WELCOME

RITA Intelligent Transportation Systems
Joint Program Office

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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Research Engineer

Texas Transportation Institute

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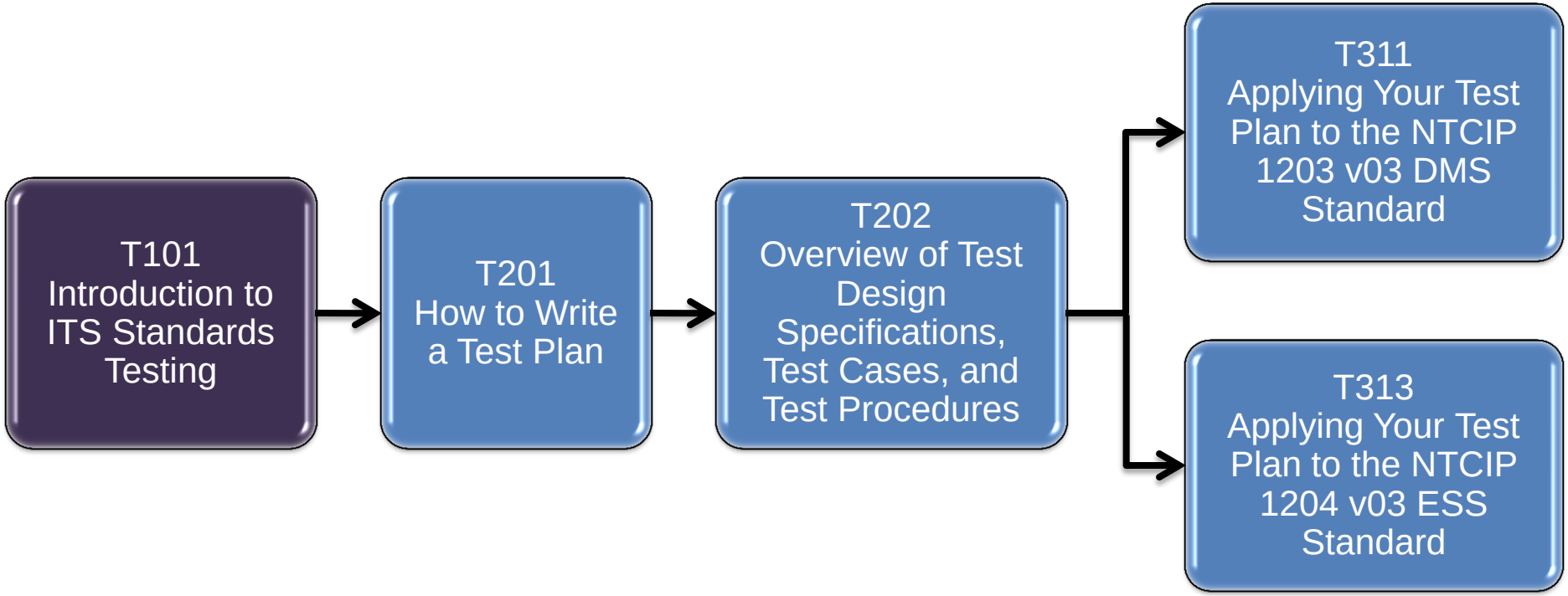
Recommended Prerequisites

- A100
- A200
- A300 level courses as appropriate

Curriculum Path (Testing)



