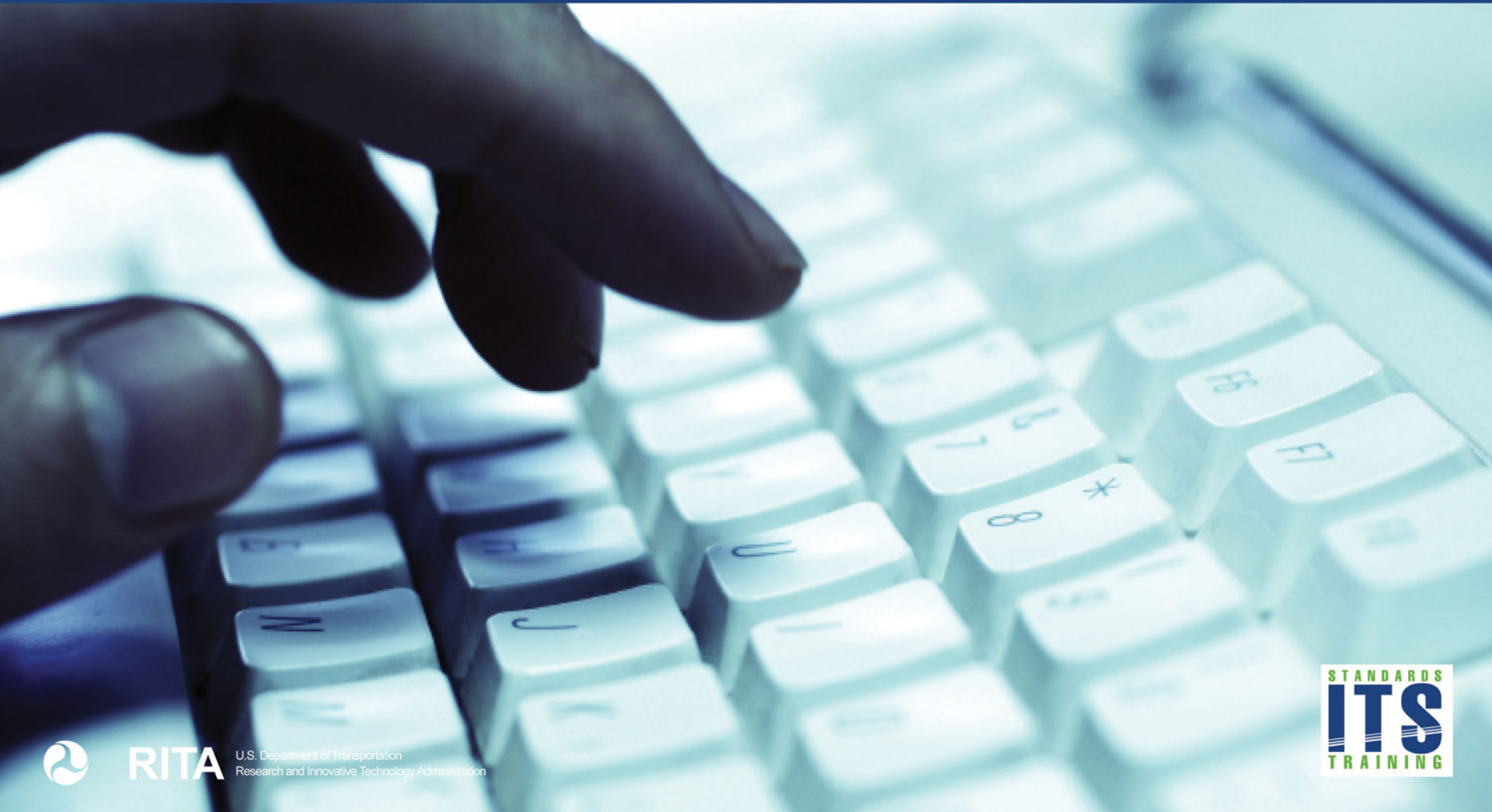STANDARDS
ITS
TRAINING

RITA Intelligent Transportation Systems
Joint Program Office

WELCOME

A304a:
Understanding User Needs for Field Management Stations – Part 1 Object Definitions for Signal System Masters (SSM) Based on NTCIP 1210 Standard

ACTIVITY

Instructor

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Target Audience

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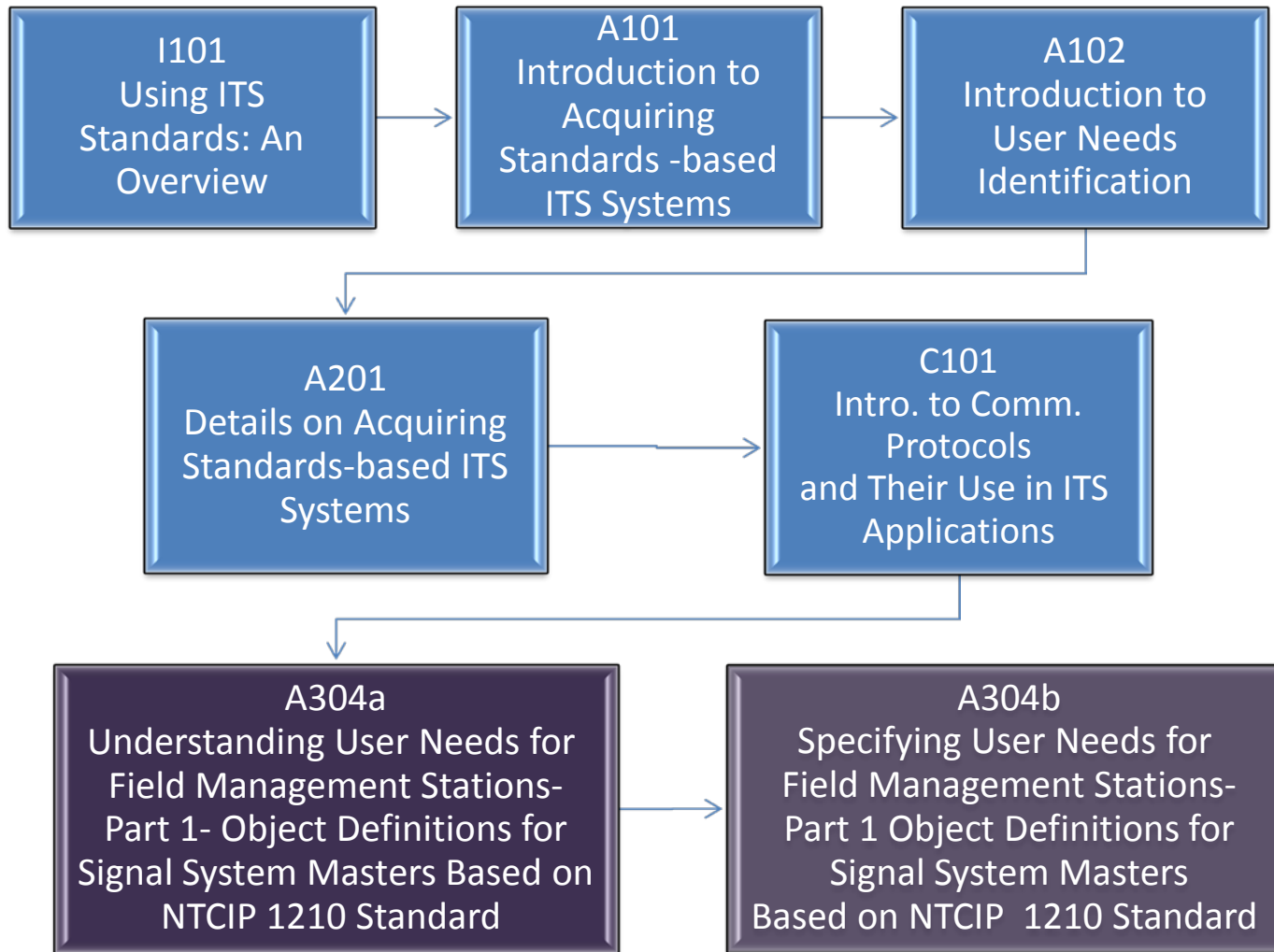- Private and public sector users including manufacturers

