



W E L C O M E

RITA Intelligent Transportation Systems
Joint Program Office

Welcome



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Research and Innovative Technology Administration

Intelligent Transportation Systems Joint Program Office
ITS Professional Capacity Building Program / Advancing ITS Education

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- February 2, 2013
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- Telecommunications and Networking Fundamentals (begins Feb. 15)
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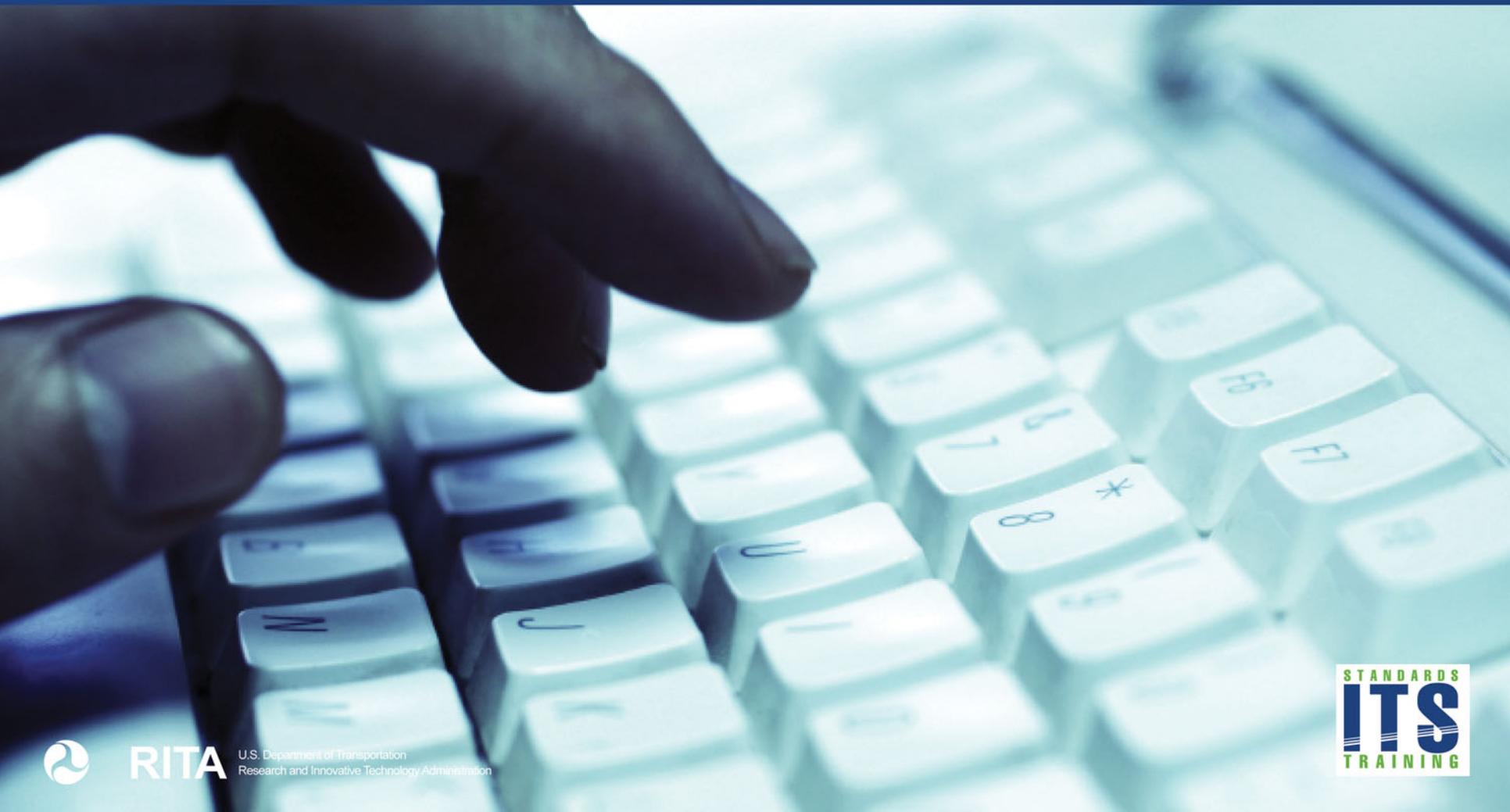


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T321: Applying Your Test Plan to the TMDD Standard





Instructor



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Target Audience

- Engineering staff
- Operations and maintenance staff
- System integrators
- Device manufacturers
- Testing contractors

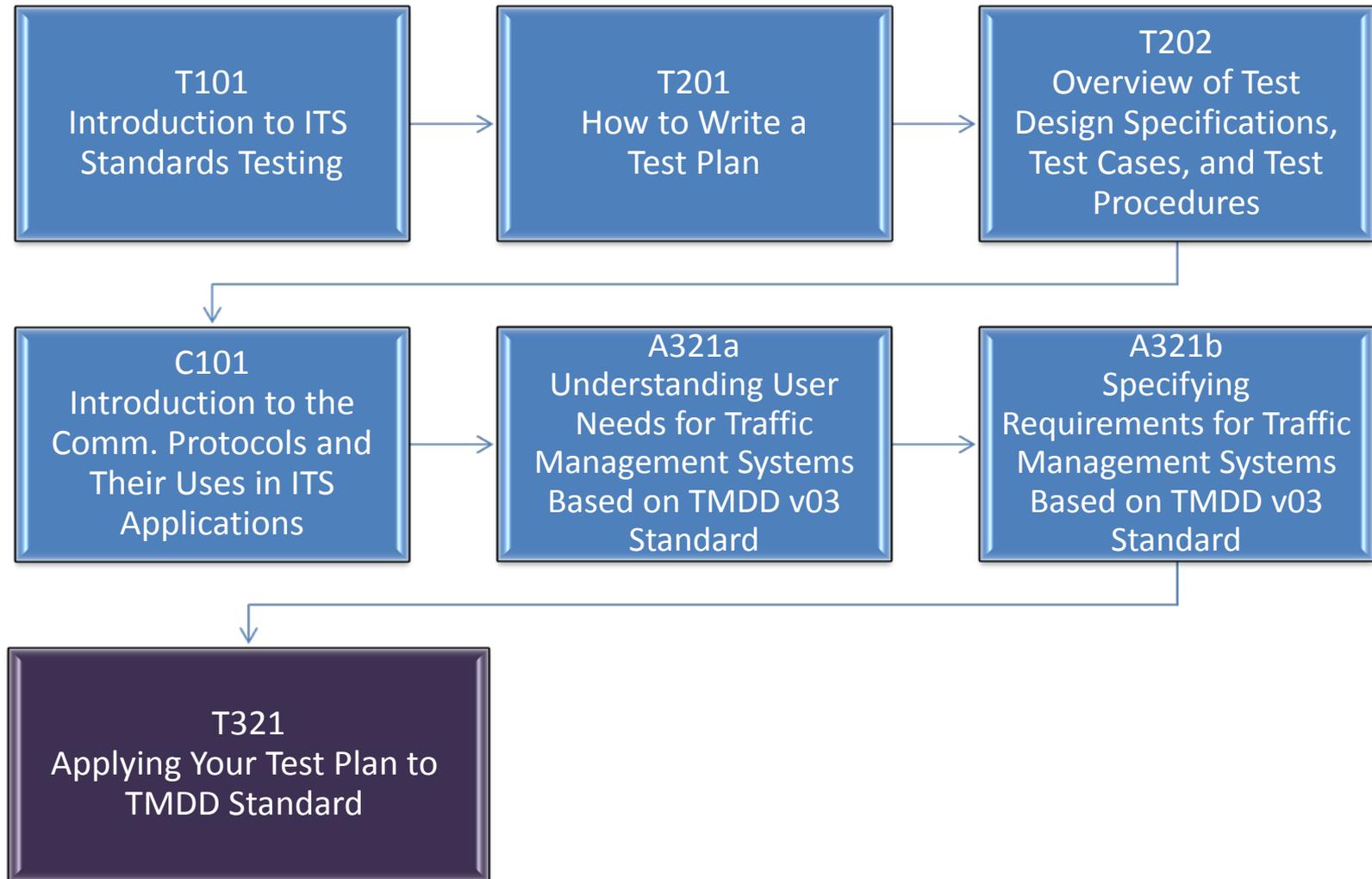


Recommended Prerequisite(s)

- T101: Introduction to ITS Standards Testing
- T201: How to Write a Test Plan
- T202: Overview of Test Design Specifications, Test Cases, and Test Procedures
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications
- A321a: Understanding User Needs for Traffic Management Systems Based on TMDD v3.03 Standard
- A321b: Specifying Requirements for Traffic Management Systems Based on TMDD v3.03 Standard



Curriculum Path (SEP)





Learning Objectives

1. Describe within the context of a testing life cycle the role of a test plan and the testing to be undertaken.
2. Recognize the purpose, structure, and content of a well-written test plan for a TMDD-based system interface.
3. Describe the application of a good test plan to a TMDD-based system being procured using a sample TMDD test plan.



Learning Objectives (cont.)

4. Identify the process to write a test plan in the context of the requirements of TMDD that have been selected by the user.
5. Analyze how to ensure conformance with the TMDD v3.03 Standard.
6. Describe test documentation for TMDD: Test Plan, Test Design Specification, Test Case Specification, Test Procedure Specifications, and Test Reports.





Learning Objective #1 – Describe within the context of a testing life cycle the role of a test plan and the testing to be undertaken

- Explain why testing is important within the life cycle of a system.
- Identify how to break up (partition) the testing (meaning verification of requirements), and when, during the system development life cycle, requirements are tested.



Purpose of Testing

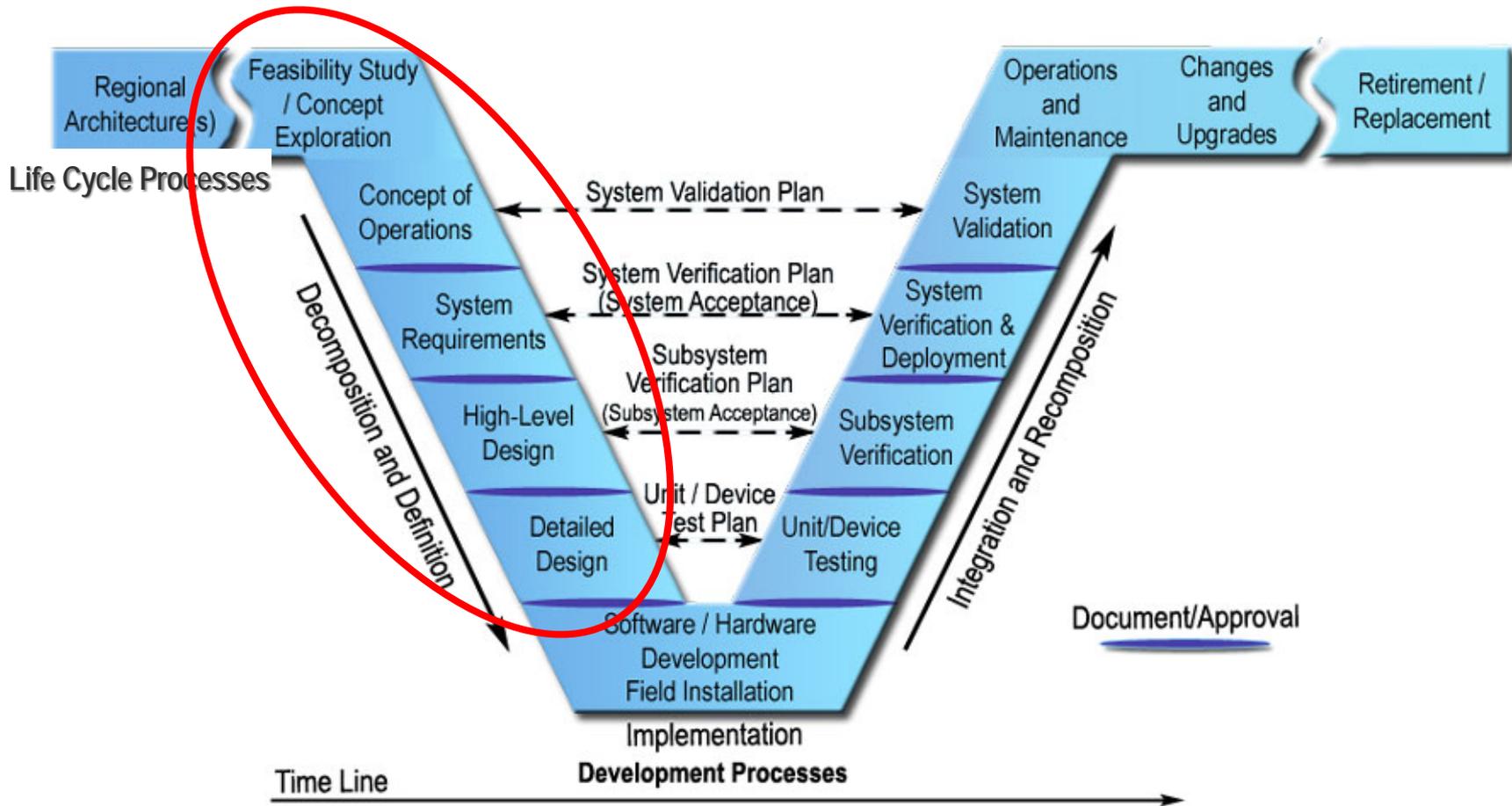
Why Test:

