Welcome

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T101: Introduction to ITS Standards Testing
Target Audience

- Engineering staff
- Operational staff
- Maintenance staff
- Decision makers (in feedback loop) in a procurement capacity (acquisitions department)
Instructor

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Recommended Prerequisites

- A100
- A200
- A300 level courses as appropriate
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
Learning Objectives

1. Explain the need for and benefits of testing
2. Describe how ITS standards testing fits into the overall scope of a systems test and a systems life cycle
3. Discuss how to test an implementation for conformance to standards
4. Distinguish the difference between standard conformance and project compliance
What is Testing?

Two types:

1. Standards testing
   - Provides information to users on the reliability, interoperability, functionality, and performance of systems using the standard

2. System’s conformance to documented test plan based upon an ITS standard
   - The topic of this Webinar
ACTIVITY
Benefits of Testing

- What do you see as possible benefits of testing?
- Use the chat pod to answer
Benefits of Testing

- Verify that requirements are fulfilled
- Reduce the risk of misinterpretation between agency and manufacturers
- Reduce the risk of financial mismanagement
- Reduce the risk of perceived lack of oversight
- Ensure interoperability to allow system expansion
Who Does the Testing?

- Agency should identify party
- Typical testing parties:
  - Agency (includes agency’s contractor)
  - Manufacturer
  - Independent laboratory
- All parties should have a clear understanding of their testing responsibilities
  - Clear description of the consequences of test failure(s)
Terminology

- **Conformance**: A condition that exists when an item meets all of the mandatory and selected optional requirements as defined by a standard.

- **Compliance**: A condition that exists when an item meets all of the requirements of an agency specification.
Terminology

- **Validation**: Making sure a system, when placed in operation, will support agency needs
  - In other words: Have we built the *right* thing?

- **Verification**: Making sure a design complies with requirements and that the systems (as proposed and delivered) comply with both design and requirements
  - In other words: Have we built the *thing* right?

- **Traceability**: A tool to help determine if the agency’s requirements are fulfilled by the design and that implementation was done correctly
Testing and the Systems Engineering Process

Traceability

Testing

Life Cycle Time Line
Testing and the Systems Engineering Process

Unit/Device Testing

- Focuses on comparing an implementation against the standards and specified options
- May be performed by inspecting the code to use “proven” software to send test messages to the device.
Testing and the Systems Engineering Process

Subsystem Testing

- Consists of connecting two or more devices together and exchanging data
- Assumes devices and components have passed a designed unit test plan
- Assumes devices or subsystem components support same ITS operational and/or functional features.
Testing and the Systems Engineering Process

System Testing

- Highest level of testing
- Performed after all lower level testing is successfully completed
- Performed in an operational environment
- Includes acceptance testing
IEEE 829

- Standard that specifies the form of a set of documents for use in eight defined stages of software testing
- Each stage may have its own document
  - Specifies the format of these documents
  - Does not stipulate whether they all must be produced
  - Does not include any criteria regarding adequate content for these documents
- Software testing standard applicable to other types of testing
- A framework for testing within the life cycle
ACTIVITY
What Should a Test Plan Cover?

- What do you think a test plan should cover?
- Use the chat pod to answer
Testing Considerations

- Maturity of device, software, interface, or system
- Number of units (if a device)
- Agency’s ability to test
- Available expertise
- Significance of specification requirement
Test Plans

- Management planning document that covers the “who, what, when, and how”
- Defined in IEEE 829-1998
- Convey the scope, approach, resources, and schedule of testing activities
- Identifies:
  - Items and features to be tested
  - Tasks to be performed
  - Personnel responsible
  - Associated risks
- A well-designed test plan feeds into the more detailed test procedures
Test Plan Benefits

- Provides framework and process to verify that the system meets user needs
- Improve stakeholder participation
- More adaptable, resilient systems
- Verify functionality and fewer defects
- Higher level of reuse from one project to the next
- Better documentation
Test Procedures

- Details regarding how to run each test
- Includes set-up preconditions and steps to be followed
- Allows for flexibility
- Format for test procedures
  - Included in NTCIP 8007 v.01
  - Should reference agency specification requirements
Systems Engineering Testing Phases

