



W E L C O M E

RITA Intelligent Transportation Systems
Joint Program Office

Welcome



Ken Leonard, Director
ITS Joint Program Office
Ken.Leonard@dot.gov

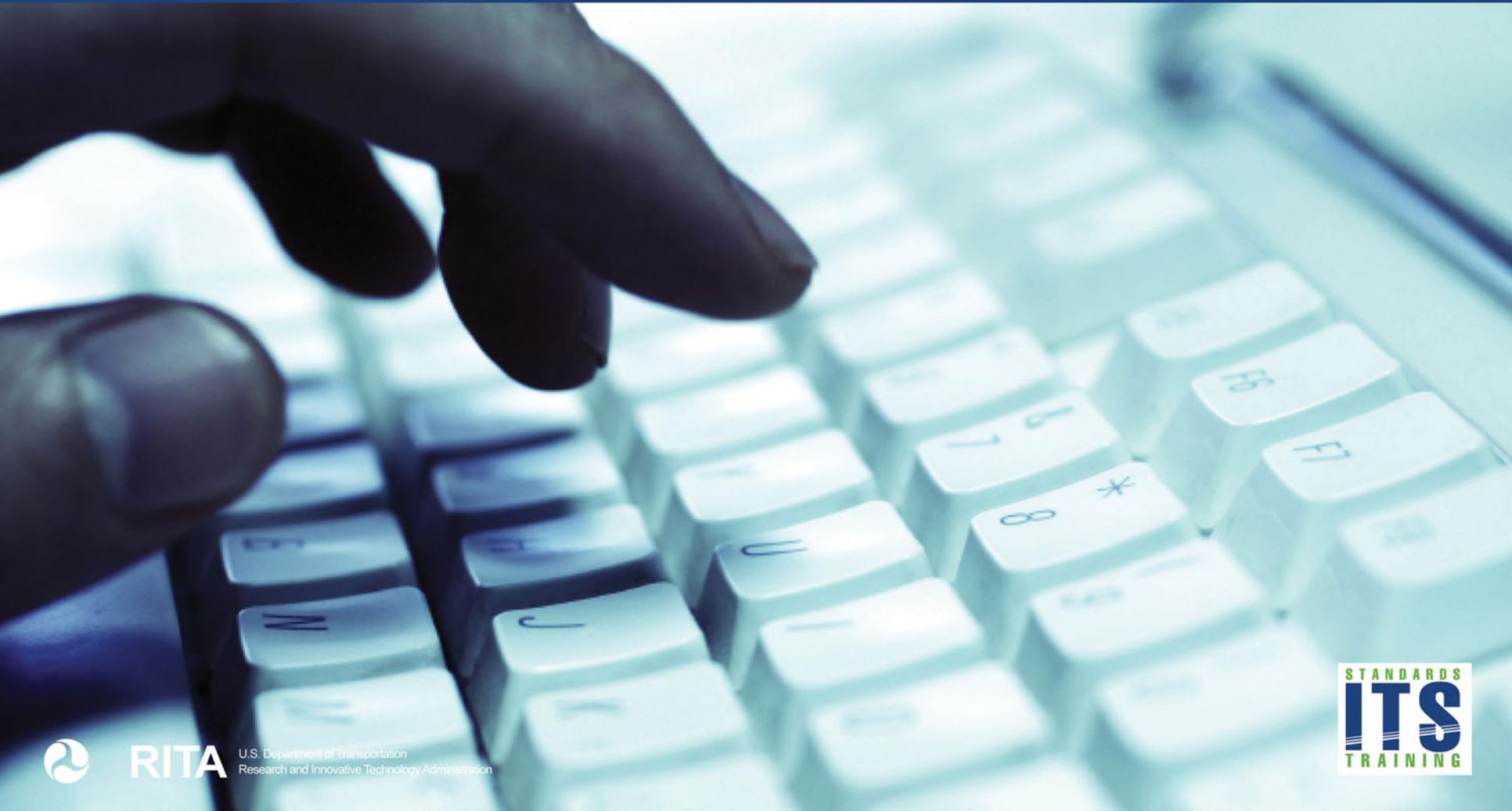
The screenshot shows the RITA website for the ITS Professional Capacity Building Program. The header includes the RITA logo and the text "U.S. Department of Transportation Research and Innovative Technology Administration". Below the header, it says "Intelligent Transportation Systems Joint Program Office" and "ITS Professional Capacity Building Program / Advancing ITS Education". The main content area features a large banner with the text "Welcome to ITS Professional Capacity Building" and "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." To the right of the banner is a "What's New" section with a list of recent events: "March 18, 2013: Upcoming T3 Webinar: Smart Traffic Management: Lessons from New York City's Midtown in Motion Project (4/18/13)", "Starting February 15, 2013: Several training opportunities are available from the Consortium for ITS Training and Education", and "February 2, 2013: So You Think You Can T3? Send us your T3 Webinar idea!". Below the banner are three columns of content: "Available E-Training (free)" listing various web courses and blended training; "Free ITS Training" with a sub-section for "Free ITS Training! Achieve Your ITS Learning Needs" listing web-based and blended courses, standards training, upcoming webinars, and a webinar archive; and "T3 Webinars" with a sub-section for "Free ITS Technical Assistance!" open to state and local agencies and FHWA Field Offices, including a peer-to-peer program and a help line.

www.pcb.its.dot.gov





ACTIVITY



RITA

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





**A304b:
Specifying Requirements for
Field Management Stations – Part 1
Object Definitions for Signal System Masters (SSM)
Based on NTCIP 1210 Standard**



Instructor



Patrick Chan, P.E.

Senior Technical Staff
Consensus Systems Technologies
(ConSysTec)
Flushing, NY, USA

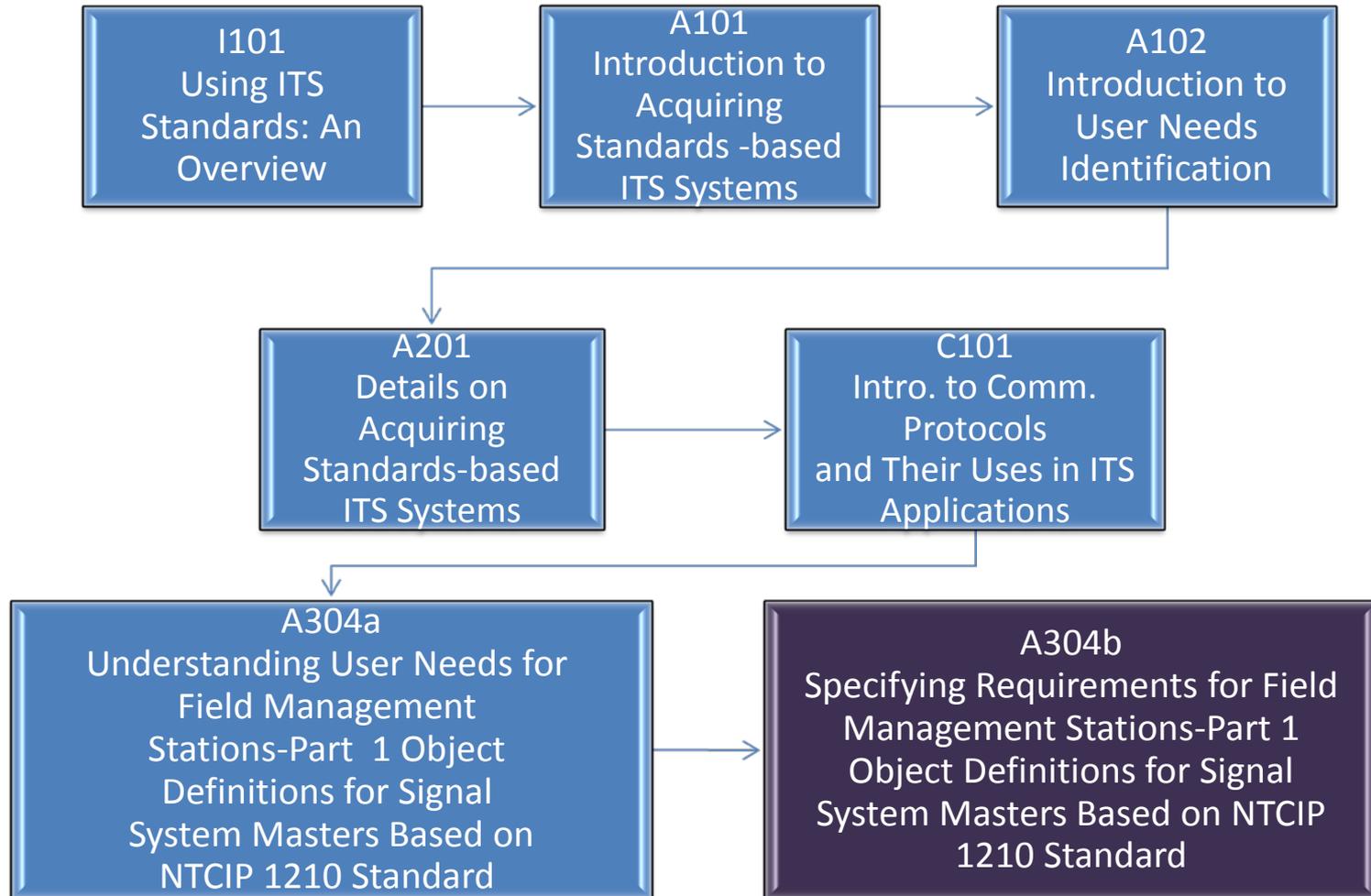


Target Audience

- Traffic engineering staff
- Traffic Management Center (TMC)/Operations staff
- System developers
- Private and public sector users including manufacturers



Curriculum Path (SEP)





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
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications
- A304a: Understanding User Needs for Field Management Stations – Part 1 Object Definitions for Signal System Masters Based on NTCIP 1210 Standard





Learning Objectives

1. Describe requirements included in NTCIP 1210
2. Use the Protocol Requirements List (PRL) to specify an NTCIP Signal System Master (SSM) interface
3. Achieve interoperability and interchangeability using the Requirements Traceability Matrix (RTM)
4. Understand the NTCIP 1210 SNMP interface and dialogs
5. Incorporate requirements not covered by the standard

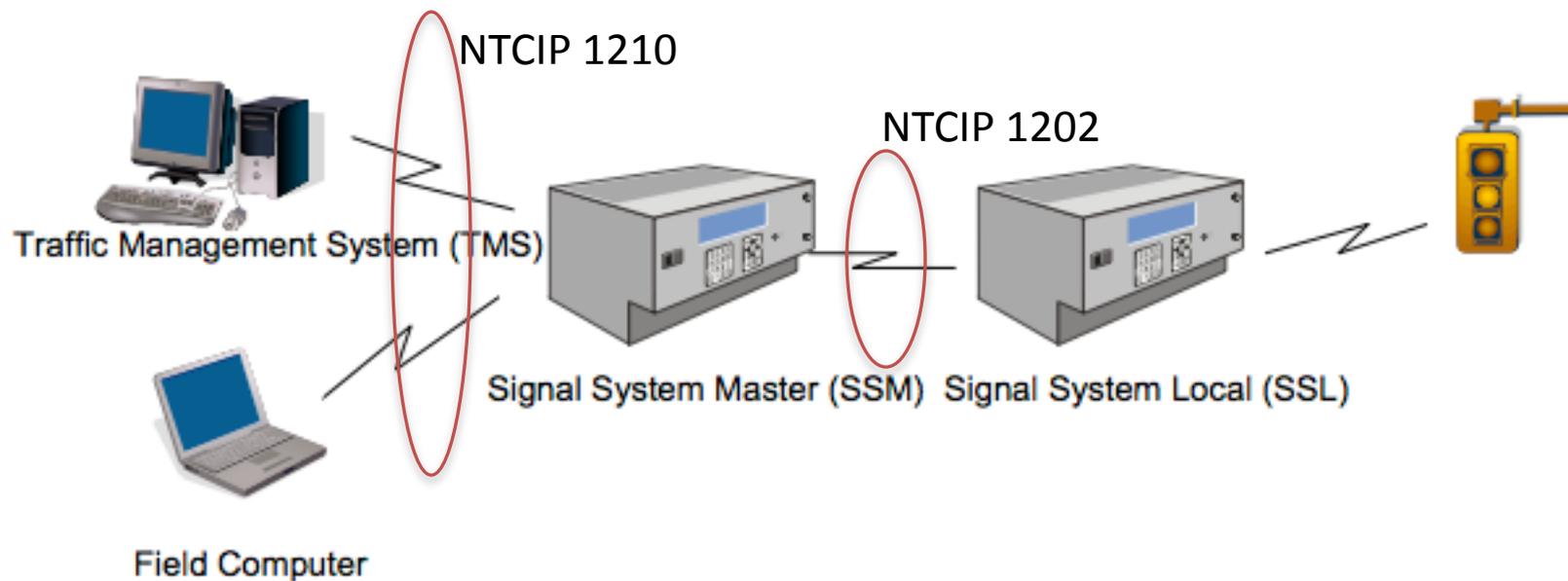


Learning Objective #1 — Describe the requirements in NTCIP 1210

- Review components and structure of NTCIP 1210
- Use the PRL to trace from user needs to requirements
- Organization and decomposition of requirements of NTCIP 1210