- To verify that the system works
- To meet a payment milestone

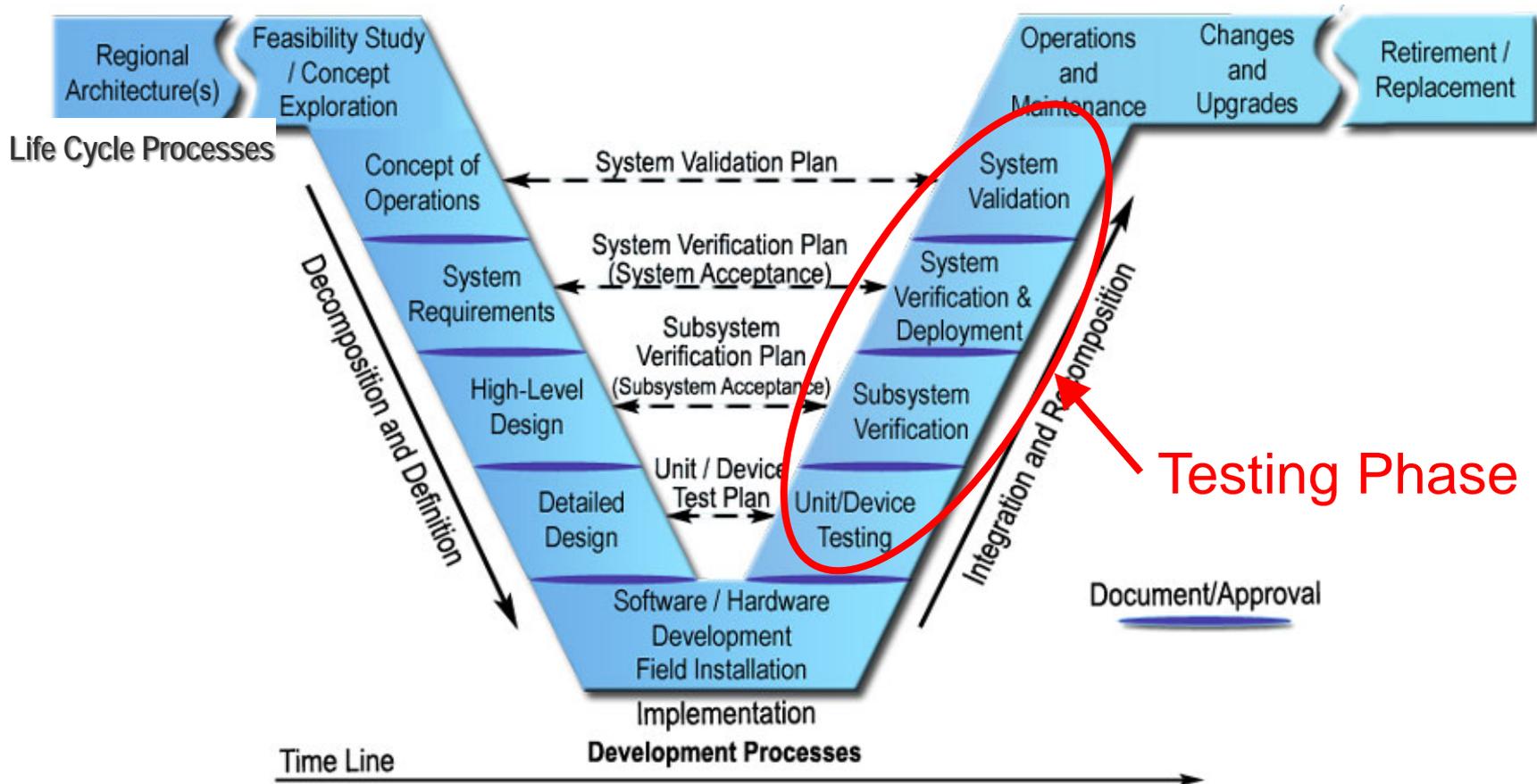
Why Test -Technically:

- To verify the system interface meets the procurement specification and satisfies the requirements (Was the system built right?)
- To identify errors/bugs so they can be corrected
- To validate that the system interface satisfies the user and operational needs (Did you build the right system?)

System Life Cycle



System Life Cycle



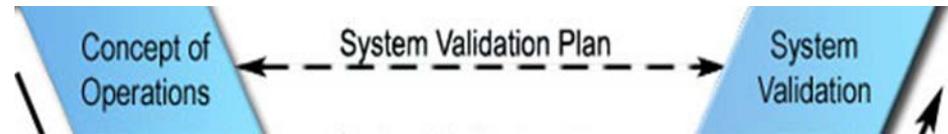
Testing Process

IEEE 829:

- The testing process provides an objective assessment of the system products through each system's life cycle:
 - At the completion of each development iteration
 - At installation and go-live
 - During operations and maintenance
 - During system upgrades
 - During system replacement

Review of Testing

Validation



- Validation – e.g., answers the question: Can I operate the system and satisfy all my stakeholder’s user needs?
- Validation ensures the requirements and the system are the right solution to the stated problem – i.e., “you built the right system.”
- The system is validated when:
 - Approved by the key stakeholders and agencies.
 - All the project requirements are fulfilled.
 - Corrective actions have been implemented for any anomalies that have been detected.

Review of Testing (Cont.)

Verification

- Ongoing process that builds quality into the system through a systematic approach of verification of requirements – i.e., “you built the system right.”
 - **Unit/Device Testing** – e.g., test a standalone TMDD interface



Review of Testing (Cont.)

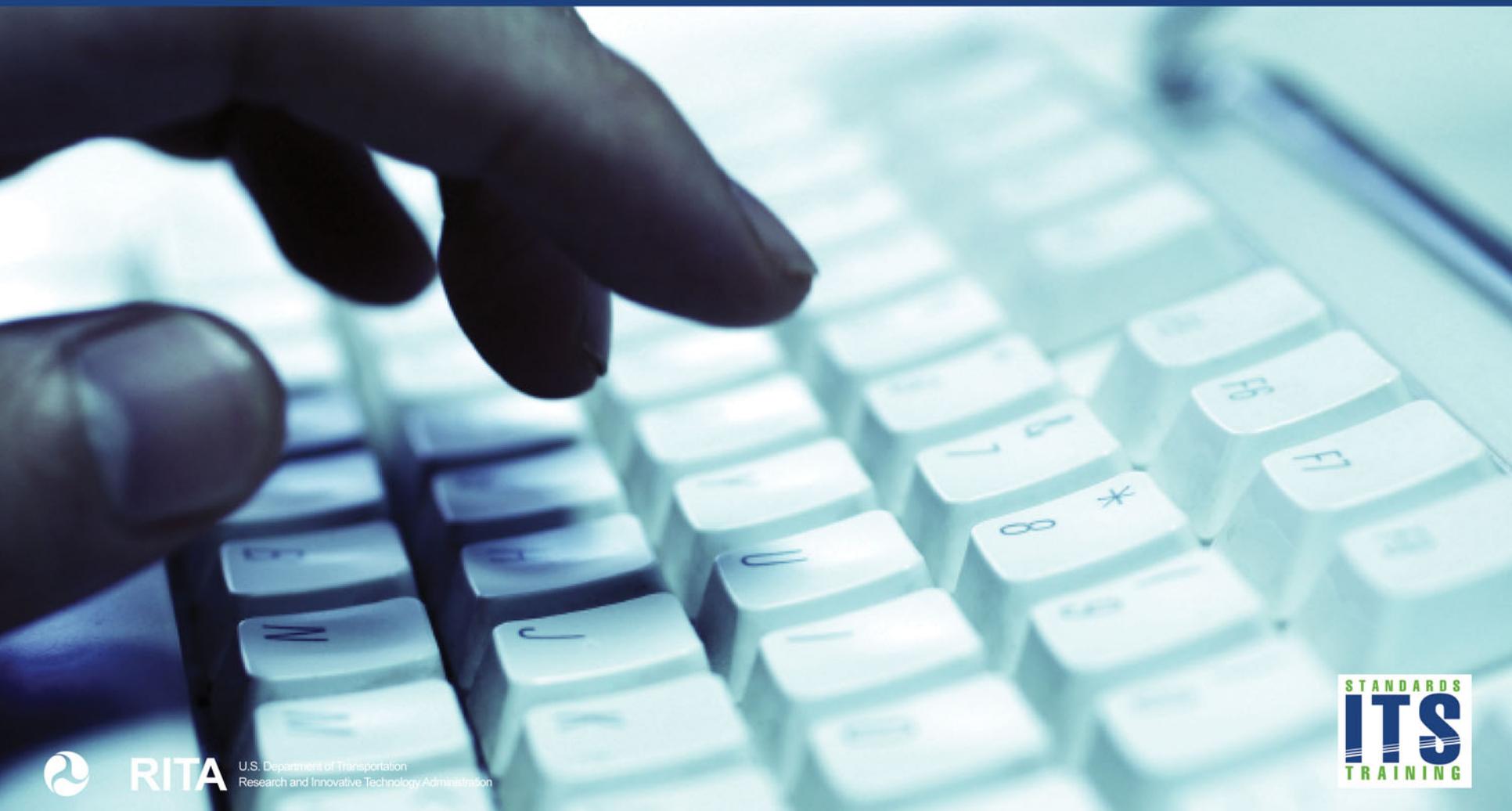
Verification

- **Subsystem Verification** – e.g., tests a TMDD system interface and its immediate environment, typically under laboratory or center environment
- **System Verification & Deployment** – e.g., Tests the entire TMDD system, including the TMC software





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Which of the following is NOT a reason to perform testing?

Answer Choices

- a) Develop Concept of Operations
- b) Verify requirements are fulfilled
- c) Validate the user needs are satisfied
- d) Assess a system upgrade versus the existing system

Review of Answers



a) Develop Concept of Operations

Correct! ConOps belongs in the definition phase of the system life cycle.



b) Verify requirements are fulfilled

Incorrect; this is a reason for testing.



c) Validate the user needs are satisfied

Incorrect; this is a reason for testing.



d) Assess a system upgrade against the existing system

Incorrect; this is a reason for testing.



Summary of Learning Objective #1

Describe within the context of a testing life cycle the role of a test plan and the testing to be undertaken

- Explain why testing is important within the life cycle of a system.
- Identify how to break up (partition) the testing (meaning verification of requirements), and when, during the system development life cycle, requirements are tested



Learning Objective #2 – Recognize the Purpose, Structure, and Content of a Well-Written Test Plan for a TMDD-based System Interface

- Identify the purpose of a test plan
- Describe the components of a test plan and explain the purpose of each component



What is a Test Plan?

IEEE 829 Defines a Test Plan as:

- A document describing the scope, approach (technical and management), resources, schedule of intended test activities, and deliverables.
 - Identifies the risks and their contingencies
- The document may be a Master Test Plan or a Level Test Plan
- Covered in detail in Module T201 – How to Write a Test Plan

Test Plans are not defined in the TMDD standard

Test Plans

A Test Plan is a high-level plan that defines:

- What item is to be tested?
 - Identifies the scope of the test plan
 - *What portions of the TMDD-based system interface (portion of the TMDD standard) you are going to test and in what order?*

- What features are to be tested?
 - Identifies the features to be tested
 - *What TMDD v3.03 requirements will be tested?*

Types of Test Plans

- There may be a separate Test Plan for each type of testing:
 - Unit/Device Test Plan
 - Subsystem Verification Plan (System Integration)
 - System Verification Plan (System Acceptance)
 - System Validation Plan
 - Periodic Maintenance

- Master Test Plan
 - Describes how all the test plans work together to verify and validate the system

Approach to Test Plans

- What is the overall approach to testing?
 - Permit identification of the major testing tasks and estimation of time
 - Trace the requirements to be tested
 - Identify significant constraints such as item availability, resource availability, and deadlines

- *Answers the questions*
 - *Does the test item conform to the standard?*
 - *Does the system exhibit the functionality defined in the specifications?*

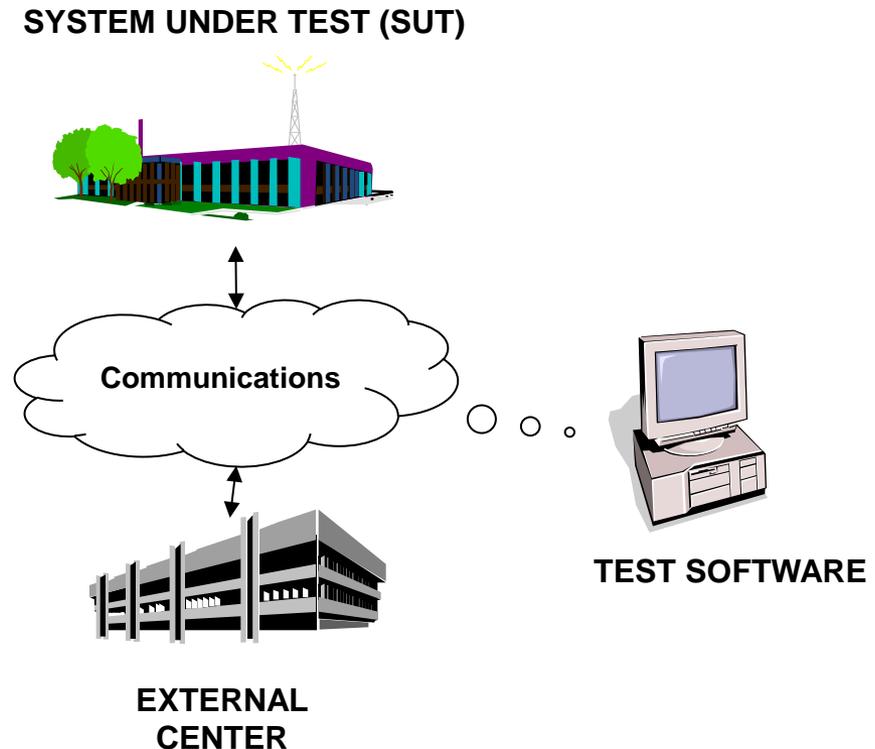
Approach to Test Plans (cont.)

