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Advanced Systems & Supportability Engineering Technology and Tools

A Test Strategy Done Early Drives Test Planning and Successful Testing

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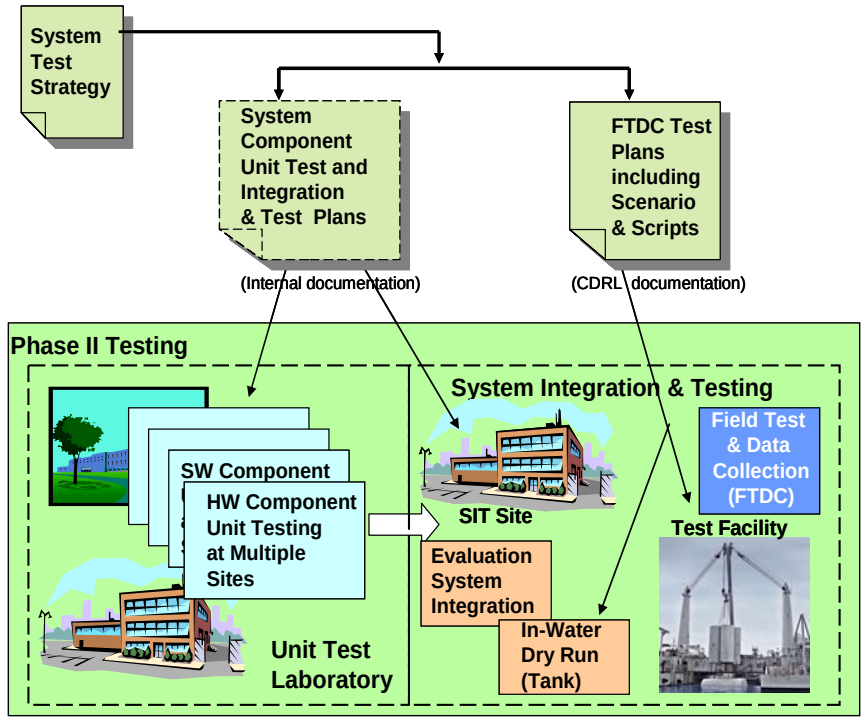
Agenda

- T&E Strategy, an important early document in the SE Process
- Key Information: Contents in a T&E Strategy
- Where the Features of a Test Strategy are Verified
- T&E Lessons Learned at ASSETT
- Summary and Conclusions
- Q&A

