Welcome

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WWW.PCB.ITS.DOT.GOV/STANDARDSTRAINING
T202
Overview of Test Design Specifications, Test Cases, and Test Procedures
Target Audience

- Engineering Staff
- Operational Staff
- Maintenance Staff
- Testing Staff (testing personnel and systems integrators, with specialized capabilities)
Instructor

Russ Brookshire
Product Manager
Intelligent Devices
Suwanee, GA, USA
Recommended Prerequisites

- T101: Introduction to ITS Standards Testing
- T201: How to Write a Test Plan
Curriculum Path (Testing)

T101 Introduction to ITS Standards Testing

T201 How to Write a Test Plan

T202 Overview of Test Design Specifications, Test Cases, and Test Procedures

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

T313 Applying Your Test Plan to the NTCIP 1204 v03 ESS Standard

T3XX Applying Your Test Plan to NTCIP/TMDD/ATC Standards
Learning Objectives

1. Describe, within the context of the testing lifecycle, the role of Test Plans, Test Design Specifications, Test Cases and Test Procedures

2. Describe the purpose and content of Test Design Specifications, Test Cases, and Test Procedures
Learning Objectives (Cont’d)

3. For standards using the Systems Engineering Process (SEP), detail the manner that Protocol Requirements Lists (PRLs) and Requirements to Test Cases Traceability Matrices (RTCTMs) can be used to create Test Specifications

4. For standards that do not use SEP, detail the manner that Conformance Groups can be used to create Test Specifications
Testing and the Project Life Cycle

Pages 7 and 8 in the Supplement
Why Test?

- To validate the system against the user needs
- To verify compliance with the procurement specifications
- To verify conformance to the standard, ensuring interoperability and interchangeability
Testing Methods

- Inspection – verification by physical and visual examination
- Analysis – verification by means of calculations
- Demonstration – verification of a function observed under a specific condition
- Formal Testing – verification of a function observed under controlled exercises using real or simulated stimulus
ACTIVITY
What are some of the benefits of NTCIP Conformance Testing?

Enter response in the chat box
Benefits of Conformance Testing

- Testing for compliance with the project specifications only shows that the system works as specified.

- NTCIP conformance testing promotes interoperability of system elements by means of standardized dialogs, test cases, and test procedures.

- Standardization also reduces overall system cost and risk.
Test Plans

- Test Plans are defined in IEEE 829, and covered in detail in Module T201 – How to Write a Test Plan

- Typically developed during “Decomposition and Definition” phase of the Project Life Cycle (left-side of “V” diagram); not provided in NTCIP standards

- Test Plan: high-level document that defines:
  - What item is to be tested and when it is to be tested
  - In what detail the item is to be tested
  - How is the item to be tested
  - Who is to design and perform testing
What Item is to be Tested, and When is it to be Tested

- Unit / Device Test – covers an item and its interfaces
- Subsystem Verification – tests the item, its communications, and other items that communicate with the test item
- System Verification – ensures that the entire system meets the system requirements
- System Validation – used to show that the system as implemented meets the original user needs
In What Detail is the Item to be Tested

- Communications: serial, Ethernet, packet errors
- Functionality: camera zoom, sign brightness, monitoring of air temperature
- Performance: speed, reliability, capacity
- Hardware: materials, strength, vibration
- Environmental: temperature, humidity, water intrusion, ice buildup
How is the Item to be Tested?

- NTCIP testing - a combination of communications testing and functional testing
- Communications testing can be performed by NTCIP test software and/or protocol analyzers
- Functional testing may require specialized equipment to simulate testable conditions
- Data that are communicated with the device must correlate at some point with observable behavior, which constitutes the functionality to be tested.
Who is to Design and Perform the Testing

- Agency personnel, out-of-house expert, manufacturer’s representative?
- Note that each have pros and cons
- In many instances, a combination is the answer
Additional Considerations for Test Plans

- Item Pass/Fail Criteria
- Suspension Criteria and Resumption Requirements
Test Specifications

- **Test Design Specification (TDS)** – A document specifying the details of the test approach for a feature or combination of features and identifying the associated tests.

- **Test Case Specification (TCS)** – A document specifying inputs, predicted results, and a set of execution conditions for a test item.

- **Test Procedure Specification (TPS)** – A document specifying a sequence of actions for the execution of a test.

