



W E L C O M E



U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

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New Web-Based Training from ITS Joint Program Office

- Connected Vehicle Reference Implementation Architecture Training now available

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- Systems Engineering for Signal Systems Including Adaptive Control (NHI-133123)

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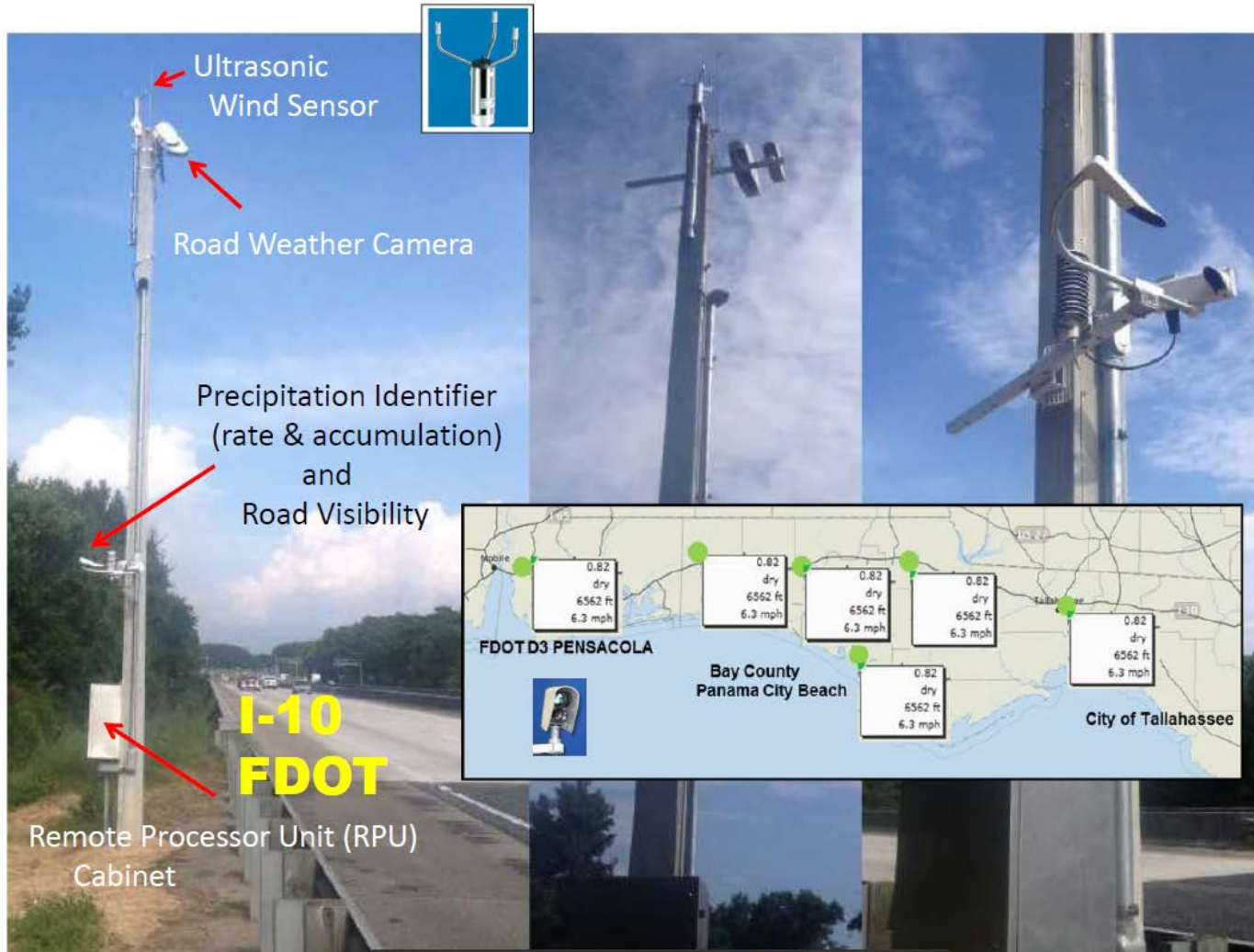
- National ITS Architecture

Added to T3 Archive

- Learn from the Experts: Open Data Policy Guidelines for Transit - Maximizing Real Time and Schedule Data-Legalities, Evolutions, Customer Perspectives, Challenges, and Economic Opportunities - Part II Presented on August 7, 2014
- Saving Lives and Keeping Traffic Moving: Quantifying the Outcomes of Traffic Incident Management (TIM) Programs Presented on July 31, 2014

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A313b: Specifying Requirements for ESS Systems Based on NTCIP 1204 Standard v04



Instructor



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Learning Objectives

Review the **structure** of the standard

Use the **PRL** and **RTM** to specify requirements

Use the RTM to specify the **standardized design**

How to specify requirements **not covered** by the standard

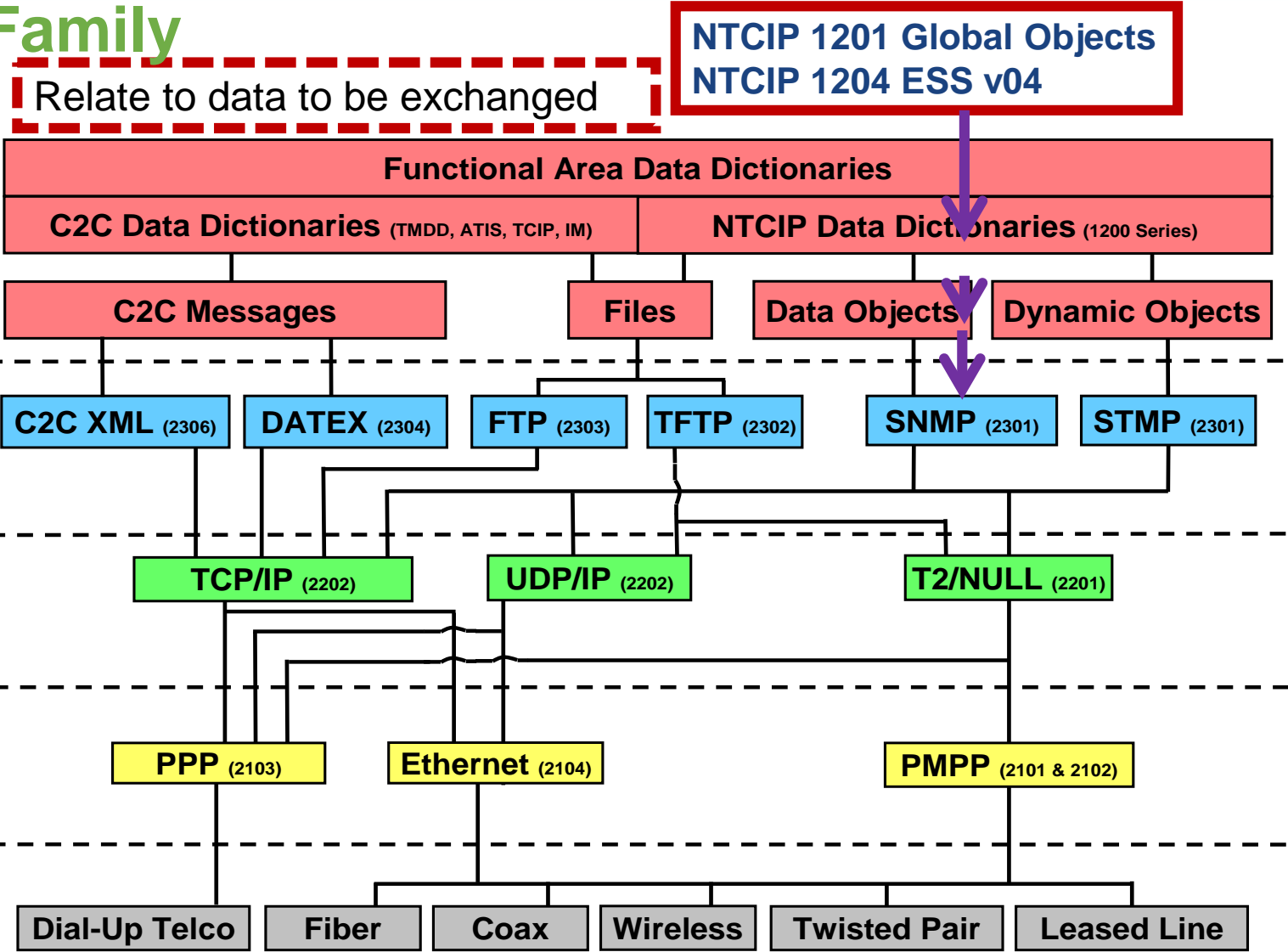
Infer the **relationship** between selecting requirements and testing