- What are the pass/fail criteria?
 - Identifies the criteria to determine whether each test item has passed or failed testing.

- What are the suspension criteria and resumption requirements?
 - Specifies the criteria to suspend all or a portion of the testing activities.
 - Specifies the criteria for regression testing (repeating testing activities) and when testing is resumed.

Test Environment

- How is the item to be tested?
 - Identifies the test environment (*environmental needs*) to be used for executing the test plan, such as facilities, hardware, communications, system software, and pre-conditions for testing.

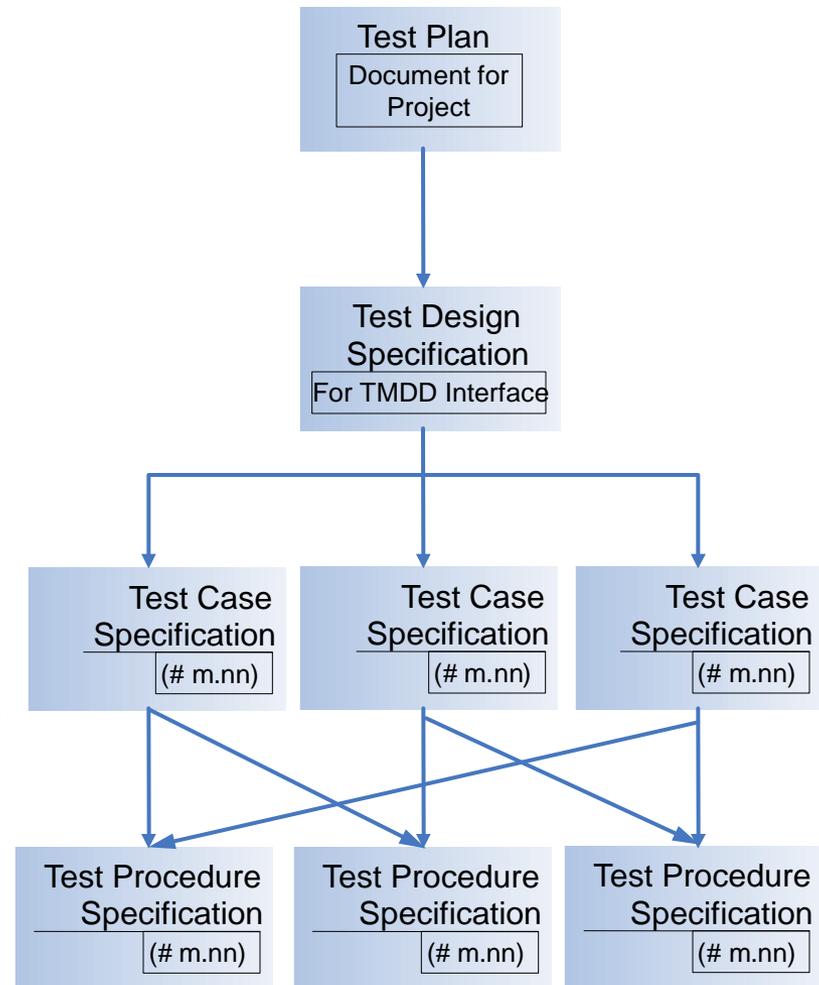


Test Plan Deliverables

- What are the test deliverables?
 - **Test Design Specifications.** Specifies the test approach for a feature or combination of features and identifying the associated tests.
 - **Test Case Specifications.** Specifies inputs, predicted results, and a set of execution conditions for a test item.
 - **Test Procedure Specifications.** Specifies a sequence of actions for the execution of a test.
 - **Test Reports.** Summarizes the results of the testing activities and results, including any incidents.

Example Framework for Test Documentation

- A **Test Plan** may consist of several **Test Design Specifications** (e.g., unit test, integration test, acceptance test)
- There may be a separate Test Design Specification for each implementation
- Each Test Design Specification may consist of several **Test Case Specifications** and **Test Procedure Specifications**



Test Plan – Staff and Resources

- Who is to test the item?
 - Identifies the roles and responsibilities for each person in managing, designing, preparing, executing, and resolving.

- What staffing and training is needed?
 - Specify staffing needs by skills, and identify training options for providing necessary skills.
 - *Project managers, programmers, test managers, TMC supervisors?*

Test Plan – Schedule, Risk, Approvals

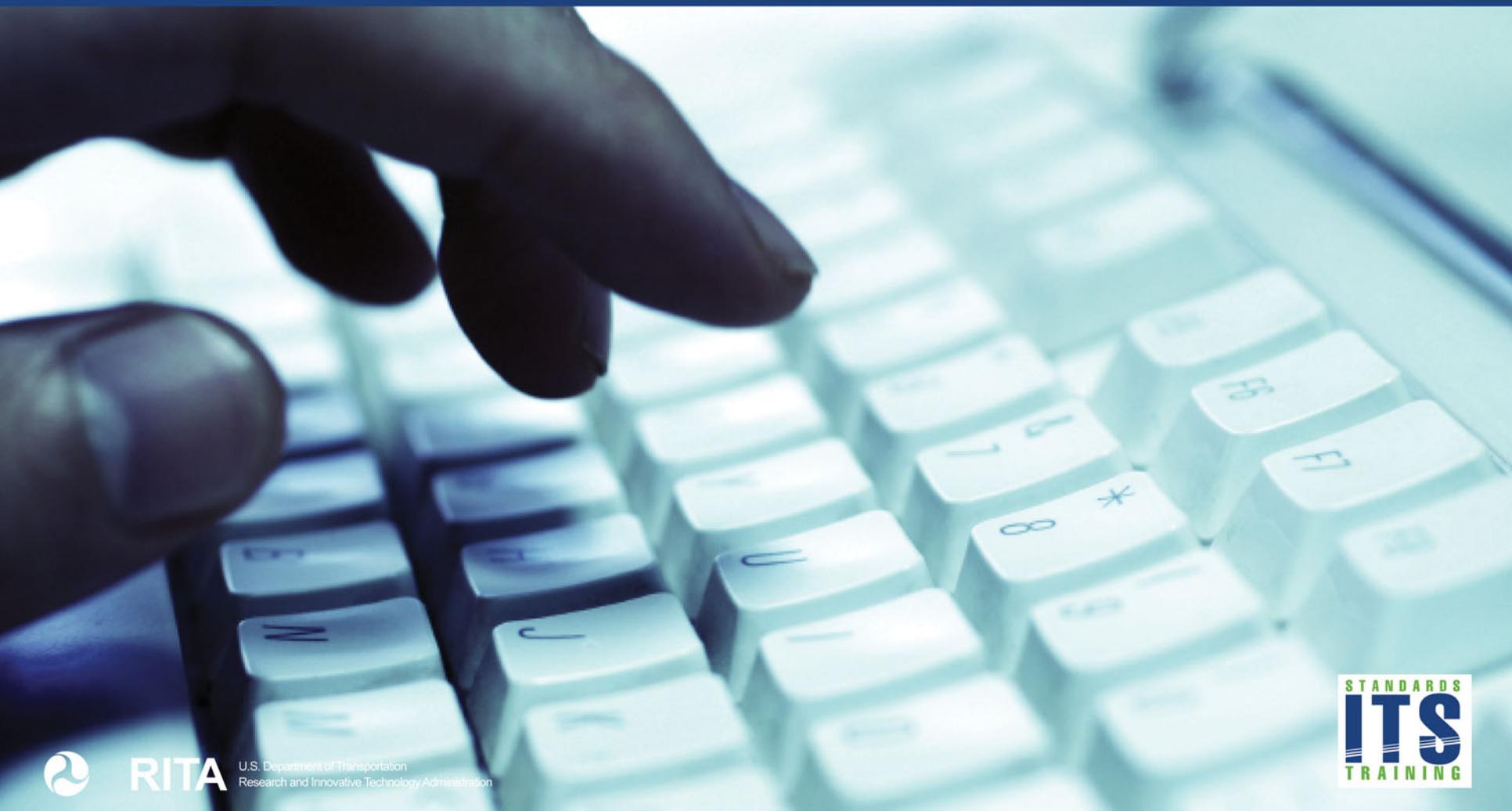
- When is the testing to take place?
 - Identifies the testing milestones, including testing dependencies, submittals, time to perform each task, and testing resources.

- What are the risks and contingency plans?
 - Identifies the high risk assumptions of the test plan and specifies contingency plans for each.

- Who needs to approve the test plans?



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Which of the following does NOT belong in a well-written test plan?

Answer Choices

- a) Testing Environment
- b) Testing Plan Staff Requirements
- c) Pass/Fail Criteria
- d) Sequence of Actions to be Performed

Review of Answers



a) Testing Environment

Incorrect; the testing environment is defined in a test plan.



b) Testing Plan Staff Requirements

Incorrect; staffing requirements are defined in a test plan.



c) Pass/Fail Criteria

Incorrect; the pass/fail criteria is part of a test plan.



d) Sequence of Actions to be Performed

Correct! the sequence of actions to be performed are part of the Test Procedures Specifications.



Summary of Learning Objective #2

Recognize the purpose, structure, and content of a well-written test plan for a TMDD-based system interface

- Identify the purpose of a test plan
- Describe the components of a test plan and explain the purpose of each component





Learning Objective #3 – Describe the application of a good test plan to a TMDD-based system being procured using a sample TMDD test plan

- Describe the structure of the TMDD v3.03 Standard
- Explain what is and is not tested when testing a TMDD-based system
- Review a sample test plan for a TMDD-based system

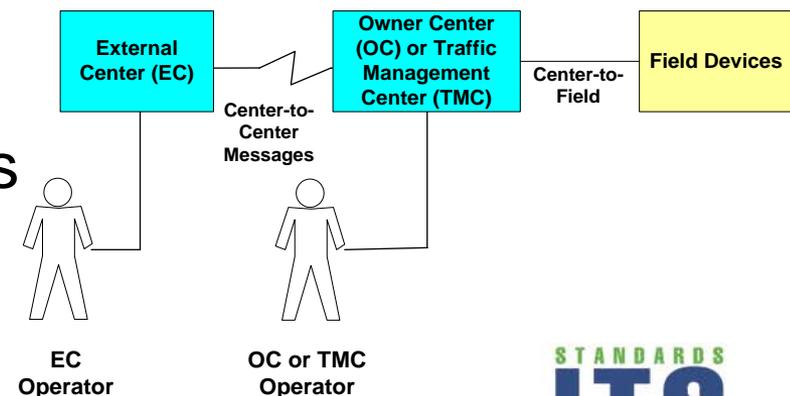


Traffic Management Data Dictionary (TMDD)

What is TMDD?

- TMDD is a communications system interface standard designed primarily for the traffic management domain
 - TMDD contains a data dictionary (vocabulary) to exchange incident information, traffic network information, and the monitoring and control of devices operated by a remote center

- TMDD data concepts are also utilized by other ITS applications such as incident management



Content of the TMDD

Recall Structure of the Standard

- Defines user needs
- Defines requirements
- Defines a **single** design for each requirement supported by the standard
 - Supports interoperability between a traffic management center and other centers (e.g., other traffic management, transit, public safety, maintenance, planning organizations, etc...)

Content of the TMDD (cont.)

- **NRTM (Needs to Requirements Matrix)**
 - ❑ Traces a user need and the requirements that satisfies the user need
 - ❑ A completed NRTM indicates what requirements (features) have been selected for the procurement specification

- **RTM (Requirements Traceability Matrix)**
 - ❑ Defines the design (dialogs, messages, and data elements) that must be used to fulfill a requirement.

Test Plan for a TMDD-based System

What are we testing?

- Compliance with the procurement specification - Does the TMDD-based system fulfill all the requirements (*shall* statements) in the procurement specification?
- Conformance with the TMDD Standard - Does the TMDD-based system fulfill the mandatory requirements identified by the standard. The TMDD-based system must also fulfill other specified (user-selected) requirements of TMDD and the standards it references.
- Conformance is NOT compliance!

Testing a TMDD-based System (cont.)

What is being tested?

- Testing that the proper protocols are being used?
 - E.g., NTCIP 2304 or NTCIP 2306
- Testing that the data exchanges occur as defined by the standard?
 - Sequence of request-response messages
 - Sequence of subscription and publication messages
 - Correct handling of error messages
 - Correct structure of the TMDD messages
 - Correct data content is being exchanged

Testing a TMDD-based System (cont.)