A Test Strategy Sets the Stage for Testing

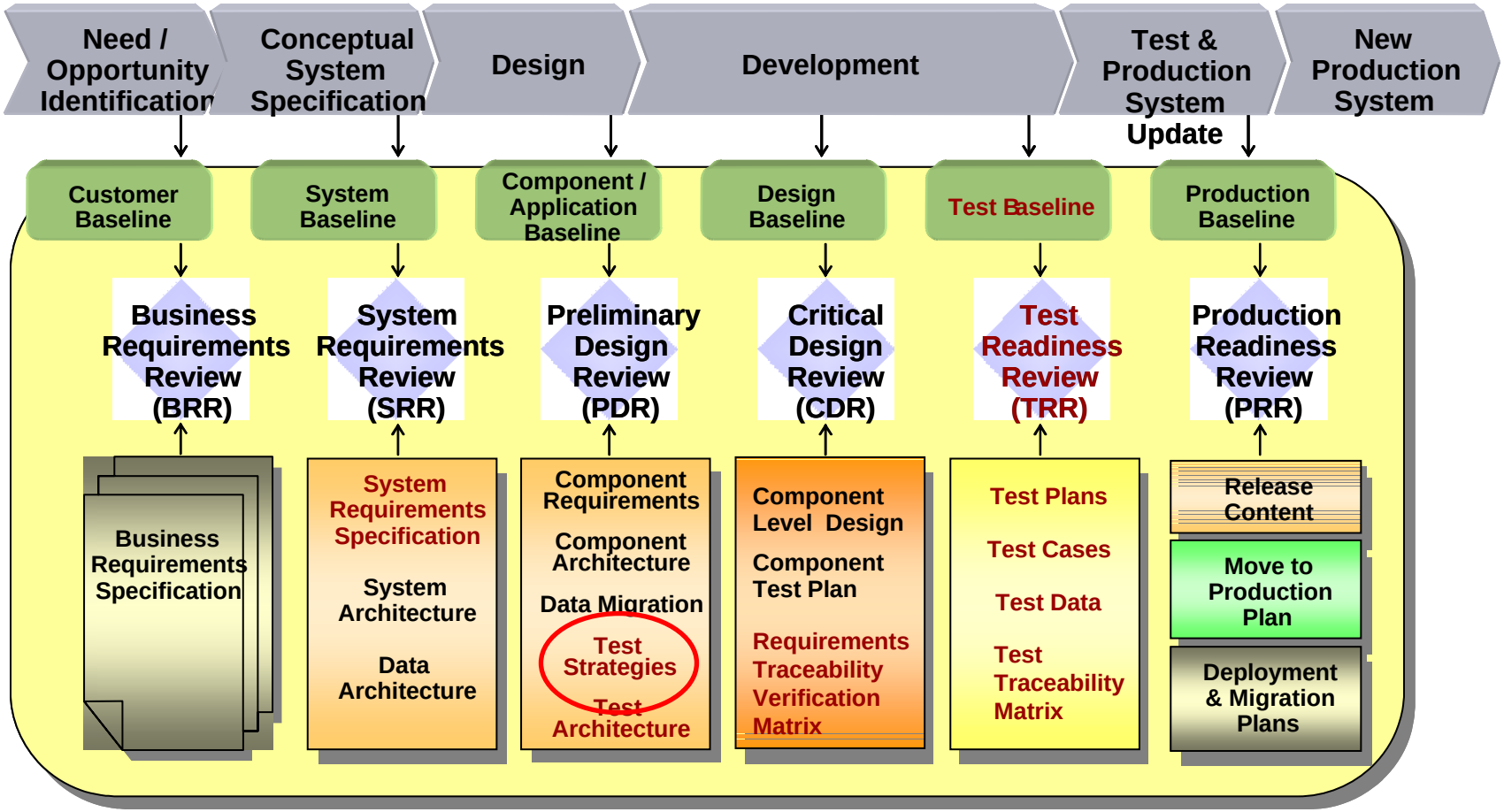
- Test Strategy is a high level description of major system wide activities that achieve the project's testing objectives
- It outlines the approach to ensure the system is adequately tested
- Ground rules for writing the Test Plan
- Done early in the life cycle, it is a generic approach and defines the basis for test plans and test procedures to follow.
  - Sometimes features done with proposal
  - Should complete by PDR

One early Strategy is to define the Test Environment Locations for Test Events



T&E Strategy, an early SE Process product

The features of a Test Strategy should all be baselined by the PDR



Key Information: Contents in a Test Strategy

Table of Contents

- Introduction
- Scope
- Testing Objectives
- Assumptions
- A Risk Assessment
- The Critical Attributes as Test Focus Areas
- The Levels of Testing to be Included
- Types of Tests
- Test Methods
- Organizational Responsibilities for Testing
- Entry/Exit Criteria
- Test Equipment
- Test Metrics relevant to Quality Criteria
- Test Management and Reporting
- Approvals
- Glossary of Terms

Contents: Test Scope & Objectives

Bounding the amount of Testing early is a key test program planning objective

Test Scope

- Define boundaries of test – a test work flow
- Contractual limitations
- Lists of applicable system components planned in tests
- Emphasis on a cost effective, team approach
- SOW emphasis on specific efforts to verify technical requirements and limit risks

Testing Objectives

- Clearly define overall project technical objectives
- Define the multiple levels of testing within the test scope
  - Laboratory
  - Field Test
  - Test Platform
  - Operational
- Technical objectives for each level of testing
- Customer objectives and importance