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

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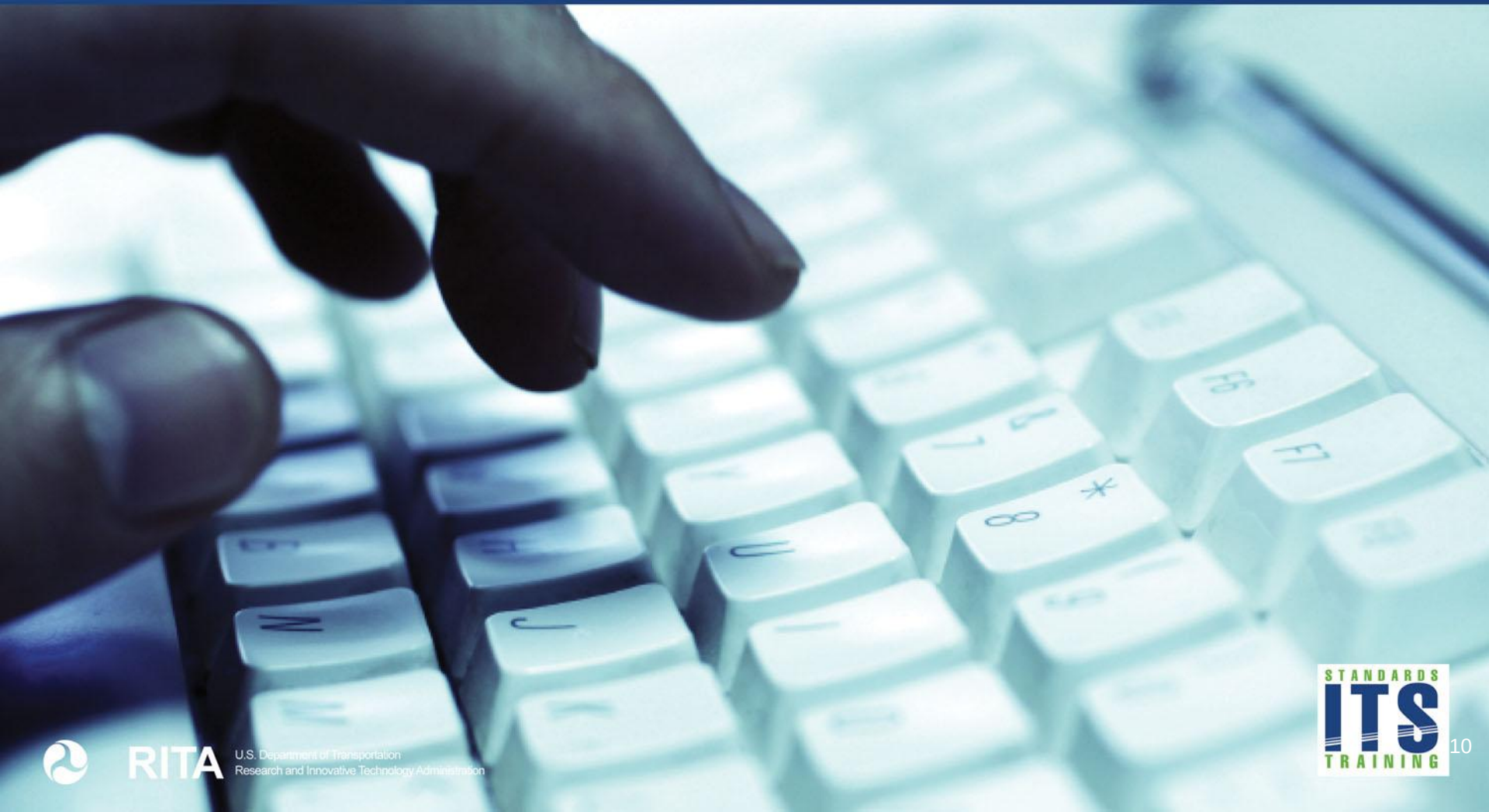


Benefits of Testing

- 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)