T321 module does not directly address:

- How the data is used in the implementation's environment
 - It only verifies that the design content (interface) fulfills requirements so the operational needs are satisfied

- The operation(s) the implementation is attempting to support via the interface
 - E.g., this test plan does not consider how a device is monitored or controlled, how an operator views event information, or how a device queue or plan library is managed



Example Test Plan for a TMDD-based System

Introduction and Test Items

- Test Plan Identifier: *TP-TMDD-xxxx*
- Introduction:
 - Purpose: Verify center-to-center interface between Agency X and Agency Y complies with Interface Control Document version yyyy, and verify conformance with TMDD v3.03.
- Test Items:
 - C2C interface as defined in TMDD v3.03
 - Agency X ATMS software, Version nn.nn
 - Agency Y ATMS software, Version mm.mm

Example Test Plan for a TMDD-based System

- Features to be tested:
 - Verify Connection Active
 - Need to Provide Information on Organizations, Centers, and Contacts
 - Need for An Index of Events
 - Need for Node Inventory
 - Need for Link Inventory
 - Need to Share DMS Inventory
 - Need to Share DMS Status
 - Need for Roadway Characteristics Data

Example Test Plan for a TMDD-based System Needs To Requirements Matrix (NRTM)

UN ID	User Need	Requirement ID	Requirement	Conformance	Support	Other Requirements
2.3.2	Need to Provide Information on Organizations, Centers, and Contacts			Optional	Yes / No	
		Dialogs				
		3.3.2.1	Send Organization Information Upon Request	M	Yes	The owner center shall respond within ____ (100 ms – 1 hour; Default = 1 minute) after receiving the request.
		3.3.2.2	Publish Organization Information	Subscription:O	Yes / No / NA	The owner center shall begin sending the updated response message within ____ (100 ms – 24 hours; Default = 15 minutes) after the information is updated in the owner center.
		3.3.2.3	Subscribe to Organization Information	Subscription:O	Yes / No / NA	
		Request Message				
		3.3.2.4	Contents of the Organization Information Request	M	Yes	
		3.3.2.4.1	Required Organization Information Request Content	M	Yes	
		3.3.2.4.2.1	Authentication - Organization Information (AuthOrg)	O	Yes / No	
		3.3.2.4.2.1.1	Operator Identifier - Organization Information	AuthOrg:O	Yes / No / NA	
		3.3.2.4.2.2	Owner Organization Identifier	O	Yes / No	
		3.3.2.4.2.3	Owner Center Identifier	O	Yes / No	
		Response Message				
		3.3.2.5	Contents of the Organization and Centers Information	M	Yes	
		3.3.2.5.1	Required Organization Information Content	M	Yes	
		3.3.2.5.2.1	Organization Name	O	Yes / No	
		3.3.2.5.2.2	Organization Location	O	Yes / No	
		3.3.2.5.2.3	Organization Function Description	O	Yes / No	
		3.3.2.5.2.4	Organization Contact Information	O	Yes / No	

Example Test Plan for a TMDD-based System

- Approach:
 - Organize tests by the selected features in the completed NRTM
 - Modular Test Procedure Design (some data concepts fulfill multiple individual requirements, e.g., the data frame *organizationInformation*)
 - Discuss how results are logged.
- Items Pass/Fail:
 - To pass the test, the item under test shall pass all test procedures associated with requirements for the test item identified in the NRTM.

Example Test Plan for a TMDD-based System

- Suspension Criteria and Resumption Requirements:
 - The test may be suspended between the performance of any two test procedures
 - A test shall always resume at the start of a test procedure
 - Any modifications to the test item(s) may require performing a regression test

Example Test Plan for a TMDD-based System

- Test Deliverables:
 - Test Plan: *TP-TMDD-xxxx*
 - Test Design Specification: TD-TMDD-xxxx
 - Test Case Specifications: TC-TMDD-xxxx
 - Test Procedure Specifications: TPS-TMDD-xxxx
 - Test Transmittal Reports
 - Test Log Reports
 - Test Incident Reports
 - Test Summary Reports

Example Test Plan for a TMDD-based System

- Testing Tasks:
 - Develop Test Documentation (Test Plan, Test Design Specifications, Test Case Specifications, Test Procedure Specification)
 - Training Workshop
 - Prepare for Testing
 - Conduct test and generate test logs
 - Prepare Test Summary Report
 - Transmit test documentation to project manager

Example Test Plan for a TMDD-based System

- Environmental Needs:
 - Test environment (facility, software programs); test items (ATMS software version); test hardware (laptops, servers, line analyzers, cabling, projectors, external drives for collecting test logs); test software (software programs, test database); documentation (TMDD v3.03 Standard in hardcopy, Test Plan in hardcopy)
- Staffing and Training Needs
 - Project Manager [Training – Yes], Test Analyst [Yes], Systems Integrator, QA/QC Manager [Yes]

Example Test Plan for a TMDD-based System

- Responsibilities
 - Project Manager - approve test plan; work with Team members to address concerns; witness the performance of the test; approve completion of tests
 - Test Analyst - develop the test documentation; prepare the test environment; execute tests according to the test plan; verify test results against TMDD v3.03 standard
 - Systems Integrator - witness the performance of the tests; resolve issues from the performance of the test; resolve areas of non-conformance

Example Test Plan for a TMDD-based System

- Schedule
 - Approval of Test Plan (*TP-TMDD-xxxx*): NTP
 - Review and Documentation of Test Certificates and Test Setup: NTP + 9 days
 - Perform *TD-TMDD-xxxx*, *TC-TMDD-xxxx*: NTP + 10 days
 - Review Test Log Reports and Test Summary Reports: NTP + 20 to NTP + 25 days
 - Recommendation (Approve, No Approval): NTP + 30 to NTP to 35 days

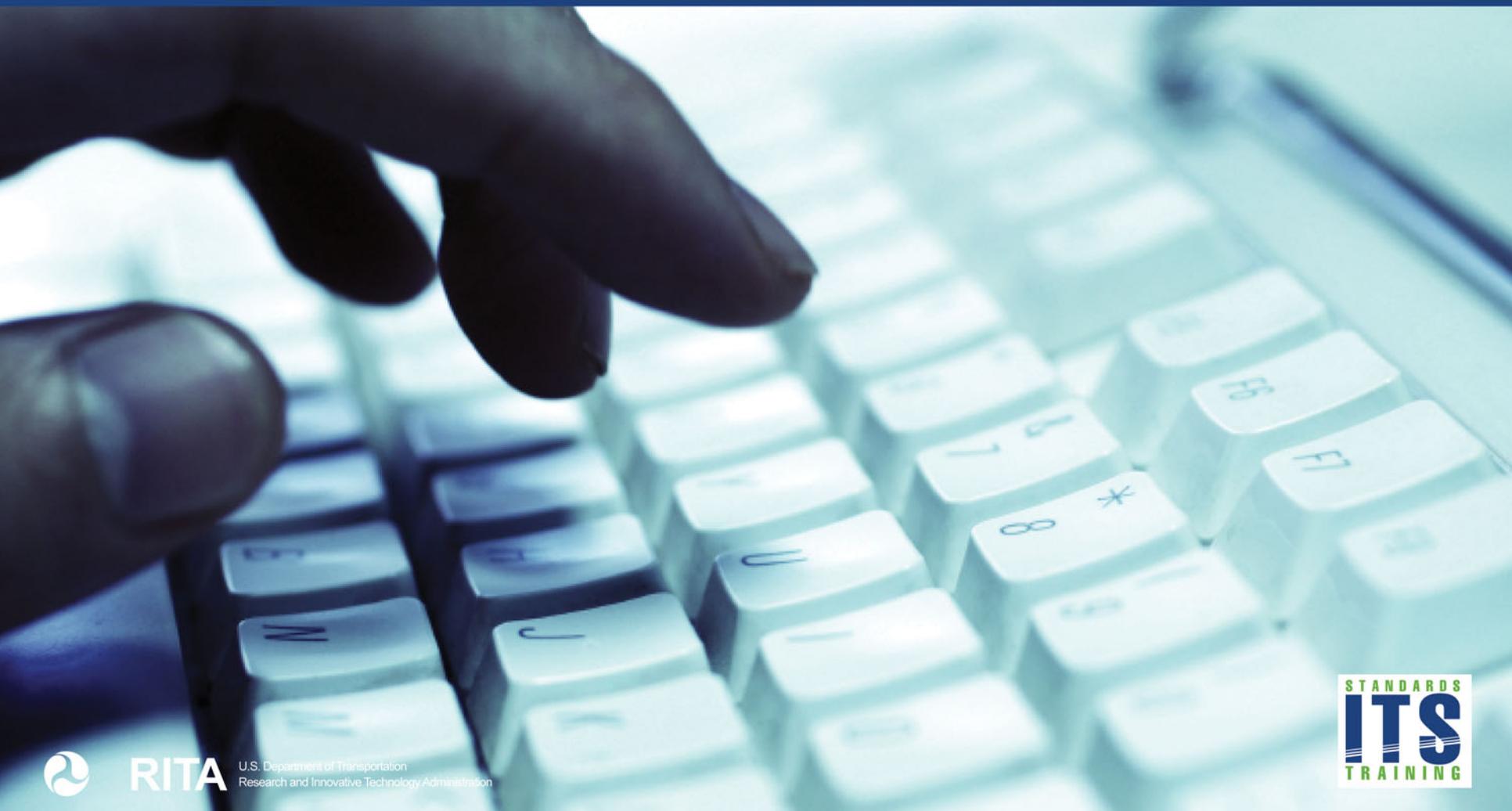
Example Test Plan for a TMDD-based System

- Risk and Contingencies
 - Unable to complete all Test Procedures on schedule.
 - *Schedule remaining test procedures*
 - Agency X ATMS software and Agency Y ATMS software are unable to successfully exchange information – *Conduct preliminary spot check if any major issues exist.*

- Approvals
 - Names and titles of all persons to approve this plan.



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Which of the following is NOT in the TMDD Standard v3.03?

Answer Choices

- a) Needs to Requirements Traceability Matrix
- b) Requirements Traceability Matrix
- c) Requirements to Test Case Traceability Matrix
- d) A single design to fulfill each requirement

Review of Answers



a) Needs to Requirements Traceability Matrix
Incorrect; a NRTM is included in the Standard.



b) Requirements Traceability Matrix
Incorrect; an RTM is included in the Standard.



c) Requirements to Test Case Traceability Matrix
Correct! this Matrix is not included in the Standard.



d) A single design to fulfill each requirement
Incorrect; a single design is defined for each requirement in the Standard.



Summary of Learning Objective #3

Describe the application of a good test plan to a TMDD-based system being procured using a sample TMDD test plan

- Described the structure of the TMDD v3.03 Standard
- Explained what is and is not to be tested when testing a TMDD-based system
- Reviewed a sample test plan for a TMDD-based system





Learning Objective #4 - Identify the process to write a test plan in the context of the requirements of TMDD that have been selected by the user

- Use the NRTM to identify the features to be tested
- Use the RTM to determine the standard design to verify a requirement
- Create a Requirements to Test Case Traceability Matrix
 - Indicates the test case(s) that must be passed for the requirement to be fulfilled
 - Verifies that the test cases capture testing of all requirements at least once

Process to Writing TMDD-based Test Plans

NRTM

UN ID	User Need	Requirement ID	Requirement	Conformance	Support	Other Requirements
2.3.2	Need to Provide Information on Organizations, Centers, and Contacts			Optional	Yes / No	
		Dialogs				
		3.3.2.1	Send Organization Information Upon Request	M	Yes	The owner center shall respond within ____ (100 ms – 1 hour; Default = 1 minute) after receiving the request.
		3.3.2.2	Publish Organization Information	Subscription:O	Yes / No / NA	The owner center shall begin sending the updated response message within ____ (100 ms – 24 hours; Default = 15 minutes) after the information is updated in the owner center.
		3.3.2.3	Subscribe to Organization Information	Subscription:O	Yes / No / NA	
		Request Message				
		3.3.2.4	Contents of the Organization Information Request	M	Yes	
		3.3.2.4.1	Required Organization Information Request Content	M	Yes	
		3.3.2.4.2.1	Authentication - Organization Information (AuthOrg)	O	Yes / No	
		3.3.2.4.2.1.1	Operator Identifier - Organization Information	AuthOrg:O	Yes / No / NA	
		3.3.2.4.2.2	Owner Organization Identifier	O	Yes / No	
		3.3.2.4.2.3	Owner Center Identifier	O	Yes / No	
		Response Message				
		3.3.2.5	Contents of the Organization and Centers Information	M	Yes	
		3.3.2.5.1	Required Organization Information Content	M	Yes	
		3.3.2.5.2.1	Organization Name	O	Yes / No	
		3.3.2.5.2.2	Organization Location	O	Yes / No	
		3.3.2.5.2.3	Organization Function Description	O	Yes / No	
		3.3.2.5.2.4	Organization Contact Information	O	Yes / No	

Process to Writing TMDD-based Test Plans (cont.)