Contents: Assumptions

The key and critical underlying assumptions behind test strategy

For your efforts

For your team & customer

Test Environments

- Locations of different test environments
- Infrastructure requirements
- Simulation / Stimulation fidelity
- Development and T&I environment HW / SW
- Owners and maintenance responsibilities
- Sharing of components between environments

Test Operations

- Company / organizations testing each component
- Hardware / Software delivery schedule and methods
- Planning and conducting DT& E (T&I) and OT&E
- Plans for incorporation of OT&E early in cycle
- Test teams by company and test event
- Field testing and Customer site acceptance tests
- Discrepancy level definitions – PTR Severity
- Regression testing

Test Documentation

- Information Level & Product Schedule
  - Components
  - System T&I
  - Test Plans
  - Test Procedures
  - Test Reports
  - Test Data

Contents: Risks and Critical Attributes

Risks to successful testing should be assessed with mitigation plans

Risk #	Risk Description	Probability (H, M, L)	Priority (H, L, M)	Mitigation
1	IF the Cabinet Components for the First Article TPS Cabinet do not arrive or are not accepted per the IVT start date THEN the Cabinet IVT will not be able to start on time.	M	M	The Cabinet components ordered for the Prototype required a longer lead time than originally expected. So the FA components are being ordered earlier than originally planned.
2	IF the Cabinet Integration is not successfully completed by January 4, 2008 so the Certification Test can be completed by 22 January, 2008 THEN the Cabinet cannot be shipped to the Prime and their Integration of the Cabinet will be impacted.	M		ASSETT is investigating advancing the component purchasing plans to be able to have the Cabinet components 1-2 months earlier. This could allow a 1-2 month earlier start for Cabinet Integration. Also the planned test time for IVT includes some buffer time for unexpected problems.

Example

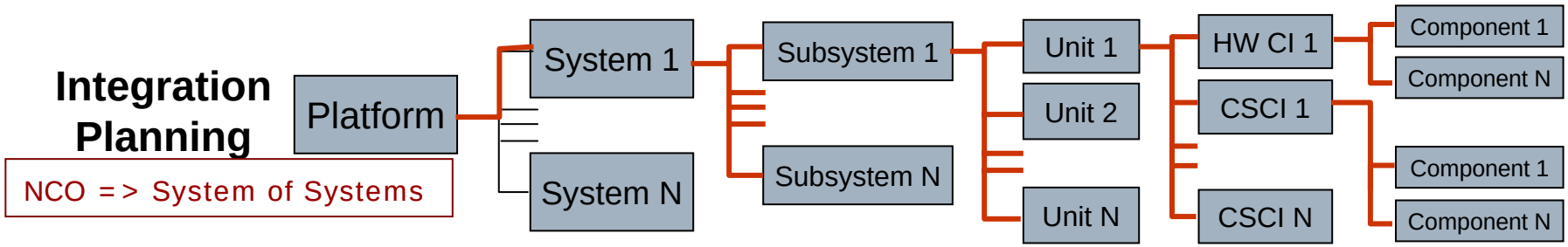
Test Focus areas or the Critical Attributes of the system that must be tested to provide the customer's level of confidence in the system

Examples of critical attributes:
- System thru put
- Ability to handle specific data types
- Ability to support legacy interfaces
- Ability to be maintained
- Reliability if a very high reliability is necessary
- Performance
- Support operational situations

Examples

Contents: Plan Strategies for each Level of Testing

The System Integration Planning Strategy Must Address All Levels of Test & Leverage the Coverage at Each Level to Eliminate Duplication



