



W E L C O M E



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Office of the Assistant Secretary for
Research and Technology

Welcome



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The screenshot shows the homepage of the ITS Professional Capacity Building Program. At the top, it identifies the United States Department of Transportation, Office of the Assistant Secretary for Research and Technology, and the Intelligent Transportation Systems Joint Program Office. A navigation menu includes links for About, ITS Training, Knowledge Exchange, Technology Transfer, ITS in Academics, and Media Library. A central banner features a photo of people in a classroom and a blue text box that reads: "Welcome to ITS Professional Capacity Building. The ITS PCB Program is the U.S. Department of Transportation's leading program for delivering ITS training and learning resources to the nation's ITS workforce." Below this, a "FREE TRAINING" section lists: "Web and Blended Courses from CITE", "ITS Standards Training", and "Upcoming T3 Webinars". On the right, a "WHAT'S NEW" section lists: "New Web-Based Training from ITS Joint Program Office" (Connected Vehicle Reference Implementation Architecture Training), "New NHI Course" (Systems Engineering for Signal Systems Including Adaptive Control), "New ITS Case Study Available" (National ITS Architecture), and "Added to T3 Archive" (Learn from the Experts: Open Data Policy Guidelines for Transit and Saving Lives and Keeping Traffic Moving).

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**T309:
Applying Your Test Plan to Ramp Meter
Control (RMC) Units Based on NTCIP 1207
Standard v02**

Instructor



Dave Miller,

Chair: NEMA / AASHTO / ITE

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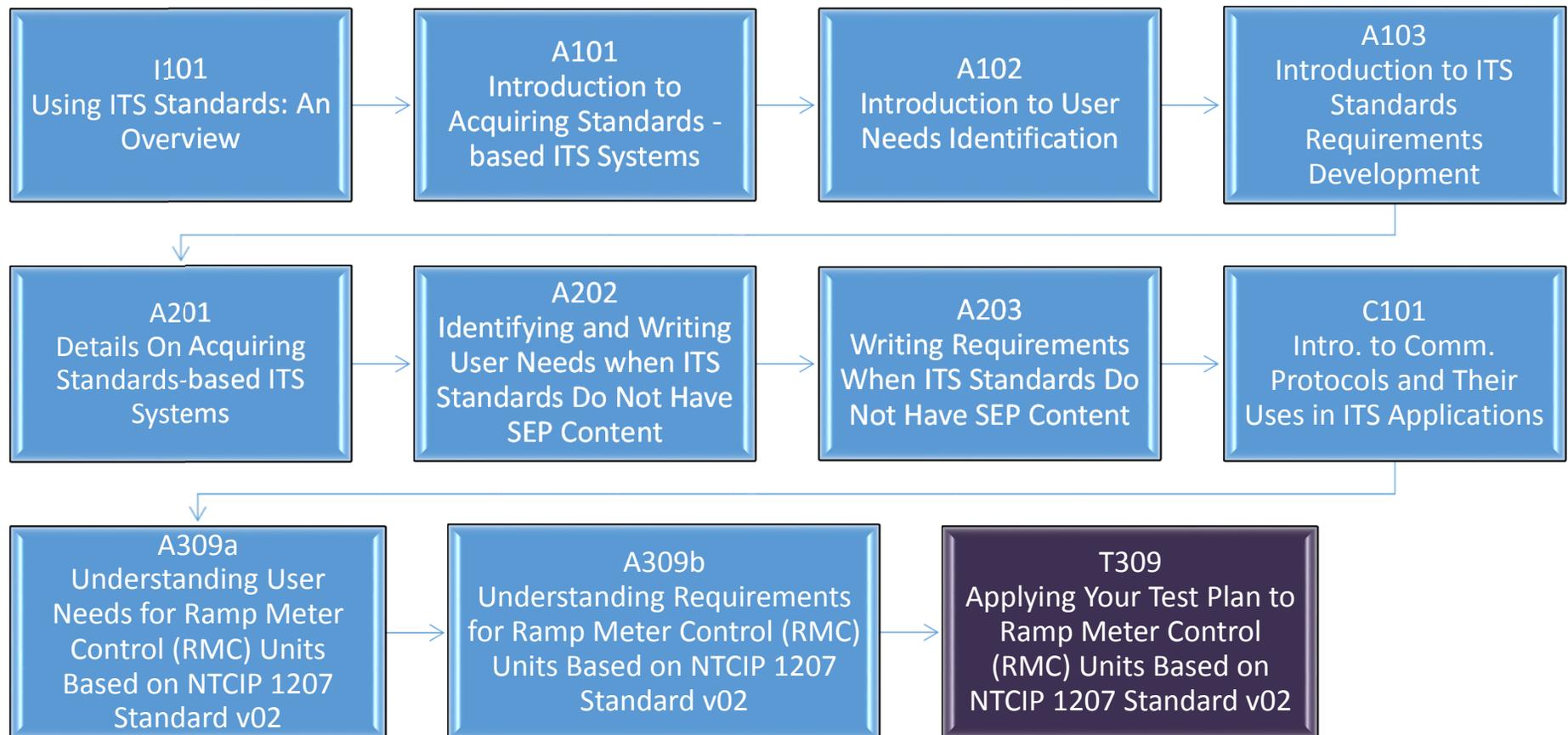
Target Audience

- Traffic management and engineering staff
- Traffic Management Center/operations staff
- Freeway and traffic signal maintenance staff
- System developers
- Private and public sector users, including manufacturers

Recommended Prerequisite(s)

- I101: Using ITS Standards: An Overview
- A101: Introduction to Acquiring Standards-based ITS Systems
- A102: Introduction to User Needs Identification
- A103: Introduction to ITS Standards Requirements Development
- A201: Details On Acquiring Standards-based ITS Systems
- A202: Identifying and Writing User Needs When ITS Standards Do Not Have SEP Content
- A203: Writing Requirements When ITS Standards Do Not Have SEP Content
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications
- A309a: Understanding User Needs for Ramp Meter Control (RMC) Units Based on NTCIP 1207 Standard v02
- A309b: Understanding Requirements for Ramp Meter Control (RMC) Units Based on NTCIP 1207 Standard v02

Curriculum Path



Learning Objectives

1. Describe within the context of a systems life cycle the role of a test plan and the testing to be undertaken
2. Recognize the purpose, structure, and content of a well-written test documentation based on IEEE 829
3. Describe test documentation for NTCIP 1207 Standard v02: Test plan, test design specifications, test cases, test procedures, and test reports
4. Describe the application of good test documentation to a ramp metering unit based on the NTCIP 1207 Standard v02
5. Identify a process to write test plans to verify NTCIP 1207 Standard v02 requirements

Learning Objective #1: Describe Within the Context of a Systems Life Cycle the Role of a Test Plan and the Testing to Be Undertaken

- The purpose of testing RMC units
- Review the concept of a systems life cycle and testing to be undertaken
- Review verification methods
- Describe the testing process in relation to the systems life cycle

The Purpose of Testing RMC Units

How Do We Know RMC Units Will Work as Intended?

