



W E L C O M E

RITA Intelligent Transportation Systems
Joint Program Office

Welcome



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The screenshot shows the RITA website header with the logo and navigation menu. The main content area is titled "ITS Professional Capacity Building Program" and includes sections for "Welcome to ITS Professional Capacity Building", "ITS Technical Assistance", "News", and "Scheduled T3 Webinars".

ITS Professional Capacity Building

The ITS Professional Capacity Building (PCB) Program provides comprehensive, accessible, and flexible ITS learning for the transportation industry. By using the program, public agencies can build and sustain a capable and technically proficient ITS workforce, and transportation professionals can develop their knowledge, skills, and abilities while furthering their career paths.

The plan, [ITS Professional Capacity Building: Setting Strategic Direction 2010-2014](#), describes the strategy the ITS PCB Program is pursuing to create a 21st century learning environment and build an ITS profession that leads the world in the innovative use of ITS technologies.

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- [ITS Peer-to-Peer Program](#) helps resolve ITS challenges by speaking to your peers.
- The ITS Help Line provides [technical support by e-mail](#) or telephone 866-367-7487.

Scheduled T3 Webinars

Register now for these upcoming T3 webinars:

Date	Time	Topic
June 23, 2011	1:00 PM – 2:30 PM ET	2011 Enhancements to the ITS Knowledge Resources Websites: Improving Access to Information on ITS Benefits, Costs, Lessons Learned and Deployment
June 29, 2011	1:00 PM – 2:30 PM ET	Open Payments, Mobile Payments and Personal Identification Verification (PIV) Acceptance – Overview of Innovations in Public Transit Payment Systems

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WWW.PCB.ITS.DOT.GOV/STANDARDSTRAINING



A313b

Specifying Requirements for ESS Systems Based on NTCIP 1204 v03 Standard



Target Audience

- Engineering staff
- Traffic management center (TMC)/operations staff
- System developers and integrators/coders
- Private and public sectors
- Users (Clarus Initiative, public safety)
- Other stakeholders



Instructor



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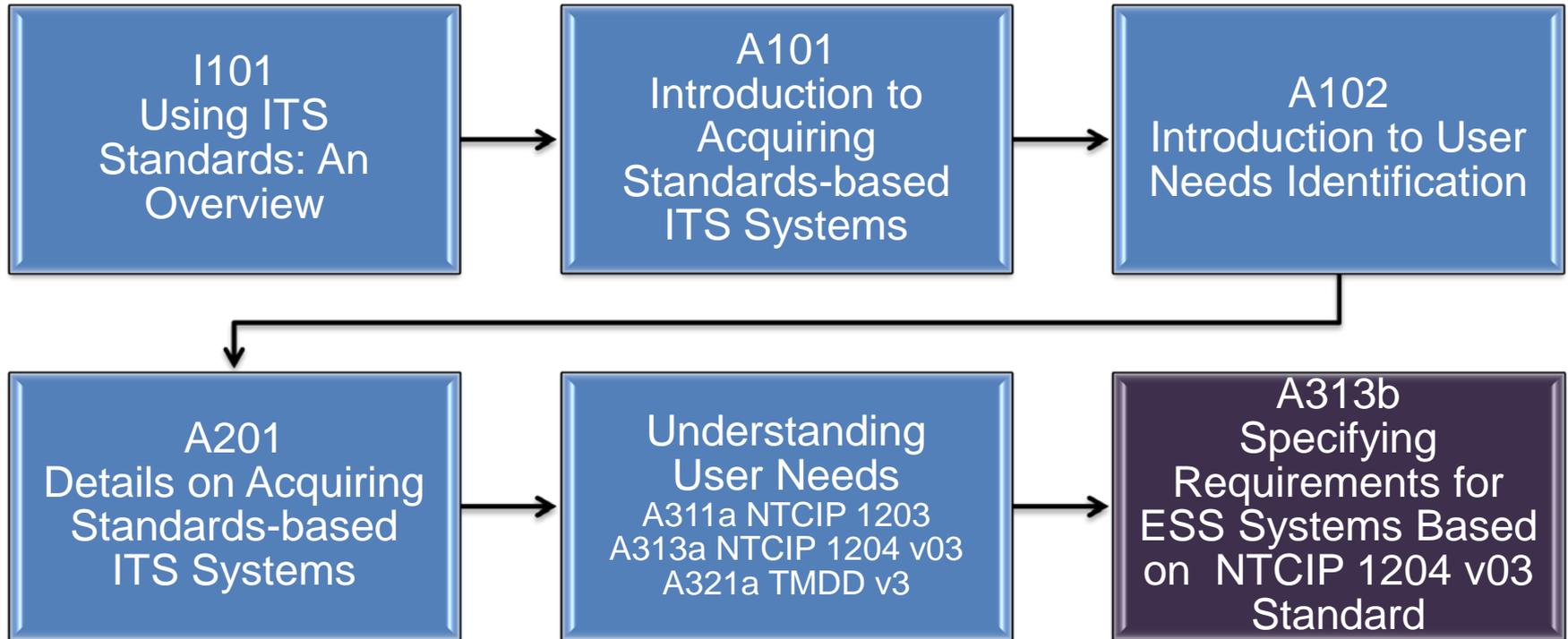