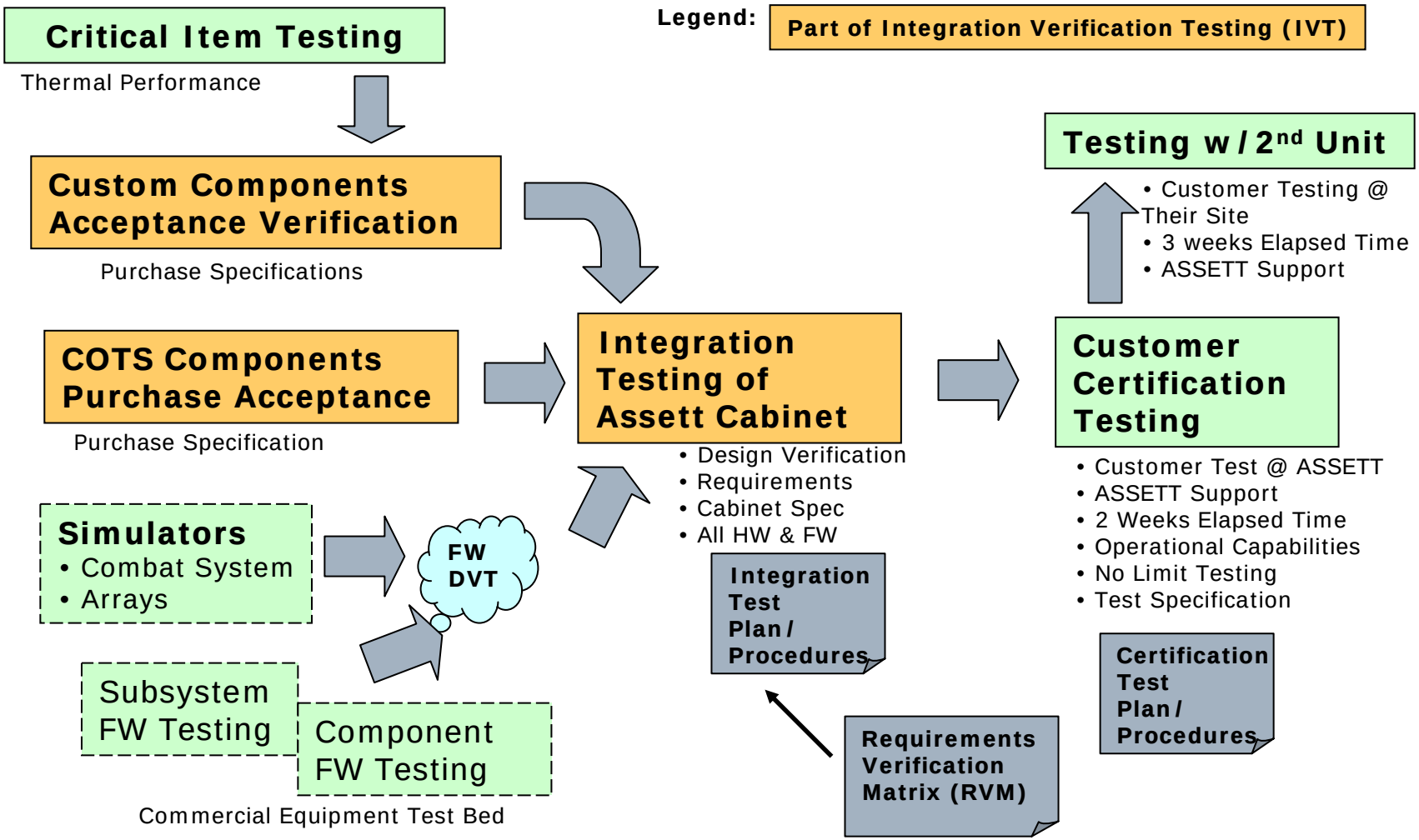
- Levels of Planning
  - Platform
  - System
  - Subsystem
  - Unit/Program
  - Configuration Item
  - Component
  - Field Test
- Results in Multiple Test Plans

System Test Strategy

- Acceptance Criteria for each system requirement is identified.
- Test Strategy for each system requirement is established.

