



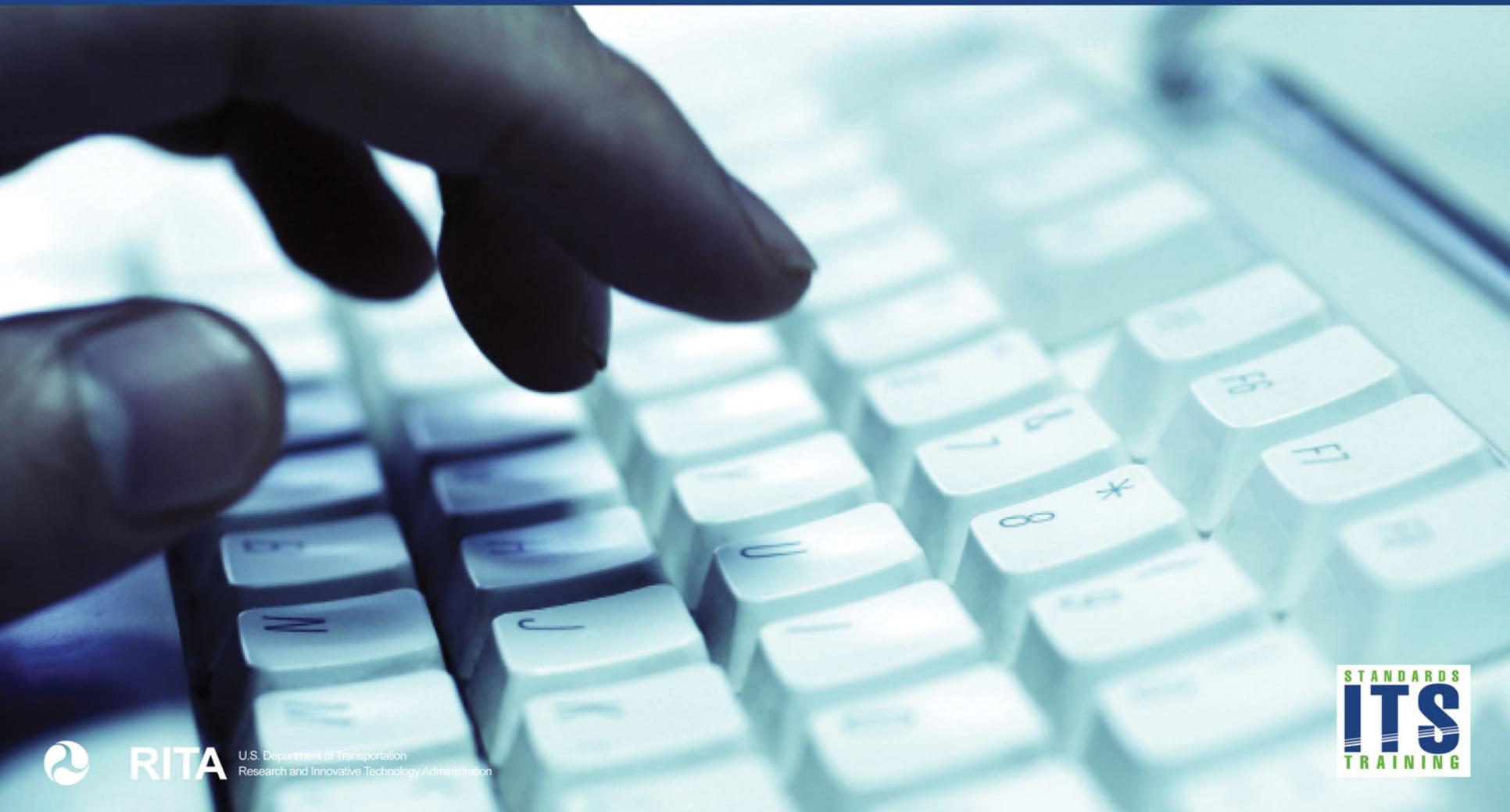
W E L C O M E

RITA Intelligent Transportation Systems
Joint Program Office

A306a:
Understanding User Needs for
Electrical and Lighting Management Systems
(ELMS)
Based on NTCIP 1213 Standard



