STANDARDS ITS TRAINING

WELCOME

RITA Intelligent Transportation Systems Joint Program Office

Welcome

Shelley Row, P.E., PTOE

Director

ITS Joint Program Office

Shelley.Row@dot.gov

RITA RESEARCH AND INNOVATIVE TECHNOLOGY ADMINISTRATION
INTELLIGENT TRANSPORTATION SYSTEMS

About RITA | Communities of Interest | Contact Us | Press Room | RITA Offices | Site Map | Search

About Us | T3 Webinars | ITS Peer-to-Peer | Resources | Local ITS PCB | Testimonials

Updated June 3, 2011

ITS Professional Capacity Building Program

Welcome to ITS Professional Capacity Building

The ITS Professional Capacity Building (PCB) Program provides comprehensive, accessible, and flexible ITS learning for the transportation industry. By using the program, public agencies can build and sustain a capable and technically proficient ITS workforce, and transportation professionals can develop their knowledge, skills, and abilities while furthering their career paths.

The plan, ITS Professional Capacity Building: Setting Strategic Direction 2010-2014, describes the strategy the ITS PCB Program is pursuing to create a 21st century learning environment and build an ITS profession that leads the world in the innovative use of ITS technologies.

News

- **Act Now!** Fee Waived for June CITE Blended Course
- NTI Offering: Implementing Rural Transit Technology
- T3 Webinar playback and archives now available for 1/18/2011 webinar: "The Emergence of Open Electronic Payment Systems in Public Transit"
- New NTI Course: Implementing Contactless Fare Collection Systems
- T3 Webinar Archive Now Available: Open Source Alternative to Deploying Transportation Management Systems
- T3 Webinar Archive Now Available: TSAG Case Studies Workshop and Webinar - NG9-1-1 What's Next Forum & Webinar
- Two new CITE offerings: Road Weather Information Systems (RWIS) Equipment and Operations and Configuration Management for Traffic Management Systems
- Added to the T3 Archives: 8/3/10 Webinar: TSAG Case Studies Workshop and Webinar — 2009 Fort Hood, Texas Army Base Shooting Incident: A Multi-Agency

ITS Technical Assistance

The ITS PCB Program offers technical assistance resources to State and local transportation agencies, and to FHWA Field Offices.

- ITS Peer-to-Peer Program helps resolve ITS challenges by speaking to your peers.
- The ITS Help Line provides technical support by e-mail or telephone 866-367-7487.

Scheduled T3 Webinars

Register now for these upcoming T3 webinars:

June 23, 2011 1:00 PM – 2:30 PM ET
2011 Enhancements to the ITS Knowledge Resources Websites: Improving Access to Information on ITS Benefits, Costs, Lessons Learned and Deployment

June 29, 2011 1:00 PM – 2:30 PM ET
Open Payments, Mobile Payments and Personal Identification Verification (PIV) Acceptance – Overview of Innovations in Public Transit Payment Systems

View T3 webinar archives.

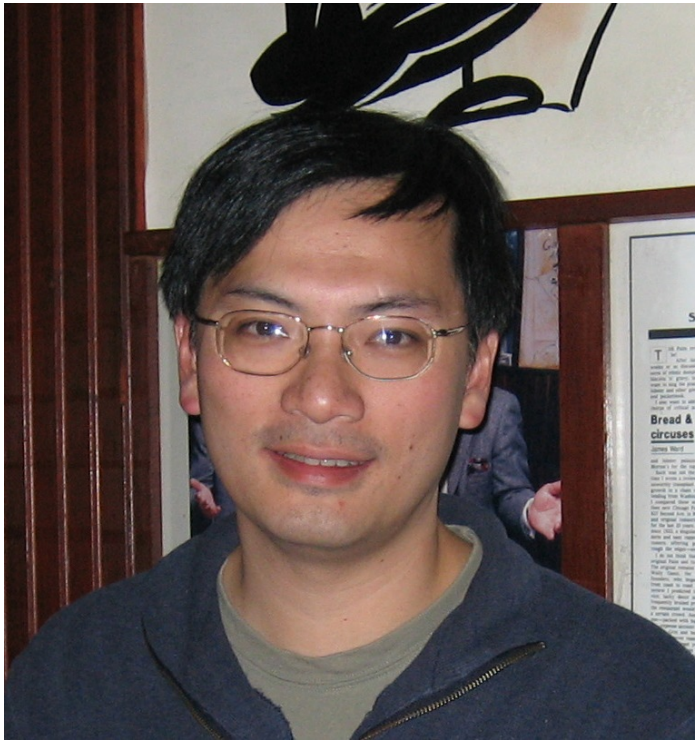
WWW.PCB.ITS.DOT.GOV/STANDARDSTRAINING

T311
Applying Your Test Plan to the NTCIP 1203 v03 DMS Standard

Target Audience

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

Instructor



Patrick Chan, P.E.