Recommended Prerequisites

- I101 – Using ITS Standards: An Overview
- A101 – Introduction to Acquiring Standards-based ITS Systems
- A102 – Introduction to User Needs Identification
- A201 – Details on Acquiring Standards-based ITS Systems
- A313a – Understanding User Needs for ESS Systems based on NTCIP 1204 v03 Standard



Curriculum Path (SEP)



Value of ESS Modules Group

- Module A313b – ESS Requirements is part of a group of ITS standards modules
- Group consists of:
 - A313a – Understanding User Needs for Environmental Sensor Stations (ESS) Based on NTCIP 1204 v03 Standard
 - A313b - Specifying Requirements for ESS Systems Based on NTCIP 1204 v03 Standard
 - T313 – Applying your Test Plan to the NTCIP 1204 v03 ESS Standard



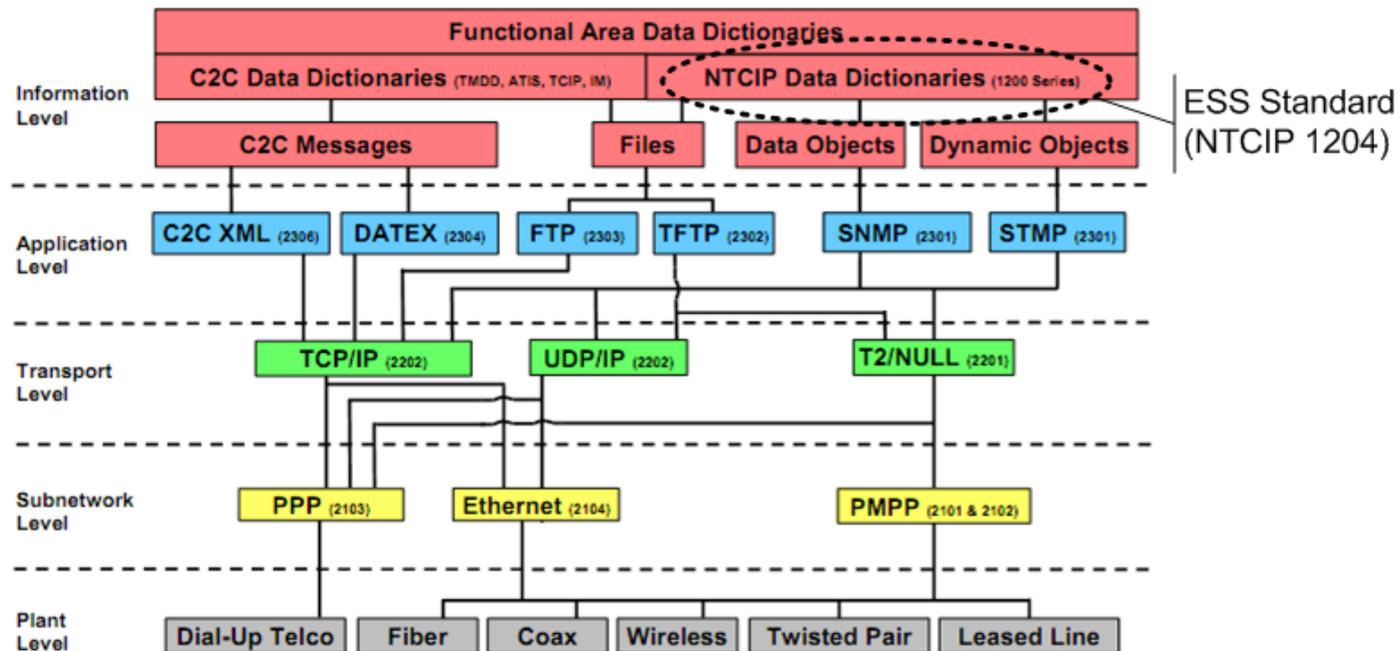
Learning Objectives

1. Discuss the structure of the standard
2. Use the protocol requirements list (PRL) and requirements traceability matrix (RTM) to specify the standardized structure of requirements
3. Use the RTM to specify the standardized design. Include the requirements from the PRL and RTM in the specification
4. Understand how to specify requirements not covered by the standard
5. Infer the relationship between selecting requirements and testing



NTCIP Family

- NTCIP: a family of standards for the ITS industry
 - Information profile standards – called objects
 - Underlying communications standards – called protocols
- NTCIP 1204 (ESS) is an information level standard



Review of NTCIP 1204 - ESS

- Defines a communications interface standard
- Specifies the interface between the environmental sensor stations (ESS) and the monitoring systems
- The host system includes the traffic management center (TMC) central software.
- Contains the object definitions (vocabulary) used to monitor an ESS
- Version 03 is an improvement over older versions, adding test procedures

Functional Requirements Section

Functional requirements section (Section 3) includes:

- Tutorial
- Scope of the interface
- Protocol requirements list (PRL)
- Architectural requirements
- Data-exchange requirements
- Supplemental requirements



What is a Requirement?