Recommended Prerequisite(s)

- I101: Using ITS Standards an Overview
- A101: Introduction to Acquiring Standards-based ITS Systems
- A102: Introduction to User Needs Identification
- A201: Details on Acquiring Standards-based ITS Systems
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications

Curriculum Path (SEP)

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
Intro. to Comm. Protocols and Their Use in ITS Applications

A304a
Understanding User Needs for Field Management Stations- Part 1- Object Definitions for Signal System Masters Based on NTCIP 1210 Standard

→

A304b
Specifying User Needs for Field Management Stations- Part 1 Object Definitions for Signal System Masters Based on NTCIP 1210 Standard

Learning Objectives

1. Review the structure of the NTCIP 1210 standard
2. Identify specific Field Management Station (FMS) user needs within the context of Signal System Master (SSM)
3. Use the Protocol Requirements List (PRL) to select the user needs and link to requirements
4. Explain how the PRL table of the NTCIP 1210 Standard integrates into the FMS Specification

Learning Objective #1 — Review the structure of the NTCIP 1210 standard

- Purpose of the standard

- Location of user needs and standards on systems engineering "V" diagram

- Identify components of the standard

History of NTCIP 1210

Version 1: v01.53 is the "ballot ready version."

- **It contains known design flaws and is not yet ready for deployment – look for an update.**

- User needs and requirements are not expected to change.

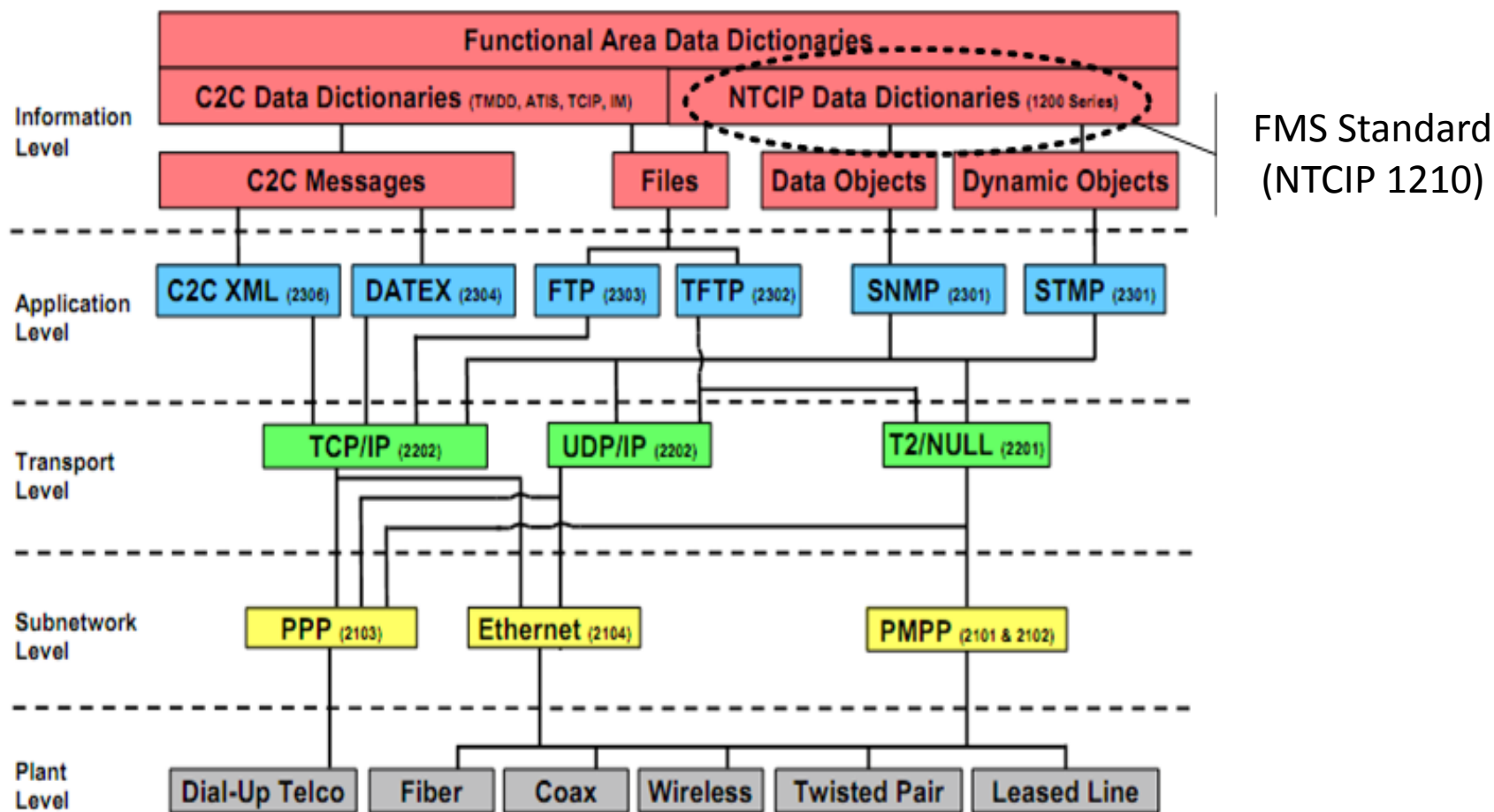- Specification process should not change.

NTCIP Family

NTCIP: A family of standards for ITS

- Information level standards – Data to be exchanged
- Underlying standards – How data is exchanged

NTCIP Family

FMS Standard
(NTCIP 1210)

Source: NTCIP 9001v04, Page 12, Figure 4

What is NTCIP 1210?