Learning Objective 1

Review the **structure** of the
standard

Overall Structure of the Environmental Sensors Station (ESS) Standard

NTCIP Family



Standard Organization

Structure of the ESS Standard (NTCIP 1204 v04)

Section 1 General

Section 2 Concept of Operations
(Features-User Needs)

Section 3 **Functional Requirements**

Section 3.3 **Protocol Requirements List (PRL)**

Section 4 **Dialogs (Standardized)**

Section 5 **Object Definitions**
(Management Information Base – MIB)

Specification writers will need to refer to these sections



Standard Organization

Structure of the Standard (NTCIP 1204 v04)

Annex A	Requirements Traceability Matrix (RTM)
Annex B	Object Tree
Annex C	Test Procedures
Annex D	Documentation of Revisions
Annex E	User Requests
Annex F	Generic Clauses (applicable to NTCIP devices)
Annex G	Encoding of Sample Block Objects
Annex H	Controller Configuration Objects

Specification writers will need to refer to RTM and Test Procedures



What Is New in v04

What Has Changed in v04 Compared to v03?

The **primary changes** from NTCIP 1204 v03 to NTCIP 1204 v04:

- Improved support for **multiple sensor readings** of the same sensor type
- Improved support for **new infrared technologies** that collect different sensor readings from a single device
- Expanded support for metadata

This updated Module incorporates new user needs and **Test Procedures.**



What Is New in v04

What Has Changed in v04 Compared to v03?

- Reflects lessons learned since publication of NTCIP 1204 v03
- Supports newly identified user needs
- v04 is backward compatible to v03, v02, and v01
- PRL and RTM (some) Headings are renamed in v04

Requirements Supported by the Standard

What Is a Requirement?

“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.”

- INCOSE Systems Engineering Handbook



Requirements Supported by the Standard

NTCIP 1204 ESS Standard Definition of a Requirement

*“A requirement describes a condition or capability to which a system shall conform; either **derived directly from user needs**, or stated in a contract, standard, specification, or other normative document.*

*A desired **feature**, property, or behavior of a system.”*

Requirements Supported by the Standard

Examples of Weather Events

- **Close** threatened roadways and bridges
- **Disseminate** information to the public



Source: NJTPA-Daktronics



Requirements Supported by the Standard

Best Practice: FDOT High-Wind Alert System

*“FDOT has deployed a **high-wind alert** system for road bridges.*

*The system assists the transportation and public-safety communities by providing real-time **wind speed status** information during severe **weather events** from each monitored bridge structure.*

*This information is **used to assist** transportation managers with **bridge closure decisions.**”*



EXAMPLE

Requirements Supported by the Standard

3.5.2.3.2.2 Retrieve Wind Data

Upon request, the ESS **shall** return the following information for each wind sensor reporting to the ESS:

- a) the average **wind speed** recorded during the
- b) the average **direction** the wind is blowing from.....
- c) the current wind speed in **tenths of meters** per second.....



EXAMPLE

Requirements Supported by the Standard

Retrieve Weather Data

Observation Date and Time		
7/3/2016 8:00:02 AM		
Atmospheric Data		
Air Temperature	61.0°F	
Dew Point	58.6°F	
Relative Humidity	91.0%	
Average Wind Speed	9 mph(8 knots)	
Wind Gust	10.01 mph(9 knots)	
Wind Direction	NE(55°)	
Precipitation	None	
Visibility	7.1 Miles	
Surface Data		
<u>Location</u>	<u>Surface Temperature</u>	
I-35 NB Driving Deck	66.7°F	
I-35 NB Driving Pavement	72.3°F	
I-35 SB Passing Deck	66.9°F	
Sub Surface Data		
<u>Location</u>	<u>SubSurface Temperature</u>	
I-35 NB	81.1°F	
Traffic Data (2-minute average)		
<u>Location</u>	<u>Speed</u>	<u>Source Volume</u>
I-35 N/B Drive Lane	70.8	16.0
I-35 N/B Pass Lane	73.9	5.0
I-35 S/B Pass Lane	73.9	8.0
I-35 S/B Drive Lane	67.7	22.0



Requirements Supported by the Standard

Where to Find ESS Requirements

Categories

Section 3 Functional Requirements [Normative]	23
3.1 Tutorial [Informative]	23
3.2 Scope of the Interface [Informative]	23
3.3 Protocol Requirements List (PRL)	24
3.3.1 Notation [Informative]	24
3.3.2 Instructions for Completing the PRL [Informative]	26
3.3.3 Protocol Requirements List (PRL) Table	27
3.4 Architectural Requirements	46
3.5 Data Exchange and Operational Environment Requirements	46
3.5.1 ESS Manager Requirements	46
3.5.2 Sensor Manager Requirements	48
3.5.3 PTS Manager Requirements	69
3.5.4 Backward Compatibility Requirements	72
3.6 Supplemental Non-Communications Requirements	75
3.6.1 Required Number of Atmospheric Pressure Sensors	75
3.6.2 Required Number of Wind Sensors	75
3.6.3 Required Number of Temperature Sensors	76
3.6.4 Required Number of Humidity Sensors	76

Protocol Requirements List (PRL) was discussed in
Module A313a – User Needs



Requirements Supported by the Standard

Where to Find ESS Requirements with Design Elements

Annex A	Requirements Traceability Matrix (RTM) [Normative]	211
A.1	Notation [informative]	211
A.1.1	Functional Requirement Columns	211
A.1.2	Dialog Column	211
A.1.3	Object Columns	212
A.1.4	Additional Specifications	212
A.2	Instructions for Completing the RTM [Informative]	212
A.3	Requirements Traceability Matrix (RTM) Table	212



Introduce Requirements Traceability Matrix (RTM)

Parts of RTM (Table)

- 2nd line contains the headings of the RTM
FR ID – Section number of the functional requirement, Section 3

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.4	Architectural Requirements				
	Data Exchange and Operational Environment Requirements				
3.5	ESS Manager Requirements				
3.5.1	ESS Configuration Requirements				
3.5.1.1	Retrieve ESS Characteristics	G.1			
			5.2.1	essNtcipCategory	
			5.2.2	essNtcipSiteDescription	
			5.3.1	essTypeofStation	
			5.4.1	essLatitude	
			5.4.2	essLongitude	
			5.5.1	essReferenceHeight	

- Dialog ID – Section number of the dialog associated with this requirement, Appendix G (G1, G2, and G3)
- Object name and location (derived from MIB)