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Instructor



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Target Audience

- Engineering staff
- Street lighting maintenance staff
- TMC/operations staff
- System developers
- Private and public sector users including manufacturers

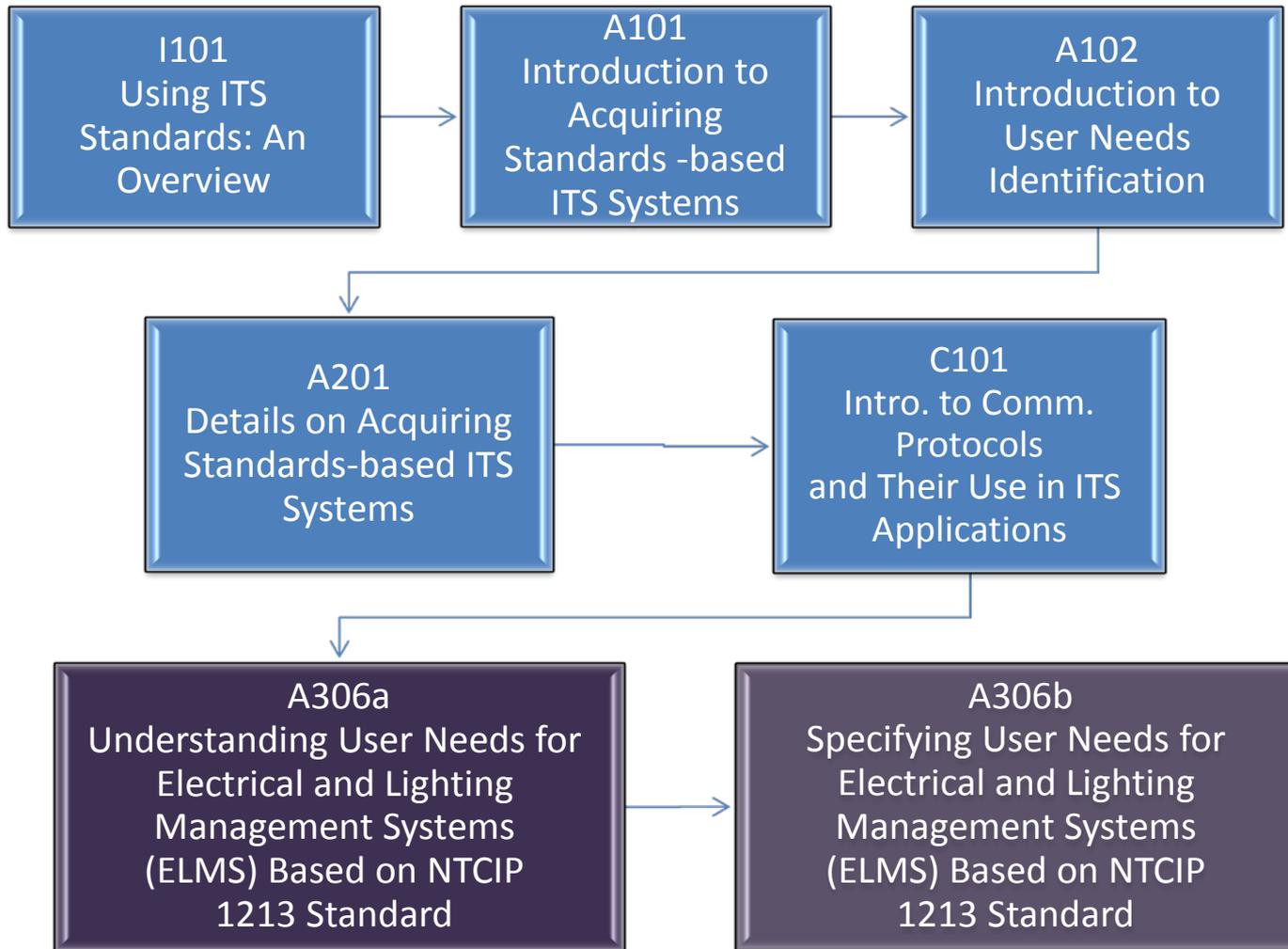


Recommended Prerequisite(s)