NTCIP 1210

Typical Physical Architecture



Source: NTCIP 1210, Fig. 3, Pg: 13



RITA

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



History of NTCIP 1210

Version 1: v01.53 is the “ballot ready version”

- Was recently approved
- Has not yet been deployed
 - Early deployments often reveal issues with standard
 - Some potential issues have been discovered and are addressed in this course
 - Those deploying equipment should seek assistance and coordinate with others

Structure of the Standard

Outline

- Section 1: General
- Section 2: Concept of Operations (ConOps)
- Section 3: Functional Requirements
- Section 4: Dialog Specifications
- Section 5: Signal System Master Object Definitions
- Section 6: SSM Block Object Definitions
- Annex A: Requirements Traceability Matrix
- Annex B: SSM Device and Information Profile
- Annex C: SSM Control Hierarchy

Structure of the Standard

Missing Components of NTCIP 1210

- Does not include test cases
 - Need to be produced for your project

Use the PRL to Trace User Needs to Requirements

- PRL introduced in Module A304a to select user needs
- Now, use the PRL to select functional requirements

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	

Use the PRL to Trace User Needs to Requirements

- First column identifies the clause of the user need
- Second column provides the name of the user need

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	

User Need Definition

2.5.1.1 Configure Cycle Timers and Unit Backup Time

The system owner needs to be able to determine the capabilities of the SSM. The system owner may need to configure the SSM to operate cycle timers for synchronizing the SSLs directly using a sync pulse.

Source: NTCIP 1210, Page 17

Use the PRL to Trace User Needs to Requirements

- Third column identifies the clause of the requirement
- Fourth column provides the name of the requirement
- Traceability is shown by hierarchical presentation

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	

Requirement Text

3.4.2.2.1 Determine SSLs Currently Connected

The SSM shall allow a TMS to determine the SSLs currently connected to the SSM.

3.4.2.2.4.1 Configure Cycle Timer Reference

The SSM shall allow the TMS to configure the specific time-of-day used for calculation of the cycle timers from the SSM.

Source: NTCIP 1210, Page 38

SSM Requirements are Well Formed

[Actor] [Action] [Target] [Constraint] [Localization]

- **Actor** – Identifies who or what that does the action
- **Action** – Identifies what is to happen
- **Target** – Identifies who or what receives the action
- Optional
 - **Constraint** – Identifies how to measure success or failure of the requirement
 - **Localization** – Identifies the circumstances under which the requirement applies

Example SSM Requirement

[Actor] [Action] [Target] [Constraint] [Localization]

Target Actor Action Target

The SSM shall allow a TMS to determine the SSLs currently connected to the SSM.

Constraint

Source: NTCIP 1210, Page 38



RITA

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



Outline of Requirements

3.3 Operational Requirements

3.3.1 Support Basic Communications

3.3.2 Support Logged Event Data

3.3.3 Manage Access



Outline of Requirements

3.4 Data Exchange Requirements

3.4.1 Collect System Detector Data

3.4.2 Manage the SSM Configuration

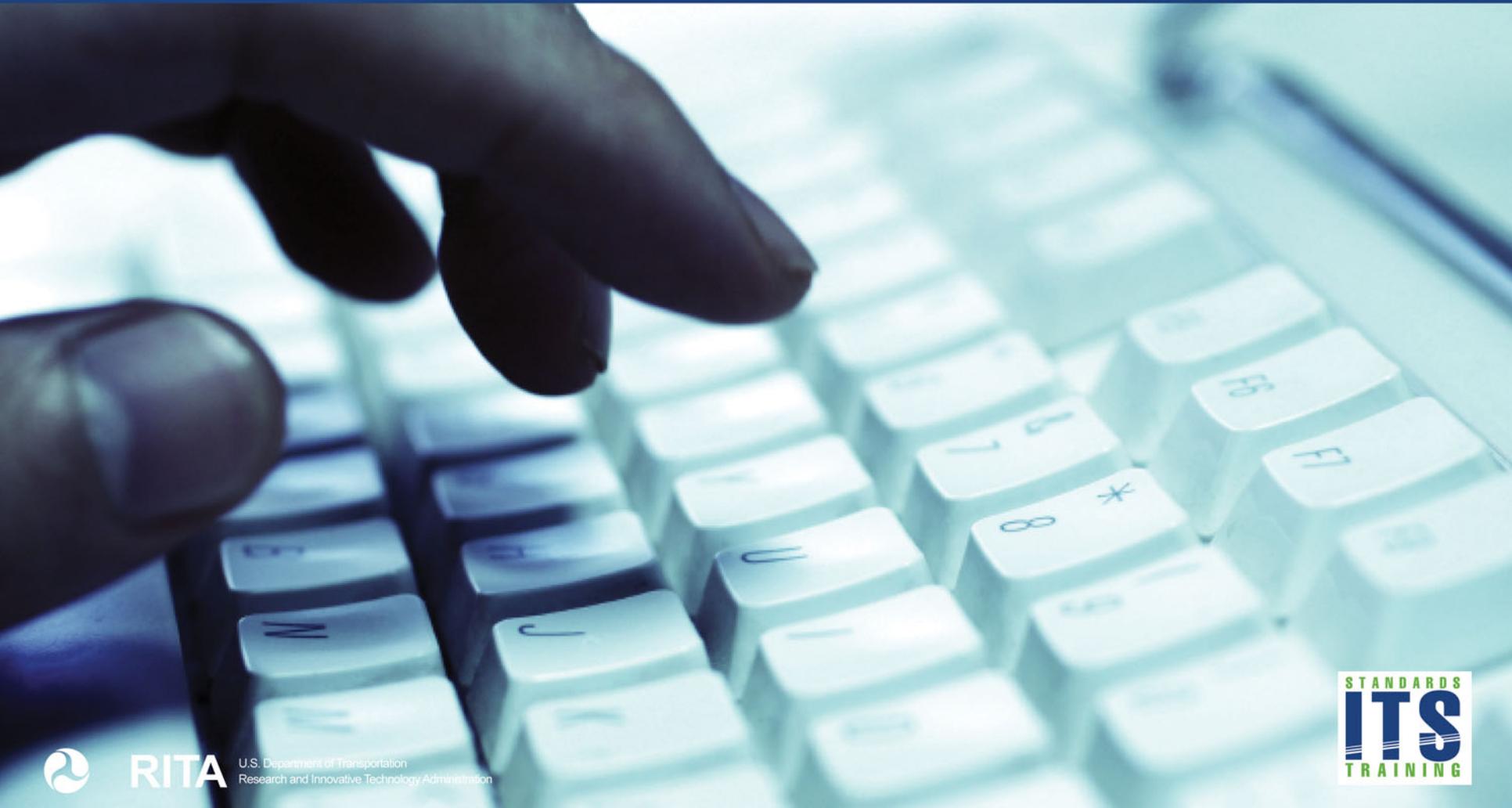
3.4.3 Manage the System Timing Plans

3.4.4 Monitor the SSM Operation

NOTE: Version 1 standards do not have standardized backwards compatibility issues



ACTIVITY



RITA

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



Which of the following is **not** a major group of requirements in NTCIP 1210?

See Student Supplement for PRL

Answer Choices

- a) Collect System Detector Data
- b) Manage SSM Configuration
- c) Monitor the SSM Operation
- d) Backwards Compatibility Requirements

Review of answers



a) Collect System Detector Data

Incorrect; these requirements provide for configuring and monitoring system detectors.



b) Manage SSM Configuration

Incorrect; these requirements allow monitoring and adjusting the configuration of the SSM.



c) Monitor the SSM Operation

Incorrect; these requirements provide for monitoring alarms and device status.



d) Backwards Compatibility Requirements

Correct! This is the first version of NTCIP 1210 and therefore there are no backwards compatibility requirements.



Summary of Learning Objective #1

Describe the requirements in NTCIP 1210

- Review components and structure of NTCIP 1210
- Use the PRL to trace user needs to requirements
- Organization and decomposition of requirements of NTCIP 1210





Learning Objective #2—Use the PRL to Specify an SSM Interface

- Use of optional requirements, constraints, and predicates within the PRL
- Specify performance criteria for functional requirements within the PRL
- Use the PRL in a specification

Conformance

- “M” indicates mandatory within the defined context
- “O” indicates optional

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	

Conformance

Option Groups

- “O” = Optional
- “.1” = part of first option group
- “(1..*)” = One or more options from group required

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.5.2	Configure Threshold Selection			O.1 (1..*)	Yes / No	
2.5.1.2.5.3	Configure Signature Selection			O.1 (1..*)	Yes / No	

Conformance

Conditional Conformance

- Predicates are defined prior to the PRL
- If the predicate is supported, the conformance statement applies

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.1.2	Failed System Detectors			M	Yes	
		3.4.4.1.4.2	Failed System Detectors for Threshold Selection of Timing Plans	Threshold:M	Yes / No	
		3.4.4.1.4.3	Failed System Detectors for Signature Selection of Timing Plans	Signature:M	Yes / No	

Conformance

Support

- “Support” column indicates
 - What is required in a procurement, or
 - What a device supports

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	

Additional Specifications

Fill in the Blanks

- “Additional Specifications” column indicates other items that need to be specified
 - Requirements = standardized text
 - Specifications = project text

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.3.1.2	Deliver Data to the TMS	M	Yes	The Response Start Time for all requests shall not be greater than <u>500</u> ms (Default = 2000)