- Defines a communications interface standard
  - Between SSM and monitoring (e.g., central) systems
    - An SSM is one type of FMS
  - Closely related to Actuated Signal Controllers
  - NTCIP 1202
- Includes Systems Engineering Process (SEP) content
  - User needs, requirements, and design elements
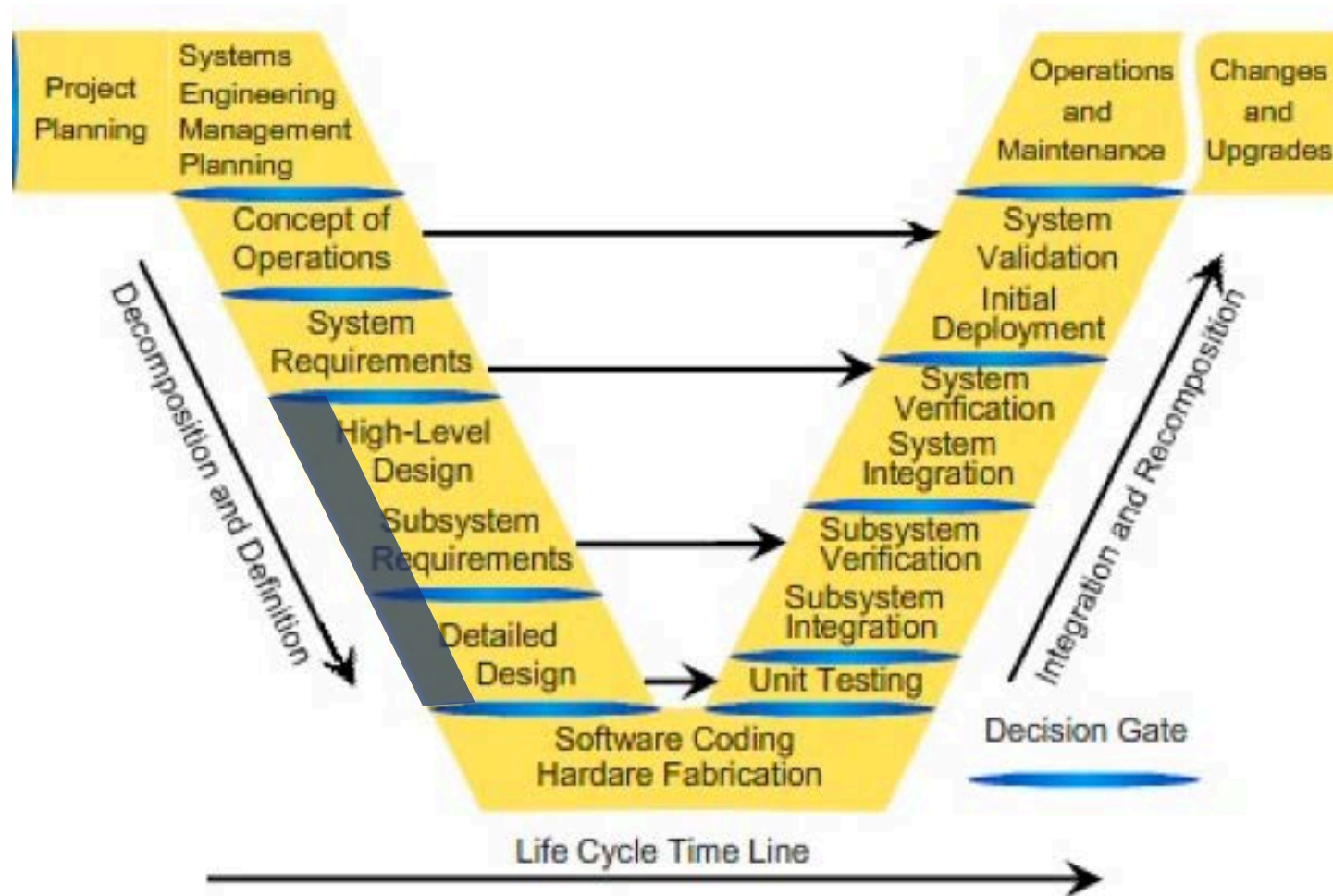
Structure of the Standard

Overview

- Defines user needs supported by the standard
  - E.g., Implement Plan Based on Timebase Schedule
- Defines functional requirements supported by the standard
  - E.g., Synchronize SSM Clock with Traffic Management System (TMS)
- Defines a single design for each requirement
  - Supports interoperability

Structure of the Standard

Location in SEP

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
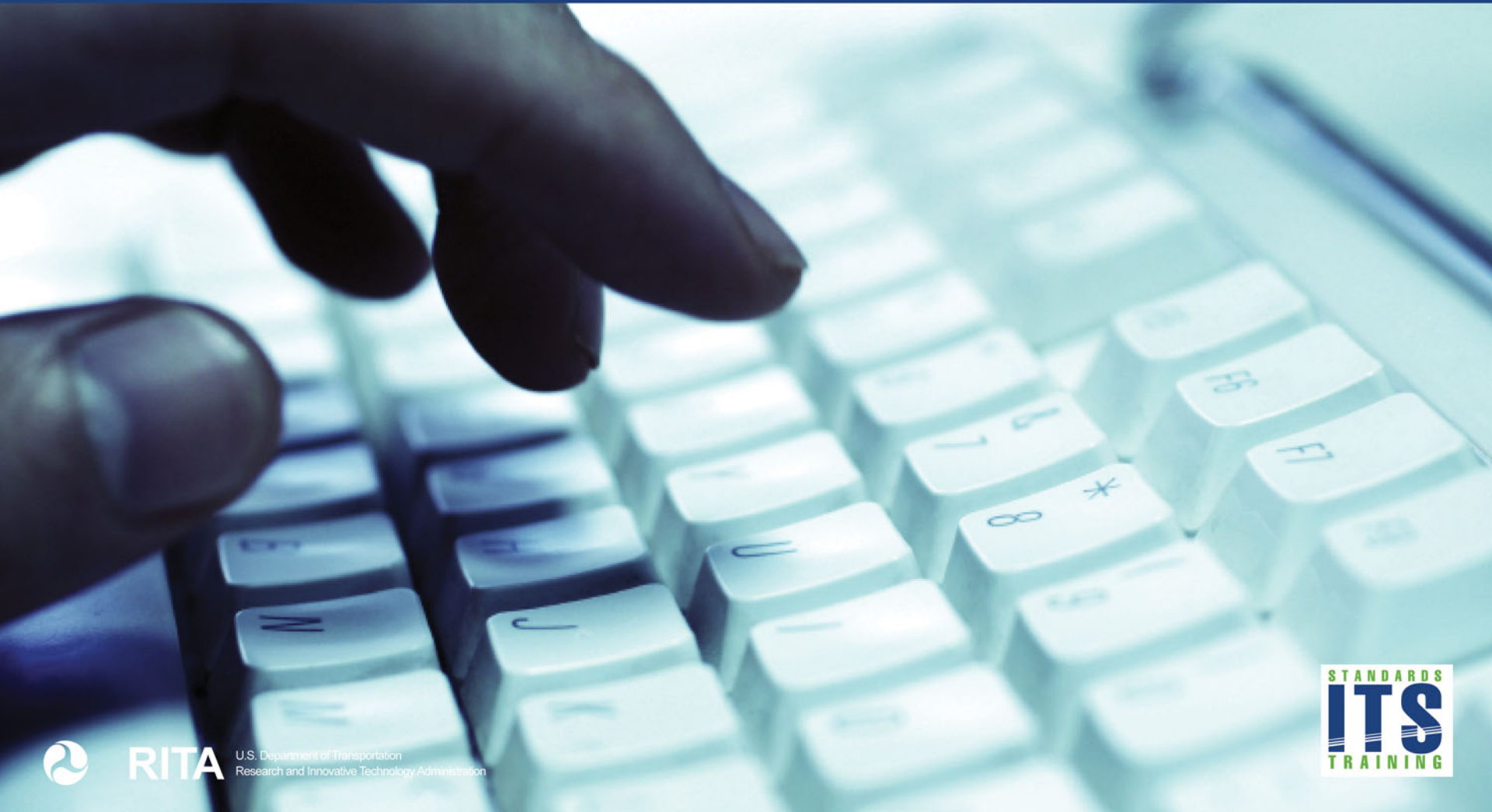- Annex C: SSM Control Hierarchy

Advantages of NTCIP 1210

Follows the Systems Engineering Process and yields the following benefits when procuring SSMs:

- Ease of use
- Easy to specify
- Easy to test
- Supports interoperability
- Provides drop-in user needs

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What is the purpose of the Systems Engineering Process?

Answer Choices

a) It provides a structured and reproducible approach to specifying a system.

b) It provides a structured and reproducible approach to testing a system.

c) It provides checkpoints at various stages of development to ensure the system will deliver what is needed.

d) All of the above.

Review of answers

a) Reproducible approach to specifying a system

   This answer is incomplete because the SEP includes testing and validation checkpoints.

b) Reproducible approach to testing a system

   This answer is incomplete because the SEP includes specifying and validation checkpoints.

c) Checkpoints at various stages of development

   This answer is incomplete because the SEP includes specifying and testing the system.

d) All of the above

   The SEP provides a reproducible approach for specifying and testing a system and provides checkpoints to ensure user needs are fulfilled.

Summary of Learning Objective #1

NTCIP 1210 was developed using the Systems Engineering Process and contains:

- User needs
- Functional requirements
- Protocol Requirements List (traceability)
- Dialogs
- Object definitions
- Requirements Traceability Matrix (more traceability)

Learning Objective #2 — Identify specific FMS user needs for an SSM

- NTCIP 1210 ConOps: architecture, architectural needs, and operational needs

- Introduce components of a Signal System Master (SSM) system

NTCIP 1210
Concept of Operations

- Focuses on the system and its users
- Considers the life cycle of the system
- Defines the user needs supported by the standard
- Provides an operational context for the system

NTCIP 1210
Problem Statement

- Agencies are required to efficiently manage system-wide traffic flow.
- There are competing definitions of efficient flow:
  - Minimizing delays, stops, and/or travel times
  - Maximizing throughput
  - Minimizing emissions
- There are competing algorithms to optimize these measures.
- Traffic data changes in real-time.
- Signal System Locals (SSLs) and SSMs are located throughout the city and need to be managed remotely.