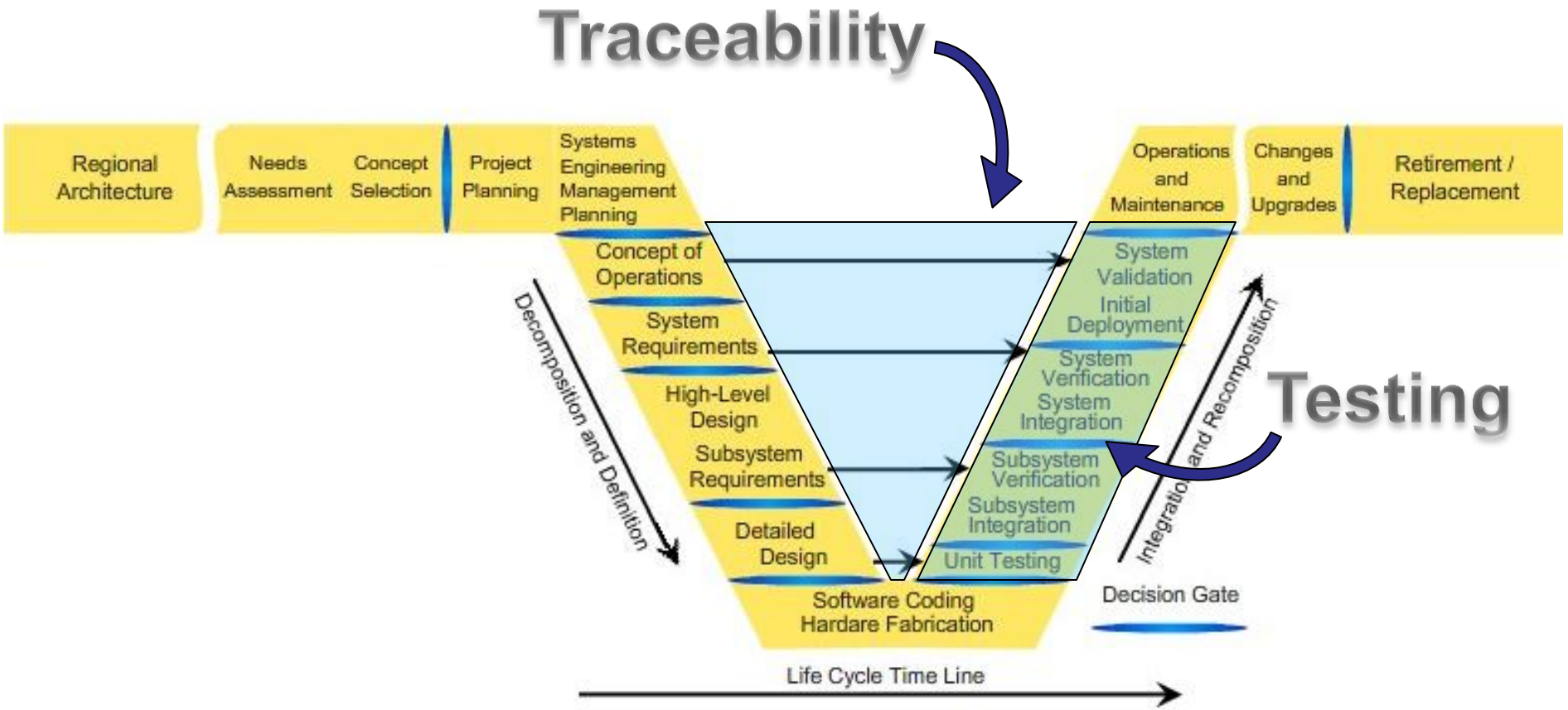
Terminology

- **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

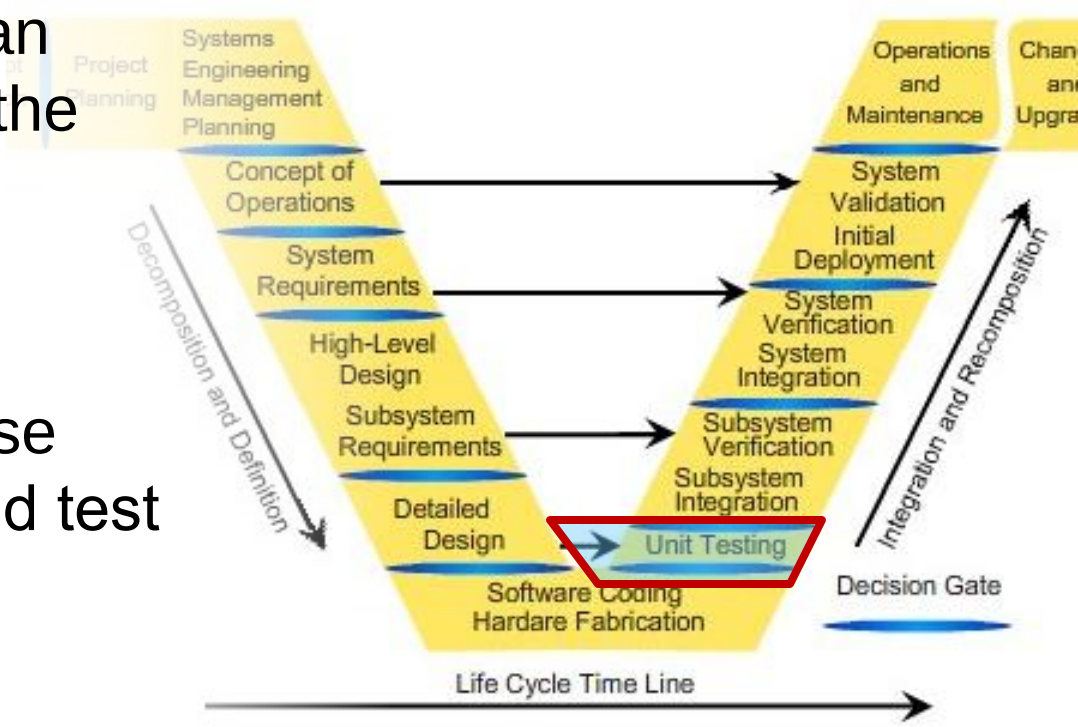
Testing and the Systems Engineering Process