- Definition of Requirements (INCOSE *Systems Engineering Handbook*)
 - “A statement that identifies a system, product or process’ characteristic or constraint, which is unambiguous, clear, unique, consistent, standalone (not grouped), and verifiable, and is deemed necessary for stakeholder acceptability.”
- Presented in the form of “shall” statements
- See Module A103 (Introduction to ITS Standards Requirements Development) to review “well-formed” requirements

Architectural Requirements

- Defined in Section 3.4 of NTCIP 1204 v03
- Requirements related to the communications capabilities of an ESS system
- Architectural requirements supported by NTCIP 1204 v03:
 - Provide live data
 - Provide compressed data
 - Provide offline log data

Data Exchange Req's – ESS Manager

- Defined in Section 3.5 of NTCIP 1204 v03
- Defines ESS manager requirements
 - Configuration requirements include retrieving and configuring the ESS characteristics in either normal or compressed mode
 - Monitoring requirements include retrieving ESS door status, retrieving battery status, and retrieving line voltage
 - Data retrieval requirements include movement information for mobile ESS in either normal or compressed mode

Data Exchange Req's – Sensor Manager

- Defines sensor manager requirements
 - Sensor configuration requirements include retrieving and configuring atmospheric pressure, wind sensor, temperatures, pavement sensor data, subsurface sensor, and camera metadata
 - Sensor data retrieval requirements include retrieval of weather profiles for mobile pavement treatment systems (PTS), weather information, pavement conditions, subsurface conditions, air quality and biohazard conditions, water levels, and snapshot images
 - Sensor control requirements include controlling snapshot cameras

Data Exchange Req's – Pavement Treatment System (PTS)

- Defines pavement treatment system (PTS) requirements
 - PTS configuration requirements include retrieval of current configuration and commands to configure both stationary PTS and mobile PTS stations and sensors
 - PTS status monitoring requirements include retrieval of current status of sprayers and the number of sprayer events
 - PTS control requirements include setting of operational modes and manual activation for configurable durations



Data Exchange Req's – Backwards Compatibility

- Defines backwards compatibility requirements
 - Defines requirements to ensure data elements that were deprecated between version 01, v02, and v03 are compatible within a new or updated deployment.
 - Example: wind sensor data was defined differently in v01 versus v02 and v03, where they stayed the same.
- Backwards compatibility built into PRL

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Poll Exercise

Assume the following User Need:

A transportation system operator may need to monitor the temperature at the ESS location.

Which of the listed requirements fulfills this user need?

- A. Retrieve Temperature
- B. Retrieve Humidity
- C. Retrieve Daily Minimum and Maximum Temperatures



Protocol Requirements List (PRL) - Definition

- A table that maps the user needs to the requirements
- Must be part of agency's specification
- Specifies the standard (defines the communications interface)
- Designed to help specify what you want the interface to do