Additional Specifications

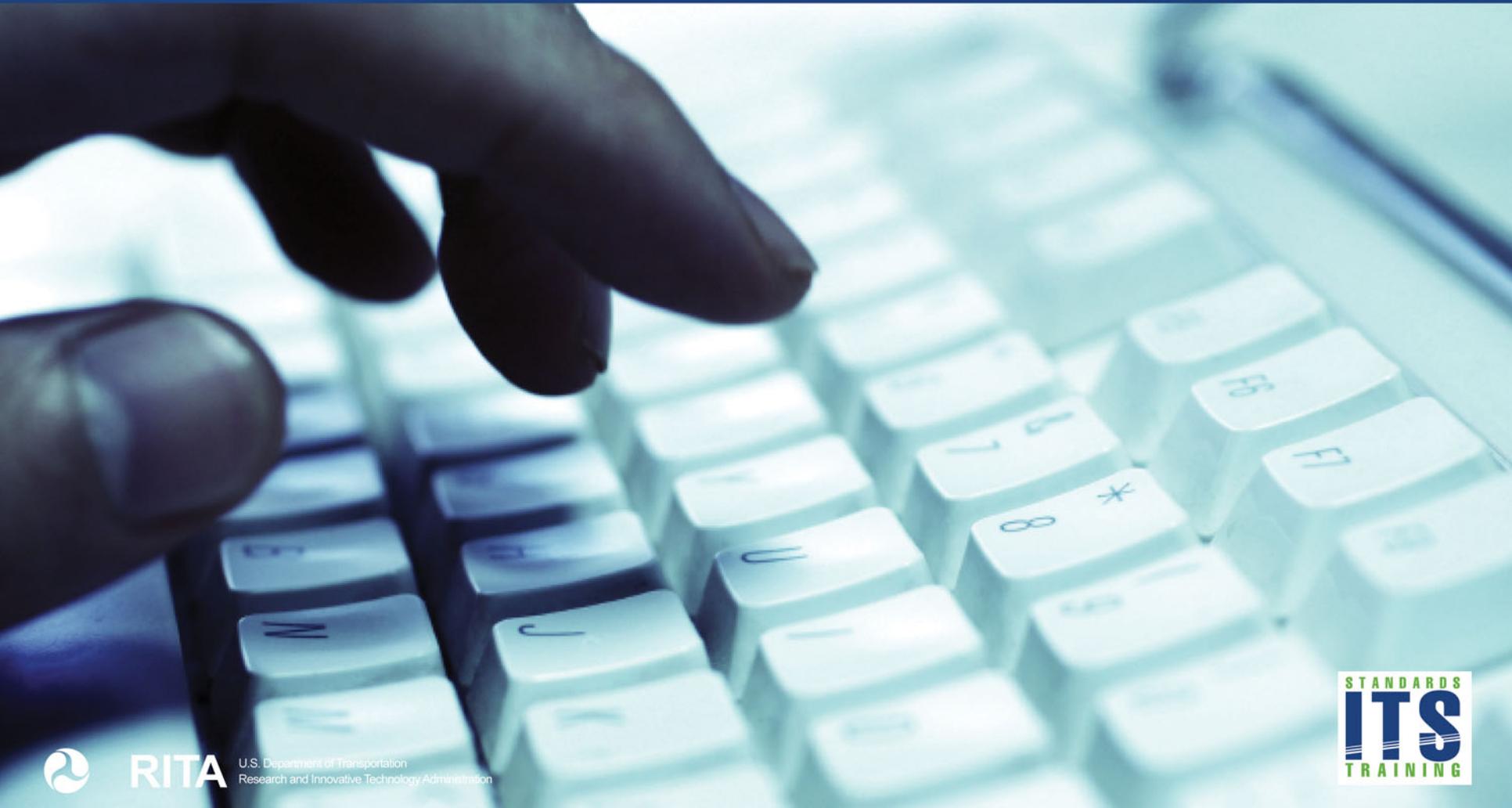
Participant Student Supplement

- Standard allows projects to add custom specifications
- **See Participant Student Supplement**
 - Listing of potential issues
 - Sample specifications to address these issues

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.3.3.2	Configure Access	M	Yes	<i>The SSM shall support at least 3 access levels in addition to the administrat or access level.</i>



ACTIVITY



RITA

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



Where is a list of potential issues and sample specifications to consider for NTCIP 1210 deployments?

Answer Choices

- a) In the User Needs Section of the standard
- b) In the Requirements Section of the standard
- c) In the Participant Student Supplement
- d) A and B

Review of answers



a) In the text of the User Needs Section

Incorrect; user needs only define potential needs of stakeholders.



b) In the text of the Requirements Section

Incorrect; requirements give little to no guidance on additional specifications.



c) In the Participant Student Supplement

Correct! The Student Supplement contains a list of potential issues coupled with sample specifications that may be used.



d) A and B

Incorrect; This information is not contained in either of these sections.

CASE STUDY



RITA

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



Use the PRL in a Specification

Sample Project to Deploy SSMs

Suburbanville wants to upgrade its old closed-loop system so that it supports ITS standards. They want:

- Regional masters to control normal operations
- To be able to monitor detailed operations of local controllers when needed
- Time-of-day pattern selection
- Signature selection for traffic responsive operation
- Instant notification of unusual traffic conditions

Use the PRL in a Specification

General Clauses

- Require support of all values for all NTCIP objects, unless otherwise noted
 - Specific range specifications are discussed on following slides
- Define “Response Start Time”
- Include a “filled-out” version of the PRL

See example in the Participant Student Supplement



Use the PRL in a Specification

Provide Live Data

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4.1	Provide Live Data			M	Yes	
		3.3.1.1	Accept Data from the TMS	M	Yes	
		3.3.1.2	Deliver Data to the TMS	M	Yes	The Response Start Time for all requests shall be not greater than <u>500</u> ms (Default 2000).
		3.3.1.3	Explore SSM Data by the TMS	M	Yes	The Response Start Time for all requests shall be not greater than <u>500</u> ms.
		3.3.3.1	Determine Access Settings	M	Yes	
		3.3.3.2	Configure Access	M	Yes	<i>The SSM shall support at least <u>3</u> access levels in addition to the administrator access level.</i>

Use the PRL in a Specification

Provide Off-line Logged Data

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4.2	Provide Off-line Logged Data			M	Yes	
		3.3.2.1	Determine Current Configuration of Event Logging Service	M	Yes	
		3.3.2.2	Configure Event Logging Service	M	Yes	<i>See following slides</i>
		3.3.2.3	Retrieve Event Logged Data	M	Yes	
		3.3.2.4	Clear Event Log	M	Yes	
		3.3.2.5	Determine Capabilities of Event Logging Service	M	Yes	

Structure of Off-line Logged Data

Example of What Needs to be Logged

Example: Record pattern number every time it changes for any section

- When did the event occur?
- What timing pattern was selected?
- What section was affected?
- How do I retrieve the data?

Number	ID	Time	Value
1	5	2013-01-01 00:00:00	16
2	3	2013-01-01 00:00:00	5

Structure of Off-line Logged Data

Example of What Needs to be Logged

Example: Record all changes in communication status

- When did the event occur?
- What is the new status?
- What intersection changed?
- How do I retrieve the data?

Number	ID	Time	Value
1	27	2012-12-30 16:30:21	responding
2	27	2012-12-30 11:05:18	notResponding

Structure of Off-line Logged Data

May Want to Segregate Types of Events

Event Log Table

Class	Number	ID	Time	Value
1	1	27	2012-12-30 16:30:21	responding
1	2	27	2012-12-30 11:05:18	notResponding
2	1	5	2013-01-01 00:00:00	16
2	2	3	2013-01-01 00:00:00	5

Event Log Configuration

What Needs to be Specified?

Class	Number	ID	Time	Value
1	1	27	2012-12-30 16:30:21	responding
1	2	27	2012-12-30 11:05:18	notResponding
2	1	5	2013-01-01 00:00:00	16
2	2	3	2013-01-01 00:00:00	5

- How many event classes do I need?
- How many event types (IDs) do I need?
- How many events should be stored per event class?
- Which objects should the controller be able to monitor?

Event Log Configuration

What Types of Events?

- On change
 - When the object value changes
- Greater than (Less than)
 - When value first goes above (below) reference
- Hysteresis
 - When value goes above maximum or below minimum
- Periodic
 - Every “x” seconds
- Bitwise “and” logic
 - When value can be “ANDed” with reference and result is non-zero



Use the PRL in a Specification

Connect Communication Networks

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4.3	Connect Communication Networks			M	Yes	
		3.3.1.4	Accept Data from the SSLs	M	Yes	
		3.3.1.5	Deliver Data to the SSLs	M	Yes	
		3.3.1.6	Explore SSL Data by the TMS	M	Yes	
		3.3.1.7	TMS Acceptance of Data fr SSL	M	Yes	
		3.3.1.8	TMS Delivery of Data to SSL	M	Yes	
		3.3.3.1	Determine Access Settings	M	Yes	
		3.3.3.2	Configure Access	M	Yes	

See Participant Student Supplement for discussion of potential issues and three possible solutions that could be added to your specification.

Use the PRL in a Specification

Support Legacy Communication Networks

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4.4	Support Legacy Communication Networks			O	Yes / No	
		3.3.1.9.1	Configure Using Block Objects	M	Yes	
		3.3.1.9.2	Retrieve Block Objects	M	Yes	
		3.3.1.9.3	Retrieve Block Status	M	Yes	
		3.3.1.9.4	Support STMP	O	Yes / No	

Use the PRL in a Specification

Configure Cycle Timers and Unit Backup Time

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	
		3.4.2.2.2	Determine Pattern Selection Capabilities	M	Yes	
		3.4.2.2.3	Determine SSM Section Characteristics	M	Yes	
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	
		3.4.2.2.4.2	Determine Cycle Timer Capability	O	Yes / No	
		3.4.2.2.5	Determine SSM Software Version	M	Yes	
		3.4.3.7.4	Sync SSL by Direct Command	O	Yes / No	



Use the PRL in a Specification

Configure Cycle Timers and Unit Backup Time

- Sync Pulse
 - Issued at start of every cycle
 - Issued by SSM
 - Used when local clocks are not accurate

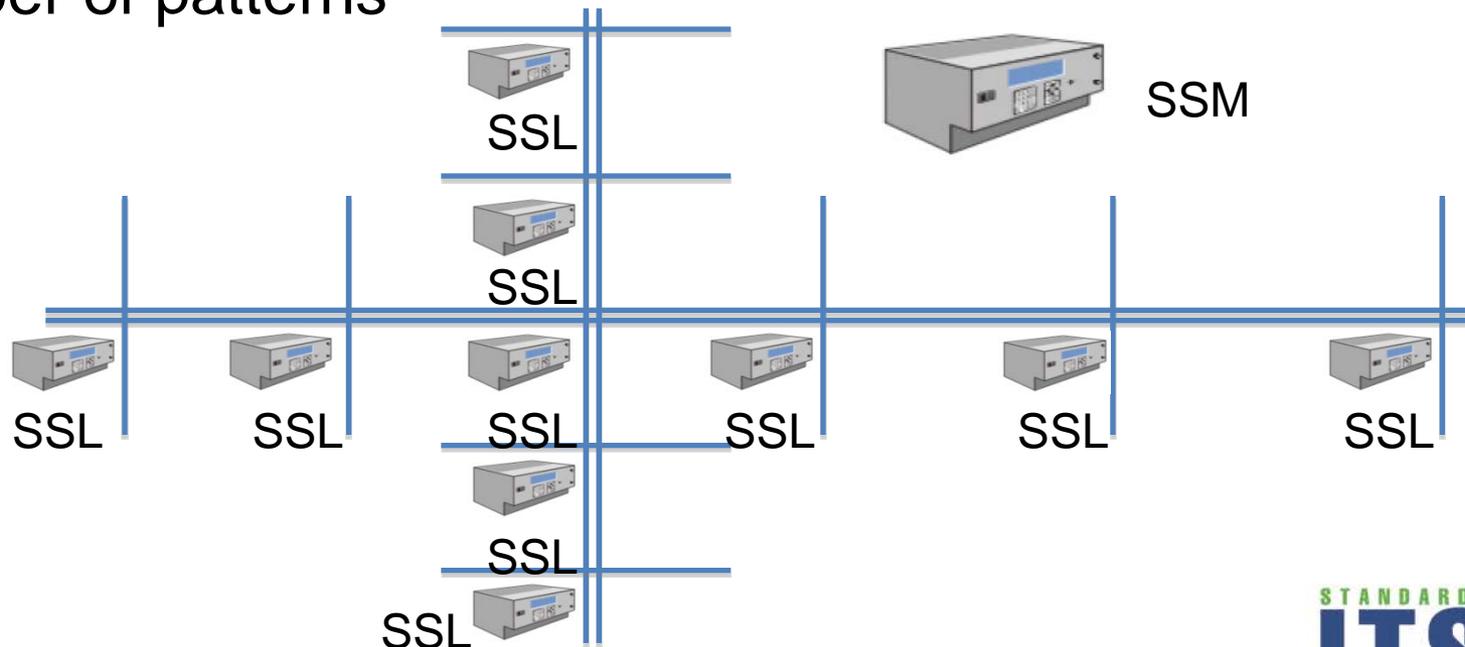
- Clock synchronization
 - Typically synchronized once a day
 - Can use any common time source (GPS, WWV, etc.)
 - Typical for modern controllers