- 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)



Learning Objectives

1. Review the structure of the NTCIP 1213 v02 Standard for Electrical and Lighting Management Systems (ELMS)
2. Identify ELMS specific user needs
3. Use the Protocol Requirements List (PRL) to select the user needs and link to requirements
4. Explain how the ELMS PRL table of the NTCIP 1213 Standard fits into the development of ELMS project specifications and contract documents



Value of an ELMS Module Sequence

The ELMS NTCIP 1213 Group of Modules consists of:

- A306a - Understanding User Needs for Electrical and Lighting Management Systems (ELMS)
- A306b - Specifying Requirements for Electrical and Lighting Management Systems (ELMS)
- T306 - Applying your Test Plan for Electrical and Lighting Management Systems (ELMS)



Learning Objective #1 – Review the Structure of the NTCIP 1213 v02 Standard

- Purpose of the NTCIP 1213 v02 Standard
- Components and structure of the NTCIP 1213 v02 Standard
- How the standard fits into the Systems Engineering Process (SEP) life cycle



Definition and Purpose of an ELMS

An ELMS is defined as a system or device that:

- Senses and communicates near real-time data
- Focuses on electrical and lighting parameters
- Uses the USDOT NTCIP protocol

What Defines a System as an ELMS?

To be an ELMS system, a system needs to:

- Communicate using NTCIP
- Support mandatory ELMS attributes
- Communicate near real-time data



CASE STUDY



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ELMS Case Study – Anytown, USA

- You are the public works manager responsible for:
 - Traffic signals, roadway lighting, and infrastructure.

- Users
 - The finance director
 - Field staff

- You need to:
 - Deploy dimmable LED street lighting
 - Prepare for adaptive dynamic roadway lighting systems of the future
 - Minimize ground fault injuries

ELMS Case Study – Anytown, USA

The User Needs

- Energy use must be controllable
- Power outages must be communicated in near real-time
- Dimmable LED lighting must be deployed
- Adaptive control of lighting based on vehicular and pedestrian traffic must be deployed
- Ground fault conditions must be communicated in near real-time



ELMS Case Study – Anytown, USA

- You have reviewed ELMS standards-based solutions
- You consider ELMS-based solutions very promising
- You then ask yourself:

Can an ELMS system satisfy these five wide ranging user needs?

The answer is **YES**.

This course will provide the domain knowledge to achieve those goals.



The NTCIP 1213 ELMS Standard

- User needs supported by the standard
 - Example: Implement Roadway Lighting Plan based on time schedule

- Functional requirements supported by the standard
 - Example: Control Roadway Lighting Levels based on time-of-day

- Supports interoperability
 - Example: By providing standardized functionality with NTCIP, ITS, and Smart Grid systems



Structure of the ELMS NTCIP 1213 Standard

NTCIP 1213 Table of Contents

- Section 1: General
- Section 2: Concept of Operations (ConOps)
- Section 3: Functional Requirements
- Section 4: Dialog Specifications
- Section 5: Master Object Definitions
- Annex A: Requirements Traceability Matrix (RTM)
- Annex B: Object Tree
- Annex C: Revised Object Definitions for Astronomical Clock



Benefits of the ELMS NTCIP 1213 Standard

Follows the Systems Engineering Process (SEP) and provides the following benefits:

- Ease of Use
- Easy to Specify
- Easy to Test
- Supports Interoperability
- Provides “drop-in” user needs



Review of the ELMS Standard NTCIP 1213

National Transportation Communications for ITS Protocols (NTCIP): a family of standards for the ITS industry

- Provides rules for communicating (called protocols)
- Provides the vocabulary (called objects) necessary to control and monitor ELMS field equipment such as:
 - Roadway Lighting
 - Ground Fault Equipment
 - Revenue Grade Power Metering