Example Test Level Strategy Work Flow

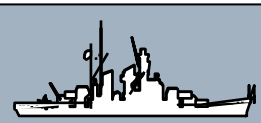
Create a flow diagram of planned test activities to visualize schedule & overlaps



Contents: Types of Testing and Strategies

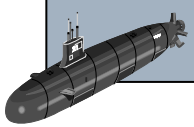
The Types of Testing can be planned for by the types of requirements

- **Test Planning by Types**
  - **Functional:**
    - **Business Functions, System Functions,**
    - **System Performance, Interfaces. etc.**
  - **Non-Functional:**
    - **Construction, Shipping, Environmental, RMA, etc.**



- **Schedule Driven vs. Event Driven Strategies**
  - **Event Driven Testing**
    - **Event driven best for reducing technical risks**
    - **Only advance when lower level of technical verifications are completed**
      - **Component, Unit, Cabinet or Computer Program, …. System**
    - **Can be more expensive if delays in Subsystem or System level testing impacted**
  - **Schedule Driven Testing**
    - **Rigorous schedule of testing to consider funding profile**

- **Integrating DT&E Events with early OT&E Events**
  - **DT&E is Laboratory level testing – little or no human environment**
  - **DT&E uses simulators for operating environment conditions**
  - **OT&E includes the human element in testing**
  - **OT&E has the real platforms and real operating environments**
  - **Early OT&E Alignment in DT&E environment can be done**
    - **Plan long duration operability demonstration tests with real system operators**
    - **Schedule regular test shifts for 3-6 months for real system operators**



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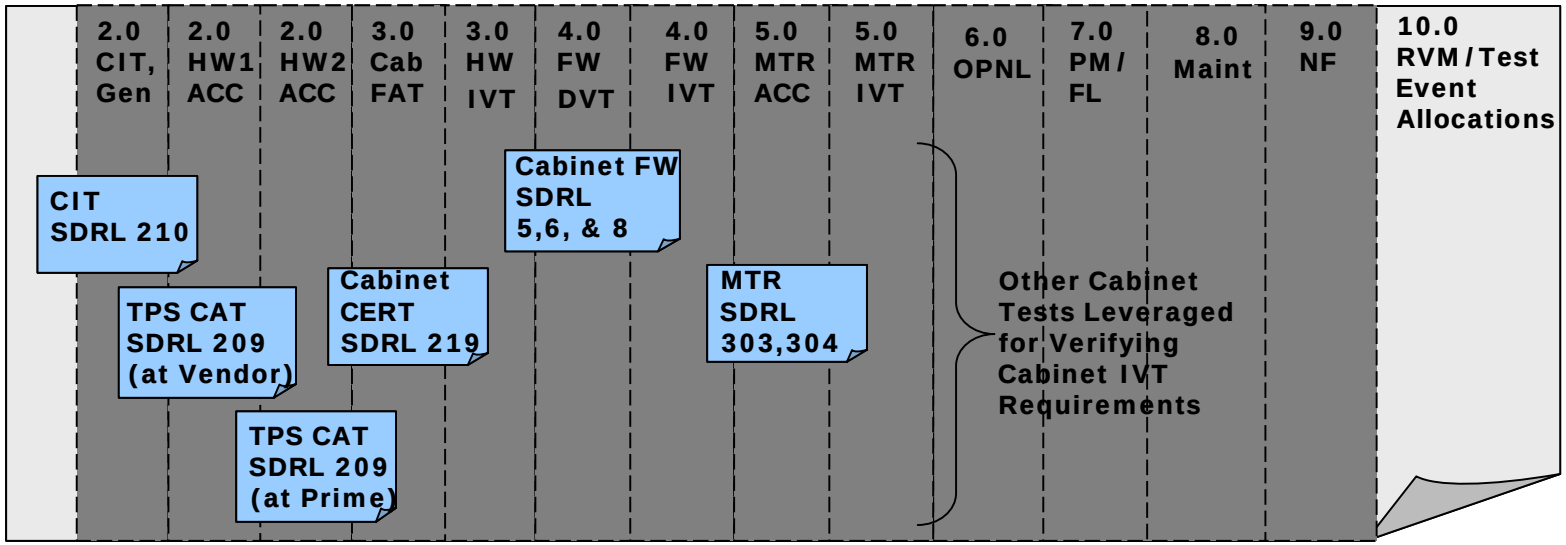
Contents: A Test Procedure Strategy and Test Methods