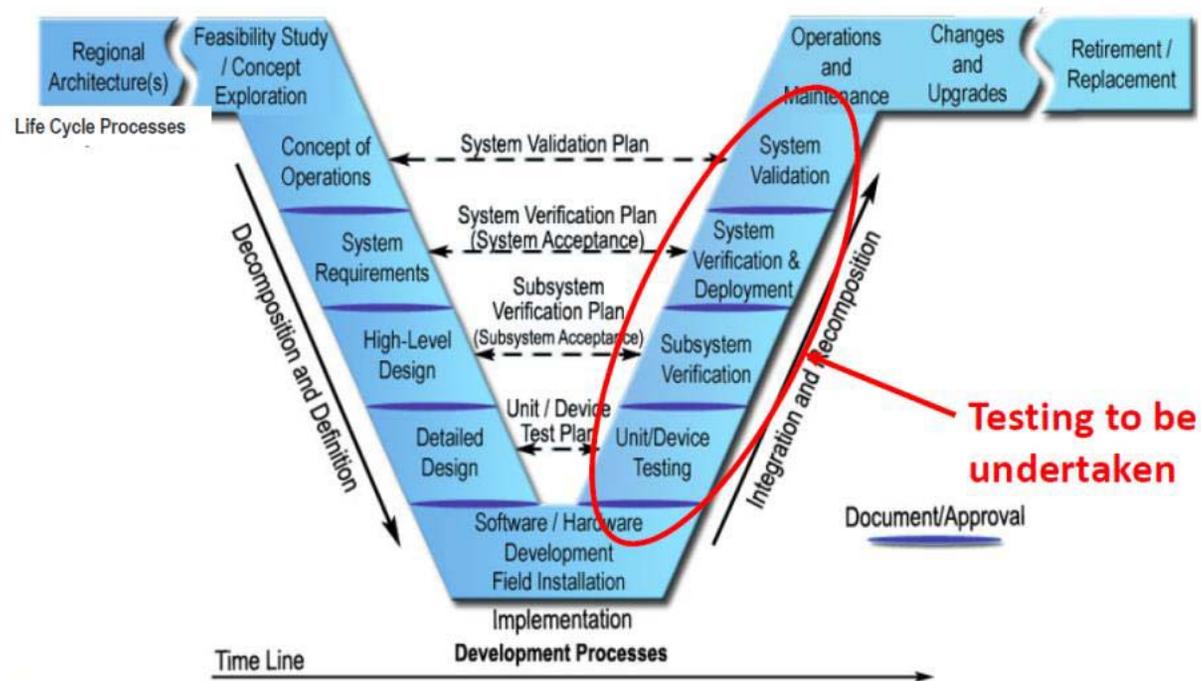
- Many legacy RMC units were developed for a particular agency
- Purpose of testing RMC units:
 - Verify that the RMC unit works as intended for this project.
 - Provide objective evidence that the RMC unit will:
 - Satisfy the allocated RMC unit requirements
 - Solve the right problem
 - Satisfy the intended use and user needs
- Evidence is delivered according to the IEEE 829-2008 standard
 - Test steps that are familiar to all stakeholders
 - Common understanding of terms for all stakeholders

Concept of a Systems Life Cycle and Testing to Be Undertaken

RMC Testing Fits Within the Systems Life Cycle

RMC unit life cycle: Vee model

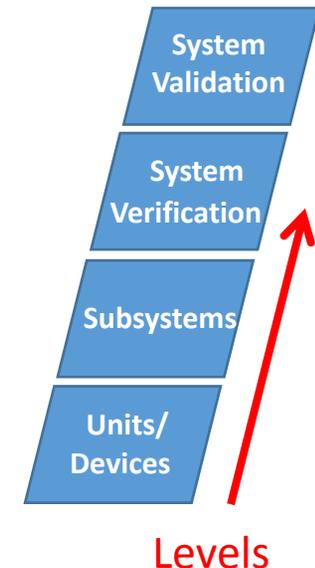
System Life Cycle



Concept of a Systems Life Cycle and Testing to Be Undertaken

RMC Testing Fits Within the Systems Life Cycle (cont.)

- RMC unit testing to be undertaken includes level tests of:
 - Unit/Device: Each hardware or software module
 - Subsystem: Integrated hardware, software, interfaces
 - System Verification: Subsystems connected together
 - System Validation: Final system configuration
- Evidence is delivered according to the IEEE 829-2008
 - Test steps that are familiar to all stakeholders
 - Common understanding of terms for all stakeholders

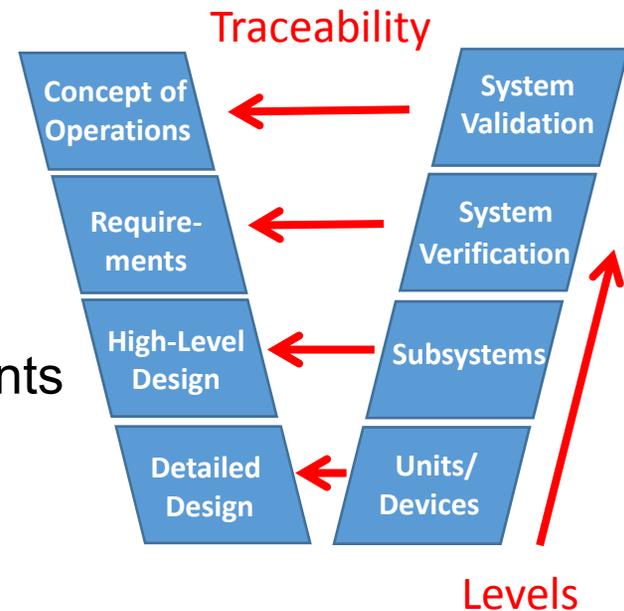


Concept of a Systems Life Cycle and Testing to Be Undertaken

Traceability Within Life Cycle

Trace each level to the design documents:

- Unit/Device Level to Detailed Design
- Subsystem Levels to High-Level Design
- Integrated System to System Requirements
- Configured System to Concept of Operations



Review of Verification Methods

Testing Process to Verify Conformance

Verification Methods

- The testing process determines whether the system:
 - Conforms to the requirements
 - Satisfies the intended use, the user needs (IEEE 829)
- Determination may be based on one or more methods:
 - Inspection
 - Demonstration
 - Analysis
 - Testing

Testing Process Relative to System Life Cycle

The Testing Process

According to IEEE 829

- The testing process provides:
 - An objective assessment of the system products
 - Carries forward throughout each project's life cycle
- Project life cycle testing points:
 - At the completion of each development iteration
 - During installation
 - At system "go-live"
 - During operations and maintenance
 - At each system upgrade
 - At system decommissioning and replacement

Testing Process Relative to System Life Cycle

The Testing Process (cont.)

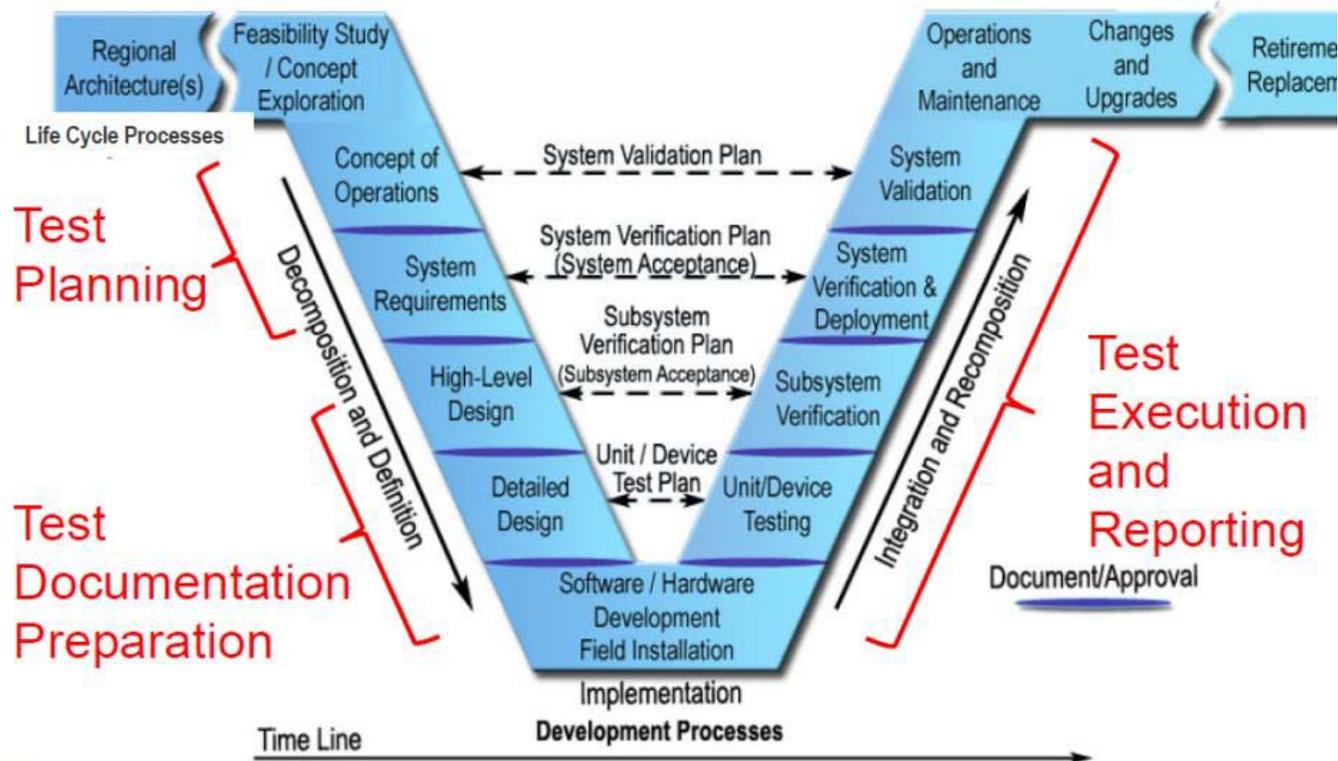
Steps of the Testing Process:

- Step 1: Test Planning
 - Test plan
- Step 2: Test Documentation Preparation
 - Test design
 - Test case
 - Test procedure
- Step 3: Test Execution and Reporting
 - Test report

Testing Process Relative to System Lifecycle

Test Planning

Testing Process and System Life Cycle



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Which of the below is not a reason to test an RMC unit?

Answer Choices

- a) Satisfy system requirements
- b) Testing is part of the NTCIP 1207 Standard v02
- c) Solve the right problem
- d) Satisfy user needs

Review of Answers



a) Satisfy system requirements

Incorrect. RMC is tested at the system verification level.



b) Testing is part of the NTCIP 1207 Standard v02

Correct! Testing is not part of the NTCIP 1207 Standard v02, but must be designed and documented during the project.



c) Solve the right problem

Incorrect. Testing confirms that the right problem is solved.



d) Satisfy user needs

Incorrect. As we saw in the Vee model of the systems life cycle, testing traces back to user.

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Which is not a testing process within the life cycle?

Answer Choices

- a) Test planning
- b) Preparation of test documentation
- c) Test execution and reporting
- d) Identification of system requirements

Review of Answers



a) Test planning

Incorrect. Test planning is done during concept of operations and system requirements.



b) Preparation of test documentation

Incorrect. Test documents are created during high-level design and detailed design.



c) Test execution and reporting

Incorrect. Test execution and reporting are done at each level of the testing workflow.



d) Identification of system requirements

Correct! System requirements are not a testing process. Test planning is based on system requirements.

Summary of Learning Objective #1

Describe Within the Context of a Systems Life Cycle the Role of a Test Plan and the Testing to Be Undertaken

- Reviewed that RMC units are tested to insure that the installed RMC unit meets the expected user needs
- Testing fits within the systems life cycle on the right side of the Vee model, which is traceable back to the user needs
- Reviewed that verification methods include inspection, demonstration, analysis, and testing
- Testing process is conducted within the life cycle in three steps—planning, documentation preparation, and test execution—that results in test reports

Learning Objective #2: Recognize the Purpose, Structure, and Content of Well-Written Test Documentation Based on IEEE 829

- Purpose of a test plan
- What is a test plan?
- Structure of test plans
- Content of test plans

Purpose of a Test Plan

Used to Plan and Manage the Execution of Tests

- Identifies an overall document for:
 - Planning the RMC unit tests
 - Managing the RMC unit tests
- Identifies test activities and methods
- Sets objectives for each test activity
- Identifies the testing risks, resources, and schedule
- Determines the requirements for test documentation

What Is a Test Plan?

From IEEE 829-2008 Standard

- A test plan is a document describing:
 - Scope (technical management)
 - Approach
 - Resources needed
 - Schedule to complete
- A test plan identifies:
 - Test items
 - Features to be tested
 - Testing tasks
 - Risks requiring contingency plan

What is a Test Plan?

From IEEE 829-2008 Standard (cont.)

- Two types of test plans:
 - Level Test Plan (LTP)
 - Master Test Plan (MTP)
- Be aware that test plans are not part of the ITS standards

Structure of Test Plans

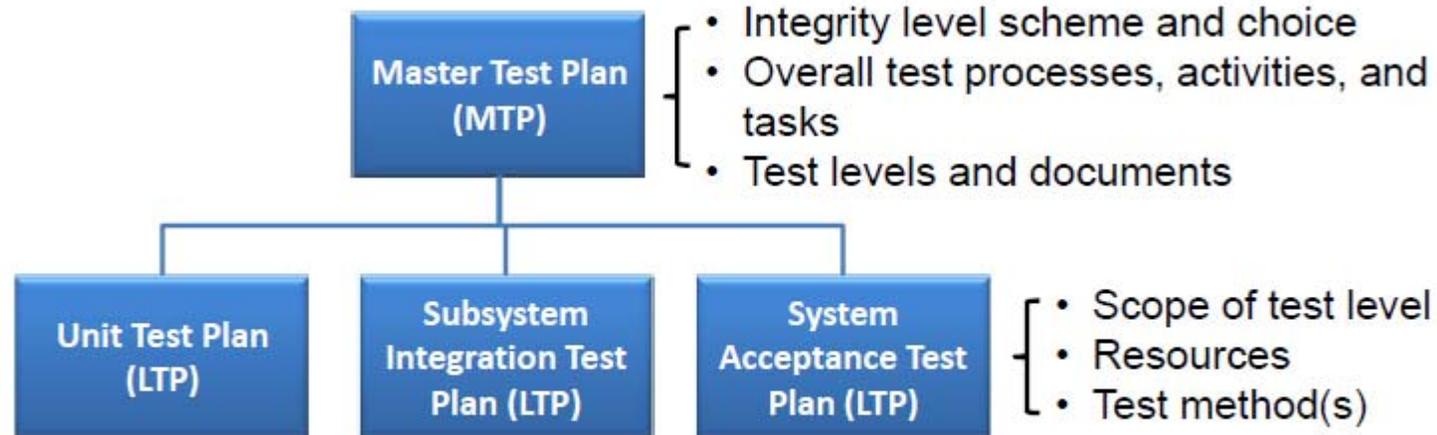
From IEEE 829-2008 Standard

- Master Test Plan
 - Integrity level scheme and choice
 - Overall test processes, activities, and tasks
 - Test levels and documents

- Level Test Plan
 - Unit test plans(s)
 - Subsystem integration test plans(s)
 - System acceptance test plan