NTCIP 1210
Typical Architecture
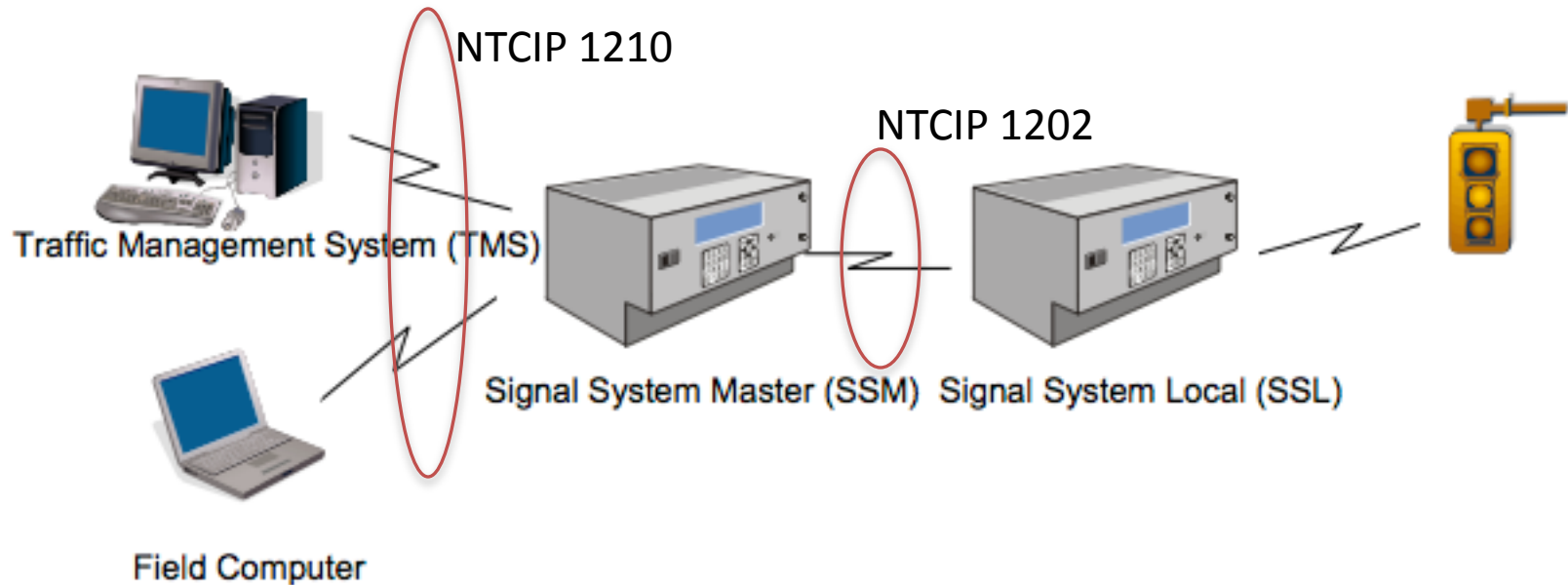
Typical physical architecture for NTCIP 1210

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

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NTCIP 1210
Architecture Alternatives

Two common designs

- Remote signal system
  - E.g., dial-up operation

- Hierarchical distributed signal system
  - Always-on connection, but pattern selection is still performed in regional SSMs

NTCIP 1210
Architectural Needs

Provide live data (Mandatory – 'M')

- Data retrieval
- Commands
- The basic capabilities to exchange data when connected

NTCIP 1210
Architectural Needs

Provide off-line logged data (M)

- Addressing operational environments without always-on connections (e.g., dial-up locations)

- Monitoring exceptional conditions

- Logging is important for situations without communications or when recording field information

NTCIP 1210
Architectural Needs

Connect communication networks (M)

- The TMS often needs to connect to the SSL
- The SSM sits between the TMS and SSL
- The SSM needs to seamlessly connect the two
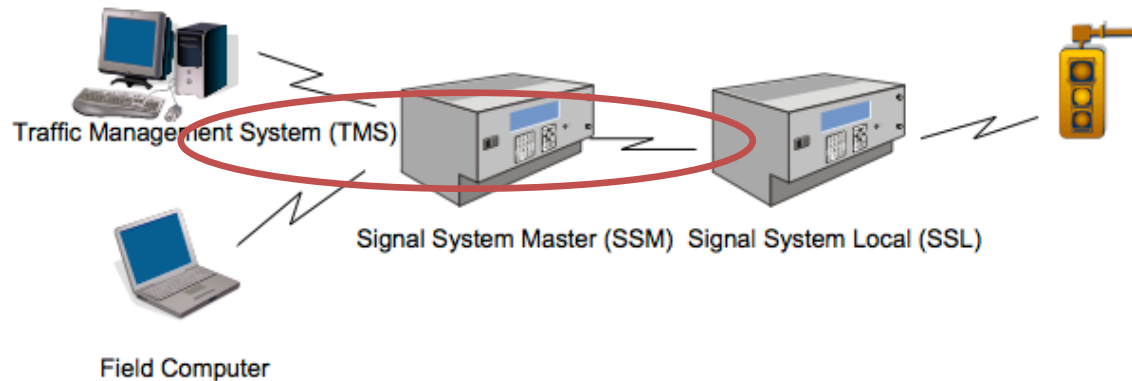
Source: NTCIP 1210, Figure 3, Page 13

NTCIP 1210
Architectural Needs

Support legacy communication networks (Optional – 'O')

- The connection to the SSM may be very low speed.
- NTCIP offers options to increase bandwidth efficiency.
- Most modern systems are designed with high-speed connections to the SSM.

NTCIP 1210
Operational Needs (Features)

Operational needs are called "features."

- Relate to the informational needs of the users
- Divided into two major categories
    - Manage SSM
    - Manage SSL

NTCIP 1210
Manage SSM Features

- Configure cycle timers and unit backup time
- Manage system timing plans
- Monitor system operations

NTCIP 1210
Cycle Timers and Backup Time

Configure cycle timers and unit backup time (M)

- Determine capabilities of an SSM
- Configure the SSM network of SSLs
- Configure a sync pulse for SSLs

NTCIP 1210

Manage System Timing Plans

Manage system timing plans includes several sub-features:

1. Manage section definition set
2. Implement a manually selected plan
3. Implement plan based on TMS command
4. Implement plan based on timebase schedule
5. Implement plan responsively based on traffic conditions
6. Configure plan selection mode schedule
7. Synchronize clocks of SSLs
8. Configure cycle length by plan

NTCIP 1210
Manage System Timing Plans

1. Manage section definition set (M)
   - Allows a TMS operator to assign an SSL to a section
   - Each section is timed as a coordinated system

NTCIP 1210
Manage System Timing Plans

2. Implement a manually selected plan (M)

- Allows a Traffic Management System (TMS) operator to manually override plan selection
- Stays in effect until changed

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NTCIP 1210
Manage System Timing Plans

3. Implement plan based on TMS command (M)

- Allows automatically-generated TMS plan selection
  - Could be time-based
  - Could be algorithmic
- SSM will override if communication is lost

NTCIP 1210
Manage System Timing Plans

4. Implement plan based on timebase schedule (M)

- Allows the TMS to automatically select the plan based on time-of-day

- Allows for different schedules by day-of-week and holidays

- Useful when traffic patterns are predictable

NTCIP 1210
Manage System Timing Plans

5. Implement plan responsively based on traffic conditions

Configure traffic responsive mode (M)

- Allows selection of algorithm
  - Must support threshold and/or signature selection
- Allows configuration of features common to both algorithms
- Each algorithm allows selection among a wide variety of plans with different cycles, splits, and offsets

NTCIP 1210
Manage System Timing Plans

5. Implement plan responsively based on traffic conditions

Configure threshold selection (O*)

- Plan selection is based on weighted system detector readings as they cross upper and lower thresholds
- System detectors are grouped into 9 groups that jointly determine cycle, split, and offset parameters

  * Optional, but either this or the next feature must be selected.