Definitions per IEEE 829
Each Test Plan has a Test Design Specification

Each Test Design Specification may reference multiple Test Case Specifications

Each Test Case Specification may reference multiple Test Procedure Specifications and vice versa
Example of Test Specifications

Test Item: Calculator

Test Design Specification
Feature to be Tested: Addition

Test Case 1:
Add two positive numbers
Input 1: 7  Operation: +
Input 2: 12  Result: Displays 19

Test Case 2:
Sum too large
Input 1: 500  Operation: +
Input 2: 500  Result: Displays “Err”

Test Procedure 1: Arithmetic
1. Enter Input 1
2. Enter operation
3. Enter input 2
4. Press the “=” key
5. Verify result
POLLING
Which of the following are included in NTCIP standards?

1. Test Design Specifications (TDS)
2. Test Case Specifications (TCS)
3. Test Procedure Specifications (TPS)
4. All three
5. It depends
Summary of Test Documents

- Test Plan - *Overview of entire testing process*

- Test Design Specification (TDS) - *Specifies details of the test approach*

- Test Case Specification (TCS) - *Specifies inputs, outputs and conditions*

- Test Procedure Specification (TPS) - *Specifies a sequence of actions for the execution of a test.*
CASE STUDY
Case Study: NTCIP 1203 v03 - DMS

- SEP-based Standard Provides Test Cases and Test Procedures for Device Testing
- Case Study shows how to Create TDS and Select Correct Test Cases and Test Procedures
Case Study: NTCIP 1203 v03 - DMS

DMS Configuration:

• Character matrix
• Three lines by 18 characters
• Each character is 7 rows high by 5 columns wide

Courtesy: Intelligent Devices, Inc.
Content of Test Design Specifications

Not included in NTCIP standards

- Test design specification identifier – must be unique
- Features to be tested – identify the test items and the specific features to be tested
- Approach refinements – include specific test techniques; summarize common attributes of any test cases
- Test identification – identify the test cases to be used
- Feature pass/fail criteria
Case Study: TDS for DMS

Selecting Features using PRL

- Features are selected by the specifying authority using the Protocol Requirements List in NTCIP 1203 v03.
- Functional Requirement “DMS Display Matrix Configuration” is Mandatory

<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>2.3.2.3</td>
<td>DMS Display Matrix Configuration</td>
<td></td>
<td>M</td>
<td>Yes</td>
<td></td>
<td>The DMS shall be 9,000 millimeters wide (0.65535) and 2,700 millimeters high (0.65535), inclusive of borders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The Sign’s Border shall be at least 400 millimeters wide (0.65535) and 400 millimeters high (0.65535).</td>
</tr>
<tr>
<td>2.3.2.3.1</td>
<td>Non-Matrix</td>
<td>O.2 (1)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3.2.3.2 (Matrix)</td>
<td>Matrix</td>
<td>O.2 (1)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>The pitch between pixels shall be at least 66 millimeters (0.255).</td>
</tr>
<tr>
<td>2.3.2.3.2.1</td>
<td>Full Matrix</td>
<td>O.3 (1)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>The sign shall be ____ pixels wide (0.65535) and ____ pixels high (0.65535).</td>
</tr>
<tr>
<td>2.3.2.3.2.2</td>
<td>Line Matrix</td>
<td>O.3 (1)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>The sign shall have ____ lines with each line being ____ pixels wide and ____ pixels high.</td>
</tr>
<tr>
<td>2.3.2.3.2.3</td>
<td>Character Matrix</td>
<td>O.3 (1)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>The sign shall be 18 characters wide and 3 characters high with each character being 5 pixels wide (0.255), 7 pixels high (0.255).</td>
</tr>
</tbody>
</table>
Case Study: TDS for DMS

Selecting Features using PRL (Cont’d)

- O.# (range) means these options are part of an option group. Support of the number of items indicated by the “(range)” is required from all options labeled with the same numeral #.