Structure of Test Plans

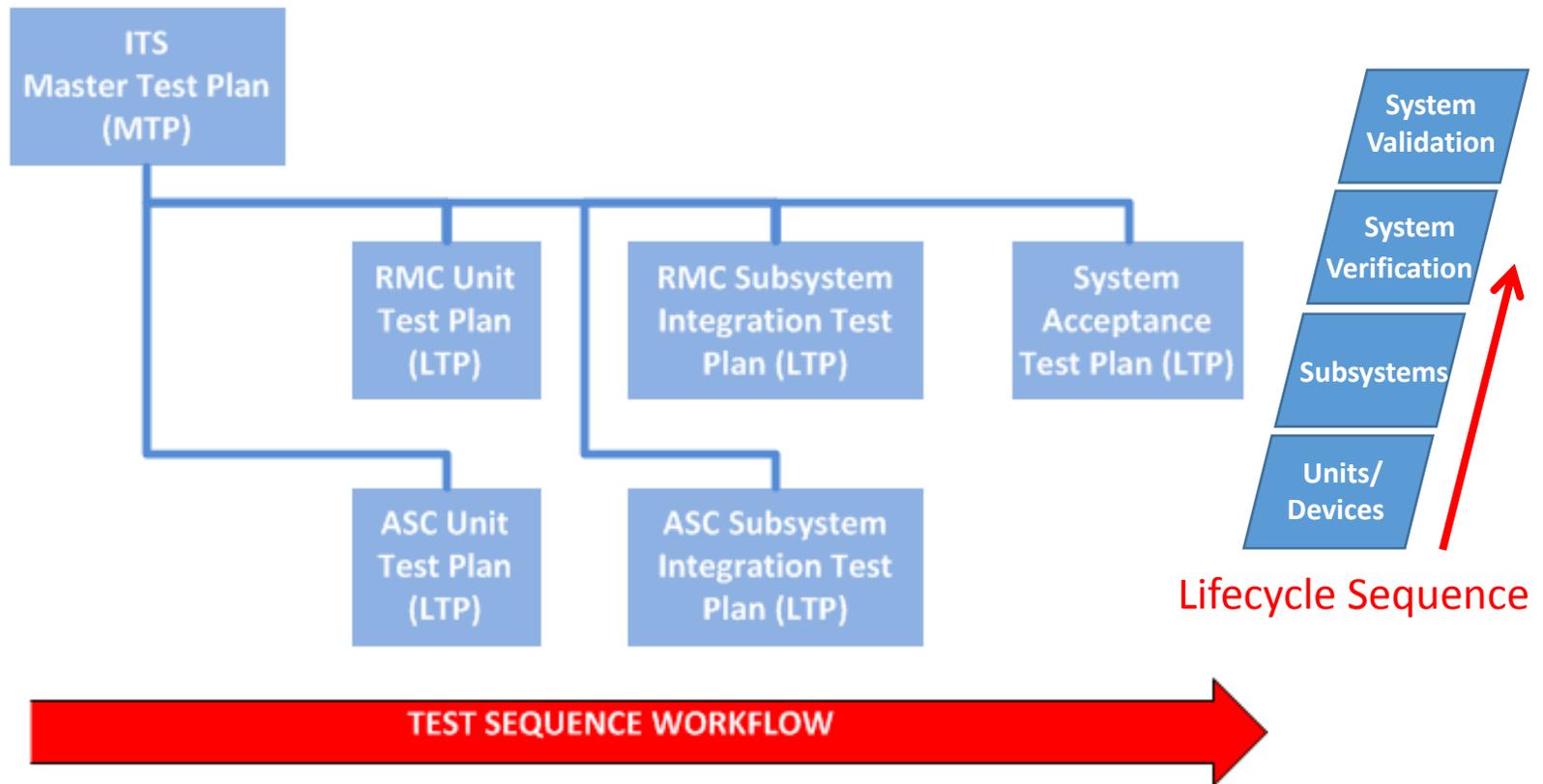
Structure of Test Plans



A Master Test Plan may not always be required!

Structure of Test Plans

Workflow of RMC Unit Test Plans



Content of Test Plans: PRL for RMC System

Protocol Requirements List from A309b

UN ID	User Need	RQ. ID	Requirement	Conformance	Project Requirement	Additional Project Requirements
2.1	Provide Live Data	3.2.1	Provide Live Data	M	YES	
2.2	Provide Logged Data	3.2.2	Provide Off-Line Logged Data	M	YES	
2.3	Retrieve Identity	3.3.1	General Configuration	M	YES	NTCIP 1207 v02 Annex B, CG B.3
2.9	Configure RMC Unit	3.3.1	Configuration of Device	M	YES	NTCIP 1201, CL 2.2
2.4	Fixed Rate	3.3.2	Metered Lane	M	YES	NTCIP 1207-3.3
2.5	Queue Override	3.3.3	Queue Override	O	YES/NO	Not widely used
2.N	Block Objects	3.N		O		Undecided

Users may modify entries in rows to suit local project needs, but columns should not be changed to remain consistent with SEP

Content of Test Plans

Master Test Plan Outline per IEEE 829

- Introduction
 - Document identifier, scope, and references
 - System overview key features
 - Test overview (organization, schedule, resources, tools, etc.)
- Details of the Master Test Plan
 - Test processes, definitions
 - Test documentation requirement for NTCIP 1207 v02
 - Test administration requirement
 - Test reporting requirement
- General
 - Glossary
 - Change procedures, history

Content of Test Plans

Level Test Plan Outline per IEEE 829

- Introduction
 - Document identifier, scope, and references
 - Level in the overall sequence
 - Test classes and test conditions
- Details of the Level Test Plan
 - Test items and their identifiers
 - Test Traceability Matrix of NTCIP 1207 v02 objects and dialogs
 - Features tested/not tested
 - Test approach
 - Pass/Fail criteria
 - Suspension criteria and requirements to resume testing
 - Test deliverables

Content of Test Plans

Level Test Plan Outline per IEEE 829 (cont.)

- Test Management
 - Planned activities and tasks
 - Test progression
 - Environment/infrastructure
 - Responsibilities/authorities
 - Interfaces among stakeholders
 - Resources and training
 - Schedules, estimates, and costs
 - Risk(s) and contingencies

Content of Test Plans

Level Test Plan Outline per IEEE 829 (cont.)

- General
 - Quality assurance procedures
 - Metrics for specific measures
 - Glossary
 - Document change procedures and history

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Which is not a reason to use the IEEE 829 Standard?

Answer Choices

- a) IEEE 829 is part of NTCIP 1207 Standard v02
- b) Provides familiar documents
- c) Standard definition of terms
- d) Reuse in later projects

Review of Answers



a) IEEE 829 is part of NTCIP 1207 Standard v02

Correct! NTCIP 1207 Standard v02 does not reference IEEE 829 standard.



b) Provides familiar documents

Incorrect. IEEE 829 provides familiar documents and steps.



c) Standard definition of terms

Incorrect. IEEE 829 does provide standard definitions.



d) Reuse in later projects

Incorrect. Using the standard steps and definitions of IEEE 829 results in documents that can be easily reused in later projects or when the existing system is expanded at a later date.

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Which is not a part of a Level Test Plan?

Answer Choices

- a) Introduction
- b) Test details
- c) Planning for multiple levels of test
- d) Test management

Review of Answers



a) Introduction

Incorrect. Each Level Test Plan includes an Introduction to the testing.



b) Test details

Incorrect. Each Level Test Plan includes test details.



c) Planning for multiple levels of testing

Correct! The Master Test Plan documents and coordinates multiple Level Test Plans



d) Test management

Incorrect. Each Level Test Plan includes test management.