NTCIP 1210
Manage System Timing Plans

5. Implement plan responsively based on traffic conditions

Configure signature selection (O*)

- Plan selection is based on how closely current conditions match a defined signature of system detector readings.

* Optional, but either this or the previous feature must be selected.

NTCIP 1210
Manage System Timing Plans

6. Configure plan selection mode schedule (M)

- Allows the SSM to use traffic responsive plan selection according to a defined schedule

- Allows user to force plan selection during certain times (e.g., known peak periods) while allowing more responsive operation at other times

NTCIP 1210
Manage System Timing Plans

7. Synchronize clocks of SSLs (M)

- Allows an SSM to synchronize the time-of-day clocks in each connected SSL (either by schedule or manually)

- Provides each SSL with its own common reference point when timing its own signal operations

- Alternative to using a sync-pulse

NTCIP 1210
Manage System Timing Plans

8. Configure cycle length by plan (SyncPulse:M)

- Allows each plan to be associated with a cycle length
- The SSM can then generate a sync pulse so that all signals have a common reference point every cycle
- An alternative to synchronizing clocks
  - Generally used with older equipment that do not have accurate clocks
  - Only required if specification requires use of sync pulses

NTCIP 1210
Monitor System Operation

▪ **Monitoring system operation includes:**

1. Managing alarms:

    a. Loss of control of SSLs

    b. Failed system detectors

    c. Other SSL alarms

    d. Forward SSM alarms and events

2. Manage System Display Data

3. Monitor Traffic Conditions

NTCIP 1210
Monitor System Operation

1.a. Loss of control of SSLs (M)

- Allows the TMS to monitor the number of SSLs that are not actively communicating with the SSM

- Allows the SSM to return control to SSLs if too many SSLs stop communicating

NTCIP 1210
Monitor System Operation

1.b. Failed system detectors (M)

- Allows the SSM to terminate traffic responsive operation if the number of working system detectors fall below a defined level

NTCIP 1210
Monitor System Operation

1.c. Other SSL alarms (M)

- Allows the SSM to relay other SSL alarms to the TMS, such as:
  - Local flash
  - Malfunction Management Unit (MMU) flash
  - Coordination failures
  - Stop time
  - Low battery
  - Power restart

NTCIP 1210
Monitor System Operation

1.d. Forward SSM alarms and events (M)

- User can configure SSM to monitor any parameter and report when this parameter meets user-defined conditions

NTCIP 1210
Monitor System Operation

2. Manage system display data (M)

- Allows a TMS operator to monitor data needed to ensure the proper, efficient operation of the system
  - Fault information
  - Current configuration and status of SSM
  - Certain status information for each SSL

NTCIP 1210
Monitor System Operation

3. Monitor traffic conditions (M)

- Allows collection of volume and occupancy data summarized over a period of time
- Can be used to determine when new timing plans might be needed

NTCIP 1210
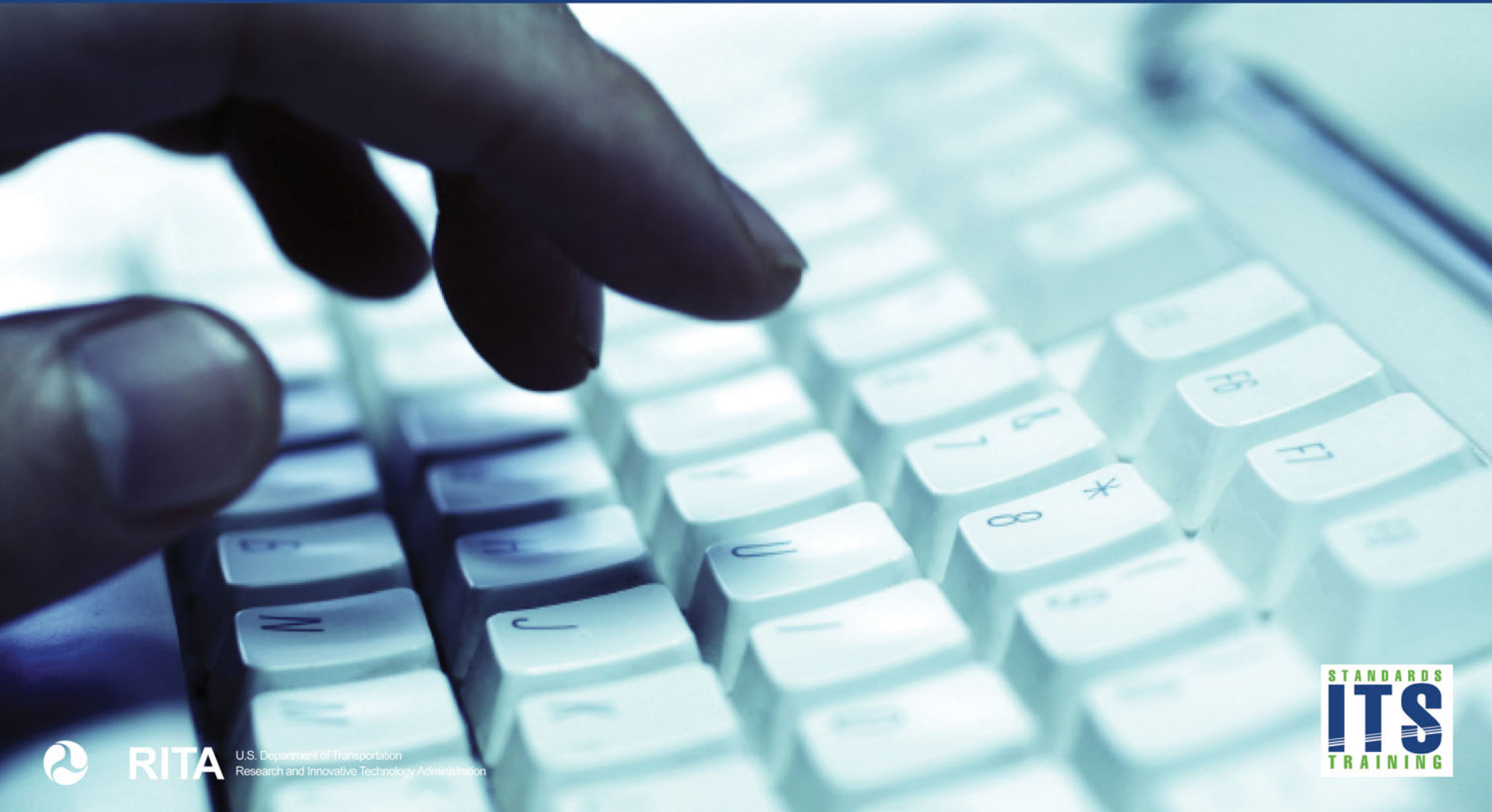## Manage Signal System Locals (SSLs)

- Manage SSLs (Optional, but really Mandatory)
    - Allows communications with an SSL.
    - Data to be exchanged is dependent on type of SSL.
    - Data is defined in an SSL specific standard (e.g., NTCIP 1202).
    - The Standard labels this as optional, but the entire design is required per architectural requirements.

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Which user need allows the SSM to *instantly* notify the user of unusual traffic conditions?