RTM

- The Requirements Traceability Matrix (RTM) in the TMDD Standard defines a single (standard) design (in the form of dialogs, messages, data frames, data elements) that must be supported to fulfill a requirement.
 - Dialogs are the sequence of data exchanges that are defined by the standard

Process to Writing TMDD-based Test Plans (cont.)

RTM

Req ID (Vol. I)	Requirement	Dialog	DC Type	Definition Class Name	DC ID (Vol. II)	Data Concept Instance Name
3.3.5.5.1.1	Send DMS Inventory Information Upon Request	2.4.1	dialog	dIDMSInventoryRequest	3.1.6.1	dIDMSInventoryRequest
3.3.5.5.1.2	Publish DMS Inventory Information	2.4.2	dialog	dIDMSInventoryUpdate	3.1.24.1	dIDMSInventoryUpdate
3.3.5.5.1.3	Subscribe to DMS Inventory Information	2.4.3	dialog	dIDeviceInformationSubscription	3.1.5.3	dIDeviceInformationSubscription
3.3.5.5.1.4	Contents of the DMS Inventory Request		message	deviceInformationRequestMsg	3.2.5.4	deviceInformationRequestMsg
3.3.5.5.1.5	Contents of the DMS Inventory Information		message	dMSInventoryMsg	3.2.6.4	dMSInventoryMsg
3.3.5.5.1.5.1	Required DMS Inventory Content		data-frame	deviceInventoryHeader	3.3.5.8	device-inventory-header
3.3.5.5.1.5.1	Required DMS Inventory Content		data-element	dmsSignType	3.6.3.25	dms-sign-type
3.3.5.5.1.5.2.1	Sign Technology		data-element	dmsSignTechnology	3.6.2.21	signTechnology

Process to Writing TMDD-based Test Plans (cont.)

RTM

Req ID (Vol. I)	Requirement	Dialog	DC Type	Definition Class Name	DC ID (Vol. II)	Data Concept Instance Name
3.3.5.5.1.1	Send DMS Inventory Information Upon Request	2.4.1	dialog	dIDMSInventoryRequest	3.1.6.1	dIDMSInventoryRequest
3.3.5.5.1.2	Publish DMS Inventory Information	2.4.2	dialog	dIDMSInventoryUpdate	3.1.24.1	dIDMSInventoryUpdate
3.3.5.5.1.3	Subscribe to DMS Inventory Information	2.4.3	dialog	dIDeviceInformationSubscription	3.1.5.3	dIDeviceInformationSubscription
3.3.5.5.1.4	Contents of the DMS Inventory Request		message	deviceInformationRequestMsg	3.2.5.4	deviceInformationRequestMsg
3.3.5.5.1.5	Contents of the DMS Inventory Information		message	dMSInventoryMsg	3.2.6.4	dMSInventoryMsg
3.3.5.5.1.5.1	Required DMS Inventory Content		data-frame	deviceInventoryHeader	3.3.5.8	device-inventory-header
3.3.5.5.1.5.1	Required DMS Inventory Content		data-element	dmsSignType	3.6.3.25	dms-sign-type
3.3.5.5.1.5.2.1	Sign Technology		data-element	dmsSignTechnology	3.6.2.21	signTechnology

Process to Writing TMDD-based Test Plans (cont.)

RTM

Req ID (Vol. I)	Requirement	Dialog	DC Type	Definition Class Name	DC ID (Vol. II)	Data Concept Instance Name
3.3.5.5.1.1	Send DMS Inventory Information Upon Request	2.4.1	dialog	dIDMSInventoryRequest	3.1.6.1	dIDMSInventoryRequest
3.3.5.5.1.2	Publish DMS Inventory Information	2.4.2	dialog	dIDMSInventoryUpdate	3.1.24.1	dIDMSInventoryUpdate
3.3.5.5.1.3	Subscribe to DMS Inventory Information	2.4.3	dialog	dIDeviceInformationSubscription	3.1.5.3	dIDeviceInformationSubscription
3.3.5.5.1.4	Contents of the DMS Inventory Request		message	deviceInformationRequestMsg	3.2.5.4	deviceInformationRequestMsg
3.3.5.5.1.5	Contents of the DMS Inventory Information		message	dMSInventoryMsg	3.2.6.4	dMSInventoryMsg
3.3.5.5.1.5.1	Required DMS Inventory Content		data-frame	deviceInventoryHeader	3.3.5.8	device-inventory-header
3.3.5.5.1.5.1	Required DMS Inventory Content		data-element	dmsSignType	3.6.3.25	dms-sign-type
3.3.5.5.1.5.2.1	Sign Technology		data-element	dmsSignTechnology	3.6.2.21	signTechnology

Process to Writing TMDD-based Test Plans (cont.)

RTM

Req ID (Vol. I)	Requirement	Dialog	DC Type	Definition Class Name	DC ID (Vol. II)	Data Concept Instance Name
3.3.5.5.1.1	Send DMS Inventory Information Upon Request	2.4.1	dialog	dIDMSInventoryRequest	3.1.6.1	dIDMSInventoryRequest
3.3.5.5.1.2	Publish DMS Inventory Information	2.4.2	dialog	dIDMSInventoryUpdate	3.1.24.1	dIDMSInventoryUpdate
3.3.5.5.1.3	Subscribe to DMS Inventory Information	2.4.3	dialog	dIDeviceInformationSubscription	3.1.5.3	dIDeviceInformationSubscription
3.3.5.5.1.4	Contents of the DMS Inventory Request		message	deviceInformationRequestMsg	3.2.5.4	deviceInformationRequestMsg
3.3.5.5.1.5	Contents of the DMS Inventory Information		message	dMSInventoryMsg	3.2.6.4	dMSInventoryMsg
3.3.5.5.1.5.1	Required DMS Inventory Content		data-frame	deviceInventoryHeader	3.3.5.8	device-inventory-header
3.3.5.5.1.5.1	Required DMS Inventory Content		data-element	dmsSignType	3.6.3.25	dms-sign-type
3.3.5.5.1.5.2.1	Sign Technology		data-element	dmsSignTechnology	3.6.2.21	signTechnology

Process to Writing TMDD-based Test Plans (cont.)

Design

- Below is the dialog that fulfills this requirement.

3.1.6.1.2 ASN.1 REPRESENTATION

```

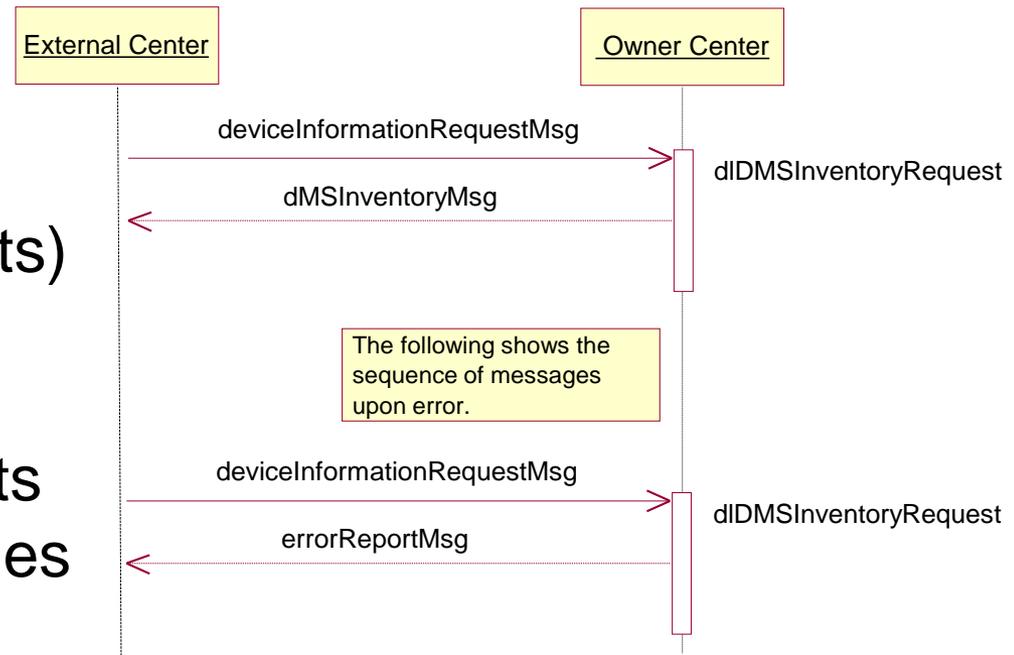
dIDMSInventoryRequest ITS-INTERFACE-DIALOGUE ::= {
  DESCRIPTIVE-NAME      "ExternalCenter<-DIDMSInventoryRequest->OwnerCenter"
  ASN-NAME              "DIDMSInventoryRequest"
  ASN-OBJECT-IDENTIFIER { tmddDialogs 16 }
  URL "R-R.gif"
  DEFINITION "A request-response dialog that allows an external center to request an owner center to provide an inventory of
    the owner center's dynamic message signs."
  DESCRIPTIVE-NAME-CONTEXT {"Manage Traffic"}
  ARCHITECTURE-REFERENCE {"device data"}
  ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
  ARCHITECTURE-VERSION {"7.0"}
  DATA-CONCEPT-TYPE interface-dialogue
  STANDARD "TMDD"
  REFERENCED-MESSAGES {
    { tmddMessages 20 }, -- deviceInformationRequestMsg (Input Message)
    { tmddMessages 25 }, -- dMSInventoryMsg (Output Message)
    { tmddMessages 10 } -- errorReportMsg (Fault Message)
  }

```

Process to Writing TMDD-based Test Plans (cont.)

Design

- The test should confirm that the interface:
 - performs the same sequence of data exchanges (and events) as defined in the standard
 - uses the data concepts (messages, data frames or data elements) indicated in the RTM



Process to Writing TMDD-based Test Plans (cont.)

Requirements to Test Case Traceability Matrix

- Create a Requirements to Test Case Traceability Matrix (RTCTM)
 - Traces each requirement selected to the test case(s) that verifies that the implementation fulfills the requirement
 - Used to verify that the test cases capture testing of all requirements at least once.
- One or more test cases may be needed to completely test a requirement
 - Each test case may test a different set of values
 - Each test case may test different conditions

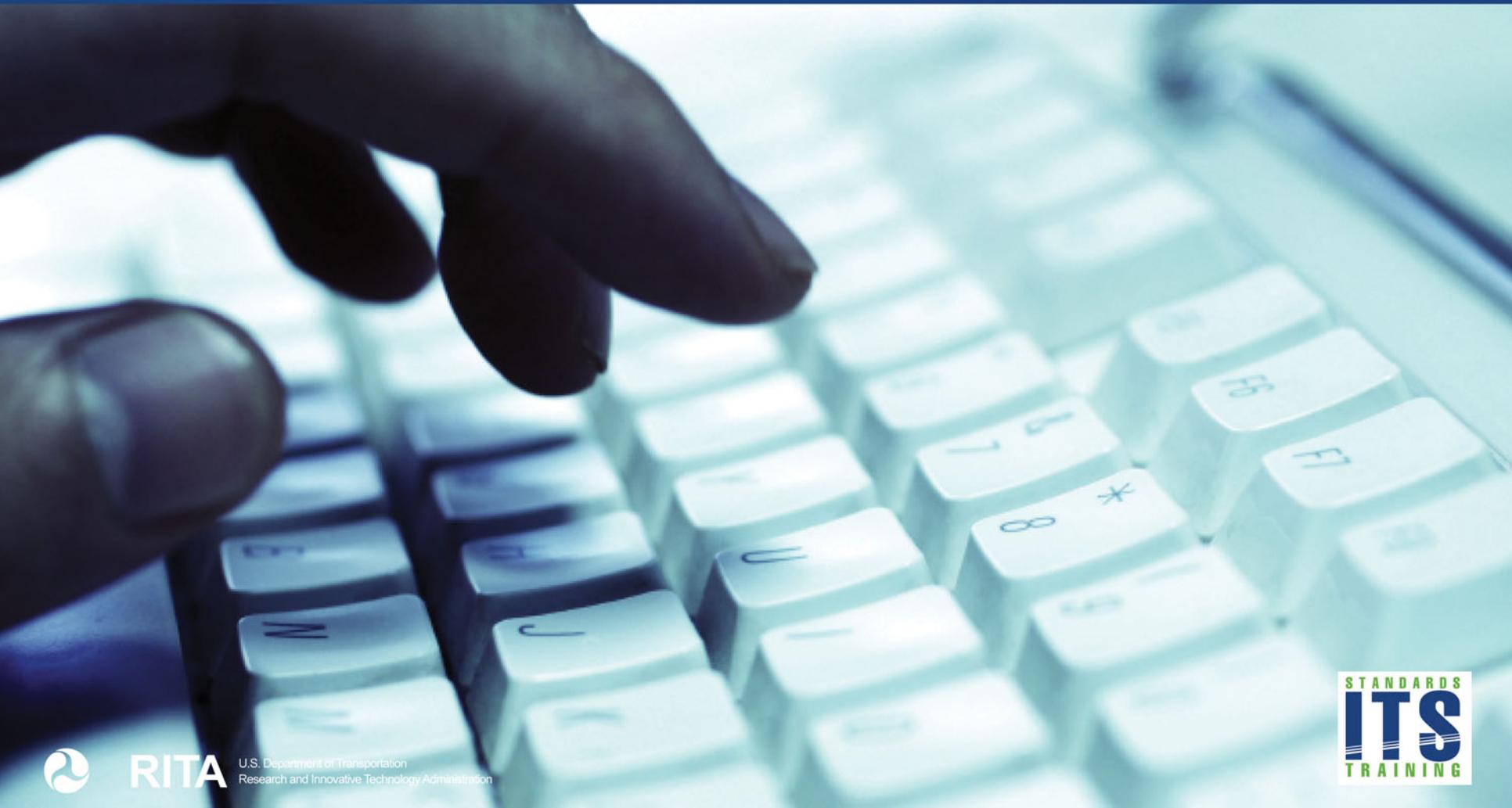
Process to Writing TMDD-based Test Plans (cont.)