Strategy: Consider leveraging early requirement verifications for integration testing



Strategies for which Test Methods to later be defined for each requirement or use case need to be identified early

- **Analysis** (A) – Verification by analysis includes quantitative proof that an item meets the requirement by the technical evaluation of equations, diagrams, or representative data.
- **Demonstration** (D) – Verification by demonstration includes exercising an item to provide qualitative data that an item meets a requirement.
- **Hierarchical** (H) – These requirements contain no significant content but are used to establish a hierarchical relationship between requirements. They are verified by the verification of their subordinate requirements. (Does not require a test)
- **Inspection** (I) – Verification by inspection includes examination of hardware or documentation to see if an item meets the requirement.
- **Similarity** (S) – Verification by similarity includes a comparison of one item to another item that has been verified to meet the requirement.
- **Test** (T) – Verification by test includes using an instrument to make a measurement that provides qualitative data that an item meets the requirement.

Contents: Organizational Responsibilities, Criteria

Consider the expected Test Organizations and their Responsibilities in your plans

Role/Responsibility	Name/Organization	Phone number
ASSETT Test Director	Bill /ASSETT	800-555-1234
ASSETT Hardware Tester #1	Patrick /ASSETT	800-555-4567
ASSETT Hardware Tester #2	Monty /ASSETT	800-555-6789
ASSETT Firmware Tester #1	Rob /ASSETT	800-555-1357
ASSETT Firmware Tester #1	Rod ASSETT	800-555-2468
Customer Witness #1	Witness #1/EDO	
Customer Witness #2	Witness #2/EDO	

Define Specific Success Criteria in order to Enter & Exit Test Events and Levels

- **Entry Criteria**
  - **Establish pre-requisites before starting any series of test events**
  - **Example: testing of a work product at the previous level completed**
  - **Example: No significant PTRs**
- **Exit Criteria**
  - **Establish post-conditions before declaring completion of test events**
  - **Agree on Pass/Fail Criteria, e.g. statistical performance testing; reruns**
  - **Example: Customer accepts work product**
  - **Example: Acceptable level of each open Discrepancy level (PTRs)**

Other Contents (Page 1 of 2)

- **Test Equipment**
  - Technology needed in test environments
  - Determine what will be bought, GFE, CFE, capitalized
  - If field tests involved, determine transportability
- **Test Metrics**
  - Metrics programs or measurement strategy
  - Metrics could drive test method scope and equipment needed
- **Test Management and Reporting**
  - T&E Manager, Test Director, and organization
  - Approach to reporting daily & final test results
  - Capturing, tracking and reporting discrepancies (PTRs) against requirements
  - Test Reports

Other Contents (Page 2 of 2)

- **Approvals**
  - **How are tests to be witnessed**
  - **How are test results and test reports approved**
  - **What constitutes a successful completion by your customer**

A Glossary of abbreviations for the project is very helpful in understanding terminology

AIS	Active Intercept Sonar	PCA	Physical Configuration Audit
BCR	Baseline Change Request	PCI	Production Control Inspection
CAS	Cylindrical Array Sonar	PI	Production Inspection
CAT	Component Acceptance Test	PRS	Passive Ranging Sonar
CC&S	Combat Control and Surveillance	POC	Point of Contact
CI	Critical Item	PTR	Project Trouble Report
CIT	Critical Item Testing	QA	Quality Assurance
CDR	Critical Design Review	QMP	Quality Management Plan
CDRL	Contract Data Requirements List	RVDS	Requirements Verification Data Sheet
CMP	Configuration Management Plan	RVM	Requirements Verification Matrix