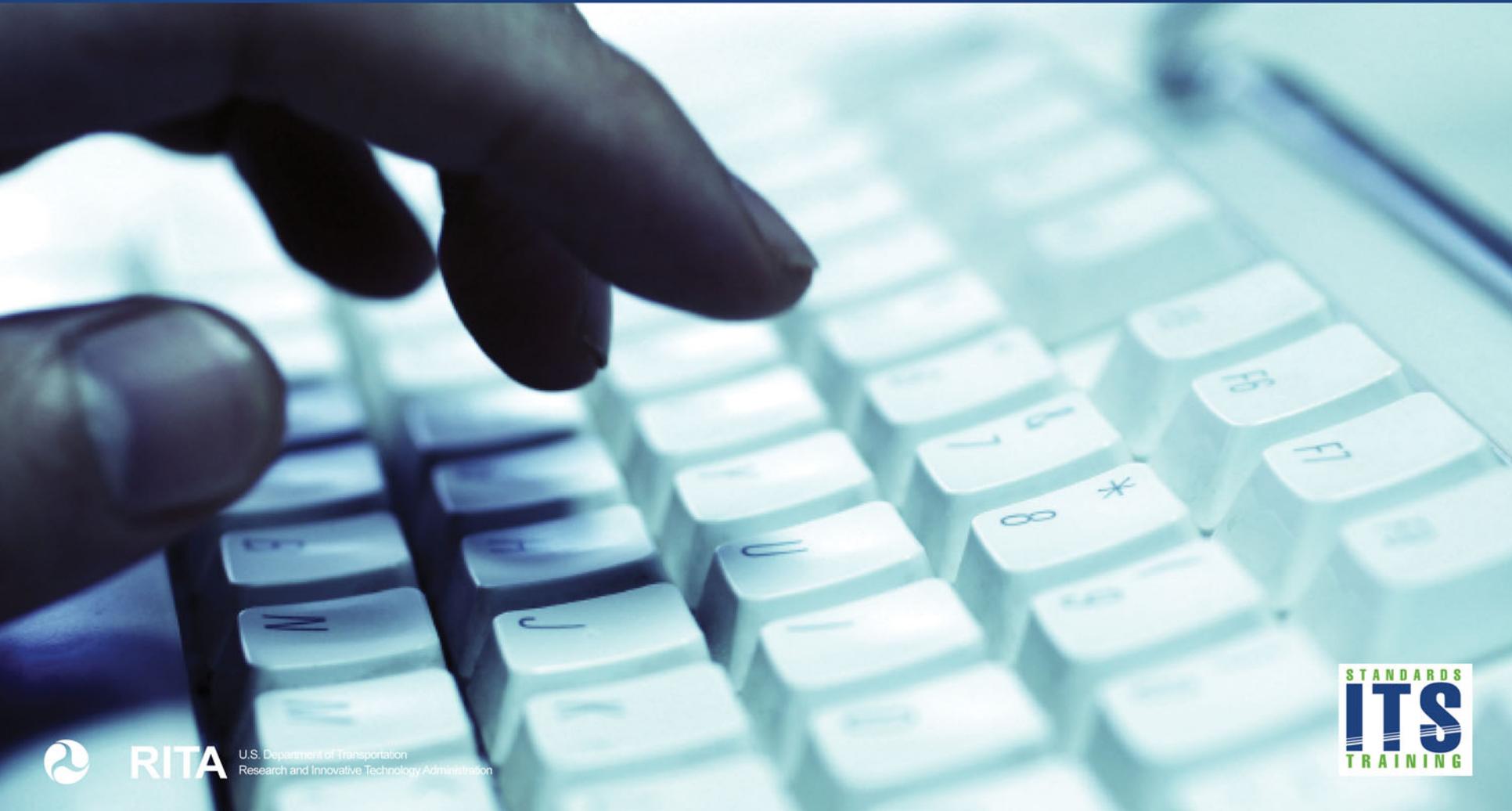


PRL – Columns “User Needs” and “Functional Requirements”

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5	Features			M	Yes	
2.5.1	ESS Manager Features			M	Yes	
2.5.1.1	Generic Features			M	Yes	(See F.1.2)
2.5.1.2	Monitor Door Status			O	Yes / No	
		3.5.1.2.1	Retrieve ESS Door Status	M	Yes / NA	
2.5.1.3	Monitor Power			O	Yes / No	
		3.5.1.2.2	Retrieve Battery Status	O.6 (1..*)	Yes / No / NA	
		3.5.1.2.3	Retrieve Line Volts	O.6 (1..*)	Yes / No / NA	

- Only select the user needs supported by the standard that satisfies your operational needs.
- Based on the user needs selected, the PRL identifies the requirements associated with those user needs and supported by the standard.

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Knowledge of the PRL

- Please describe the purpose and use of the PRL
 - What needs to be selected first from NTCIP 1204 to support the desired functionality of the system to be created?

The user needs that are “needed” for the proposed implementation

Enter answers in the chat pod



Knowledge of the PRL

- Please describe the purpose and use of the PRL
 - When you have identified this first item, what does the PRL provide a specification developer?

Based on the user needs selected, the PRL identifies the requirements associated with those user needs.

Enter answers in the chat pod



Knowledge of the PRL

- Please describe the purpose and use of the PRL
 - When you have completed the PRL, what do you do with it?
The selected requirements will become part of the project specification (by including the PRL in the specifications). The PRL references the selected requirements

Enter answers in the chat pod



PRL – Column “Conformance”

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5	Features			M	Yes	
2.5.1	ESS Manager Features			M	Yes	
2.5.1.1	Generic Features			M	Yes	(See F.1.2)
2.5.1.2	Monitor Door Status			O	Yes / No	
		3.5.1.2.1	Retrieve ESS Door Status	M	Yes / NA	
2.5.1.3	Monitor Power			O	Yes / No	
		3.5.1.2.2	Retrieve Battery Status	O.6 (1..*)	Yes / No / NA	
		3.5.1.2.3	Retrieve Line Volts	O.6 (1..*)	Yes / No / NA	

- Conformance – Identifies if the user need (or requirement) is mandatory (M) or optional (O)
 - Predicates – conformance may depend if a condition or feature is supported

PRL – Column “Support/Project Requirement”

- Support/Project Requirement - The procurer selects the user needs and associated requirements desired for his or her implementation.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5	Features			M	Yes	
2.5.1	ESS Manager Features			M	Yes	
2.5.1.1	Generic Features			M	Yes	(See F.1.2)
2.5.1.2	Monitor Door Status			O	Yes / No	
		3.5.1.2.1	Retrieve ESS Door Status	M	Yes / NA	
2.5.1.3	Monitor Power			O	Yes / No	
		3.5.1.2.2	Retrieve Battery Status	O.6 (1..*)	Yes / No / NA	
		3.5.1.2.3	Retrieve Line Volts	O.6 (1..*)	Yes / No / NA	

PRL – Column “Additional Project Requirements”

- Additional Project Requirements - Provides additional notes or requirements for the product to be procured or to provide any additional details about the implementation.
 - Provides spaces for the specification developer to indicate the performance requirements.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.2.1 (Weather)	Monitor Weather Conditions			O.2 (1..*)	Yes / No / NA	
2.5.2.1.1 (Pressure)	Monitor Atmospheric Pressure			O.3 (1..*)	Yes / No / NA	
		3.5.2.3.2.1	Retrieve Atmospheric Pressure	M	Yes / NA	
		3.6.1	Required Number of Atmospheric Pressure Sensors	M	Yes / NA	The ESS shall support at least ____ atmospheric pressure sensors.