Testing and the Systems Engineering Process

Unit/Device Testing

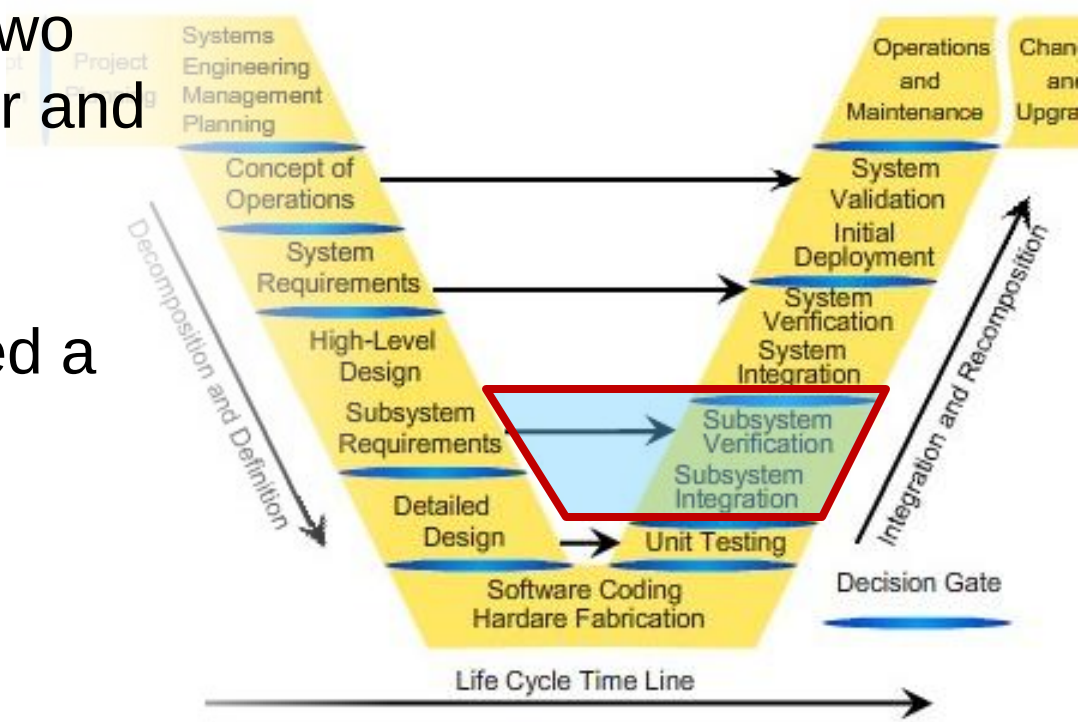
- Focuses on comparing an implementation against the standards and specified options
- May be performed by inspecting the code to use "proven" software to send test messages to the device.



Testing and the Systems Engineering Process

Subsystem Testing

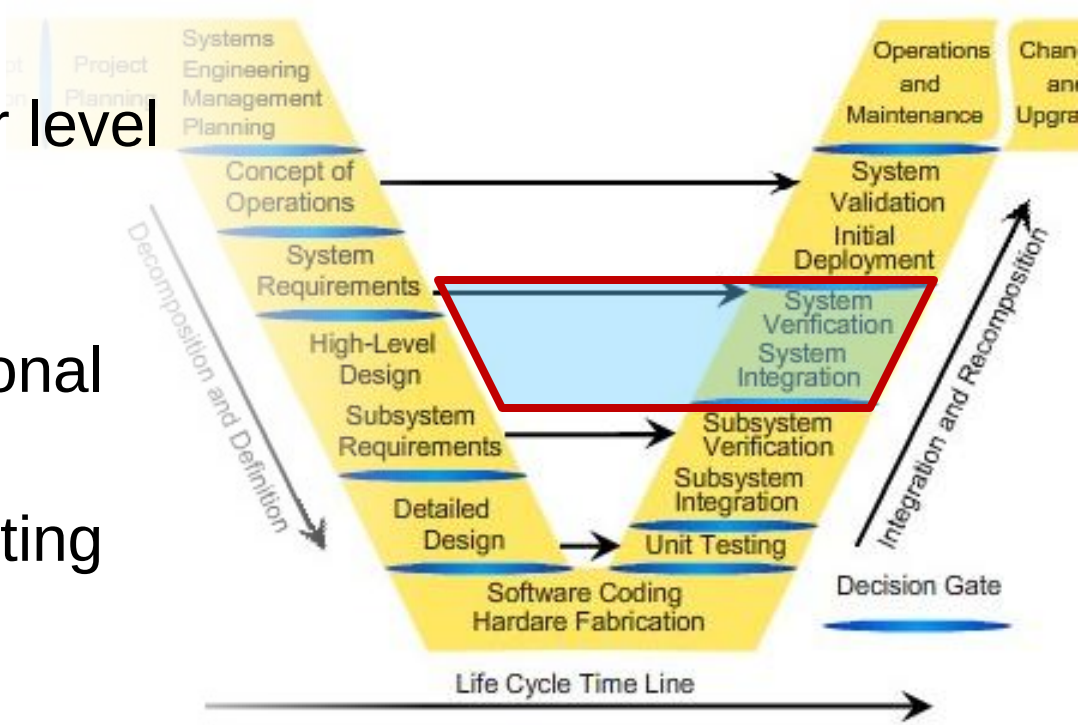
- Consists of connecting two or more devices together and exchanging data
- Assumes devices and components have passed a designed unit test plan
- Assumes devices or subsystem components support same ITS operational and/or functional features.



