What is the purpose of the Requirements to Test Case Matrix?

- A) Identify the requirements that are part of the project specification
- B) Identify all the test cases that must be passed to verify a requirement is fulfilled
- C) Identify the design content to fulfill a requirement
- D) Identify the design content to fulfill a requirement

The correct answer is:

You did not answer this question completely. You must answer the question before continuing.
Which of the following information is not provided in a test plan?

- A) What item is being tested?
- B) Who is responsible for performing the test?
- C) What are the inputs and outputs for the test case specification?
- D) What are the test deliverables?

Correct - Click anywhere or press Control Y to continue.
Incorrect - Click anywhere or press Control X to continue.

Your answer:

You did not answer this question completely.
You must answer the question before continuing.
What is the Requirements to Test Case Traceability Matrix (RTCTM) in a Test Design Specification based upon?

- A) Includes all the requirements supported by the standard
- B) Includes only the requirements selected in the PRL that the Test Design Specification is based upon
- C) Includes only those requirements that are mandatory to conform to the standard
- D) Includes all the requirements that are contained in the project specifications

Your answer:

You did not answer this question completely. You must answer the question before continuing.
Welcome

Ken Leonard, Director
ITS Joint Program Office
Ken.Leonard@dot.gov

www pcb its dot gov
T311: Applying Your Test Plan to the NTCIP 1203 v03 DMS Standard
Instructor

Patrick Chan, PE

Senior Technical Staff
Consensus Systems Technologies
(ConSysTec)
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Learning Objectives

Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken for DMS.

Identify the key elements of NTCIP 1203 v03 relevant to the test plan.

Describe the application of a good test plan to a DMS system being procured.

Describe a process of adapting a test plan based on the selected user needs and requirements.
Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken for DMS.
Why Do We Test?

Why This Module?

- As a procurer, operator or specification writer of dynamic message signs, need a method to check that the system provided fulfills all your requirements

- This module will walk through the elements on how to test!

- Develop a test plan that:
  - Checks your requirements have been fulfilled
  - Satisfies your (agency’s) specific needs
  - Conforms to the appropriate standards
Why Do We Test?

Why Test?

- **Verify** the system *meets the procurement specification and fulfills the requirements* (Was the system built right?)
  - Requirements discussed in Module A311b: Specifying Requirements for DMS Based on NTCIP 1203 Standard

- **Validate** that the system *satisfies the user and operational needs* (Did you build the right system?)
  - User needs discussed in Module A311b: Understanding User Needs for DMS Systems Based on NTCIP 1203 Standard
Why Do We Test?

Why Test?

- **Test for conformance** to the NTCIP 1203 Standard – achieve off-the-shelf Interoperability
  - Interoperability: Ability of two or more systems or components to **exchange information** and **use** the information that has been exchanged
  - NTCIP 1203 supports interoperability for dynamic message sign systems!

Source: NYCDOT
Why Do We Test?

The Vee Model

Testing Phase

- Regional Architecture(s)
- Feasibility Study / Concept Exploration
- Concept of Operations
- System Requirements
- High-Level Design
- Detailed Design
- Software/Hardware Development
- Field Installation
- Implementation
- System Validation Plan
- System Verification Plan (System Acceptance)
- Subsystem Verification Plan (Subsystem Acceptance)
- Unit/Device Test Plan
- Unit/Device Testing
Why Do We Test?

Verification

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

- **Subsystem Verification** – Verify functionality over the installed communications systems using NTCIP 1203
  - E.g., Tests a DMS and its immediate environment, including the cabinet, power supply, and communications equipment
Why Do We Test?

Verification

- **System Verification** – Verify **functionality**, using the TMC software, over the installed communications systems.
  - e.g., Tests the entire DMS system, including the Traffic Management Center (TMC) software.
Why Do We Test?

Validation

- **System Validation** – confirms that the system, as built, satisfies the stakeholder's stated needs.
- 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.
Purpose of a Test Plan

Test Plan

- Test Plan - Documents and identifies the testing activities
- High-level document that identifies:
  - What item is to be tested?
  - How is the item to be tested?
  - Who is to test the item?
  - In what detail is the item to be tested?
  - What are the test deliverables?
  - When is the testing to take place?

