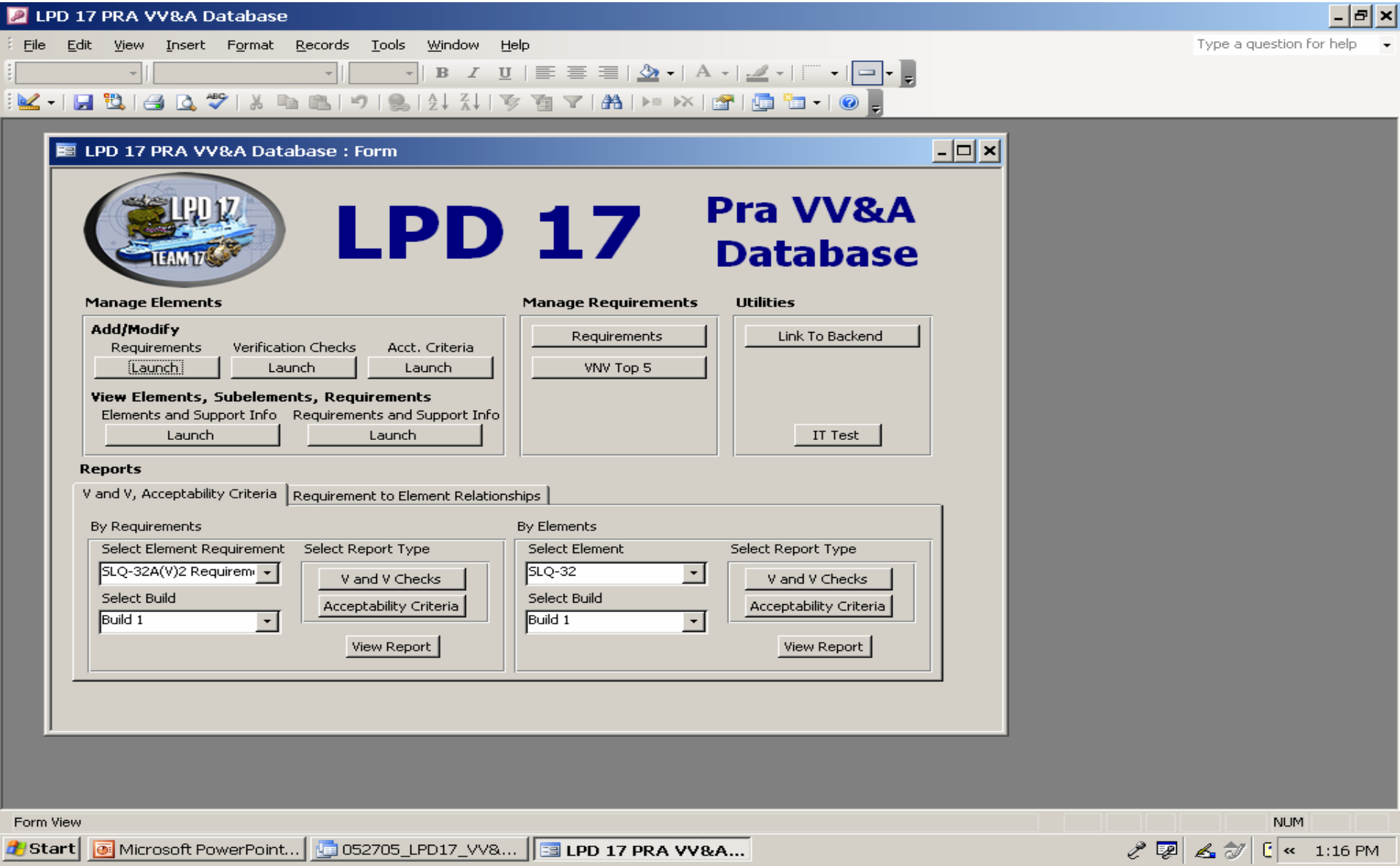
V&V CHECK SCREEN



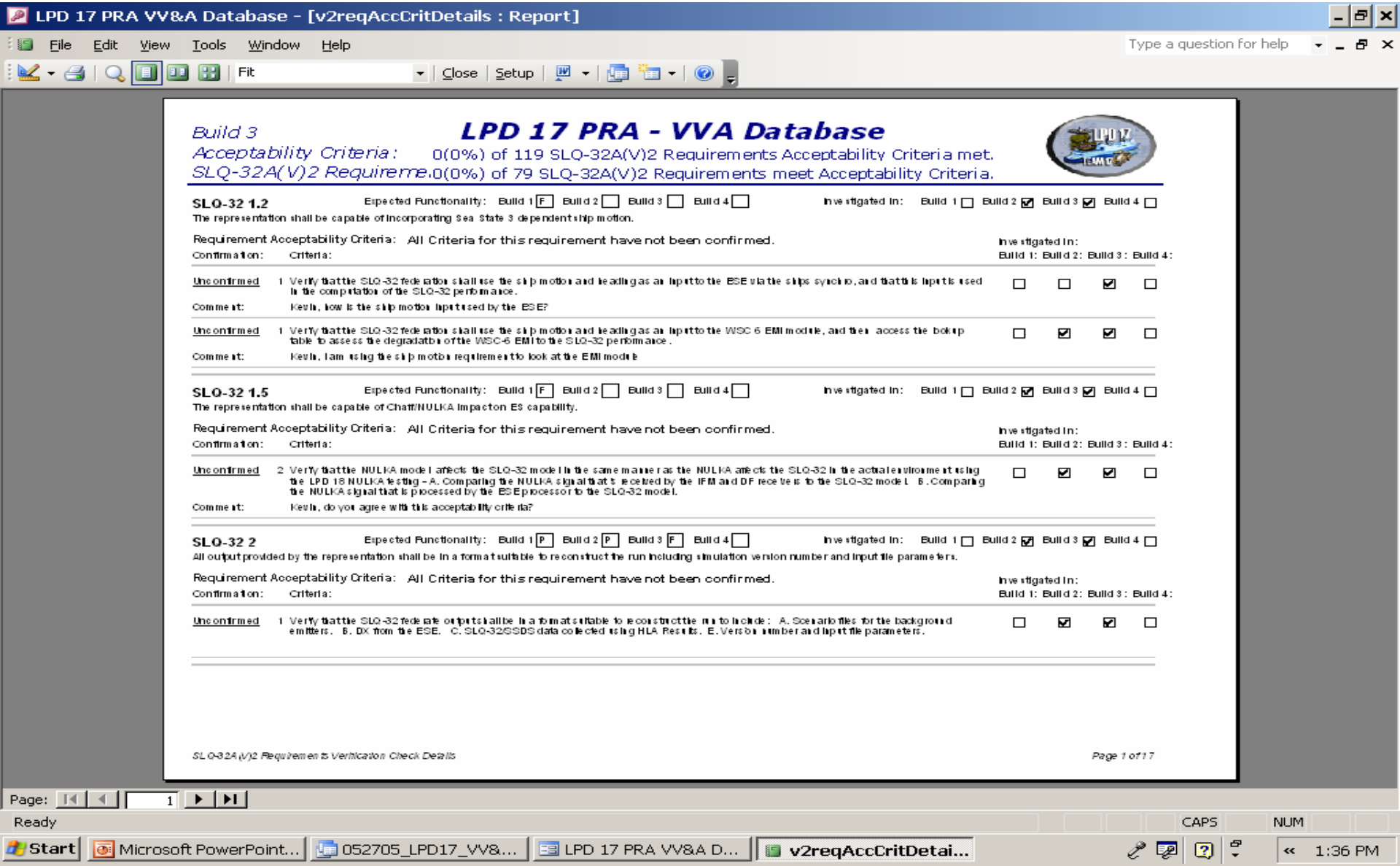
ACCEPTABILITY CRITERIA SCREEN



DATABASE FRONT PAGE



ACCEPTABILITY CRITERIA REPORT



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

File Edit View Tools Window Help

Type a question for help

Fit | 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 [F] Build 2 [ ] Build 3 [ ] Build 4 [ ] Investigated In: Build 1 [ ] Build 2 [x] Build 3 [x] 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.

Confirmation:	Criteria:	Investigated In: Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	1 Verify that the SLQ-32 federation shall use the ship motion and heading as an input to the ESE via the ships synchro, and that this input is used in the computation of the SLQ-32 performance.	[ ]	[ ]	[x]	[ ]
Comment:	Kevin, how is the ship motion input used by the ESE?				
Unconfirmed	1 Verify that the SLQ-32 federation shall use the ship motion and heading as an input to the WSC-6 EMI module, and then access the look up table to assess the degradation of the WSC-6 EMI to the SLQ-32 performance.	[ ]	[x]	[x]	[ ]
Comment:	Kevin, I am using the ship motion requirement to look at the EMI module				

SLQ-32 1.5 Expected Functionality: Build 1 [F] Build 2 [ ] Build 3 [ ] Build 4 [ ] Investigated In: Build 1 [ ] Build 2 [x] Build 3 [x] Build 4 [ ]

The representation shall be capable of Chaff/NULKA Impacton ES capability.

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

Confirmation:	Criteria:	Investigated In: Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	2 Verify that the NULKA model affects the SLQ-32 model in the same manner as the NULKA affects the SLQ-32 in the actual environment using the LPD 18 NULKA testing - A. Comparing the NULKA signal that is received by the IFM and DF receivers to the SLQ-32 model. B. Comparing the NULKA signal that is processed by the ESE processor to the SLQ-32 model.	[ ]	[x]	[x]	[ ]
Comment:	Kevin, do you agree with this acceptability criteria?				

SLQ-32 2 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 [ ]

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.

Confirmation:	Criteria:	Investigated In: Build 1:	Build 2:	Build 3:	Build 4:
Unconfirmed	1 Verify that the SLQ-32 federate 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-32SSDS data collected using HLA Results. E. Version number and input file parameters.	[ ]	[x]	[x]	[ ]

SLQ-32A(V)2 Requirements Verification Check Details *Page 1 of 17*

Page: 1

Ready CAPS NUM

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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. SECM/CM 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. SECM/CM 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. SECM/CM 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

AVW TECHNOLOGIES

BACKUP SLIDES