<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>2.3.2.3</td>
<td>DMS Display Matrix Configuration</td>
<td></td>
<td>M</td>
<td>Yes</td>
<td></td>
<td>The DMS shall be 9,000 millimeters wide (0..65535) and 2,700 millimeters high (0..65535), inclusive of borders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The Sign's Border shall be at least 400 millimeters wide (0..65535) and 400 millimeters high (0..65535).</td>
</tr>
<tr>
<td>2.3.2.3.1</td>
<td>Non-Matrix</td>
<td></td>
<td>O.2 (1)</td>
<td>Yes / No</td>
<td></td>
<td>The pitch between pixels shall be at least 66 millimeters (0..255).</td>
</tr>
<tr>
<td>2.3.2.3.2 (Matrix)</td>
<td>Matrix</td>
<td></td>
<td>O.2 (1)</td>
<td>Yes / No</td>
<td></td>
<td>The sign shall be ___ pixels wide (0..65535) and ___ pixels high (0..65535).</td>
</tr>
<tr>
<td>2.3.2.3.2.1</td>
<td>Full Matrix</td>
<td></td>
<td>O.3 (1)</td>
<td>Yes / No</td>
<td></td>
<td>The sign shall have ___ lines with each line being ___ pixels wide and ___ pixels high.</td>
</tr>
<tr>
<td>2.3.2.3.2.2</td>
<td>Line Matrix</td>
<td></td>
<td>O.3 (1)</td>
<td>Yes / No</td>
<td></td>
<td>The sign shall be 18 characters wide and 3 characters high with each character being 5 pixels wide (0..255), 7 pixels high (0..255).</td>
</tr>
</tbody>
</table>
Case Study: TDS for DMS

Selecting Features using PRL (Cont’d)

- Because “Matrix” was selected, several requirements are mandatory, including the ones selected below.

<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>2.5.1.2</td>
<td>Determine Sign Display Capabilities</td>
<td>3.5.1.2.1.1</td>
<td>Determine the Size of the Sign Face</td>
<td>O</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5.1.2.1.2</td>
<td>Determine the Size of the Sign Border</td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5.1.2.1.3</td>
<td>Determine Beacon Type</td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5.1.2.1.4</td>
<td>Determine Sign Access and Legend</td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5.1.2.2.1</td>
<td>Determine Sign Face Size in Pixels</td>
<td>Matrix:M</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5.1.2.2.2</td>
<td>Determine Character Size in Pixels</td>
<td>Matrix:M</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5.1.2.2.3</td>
<td>Determine Pixel Spacing</td>
<td>Matrix:M</td>
<td>Yes</td>
<td>NA</td>
</tr>
</tbody>
</table>
Test Design – Features to be Tested

Requirements Traceability Matrix (RTM)

- RTM maps Functional Requirements to Dialogs and Objects.

<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>3.5.1.2.2</td>
<td>Determine Matrix Capabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.1.2.2.1</td>
<td>Determine Sign Face Size in Pixels</td>
<td>G.1</td>
<td>5.3.3</td>
<td>vmsSignHeightPixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.3.4</td>
<td>vmsSignWidthPixels</td>
<td></td>
</tr>
<tr>
<td>3.5.1.2.2.2</td>
<td>Determine Character Size in Pixels</td>
<td>G.1</td>
<td>5.3.1</td>
<td>vmsCharacterHeightPixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.3.2</td>
<td>vmsCharacterWidthPixels</td>
<td></td>
</tr>
<tr>
<td>3.5.1.2.2.3</td>
<td>Determine Pixel Spacing</td>
<td>G.1</td>
<td>5.3.5</td>
<td>vmsHorizontalPitch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.3.6</td>
<td>vmsVerticalPitch</td>
<td></td>
</tr>
</tbody>
</table>
Test Design – Test Identification

Using RTCTM to Select Test Cases

- RTCTM links a Functional Requirement to one or more test cases
- All test cases referenced must be performed to verify conformance.

Table 1. Requirements to Test Case Traceability Table

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirement Title</th>
<th>Test Case ID</th>
<th>Test Case Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5.1.2.2</td>
<td>Determine Matrix Capabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.1.2.2.1</td>
<td>Determine Sign Face Size in Pixels</td>
<td>C.3.1.6</td>
<td>Determine Sign Face Size in Pixels</td>
</tr>
<tr>
<td>3.5.1.2.2.2</td>
<td>Determine Character Size in Pixels</td>
<td>C.3.1.7</td>
<td>Determine Character Size in Pixels</td>
</tr>
<tr>
<td>3.5.1.2.2.3</td>
<td>Determine Pixel Spacing</td>
<td>C.3.1.8</td>
<td>Determine Pixel Spacing</td>
</tr>
</tbody>
</table>
Test Case Specifications (TCS)

TCS – A *document specifying inputs, predicted results, and a set of execution conditions for a test item*.