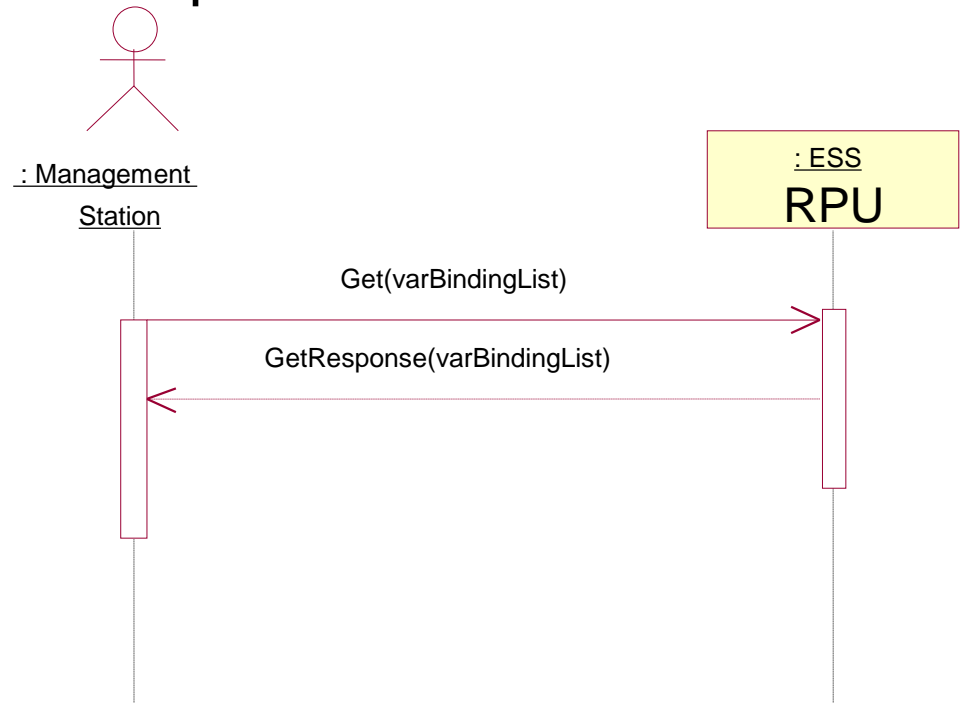
Introduce Requirements Traceability Matrix (RTM)

Parts of RTM: Example of a Dialog

G.1 Generic SNMP Get Interface

Management station can retrieve data from a **Remote Processor Unit (RPU)** to fulfill a requirement.

Messages contain a list of objects as defined by the varBindingList structure.



Introduce Requirements Traceability Matrix (RTM)

3.5.1.1.1 Retrieve ESS Characteristics Requirement

- Generic dialog **G.1** with a set of related objects are allocated by RTM to retrieve ESS data
- User has **NO role** in selecting dialog/objects

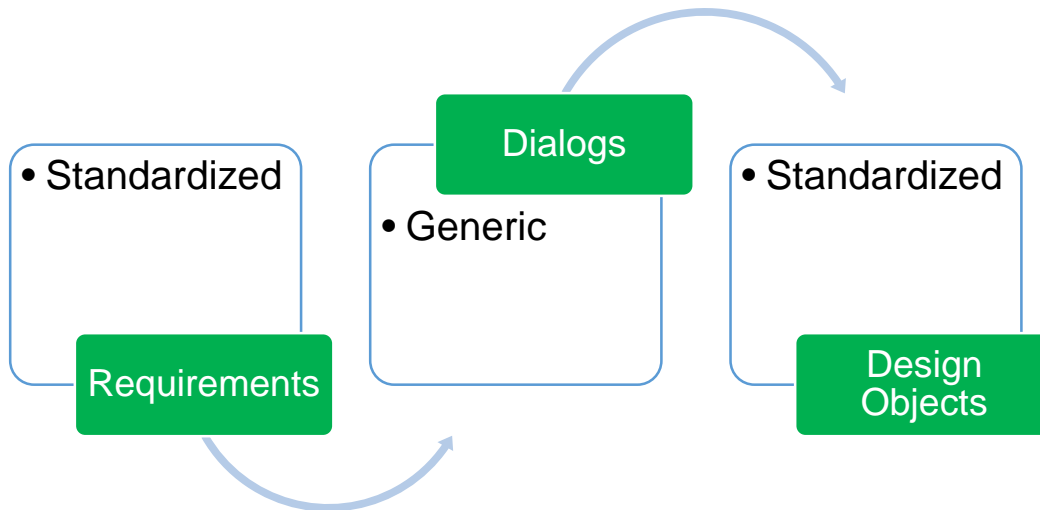
Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.1.1.1	Retrieve ESS Characteristics	G.1			
Fixed Portable Transportable			5.2.1	essNtcipCategory	
			5.2.2	essNtcipSiteDescription	
			5.3.1	essTypeofStation	
			5.4.1	essLatitude	
			5.4.2	essLongitude	
			5.5.1	essReferenceHeight	

EXAMPLE

Introduce Requirements Traceability Matrix (RTM)

Key Benefits of RTM

- Maintains **order** for interoperability, acts as a conformance tool
- **Reduces** design work (predesigned by the standard)



Source: Patel

Traceability

Creates a **common understanding** among agencies, developers, vendor, and testers; removes ambiguities.

ACTIVITY



Question

Which of the following is a False statement?

Answer Choices

- a) ESS requirements are standardized by the standard
- b) RTM provides benefits to vendors only
- c) RTM provides standardized design
- d) NTCIP 1204 v04 is backward compatible to previous versions

Review of Answers



a) ESS requirements are standardized by the standard

True statement. All ESS requirements are developed by the standard.



b) RTM provides benefits to vendors only

False statement. RTM creates a common understanding among all concerned parties: agencies, developers, and vendors.



c) RTM provides standardized design

True statement. RTM provides a single standardized design for each requirement.



d) NTCIP 1204 v04 is backward compatible to previous versions.

True statement. v04 is fully compatible to older versions.

Learning Objectives

Review the **structure** of the standard

Use the **PRL** and **RTM** to specify requirements

Learning Objective 2

Use the **PRL** and **RTM** to specify requirements

How to Obtain Off-the-Shelf Interoperability?

Terminology

Interoperability: the ability of two or more systems or components to exchange information and use the information that has been exchanged

Off-the-Shelf Interoperability: enabled by the ESS standard and obtained by using well-documented user needs, along with their corresponding requirements and design, that are broadly supported by the industry as a whole



How to Obtain Off-the-Shelf Interoperability?

What We Must Do to Achieve Interoperability

1. Select **same** user needs and requirements provided by PRL with:
 - **Mandatory** user needs and associated requirements
 - **Optional** user needs and associated requirements
2. Select **same** standardized dialogs/objects (single design) provided by RTM



How to Obtain Off-the-Shelf Interoperability?

Using PRL to Specify: What Do You Want the Interface to Do?

Map project User Operational Needs to User Needs, YES

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4	Architectural Needs			M	Yes	
2.4.1	Generic Architectural Needs			M	Yes	
2.5	Features			M	Yes	
2.5.1	ESS Manager Features			M	Yes	
2.5.1.1	Generic Features			M	Yes	
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.1 (1..*)	Yes / No / NA	
		3.5.1.2.3	Retrieve Line Volts	O.1 (1..*)	Yes / No / NA	
2.5.1.4	Monitor Mobile Station Data			Mobile:M	Yes / NA	
		3.5.1.3.1	Retrieve Mobile ESS Movement	M	Yes / NA	NTCIP 1204 v04 does not impose any accuracy requirements. Any accuracy requirements should be inserted here.
2.5.1.5	Determine ESS Type			M	Yes	
2.5.1.5.a	Permanent			O.2 (1)	Yes / No	
2.5.1.5.b	Transportable			O.2 (1)	Yes / No	
2.5.1.5.c (Mobile)	Mobile			O.2 (1)	Yes / No	
		3.5.1.1.1	Retrieve ESS Characteristics	M	Yes	
2.5.1.6	Monitor the Status of the ESS			O	Yes / No	
		3.5.1.2.4	Retrieve ESS Status	M	Yes / NA	
2.5.2	Sensor Manager Features			O.3 (1..*)	Yes / No	

What needs to be done?

How to Obtain Off-the-Shelf Interoperability?

Using PRL to Specify: What Do You Want the Interface to Do?