Summary of Learning Objective #2

Recognize the Purpose, Structure, and Content of Well-Written Test Documentation Based on IEEE 829

- The purpose of a test plan is to provide an overall document for planning and managing RMC unit tests
- Test plan documents describe the testing scope, approach, resources, and schedule, among other items
- Test plans are structured as Level Test Plans for all projects, plus an optional Master Test Plan for large, complex projects
- Test plan content includes introduction, details, management, and general information

Learning Objective #3: Describe Test Documentation for NTCIP 1207 Standard v02: Test Plan, Test Design Specifications, Test Cases, Test Procedures, and Test Reports

- Overview of test documentation
- Understand the difference between test plans and test documentation
- Overview of a test design and the relationships between test plans, test design, test cases, and test procedures

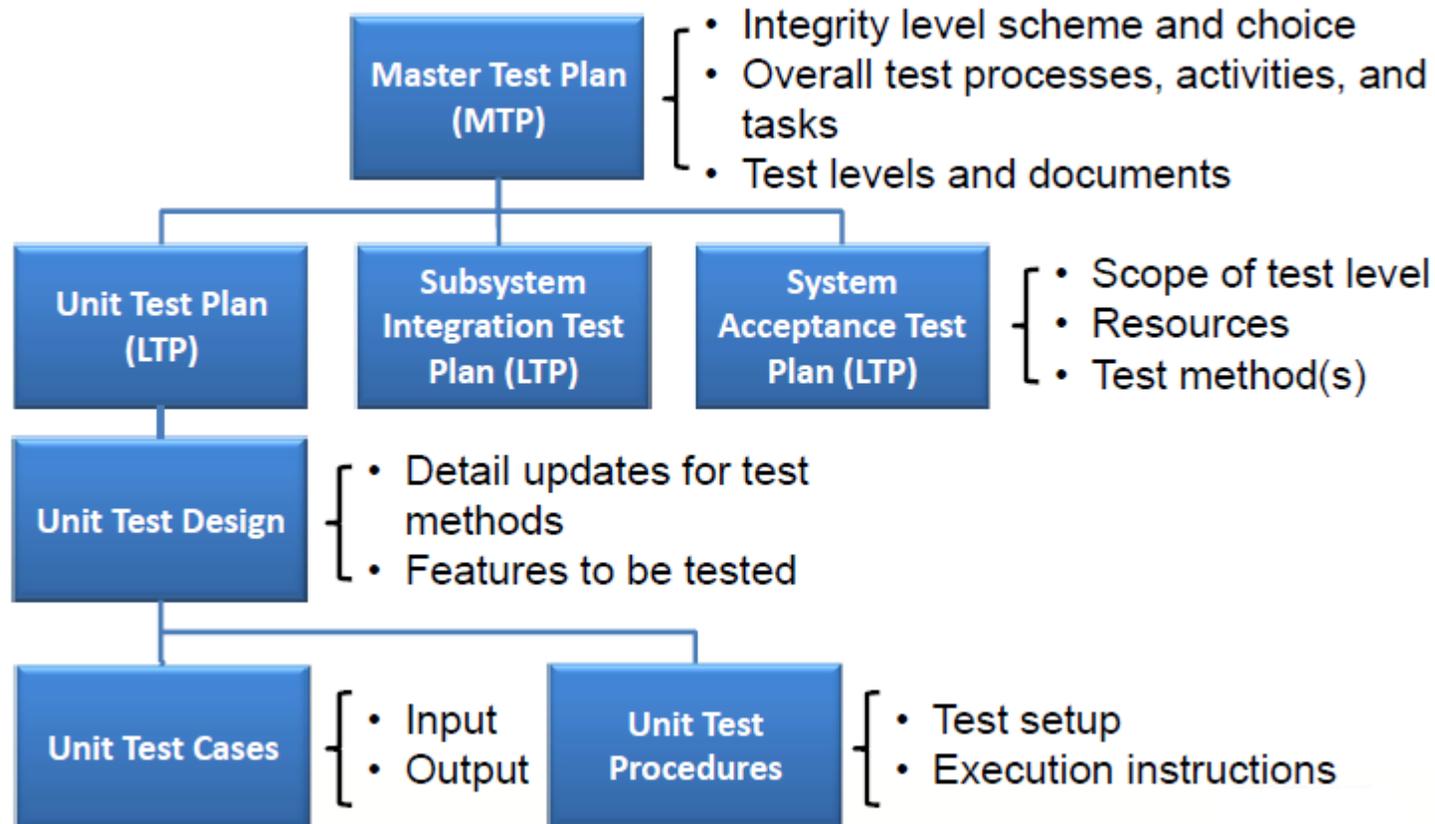
Overview of Test Documentation

Test Documentation per IEEE 829

- Test documentation requirements are specified in the MTP (if used)
- Detailed list of test deliverables specified in the LTP
 - Test plan
 - Test designs
 - Test cases
 - Test procedures
 - Test logs
 - Anomaly reports
 - Interim test status reports
 - Test reports
 - Master Test Reports (if there is an MTP)

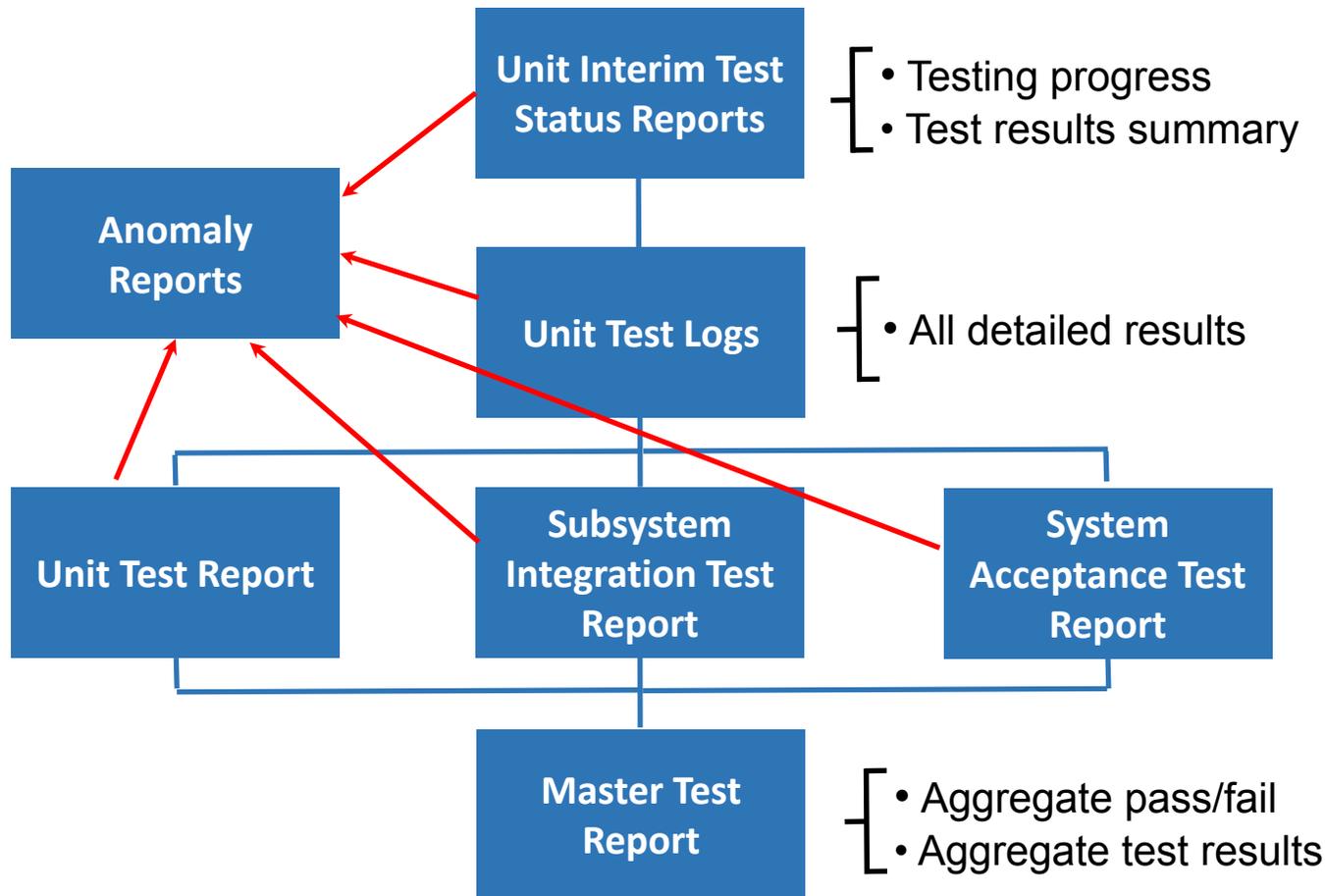
Overview of Test Documentation

Test Documentation per IEEE 829 (cont.)