- Test Case Specification Identifier
- Purpose
- Test Items
- Input Specifications
- Output Specifications
- Environmental Needs
- Special Procedural Requirements
- Intercase Dependencies

Pages 7–9 in the Supplement
# Test Case Specifications

## Inputs from PRL

- The individual test cases are provided with Test Case IDs, each of which defines the required inputs, and references the associated NTCIP 1203 Test Procedures.

<table>
<thead>
<tr>
<th>NTCIP 1203 Test Case / Test Procedure</th>
<th>Test Case / Test Procedure</th>
<th>Selected</th>
<th>Variable</th>
<th>Reference</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>Determine Sign Face Size in Pixels</td>
<td>X</td>
<td>Required_Sign_Pixel_Height</td>
<td>PRL 2.3.2.3.2.1-2.3.2.3.2.3</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Required_Sign_Pixel_Width</td>
<td>PRL 2.3.2.3.2.1-2.3.2.3.2.3</td>
<td>90</td>
</tr>
<tr>
<td>1.7</td>
<td>Determine Character Size in Pixels</td>
<td>X</td>
<td>Required_Character_Pixel_Height</td>
<td>PRL 2.3.2.3.2.3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Required_Character_Pixel_Width</td>
<td>PRL 2.3.2.3.2.3</td>
<td>5</td>
</tr>
<tr>
<td>1.8</td>
<td>Determine Pixel Spacing</td>
<td>X</td>
<td>Required_Horizontal_Pitch</td>
<td>PRL 2.3.2.3.2</td>
<td>66 (mm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Required_Vertical_Pitch</td>
<td>PRL 2.3.2.3.2</td>
<td>66 (mm)</td>
</tr>
</tbody>
</table>
Test Case Specifications

Example NTCIP Test Case/Test Procedure

- NTCIP combines Test Cases and Test Procedures as shown below, which does not strictly follow IEEE 829.

<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 sign height in pixels as required by the specification (PRL 2.3.2.3.2.1-2.3.2.3.2.3). RECORD this information as: Required_Sign_Pixel_Height</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test Procedure Specification (TPS)

- TPS – A document specifying a 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.

See Supplement
Test Procedures

- Per the IEEE 829 definition, the Test Procedure only defines the steps necessary to test the feature.
CASE STUDY
Case Study: NTCIP 1209 v02 - TSS

- Transportation Sensor Systems (TSS) are used to monitor vehicle volume, occupancy and speed over a selectable period of time.

- SEP-based Standard has PRL and Dialogs, but no Test Cases or Test Procedures

- Test Design Specifications can be created as shown in the previous DMS Case Study.

- This Case Study shows how to create Test Cases and Test Procedures
## TSS Case Study: PRL and RTM

### Protocol Requirements List (PRL) Table

<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 Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5.2.1</td>
<td>Reset the TSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.1</td>
<td>Restart the TSS</td>
<td>3.4.1.3.1</td>
<td></td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.2</td>
<td>Reinitialize User Settings</td>
<td>3.4.1.3.2</td>
<td></td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.3</td>
<td>Restore Factory Defaults</td>
<td>3.4.1.3.3</td>
<td></td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.4</td>
<td>Return</td>
<td>3.4.1.3.4</td>
<td></td>
<td>M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.8</td>
<td>Execute Pending Configuration</td>
<td>3.4.1.3.8</td>
<td></td>
<td>0.1</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.9</td>
<td>Abort Pending Configuration</td>
<td>3.4.1.3.9</td>
<td></td>
<td>0.1</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>3.4.1.3.10</td>
<td>Validate Pending Configuration</td>
<td>3.4.1.3.10</td>
<td></td>
<td>0.1</td>
<td>Yes/No</td>
<td></td>
</tr>
</tbody>
</table>