Answer Choices

a) 2.4.1 Provide Live Data

b) 2.4.2 Provide Off-line Logged Data

c) 2.5.1.3.1.4 Forward SSM Alarms and Events

d) User need is not supported by the standard

Review of answers

a) 2.4.1 Provide Live Data

Incorrect; an SSM will only provide live data in direct response to a request.

b) 2.4.2 Provide Off-line Logged Data

Incorrect; an SSM will only provide the logged data in direct response to a request.

c) 2.5.1.3.1.4 Forward SSM Alarms and Events

Incorrect; an SSM will only provide this data in direct response to a request.

d) User need is not supported by the standard

Correct; if this is a true need, the project will need to define how this should be achieved.

Summary of Learning Objective #2

Operational needs supported include:

- Configure cycle timers
- Manage system timing plans
- Monitor system operation
- Manage SSLs

Learning Objective #3 — Use Protocol Requirements List (PRL) to select user needs and link to requirements

- Learn how to:
  - Indicate which requirements are to be implemented for a project.
  - Check for conformance to NTCIP 1210.
  - Indicate the capabilities of an implementation.
  - Check the interoperability with another implementation.

Protocol Requirements List
Definition

- A table that maps user needs to requirements
- Can be used to:
  - Select requirements for a project
  - Assist deployments by providing a checklist
  - Identify capabilities supported by an implementation
  - Compare two implementations for interoperability

Protocol Requirements List
Selecting User Needs

- User Need ID references a precise clause in standard
- Conformance identifies mandatory or optional
  - "O" = Optional
  - ".1" = Part of first option group
  - "(1..*)" = One or more options from group required
- Agency selects value under Project Requirement column

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.1.2.5.2	Configure Threshold Selection			O.1 (1..*)	Yes / No / NA	
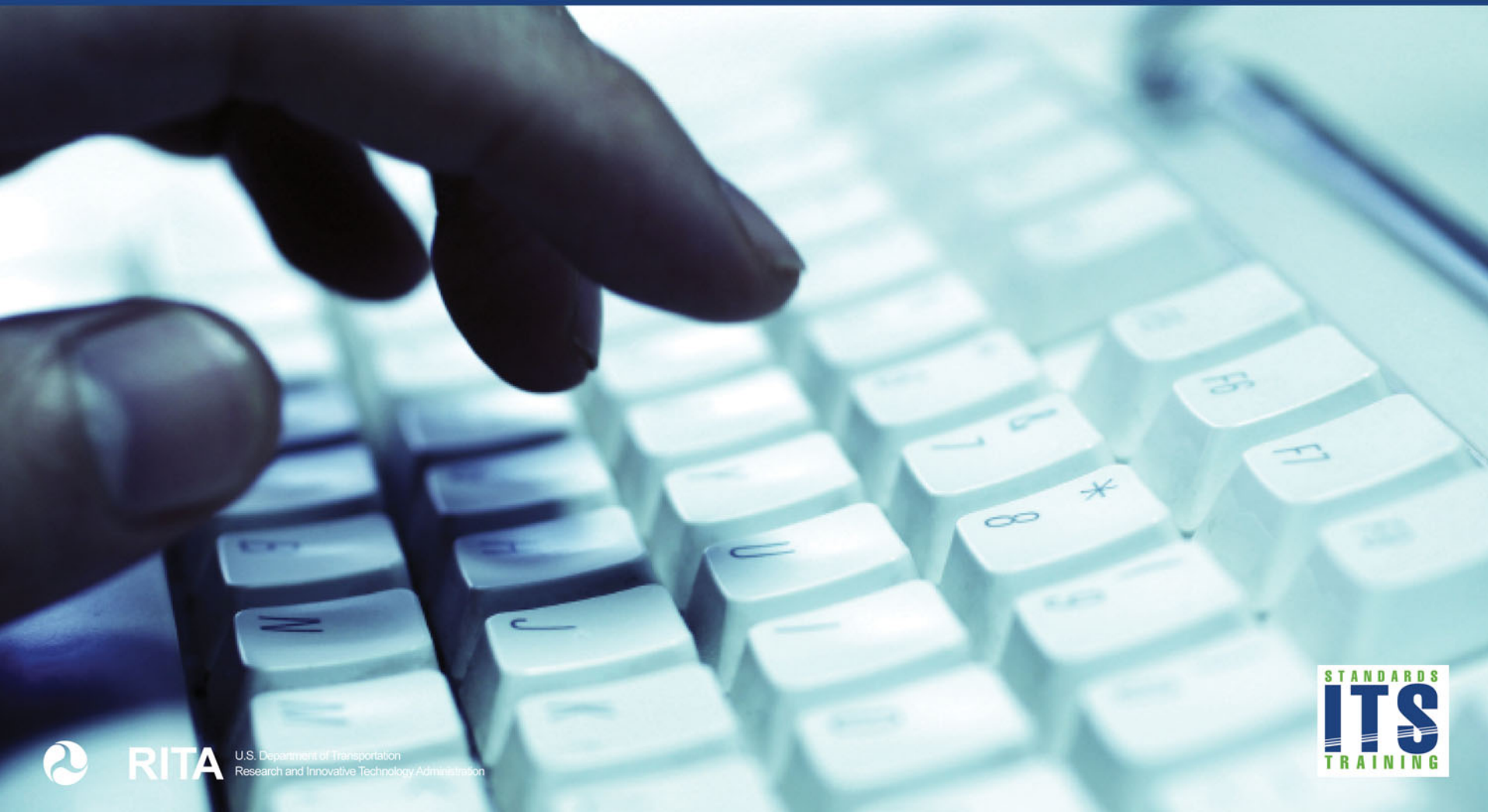
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Scenario for Quiz Questions
Sample Project to Deploy SSMs

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

Which of the following user needs does **not** need to be selected for our scenario?

See Student Supplement for PRL

Answer Choices

	User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
a)	2.5.1.2.4	Implement Plan Based on Timebase Schedule			M	Yes	
b)	2.5.1.2.5.1	Configure Traffic Responsive Mode			M	Yes	
c)	2.5.1.2.5.2	Configure Threshold Selection			O.1 (1..*)	Yes / No	
d)	2.5.1.2.5.3	Configure Signature Selection			O.1 (1..*)	Yes / No	

Review of answers

a) 2.5.1.2.4: Implement Plan Based on Timebase Schedule

Incorrect; this user need is needed for time-of-day pattern selection and is mandatory.

b) 2.5.1.2.5.1: Configure Traffic Responsive Mode

Incorrect; this user need is mandatory.

c) 2.5.1.2.5.2: Configure Threshold Selection

Correct! This user need is a part of the first option group and can be omitted if 2.5.1.2.5.3 is selected.

d) 2.5.1.2.5.3: Configure Signature Selection

Incorrect; while this is part of an option group, it is needed to support signature selection.

Which of the following user needs does not need to be selected for our scenario?

See Student Supplement for PRL

Answer Choices

	User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
a)	2.4.1	Provide Live Data			M	Yes	
b)	2.4.2	Provide Off-line Logged Data			M	Yes	
c)	2.4.4	Support Legacy Communication Networks			O	Yes / No	
d)	2.5.1.3.2	Manage System Display Data			M	Yes	

Review of answers

a) 2.4.1: Provide Live Data

Incorrect; this user need is mandatory.

b) 2.4.2: Provide Off-line Logged Data

Incorrect; this user need is mandatory.

c) 2.4.4: Support Legacy Communication Networks

Correct! This optional user need is not necessary for the project's stated goals.

d) 2.5.1.3.2: Manage System Display Data

Incorrect; this user need is mandatory.

Protocol Requirements List

Traceability to Requirements

▪ User needs describe **what** features the device needs to support and **why.**

▪ Functional requirements refine the user needs into detailed, measurable specifications.

▪ Within the PRL, the relationships between user needs and functional requirements are standardized.