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

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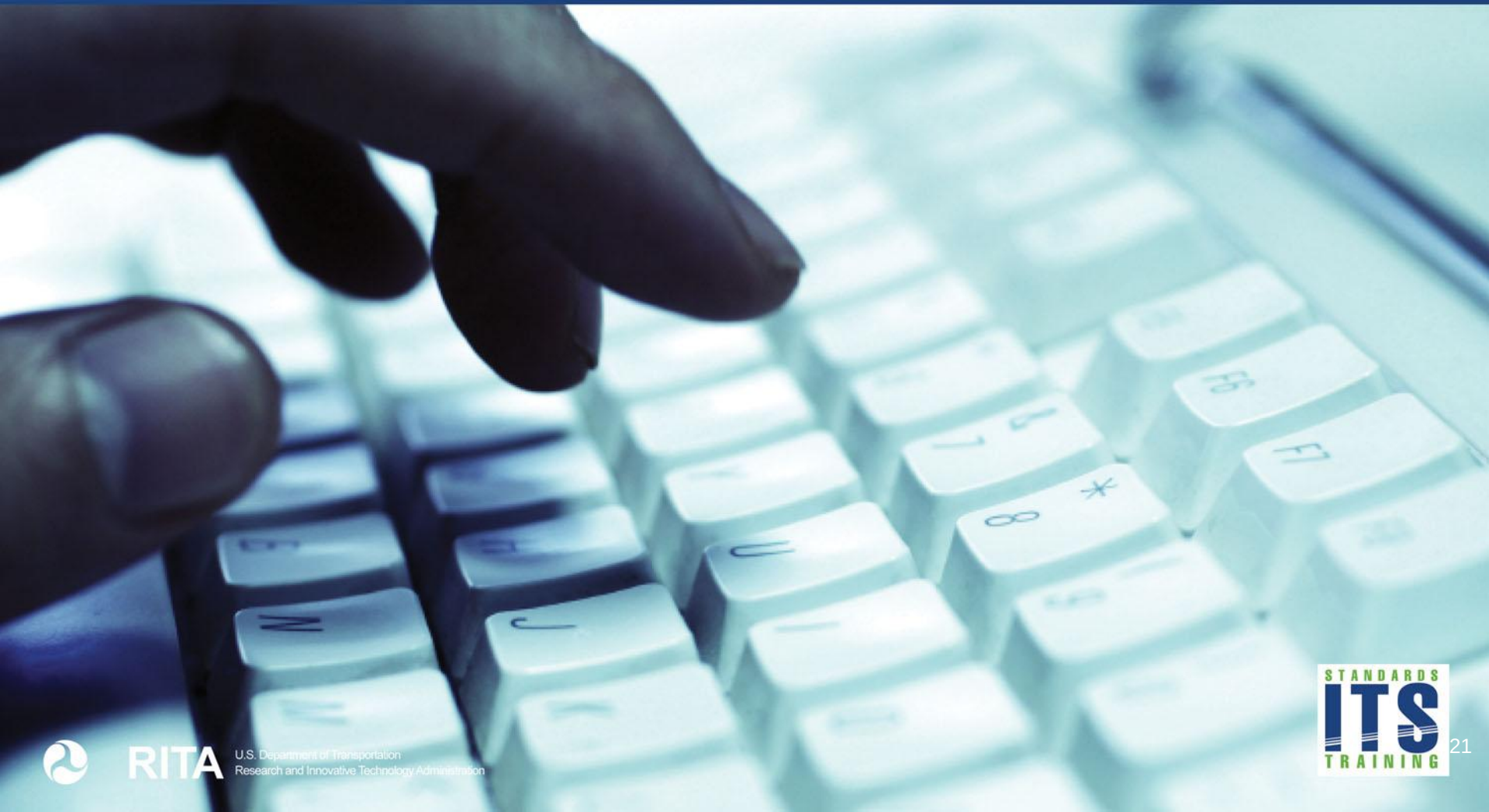


What Should a Test Plan Cover?