Senior Technical Staff

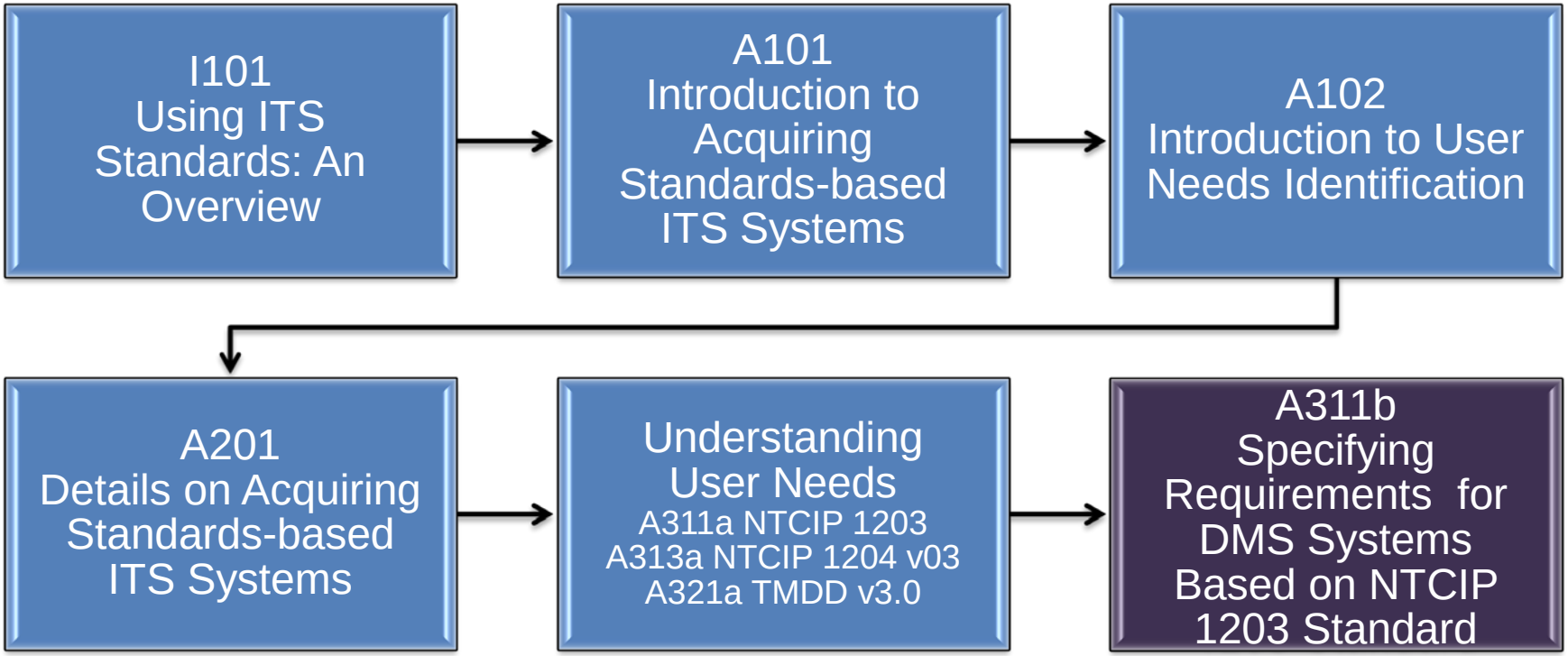
Consensus Systems Technologies (ConSysTec)

Flushing, NY, USA

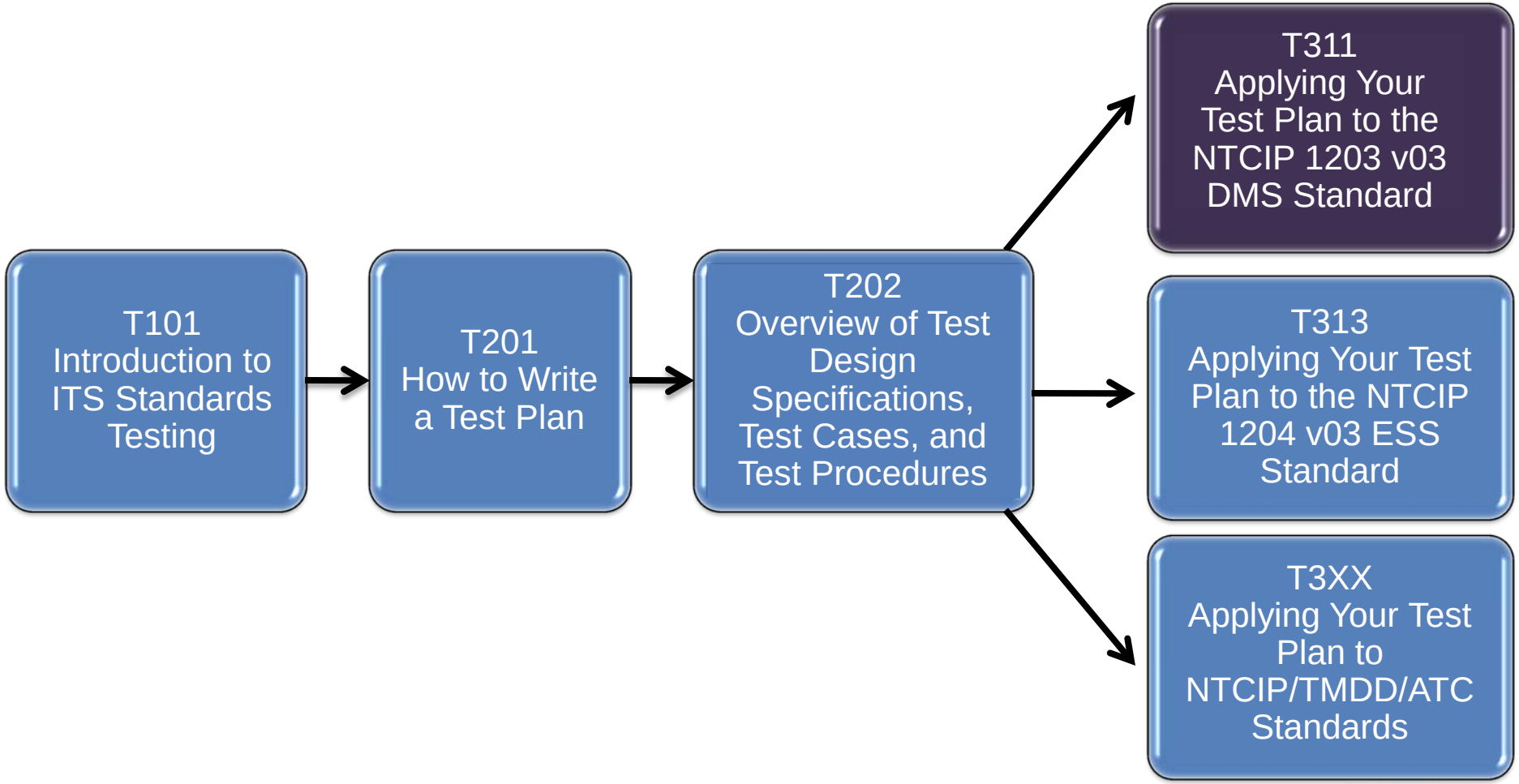
Recommended Prerequisites

- T101 – Introduction to ITS Standards Testing
- T201 – How to Write a Test Plan
- T202 – Overview of Test Design Specifications, Test Cases, and Test Procedures
- A311a – Understanding User Needs for DMS Systems Based on NTCIP 1203 Standard
- A311b – Specifying Requirements for DMS Systems Based on NTCIP 1203 Standard

Curriculum Path (SEP)