- Test Plans are defined in IEEE 829-2008
- Module T201 – How to Write a Test Plan
Purpose of a Test Plan

Test Plan Items

- **What** is being tested?
  - Identifies the **scope** of the test plan
    - Is it just the dynamic message signs? Which ones?
  - There may be a **separate** test plan for each type of testing or DMS **OR** it may be one single test plan for the entire system
Purpose of a Test Plan

Test Plan Items

- **How** is the item to be tested?
  - Identifies the test environment
  - NTCIP testing typically takes the form of interface testing
  - May require specialized equipment to simulate environmental conditions
Purpose of a Test Plan

Test Plan Items

- **Who** is to test the items?
  - Identifies the **roles and responsibilities** for each person in managing, designing, preparing, executing, and resolving
  - Potential conflicts of interest: Vendor wants a quick test to meet payment; agency wants a thorough test to assure years of useful service
Purpose of a Test Plan

Test Plan Items

- In what detail will the items will be tested?
  - 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
Purpose of a Test Plan

Test Plan Items

- What are the Test Deliverables?
  - Test Plans
  - Test Logs
  - Test Summary Reports
  - Identifies the testing milestones, including submittals, time to perform each task, and testing resources
A well-written test plan consists of [IEEE 829-2008]:

- **Test Design Specification.** Specifies the details of the test approach for a feature or combination of features and identifies the test case specifications to be performed.

- **Test Case Specification.** Specifies the inputs, predicted results, a set of execution conditions and the pass/fail criteria for the test item.

- **Test Procedure Specification.** Specifies a sequence of actions for the execution of a test.
Components of a Test Plan

- 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.
What does a “test case specification” do?

**Answer Choices**

- A) Specifies the inputs, predicted results, and the conditions for one or more functions in the test item
- B) Specifies the details of the test approach for a feature or combination of features
- C) Describes the scope, approach, and resources for the testing activities
- D) Specifies the sequence of actions for the execution of a test

The correct answer is: **A**

You did not answer this question completely. You must answer the question before continuing.
Review of Answers

a) Specifies the inputs, predicted results, and the conditions for one or more functions in the test item

Correct! A test case does all of the above.

b) Specifies the details of the test approach for a feature or combination of features

Incorrect. This describes a test design specification.

c) Describes the scope, approach, and resources for the testing activities

Incorrect. This describes a test plan.

d) Specifies the sequence of actions for the execution of a test

Incorrect. This defines a test procedure specification.
Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken for DMS.

Identify the key elements of NTCIP 1203 v03 relevant to the test plan.
Learning Objective 2

Identify the **key elements** of NTCIP 1203 v03 relevant to the test plan
What Is Being Tested?

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
What Is Being Tested?

NTCIP 1203

- NTCIP 1203 v01 (1999)
- NTCIP 1203 Amendment 1 (2001)
- NTCIP 1203 v02 (2010)
  - Added new functionality and systems engineering content
- NTCIP 1203 v03 (2014)
  - **Adds** Test Cases and Test Procedures
    - Allows agencies procuring DMS systems to consistently test for conformance to the DMS Standards
What Is Being Tested?

Interface/Communications Testing

- Compliance with the procurement specification
- Conformance with the NTCIP Standard
  - The Protocol Requirements List (PRL) defines the user needs and requirements for a procurement specification
  - The DMS system must fulfill the mandatory requirements and other specified (selected optional) requirements of NTCIP 1203 and the standards it references.
- Conformance is NOT compliance!
What Is Being Tested?

Interface/Communications Testing

- Communications requirements are fulfilled
  - The **Requirements Traceability Matrix** (RTM) in NTCIP 1203 defines the manner to fulfill a standard requirement
    - Do the data exchanges (**Dialogs**) occur as defined by the standard?
    - Are all the **data objects** used as defined by the standard?

- Functional requirements are fulfilled

- Performance requirements
NTCIP 1203 v03 provides 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 implementation
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.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5.3</td>
<td>Monitor the Status of the DMS</td>
</tr>
<tr>
<td>3.5.3.1</td>
<td>Perform Diagnostics</td>
</tr>
<tr>
<td>3.5.3.1.1</td>
<td>Test Operational Status of DMS Components</td>
</tr>
<tr>
<td>3.5.3.1.1.1</td>
<td>Execute Lamp Testing</td>
</tr>
<tr>
<td>3.5.3.1.1.2</td>
<td>Activate Pixel Testing</td>
</tr>
<tr>
<td></td>
<td>C.3.5.21 Verify Lamp Test with No Errors</td>
</tr>
<tr>
<td></td>
<td>C.3.5.22 Verify Lamp Test with Errors</td>
</tr>
<tr>
<td>3.5.3.1.1.3</td>
<td>Execute Climate-Control Equipment Testing</td>
</tr>
<tr>
<td></td>
<td>C.3.5.3 Climate-Control Equipment Test - No Errors</td>
</tr>
<tr>
<td></td>
<td>C.3.5.4 Climate-Control Equipment Test - Errors</td>
</tr>
</tbody>
</table>