- 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

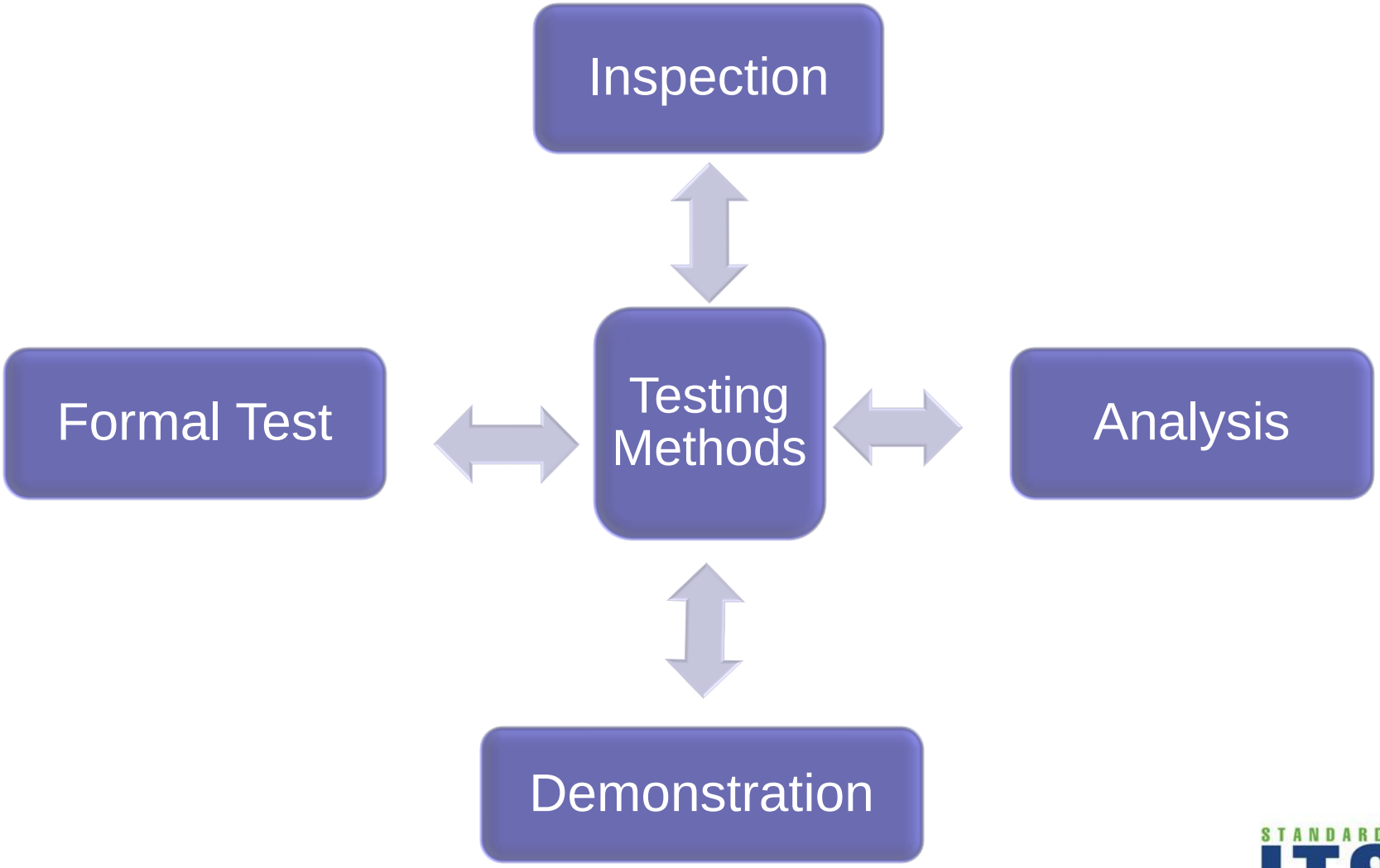
Site Acceptance Test

- 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



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 by 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