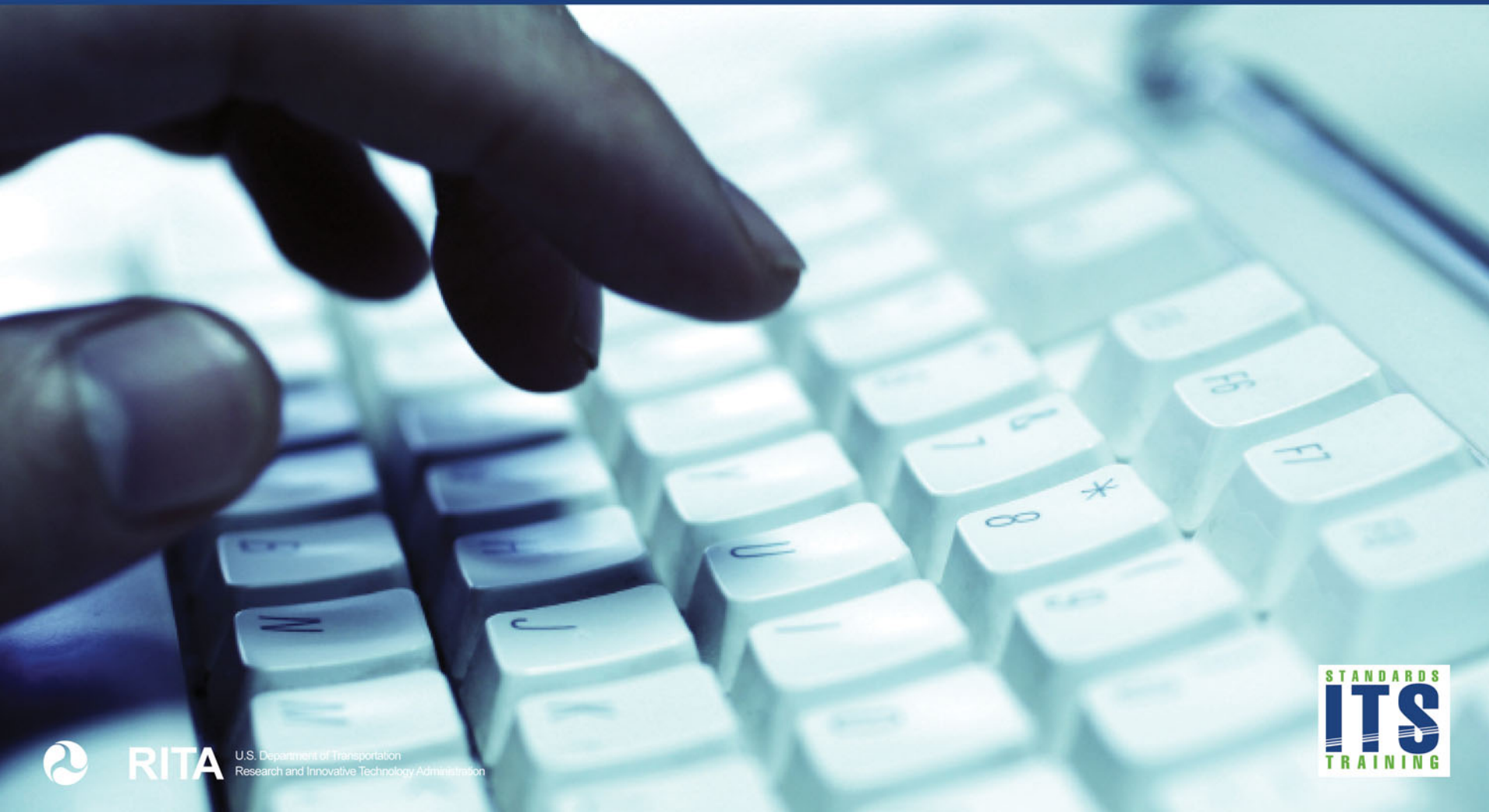
Curriculum Path (Testing)



Learning Objectives

1. Recognize the purpose, structure, and content of a well-written test plan.
2. Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken.
3. Describe the application of a good test plan to a DMS system being procured using a sample DMS test plan.
4. Identify key elements of the NTCIP 1203 standard relevant to what is covered in the test plan.
5. Walk through the process of adapting the test plan in the context of the needs and requirements of the DMS that have been selected by the user.

ACTIVITY



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

STANDARDS ITS TRAINING

Discussion

Why do you perform testing?