### REQUIREMENTS TRACEABILITY MATRIX (RTM)

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirement</th>
<th>Dialog ID</th>
<th>Dialog</th>
<th>Object ID</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4.1.3</td>
<td>Control the TSS</td>
<td>3.4.1.3</td>
<td></td>
<td>4.3.1.1</td>
<td>Reset and Synchronize the TSS</td>
</tr>
<tr>
<td>3.4.1.3.1</td>
<td>Restart the TSS</td>
<td>4.3.1.1</td>
<td>5.2.1</td>
<td>sensorSystemReset</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.2.2</td>
<td>sensorSystemStatus</td>
<td></td>
</tr>
</tbody>
</table>

Pages 11-12 in the Supplement
4.3.1.1 Reset and Synchronize the TSS

The standardized dialog for a management station to restart, reinitialize, restore, retune, re-sync, run short diagnostics or long diagnostics of a TSS shall be as follows:

a) (Precondition) None
b) The management station shall GET the sensorSystemStatus.x state. If the state of sensorSystemStatus is 'initializing', 'pendingConfigurationChange', or 'validatingPendingConfiguration', then the management station shall abort the process
c) The management station shall SET the sensorSystemReset.y state to 'restart', 'reinitializeUserSettings', 'restoreFactoryDefaults', 'retune', 'resyncSamplingPeriods', 'shortDiagnostics', or 'fullDiagnostics'
d) The management station shall GET the sensorSystemStatus.x state
e) If the management station gets no response, then repeat Step d up to maximum TSS initialization time
f) If the sensorSystemStatus.x state is 'initializing', then repeat Step d
g) If sensorSystemStatus.x state is 'ok', then the TSS reset is complete
h) If sensorSystemStatus.x state NOT 'ok', then the reset may not have completed, did not complete normally, or an error was encountered during the process. The management station shall abort the process

Pages 11-12 in the Supplement
TSS Case Study – Test Case Specification

- From the Dialog, only one parameter need be passed to the Test Procedure – the command
- The result should be sensorSystemStatus.0 = oK

<table>
<thead>
<tr>
<th>Test Case Number</th>
<th>Test Case Name</th>
<th>Test Procedure</th>
<th>Object(s) Under Test</th>
<th>Variables</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1205-001</td>
<td>Restart TSS</td>
<td>TP1205-001</td>
<td>sensorSystemStatus.0, sensorSystemReset.0</td>
<td>Reset_Command = 'restart'</td>
<td>sensorSystemStatus.0 = oK</td>
</tr>
</tbody>
</table>
# TSS Case Study – Test Procedure

**Test Procedure:** TP1209-001  
**Title:** Reset the TSS  
**Description:** This Test Case verifies that the operator can correctly reset the TSS.  
**Pass/Fail Criteria:** The DUT shall pass every verification step included within the Test Case in order to pass the Test Case.  
**Variables:** Reset_Command Command to be implemented

<table>
<thead>
<tr>
<th>Test Step Number</th>
<th>Test Step</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GET sensorSystemStatus.0</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>2.</td>
<td>IF the RESPONSE VALUE to sensorSystemStatus.0 is 'initializing', 'pendingConfigurationChange', or 'validatingPendingConfiguration' EXIT the Test Procedure, and correct the deficiency before restarting the test.</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>3.</td>
<td>SET sensorSystemReset.0 to Reset_Command.</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>4.</td>
<td>GET sensorSystemStatus.0</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>5.</td>
<td>IF the RESPONSE VALUE for sensorSystemStatus.0 equals 'initializing', then GOTO Step 4.</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td></td>
<td>NOTE--If the RESPONSE VALUE remains at 'initializing' for more than the maximum TSS initialization time, this test fails.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>VERIFY that the RESPONSE VALUE for sensorSystemStatus.0 equals 'ok'.</td>
<td>Pass / Fail</td>
</tr>
</tbody>
</table>
According to IEEE 829, which of the following are included in Test Procedures?

1. Inputs
2. Execution conditions
3. Steps to execute
4. Expected results
5. All of the above
Standards developed without SEP

- NO User Needs, Functional Requirements, or PRLs.

- Test Design Specifications, Test Cases, and Test Procedures must be generated by the specifying authority.
Conformance Groups

Purpose

- Used by NTCIP standards that were not created using SEP

- Combine objects that are similar

- Define whether groups of objects are mandatory or optional

- Can be used to specify requirements and generate Test Specifications.
NTCIP 1205 CCTV Example

- NTCIP 1205, Cameras, was not created using SEP
- No PRL
- No Test Cases or Test Procedures
- Conformance Groups are used instead

Photo by Kent Flemmer, Flemmer Photography
Conformance Groups
Mandatory and Optional Groups

- CCTV Configuration Conformance Group is Mandatory.
- CCTV Motion Control Conformance Group is Optional, but is selected as being Supported.