How it is to
be done

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4	Architectural Needs			M	Yes	
2.4.1	Generic Architectural Needs			M	Yes	
2.5	Features			M	Yes	
2.5.1	ESS Manager Features			M	Yes	
2.5.1.1	Generic Features			M	Yes	
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.1 (1..*)	Yes / No / NA	
		3.5.1.2.3	Retrieve Line Volts	O.1 (1..*)	Yes / No / NA	
2.5.1.4	Monitor Mobile Station Data			Mobile:M	Yes / NA	
		3.5.1.3.1	Retrieve Mobile ESS Movement	M	Yes / NA	NTCIP 1204 v04 does not impose any accuracy requirements. Any accuracy requirements should be inserted here. _____ _____
2.5.1.5	Determine ESS Type			M	Yes	
2.5.1.5.a	Permanent			O.2 (1)	Yes / No	
2.5.1.5.b	Transportable			O.2 (1)	Yes / No	
2.5.1.5.c (Mobile)	Mobile			O.2 (1)	Yes / No	
		3.5.1.1.1	Retrieve ESS Characteristics	M	Yes	
2.5.1.6	Monitor the Status of the ESS			O	Yes / No	
		3.5.1.2.4	Retrieve ESS Status	M	Yes / NA	
2.5.2	Sensor Manager Features			O.3 (1..*)	Yes / No	

Within the PRL, Select a Given Range of Requirements

Select Mandatory User Needs to Conform Select Optional User Needs if Project Needs Them

Certain User Needs are “Optional,” but if selected, all the requirements associated with the User Need become **mandatory**.

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.2.1	Monitor Weather Conditions			O.4 (1..*)	Yes / No / NA	
2.5.2.1.1	Monitor Atmospheric Pressure			O.5 (1..*)	Yes / No / NA	
		3.5.2.1.10.1	Retrieve Atmospheric Pressure Metadata - Location	O	Yes / No / NA	
		3.5.2.1.10.2	Retrieve Atmospheric Pressure Metadata - Sensor Information	O	Yes / No / NA	
		3.5.2.1.10.3	Configure Atmospheric Pressure Metadata - Location	PressLoc:O	Yes / No / NA	
		3.5.2.3.2.10	Retrieve Atmospheric Pressure	M	Yes / NA	
		3.6.1	Required Number of Atmospheric Pressure Sensors	M	Yes / NA	The ESS shall support at least _____ (1..255:Default=1) atmospheric pressure sensors.

PRL is NOT a “nice to have” list; unnecessary User Needs will add COST and may even hamper interoperability.

Within the PRL, Select a Given Range of Requirements

ESS Requirement Categories

3.4	Architectural Requirements
3.5	Data Exchange and Operational Environment Requirements
3.5.1	ESS Manager Requirements
3.5.2	Sensor Manager Requirements
3.5.3	PTS Manager Requirements
3.5.4	Backward Compatibility Requirements
3.6	Supplemental Non-Communications Requirements
3.6.1	Required Number of Atmospheric Pressure Sensors
3.6.2	Required Number of Wind Sensors
3.6.3	Required Number of Temperature Sensors
3.6.4	Required Number of Humidity Sensors

Twenty-four Additional Supplemental Requirements are listed in the standard

Within the PRL, Select a Given Range of Requirements

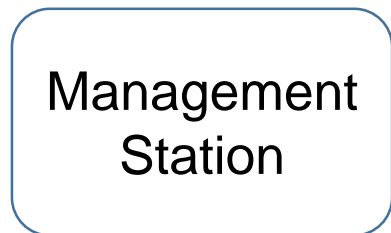
3.4 Architectural Requirements

Field ESS System

- Provide live data
- Provide compressed data
- Provide offline log data

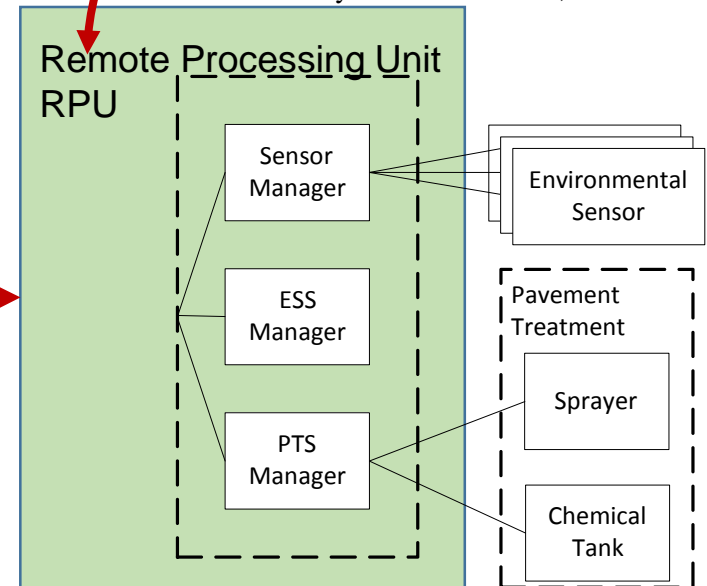


Source: City of Overland Park, KS



Central System

**Subject of NTCIP
1204 v04**



Within the PRL, Select a Given Range of Requirements

3.5 Data Exchange and Operational Environment Requirements for ESS Manager (3.5.1)

Configuration

Location

Retrieving and configuring the
ESS characteristics
Permanent ESS
Transportable ESS
Mobile ESS

Monitoring

Sensor data retrieval requirements

Data retrieval

Mobile ESS data retrieval
Location-Speed-Direction

Within the PRL, Select a Given Range of Requirements

ESS Monitoring Requirement

3.5.1.2.1 Retrieve ESS Door Status

Upon request, the ESS shall return an indication as to whether any doors related to the ESS (e.g., cabinet doors, housing doors, etc.) are open



Source: WYDOT TMC

Door status?

Door is open



Source: USDOT

EXAMPLE

Within the PRL, Select a Given Range of Requirements


3.5 Data Exchange and Operational Environment Requirements for Sensor Manager (3.5.2)

Configuration



Configure sensors, snapshot cameras

Monitoring



Retrieval of current status of sprayers and the number of sprayer events

Data retrieval



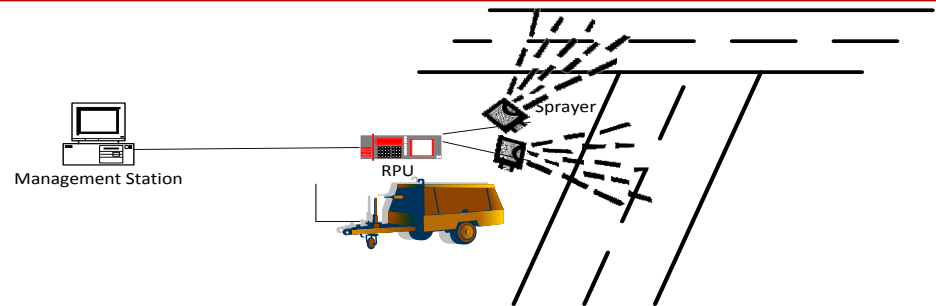
Sensors metadata

Within the PRL, Select a Given Range of Requirements

3.5 Data Exchange/Operational Environment Requirements for Pavement Treatment System (PTS) Manager

Configuration

Configure both stationary PTS and mobile PTS stations and sensors



Monitoring

Retrieval of current status of sprayers and the number of sprayer events
spray amount-width

Data retrieval

Setting of operational modes and manual activation for configurable durations

Within the PRL, Select a Given Range of Requirements

3.5 Data Exchange and Operational Environment Requirements for Backward Compatibility (3.5.4)

- 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
- Backward compatibility is secured through PRL Support column

Within the PRL, Select a Given Range of Requirements

3.6 Supplemental Requirements

3.6.3 Required Number of Temperature Sensors

The ESS shall support the **number of temperature sensors** as defined by the agency specification. If the agency specification does not define the number of temperature sensors, the number of temperature sensors supported by the ESS is one (1).

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.5.2.1.12.2	Retrieve Temperature Sensor Metadata - Sensor Information	O	Yes / No / NA	
		3.5.2.1.12.3	Configure Temperature Sensor Metadata - Location	Temperature:O; TempLoc:O	Yes / No / NA	
		3.5.2.3.2.3	Retrieve Air Temperature	M	Yes / NA	
		3.5.2.3.2.4	Retrieve Daily Minimum and Maximum Temperature	M	Yes / NA	
		3.6.3	Required Number of Temperature Sensors	M	Yes / NA	The ESS shall support at least ____ (1..255:Default=1) temperature sensors.

ACTIVITY



Question

Which of the following is a False statement as applied to ESS?