PRL - Completing the PRL - Review

- Requiring support for monitoring air quality and/or biohazards would only increase costs and limit vendors who do not offer these capabilities.
 - Increases the cost of procuring as well as testing the ESS system.
 - For example: if the ESS is to monitor temperature, wind, humidity, visibility, pavement and subsurface conditions only along a freeway, why would any agency require the monitoring of air quality and biohazard conditions?



PRL - Example of PRL usage

- The user need “*Monitor Atmospheric Pressure*” is an optional user need for the standard.
 - But if selected, all the requirements associated with this user need become mandatory.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5	Features			M	Yes	
2.5.2	Sensor Manager Features			O.1 (1..*)	Yes No	
2.5.2.1 (Weather)	Monitor Weather Conditions			O.2 (1..*)	Yes No / NA	
2.5.2.1.1 (Pressure)	Monitor Atmospheric Pressure			O.3 (1..*)	Yes No / NA	
		3.5.2.3.2.1	Retrieve Atmospheric Pressure	M	Yes NA	
		3.6.1	Required Number of Atmospheric Pressure Sensors	M	Yes NA	The ESS shall support at least ____ atmospheric pressure sensors.

Requirements Traceability Matrix (RTM)

- Definition

- Describes the (standard) design for fulfilling a requirement (supported by the standard)
 - Requirements can be traced in a standardized way
 - Reduces design work
- Design consists of a dialog (sequence of data exchanges) and object(s) to be exchanged
- Intended audience/beneficiaries
 - Device vendors
 - Central system developers
 - Testers
 - Agencies

RTM – Definition (Cont.)

- To conform to a requirement (in the standard), an ESS system shall implement all objects and the dialogs traced from that requirement
- Requirements are traced to dialogs and then to objects. This order is key to interoperability needs
- To achieve interoperability, all systems shall satisfy a specified requirement ***the same way***

RTM Table - Overview

Req ID	Dialog	Requirement	Object ID	Add'l Requirements/Object
3.5.1		ESS Manager Requirements		
3.5.1.1		ESS Configuration Requirements		
3.5.1.1.1	F.3.1	Retrieve ESS Characteristics		
			5.2.1	essNtcipCategory
			5.2.2	essNtcipSiteDescription
			5.3.1	essTypeofStation
			5.4.1	essLatitude
			5.4.2	essLongitude
			5.5.1	essReferenceHeight

- 1st line contains the headings of the RTM
- **Req ID** – Section number of the functional requirement (all are in Section 3)
- **Dialog ID** – Section number of the dialog associated with this requirement (all are in Appendix F)
- **Requirement** – Heading text of requirement

RTM - Columns “Object ID” and “Additional Requirements”

Req ID	Dialog	Requirement	Object ID	Add'l Requirements/Object
3.5.1		ESS Manager Requirements		
3.5.1.1		ESS Configuration Requirements		
3.5.1.1.1	F.3.1	Retrieve ESS Characteristics		
			5.2.1	essNtcipCategory
			5.2.2	essNtcipSiteDescription
			5.3.1	essTypeofStation
			5.4.1	essLatitude
			5.4.2	essLongitude
			5.5.1	essReferenceHeight

- Object ID – Section number of the object(s) that will fulfill this requirement
- Add'l Requirements/Object - Provides either the name of the object(s) that will fulfill this requirement or provides for additional notes on how the design can be implemented to fulfill the requirement

RTM - Example

Req ID	Dialog	Requirement	Object ID	Add'l Requirements/Object
3.5.1		ESS Manager Requirements		
3.5.1.1		ESS Configuration Requirements		
3.5.1.1.1	F.3.1	Retrieve ESS Characteristics		
			5.2.1	essNtcipCategory
			5.2.2	essNtcipSiteDescription
			5.3.1	essTypeofStation
			5.4.1	essLatitude
			5.4.2	essLongitude
			5.5.1	essReferenceHeight

The requirement 3.5.1.1.1 (Retrieve ESS Characteristics) is fulfilled by using standardized dialog F.3.1 (Generic SNMP Get Interface) and it relates to the objects: essNtcipCategory (5.2.1), essNtcipSiteDescription (5.2.2), essTypeofStation (5.3.1), essLatitude (5.4.1), essLongitude (5.4.2), and essReferenceHeight (5.5.1)

RTM - Example – Dialog details

F.3.1 Generic SNMP Get Interface

SNMP defines a generic process by which a management station can retrieve data from a device. This process consists of a Get request (GET) and a Get Response as depicted in Figure 22. Both the Get request and the Get Response messages contain a list of objects as defined by the varBindingList structure (see Annex C.4.1.4).

The RTM (Annex A) customizes this generic process by calling out the appropriate objects to meet specific requirements as defined in Section 3.