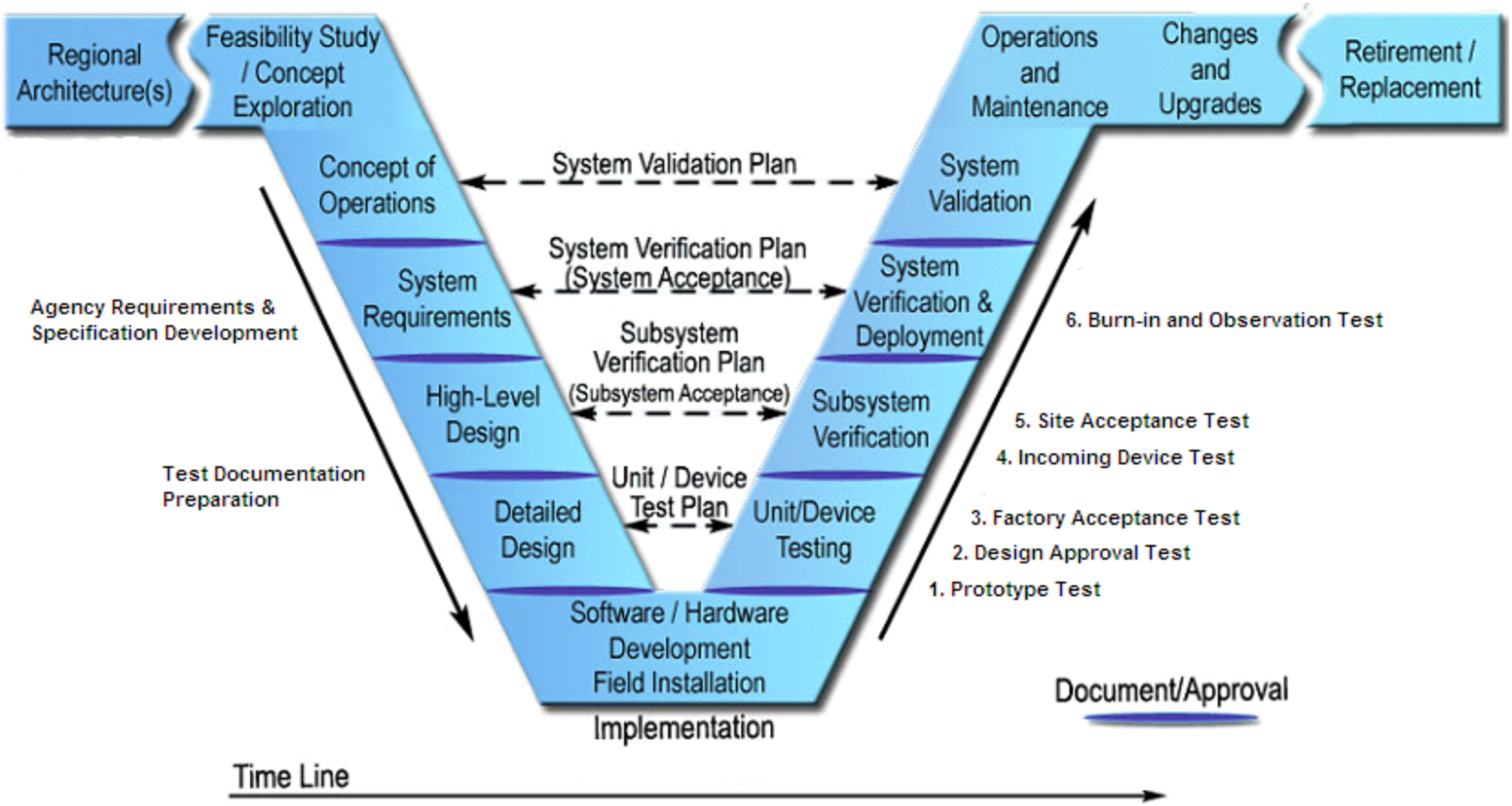
Enter responses in the chat pod

Review of Testing

Why Test?

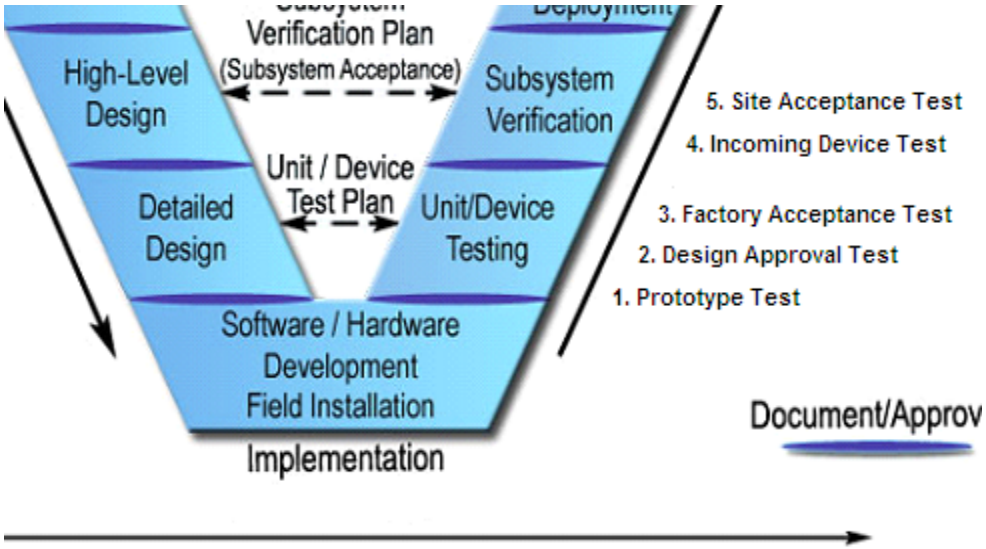
- To meet a payment milestone.
- To verify that the system works.
- Technically:
  - Verify the system meets the procurement specification and satisfies the requirements (was the system built right?)
  - Validate that the system satisfies the user and operational needs (did you build the right system?)
  - Test for conformance to the NTCIP 1203 Standard – achieve off-the-shelf interoperability.

Review of Testing



Review of Testing

Verification

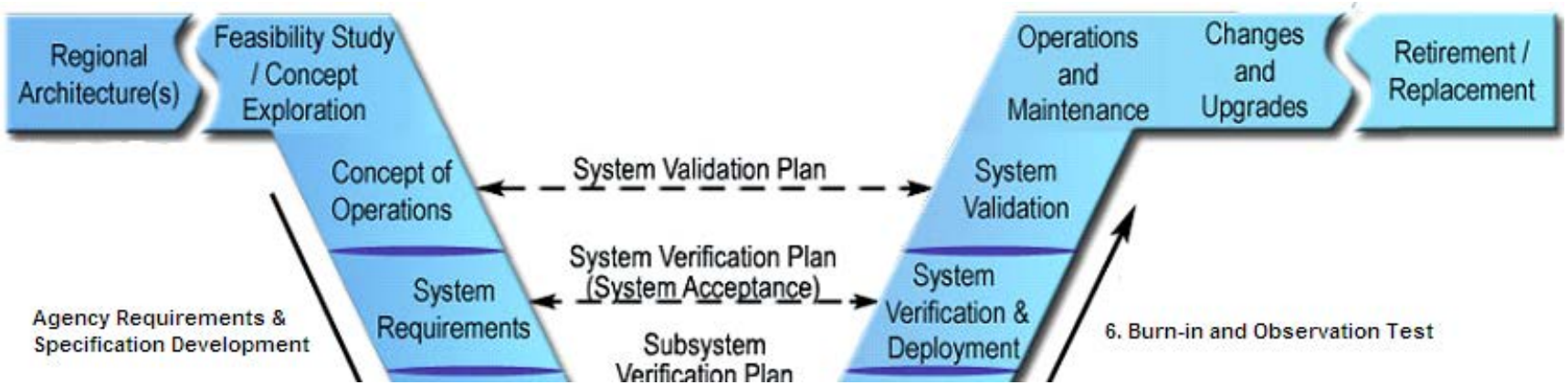


- Unit/Device Testing – e.g., Tests a standalone DMS
- Verify functionality at the DMS itself.

- Subsystem Verification – e.g., Test a DMS and its immediate environment, including the cabinet, power supply, and communications equipment.
  - With NTCIP 1203 testing, verify functionality over the installed communications systems.