  ❑ User needs justify and explain requirements

  ❑ Requirements refine needs to measurable concepts

  ❑ Promotes interoperability

Protocol Requirements List
Traceability to Requirements

- Functional Requirements Identifier (FR ID)
- Functional Requirement

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.1.2.5.2	Configure Threshold Selection			O.1 (1..*)	Yes / No	
		3.4.1.2	Configure Detector Grouping	M	Yes	
		3.4.3.5.3.5	Configure Queue Detector Override Thresholds	O	Yes / No	

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Protocol Requirements List
Conformance

- Predicate – The user needs applies only if a condition or feature is supported.

- Predicates are defined in Clause 3.2.3.2.

- Threshold is defined to be user need 2.5.1.2.5.1.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
		3.4.4.1.4.2	Failed System Detectors for Threshold Selection of Timing Plans	Threshold: M	Yes / NA	

Protocol Requirements List
Conformance

- Built-in predicate between needs and requirements
- "Configure Queue Detector Override Thresholds" is only applicable if "Configure Threshold Selection" is selected

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.1.2.5.2	Configure Threshold Selection			O.1 (1..*)	Yes / No	
		3.4.1.2	Configure Detector Grouping	M	Yes	
		3.4.3.5.3.5	Configure Queue Detector Override Thresholds	O	Yes / No	

Protocol Requirements List
Conformance

- Mandatory vs. Optional
    - If a user need is not selected, its associated requirements are not necessary, unless they are required by another user need selection.

| User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.3	Connect Communication Networks			M	Yes	
		3.3.1.6	Explore SSL Data by the TMS	M	Yes	
2.5.2	Manage SSLs			O	Yes , No	
		3.3.1.6	Explore SSL Data by the TMS	M	Yes	

Protocol Requirements List
Additional Project Requirements

- Used to enter additional notes and requirements
  - E.g., Defining performance ranges and sizes of data tables
- Used to provide further details about an implementation

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.1	Provide Live Data			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 _____ milliseconds (Default 2000).
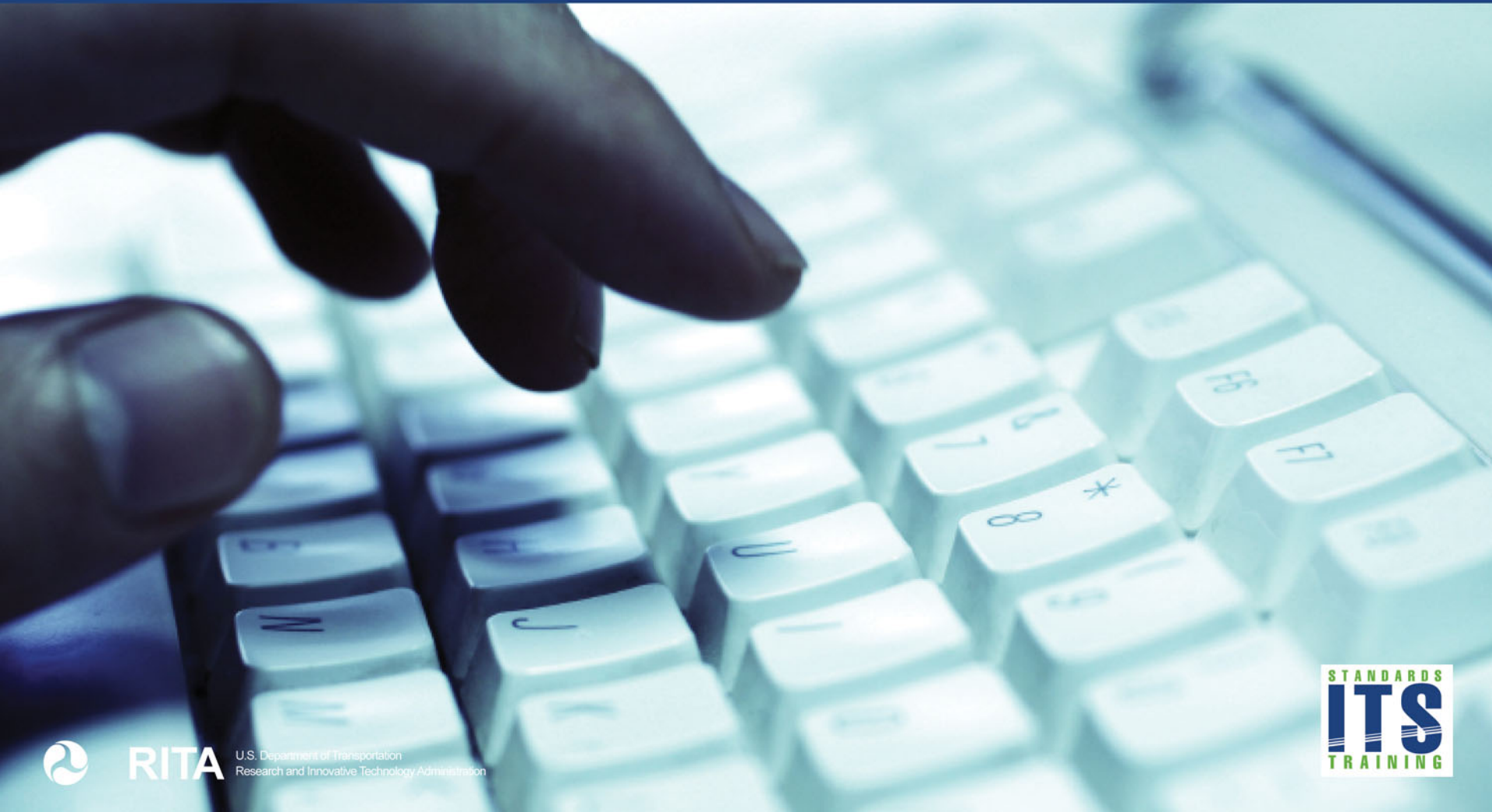
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Scenario for Quiz Questions
Sample Project to Deploy SSMs

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

Should the following user need be selected for our project?

See Student Supplement for PRL

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.1.1	Configure Cycle Timers and Unit Backup Time			M	Yes	

a) Yes

b) No

Review of answers

a) Yes

Correct! The "Configure Cycle Timers and Unit Backup Time" user need is mandatory.

b) No

This user need is mandatory and should always be selected.

Should the following user need be selected for our project?

See Student Supplement for PRL

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.1.2.5.2	Configure Threshold Selection			O.1 (1..*)	Yes / No	

a) Yes

b) No

Review of answers

a) Yes

Incorrect. The "Configure Threshold Selection" user need is optional and is not required since it does not support traffic pattern signature capabilities, which is the stated focus of the project.

b) No

Correct! This user need is not needed to fulfill the stated project capabilities.

Should the following user need be selected for our project?

See Student Supplement for PRL

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.5.1.2.5.3	Configure Signature Selection			O.1 (1..*)	Yes / No	

a) Yes
b) No

Review of answers

a) Yes

Correct! The "Configure Signature Selection" user need is needed to fulfill the stated project requirements.

b) No

Incorrect. This user need is necessary to fulfill the traffic pattern signature capabilities, which is the stated focus of the project.

Protocol Requirements List
Agency's PRL

An agency's completed PRL is useful.

- Specifies the needs and requirements for a project

- Requirements map to an interoperable design

- Becomes part of plans, specifications, and estimates (PS&E) package

- A vendor may "exceed the specification"

  - Support features not selected

  - Allows vendor to bid on more projects with a single model

- Can be used as a checklist during development

- Serves as the basis of selecting test procedures

Protocol Requirements List
Vendors' PRLs

Vendors can complete PRLs to describe their products.

- Quickly tells agencies which features are supported by the product

- Agency can archive with project documentation

Protocol Requirements List
Interoperability

PRLs can be used to check for degree of interoperability

▪ For a feature to work, both the management system and the device must support the feature.

Summary of Learning Objective #3

The PRL:

- Links user needs and requirements
- Allows selection of user needs and requirements
- Provides a checklist of features to consider
- Provides a listing of features supported by an implementation
- Provides a useful way to compare products for interoperability

Learning Objective #4

Explain how the PRL table of the NTCIP 1210 standard integrates into an FMS specification.