<table>
<thead>
<tr>
<th>Conformance Group</th>
<th>Reference</th>
<th>Conformance Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td>NTCIP 1201:1996</td>
<td>mandatory</td>
</tr>
<tr>
<td>Database Management</td>
<td>NTCIP 1201:1996, Amendment 1</td>
<td>optional</td>
</tr>
<tr>
<td>Time Management</td>
<td>NTCIP 1201:1996, Amendment 1</td>
<td>optional</td>
</tr>
<tr>
<td>CCTV Configuration</td>
<td>NTCIP 1205</td>
<td>mandatory</td>
</tr>
<tr>
<td>Extended Functions</td>
<td>NTCIP 1205</td>
<td>optional</td>
</tr>
<tr>
<td>Motion Control</td>
<td>NTCIP 1205</td>
<td>optional</td>
</tr>
<tr>
<td>On-Screen Menu Control</td>
<td>NTCIP 1205</td>
<td>optional</td>
</tr>
</tbody>
</table>
NTCIP 1205 CCTV Example
Test Design Specification

- Excerpts from two Conformance Groups show the Mandatory objects for the Zoom feature.

### 4.1.1 CCTV Configuration Conformance Group

<table>
<thead>
<tr>
<th>OBJECT OR TABLE NAME</th>
<th>REFERENCE</th>
<th>CONFORMANCE REQUIREMENT WITHIN THE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>rangeZoomLimit</td>
<td>NTCIP 1205</td>
<td>mandatory</td>
</tr>
<tr>
<td>timeoutZoom</td>
<td>NTCIP 1205</td>
<td>mandatory</td>
</tr>
</tbody>
</table>

### 4.1.3 Motion Control Conformance Group

<table>
<thead>
<tr>
<th>OBJECT OR TABLE NAME</th>
<th>REFERENCE</th>
<th>CONFORMANCE REQUIREMENT WITHIN THE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>positionZoomLens</td>
<td>NTCIP 1205</td>
<td>mandatory</td>
</tr>
</tbody>
</table>
NTCIP 1205 CCTV Example
Test Design Specification

- positionZoomLens – allows the Central to command the camera to change its zoom setting
- rangeZoomLimit – defines the maximum zoom level
- timeoutZoom – limits how long a zoom can continue
### NTCIP 1205 CCTV Example

#### Test Cases

- Excerpt from a TCS showing three of the Test Cases required to show conformance for the Zoom feature.

#### Appendix A:

<table>
<thead>
<tr>
<th>Test Case Number</th>
<th>Test Case Name</th>
<th>Test Procedure Steps</th>
<th>Object(s) Under Test</th>
<th>Variables</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1205-001</td>
<td>Zoom absolute - maximum telephoto</td>
<td>TP1205-003 Steps 4-10</td>
<td>positionZoomLens.0</td>
<td>Mode = 2 (absolute) Speed_Tele_Fast = 127 Offset = rangeZoomLimit.0</td>
<td>Camera should zoom to its maximum setting at its maximum speed</td>
</tr>
<tr>
<td>TC1205-007</td>
<td>Zoom past rangeZoomLimit.0</td>
<td>TP1205-003 Steps 39-41</td>
<td>positionZoomLens.0; rangeZoomLimit.0</td>
<td>Mode = 1 (absolute) Speed_Tele_Fast = 127 Offset = 65535</td>
<td>Response Error is badValue</td>
</tr>
<tr>
<td>TC1205-008</td>
<td>Zoom for greater duration than timeoutZoom.0</td>
<td>TP1205-003 Steps 40-46</td>
<td>positionZoomLens.0; timeoutZoom.0</td>
<td>Mode = 3 (continuous) Speed_Tele_Slow = 10 Offset = rangeZoomLimit.0</td>
<td>Camera begins zooming toward its maximum telephoto setting, but stops after Zoom_Timeout seconds</td>
</tr>
</tbody>
</table>