Answer Choices

- a) Remote Processing Unit (RPU) contains ESS Manager
- b) Sensor Manager collects data supplied by each sensor
- c) PRL allows users to select user needs and associated requirements
- d) Backward compatibility is not addressed by the PRL

Review of Answers



- a) Remote Processing Unit (RPU) contains ESS Manager

True. RPU houses ESS Manager, Sensor Manager, and PTS Manager.



- b) Sensor Manager collects data supplied by each sensor

True. Sensor Manager manages metadata from all sensors.



- c) PRL allows users to select user needs and associated requirements

True. PRL is the ONLY method to select a USER NEED and associated Requirements.



- d) Backward compatibility is not addressed by the PRL

False. Backward compatibility to v01, v02, and v03 is built into PRL as Optional; user must Select YES for support for this feature as per Section 3.5.4 entries in PRL.

Learning Objectives

Review the **structure** of the standard

Use the **PRL** and **RTM** to specify requirements

Use the RTM to specify the **standardized design**

Learning Objective 3

Use the RTM to specify the
standardized design

How RTM Fits into the Big Picture, into an ESS Specification

Components of Agency ESS Procurement Specification

Hardware Specifications

Functional Req.
Performance Req.
Structural Req.
Mechanical Req.
Electrical Req.
Environmental Req.

Software Specifications

Functional Req.
Performance Req.

Communications Interface Specifications

- ✓ User Needs
- ✓ Functional Req.
- ✓ Project PRL, RTM
- ✓ Testing Documentation

How RTM Fits into the Big Picture, into an ESS Specification

Maintaining Consistency Among Specification Components

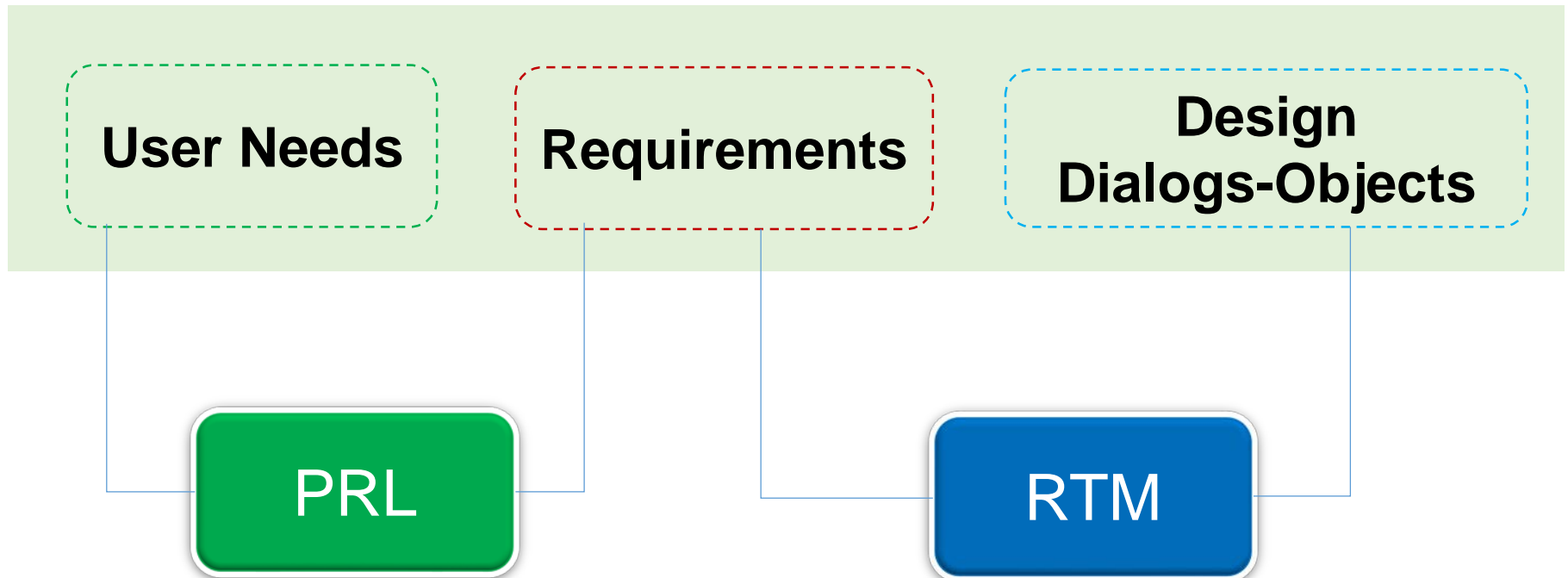
- Communications interface requirements must be **consistent** with the hardware specification

Example: measuring temperature range -22°F to $+158^{\circ}\text{F}$



How to Properly Trace User Needs to Requirements

Using PRL and RTM in the Specification for Traceability, Conformance, and Interoperability



How to Properly Trace User Needs to Requirements

PRL is the First Step Towards Preparing Communication Interface Specification

- A completed PRL **traces** the user needs to requirements for the communications interface
- PRL deals only with the information level (ESS application data)
- Underlying communications standards need to be specified too
- Make reference to interface standards
- Be specific to the version and date of issue of a standard



How to Properly Trace User Needs to Requirements

About ESS Performance Requirements

Performance requirements for the ESS system are **not** covered by the standards.

For example, number of devices on a channel, time lag when polling a device, polling rate, etc.



EXAMPLE

Management Station

Source: City of Overland Park, KS

How to Properly Trace User Needs to Requirements

Performance Requirement Supported: Response Time

“The ESS shall process the Get, Get-Next, or Set request in accordance with all of the rules of NTCIP 1103 v02 (assuming that the ESS has permission to transmit) within 100 milliseconds of receiving the last byte of the request.”

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		F.2.1.1.2	Deliver Data	M	Yes	
		F.2.1.1.3	Explore Data	M	Yes	
		3.6.21	Maximum Response Time for Requests	M	Yes	The Response Time for all requests shall be _____ milliseconds (25-500: Default 100).

Note: Users desiring a different response time may indicate this in the PRL.

EXAMPLE

How to Properly Trace User Needs to Requirements

Handling Additional Requirements in PRL

- Last column of the PRL identifies user selectable range values
- Provides additional notes and requirements for the product or details about the implementation
- In some cases default text already exists, and it should then be completed by the user

Additional Specifications	
	The ESS shall support at least ____ (1..255:Default=1) water level sensors.
	The ESS shall be capable of storing at least ____ events in the event log file.

EXAMPLE

How to Properly Trace User Needs to Requirements

Environmental Images

An optional user need, if selected YES, will require all Mandatory Requirements

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.6.7	Required Number of Visibility Sensors	M	Yes / NA	The ESS shall support at least ____ (1..255:Default=1) visibility sensors.
2.5.2.1.8	View Environmental Image			O	Yes / No	
		3.5.2.1.9	Configure Snapshot Camera	M	Yes / NA	
		3.5.2.3.8	Retrieve Snapshot	M	Yes / NA	
		3.5.2.3.9	Retrieve Snapshot Camera Configuration	M	Yes / NA	
		3.5.2.4.1	Capture Snapshot Image	M	Yes / NA	
		3.5.2.4.2	Delete Snapshot	M	Yes / NA	
		3.6.20	Required Number of Snapshot Cameras	M	Yes / NA	The ESS shall support at least ____ (1..255:Default=1) snapshot cameras.
		3.6.23	Support Camera Number in Filename	O	Yes / No / NA	
		3.6.24	Support Sequence Number in Filename	O	Yes / No / NA	
		3.6.25	Support Date in Filename	O	Yes / No / NA	
		3.6.26	Support Time in Filename	O	Yes / No / NA	
		3.6.27	Support Long Filenames	O	Yes / No / NA	

EXAMPLE

CASE STUDY



U.S. Department of Transportation
ITS Joint Program Office
Image Source: Thinkstock USDOT