Review of Testing

Verification and Validation



- System Verification and Deployment – e.g., Tests the entire DMS system, including the TMC software.
- Verify functionality, using the TMC software, over the installed communications systems.

Review of Testing

Validation

- System validation confirms that the system, as built, satisfies the stakeholder's stated needs.
- Validation ensures the requirements and the system are the right solution to the stated problem – that is, “you built the right thing.”
- The system is validated when:
  - Approved by the agency and the key stakeholders.
  - All the project requirements are fulfilled.
  - Corrective actions have been implemented for any anomalies that have been detected.

Review of Test Plans

Definition

Test Plan – High-level document that answers:

- What item is to be tested?
- How is the item to be tested?
- Who is to test the item?
- In what detail the item is to be tested?
- What are the test deliverables?
- When is the testing to take place?

- Test Plans are defined in IEEE829.
- Covered in detail in Module T201 – How to Write a Test Plan.

Review of Test Plans

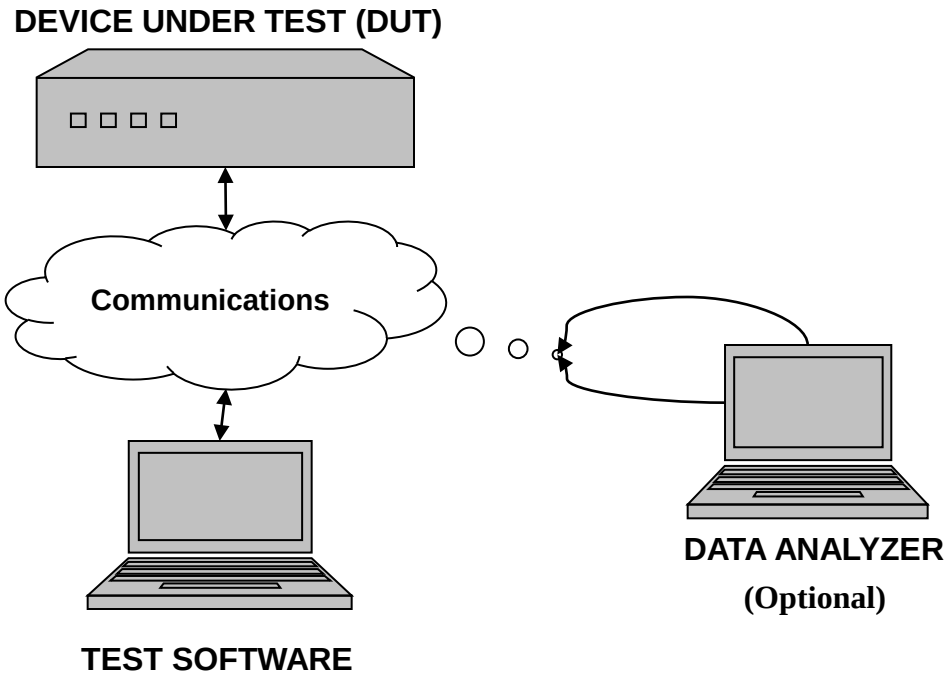
What is the Item to be tested?

- Identifies the scope of the test plan
  - Is it just the dynamic message signs? Which ones?

Review of Test Plans

How is the Item to be tested?

- Identifies the test environment to be used for executing the test plan
- NTCIP testing typically takes the form of interface testing, using NTCIP test software
- Some testing may require specialized equipment to simulate environmental conditions



Review of Test Plans

Who is to test the item?

- Identifies the roles and responsibilities for each person in managing, designing, preparing, executing, and resolving.
- Agency personnel, out-of-house expert, manufacturer's representative?
  - Potential conflicts of interest: vendor wants a quick test to meet payment; agency wants a thorough test to assure years of useful service.

Review of Test Plans

In what detail is the item to be tested?

- Sufficient detail to:
  - 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
  - Answer the questions:
    - Communications – does the test item conform to the communications standard
    - Functionality – does the unit exhibit the functionality defined in the specifications

Review of Test Plans

What Are the Test Deliverables?

- Identifies the test documentation and reports.
  - Test plans
  - Test logs
  - Test summary reports

Review of Test Plans

When is the testing to take place?

- Identifies the testing milestones, including submittals, time to perform each task, and testing resources.

CASE STUDY

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

STANDARDS ITS TRAINING

Example Test Plan for a DMS System

Introduction and Test Items

[IEEE 829-1998]

- Test Plan Identifier
- Introduction:
  - Purpose: Verify compliance to the Procurement No. 11-xxx, and verify conformance to NTCIP 1203 v02.
- Test Items:
  - ATMS software, Build yy;
  - 5 Blank Out Signs – Procurement No. 11-xxx
  - 5 VMSs (3 lines x 24 characters) – Procurement No. 11-xxx

Example Test Plan for a DMS System

Features Being Tested and Approach

- Features to be tested
  - Can just be a copy of the completed PRL.
- Features not to be tested
- Approach
  - Discussion of how the tests are organized and how the 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.

Example Test Plan for a DMS System

Test Deliverables and Setup

- Suspension criteria and resumption requirements
- Test deliverables
  - Test plan, test log reports, test summary reports
- Testing tasks
- Environmental needs
  - Test environment (facility, software programs, firmware version), test item hardware (power supplies, DMS components), test hardware (protocol analyzer), communications (RS-232 cables, Ethernet connections)

Example Test Plan for a DMS System

Responsibilities, Schedule, and Approvals

- Responsibilities
  - The agency will design, prepare, and execute the tests.
  - The consultant will manage, review, and witness the tests.
  - The vendor will witness the tests and provide repairs to anomalies.
- Staffing and training needs
- Schedule
- Risks and contingencies
- Approvals
  - Names and titles of all persons to approve this plan.