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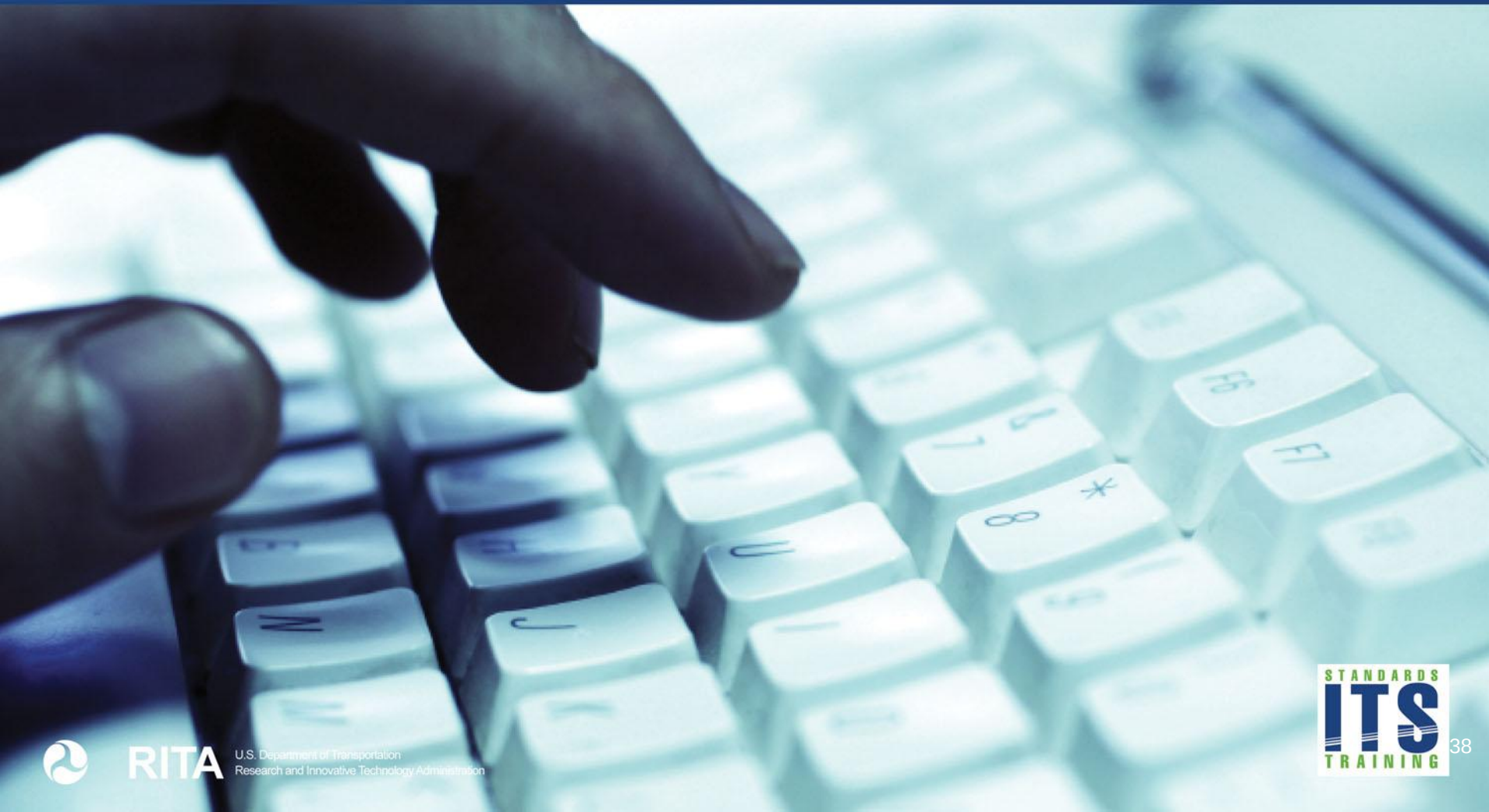


Why is Conformance Necessary?

- 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

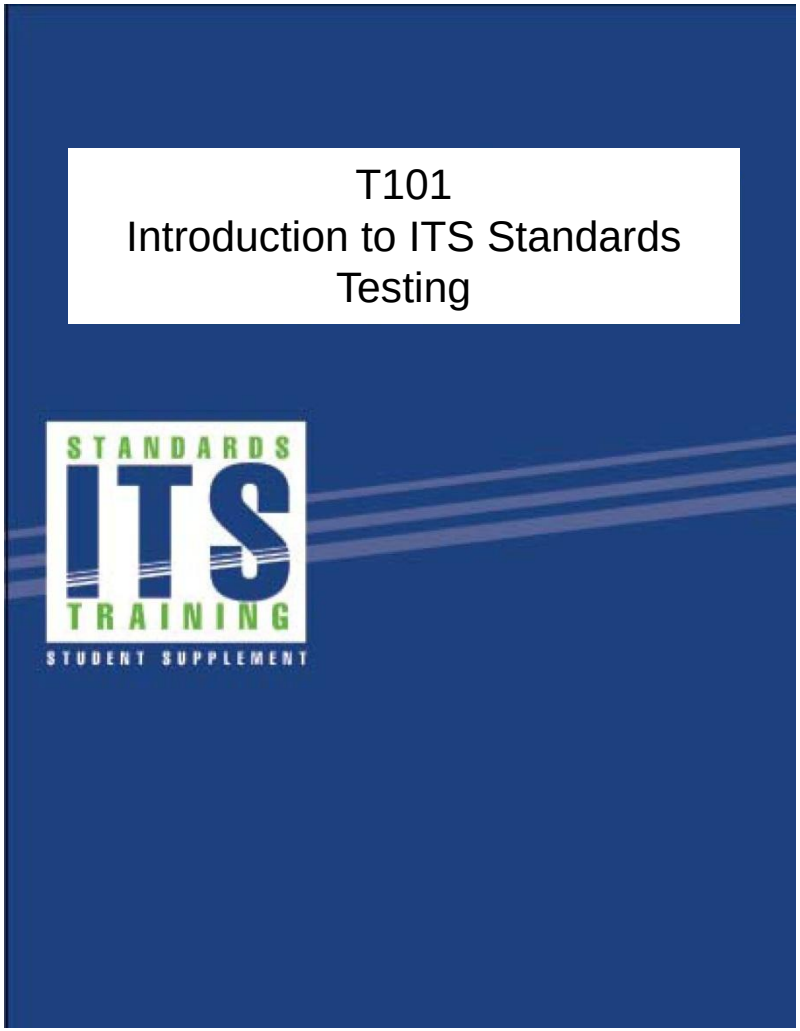
- Testing reduces risk
- Risk imposes a cost