Requirements to Test Case Traceability Matrix

Requirement		Test Case	
ID	Title	ID	Title
3.3.2.1	Send Organization Information Upon Request		
		TCS-1.2.1	Verify Organization Information with No Errors
		TCS-1.2.2	Verify Organization Information with Errors
3.3.2.4	Contents of the Organization Information		
		TCS-1.2.1	Verify Organization Information with No Errors
		TCS-1.2.2	Verify Organization Information with Errors



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Which of the following is part of the Requirements to Test Case Traceability Matrix?

Answer Choices

- a) User Needs
- b) Requirements
- c) Design
- d) Test Plans

Review of Answers



a) User Needs

Incorrect; user needs only appear in a NRTM.



b) Requirements

Correct! requirements are part of the matrix.



c) Design

Incorrect; design only appears in an RTM.



d) Test Plans

Incorrect; Test Cases are part of the RTCTM.

Summary of Learning Objective #4

Identify the process to write a test plan in the context of the requirements of TMDD that have been selected by the user

- Use the NRTM to identify the features to be tested
- Use the RTM to determine the standard design to verify a requirement
- Create a Requirements to Test Case Traceability Matrix
 - Indicates the test case(s) that must be passed for the requirement to be fulfilled
 - Verifies that the test cases capture testing of all requirements at least once





Learning Objective #5 – Analyze how to ensure conformance with the TMDD v3.03 Standard

- Review the Key Elements of the Conformance Statement
- Discuss extensions to the TMDD Standard



Conformance for a TMDD-based System

- Interoperability is the ability of different components, or for the purpose of this module, different TMDD-based implementations from different vendors, to exchange information and to use the information that has been exchanged.
 - Interoperability is a key objective for using the standards
 - Interoperability reduces risks and, by extension, costs.

Conformance for a TMDD-based System

- TMDD supports interoperability by defining a single (standard) design (in the form of dialogs, messages, data frames, data elements) to fulfill each requirement supported by the standard.
 - It defines the sequence of events (actions) and the data that must be exchanged.
 - All systems shall fulfill a requirement ***the same way.***
- By ***conforming*** to a standard – achieve interoperability.

Conformance for a TMDD-based System

- **To claim conformance to the TMDD Standard:**
 - An implementation shall satisfy all user needs identified as Mandatory in the NRTM; and all user needs identified as Optional in the NRTM, but was selected (to be supported) for the implementation

- **To claim conformance to a user need in the TMDD Standard:**
 - An implementation shall fulfill all requirements that trace to the user need identified as Mandatory in the NRTM; and all requirements that trace to the user need identified as Optional in the NRTM, but was selected (to be supported) for the implementation

Conformance for a TMDD-based System

- **To claim conformance to a requirement in the Standard**
 - An implementation fulfill a requirement by using all of the data concepts (dialogs, messages, data frames, and data elements) traced to the requirement in the RTM in the manner specified by this Standard or the referenced Standard

Conformance for a TMDD-based System

- TMDD Standard allows for extensions to support operational or user needs not supported by the Standard
 - Benefits include it allows an implementation to add functions not supported by the standard
 - By definition, implementations that add extensions are ***no longer conformant*** to the standard

- With extensions, interoperability may be compromised
 - Other centers must support extensions in a consistent manner to support interoperability
 - Test documentation needs to be expanded to support extensions



Conformance for a TMDD-based System

- **To be consistent with the TMDD Standard, the following rules shall apply:**
 - ❑ All functional requirements already supported by the Standard must be implemented as defined by the Standard
 - ❑ Different interpretations of the meaning of a data concept or how it is to be used requires a new data concept
 - ❑ A conformant center receiving a message must ignore any attributes or elements in a message that it does not recognize but shall process what it understands



Conformance for a TMDD-based System

- **To be consistent with the TMDD Standard, the following rules shall apply:**
 - ❑ New data elements may be added but cannot reuse an existing data element name
 - ❑ New enumerations may be added in a newly created data element, but cannot reuse an existing data element name
 - ❑ Extending the range of an existing data element requires that the data element be renamed
 - ❑ New messages may be added beyond those messages defined by the standard, but cannot reuse an existing message name

Conformance for a TMDD-based System

- **To be consistent with the TMDD Standard, the following rules shall apply:**
 - ❑ Dialogs contained in the Standard may not be modified. However, new dialogs may be added to support extensions.
 - ❑ All design extensions (e.g., dialogs, messages data frames, and data elements) shall be documented in a separate XML schema (or ASN.1 module).
 - ❑ All extensions shall be documented in a manner consistent with the presentation in the standard, and shall include the user needs being addressed, the requirements being fulfilled, and the traceability tables.

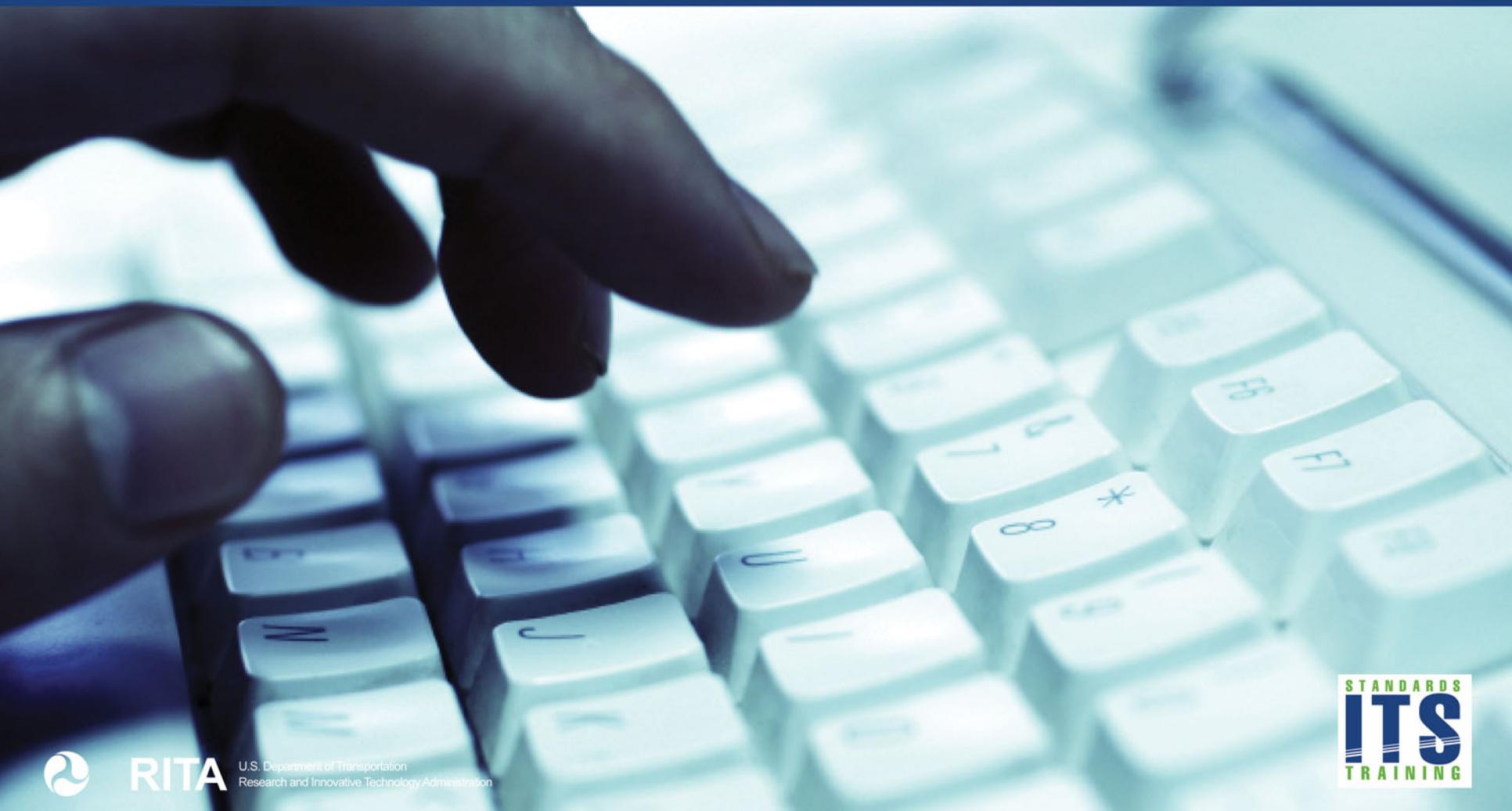
Conformance for a TMDD-based System

When adding extensions:

- NRTM should be updated to include any new user needs and any new requirements
- RTM should be updated to include the new data concepts (dialogs, messages, data frames and data elements) to fulfill each new requirement
- The Requirements to Test Case Traceability Matrix should be updated to reflect the Test Case Specifications and Test Procedure Specifications to be performed to test each new requirement



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Which of the following is permitted by the TMDD Standard?

Answer Choices

- a) Create a new message to fulfill a new requirement
- b) Change the meaning of an existing data element
- c) Create a new data element using an existing data element name
- d) Modify an existing dialog



Review of Answers



a) Create a new message to fulfill a new requirement

Correct! creating a new message to fulfill a new requirement is allowed.



b) Change the meaning of an existing data element

Incorrect; changing the meaning of an existing data element is not permitted.



c) Create a new data element using an existing data element name

Incorrect; reusing the name of an existing data concept for a new data concept is not permitted.



d) Modify an existing dialog

Incorrect; modifying an existing dialog is not permitted.



Summary of Learning Objective #5

Analyze how to ensure conformance with the TMDD v3.03 Standard

- Review the Key Elements of the Conformance Statement
- Discuss extensions to the TMDD Standard



Learning Objective #6 - Describe test documentation for TMDD: Test Plan, Test Design Specification, Test Case Specifications, and Test Reports

- Review the elements that comprise each type of test documentation that is part of a test plan
- Introduce the Reference Implementation



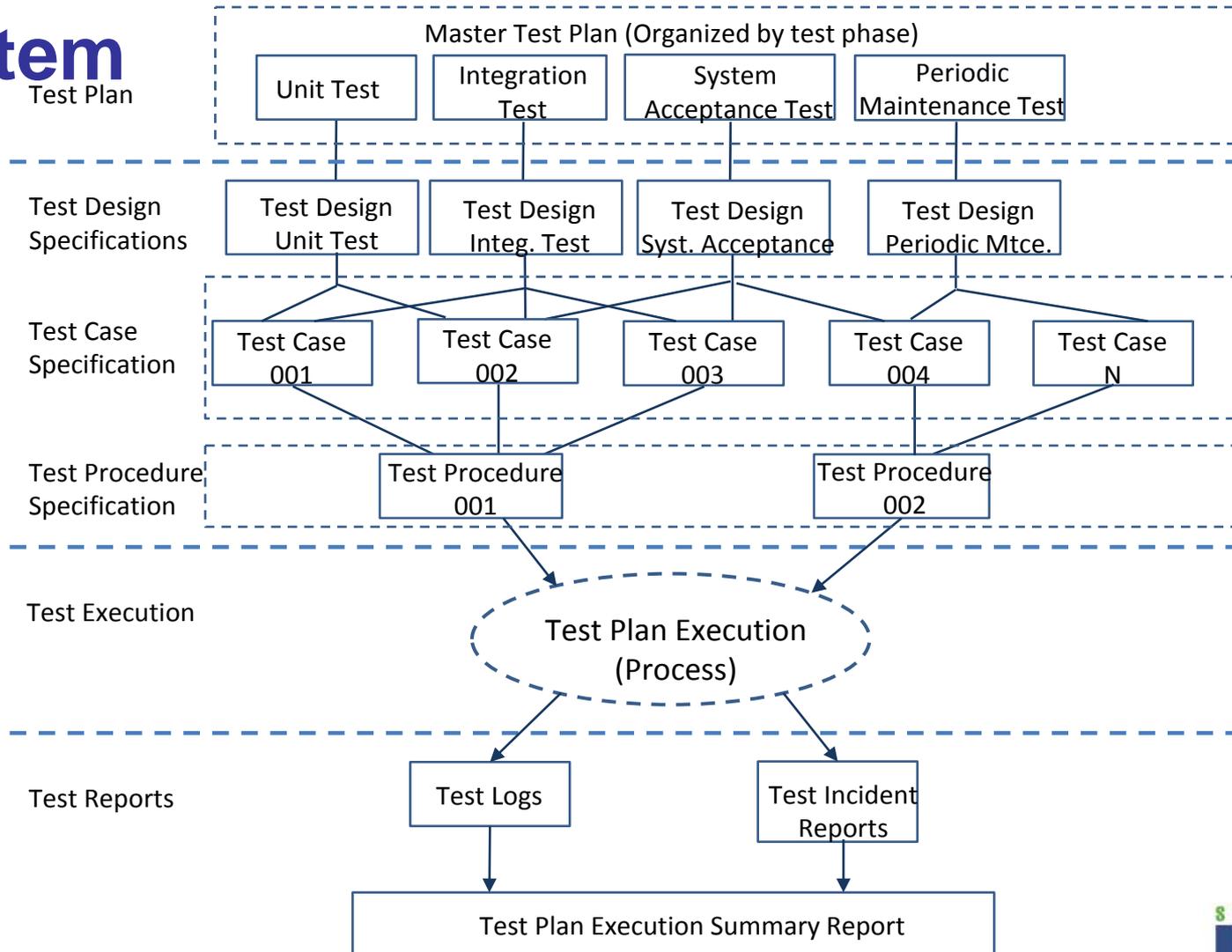
Test Documentation for a TMDD-based System

- Test Documentation, such as the Test Plan, can begin to be written after the user needs and requirements are finalized, e.g., after the NRTM has been completed and is finalized.