Types of Test Plans

- There may be a separate test plan for each type of testing:
  - Hardware
  - Environmental
  - Functional
  - Communications
  - Performance

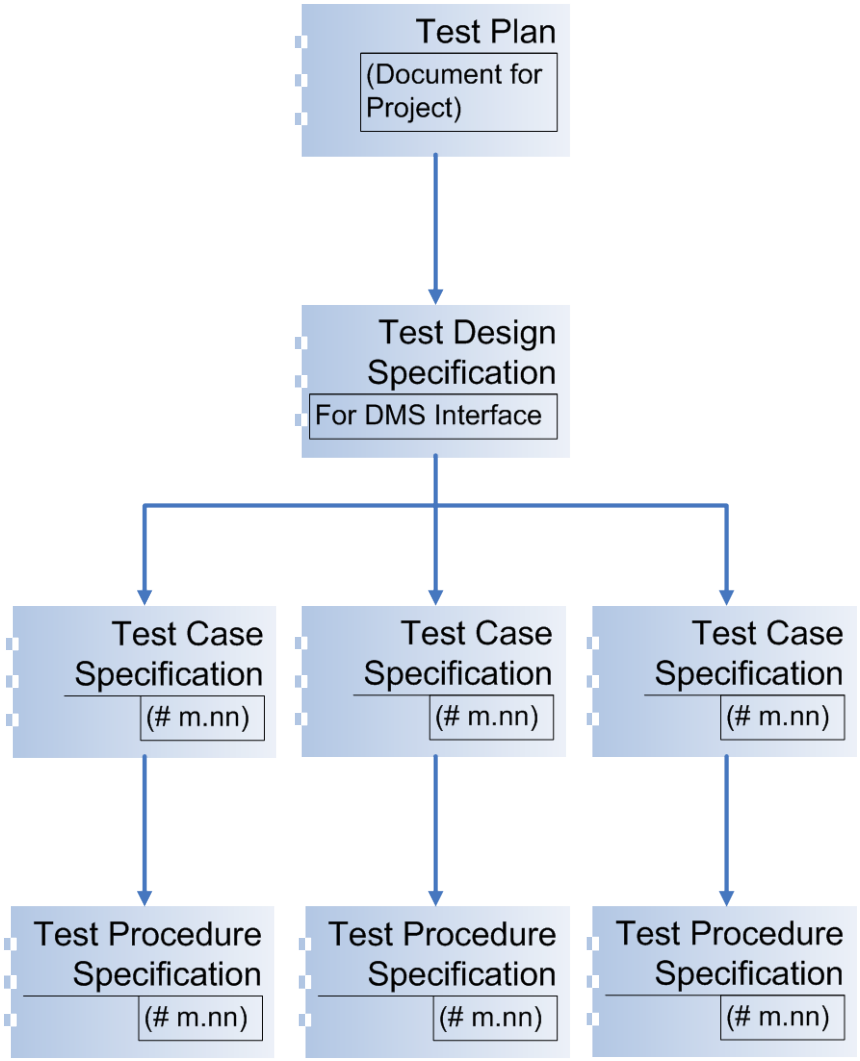
OR

- It may be one single test plan for the entire system.

Test Plan Components

- A well-written test plan consists of [IEEE 829]:
  - Test design specification – *A document specifying the details of the test approach for a…feature or combination of…features and identifying the associated tests.*
  - Test case specification – *A document specifying inputs, predicted results, and a set of execution conditions for a test item.*
  - Test procedure specification – *A document specifying a sequence of actions for the execution of a test.*

Test Plan Components



- A test plan may consist of several test design specifications.
- There may be a separate test design specification for each implementation.
- Each test design specification may consist of several test cases and test procedures.

POLLING

Poll Question

A test case does what?

1. Specifies the inputs, predicts results, and the conditions for one or more functions in the test item.
2. Specifies the details of the test approach for a feature or combination of features.
3. Describes the scope, approach, and resources for the testing activities.
4. Specifies the sequence of actions for the execution of a test.

Review of NTCIP 1203

NTCIP 1203

- What is NTCIP 1203?
  - Is a (communications) interface standard
  - Specifies the interface between the dynamic message signs in the field and the host systems that control them
  - Contains the object definitions (vocabulary) that allow for the monitoring and control of dynamic message signs

Review of NTCIP 1203

NTCIP 1203

- NTCIP 1203 v01 was published in 1999.
- NTCIP 1203 Amendment 1 was approved in 2001.
- NTCIP 1203 v02 (replacement in 2010)
  - Adds new functionality
  - Uses a systems engineering approach
- NTCIP 1203 v3 – A Proposed Recommended Standard.
  - Adds Test Cases and Test Procedures.
  - Allows agencies procuring DMS systems to consistently test for conformance to the DMS Standards.

NTCIP 1203 Testing

Interface/Communications Testing

- What are we testing?
  - Compliance with the procurement specification
    - Does the DMS system satisfy all the requirements in the procurement specification?
  - Conformance with the NTCIP Standard
    - Does the DMS system meet the referenced NTCIP standards?
    - The DMS system must satisfy the mandatory requirements identified by the standard. The DMS system must also satisfy other specified requirements of NTCIP 1203 and the standards it references.
  - Conformance is NOT compliance!

NTCIP 1203 Testing

Interface/Communications Testing

- When testing the NTCIP DMS Standard:
  - Testing that the communications requirements are fulfilled
    - Are the proper protocols being used?
    - Do the data exchanges occur as defined by the standard?
  - Testing the functional requirements are fulfilled
    - Is the DMS performing the functions as expected? For example, is a message being displayed when commanded?
  - Testing the performance requirement
    - Is the DMS responding to the performance requirements as detailed in the PRL (Protocol Requirements List)?

Test Design Specification

Definition

- The test design specification identifies the features to be covered by the design and its associated tests. It also identifies the test cases and test procedures required to accomplish the testing and specifies the pass/fail criteria.
  - For example, the features of a color variable message sign may include support for 256 colors.

Test Design Specification

Features to be Tested

- NTCIP 1203 v2 and v3
  - The completed PRL indicates what (features) requirements have been selected for the procurement specification.
  - Those requirements should be tested as part of the test plan.

Test Design Specification

Features to be Tested

- Activate pixel testing is a selected requirement in the completed PRL

USER NEED SECTION NUMBER	USER NEED	FR SECTION NUMBER	FUNCTIONAL REQUIREMENT	CONFORMANCE	SUPPORT / PROJECT REQUIREMENT	ADDITIONAL PROJECT REQUIREMENTS
2.5.3	Monitor the Status of the DMS			M	Yes	
2.5.3.1	Perform Diagnostics			M	Yes	
2.5.3.1.1	Determine Sign Error Conditions - High-Level Diagnostics			M	Yes	
		3.5.3.1.1.1 (LampTest)	Execute Lamp Testing	Lamp OR Fiber:M	Yes / NA	
		3.5.3.1.1.2 (PixelTest)	Activate Pixel Testing	Matrix:M	Yes / NA	
		3.5.3.1.1.3 (ClimateTest)	Execute Climate-Control Equipment Testing	O	Yes / No	
		3.5.3.1.2	Provide General DMS Error Status Information	M	Yes	

- Note: See Student Supplement for the full description.