Pages 14-16 in the Supplement
NTCIP 1205 CCTV Example

Test Procedures

- Excerpt from the TPS for the Zoom feature
- Referenced by TC1205-001: Zoom Absolute - Maximum Telephoto
- Causes the camera to zoom in to its zoom limit

<table>
<thead>
<tr>
<th>Test Step Number</th>
<th>Test Step</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Get rangeZoomLimit.0</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>2.</td>
<td>RECORD this integer value and its two-byte hex value as: &gt;&gt; Zoom Lim</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td></td>
<td>it &gt;&gt; Zoom_Limit_Hex</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Set timeoutZoom.0 to 0, turning off this feature.</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>4.</td>
<td>Set positionZoomLens.0 to Model: 2 (absolute) Speed: Speed_Tele_Fast Position or Offset: Zoom_Limit</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>5.</td>
<td>Delay for 10 seconds</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Verify that the camera zoomed to its absolute telephoto position</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>7.</td>
<td>Get positionZoomLens.0</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>8.</td>
<td>Verify that the Response Value equals Mode: 02 Speed: Speed_Tele_Fast Position or Offset: Zoom_Limit_Hex</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>9.</td>
<td>Get positionQueryZoom.0</td>
<td>Pass / Fail</td>
</tr>
<tr>
<td>10.</td>
<td>Verify that the Response Value equals Zoom_Limit. A Response Error of noSuchName indicates that positionQueryZoom.0 is unsupported.</td>
<td>Pass / Fail / Pass Unsupported</td>
</tr>
</tbody>
</table>

Learning Objective #4

Pages 17-19 in the Supplement
Additional Test Documents

These are used in addition to the Test Plan and Test Specifications.

- A **Test Item Transmittal** is used to document transferring a test item between entities, and includes its status.

- **Test Incident Reports** provide a means of recording anomalies that occurred during the testing.

- The **Test Summary** is typically a one-page report providing the results of the testing.

- **Test Logs** document the testing that occurred.
Learning Objectives

1. Describe, within the context of the testing lifecycle, the role of Test Plans, Test Design Specifications, Test Cases, and Test Procedures

2. Describe the purpose and content of Test Design Specifications, Test Cases, and Test Procedures
Learning Objectives (Cont’d)

3. For standards using Systems Engineering Process (SEP), detail the manner that Protocol Requirements Lists (PRLs) and Requirements to Test Cases Traceability Matrices (RTCTMs) can be used to create Test Specifications

4. For standards that do not use SEP, detail the manner that Conformance Groups can be used to create Test Specifications
What Did We Learn Today?

1) The **Test Plan** is created early in the Project Life Cycle, and defines the testing to be performed from a management-level perspective.

2) **Test Design Specifications** detail the testing to be performed.

3) Test Cases define the **inputs**, expected results, and test conditions.

4) Test Procedures define the **steps** to be performed to execute the tests.

5) **PRL** and **RTM** are two items found in standards created using SEP.

6) **Conformance Groups** are found in standards created without using SEP.
For More Information

- **Systems Engineering Guidebook for Intelligent Transportation Systems Version 3.0** (The “V” Systems Engineering Model)  


- **NTCIP 1204 Version v03.08**, National Transportation Communications for ITS Protocol, Object Definitions for Environmental Sensor Stations (ESS)  
  [www.ntcip.org](http://www.ntcip.org)

- **NTCIP 1201 Version v03.13a**, National Transportation Communications for ITS Protocol, Global Object Definitions  
  [www.ntcip.org](http://www.ntcip.org)

- **NTCIP 8007 Version 1.21**, National Transportation Communications for ITS Protocol, Testing and CA Documentation within NTCIP Standards  
  [www.ntcip.org](http://www.ntcip.org)

- **NTCIP 9001 Version v04**, National Transportation Communications for ITS Protocol, The NTCIP Guide  
  [www.ntcip.org](http://www.ntcip.org)
Curriculum Path (Testing)

T101
Introduction to ITS Standards Testing

T201
How to Write a Test Plan

T202
Overview of Test Design Specifications, Test Cases, and Test Procedures

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

T313
Applying Your Test Plan to the NTCIP 1204 v03 ESS Standard

T3XX
Applying Your Test Plan to NTCIP/TMDD/ATC Standards
QUESTIONS?