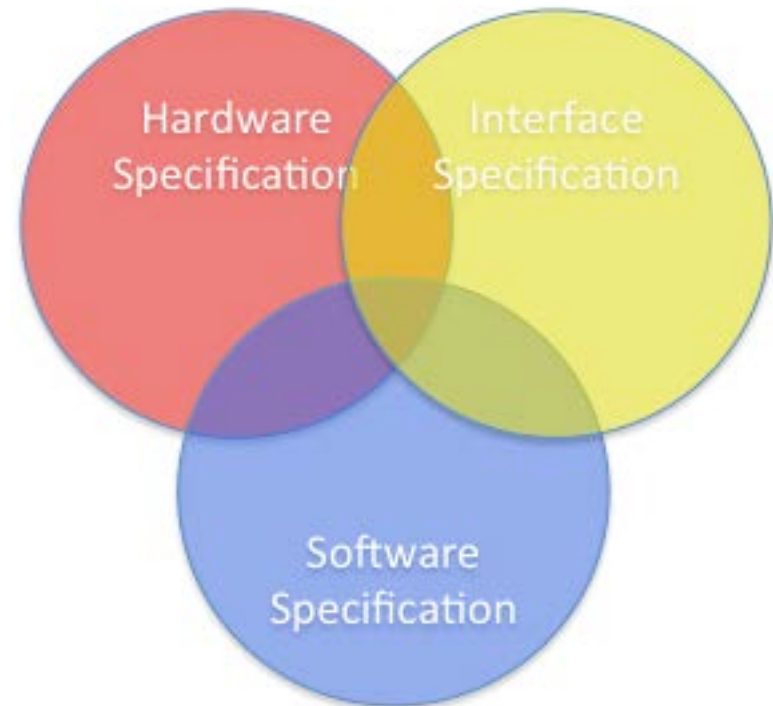# Integrating a PRL into a Specification
Part of Interface Specification

- 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

Integrating a PRL into 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

Integrating a PRL into a Specification
Sample Text

- The PRL should be properly introduced within the specification.

- A copyright disclaimer should appear with the PRL.

- Additional requirements are needed for NTCIP 1210.
  - NTCIP 1210 fails to identify all of the necessary "Additional Project Requirements" such as number of intersections that must be supported.

- See Student Supplement for sample text.

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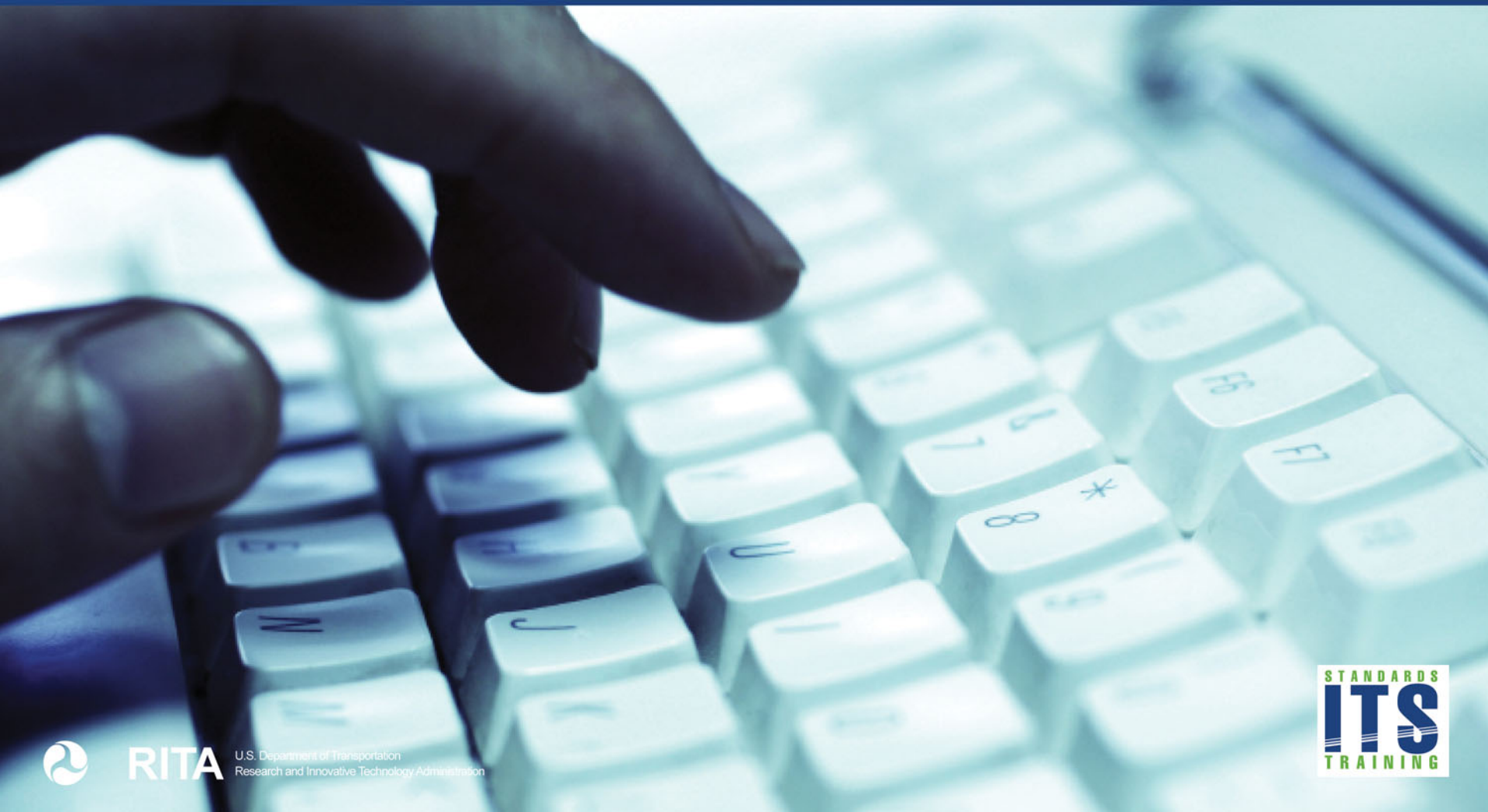
Which of the following statements is *false*?

Answer Choices

a) A vendor may support features not selected in the PRL.

b) The PRL forms a complete interface specification.

c) A deployment may support multiple interface specifications.

d) This interface specification must be consistent with the hardware and software specifications.

Review of answers

a) A vendor may support features not selected.

They may be provided if they are not explicitly prohibited and certain rules are followed.

b) The PRL forms a complete interface specification.

Correct, the PRL must first be coupled with a communication specification.

c) A deployment may support multiple interfaces.

The system may need to support legacy interfaces or other device types.

d) Interface must be consistent with hardware and software.

All interface portions must be consistent with all other parts of the specification.

Summary of Learning Objective #4

The PRL:

- Should be included in specification
- Should not conflict with other portions of the specification
- Should be supplemented with additional text per the Student Supplement

What We Have Learned

1) NTCIP 1210 defines the concept of operations and user needs for **_Signal System Masters_**.

2) NTCIP 1210 follows the **_SEP_** approach.

3) There are four major categories of SSM user needs.

   a) Configure Cycle **_Timers_**

   b) Manage **_System Timing Plans_**

   c) Monitor **_System Operation_**

   d) Manage **_SSLs_**

4) A **_Protocol Requirements List_** is used to link user needs to functional requirements.

5) A completed PRL should be integrated into the project **_specifications_**.

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 1362**
  - ❑ IEEE Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document
  - ❑ www.ieee.org

QUESTIONS?

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Next Course Module

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

- Reviews the requirements contained in the standard
- Shows relationships between requirements and design
- Shows how to select and refine requirements using PRL
- The final module in the SSM procurement path