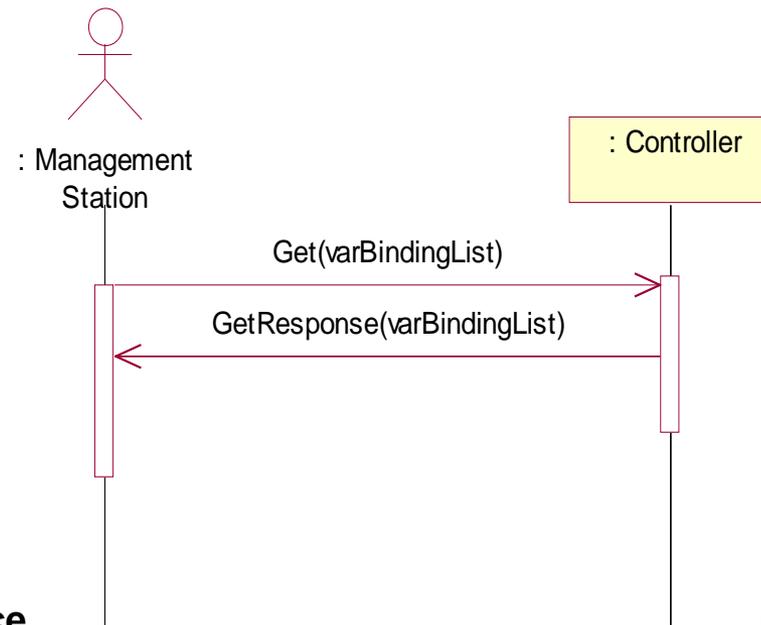


Figure 22 SNMP Get Interface

RTM - Dialogs and Interoperability

- The order of the data exchange is important, unless the dialogs state otherwise
- Interoperability may be compromised if the sequence of data exchanges is modified



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Poll Exercise

Which of the following elements are not part of the RTM?

- A. User needs supported by the standard
- B. Requirements supported by the standard
- C. Standardized dialogs to fulfill requirements
- D. Objects to fulfill requirements



Project Specifications - Overview

Contract Documents

Product Specifications

Hardware Specifications	Software Specifications	Communication Interface Specifications
<ul style="list-style-type: none"> · Functional Reqts. · Performance Reqts. · Structural Reqts. · Mechanical Reqts. · Electrical Reqts. · Environmental Reqts. 	<ul style="list-style-type: none"> · Functional Reqts. · Performance Reqts. 	<ul style="list-style-type: none"> · Functional Reqts. · Performance Reqts. · Protocol Reqts.

Contract Requirements

- Contractual requirements during system development
- Contractual requirements during testing
- Contractual requirements during deployment/integration
- Contractual requirements during operations/maintenance

Project Specifications - Contents

- **Product specifications include:**
 - Hardware specifications (functional, performance, structural, mechanical, electrical, and environmental requirements)
 - Software specifications (functional and performance requirements)
 - Communications interface specification (functional, performance, protocols)
- **Contract requirements define activities during:**
 - System development
 - Testing
 - Integration
 - Operations and maintenance

Project Specifications - Considerations

- A completed PRL defines the requirements for the communications interface
 - Only the information level (application data)
 - Underlying communications standards need to be specified too

- Considerations to reference interface standards
 - Be specific to the version and date of issue of a standard
 - Include the completed PRL
 - Include value ranges for all the objects to clarify parameters

Project Specifications - Performance Requirements

- Performance requirements for the system not covered by the standards, except response times
 - For example, number of devices on a channel, time lag when polling a device, polling rate, etc.
 - Response times are addressed in NTCIP 1204 v03 as shown below

3.6.21 Maximum Response Time for Requests

The ESS shall process all requests in accordance with all of the rules of the relevant base standards (i.e., NTCIP 1103 v01 and NTCIP 2303:2001), including updating the value in the database and initiating the transmission of the appropriate response (assuming that the ESS has permission to transmit) within the Maximum Response Time. If the agency specification does not indicate the Maximum Response Time, the Maximum Response Time shall be 100 milliseconds. The Maximum Response Time is measured as the time between the receipt of the last byte of the request and the transmission of the first byte of the response.

Project Specifications - Coordination of Requirements

- The requirements for the communications interface must be consistent with the hardware specification
- Include statement that requires implementation for all standardized design solutions, as specified in the RTM, for the requirements selected via the PRL
- Include a completed copy of the PRL plus a reference to the RTM as a source for the design of the system and the test plan