- Prototype test and inspection
- Design approval test and inspection
- Factory acceptance test
- Incoming device test
- Site acceptance test
- Burn-in and observation test
Systems Engineering Testing Phases

Prototype Test and Inspection
- Purpose: Verify the electrical and mechanical design
- Number of units: One prototype
- Test Location: Test laboratory

Design Approval Test and Inspection
- Purpose: Verify the final design
- Number of units: Pre-production or small percentage of units
- Test Location: Laboratory
Systems Engineering Testing Phases

**Factory Acceptance Test**
- Purpose: Verify production units are identical to final design and production quality
- Number of units: Percentage of production units
- Test Location: Production factory

**Incoming Device Test**
- Purpose: Inspect for damage due to shipping/handling
- Number of units: All delivered units (including spares)
- Test Location: Agency
- Conformance testing begins
Systems Engineering Testing Phases

Site Acceptance Test

- Purpose: Full functionality of the entire system
- Number of units: All installed units
- Test Location: Final location for operation
- Conformance testing continues

Burn-in and Observation Test

- Purpose: Monitor proper operation of the installed unit
- Number of units: All installed units
- Test Location: Final location for operation
Methods of Testing

- Inspection
- Testing Methods
- Formal Test
- Analysis
- Demonstration
Methods of Testing

Inspection

- Verification by physical and visual examination
- Reviewing descriptive documentation
- Comparing appropriate characteristics
- Examples:
  - Measuring cabinets sizes
  - Matching paint color samples
  - Observing printed circuit boards
Methods of Testing

Analysis

- Verification by evaluation or simulation using mathematical means
- Can be used to extrapolate past performance for scaled up deployment
- Examples:
  - Internal temperature gradients for dynamic message sign
  - Review of power supply designs to verify temperature and voltage limitations
Methods of Testing

Demonstration

- Functional verification by observing an operation or exercise performed under specific condition
- Examples:
  - Accuracy of displays
  - Comparison of system outputs with test cases
  - System recovery from induced failures
Methods of Testing

Formal testing

- Verification that requirement is met by testing under controlled exercises using real or simulated stimulus

- Examples:
  - System performance
  - System functionality
  - Data distribution
Conformance

- Exists when an item fulfills all mandatory requirements defined by a standard and any selected optional portions of the standard
- Conformance testing is designed to verify that the device fulfills the mandatory and optional requirements of the applicable standard(s)
- Prior to testing, ensure that a set of well-defined requirements exists and can be verified
- Testing addresses all parts of the standards that are mandatory for the ITS device
- Conformance is tested against all mandatory and selected optional requirements of the standard
Compliance

- Exists when an item meets all requirements of an agency specification
- Compliance testing is designed to verify that the device fulfills the requirements of an agency’s specification
- Creating a specification is necessary to ensure that all optional elements in the standard are required for your deployment
- Specifications also allow for the explicit removal of optional elements that do not apply
- Compliance is tested against the requirements developed as part of a project
Why is Conformance Necessary?

- Why do you think conformance is necessary?
- Use the chat pod to answer.
The Need for Conformance

- Helps to build the right system correctly
- Able to validate using standardized testing
- Interoperability is a chief benefit
Return on Investment

- Testing reduces risk
- Risk imposes a cost
  \[ \text{risk} = \text{cost of remediation} \times \text{probability of worst case} \]
- Cost of rejecting devices after installation include:
  - Replacement cost
  - Legal fees
  - Lost benefit during delay of implementing devices
Review of Learning Objectives

1. Explain to decision makers the need for and benefits of standardized testing.
2. Describe how ITS standards testing fits into the overall scope of a systems test and a systems life cycle.
3. Discuss how to test an implementation for conformance to standards.
4. Distinguish the difference between standard conformance and project compliance.
Student Supplement

- Excerpt from NTCIP 9001 v4.06: NTCIP Testing
- Excerpt from NTCIP 9012 v1.27: Test Documentation and Test Execution
For More Information

RITA/ITS web site
   http://standards.its.dot.gov/

ITE web site
   http://www.ite.org/standards/

ITS Architecture Implementation Program
   http://www.ops.fhwa.dot.gov/its_arch_imp/

NTCIP web site
   http://www.ntcip.org/

Systems Engineering Guide for ITS
   http://www.fhwa.dot.gov/cadiv/segb
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QUESTIONS?