Source: NTCIP 1203 v03, Volume I.
Multiple test cases may be needed to completely test a requirement:

- 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”

- Each test case may **test a different set of values** – e.g., there are separate test cases to verify left, center, and right justification

An implementation must **pass all test cases that the requirement traces** to before claiming that the requirement is fulfilled.
Test Case Specifications

Test Case Specification. A document specifying inputs, predicted results, and execution conditions. This information can be found in the header of each table.

- An agency may wish to perform a test case specification multiple times, each iteration with a different input and different expected output.

- A test case specification needs to be performed only once to verify **CONFORMANCE** to the standard, however more instances may be required to verify **COMPLIANCE** with the project specifications.

- May wish to perform negative (exception) testing - e.g., invalid values – to verify DMS behavior.
Test Case Specifications

If the project specification requires that a DMS comes preconfigured with three fonts, *Test Case C.3.2.4, Retrieve a Font Definition*, might be performed three times, once 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.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Title</td>
</tr>
<tr>
<td>3.5.1.3.4</td>
<td>Retrieve a Font Definition</td>
</tr>
<tr>
<td>C.3.2.4</td>
<td>Retrieve a Font Definition</td>
</tr>
</tbody>
</table>

Source: NTCIP 1203 v03, Volume II.
### Test Case Specifications

- Can be used for NTCIP 1203 v01 and v02 systems!

#### C.3.5.1  Pixel Test - No Errors

<table>
<thead>
<tr>
<th>Test Case: 5.1</th>
<th>Title: Pixel Test - No Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>This test case verifies that the DMS executes a pixel test and verifies that there are no failed pixels.</td>
</tr>
<tr>
<td>Variables:</td>
<td>Pixel_Test_Time</td>
</tr>
<tr>
<td></td>
<td>Message_Display_Test_Time</td>
</tr>
<tr>
<td>Pass/Fail Criteria:</td>
<td>The DUT shall pass every verification step included within the Test Case to pass the Test Case.</td>
</tr>
</tbody>
</table>

Source: NTCIP 1203 v03, Volume II.
Test Procedure Specifications

- **Test Procedure Specification.** A document that contains the sequence of actions for the execution of a test.
  - Only defines the steps necessary to test the function.

- Standard test procedures ensure that the conformance testing is performed in the same manner on separate test occasions.
  - A test procedure in a test case specification may be “called” by another test procedure in a different test case specification.

- It is important not to skip any steps in the test procedures to ensure proper conformance testing.
NTCIP 1203 v03 combines test cases and test procedures into one test case.

### Test Procedure Specifications

- **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.

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Results</th>
<th>Additional References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CONFIGURE: Determine the maximum period of time that the pixel test should require (based on manufacturer documentation). RECORD this information as: »Pixel Test Time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Test Procedure Specifications

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Results</th>
<th>Additional References</th>
</tr>
</thead>
</table>
| 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 | Pass / Fail (Section 3.5.3.1.1.2) | Section 4.2.4.2 Step a |
| 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 | Pass / Fail (RFC 1157) | Section 4.2.4.2 Step b |
| 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 |
| 5    | GET the following object(s):  

  » pixelTestActivation.0 | Pass / Fail (RFC 1157) | Section 4.2.4.2 Step b |
| 6    | IF the RESPONSE VALUE for pixelTestActivation.0 equals 'test' (3), then GOTO Step 5; otherwise, GOTO Step 7.  

  NOTE--If the RESPONSE VALUE remains at 'test' (3) for more than Pixel Test Time seconds, this test fails. | | |

Source: NTCIP 1203 v03, Volume II.
Test Cases and Test Procedures in NTCIP 1203 v03

Test Procedure Specifications

- **CONFIGURE.** Indicates the test step as a predicate to identify a configurable variable.