Test Design Specification

RTM

- The Requirements Traceability Matrix (RTM) defines the dialogs and objects that must be supported to satisfy a requirement. That is, the RTM describes how the requirement is to be fulfilled (as defined by the DMS standard).
  - The dialogs are the sequence of data exchanges (and events) that are defined by the standard.
- Conformance testing confirms that the DMS system performs the same sequence of data exchanges (and events) as defined in the standard (and referenced standards).

Test Design Specification

RTM

- The RTM defines the dialogs and object needed to fulfill the requirement “Activate Pixel Testing.”

Requirements Traceability Matrix (RTM)					
FR ID	**Functional Requirement**	**Dialog ID**	**Object ID**	**Object Name**	**Additional Specifications**
3.5.3	Monitor the Status of the DMS				
3.5.3.1	Perform Diagnostics				
3.5.3.1.1	Test Operational Status of DMS Components				
3.5.3.1.1.1	Execute Lamp Testing	4.2.4.1			
			5.11.2.5.3	lampTestActivation	
3.5.3.1.1.2	Activate Pixel Testing	4.2.4.2			
			5.11.2.4.3	pixelTestActivation	
3.5.3.1.1.3	Execute Climate Control Equipment Testing	4.2.4.3			
			5.11.2.3.5.6	dmsClimateCtrlTestActivation	
			5.11.2.3.5.7	dmsClimateCtrlAbortReason	

Test Design Specification

RTM

- Below is the dialog that fulfills this requirement.

4.2.4.2 Activating Pixel Testing

The standardized dialog for a management station to command the DMS to activate pixel testing shall be as follows:

a) The management station shall SET pixelTestActivation.0 to 'test'.
b) The management station shall repeatedly GET pixelTestActivation.0 until it either returns the value of 'noTest' or a maximum time-out is reached. If the time-out is reached, the DMS is apparently locked and the management station shall exit the process.
c) (PostCondition) The following objects will have been updated during the pixel test to reflect current conditions. The management station may GET any of these objects as appropriate.
   1) pixelFailureTableNumRows
   2) any object within the pixelFailureTable

Test Design Specification

RTCTM

- NTCIP 1203 v03 has a Requirements to Test Case Traceability Matrix (RTCTM)
  - Lists the test case(s) that must be passed to fully test whether a requirement has been fulfilled by the standard.

Test Design Specification

RTCTM

- For the requirement "Activate Pixel Testing," both test case C.3.5.1 and C.3.5.2 must be passed to verify the requirement.

Requirement		Test Case	
ID	Title	ID	Title
3.5.3	Monitor the Status of the DMS		
3.5.3.1	Perform Diagnostics		
3.5.3.1.1	Test Operational Status of DMS Components		
3.5.3.1.1.1	Execute Lamp Testing		
		C.3.5.21	Verify Lamp Test with No Errors
		C.3.5.22	Verify Lamp Test with Errors
3.5.3.1.1.2	Activate Pixel Testing		
		C.3.5.1	Pixel Test - No Errors
		C.3.5.2	Pixel Test - Errors
3.5.3.1.1.3	Execute Climate-Control Equipment Testing		
		C.3.5.3	Climate-Control Equipment Test - No Errors
		C.3.5.4	Climate-Control Equipment Test - Errors

Test Design Specification

RTCTM

- Multiple test cases may be needed to completely test a requirement.
  - Each test case may test a different set of values – e.g., there are separate test cases for page justification top, middle, bottom.
  - Each test case may test different conditions – e.g., there are separate test cases for “no errors are detected” and for “an error was reported for a pixel test”.
- An implementation must pass all test cases that the requirement traces to before claiming that the requirement is fulfilled.

Test Plan for a DMS System

Tailored RTCTM

- Based on the project requirements selected in the PRL, an agency can create a tailored RTCTM containing only those requirements and their associated test cases.
- This tailored RTCTM becomes part of the test design specification.
  - Identifies the features (requirements) to be covered by the design.
  - Identifies the test cases and test procedures required.

Test Plan for a DMS System

Tailored RTCTM

- For communication interface requirements not covered by the standard, procurers should define the dialogs and objects to fulfill these requirements.
- Test cases should be created for testing these requirements.
- The additional requirements and test cases should be added to the tailored RTCTM and the test design specification.

CASE STUDY

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

STANDARDS ITS TRAINING

Test Plan for a DMS System

Example Test Design Specification

- Test Design Specification (TDS) identifier
  - One TDS for the blank out Signs
  - One TDS for the VMSs
- Features to be tested
  - Copy of the completed PRL for the specific test item (e.g., VMS)
- Approach refinements
- Test identification
  - Tailored RTCTM
- Feature pass/fail criteria

Test Case Specifications

Definition

- Test case specification: A document specifying inputs, predicted results, and execution conditions. This information can be found in the header of each table.

- NTCIP 1203 v3 combines the test cases and test procedures, but references them as test cases.

- For “Activate Pixel Testing,” only a single instance of test case C.3.5.1 and C.3.5.2 is required to verify CONFORMANCE to the standard, whereas more instances may be required to verify COMPLIANCE with the project specifications.

Test Case Specifications

Example

- If the specification requires that a DMS comes preconfigured with three fonts, three test cases may be written using test case C.3.2.4 (below) to retrieve a font definition, one test case each to verify for each font.

3.5.1.3.4 Retrieve a Font Definition

The DMS shall allow a management station to upload the fonts defined in the sign controller.

Requirement		Test Case	
ID	Title	ID	Title
3.5.1.3.4	Retrieve a Font Definition		
		C.3.2.4	Retrieve a Font Definition

Test Procedures

Definition

- **Test procedure specification:** A document that contains the sequence of actions for the execution of a test.
- **Standard test procedures** ensure that the conformance testing is performed in the same manner on separate test occasions.
- It is important not to skip any steps in the test procedures to ensure proper conformance testing.

Test Procedures

- Per the IEEE 829 definition, the test procedure only defines the steps necessary to test the function.