Use the PRL in a Specification

Configure Cycle Timers and Unit Backup Time

Need to define range specifications for:

- Number of sections
- Number of SSLs
- Number of patterns



Use the PRL in a Specification

Configure Cycle Timers and Unit Backup Time

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	
		3.4.2.2.1	Determine SSLs Currently Connected	M	Yes	<i>The SSM shall support at least 16 SSLs</i>
		3.4.2.2.2	Determine Pattern Selection Capabilities	M	Yes	<i>The SSM shall support at least 3 patterns for each section</i>
		3.4.2.2.3	Determine SSM Section Characteristics	M	Yes	<i>The SSM shall support at least 3 sections.</i>
		3.4.2.2.4.1	Configure Cycle Timer Reference	O	Yes / No	
		3.4.2.2.4.2	Determine Cycle Timer Capability	O	Yes / No	
		3.4.2.2.5	Determine SSM Software Version	M	Yes	
		3.4.3.7.4	Sync SSL by Direct Command	O	Yes / No	

Use the PRL in a Specification

Manage Section Definition Set

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.1	Manage Section Definition Set			M	Yes	
		3.4.3.1.1	Configure Section Assignment	M	Yes	
		3.4.3.1.2	Retrieve Section Assignment	M	Yes	
		3.4.3.1.3	Configure Section Characteristics	M	Yes	

Use the PRL in a Specification

Implement a Manually Selected Plan

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.2	Implement a Manually Selected Plan			M	Yes	
		3.4.3.3	TMS Override of Plan Selection	M	Yes	



Use the PRL in a Specification

Implement Plan Based on TMS Command

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.3	Implement Plan Based on TMS Command			M	Yes	
		3.4.3.6.1	TMS Override of SSM Algorithm of Timebase Timing Plan	M	Yes	
		3.4.3.6.2	SSM Instruct SSLs to Engage TMS Timing Plan	M	Yes	
		3.4.3.6.3	Set Maximum Time Without TMS Control	M	Yes	



Use the PRL in a Specification

Implement Plan Based on Timebase Schedule

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.4	Implement Plan Based on Timebase Schedule			M	Yes	
		3.4.2.1	Synchronize SSM Clock with TMS	M	Yes	
		3.4.3.4	Configure SSM Schedule	M	Yes	
		3.4.3.6.2	SSM Instruct SSLs to Engage TMS Timing Plan	M	Yes	



Timebase Schedule

Number of Timebase Schedule Entries

Number	Month	Day	Date	Day Plan
1	All	M-F	All	1
2	All	S-S	All	2
3	Jan	All	1	3
4	Dec	Fri	31	3
5	Jan	Mon	2	3
6	Jan	Mon	15-21	3
...
17	Dec	M-F	All	4
18	Dec	S-S	All	5

Timebase Schedule

Number of Day Plans and Day Plan Events

Number	Event #	Hour	Minute	Action
1	1	05	00	1
1	2	10	00	2
1	3	15	00	3
1	4	16	00	4
1	5	22	00	5
...

Timebase Schedule

Number of SSM Actions and Action Tasks

Number	Task Number	Task Section	Pattern Enable	Pattern	Special Function Enable	Special Function
1	1	1 & 2	enabled	1	notEnabled	0
2	1	1	enabled	2	notEnabled	0
2	2	2	notEnabled	0	notEnabled	0
3	1	2	enabled	3	notEnabled	0
4	1	1	enabled	3	notEnabled	0



Structure of Off-line Logged Data

Local Time and Daylight Savings

Local time determined by:

- Global Time, in Coordinated Universal Time (UTC)
- Standard time zone
- Daylight savings mode (configurable)
 - 2nd Sunday in March to 1st Sunday in November
 - 2 a.m. local time

Number	BeginMonth	BeginOccur	BeginDoW	BeginDoM	BeginSecs
1	March	Second	Sunday	1	7200
EndMonth	EndOccur	EndDoW	EndDoM	EndSecs	Adjust
November	First	Sunday	1	7200	3600

Use the PRL in a Specification

Implement Plan Based on Timebase Schedule

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.4	Implement Plan Based on Timebase Schedule			M	Yes	
		3.4.2.1	Synchronize SSM Clock with TMS	M	Yes	
		3.4.3.4	Configure SSM Schedule	M	Yes	<i>The SSM shall support at least 32 Timebase Table entries, 8 day plans, 8 events per day plan, 32 SSM Actions in the action table with 4 events per action, and one daylight savings schedule.</i>
		3.4.3.6.2	SSM Instruct SSLs to Engage TMS Timing Plan	M	Yes	



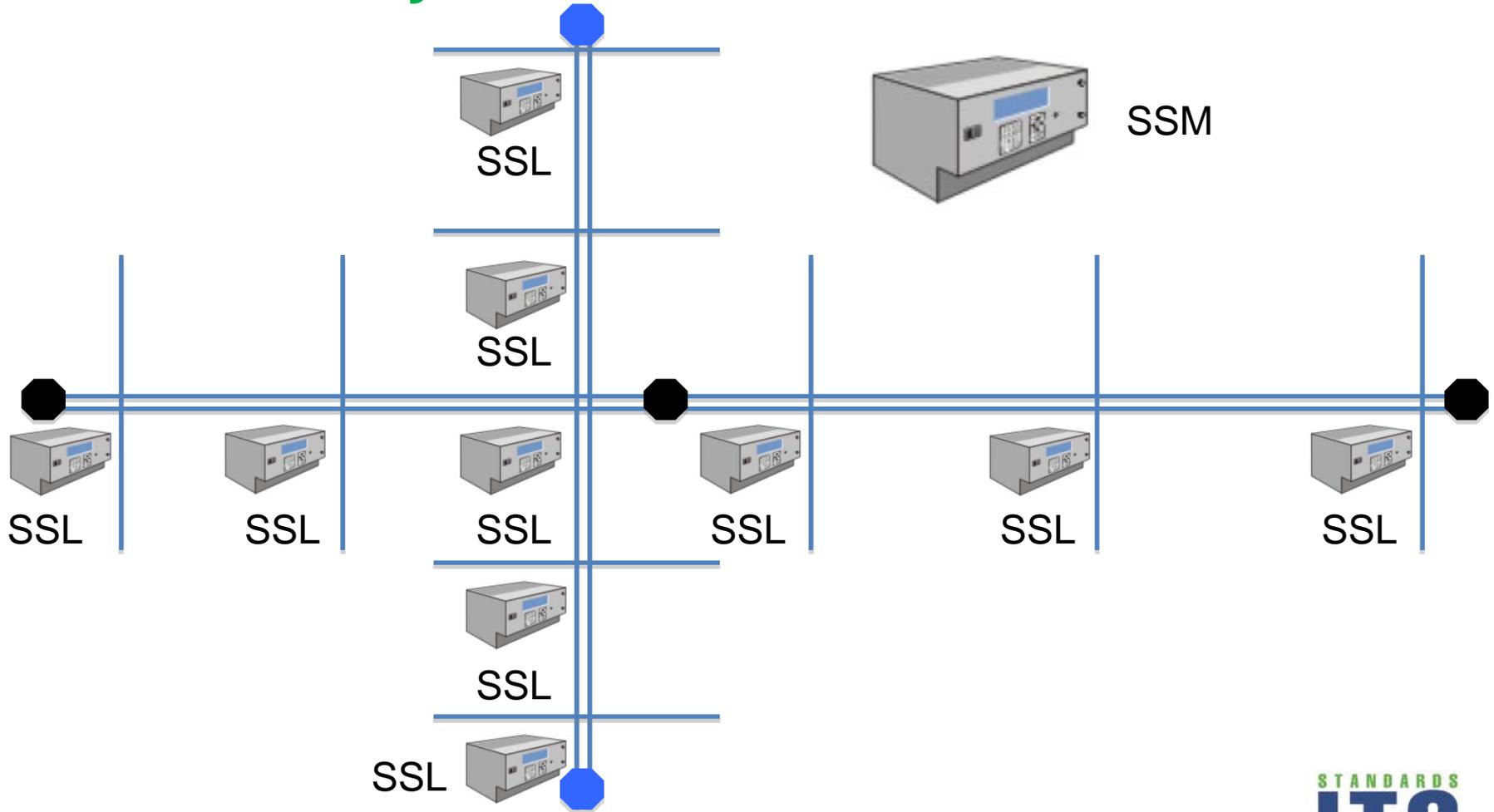
Use the PRL in a Specification

Configure Traffic Responsive Mode

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.5.1	Configure Traffic Responsive Mode			M	Yes	
		3.4.1.1	Assign System Detectors	M	Yes	
		3.4.3.5.1	Select Algorithm	M	Yes	
		3.4.3.5.2	Accept Pattern Selection Frequency	M	Yes	
		3.4.3.5.3.8	Instruct SSLs to Engage Threshold Timing Plan	M	Yes	

Configure Traffic Responsive Mode

Number of System Detectors



Use the PRL in a Specification

Configure Traffic Responsive Mode

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.5.1	Configure Traffic Responsive Mode			M	Yes	
		3.4.1.1	Assign System Detectors	M	Yes	<i>The SSM shall support at least 8 system detectors.</i>
		3.4.3.5.1	Select Algorithm	M	Yes	
		3.4.3.5.2	Accept Pattern Selection Frequency	M	Yes	
		3.4.3.5.3.8	Instruct SSLs to Engage Threshold Timing Plan	M	Yes	

Use the PRL in a Specification

Configure Threshold Selection

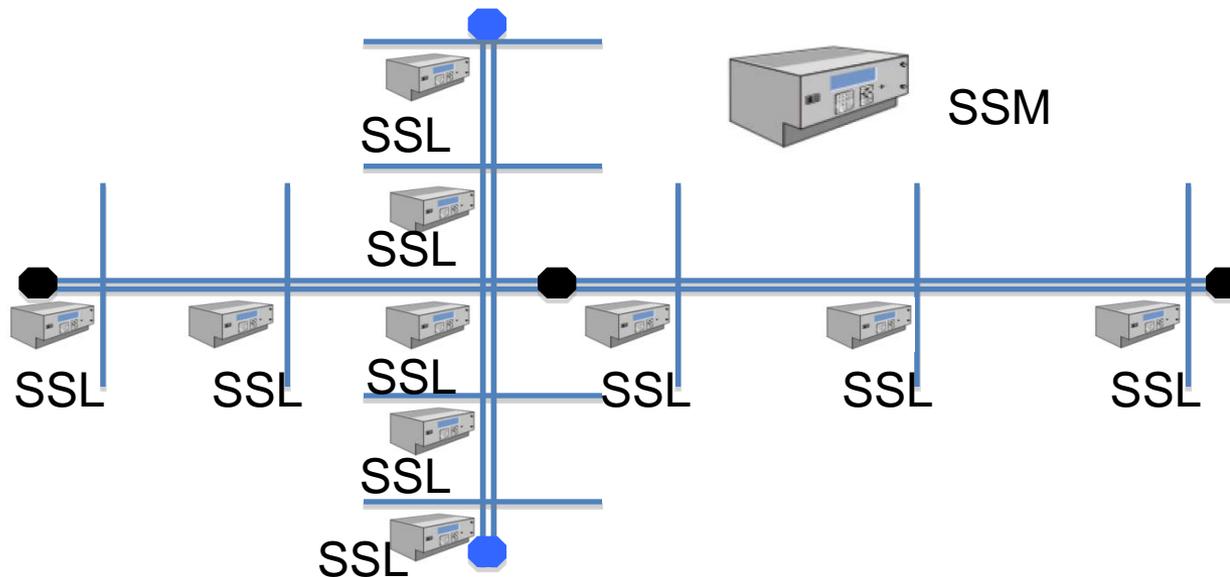
UN ID	UN	FR ID	Functional Requirement	Conform	Support	Additional Specifications
2.5.1.2.5.2			Configure Threshold Selection	O.1 (1..*)	Yes / No	
		3.4.1.2	Configure Detector Grouping	M	Yes	
		3.4.1.3	Configure Group Smooth	M	Yes	
		3.4.1.4	Configure Override Smoothing	M	Yes	
		3.4.1.5	Configure Minimum Samples	M	Yes	
		3.4.1.6	Configure Avg or Highest Value	M	Yes	
		3.4.3.5.3.1	Config Directional Thresholds	M	Yes	
		3.4.3.5.3.2	Configure Cycle Thresholds	M	Yes	
		3.4.3.5.3.3	Configure Split Thresholds	M	Yes	
		3.4.3.5.3.4	Configure Minimum Detectors	M	Yes	
		3.4.3.5.3.5	Configure Queue Thresholds	O	Yes / No	
		3.4.3.5.3.6	Config Occupancy Thresholds	O	Yes / No	
		3.4.3.5.3.7	Config Non-Arterial Thresholds	O	Yes / No	
		3.4.3.5.3.8	Instruct SSLs to Engage Plan	M	Yes	