Test Documentation for a TMDD-based System (cont.)

"V" Element	TMDD Document	TMDD-based Test Document
Concept of Operations	Needs To Requirements Matrix	Basis for Test Plan
System Requirements	Requirements Traceability Matrix	Basis for Test Design Specifications
High-Level & Detailed Design	Dialogs, messages, data frames, and data elements	Basis for Test Case Specifications and Test Procedure Specifications
Implementation	Not Applicable	Basis for Test Execution and Resulting Test Reports

Test Documentation for a TMDD-based System



Test Documentation for a TMDD-based System (cont.)

- Test documentation development in the initial phase is an iterative process (with the exception of the test reports).
- Test documentation developers may need to work on several documents concurrently to maintain consistency (i.e., consistent referencing – e.g., Test Design to Test Cases)

Test Design Specifications

- Identifies the features to be covered by the design and its associated tests.
- Identifies the test cases and test procedures required to accomplish the testing and specifies the pass/fail criteria.
- May have separate Test Design Specifications
 - By System Life Cycle Phase
 - By Functional Area
 - E.g., there may be one test design specification for CCTV cameras, and a second test design specifications for dynamic message signs)

Example Test Design Specification for a TMDD-based System

Test Design Specification			
ID: TD-TMDD-015		Title: <i>Need to Share DMS Status and Control</i>	
Approach Refinement		<ul style="list-style-type: none"> Automated test scripts will be used Communications configuration tables 	
Features to be Tested		Test Identification	
ID	Title	ID	Title
3.3.5.5.1.1	Send DMS Inventory Information Upon Request		
		TC-TMDD-020	Need to Share DMS Inventory (With No Errors)
		TC-TMDD-021	Need to Share DMS Inventory (With Errors)
3.3.5.5.1.4	Contents of the DMS Inventory Request		
		TC-TMDD-020	Need to Share DMS Inventory (With No Errors)
		TC-TMDD-021	Need to Share DMS Inventory (With Errors)
3.3.5.5.1.5	Contents of the DMS Inventory Information		
		TC-TMDD-020	Need to Share DMS Inventory (With No Errors)
		TC-TMDD-021	Need to Share DMS Inventory (With Errors)
Feature Pass-Fail Criteria		This test design is passed if: 1) the dialogs represented in TC-TMDD-020 and TC-TMDD-021 complete round trip communications per test procedures TPS-TMDD-021 and TP-TMDD-002; and 2) the data content of dialog responses are verified correct against the project XML schema.	

Example Test Design Specification for a TMDD-based System

Test Design Specification			
ID: TD-TMDD-015		Title: <i>Need to Share DMS Status and Control</i>	
Approach Refinement		<ul style="list-style-type: none"> Automated test scripts will be used Communications configuration tables 	
Features to be Tested		Test Identification	
ID	Title	ID	Title
3.3.5.5.1.1	Send DMS Inventory Information Upon Request		
		TC-TMDD-020	Need to Share DMS Inventory (With No Errors)
		TC-TMDD-021	Need to Share DMS Inventory (With Errors)
3.3.5.5.1.4	Contents of the DMS Inventory Request		
		TC-TMDD-020	Need to Share DMS Inventory (With No Errors)
		TC-TMDD-021	Need to Share DMS Inventory (With Errors)
3.3.5.5.1.5	Contents of the DMS Inventory Information		
		TC-TMDD-020	Need to Share DMS Inventory (With No Errors)
		TC-TMDD-021	Need to Share DMS Inventory (With Errors)
Feature Pass-Fail Criteria		This test design is passed if: 1) the dialogs represented in TC-TMDD-020 and TC-TMDD-021 complete round trip communications per test procedures TPS-TMDD-021 and TP-TMDD-002; and 2) the data content of dialog responses are verified correct against the project XML schema.	

Test Case Specification

- Specifies the inputs, predicted results, and a set of execution conditions for a test item.

- **Recall:** The RTM defines the dialogs and data concepts that must be supported to fulfill a requirement. *How is the requirement fulfilled?*

- **Recall:** The RTCTM defines the test case(s) that must be passed to verify a requirement is fulfilled.
 - The test case(s) should confirm that the system performs the same sequence of data exchanges (and events) or use the data concepts to fulfill the requirement being verified.

Test Case Specification

Test Case Specification	
ID: <i>TC-TMDD-020</i>	Title: <i>Need to Share DMS Inventory</i>
Test Case Objectives	To verify the ability for an owner center and an external center to exchange the inventory and configuration of the dynamic message signs operated by the owner center.
Test Items	<ul style="list-style-type: none"> • REQ 3.3.5.5.1.1 - Send DMS Inventory Information Upon Request • REQ 3.3.5.5.1.4 - Contents of the DMS Inventory Request • REQ 3.3.5.5.1.5 - Contents of the DMS Inventory Information
Input Specifications	TCI-TMDD-020-1 - Need to Share DMS Inventory Inputs
Output Specifications	TCO-TMDD-020-1 – Need to Share DMS Inventory Outputs
Environmental Needs	No additional needs outside of those specified in the test plan
Special Procedure Requirements	None
Intercase Dependencies	Perform test case TC-TMDD-019, Need to Share Updated DMS Inventory to set up a subscription.

Test Case Specification

Test Case Specification	
ID: TC-TMDD-020	Title: <i>Need to Share DMS Inventory</i>
Test Case Objectives	To verify the ability for an owner center and an external center to exchange the inventory and configuration of the dynamic message signs operated by the owner center.
Test Items	<ul style="list-style-type: none"> • REQ 3.3.5.5.1.1 - Send DMS Inventory Information Upon Request • REQ 3.3.5.5.1.4 - Contents of the DMS Inventory Request • REQ 3.3.5.5.1.5 - Contents of the DMS Inventory Information
Input Specifications	TCI-TMDD-020-1 - Need to Share DMS Inventory Inputs
Output Specifications	TCO-TMDD-020-1 – Need to Share DMS Inventory Outputs
Environmental Needs	No additional needs outside of those specified in the test plan
Special Procedure Requirements	None
Intercase Dependencies	Perform test case TC-TMDD-019, Need to Share Updated DMS Inventory to set up a subscription.

Test Case Specification

Test Case Specification	
ID: TC-TMDD-020	Title: <i>Need to Share DMS Inventory</i>
Test Case Objectives	To verify the ability for an owner center and an external center to exchange the inventory and configuration of the dynamic message signs operated by the owner center.
Test Items	<ul style="list-style-type: none"> • REQ 3.3.5.5.1.1 - Send DMS Inventory Information Upon Request • REQ 3.3.5.5.1.4 - Contents of the DMS Inventory Request • REQ 3.3.5.5.1.5 - Contents of the DMS Inventory Information
Input Specifications	TCI-TMDD-020-1 - Need to Share DMS Inventory Inputs
Output Specifications	TCO-TMDD-020-1 – Need to Share DMS Inventory Outputs
Environmental Needs	No additional needs outside of those specified in the test plan
Special Procedure Requirements	None
Intercase Dependencies	Perform test case TC-TMDD-019, Need to Share Updated DMS Inventory to set up a subscription.

Example Test Case Input Specification for a TMDD-based System

Test Case Input Specification				
ID: TCI-TMDD-020-1		Title: Need to Share DMS Inventory Inputs		
FR ID	DC Type	DC Instance Name	DC ID	Value
Dialog (For Reference Only)				
3.3.5.5.1.1	dialog	dIDMSInventoryRequest	3.1.6.1	-
Request Message				
3.3.5.1.1.1	message	deviceInformationRequestMsg	3.2.5.4	-
3.3.5.1.1.1.1	data-frame	organization-information	3.3.16.3	-
	data-element	organization-id	3.4.16.8	Center5
3.3.5.1.1.1.1	data-element	device-type	3.4.5.15	Enumerated. dynamic-message-sign (3)
3.3.5.1.1.1.1	data-element	device-information-type	3.4.5.7	Enumerated. device-inventory (1)
3.3.5.5.1.4	message	deviceInformationRequestMsg	3.2.5.4	

Example Test Case Input Specification for a TMDD-based System

Test Case Input Specification				
ID: TCI-TMDD-020-1		Title: Need to Share DMS Inventory Inputs		
FR ID	DC Type	DC Instance Name	DC ID	Value
Dialog (For Reference Only)				
3.3.5.5.1.1	dialog	dIDMSInventoryRequest	3.1.6.1	-
Request Message				
3.3.5.1.1.1	message	deviceInformationRequestMsg	3.2.5.4	-
3.3.5.1.1.1.1	data-frame	organization-information	3.3.16.3	-
	data-element	organization-id	3.4.16.8	Center5
3.3.5.1.1.1.1	data-element	device-type	3.4.5.15	Enumerated. dynamic-message-sign (3)
3.3.5.1.1.1.1	data-element	device-information-type	3.4.5.7	Enumerated. device-inventory (1)
3.3.5.5.1.4	message	deviceInformationRequestMsg	3.2.5.4	

Example Test Case Specification for a TMDD-based System

Test Case Output Specification				
ID: TCO-TMDD-020-1		Title: Need to Share DMS Inventory Inputs		
FR ID	DC Type	DC Instance Name	DC ID	Value Domain
Dialog (For Reference Only)				
3.3.5.5.1.1	dialog	dIDMSInventoryRequest	3.1.6.1	-
Response Message				
3.3.5.1.2.1	data-frame	deviceInventoryHeader	3.3.5.8	-
3.3.5.1.2.1.1	data-frame	organization-information	3.3.16.3	-
3.3.5.1.2.1.1	data-element	device-id	3.4.16.8	AgencyA-DMS-006
3.3.5.1.2.1.1	data-frame	device-location	3.6.9.4	-
3.3.5.1.2.1.1	data-element	device-name	3.4.16.9	DMSI-495NB-MM128.3
3.3.5.5.1.5	message	dMSInventoryMsg	3.2.6.4	-
3.3.5.5.1.5.1	data-frame	device-inventory-header	3.3.5.8	-
3.3.5.5.1.5.1	data-frame	dms-sign-type	3.6.3.35	Enumerated. Should be: vmsLine (5)

Test Procedure Specification

- Specifies the sequence of actions for the execution of a test.
 - It is important not to skip any steps in the test procedures to ensure proper conformance testing.

- Set up test procedures so that they may be reused.
 - For example, the Authentication data frame appears in every request message in TMDD v3.03.
 - Create a test procedure specification to verify the Authentication requirement.
 - For each test procedure to verify a request message, call the Authentication test procedure specification if applicable.