Some DT&E & OT&E Lessons Learned at ASSETT

- **Get testable requirements and test pass/fail criteria defined early and agreed upon with the Customer**
- **Create a Test Strategy and Master Test Plan**
  - **Get buy in by all parties involved**
- **Prepare Test Plans for each of the different levels of integration and conduct peer reviews and customer reviews as necessary – don't want surprises at acceptance**
- **Create a SRVM and get it reviewed/approved**
- **Fully dry run all test procedures**
- **Document all test findings and share them with both Customer and own teams**

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Test Strategy Contents: Agreement & Verification done at Different SE Milestones

Proposal / SRR Milestone	PDR Milestone	CDR Milestone	TRR Milestone
Scope	-	-	-
Test Objectives	Test Objectives	-	-
Assumptions	Assumptions	-	-
	Risk Assessment	Risk Assessment	-
	Critical Attributes	Critical Attributes	-
		Types of Tests	Types of Tests
		Test Methods	Test Methods
		Organization	Organization
			Entry / Exit Criteria
			Test Equipment
			Test Management
			Test Reporting
			Approvals
☐ Proposal	☐ Test Strategies		
☐ System Requirements Specification	☐ Test Architecture	☐ Requirements Traceability (SRVM)	☐ Test Plans
			☐ Test Procedures
			☐ Test Data
			☐ Test Traceability

Summary & Conclusions

1. **An initial Test Strategy should be completed very early in the SE Process…often in the proposal!**

2. **More detailed Test Strategy Contents can be defined and refined in later SE Phases in Test Architectures, Test Plans, & Test Procedures**

3. **Test Strategy Features are agreed upon early and verified at design reviews and test readiness reviews during the SE Process**

Systems Engineering provides a structured approach to managing the technical solution over the full life cycle from concept to deployment to retirement…

…Test and Evaluation complements this approach with support for defining requirements and integration planning…and conducting many levels of integration tests with systems engineering support to achieve customer acceptance of a system…

Q&A

Abstract

Successful test and evaluation (T&E) starts at the beginning of the SE process by defining testable requirements and a test strategy for verifying those requirements. A Test Strategy is a high level view of a project's Test Plan and the necessary Test Equipment Support. The SE defines the test strategy, implements it in test plans & test procedures, and then supports the T&E team doing the testing. This presentation will identify lessons learned and how ASSETT Inc. has successfully defined test strategies for both large and small projects for military systems both with/without integrated commercial components.

The T&E Strategy is an important early document in the SE Process: The T&E Strategy is a high level description, developed prior to PDR, of major system-wide activities to achieve the testing objectives. It outlines the planned approach to ensure the system is tested adequately. An event-drive test program is recommended over a schedule driven test program to reduce technical risk. A transition of developmental tests (DT) with operational tests (OT) is recommended.

The Key information in the T&E Strategy: A Test Strategy, whether in a stand-alone document or incorporated into a project Test Plan, defines the testing objectives, assumptions, an initial project risk assessment, test focus areas, the different levels and types of testing, the test organization responsibilities, entry/exit criteria for the different testing levels, test tools, and any metrics relevant to project quality criteria. A brief explanation and the importance of each of these will be summarized.

Where the Features of a Test Strategy are verified: At the PDR where a Test Plan is presented, the features of a test strategy begin to be verified. The plans for validation of stakeholder requirements, test time and resources, and planned tests and accompanying test procedures are reviewed. These features are again reviewed in more detail at the CDR. And finally, at the TRR prior to starting the test, the requirements traceability and test resources (tools, procedures, limitations, and validity of the test procedures) are confirmed.

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Author Biography – Mr. Lyders has over 37 years of both systems engineering and project management experience in both federal software and commercial Information Technology (IT) development projects. He has significant complex system test and integration expertise developed through his federal work with multiple Sonar, Combat Control, and Submarine Combat Systems and multiple SBIR projects for the Navy. He was also the Test Team Lead on large commercial projects for both domestic and international financial institutions. Mr. Lyders is currently Lead Systems Engineer and Test Director on two projects at ASSETT. Mr. Lyders is also a member of both NDIA and INCOSE.