Configure Threshold Selection

Range Specifications

- Number of Detectors per Group
- Number of Levels in Cycle Threshold Channel
- Number of Levels in Split Threshold Channel
- Number of Levels in Offset Threshold Channel



Configure Threshold Selection Options

- May be concerned about traffic backups
 - Queue detector override option
 - Occupancy detector override option
 - Non-arterial detector override option

Use the PRL in a Specification

Configure Signature Selection

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.5.3	Configure Signature Selection			O.1 (1..*)	Yes / No	
		3.4.3.5.4.1	Configure Signature Parameters	M	Yes	
		3.4.3.5.4.2	Instruct SSLs to Engage Signature Timing Plan	M	Yes	



Configure Signature Selection Range Specifications

- Number of Signatures
- Number of Signature Detectors



Use the PRL in a Specification

Configure Plan Selection Mode Schedule

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.6	Configure Plan Selection Mode Schedule			M	Yes	
		3.4.3.2	Configure Plan Selection Mode Schedule	M	Yes	



Use the PRL in a Specification

Synchronize Clocks of SSLs

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.7	Synchronize Clocks of SSLs			M	Yes	
		3.4.3.7.1	Accept User-Defined Period for SSL Clock Synchronization	M	Yes	
		3.4.3.7.2	Periodically Set Clocks of SSLs	M	Yes	
		3.4.3.7.3	Instruct SSM to Set Clocks of SSLs	M	Yes	



Use the PRL in a Specification

Configure Cycle Length by Plan

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2.8	Configure Cycle Length by Plan			SyncPulse:M	Yes / No	
		3.4.2.2.6	Accept Cycle Length by Plan	M	Yes	



Use the PRL in a Specification

Manage Alarms

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.1	Manage Alarms			M	Yes	
		3.4.4.1.1	Configure Critical Alarms and Events to Monitor	M	Yes	
		3.4.4.1.2	Provide Critical Alarms and Events Logging Requirements to SSM	M	Yes	
		3.4.4.1.3	Critical Alarms and Events Reporting Requirements	M	Yes	



Use the PRL in a Specification

Loss of Control of SSLs

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.1.1	Loss of Control of SSLs			M	Yes	
		3.4.4.1.4.1	Lost Communications to a SSL	M	Yes	
		3.4.4.1.5	Configure Intersection Non-Responsive Time to Constitute Failure	M	Yes	
		3.4.4.1.6	Coordination Failure Caused by Loss of Control	M	Yes	

Use the PRL in a Specification

Failed System Detectors

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.1.2	Failed System Detectors			M	Yes	
		3.4.4.1.4.2	Failed System Detectors for Threshold Selection of Timing Plans	Threshold: M	Yes / No	
		3.4.4.1.4.3	Failed System Detectors for Signature Selection of Timing Plans	Signature: M	Yes / No	

Use the PRL in a Specification

Other Alarms Within a SSL

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.1.3	Other Alarms Within a SSL			M	Yes	
		3.4.4.1.4.4	SSL Alarms and Events	M	Yes	



Use the PRL in a Specification

Forward SSM Alarms and Events

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.1.4	Forward SSM Alarms and Events			M	Yes	
		3.3.2.2	Configure Event Logging Service	M	Yes	
		3.3.2.3	Retrieve Event Logged Data	M	Yes	

Use the PRL in a Specification

Manage System Display Data

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.2	Manage System Display Data			M	Yes	The Response Start Time for all requests shall be not greater than <u>500</u> ms
		3.4.3.1.2	Retrieve Section Assignment	M	Yes	
		3.4.4.2.1	Provide Time Plan for Ea. Sect.	M	Yes	
		3.4.4.2.2	Provide Cycle Len. for Ea. Sect.	M	Yes	
		3.4.4.2.3	Provide Display Status of the Signal Displays for Each SSL	M	Yes	
		3.4.4.2.4	Provide Current Traffic Responsive Comparison	O	Yes / No	
		3.4.4.2.5	Provide Mode and Pattern Number for Each SSL	M	Yes	
		3.4.4.2.6	Provide Status for Each SSL	M	Yes	
		3.4.4.2.7	Provide Status for Each System Detector	M	Yes	

Use the PRL in a Specification

Monitor Traffic Conditions

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.3.3	Monitor Traffic Conditions			M	Yes	
		3.4.1.7	SSM Collect Volume and Occupancy Data	M	Yes	
		3.4.1.8	TMS Collect Volume and Occupancy Data	M	Yes	

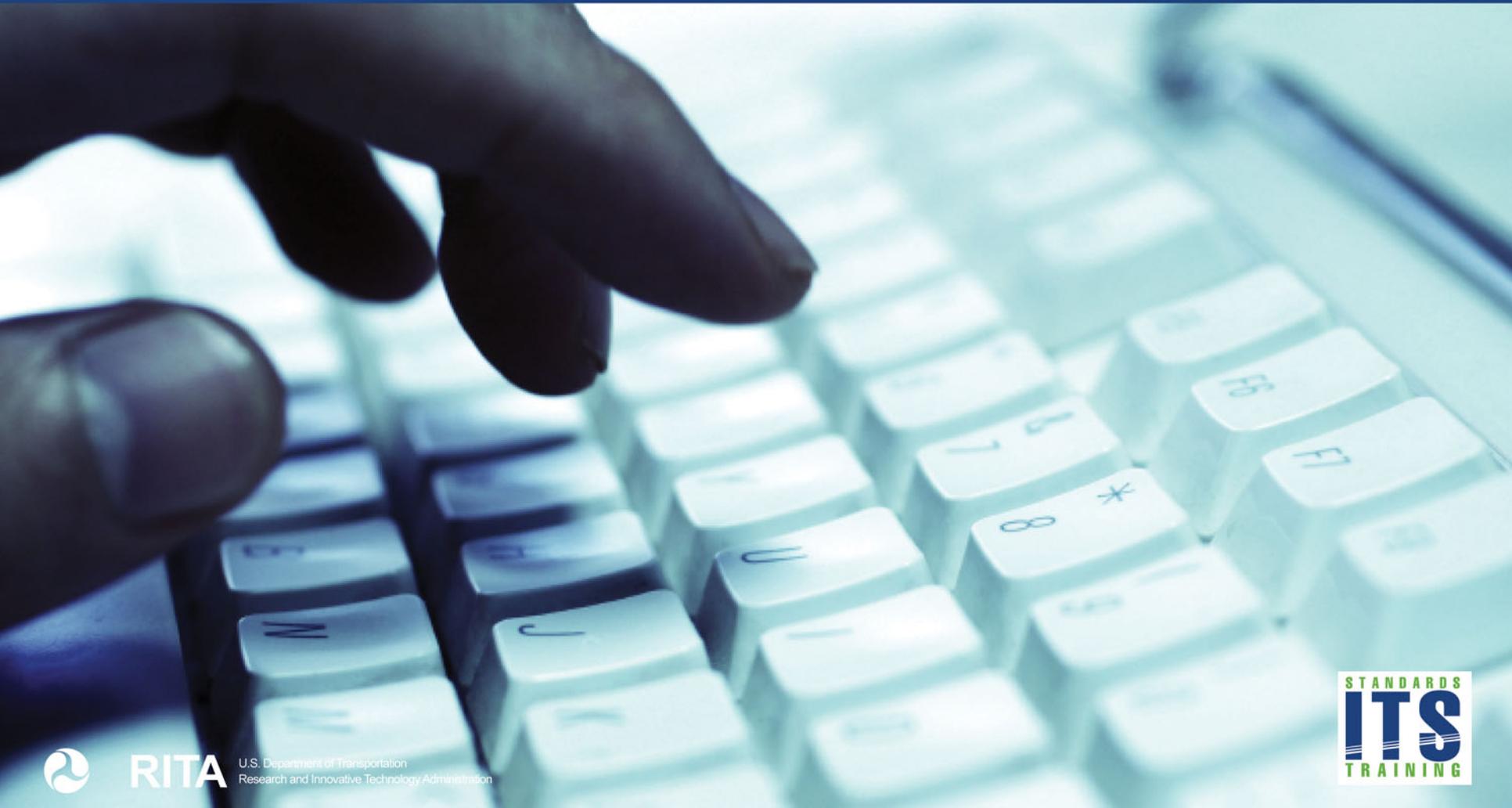
Use the PRL in a Specification

Manage SSLs

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.2	Manage SSLs			O	Yes / No	
		3.3.1.6	Explore SSL Data by the TMS	M	Yes	
		3.3.1.7	TMS Acceptance of Data from the SSL	M	Yes	
		3.3.1.8	TMS Delivery of Data to the SSL	M	Yes	
		3.4.2.3	Configure Connected SSLs	M	Yes	



ACTIVITY



RITA

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



When should a requirement with a conformance “Threshold:M” be selected?

From NTCIP 1210 Clause 3.2.3.2 and Participant Student Supplement Page 2

Predicate	Section
SyncPulse	2.5.1.2.8
Threshold	2.5.1.2.5.2
Signature	2.5.1.2.5.3

Answer Choices

- a) Only when User Need 2.5.1.2.5.2 is selected
- b) Always
- c) Only when Requirement 3.4.4.1.4.2 is selected
- d) Only when Requirement 3.4.3.5.3.5 is selected

Review of answers



a) Only when User Need 2.5.1.2.5.2 is selected

Correct! Clause 3.2.3.2 of the standard maps the predicate “Threshold” to Clause 2.5.1.2.5.2.



b) Always

Incorrect; The predicate means that support is conditional upon another selection.



c) Only when Requirement 3.4.4.1.4.2 is selected

Incorrect; this requirement has this conformance and thus this would result in circular logic.



d) Only when Requirement 3.4.3.5.3.5 is selected

Incorrect; the conformance may be mandatory even when 3.4.3.5.3.5 (Override Thresholds) is not selected.