IDAHO DOT Statewide Weather Stations Deployment

Snapshot-Map-Data



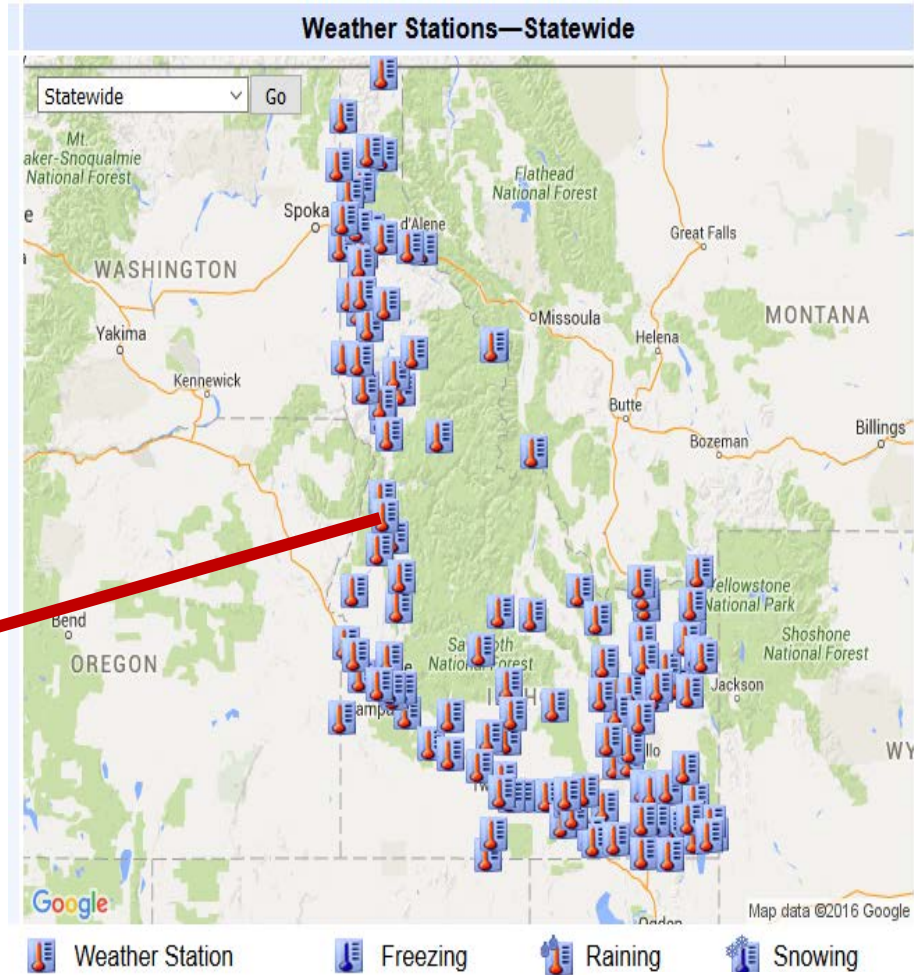
Winter

US 95: Whitebird Hill
6 miles north of the White Bird area

78 °F

Summer

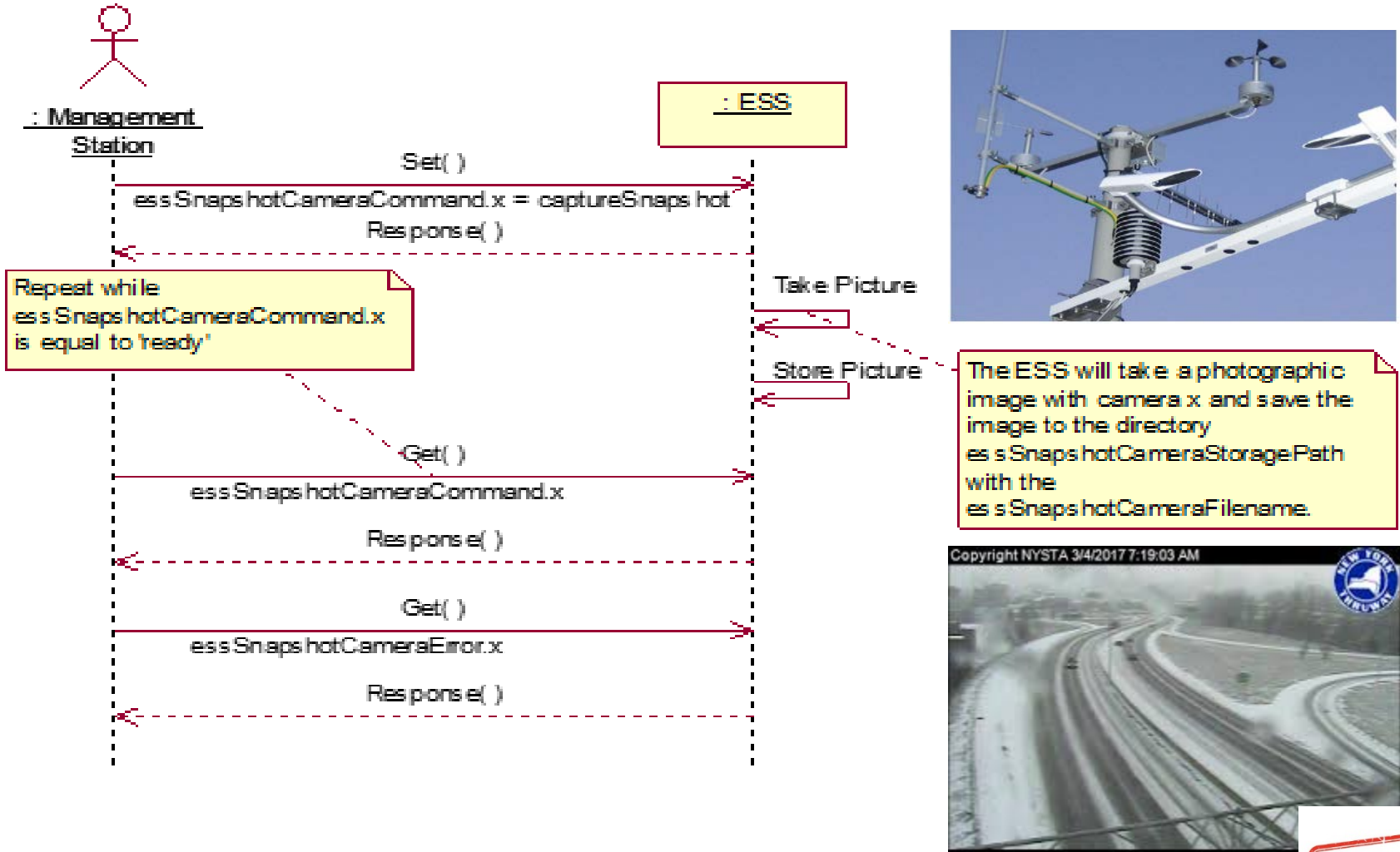
Precip (Yes/No)	No
Surface Status	Dry
Surface Friction	Good
Visibility	1.24 miles
Wind Speed (avg)	3.4 mph
Wind Speed (gust)	5.1 mph



EXAMPLE

Using RTM

Specify Standardized Dialog 4.2.2 to Retrieve Snapshot



The ESS will take a photographic image with camera x and save the image to the directory `essSnaps hotCameraStoragePath` with the `essSnaps hotCameraFilename`.



EXAMPLE

Using RTM

Using RTM to Specify Design for Retrieving a Snapshot

Standardized dialog 4.2.2 will utilize two objects: 5.17.1 and 5.17.2

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.2.3.8	Retrieve Snapshot	4.2.2			Upon ESS delivery the FTP username shall be _____. Upon ESS delivery, the FTP password shall be _____. Note: For agencies that restrict the use of FTP, see Annex E.3 for additional information.
			5.17.1		<not an SNMP Object> Snapshot.filename:text
			5.17.2		<not an SNMP object> Snapshot.image:frame



Using RTM

Example

A state highway winter maintenance unit has a user need to procure a sprayer as part of an ESS

2.3.4 Sprayer Combined with a Pavement Sensor

Figure 6 depicts an ESS consisting of a RPU, a pavement sensor, and a sprayer. The RPU is connected to the management station through a separate connection, perhaps a dial-up link.