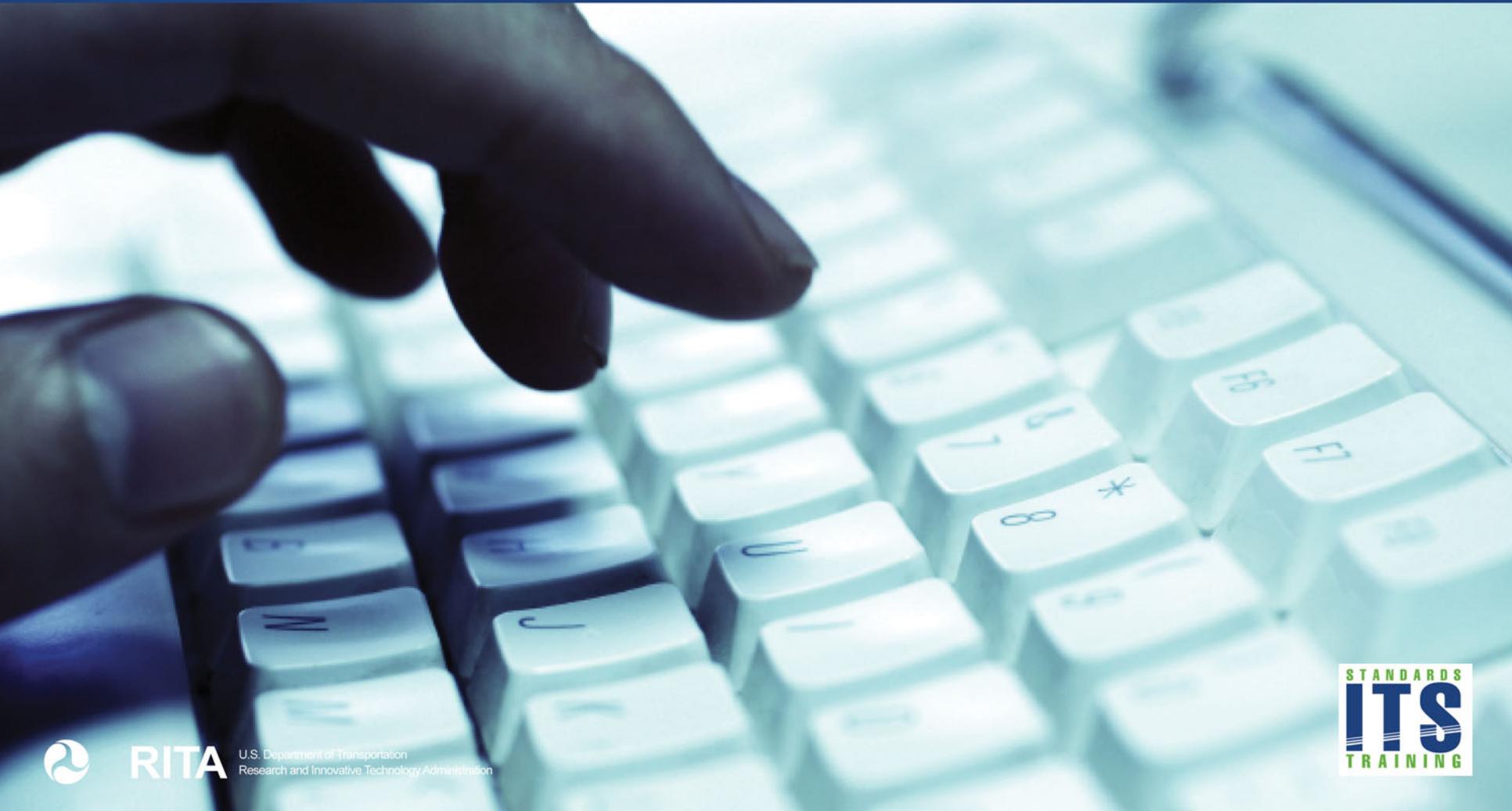


Specifying Requirements NOT Covered by the Standard = Extensions

- The NTCIP ESS standard support extensions
- User needs/requirements not supported by the standard
 - May result in user-specific requirements
 - Procuring agencies should specify the dialogs and objects to fulfill the user-specific requirements



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Extensions – Activity about Benefits/Drawbacks

What do you think are the benefits and drawbacks associated with extensions (allowing and creating them) to the NTCIP standards?

Enter answers in the chat pod



Extensions - Benefits

- Allows procurers to use the NTCIP family of standards and still support operational or user needs not supported by the family



Extensions – Example of Benefits

Let us pretend that Agency A wants to add an over-height sensor to an ESS installed at a tunnel. Such a sensor is not currently covered by any NTCIP standard. This requirement is therefore not supported by NTCIP 1204 v03. Agency A could define a new object and could start to monitor the over-height sensor using an existing dialog (F.3.1 – Generic SNMP GET Interface).