Using the PRL in a Specification

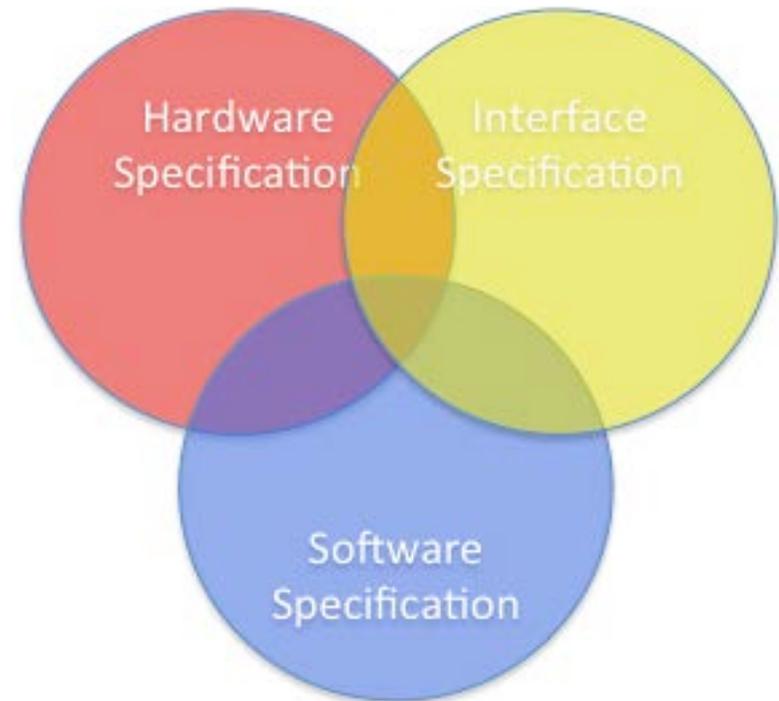
Part of Interface Specification

- A completed PRL defines the data requirements for the NTCIP interface
- When combined with the communication specification (See Module C101), it forms an interface specification
- A deployment may need multiple interface specifications
 - Management systems that support multiple devices
 - May need support for legacy protocol

Using the PRL in a Specification

Consistency

- The interface specification must be consistent with the remainder of the specification
- Interface requires ability to synchronize clocks
 - Implies existence of clock in SSM
 - Requires software logic for SSM to periodically synchronize clocks



Using the PRL in a Specification

Sample Text

- The PRL should be properly introduced within the specification
- Copyright disclaimer should appear with the PRL
- Refer to the Student Supplement for additional text, including “Additional Specifications”



Summary of Learning Objective #2

Use the PRL to Specify an SSM Interface

- Use of optional requirements, constraints, and predicates within the PRL
- Specify performance criteria for functional requirements within the PRL
- Specify limits or ranges for functional requirements within the PRL
- Use the PRL in a specification





Learning Objective #3 — Achieve Interoperability and Interchangeability

- How the RTM traces to a single design
- How to compare for interoperability
- How to compare for interchangeability

Interoperability and Interchangeability Requirements Traceability Matrix

- Annex A contains the RTM
- Maps requirements to a specific design
- Several ambiguities in the current draft
 - Early deployments should coordinate with industry experts

Interoperability and Interchangeability Requirements Traceability Matrix

- First two columns reference a requirement

Func Req't Reference	Functional Requirement	Dialog Reference	Object Reference	Object	Comments (Informative)
3.3.1.6	Explore SSL Data by the TMS	4.2.13	5.7 Group	PMPP Routing	TMS to SSL message management
3.3.1.9.2	Retrieve Block Objects	4.2.11	5.25.1	ssmBlockGetControl	
			5.25.2	ssmBlockData	

Interoperability and Interchangeability Requirements Traceability Matrix

- The third column defines the associated dialog
 - A requirement traces to only one dialog

Func Req't Reference	Functional Requirement	Dialog Reference	Object Reference	Object	Comments (Informative)
3.3.1.6	Explore SSL Data by the TMS	4.2.13	5.7 Group	PMPP Routing	TMS to SSL message management
3.3.1.9.2	Retrieve Block Objects	4.2.11	5.25.1	ssmBlockGetControl	
			5.25.2	ssmBlockData	

Interoperability and Interchangeability Requirements Traceability Matrix

- The fourth and fifth columns define the associated objects
 - All objects that trace to the requirement must be supported, if the requirement is supported
 - Many-to-many relationships between requirements and objects

Func Req't Reference	Functional Requirement	Dialog Reference	Object Reference	Object	Comments (Informative)
3.3.1.6	Explore SSL Data by the TMS	4.2.13	5.7 Group	PMPP Routing	TMS to SSL message management
3.3.1.9.2	Retrieve Block Objects	4.2.11	5.25.1	ssmBlockGetControl	
			5.25.2	ssmBlockData	

Interoperability and Interchangeability Requirements Traceability Matrix

- The sixth column provides comments
 - These are defined as informative and have no normative standing

Func Req't Reference	Functional Requirement	Dialog Reference	Object Reference	Object	Comments (Informative)
3.3.1.6	Explore SSL Data by the TMS	4.2.13	5.7 Group	PMPP Routing	TMS to SSL message management
3.3.1.9.2	Retrieve Block Objects	4.2.11	5.25.1	ssmBlockGetControl	
			5.25.2	ssmBlockData	

Interoperability and Interchangeability Requirements Traceability Matrix

RTM Maps each requirement to a specific design

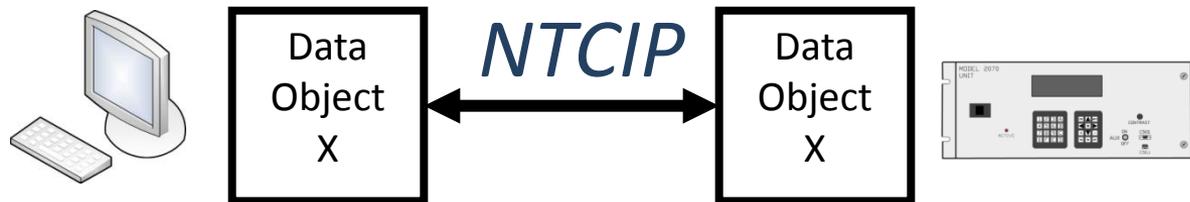
- A precise dialog
- A precise list of objects

Interoperability and Interchangeability

Comparisons of PRLs for Interoperability

- RTM provides interoperability at individual requirement level
- PRL indicates which requirements are supported/required
- Comparison of PRLs allow quick determination of interoperability
 - Ability of two or more systems to exchange information and use the information that has been exchanged

Interoperability



Interoperability and Interchangeability

Comparisons of PRLs for Interoperability

- Both TMS and SSM support a feature
 - Interoperability provided

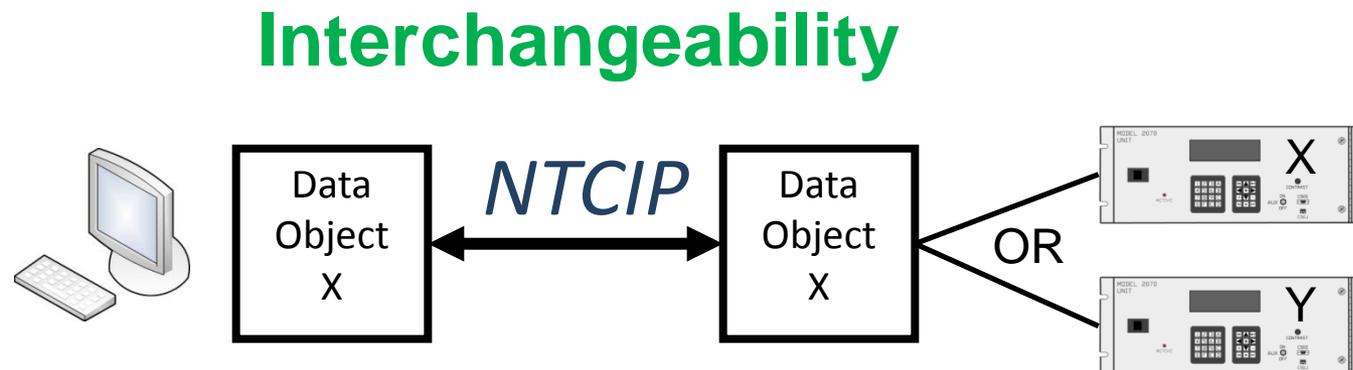
- TMS supports, SSM does not
 - TMS can still use other features (typically)
 - TMS can still interoperate with feature with other devices

- SSM Supports, TMS does not
 - Feature could be used by other/future TMS
 - Feature can potentially be used manually

Interoperability and Interchangeability

Comparisons of PRLs for Interchangeability

- Comparison of PRLs allow quick determination of interchangeability
 - Ability to replace one component with another from a different manufacturer



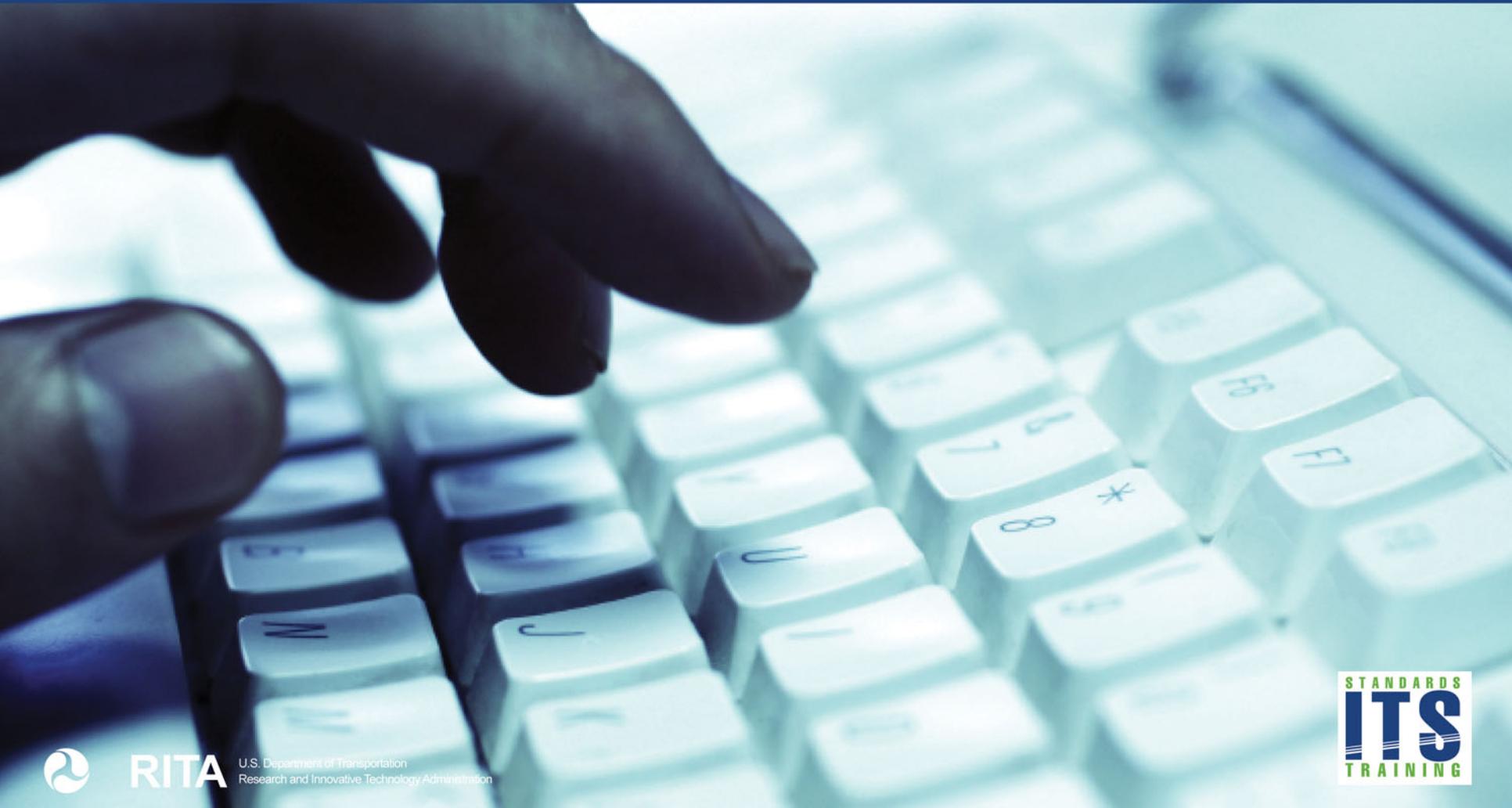
Interoperability and Interchangeability

Comparisons of PRLs for Interchangeability

- Both support a feature
 - Equipment is interchangeable for feature
- New equipment supports, old equipment does not
 - New equipment is interchangeable for feature (meets or exceeds)
- Old equipment supports, new does not
 - Feature will not be supported
 - ✓ Is feature really needed?



ACTIVITY



RITA

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



What does the following table mean?