Example Test Procedure Specification for a TMDD-based System

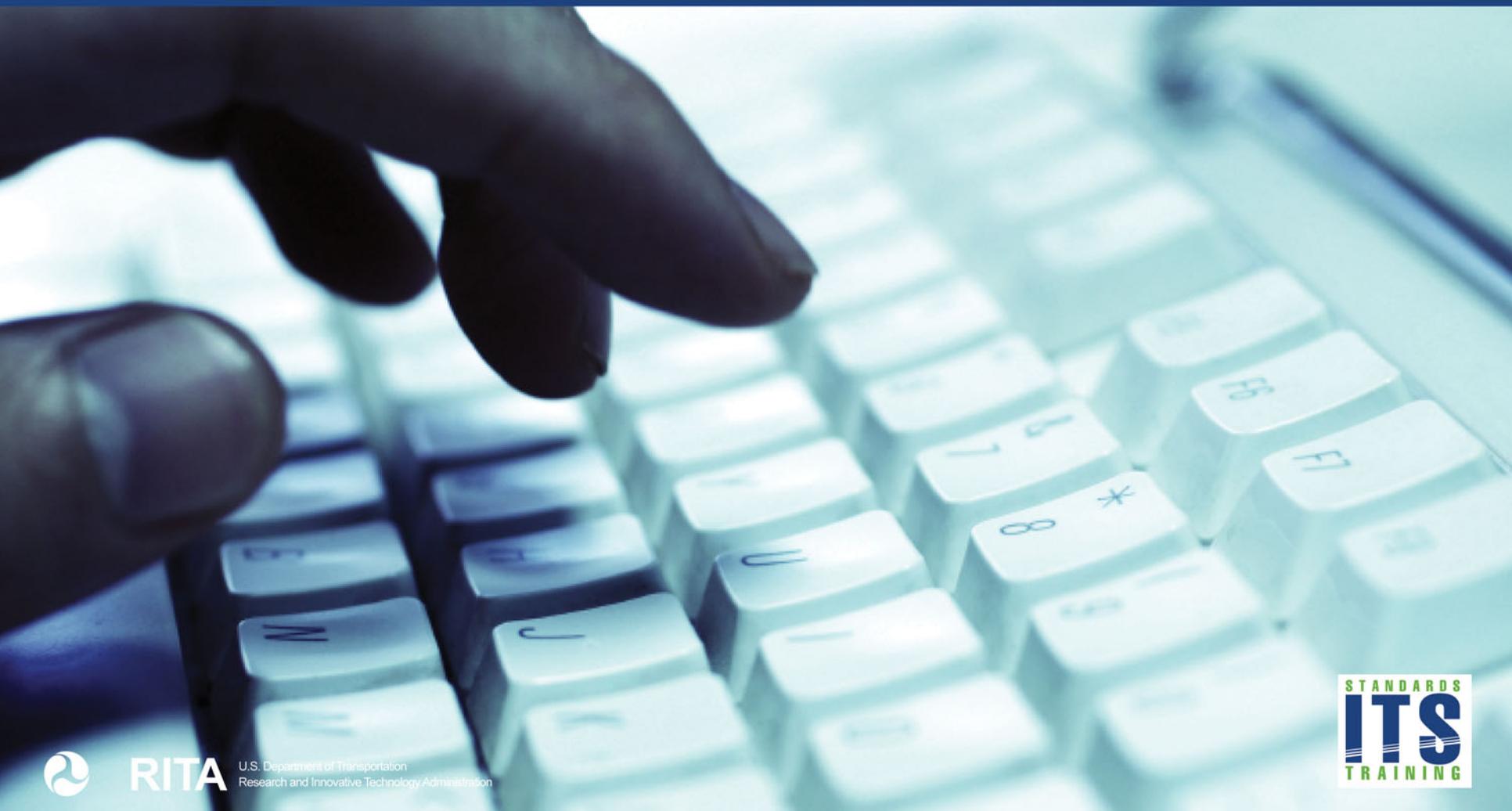
Test Procedure			
ID: TPS-TMDD-021	Title: Need to Share DMS Inventory Procedures		
Scope	This test procedure verifies that the dIDMSInventoryRequest dialog of an Owner Center system interface is implemented properly. It tests when a deviceInformationRequestMsg is sent to an owner center, that the owner center responds with an dMSInventoryMsg response message.		
Special Requirements	None		
Preconditions			
<ol style="list-style-type: none"> 1. Verify that the XML Request Message is valid against Project XML Schema 2. Verify that the WSDL for the Dialog to be tested is correct 			
Step	Test Procedure	Results	References
1	CONFIGURE: Determine the identifier, location, name, and type of the dynamic message sign (per the Owner Center's database) being requested from the Owner Center. RECORD that information as, respectively: dms_id, dms_location, dms_name, dms_type		
2	SETUP: Check the deviceInformationRequestMsg inputs so: >organization-id = "Center5" >device-type = "dynamic-message-sign (3)" >device-information-type = "device-inventory (1)"		TCI-TMDD-020-1
3	SETUP: Start HTTP Client		
4	Load XML deviceInformationRequestMsg		
5	Send XML deviceInformationRequestMsg to Owner Center	Pass / Fail	TMDD Vol. II (3.1.6.1)
6	Receive XML dMSInventoryMsg from Owner Center	Pass / Fail	TMDD Vol. II (3.1.6.1)
7	Log XML dMSInventoryMsg from Owner Center to a log file.		

Example Test Procedure Specification for a TMDD-based System

Test Procedure			
ID: TPS-TMDD-021	Title: Need to Share DMS Inventory Procedures		
Scope	This test procedure verifies that the dIDMSInventoryRequest dialog of an Owner Center system interface is implemented properly. It tests when a deviceInformationRequestMsg is sent to an owner center, that the owner center responds with an dMSInventoryMsg response message.		
Special Requirements	None		
Preconditions			
<ol style="list-style-type: none"> 1. Verify that the XML Request Message is valid against Project XML Schema 2. Verify that the WSDL for the Dialog to be tested is correct 			
Step	Test Procedure	Results	References
1	CONFIGURE: Determine the identifier, location, name, and type of the dynamic message sign (per the Owner Center's database) being requested from the Owner Center. RECORD that information as, respectively: dms_id, dms_location, dms_name, dms_type		
2	SETUP: Check the deviceInformationRequestMsg inputs so: >organization-id = "Center5" >device-type = "dynamic-message-sign (3)" >device-information-type = "device-inventory (1)"		TCI-TMDD-020-1
3	SETUP: Start HTTP Client		
4	Load XML deviceInformationRequestMsg		
5	Send XML deviceInformationRequestMsg to Owner Center	Pass / Fail	TMDD Vol. II (3.1.6.1)
6	Receive XML dMSInventoryMsg from Owner Center	Pass / Fail	TMDD Vol. II (3.1.6.1)
7	Log XML dMSInventoryMsg from Owner Center to a log file.		



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Example TMDD Dialog

3.1.37.2 dIVideoSwitchStatusUpdate

3.1.37.2.1 PRE CONDITIONS

An owner center shall provide updates to an external center upon acceptance of a dIDeviceInformationSubscription dialog.

3.1.37.2.2 DIALOG REFERENCE

See Clause 2.4.3 Generic Publication Update Dialog

3.1.37.2.3 ASN.1 REPRESENTATION

dIVideoSwitchStatusUpdate ITS-INTERFACE-DIALOGUE ::= {

DESCRIPTIVE-NAME "OwnerCenter<-DVideoSwitchStatusUpdate->ExternalCenter"

ASN-NAME "DVideoSwitchStatusUpdate"

ASN-OBJECT-IDENTIFIER { tmddDialogs 122 }

URL "Pub.gif"

DEFINITION "A publication dialog that allows an owner center to provide status updates to an external center on the owner center's video switches."

DESCRIPTIVE-NAME-CONTEXT {"Manage Traffic"}

ARCHITECTURE-REFERENCE { "emergency traffic control information",
"device status",
"field equipment status" }

ARCHITECTURE-NAME {"U.S. National ITS Architecture"}

ARCHITECTURE-VERSION {"7.0"}

DATA-CONCEPT-TYPE interface-dialogue

STANDARD "TMDD"

REFERENCED-MESSAGES {

[{ tmddMessages 85 }](#), -- videoSwitchStatusMsg (Input Message)

[{ c2cMessages c2cMessageReceipt\(1\) }](#), -- c2cMessageReceipt (Output Message)

[{ tmddMessages 10 }](#) -- errorReportMsg (Fault Message)}

Which of the following is not an appropriate test step for the previous dialog?

Answer Choices

- a) The Owner Center sends the videoSwitchStatusMsg to the External Center
- b) Pre-condition to execute the dlDeviceInformationSubscription dialog
- c) The External Center sends a c2cMessageReceipt message to the Owner Center
- d) The External Center sends a deviceInformationRequestMsg to the Owner Center



Review of answers



- a) The Owner Center sends the videoSwitchStatusMsg to the External Center

Incorrect; videoSwitchStatusMsg is the input message for the dialog



- b) Precondition to execute the dlDeviceInformationSubscription dialog

Incorrect; dlDeviceInformationSubscription is a pre-condition for the dialog



- c) The External Center sends a c2cMessageReceipt message to the Owner Center

Incorrect; c2cMessageReceipt is the output message for this dialog



- d) The External Center sends a deviceInformationRequestMsg to the Owner Center

Correct! The External Center sends a c2cMessageReceipt to the Owner Center

Test Log

- Provides a chronological record of relevant details about the execution of the tests
- Identifies the tester(s)
- Identifies the items being tested (including version levels) and the test environment
- Includes the identifier of the test procedure being executed, records the results, and indicates if the test has been successfully executed or not.
 - May include a completed copy of the test procedure specifications with approval signatures
 - May include printer outputs, screen snapshots, etc... to verify a test result

Test Incident Report

- Documents any event that occurs during testing that requires additional investigation
- Includes a summary of the incident
- Identifies the inputs, the expected results, the actual results, any anomalies observed, the date and time of the event, the test procedure (and step) being executed, and the observers
- Indicate the impacts that the incident will have on the test plan, test design specifications, test case specifications, and test procedure specifications

Test Summary Report

- Summarizes of the results from the testing activities and provides an evaluation based of the test items based on these results.
- Notes any variances, and the reasons, of the test items from the design specifications (or standard), test plan, test designs, or test procedures.
- Specifies the names of all persons who must approve this report.

Reference Implementation

- Motivation: TMDD v3.03 consists of 122 user needs and 1,160 requirements. Developing test plans, test cases, and test procedures is an enormous effort.

- USDOT developed a Reference Implementation (RI) tool to aid in performing testing of center-to-center interfaces. The RI:
 - Allows the user to create a test configuration based on its selected user needs and requirements
 - Executes the test
 - Creates test reports

Reference Implementation (cont.)

- Follows a systems engineering process and the IEEE 829 standard
 - Includes the key elements of the TMDD standard relevant to testing: NRTM, requirements, and a Requirements to Test Case Traceability Matrix
 - Includes or uses test documentation such as test design specifications, test case specifications, and test procedure specifications
 - Outputs test reports and test logs

- Supports XML implementations only, not designed for ASN.1 implementations

Reference Implementation (cont.)

- Allows custom test configurations to define the requirements for the C2C interface
 - Allows the user to select the Information Layer Standard, Application Layer Standard, and indicate if the RI acts as the owner center or the external center
 - Allows the user to identify the System Under Test (IP address, location of web services, username/password)

Reference Implementation (cont.)

- Configure Information Layer Parameters
 - Select the Information Layer user needs to be tested
 - Based on the user need highlighted, select the requirements to be tested
 - The NRTM is shown, indicating any predicates, and if the requirement is mandatory or optional
 - All mandatory user needs and requirements are pre-selected
 - Any additional specifications in the NRTM can be filled in

Reference Implementation (cont.)

- The RI provides a list of test case(s) that are applicable based on the user needs / requirements selected in the test configuration file
 - Allows for the selection of test cases to be executed, including the selection of user-defined test cases
- The RI executes the tests
 - Provides the results of each test case and each test procedure step on the screen
- Provides Test Reports
 - Includes Conformance / Compliance reports for each user need and requirement selected
 - Highlights any errors that were encountered

Reference Implementation (cont.)

- An official test suite is provided. Includes:
 - A TMDD Standard WSDL and Schema definition
 - The NRTM as defined in TMDD 3.03
 - A Requirements to Test Case Traceability Matrix
 - Test Case Definition files - identifies data parameters and expected results of each test case
 - Test Procedures Scripts

- User-defined test suites can be created
 - Support user-defined user needs and requirements
 - Support additional test cases and test procedure scripts

Reference Implementation (cont.)

- **Verifies:**

- Compliance with a specification
- Conformance with the standards (TMDD v3.03 and NTCIP 2306 v1.69)

- **Does NOT verify**

- How the data is used in the implementation's environment
- The operation(s) the implementation is attempting to support via the interface

- **Cannot validate the system:**

- Can the agency use the system as expected?
- Does it address the problem (satisfy the user need)?

Other Test Tools

XML Schema Validator

- Validate an XML document (i.e., TMDD message) against the TMDD Schema
 - Verify the XML structure is well-formed
 - Verify Structure of Data is Correct
 - Verify Data Content is Correct

Summary of Learning Objective #6

Describe test documentation for TMDD: Test Plan, Test Design Specification, Test Case Specifications, and Test Reports

- Review the elements that comprise each type of test documentation that is part of a test plan
- Introduce the Reference Implementation



What We Have Learned

- 1) We test a TMDD-based system interface to verify it fulfills the system requirements and to validate it satisfies the user needs.
- 2) The test plan for a TMDD-based system interface defines what portion of the system interface is to be tested.
- 3) A completed NRTM and RTM are key elements of the TMDD standard that should be used to develop the test plan.
- 4) A Requirements to Test Case Traceability Matrix should be created to ensure all requirements are tested at least once.



What We Have Learned

- 5) The TMDD Standard supports *interoperability* by defining a single *design* to fulfill each requirement.
- 6) *Extensions* are allowed by the TMDD Standard but are *discouraged*.
- 7) The *Reference Implementation* is a tool to aid in performing testing of *center-to-center* interfaces.



Resources

- T321 Student Supplement
- TMDD v3.03 Standard for Traffic Management Center-to-Center Communications Volumes I and II – www.ite.org/standards/tmdd
- TMDD Guide - <http://www.ite.org/standards/TMDDstandardv03Guide.pdf>
- NTCIP 9001 v04 – The NTCIP Guide – www.ntcip.org
- NTCIP 8007, Testing and Conformity Assessment Documentation within NTCIP Standards – www.ntcip.org

QUESTIONS?



RITA

U.S. Department of Transportation
Research and Innovative Technology Administration