Overview of Test Documentation

Test Documentation per IEEE 829 (cont.)



Understand the Difference Between Test Plans and Test Documentation

Test Plans vs. Test Documents

- Test plans
 - Define the required RMC unit test documents
 - Are developed earlier than test documents
- Test documentation includes all information to be delivered by all of the test activities:
 - Test documents, including among others:
 - Test cases
 - Test procedures
 - Test reports
 - Test inputs
 - Test output data
 - Test tools

Overview of a Test Design and the Relationships Between Test Plans, Test Design, Test Cases, and Test Procedures

Test Design

- IEEE 829 defines a test design as a test document that:
 - Specifies the details of the test approach
 - Identifies the features to be tested by this design
 - RTCTM
- Identifies the associated tests—commonly including the organization of the tests into groups
 - Test cases
 - Test procedures

Overview of Test Documentation

Example of RMC Unit Test Documentation

Requirement		Test Case	
ID	Title	ID	Title
1.	Metered Lane Main Configuration		
1.1	Maximum Number of Metered Lanes		
		TC1.1	Test the Boundaries
1.2	Number of Metered Lanes		
		TC1.2	Test the Combinations
1.3	Metered Lane Configuration Table		
		TC2.1	Test the Min Meter Time
		TC2.2	Test the Min Red
		TC2.3	Test the Min Green

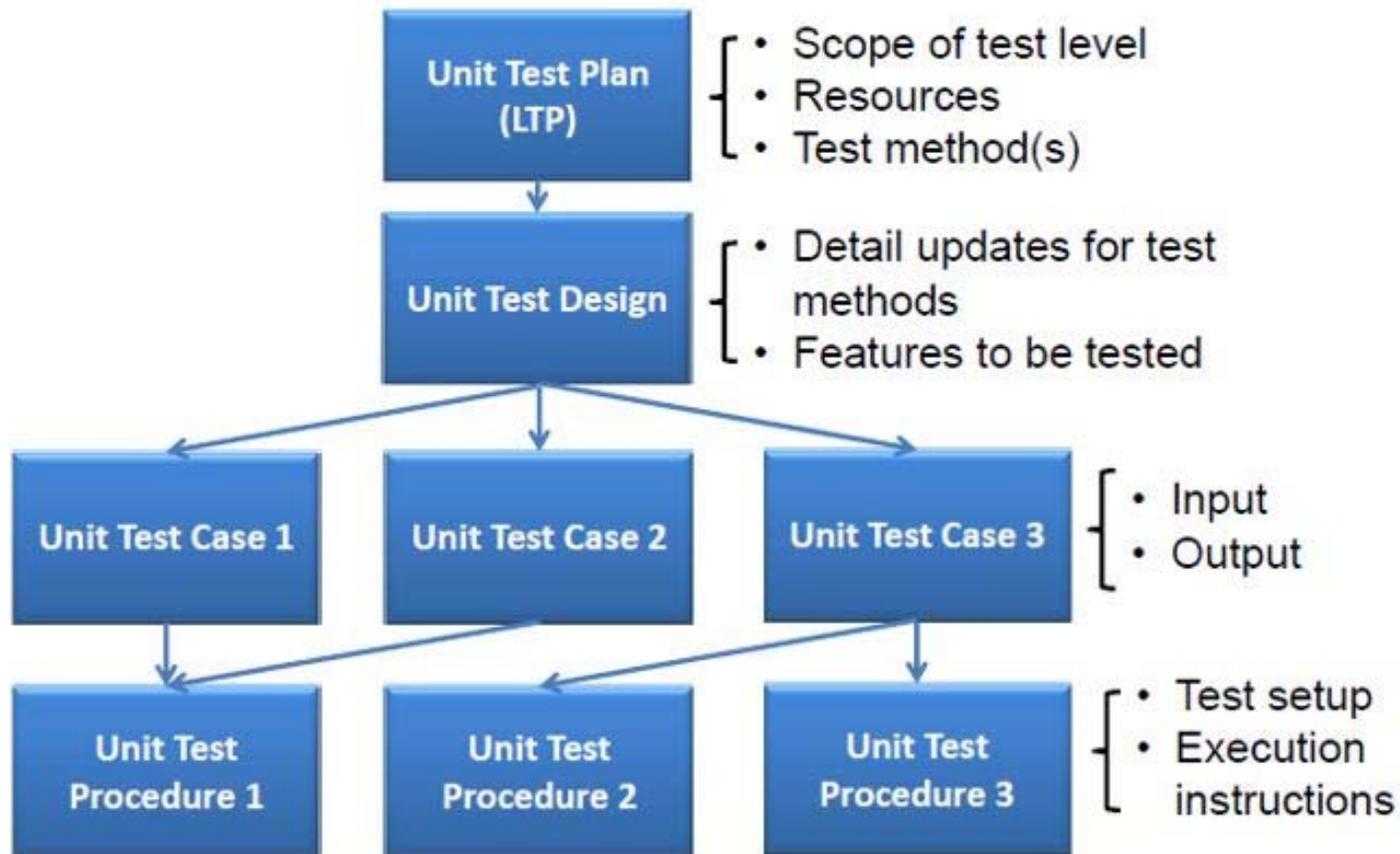
Overview of a Test Design and the Relationships Between Test Plans, Test Design, Test Cases, and Test Procedures

Test Sequence

- Test plan vs. Test design
 - Only one test design per test plan
- Test design vs. Test case
 - One test design may be associated with multiple test cases
 - Any one test case is associated with only one test design
- Test case vs. Test procedure
 - One test case may be associated with multiple test procedures and vice versa (IEEE 829)
- For simple devices, NTCIP combines test case and test procedure

Overview of Test Documentation

Example of RMC Unit Test Documentation



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When is the test documentation completed?

Answer Choices

- a) Before the test is executed
- b) Only during the test execution
- c) Only after the test is executed
- d) During and after the test execution

Review of Answers



a) Before the test is executed

Incorrect. The test plan is developed before test execution, but is not filled in with test documentation results.



b) Only during the test execution

Incorrect. The test data are recorded during the test execution, but documentation also requires summaries after execution.



c) Only after the test is executed

Incorrect. Test summaries are documented after test execution, but also include the test data during test execution.



d) During and after the test execution

Correct! Test data and test summaries are both part of documentation, taken during and after test execution.

Summary of Learning Objective #3

Describe Test Documentation for NTCIP 1207 Standard v02: Test Plan, Test Design Specifications, Test Cases, Test Procedures, and Test Reports

- List of test documentation according to IEEE 829
- Test plan documents describe the testing scope, approach, resources and schedule that are delivered before testing. Test documentation includes test data and test summaries delivered during and after testing
- Test design specifies the details of the test approach and identifies the features to be tested, usually organized into groups of test cases and test procedures

Learning Objective #4: Describe the Application of Good Test Documentation to a Ramp Metering Control Unit Based on NTCIP 1207 Standard v02

- Identify key elements of NTCIP 1207 Standard v02 relevant to what is covered in the test plan
- Develop a Requirements Test Case Traceability Matrix (RTCTM)
- Review key elements of the conformance statement