Func Req't Reference	Functional Requirement	Dialog Reference	Object Reference	Object
3.4.1.1	Assign System Detectors	4.2.1	5.12.1	maxSensorSources
			5.12.2.1.2	sensorSourceIntersection
			5.12.2.1.3	sensorSourceDetNumber
			5.12.2.1.7	sensorSourceVolumeFactor
			5.12.2.1.11	sensorSourceOccWeighting

Answer Choices

- All of the objects must be supported
- At least one of the objects must be supported
- All of the objects must be supported, if the requirement is supported
- At least one of the objects must be supported, if the requirement is supported

Review of answers



a) All of the objects must be supported

Incorrect; they only need to be supported if the requirement has been selected in the PRL.



b) At least one of the objects must be supported

Incorrect; if the requirement is selected, all of the indicated objects must be supported.



c) All of the objects must be supported, if the requirement is supported

Correct!



d) At least one of the objects must be supported, if the requirement is supported

Incorrect; if the requirement is selected, all of the indicated objects must be supported.



Summary of Learning Objective #3

Achieve Interoperability and Interchangeability

- The RTM traces requirements to a single design
- The PRL and RTM allow easy checks for interoperability
- The PRL and RTM allow easy checks for interchangeability





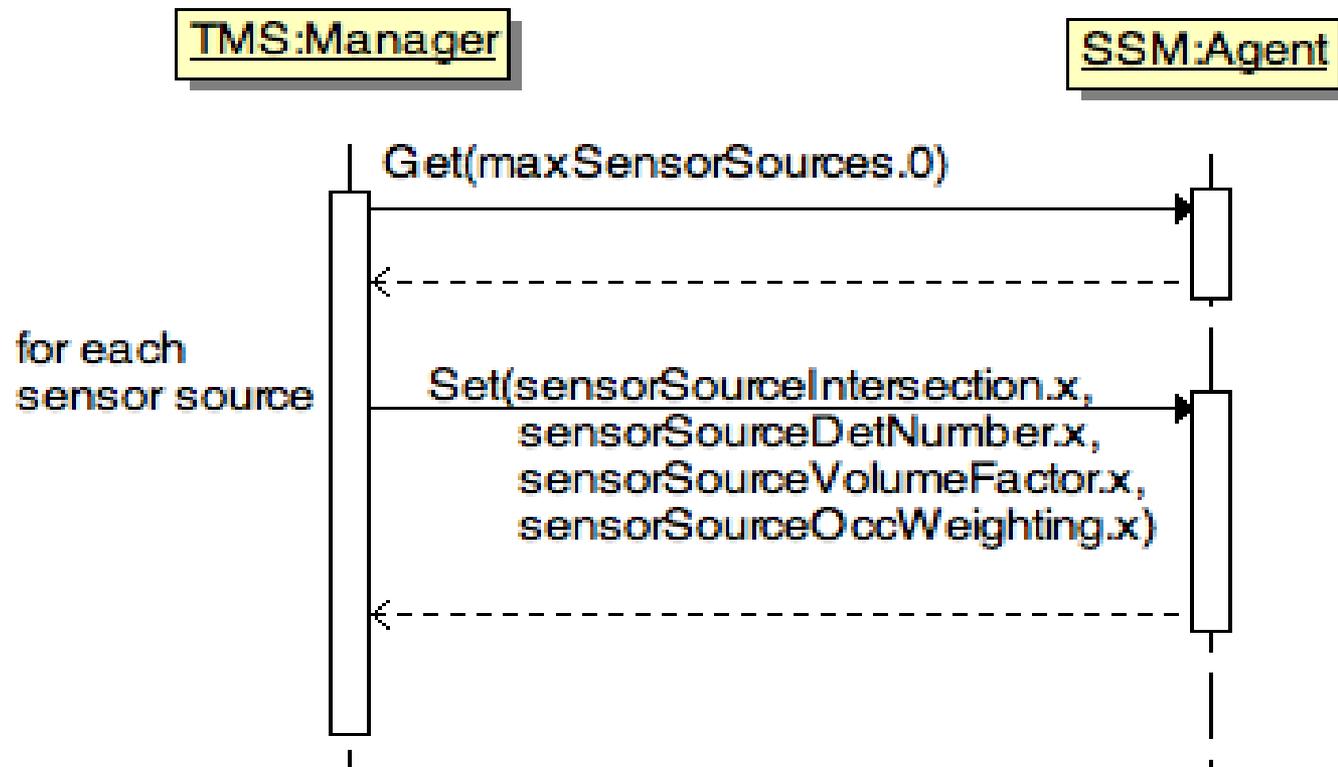
Learning Objective #4 — Understand NTCIP 1210 Dialogs

- Example NTCIP 1210 dialog to an SSM
- Example NTCIP 1210 dialog with an SSL

Understand NTCIP 1210 Dialogs

TMS – SSM

Dialog 4.2.1



Understand NTCIP 1210 Dialogs

TMS – SSM

- All objects referenced anywhere in dialog are shown in RTM
 - RTM provides traceability
 - Dialog gives sequencing rules

Func Req't Reference	Functional Requirement	Dialog Reference	Object Reference	Object
3.4.1.1	Assign System Detectors	4.2.1	5.12.1	maxSensorSources
			5.12.2.1.2	sensorSourceIntersection
			5.12.2.1.3	sensorSourceDetNumber
			5.12.2.1.7	sensorSourceVolumeFactor
			5.12.2.1.11	sensorSourceOccWeighting

Understand NTCIP 1210 Dialogs

TMS – SSM – SSL

2.4.3 Connect Communication Networks

The SSM needs to provide the ability to connect communication networks.

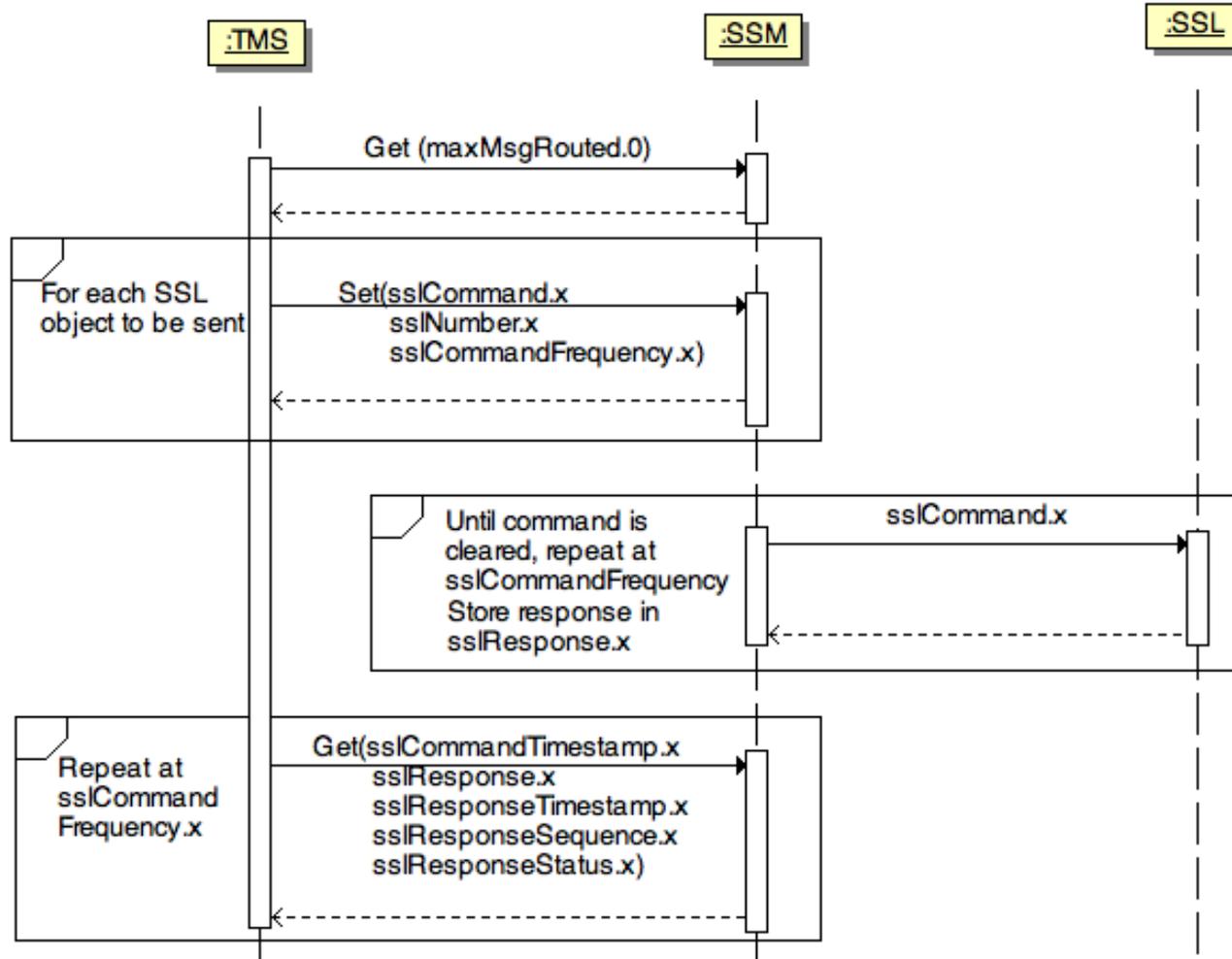
3.3.1.8 TMS Delivery of Data to the SSL

The SSM shall provide a pass-through capability for the TMS to deliver data to the SSL.

There are potential issues as we will discuss on the following slides along with three possible work-arounds

Use the PRL in a Specification

Connect Communication Networks



Use the PRL in a Specification

Connect Networks – Support for Any Message

- Allows sending any packetized data
 - Any SNMP request
 - Any STMP request
 - Any message conforming to another standard
 - Any message in a proprietary format
- The SSM does not need to understand the contents of the message
 - Only the SSL needs to understand

Use the PRL in a Specification

Connect Networks – Potential Issue #1

sslResponse contains “ALL responses from the SSL.” Most would likely to interpret this to mean:

- The last packet received from the SSL, which may be:
 - A response to the sslCommand
 - A response to another sslCommand
 - A response to an automated request from the SSM
 - An unsolicited report from the SSL

Actual response may be overwritten before TMS can retrieve

Use the PRL in a Specification

Connect Networks – Work Around #1

The user need does not identify bandwidth constraints.

- Could use IP for connecting networks
 - Needs high-speed connection

Use the PRL in a Specification

Connect Networks – Work Around #2

- Could use the pre-defined commands
 - Set time
 - Set sync control
 - Set pattern
 - Set special functions
 - Get status
 - Get detector volume and occupancy

Use the PRL in a Specification

Connect Networks – Work Around #3

Could use a refined interpretation of standard

- Interpret “ALL responses” to mean “the most recent response, as determined by the transport layer”
- Require TMS to include port numbers in transport layer
 - Responses could also contain port numbers
 - Transport layer could then associate response to command
- Allows exchange of virtually any connectionless data