- **SET-UP.** Indicates the test step is a preparatory step to set up the environment for the actual test.

```
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
```

Source: NTCIP 1203 v03, Volume II.
Test Cases and Test Procedures in NTCIP 1203 v03

Test Procedure Specifications

Output Specifications

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

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Description</th>
<th>Pass / Fail (Section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>VERIFY that the RESPONSE VALUE for shortErrorStatus.0 has bit 5 (pixel error) cleared.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>PERFORM the test case labeled 'Blank the Sign' (C.3.7.15).</td>
<td></td>
</tr>
</tbody>
</table>

Test Case Results

<table>
<thead>
<tr>
<th>Tested By:</th>
<th>Date Tested:</th>
<th>Pass / Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Case Notes:

Source: NTCIP 1203 v03, Volume II.
Intercase Dependencies

- Identify any test cases to be performed during this test case.
- E.g., PERFORM the test case labeled…

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

Test Case Results

<table>
<thead>
<tr>
<th>Tested By:</th>
<th>Date Tested:</th>
<th>Pass / Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Case Notes:

Source: NTCIP 1203 v03, Volume II.
ACTIVITY
What is the purpose of the Requirements to Test Case Matrix?

Answer Choices

a) Identify the requirements that are part of the project specification
b) Identify all the test cases that must be passed to verify a requirement is fulfilled
c) Identify the design content to fulfill a requirement
d) Identify one of the possible test cases that must be passed to verify a requirement is fulfilled
Review of Answers

a) Identify the requirements that are part of the project specification

Incorrect. The Protocol Requirements List (PRL) identifies the requirements that are part of a project specification.

b) Identify all the test cases that must be passed to verify a requirement is fulfilled

Correct! The RTCTM identifies all the test cases that must be passed to verify a requirement is fulfilled.

c) Identify the design content to fulfill a requirement

Incorrect. The Requirements Traceability Matrix identifies the design content to fulfill a requirement.

d) Identify one of the possible test cases that must be passed to verify a requirement is fulfilled

Incorrect. All the test cases traced to a requirement must be passed to verify the requirement is fulfilled.
Learning Objectives

Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken for DMS

Identify the key elements of NTCIP 1203 v03 relevant to the test plan

Describe the application of a good test plan to a DMS system being procured
Describe the application of a good test plan to a DMS system being procured
Introduction and Test Items

[IEEE 829-2008]

- Test Plan Identifier
- Introduction:
  - Purpose: Verify compliance to the Procurement No. 11-xxx, and verify conformance to NTCIP 1203 v03
- 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
Test Plan for a DMS System

Features Being Tested and Approach

- Features to be tested
  - Can just be a copy of the completed Protocol Requirements List (PRL)
    - User needs and requirements selected for the project
- 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
Test Plan for a DMS System

Features Being Tested and Approach

- 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)
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
ACTIVITY
Which of the following information is not provided in a test plan?

Answer Choices

a) What item is being tested?

b) Who is responsible for performing the test?

c) What are the inputs and outputs for the test case specification?

d) What are the test deliverables?
Review of Answers

a) What item is being tested?

Incorrect. A test plan identifies the test item.

b) Who is responsible for performing the test?

Incorrect. A test plan identifies the roles and responsibilities of the persons involved with the test.

c) What are the inputs and outputs for a test case?

Correct! The inputs and outputs for a test case is defined in a test case specification.

d) What are the test deliverables?

Incorrect. A test plan does identify the deliverables of the testing, such as test documentation.
Learning Objectives

Describe within the context of a testing lifecycle the role of a test plan and the testing to be undertaken for DMS

Identify the key elements of NTCIP 1203 v03 relevant to the test plan

Describe the application of a good test plan to a DMS system being procured

Describe a process of adapting a test plan based on the selected user needs and requirements
Learning Objective 4

Describe a process of adapting a test plan based on the selected user needs and requirements
Develop a Test Design Specification Based on NTCIP 1203 v03

Definition

- **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, Test Design Specifications for color variable message signs and blank-out signs.

![Coordinating Symbol for Major Accident 15 mi ahead and reduce speed]
Develop a Test Design Specification Based on NTCIP 1203 v03

Features to Be Tested

- NTCIP 1203 v02 and v03
  - The completed PRL indicates what features and requirements have been selected for the procurement specification.
  - Those requirements should be tested as part of the test plan.