Key Elements of NTCIP 1207 Standard v02 Relevant to Test

Definition of RMC Unit from Module A309

Ramp Meter Control	A system in which the entry of vehicles onto a freeway from an on-ramp is controlled by a traffic signal, allowing a fixed number of vehicles to enter from each metered lane of the on-ramp during each cycle.
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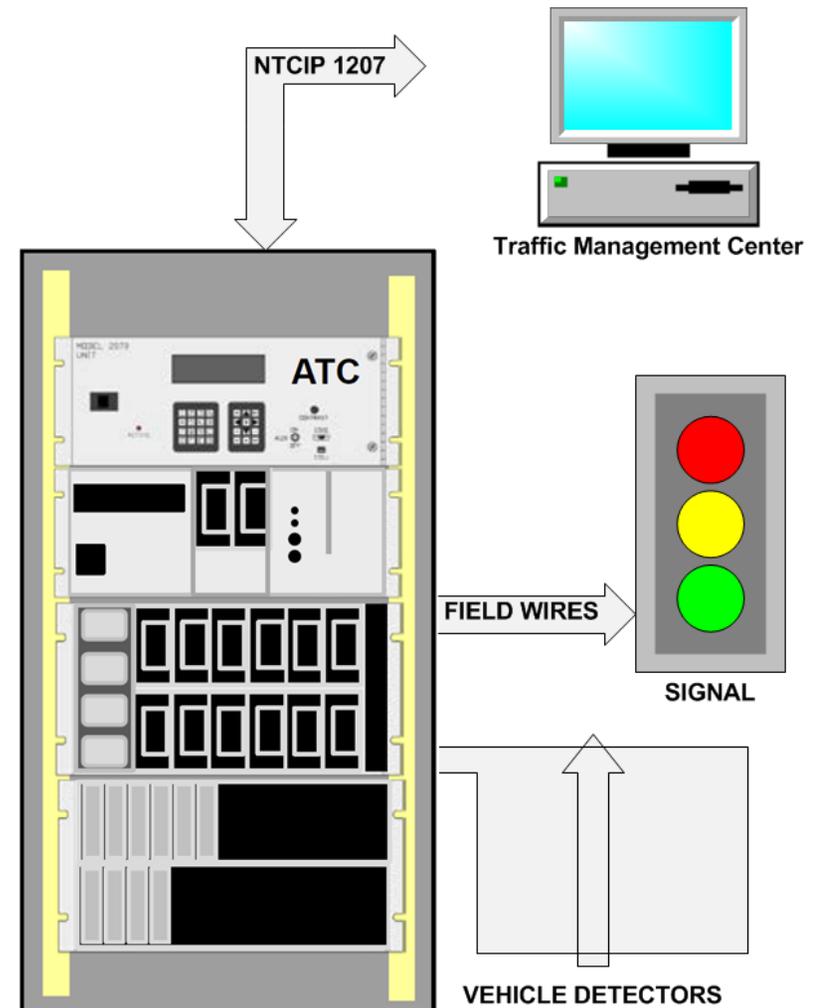
A Ramp Meter Control (RMC) unit consists of:

- The field controller
- Suite of sensors
- Warning signs and signals

Key Elements of NTCIP 1207 Standard v02 Relevant to Test

Basic RMC Unit Hardware

- RMC Field Hardware
 - ATC 5201, 5202 or legacy
 - Communications Device
 - Vehicle Detection
 - Inductive Loops
 - Video Detection
 - Magnetic, radar, others
 - Load Switches
 - Equipment Electrical Cabinet
 - Traffic Signals
 - Green Amber Red option
 - Green Red option
 - STOP BAR



Key Elements of NTCIP 1207 Standard v02 Relevant to Test

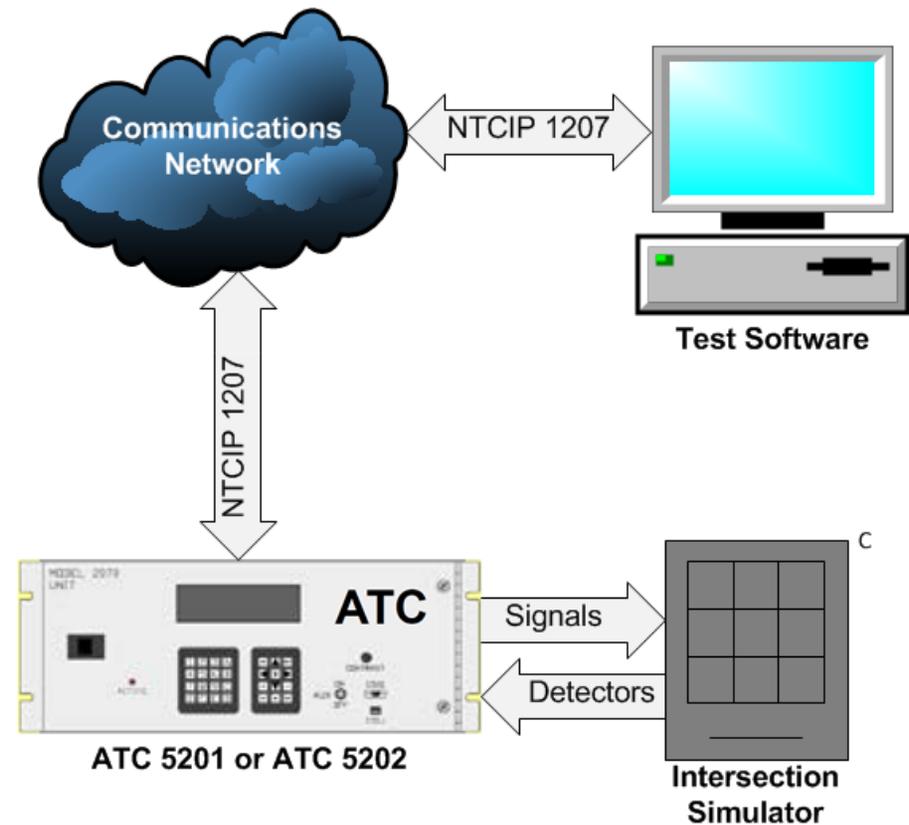
Basic RMC Unit Software (cont.)

- RMC unit software application
 - RMC unit configuration
 - Read inputs from detectors
 - Control algorithm
 - Write outputs to signal heads
 - Communications to/from TMC

Key Elements of NTCIP 1207 Standard v02 Relevant to Test

RMC Unit Test Environment for Unit Level Testing

- Simulated inputs (vehicle calls)
- RMC unit outputs to simulator
- Communications network
- RMC units (NTCIP 1207 v02)
- Test software (TMC simulator)
- Data analyzer (as required)



Key Elements of NTCIP 1207 Standard v02 Relevant to Test

What Is Provided by NTCIP 1207 Standard v02?

- Conformance Groups (CG)
- CG is a set of managed objects

Ref	Conformance Group	Clause of Profile	Status	Support
B.5	Metered Lane Conformance Group	NTCIP 1207 3.3	M	Yes
B.12	Configuration Conformance Group	NTCIP 1207 2.2	M	Yes
B.10	Physical I/O Conformance Group	NTCIP 1207 3.7	O	Yes / No
	- Metered Lane Output	NTCIP 1207 3.7	O	Yes / No
	- Dependency Group Output	NTCIP 1207 3.7	O	Yes / No

Key Elements of NTCIP 1207 Standard v02 Relevant to Test

What Is Not Included in NTCIP 1207 Standard v02?

From Prior Modules:

- User needs
- Requirements
- Dialogs
- Protocol Requirements List (PRL)
- Requirements Traceability Matrix (RTM)
- Requirements Test Case Traceability Matrix (RTCTM)
- Test cases
- Test procedures

Although not included, each is required to develop test documents.

Develop an RTCTM

Example of RTCTM

- Correlates each requirement to a test case
 - Requirement identification and title
 - Test case identification and title

Requirement		Test Case	
ID	Title	ID	Title
1.	Metered Lane Configuration		
1.1	Set maximum # of metered lanes	TC1.1	Test the Boundaries
1.2	Set number of metered lanes	TC1.2	Test the Combinations

Example of Requirements Test Case Traceability Matrix

Key Elements of a Conformance Statement

Conformance Statement (CF)

- Suppliers claiming conformance to NTCIP shall provide a CF
- CF applies to specific implementations (e.g. RMC)
- Uses for conformance statement
 - Supplier: Checklist of objects
 - Procurement: Clear, unambiguous list of NTCIP deliverables
 - User: System interoperability
 - Tester: Selection of tests to assess the conformance claim
- Conformance statement content
 - Requirements list
 - Indicates the features that are supported in the implementation

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What is the primary purpose of the RTCTM ?