Work with standards committees to finalize interpretation once implemented

Use the PRL in a Specification

Connect Networks – Potential Issue #2

sslNumber is ambiguous, defined as both

- Intersection number and
- Drop number

Possible Work-Around

- Use literal interpretation
- Routing feature is limited to 62 SSLs

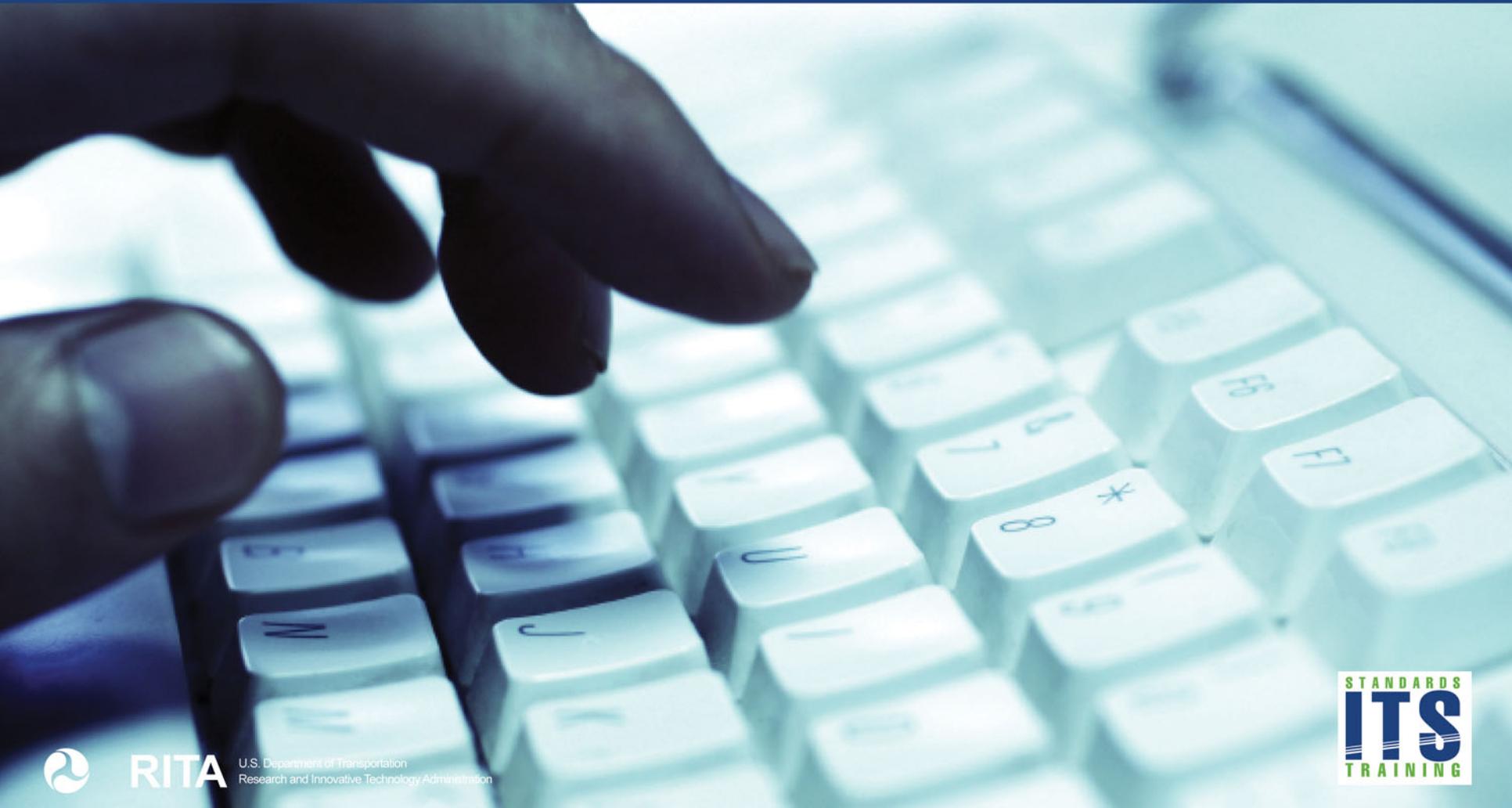
Use the PRL in a Specification

Connect Networks – Summary

- sslResponse may be overwritten before read
 - IP routing
 - Command feature
 - Require transport layer processing

- sslNumber definition confuses intersection and drop
 - Use definition as written
 - Limits routing to 62 intersections

ACTIVITY



RITA

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



What types of messages does the standard allow to be sent to the SSL using the sslCommand feature?

Answer Choices

- a) Any of thirteen standardized messages
- b) Any of thirteen user-defined messages
- c) Any message clearly defined in the specification
- d) Virtually any packetized message



Review of answers



a) Any of thirteen standardized messages

Incorrect; the standard does not define thirteen messages.



b) Any of thirteen user-defined messages

Incorrect; STMP includes thirteen user-defined dynamic objects – these can be sent along with any other message.



c) Any message clearly defined in the specification

Incorrect; the routing feature allows virtually any message to be sent.



d) Virtually any packetized message

Correct! The sslCommand feature can be used to send any single datagram.



Summary of Learning Objective #4

We discussed:

- Dialogs between the TMS and SSM
- Routing from the TMS to the SSL via the SSM



Learning Objective #5 — Incorporate requirements not covered by the standard

- Conditions and context for extending the NTCIP 1210 standard
- Example of extending the standard



Extending the Standard

Interoperability and Interchangeability

Extending the standard complicates interoperability and interchangeability

- Not achievable unless all design details are known
- Extensions are custom solutions
 - ❑ Increased specification costs
 - ❑ Increased development costs
 - ❑ Increased testing costs
 - ❑ Increased integration costs
 - ❑ Longer deployment timeframe
 - ❑ Increased maintenance costs

Extending the Standard Conditions

Extensions should only be considered when:

- NTCIP features are inadequate to meet need
- Benefits of extension outweigh the added costs

Extending the Standard Design

Extended equipment should be designed to:

- Appropriately integrate with NTCIP-only deployments
 - Do not add new enumerations to standard objects
 - Properly register new objects on OID Tree
 - Allow mode to have standard operation

- Minimize added complexity
 - Try to use bulk of NTCIP design with minimal extensions



Extending the Standard

Example User Need

X.1 Custom Needs

X.1.1 Plan Selection Based on Ice Detection

A TMS operator needs the SSM to override timing pattern selection based on the detection of ice in the area. The formation of ice on certain roadways can create traffic hazards that may warrant the prohibition of certain movements at intersections resulting in changed demand patterns on the roadway network. This feature allows SSMs to ensure these conditions are handled smoothly.

Extending the Standard

Example Specifications

X.2 Custom Specifications

X.2.1 Configure Ice Detection Override

The SSM shall allow the TMS to define which plan to use when ice is detected for more than one minute.

X.2.2 Monitor Ice Detection Override

The SSM shall allow the TMS to determine whether ice is currently detected, how long it has been detected, and whether the Ice Detection Override Plan is active.

Extending the Standard

Example RTM

Function Reference	Function	Dialog Reference	Object Reference	Object
X.2.1	Configure Ice Detection Override	NTCIP 1210 4.1.3 (Set)	X.4.1	xxxIceDetectionOverridePattern
X.2.2	Monitor Ice Detection Logic	NTCIP 1210 4.1.1 (Get)	X.4.2	xxxIceDetected
			X.4.3	xxxIceDetectedTime
			X.4.4	xxxIceDetectionOverrideActive

Extending the Standard

Example Object

xxxIceDetectionOverridePattern OBJECT-TYPE

SYNTAX INTEGER (1..255)

ACCESS read-write

STATUS mandatory

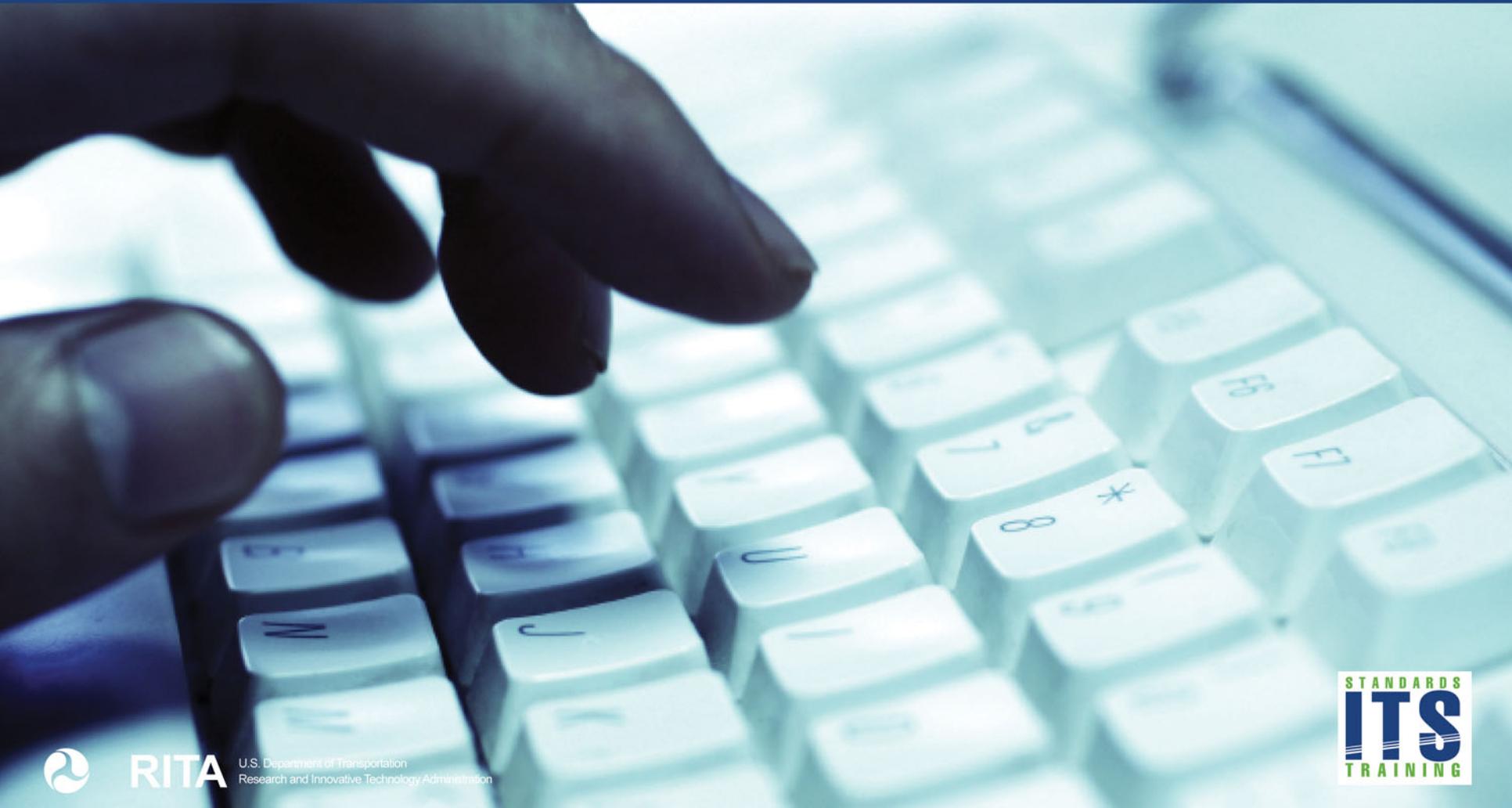
DESCRIPTION “<DEFINITION> The timing pattern that is to be activated when xxxIceDetected is true and xxxIceDetectedTime is more than 60 seconds in the past.

<UNIT> pattern number”

::= {xxxIceDetection 1}



ACTIVITY



RITA

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



Which of the following is the best reason to extend a standard?

Answer Choices

- a) There is an unmet need that justifies the added cost
- b) The existing system uses a non-standard design
- c) You want to use your specification to favor a specific vendor
- d) The standardized solution is overly complex for your simple needs



Review of answers



a) Unmet need justifies the cost

Correct! Sometimes you just have to accept the added costs



b) Existing system uses non-standard design

Incorrect; doing this will prolong the expensive customized approach for another generation



c) To favor a specific vendor

Incorrect; this opens the project up to a lawsuit and potentially traps you into a proprietary design



d) Standardized solution is overly complex

Incorrect; even if a simpler solution would work, the life-cycle costs of implementing a non-standard solution are significant



Summary of Learning Objective #5

Incorporate requirements not covered by the standard

We discussed:

- Conditions and context for extending the standard
- Example of extending the standard



What We Have Learned

- 1) The PRL can be used to trace user needs to requirements.
- 2) The “Additional Specifications” PRL column can define performance and object range specifications.
- 3) The Student Supplement has a list of additional specifications that could be considered for the PRL.
- 4) The RTM traces each requirement to a single design solution, thereby providing for interoperability.
- 5) NTCIP 1210 allows a TMS to send virtually any message to an SSL.
- 6) Developing custom features entails significant effort and risk.





Resources

- **NTCIP 1210 v01.53**
 - ❑ Field Management Stations – Part 1: Object Definitions for Signal System Masters
 - ❑ www.ntcip.org

- **NTCIP 9001**
 - ❑ The NTCIP Guide
 - ❑ www.ntcip.org

- **IEEE 1233**
 - ❑ IEEE Guide for Developing System Requirements Specifications
 - ❑ www.ieee.org



QUESTIONS?



RITA

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