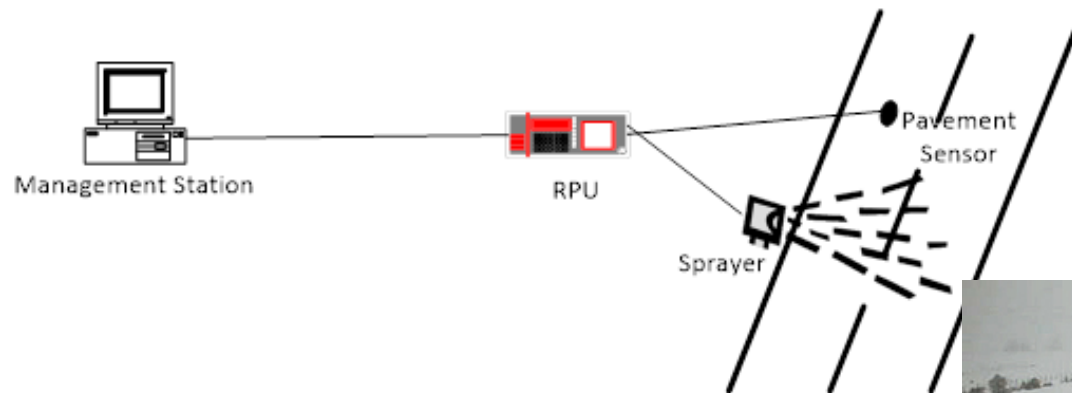


Figure 6 Sprayer Combined with a Pavement Sensor



EXAMPLE

Using RTM

Example: PRL Entries That Support User Need

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.3.2	Manage Mobile Spray System			Mobile: O	Yes No / NA	
		3.5.2.1.21.1	Retrieve Pavement Treatment System Metadata - Location (PTSLoc)	O	Yes No / NA	
		3.5.2.1.21.2	Retrieve Pavement Treatment Metadata - System Information	O	Yes No / NA	
		3.5.2.1.21.3	Configure Pavement Treatment System Metadata - Location	PTSLoc:O	Yes No / NA	
		3.5.3.1.4	Configure Mobile Pavement Treatment System	O	Yes No / NA	
		3.5.3.1.5	Retrieve Mobile Pavement Treatment Configuration	O	Yes No / NA	
		3.5.3.2.1	Retrieve Pavement Treatment Status	M	Yes NA	
		3.5.3.3.1	Retrieve Pavement Treatment Profile with Mobile Sources	O	Yes No / NA	
		3.5.3.4.1	Set PTS Operational Mode	O	Yes No / NA	
		3.5.3.4.2	Manually Activate PTS Sprayer	O	Yes No / NA	

SUPPLEMENT

Using RTM

RTM Entries That Support Requirements

Using Standard-Supplied Table Dialogs to Retrieve Data and Configure ESS

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.2.1.21	Manage Pavement Treatment System Metadata				
3.5.2.1.21.1	Retrieve Pavement Treatment System Metadata - Location	F.3.3.1			
			5.13.21	essPavementTreatmentLatitude	
			5.13.22	essPavementTreatmentLongitude	
			5.13.23	essPavementTreatmentLocation	
3.5.2.1.21.2	Retrieve Pavement Treatment Metadata - System Information	F.3.3.1			
			5.13.24	essPavementTreatmentModelInformation	
3.5.2.1.21.3	Configure Pavement Treatment System Metadata - Location	F.3.3.3			
			5.13.21	essPavementTreatmentLatitude	
			5.13.22	essPavementTreatmentLongitude	
			5.13.23	essPavementTreatmentLocation	

EXAMPLE

Using RTM

Steps to Achieve Conformance to Standard

1. Secure user need **support** by selecting **YES** in the PRL, making those requirements Mandatory.
2. RTM-identified **dialogs**, in proper sequence-order.
3. RTM-identified **objects** as allocated by the standard.
4. Both PRL and RTM are required for **Conformance** to the standard.

Implementations seeking to achieve **interoperability** must have selected same **user needs-requirements-dialogs-objects**.



ACTIVITY







Question

Which of the following is Not a correct statement as applied to communications interface specification?

Answer Choices

- a) Project PRL lists standardized user needs
- b) Only PRL is necessary for conformance to standard
- c) PRL lists optional user needs
- d) RTM provides complete design

Review of Answers

-  a) Project PRL lists standardized user needs
Correct statement. PRL lists ESS standardized user needs.
-  b) Only PRL is necessary for conformance to standard
Incorrect statement. Both PRL and RTM are needed to ensure conformance to the standard.
-  c) PRL lists optional user needs
Correct statement. PRL lists both optional and mandatory user needs; the specification must indicate support for Optional needs.
-  d) RTM provides complete design
Correct statement. RTM provides dialogs and objects in order to complete a message to the ESS device.

Learning Objectives

Review the **structure** of the standard

Use the **PRL** and **RTM** to specify requirements

Use the RTM to specify the **standardized design**

How to specify requirements **not covered** by the standard

Learning Objective 4

How to specify requirements
not covered by the standard

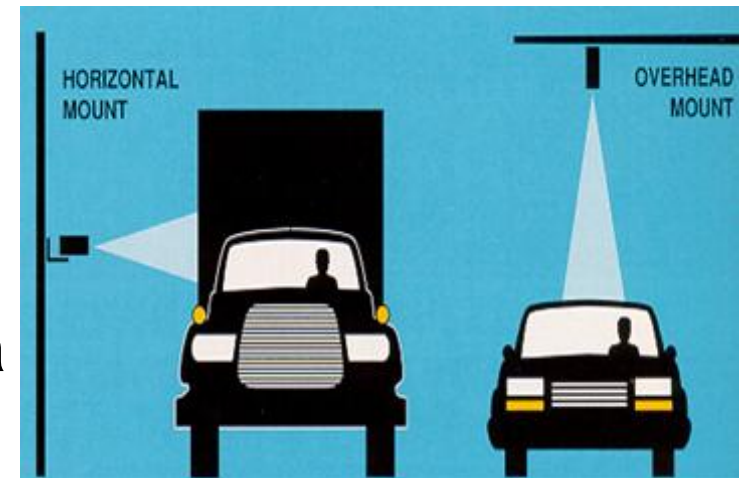
Context and Conditions for Extending the Standard

Context: When Do We Extend the Standard? Why?

- Current standard (v04) provides for common ESS requirements, including some newly added features
- However, there may be some features and requirements **specific** to a certain application not yet covered

Example of an Unmet User Need:

An agency may have a need for monitoring an over-height sensor at a tunnel entrance.



Source: FHWA

Context and Conditions for Extending the Standard

Conditions: What/How to Do It?

- Adding new objects (user needs) to ESS MIB is possible if it is documented and made available **to anyone** (agency, other vendors, developers)
- Agency must make sure that the vendor-supplied ESS design objects are based on ASN.1 format and the MIB structure
- Agency must specify a dialog and private objects in an approved RTM

Context and Conditions for Extending the Standard

Technical Conditions

- When a new requirement associates a design object, behavior of the device may be affected
- ASN.1 (Abstract Syntax Notation)-based Objects must support READ operation for retrieval and WRITE operation for control functions without restrictions
- Syntax must be a nonnegative Integer/Bytes
- Object must have an OID (Object ID) within the current MIB node
- Only Simple Network Management Protocol (SNMP) interface will be allowed (as per NTCIP 1103 rules)

Benefits and Drawbacks

Benefits of an Extension

- Allows procurers to use the NTCIP family of standards and still support operational or user needs not supported by the family
- New operational needs may emerge within a regional or corridor context, or new applications such as Connected Vehicles or Integrated Corridor Management (ICM); some flexibility is useful

Benefits and Drawbacks

Drawbacks of an Extension

- Other management stations that do not support the **new objects** will be unable to exercise the new capabilities
- Additional cost of (custom) integration, test procedures, and maintenance
- Vendor's reluctance to share features with other implementations
- Other potential unknown issues (bugs) typically are discovered in the implementation stage
- Private objects impact interoperability/interchangeability adversely and may have further impact on regional RWIS

ACTIVITY



Question

Which of the following is a Correct statement related to ESS extension?