C.3.5.1 Pixel Test - No Errors

Test Case: 5.1	**Title:**	**Pixel Test - No Errors**	
	Description:	This test case verifies that the DMS executes a pixel test and verifies that there are no failed pixels.	
	Variables:	Pixel_Test_Time	From Manufacturer's Documentation
		Message_Display_Test_Time	From Manufacturer's Documentation
	Pass/Fail Criteria:	The DUT shall pass every verification step included within the Test Case to pass the Test Case.	

Step	Test Procedure	Results	Additional References
1	CONFIGURE: Determine the maximum period of time that the pixel test should require (based on manufacturer documentation). RECORD this information as: »Pixel_Test_Time		
2	CONFIGURE: Determine the maximum period of time that the message display pixel test should require (based on manufacturer documentation). RECORD this information as: »Message_Display_Test_Time		
3	SET-UP: Ensure that all pixels are functioning prior to this test.		
4	SET the following object(s) to the value(s) shown: »pixelTestActivation.0 = 'test' (3) NOTE--Valid enumerated values are defined in Section 5.11.2.4.3 (Pixel Test Activation Parameter).	Pass / Fail (Section 3.5.3.1.1.2)	Section 4.2.4.2 Step a

Test Procedures

Elements of Test Procedures

- Output specifications
  - What are the expected values/output?
  - E.g., VERIFY that the RESPONSE VALUE for shortErrorStatus.0 has bit 5 cleared.

17	VERIFY that the RESPONSE VALUE for shortErrorStatus.0 has bit 5 (pixel error) cleared.	Pass / Fail (Section 3.5.3.1.2)	
18	PERFORM the test case labeled 'Blank the Sign' (C.3.7.15).	Pass / Fail (Section 3.5.2.3.1)	

Test Case Results		
Tested By:	**Date Tested:**	**Pass / Fail**
Test Case Notes:		

Test Procedures

Elements of Test Procedures

- Environmental needs
  - Test setup.
  - E.g., SET-UP
- Special procedural requirements
  - Any special constraints or setup.
  - E.g., NOTE--

1	CONFIGURE: Determine the enumerated value corresponding to the beacon type required by the specification (PRL 2.3.2.4). RECORD this information as: »Required_Beacon_Type NOTE--Valid enumerated values are defined in Section 5.2.8 (Beacon Type Parameter).
2	SET-UP: Determine the enumerated value indicating the actual type of beacons on the sign (See Section 5.2.8). RECORD this information as: »Actual_Beacon_Type

Test Procedures

Elements of Test Procedures

- Intercase dependencies
  - Identifies any test cases to be performed prior to this test case.
  - E.g., PERFORM the test case labeled…

17	VERIFY that the RESPONSE VALUE for shortErrorStatus.0 has bit 5 (pixel error) cleared.	Pass / Fail (Section 3.5.3.1.2)	
18	PERFORM the test case labeled 'Blank the Sign' (C.3.7.15).	Pass / Fail (Section 3.5.2.3.1)	

Test Case Results		
Tested By:	**Date Tested:**	**Pass / Fail**
Test Case Notes:		

Test Procedures

Elements of Test Procedures

- Procedure steps
  - Test Step Number
  - E.g., Perform Steps or GOTO.

8	FOR EACH value, N, from 1 to Actual_Graphic_Entries, perform Steps 8.1 through 8.2.		
8.1	SET-UP: GET the following object(s): »dmsGraphicStatus.N »dmsGraphicID.N		
8.2	IF the RESPONSE VALUE for dmsGraphicStatus.N does not equal 'permanent' (6), then GOTO Step 8.2.1; otherwise, GOTO Step 9. NOTE--Valid enumerated values are defined in Section 5.12.6.10 (Graphic Status Parameter)		
8.2.1	VERIFY that the RESPONSE VALUE for dmsGraphicStatus.N is not 'inUse' (5).	Pass / Fail	

POLLING

Test Plan for a DMS System

Exercise

Below is a dialog in NTCIP 1203 v03.

b) The management station shall GET the following data:
   1) dmsMessageMultiString.x.y
   2) dmsMessageOwner.x.y
   3) dmsMessageRunTimePriority.x.y
   4) dmsMessageStatus.x.y

c) The management station shall GET dmsMessageBeacon.x.y.

d) The management station shall GET dmsMessagePixelService.x.y.

NOTE—The response to this request may be a noSuchName error, indicating that the DMS does not support this optional feature. This error will not affect the sequence of this dialog, but the management station should be aware that the CRC will be calculated with this value defaulted to zero (0).

Look at Step C of this dialog.

Test Plan for a DMS System

Exercise

Which test step properly reflects Step C of the previous dialog?

Get the following object(s):

>>_____

1. dmsMessageMultiString.x.y
2. dmsMessageStatus.x.y
3. dmsMessageBeacon.x.y
4. dmsMessagePixelService.x.y

Enter responses in the chat pod

Review

- Recognize the purpose, structure and content of a well-written test plan.
  - A Test Plan identifies the scope of the testing, the test environment, roles and responsibilities, and the deliverables.
- Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken.
  - Testing occurs after the requirements development and implementation of the system.
  - Testing verifies that the system fulfills all the requirements and validates that the system satisfies all the stated user needs.

Review

- Describe the application of a good test plan to a DMS system being procured using a sample DMS test plan.
  - Elements of a test plan, test design specification and a test case specification using a DMS example were provided.
- Identify key elements of the NTCIP 1203 standard relevant to the test plan.
  - The PRL identifies the requirements for satisfying a user need.
  - The RTCTM identifies the test cases and test procedures to test that a requirement is fulfilled.

Review

- Walk through the process of adapting a test plan in the context of the needs and requirements of the DMS that have been selected by the user.
  - Use the completed PRL to determine the (selected) project requirements for the DMS system.
  - Based on the project requirements, use the RTCTM to determine the applicable test cases.
  - Tailor the test plan for the specific implementation using only the test cases associated with the (selected) project requirements in the PRL.

Resources

- NTCIP 1203 v3.03, Object Definitions for Dynamic Message Signs, proposed Recommended Standard
- NTCIP 1203 v2.039b, Object Definitions for Dynamic Message Signs
- NTCIP 9001 v03, The NTCIP Guide
- NTCIP 8007, Testing and Conformity Assessment Documentation within NTCIP Standards
- NTCIP 9012, NTCIP Testing Guide for NTCIP Center-to-Field Communications

www.ntcip.org

QUESTIONS?

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

STANDARDS ITS TRAINING