<table>
<thead>
<tr>
<th>UN Section Number</th>
<th>User Need (UN)</th>
<th>FR Section Number</th>
<th>Functional Requirement (FR)</th>
<th>Conformance</th>
<th>Support / Project Requirement</th>
<th>Additional Project Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5.2.3.1</td>
<td>Activate and Display a Message</td>
<td>M</td>
<td>[Yes]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.2.3.1</td>
<td>Activate a Message</td>
<td>M</td>
<td>[Yes]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.2.3.3.5</td>
<td>Retrieve Message</td>
<td>M</td>
<td>[Yes]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.2.3.6</td>
<td>Activate a Message with Status</td>
<td>Drum.M</td>
<td>[Yes NA]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Develop a Test Design Specification Based on NTCIP 1203 v03

Features to Be Tested

- For example, “Activate Pixel Testing” is a selected requirement in the completed PRL
  - See Student Supplement for the full description

---

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

Source: NTCIP 1203 v03, Volume I.
Develop a Test Design Specification Based on NTCIP 1203 v03

Requirements Traceability Matrix

- The Requirements Traceability Matrix (RTM) defines the **dialogs** and **data objects** that must be used to **fulfill** the requirement.
  - 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).
Develop a Test Design Specification Based on NTCIP 1203 v03

Requirements Traceability Matrix

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

<table>
<thead>
<tr>
<th>FR ID</th>
<th>Functional Requirement</th>
<th>Dialog ID</th>
<th>Object ID</th>
<th>Object Name</th>
<th>Additional Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5.3</td>
<td>Monitor the Status of the DMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1</td>
<td>Perform Diagnostics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1</td>
<td>Test Operational Status of DMS Components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1.1</td>
<td>Execute Lamp Testing</td>
<td>4.2.4.1</td>
<td>5.11.2.3.3</td>
<td>lampTestActivation</td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1.2</td>
<td>Activate Pixel Testing</td>
<td>4.2.4.2</td>
<td>5.11.2.4.3</td>
<td>pixelTestActivation</td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1.3</td>
<td>Execute Climate Control Equipment Testing</td>
<td>4.2.4.3</td>
<td>5.11.2.3.5.6</td>
<td>dmsClimateCtrlTestActivation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.11.2.3.5.7</td>
<td>dmsClimateCtrlAbortReason</td>
<td></td>
</tr>
</tbody>
</table>

Source: NTCIP 1203 v03, Volume I.
Develop a Test Design Specification Based on NTCIP 1203 v03

Requirements Traceability Matrix

Below is the dialog that fulfills the requirement Activate Pixel Testing

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 CET 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

Source: NTCIP 1203 v03, Volume I.
Develop a Test Design Specification Based on NTCIP 1203 v03

Requirements to Test Case Traceability Matrix

- Based on the project **requirements selected in the PRL**, an agency can **create a RTCTM** containing only those **selected requirements** and their associated test cases.

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Title</th>
<th>Test Case ID</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5.3</td>
<td>Monitor the Status of the DMS</td>
<td>C.3.5.1</td>
<td>Pixel Test - No Errors</td>
</tr>
<tr>
<td>3.5.3.1</td>
<td>Perform Diagnostics</td>
<td>C.3.5.2</td>
<td>Pixel Test - Errors</td>
</tr>
<tr>
<td>3.5.3.1.1</td>
<td>Test Operational Status of DMS Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1.1</td>
<td>Execute Lamp Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1.2</td>
<td>Activate Pixel Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1.1.3</td>
<td>Execute Climate-Control Equipment Testing</td>
<td>C.3.5.3</td>
<td>Climate-Control Equipment Test - No Errors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C.3.5.4</td>
<td>Climate-Control Equipment Test - Errors</td>
</tr>
</tbody>
</table>
Develop a Test Design Specification Based on NTCIP 1203 v03

Requirements to Test Case Traceability Matrix

- The tailored RTCTM becomes part of the test design specification.
  - Identifies the requirements to be tested.
  - Identifies the test cases and test procedures to be performed.
Test Design Specification

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., one PRL for the BOS, one PRL for the VMS)
- Approach refinements
- Test identification
  - Tailored RTCTM
- Feature pass/fail criteria
How to Develop Test Cases and Test Procedures for Extensions

Extensions

- Extensions – to support agency-specific features and/or requirements not supported by the standard
- Permitted but not encouraged
  - Interoperability is not achieved
How to Develop Test Cases and Test Procedures for Extensions