Answer Choices

- a) Sets the testing workflow sequences
- b) Correlates User Needs to Requirements
- c) Describes the Optional Objects needed to fulfill Requirements
- d) Correlates each RMC Requirement to Test Case

Review of Answers



a) Sets the testing workflow sequences

Incorrect. Testing workflow is part of the Level Test Plans



b) Correlates User Needs to Requirements

Incorrect. User Needs to Requirements are part of the Protocol Requirements List



c) Describes the Optional and Mandatory Objects

Incorrect. Optional and Mandatory Objects provided by the manufacturer are part of the Conformance Statement



d) Correlates each RMC Requirement to Test Case

Correct! RTCTM depicts the Test Cases that will be used to verify each Requirement.

Summary of Learning Objective #4

Describe the Application of Good Test Documentation to a Ramp Meter Unit Based on NTCIP 1207 Standard v02

- The key elements of the NTCIP 1207 Standard v02 that are relevant to the test plan include the RMC unit configuration, detector inputs, signal outputs, and others
- We developed a RTCTM based on test cases, features to be tested, and RMC unit requirements
- The conformance statement must be provided by RMC unit manufacturers claiming compliance to the NTCIP 1207 Standard v02. The Conformance Statement includes the requirements list and the RMC unit features that are supported in the manufacturer's implementation

Learning Objective #5: Identify a Process to Write Test Plans to Verify NTCIP 1207 Standard v02 Requirements

- Apply the process of creating test documentation based on test specifications
- Address consequences of testing boundary and error conditions
- Describe test tools and equipment available

Test Documentation Based on Test Specification

Develop Test Case Documents – Test Case

Test Case: TC1.1	Title:	Test the Boundaries	
	Description	This test case verifies the maximum number of metered lanes that can be SET by the central station. The test is conducted just below, just above, and exactly at the boundary	
	Variables	Max Lanes	From project requirements
		Max Lanes - 1	From the test plan
		Max Lanes +1	From the test plan
Pass/Fail Criteria	<ol style="list-style-type: none"> 1. The DUT shall accept data at Max Lanes 2. The DUT shall accept data at Max Lanes -1 3. The DUT shall return an error at Max Lanes +1 		

Step	Test Procedure	Expected Results
1	Configure: SET the Max Lanes = 2, record the DUT response	Responds with Max Lanes = 2
2	SET the number of Metered Lanes = 1, record the DUT response	Responds with Metered Lanes = 1
3	SET the number of Metered Lanes = 2, record the DUT response	Responds with Metered Lanes = 2
4	SET the number of Metered Lanes = 3, record the DUT response	Error, exceeds Max Lanes = 2

Testing Boundary and Error Conditions

Positive and Negative Testing

- Positive testing
 - Valid input values, dialogs, and sequences per test procedure
 - Expected outputs from Device Under Test (DUT)
- Negative testing
 - Assert invalid input values, dialogs, or sequences per the test procedure
 - DUT does not process
 - DUT retains normal operation
 - DUT output per test procedure
 - Error message
 - Error type

Testing Boundary and Error Conditions

Testing Boundary Conditions

- All boundary condition are tested:
 - Just below each limit
 - Just above each limit
 - Exactly on each limit
- Boundary is valid, DUT should:
 - Process successfully
 - Respond accordingly
- If error conditions occur, DUT should:
 - Respond with error message
 - Remain in normal operation
 - No communications loss

Testing Boundary and Error Conditions

NTCIP Testing: Extent Should be Part of Specification

- Complex process that requires:
 - Test planning
 - Test documentation preparation
 - Test execution
 - Test result reporting
- Every NTCIP object should be tested
 - Sampling of valid inputs
 - Test each boundary condition
 - Selectively test error conditions for critical functions
- Progression testing for new and corrected features
- Regression testing
 - No unintended changes
 - Done for all software affected by the test failure

Test Tools and Equipment Available

NTCIP Test Tools

- Capable of performing tests for conformance to specific NTCIP information level standards
- Support for communications testing such as SNMP
- Scripting features to support automated testing
- Support of various protocols such as PPP, PMPP, TCP/IP, etc.
- Support a wide variety of media including Ethernet and Serial

Test Tools and Equipment Available

Passive NTCIP Test Tools

- Used as a data analyzer
- Monitor the data exchange only
- Provide real-time data capture
- Do not provide an NTCIP stimulus
- Do not respond to an ITS device
- Examples
 - Serialtest
 - Ethereal
 - Others

Test Tools and Equipment Available

Active Test Tools

- Used as the main test software
- Send message to DUT
- Timestamp and log DUT response
- Mandatory and optional objects
- Active NTCIP tool limitations, require special-purpose software
 - Block objects
 - Manufacturer-specific objects
 - Communications load tests
- Active NTCIP test tool examples
 - DeviceTester
 - NTCIP Exerciser
 - Ntester
 - SimpleTester

Summary of Learning Objective #5

Identify a Process to Write Test Plans to Verify NTCIP 1207 Standard v02 Requirements

- We created test documentation from test specifications including:
 - Test cases
 - Test procedures
- We learned consequences of boundary conditions and error conditions
 - Sample of valid inputs
 - Each boundary condition
 - Critical functions
- Use of test tools automate the test process, but have limitations
 - Passive: Monitor and record
 - Active: Stimulate with response
 - No block objects and no manufacturer-specific objects
 - Development of special tests for special features

What We Have Learned

- 1) RMC units are tested to ensure that the RMC units meet the expected user needs and associated requirements when installed. In addition to testing, other verification methods include inspection, demonstration, and analysis.
- 2) Test plan is used to plan and manage the RMC tests, including the scope, approach, resources, and schedule.
- 3) According to the IEEE 829 standard, the test documentation includes test data and test summaries delivered before, during, and after the test execution by the test operator.

What We Have Learned

- 4) Key elements of an RMC that are relevant to the test plan include configuration , detector inputs , and signal outputs . These key elements are included in an RTCTM based on test cases .
- 5) Manufacturers claiming conformance to NTCIP 1207 must provide a conformance statement including the requirements list and the features supported in the RMC implementation.
- 6) For Boundary Conditions and Error Conditions a sample of valid inputs of the most critical functions is tested at each boundary condition . Passive tools monitor and record while Active tools stimulate to create responses . Special tests must be developed for block objects and manufacturer-specific objects .

Resources

- US Department of Transportation, *Systems Engineering for Intelligent Transportation Systems, USDOT, January 2007*
- NTCIP 1207 RMC Units Standard v02
- T202: Overview of Test Design Specifications, Test Cases and Test Procedures
- T203 Part 1 of 2: How to Develop Test Cases for an ITS Standards-based Test Plan, Part 1 of 2
- T203 Part 2 of 2: How to Develop Test Cases for an ITS Standards-based Test Plan, Part 2 of 2
- T204 Part 1 of 2: How to Develop Test Procedures for an ITS Standard-based Test Plan, Part 1 of 2
- T204 Part 2 of 2: How to Develop Test Procedures for an ITS Standard-based Test Plan, Part 2 of 2

Resources (cont.)

- Institute of Transportation Engineers, ATC 5201 Advanced Transportation Controller (ATC) Standard Version 06. ATC Joint Committee, 30 July 2012.
- Institute of Transportation Engineers, ATC 5202 Model 2070 Controller Standard Version 03. ATC Joint Committee, 28 December 2012.
- IEEE Standard for Software and System Test Documentation, IEEE Computer Society, IEEE Std 829-2008, July 18, 2008.

QUESTIONS?



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