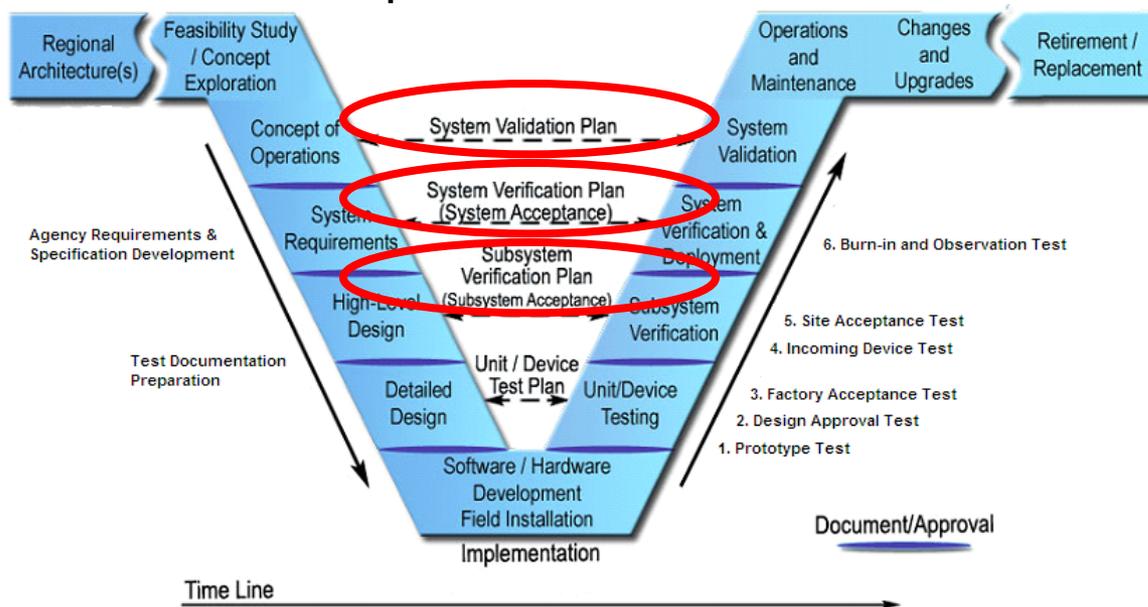


Extensions - Drawbacks

- Interoperability may be compromised
 - Other management stations that do not support the new objects will be unable to exercise the new capabilities
 - If the agency is not consistent on defining how the requirement is fulfilled for all ESS, interoperability cannot be achieved without custom integration for each deployment
 - Other agencies with the same requirement may not have the same design
- Test plans need to be expanded and test procedures be developed to support the new requirement
 - Feature is relatively untested and therefore more likely to experience bugs

User Needs \leftrightarrow Validation and Requirements \leftrightarrow Verification

- Testing must be considered early on during the project development process
 - V-Diagram shows relationship between user needs and validation and requirements to verification



Relationship between Selecting Requirements and Testing

- Test procedures are standardized in NTCIP 1204 v03
- A separate table “Requirements to Test Case Traceability Table” traces requirements to test cases (Annex C)

<i>Requirement</i>		<i>Test Case</i>	
<i>ID</i>	<i>Title</i>	<i>ID</i>	<i>Title</i>
3.5	<i>Data Exchange Requirements</i>		
3.5.1	<i>ESS Manager Requirements</i>		
3.5.1.1	<i>ESS Configuration Requirements</i>		
3.5.1.1.1	<i>Retrieve ESS Characteristics</i>		
		C.2.3.1.1	<i>ESS Characteristics</i>

Test Case Definition in NTCIP 1204 v03

Example

Test Case: 1.1	Title:	ESS Characteristics	
	Description:	This test case verifies that the ESS accurately reports its type, category and location and allows a management station to edit the site description.	
	Variables:		
	Pass/Fail Criteria:	The device under test (DUT) shall pass every verification step included within the Test Case to pass the Test Case.	
Step	Test Procedure	Device	
1	GET the following object(s): »essNtcipCategory.0 »essNtcipSiteDescription.0 »essTypeofStation.0 »essLatitude.0 »essLongitude.0 »essReferenceHeight.0	Pass / Fail (Sec. 3.5.1.1.1)	
2	VERIFY that the RESPONSE VALUE for essNtcipCategory.0 is APPROPRIATE. NOTE—See NTCIP 1204 v03 Sec. 5.2.1 for valid enumerated values.	Pass / Fail (Sec. 5.2.1)	
ETC	ETC	ETC	
Test Case Results			
Tested By:		Date Tested:	Pass / Fail
Test Case Notes:			

Testing in Project Specifications

- Procurement specifications should include language to use the standardized test procedures to verify conformance for the requirements selected in the PRL.
- Test plans and procedures for ESS is the topic of the next module – T313



Summary

- NTCIP 1204 v03:
 - Defines requirements, dialogs, and objects
 - Defines test procedures
 - Relates user needs to requirements to dialogs to test procedures
 - Contains user-definable, pre-defined protocol requirements list (PRL)
 - Contains requirements traceability matrix (RTM) automatically relating user-selected requirements to dialogs and object definitions
 - Contains requirements to test case traceability table and test cases and procedures



What Did We Learn Today?

- 1) A **protocol requirements list (PRL)** is used to link the user needs to the functional requirements
- 2) Tracing of selected functional requirements to dialogs and objects is standardized within the **requirements traceability matrix** Table.
- 3) Inter**operability** is achieved via the use of PRL and RTM as well as standardized test procedures.
- 4) **Extensions** may be used to specify non-standardized functions but are sources for interoperability problems.
- 5) A completed PRL and a reference to the RTM should be integrated into the **project specifications** as part of the plan, specification, and estimate package.



Resources

- NTCIP 1204 v3.08r2, Object Definitions for Environmental Sensor Stations – www.ntcip.org
- NTCIP 9001 v04 – The NTCIP Guide – www.ntcip.org
- IEEE 830-1998 - IEEE Recommended Practice for Software Requirements Specification
- FHWA Systems Engineering Website: <http://www.fhwa.dot.gov/cadiv/segb/>
- ITS Standards website: <http://www.standards.its.dot.gov/>



Next Steps

- Module T313 – Applying your Test Plan to the NTCIP 1204 v03 ESS Standard.
 - Shows how to apply test plans to verify an ESS system meets the agency specifications and the requirements supported by the standard.
 - Shows the relationship between testing for compliance to the standard and how it fits into an overall testing program.



QUESTIONS?



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