Extensions

- For communication interface features not covered by the standard, procurers should document and clearly define:
  - The user need/feature
  - Customized requirements to satisfy the new user need
  - The dialogs and objects to fulfill each customized requirement

- Test cases should be created for testing the customized requirements

- The identifier of the customized requirements and test cases should be included in the tailored RTCTM and the test design specification
How to Use the Test Procedure Generator Tool

Test Procedure Generator (TPG)

- Free tool from USDOT to guide the development of test procedures for requirements in NTCIP Center-to-Field (C2F) standards with systems engineering content to:
  - determine an implementation’s conformance to the NTCIP C2F Device Interface Standard
  - determine compliance to a project specification
  - develop test procedures for extensions
- Also used by NTCIP C2F Standards developers to verify traceability and conformance to NTCIP 8002
How to Use the Test Procedure Generator Tool

Starting a New Session

The image shows a window for starting a new session with the Test Procedure Generator tool. The window displays fields for selecting the NTCIP C2F Device Interface Standard Number, Major Version Number, Minor Version Number, and Revision Letter. It also includes options for New Session and Verification Options.
How to Use the Test Procedure Generator Tool

Creating a New Set of Test Procedures
How to Use the Test Procedure Generator Tool

Creating a New Test Procedure

NTCIP 1203v03-01b

National Transportation Communications for ITS Protocol
Creating a New Test Procedure

Test Procedure: 01.00

Select the Test Procedure->Define Header Menu Item to enter the Test Procedure Title

Description:

Select the Test Procedure->Define Header Menu Item to enter the Test Procedure Description

Requirement(s):

Select the Test Procedure->Select Requirements Menu Item to enter the Test Procedure Requirements

Variable(s):

Select the Test Procedure->Define Variables menu item to enter the Test Procedure Variables

Pass/Fail Criteria:

Select the Test Procedure->Define Header Menu Item to enter the Test Procedure Pass/Fail Criteria

Test Step

Test Procedure: 01.00

Select the Test Procedure->Define Header Menu Item to enter the Test Procedure Title

Description:

Select the Test Procedure->Define Header Menu Item to enter the Test Procedure Description

Requirement(s):

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Test Step

Test Procedure: 01.00

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Select the Test Procedure->Define Header Menu Item to enter the Test Procedure Pass/Fail Criteria
How to Use the Test Procedure Generator Tool

Creating a New Test Procedure
Creating a New Test Procedure
How to Use the Test Procedure Generator Tool

Creating a New Test Procedure
How to Use the Test Procedure Generator Tool

Opening Test Procedures

A Recommended Standard of the Joint Committee on the NTCIP

NTCIP 1203 version v03

National Transportation Communications for ITS Protocol
Object Definitions for Dynamic Message Signs (DMS)
What is the Requirements to Test Case Traceability Matrix (RTCTM) in a Test Design Specification based upon?

Answer Choices

a) Includes all the requirements supported by the standard
b) Includes only the requirements selected in the PRL that the Test Design Specification is based upon
c) Includes only those requirements that are mandatory to conform to the standard
d) Includes all the requirements that are contained in the project specifications
Review of Answers

a) Includes all the requirements supported by the standard

 Incorrect. The RTCTM should list only those requirements specified in the TDS.

b) Includes only the requirements selected in the PRL that the TDS is based upon

 Correct! The RTCTM is based on the requirements selected.

c) Includes only those requirements that are mandatory to conform to the standard

 Incorrect. The RTCTM includes selected optional requirements.

d) Includes all the requirements that are contained in the project specifications

 Incorrect. Could be correct, but the PRL is complete, accurate and contains only the applicable requirements.
Module Summary

Describe within the context of a testing lifecycle the **role of a test plan** and the testing to be undertaken for DMS

Identify the **key elements** of NTCIP 1203 v03 relevant to the test plan

Describe the **application** of a good test plan to a DMS system being procured

Describe a **process** of adapting a test plan based on the selected user needs and requirements
We Have Now Completed the DMS Curriculum

**Module A311a:** Understanding **User Needs** for DMS Systems based on NTCIP 1203 Standard v03

**Module A311b:** Specifying **Requirements** for DMS Systems based on NTCIP 1203 Standard v03

**Module T311:** Applying Your **Test Plan** to Dynamic Message Signs based on NTCIP 1203 DMS Standard v03
Thank you for completing this module.

Feedback
Please use the Feedback link below to provide us with your thoughts and comments about the value of the training.

Thank you!