  risk = cost of remediation x 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

- Explain to decision makers the need for and benefits of standardized testing.
- Describe how ITS standards testing fits into the overall scope of a systems test and a systems life cycle.
- Discuss how to test an implementation for conformance to standards.
- 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/

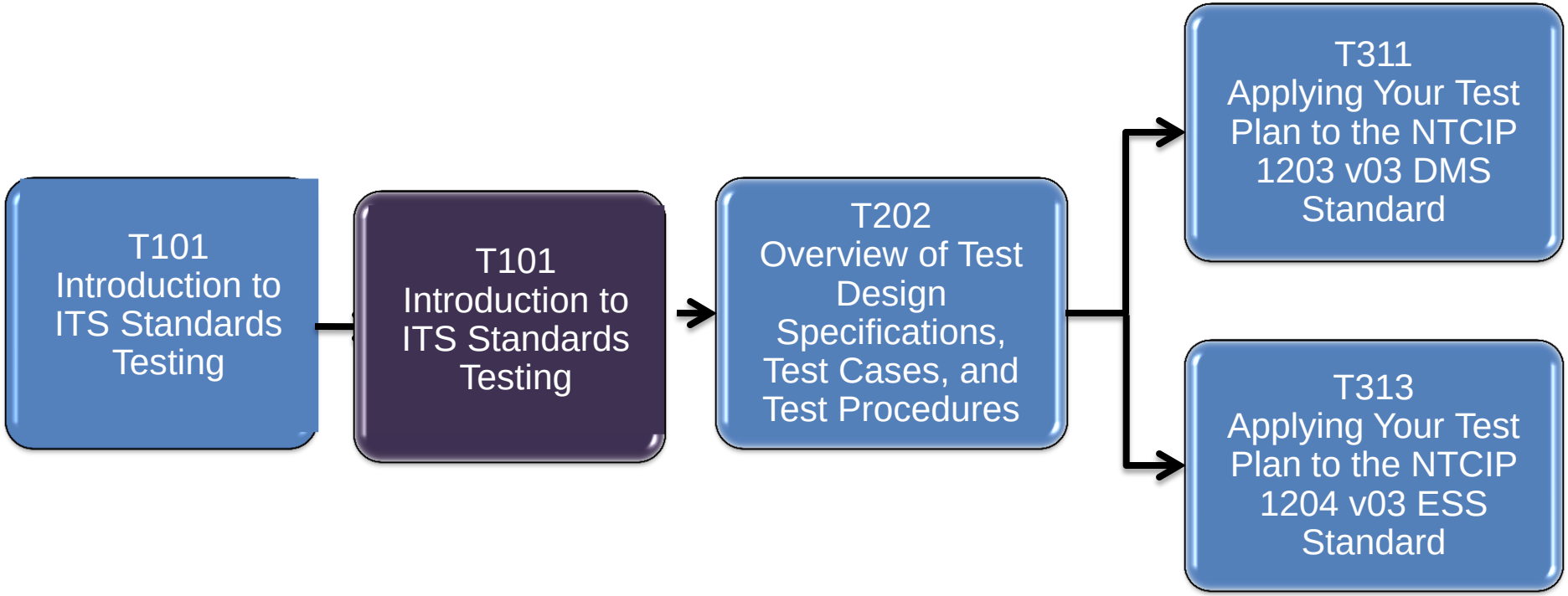
NTCIP web site

http://www.ntcip.org/

Systems Engineering Guide for ITS

http://www.fhwa.dot.gov/cadiv/segb

Curriculum Path (Testing)



QUESTIONS?

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

STANDARDS ITS TRAINING