Answer Choices

- a) Extension will be conformant to the ESS standard
- b) Extension will break regional RWIS interoperability
- c) ESS implementation with extensions is manageable
- d) Extension does not affect remote operation of ESS field devices

Review of Answers



a) Extension will be conformant to the ESS standard

Incorrect statement. A testing process is needed to prove that an extended implementation is conformant to the standard.



b) Extension will break regional RWIS interoperability

Correct statement. Extended design in one implementation will not be known to other deployments or versions; user needs and requirements may not be the same regionally.



c) ESS implementation with extensions is manageable

Incorrect statement. The additional cost of integration, test procedures, and maintenance will not be in best interest of agency.



d) Extension does not affect remote operation of ESS field devices

Incorrect statement. Remote operation by management stations are affected by extended implementation, and may result in local operation only.

Learning Objectives

Review the **structure** of the standard

Use the **PRL** and **RTM** to specify requirements

Use the RTM to specify the **standardized design**

How to specify requirements **not covered** by the standard

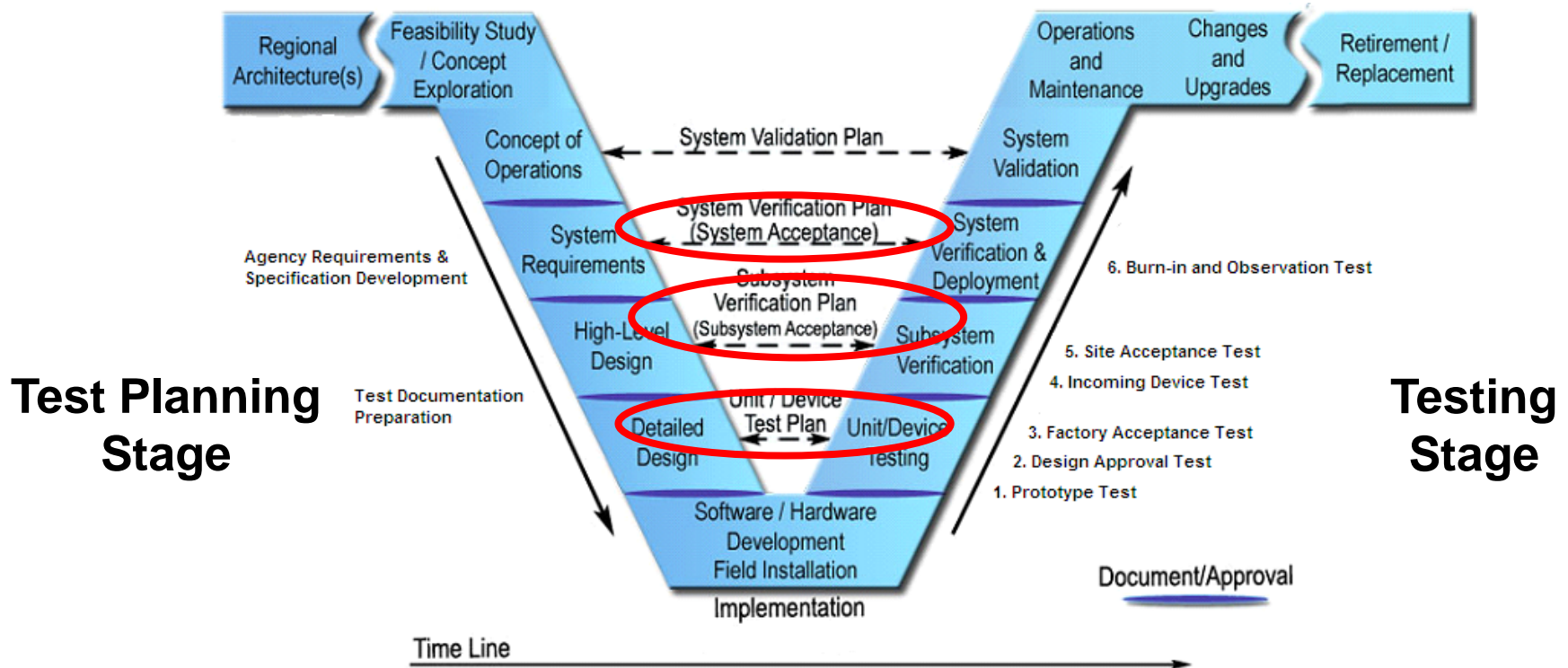
Infer the **relationship** between selecting requirements and testing

Learning Objective 5

Infer the **relationship**
between selecting
requirements and testing

Considerations for Testing

Testing for Validation of User Needs Testing for Verification of Requirements



Considerations for Testing

Relationship Between Selecting Requirements and Testing

- Test procedures are standardized in NTCIP 1204 v04, Annex C
- 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>

Module T313: Applying Your **Test Plan** to the ESS Systems Based on NTCIP 1204 v04 ESS Standard



Considerations for Testing

Specifications should include Test Procedures (Annex C) to verify requirements selected in PRL

C.2.3.1.3 Retrieve ESS Door Status

Test Case: 1.3	Title:	Retrieve ESS Door Status
	Description:	This test case verifies that the ESS allows a management station to determine whether any of the doors related to the ESS are open. ←
	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	Verify that all doors associated with the ESS are closed.	
2	GET the following object(s): »essDoorStatus.0	Pass / Fail (Sec. 3.5.1.2.1)
3	VERIFY that the RESPONSE VALUE for essDoorStatus.0 is equal to 0.	Pass / Fail (Sec. 5.3.2)
4	Open at least one door associated with the ESS	
5	GET the following object(s): »essDoorStatus.0	Pass / Fail (Sec. 3.5.1.2.1)
6	VERIFY that the RESPONSE VALUE for essDoorStatus.0 is equal to 1.	Pass / Fail (Sec. 5.3.2)
7	Return all doors to their original state.	

Test Case Results

Tested By:	Date Tested:	Pass / Fail
-------------------	---------------------	--------------------

Test Case Notes:



EXAMPLE

ACTIVITY



Question

Which is Not a correct statement as applied to ESS Testing?

Answer Choices

- a) Test procedures connect requirements to testing steps
- b) NTCIP 1204 v04 standard provides test procedures
- c) Test plan documentation includes test procedures
- d) Test planning is done at the testing stage

Review of Answers



a) Test procedures connect requirements to testing steps

The statement is true. Steps to testing are listed in test procedures.



b) NTCIP 1204 v04 standard provides test procedures

The statement is true. Test procedures are provided by v04.



c) Test Plan documentation includes test procedures

The statement is true. The ESS Test Plan does include test procedures.



d) Test planning is done at the testing stage

False. This statement is incorrect. Test planning occurs at the early stage of user needs/requirements setting, not at a later stage.

Module Summary

Review the **structure** of the standard

Use the **PRL** and **RTM** to specify requirements

Use the RTM to specify the **standardized design**

How to specify requirements **not covered** by the standard

Infer the **relationship** between selecting requirements and testing

We Have Now Completed A313a and A313b in the ESS Curriculum



Module A313a: Understanding **User Needs** for ESS Systems Based on NTCIP 1204 v04 ESS Standard



Module A313b: Specifying **Requirements** for ESS Systems Based on NTCIP 1204 v04 ESS Standard

Module T313: Applying Your **Test Plan** to the ESS Systems Based on NTCIP 1204 v04 ESS Standard

Next Course Module

Module T313: Applying Your Test Plan to the ESS Systems Bon NTCIP 1204 v04 ESS Standard

Concepts taught in next module (Learning Objectives):

- 1) Describe within the context of the testing lifecycle the role of test plans and the testing to be undertaken
- 2) Identify key elements of NTCIP 1204 v04 relevant to the test plan
- 3) Describe the application of a good test plan to an ESS system being procured
- 4) Describe the testing of an ESS using standard procedures

Thank you for completing this module.

Feedback

Please use the Feedback link below to provide us with your thoughts and comments about the value of the training.

Thank you!