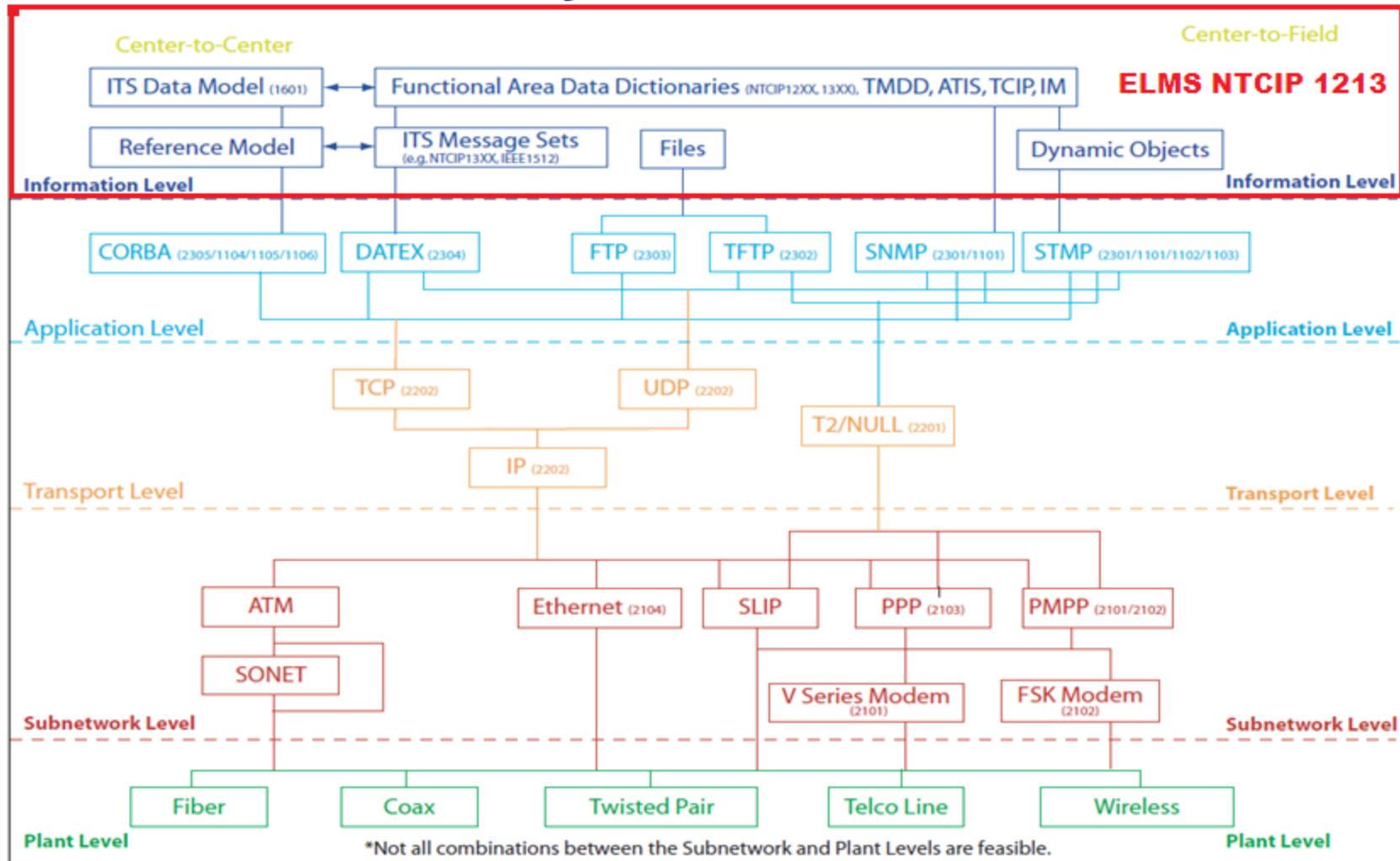
The NTCIP Family of ITS Standards

A family of standards for the ITS industry (cont.)

- Information profile standards contain “objects.”
- Objects are aggregated in a data table known as a Management Information Base (MIB).
- Underlying communications standards are called “protocols.”
- NTCIP 1213 is an information content standard.



The NTCIP Family of ITS Standards



Source: NTCIP 9001, Exhibit 3.3: NTCIP Standards Framework

Review of the ELMS NTCIP 1213 Standard

What is NTCIP 1213?

- Standardizes the communications interface
- Specifies the interface between the ELMS systems in the field and the host system

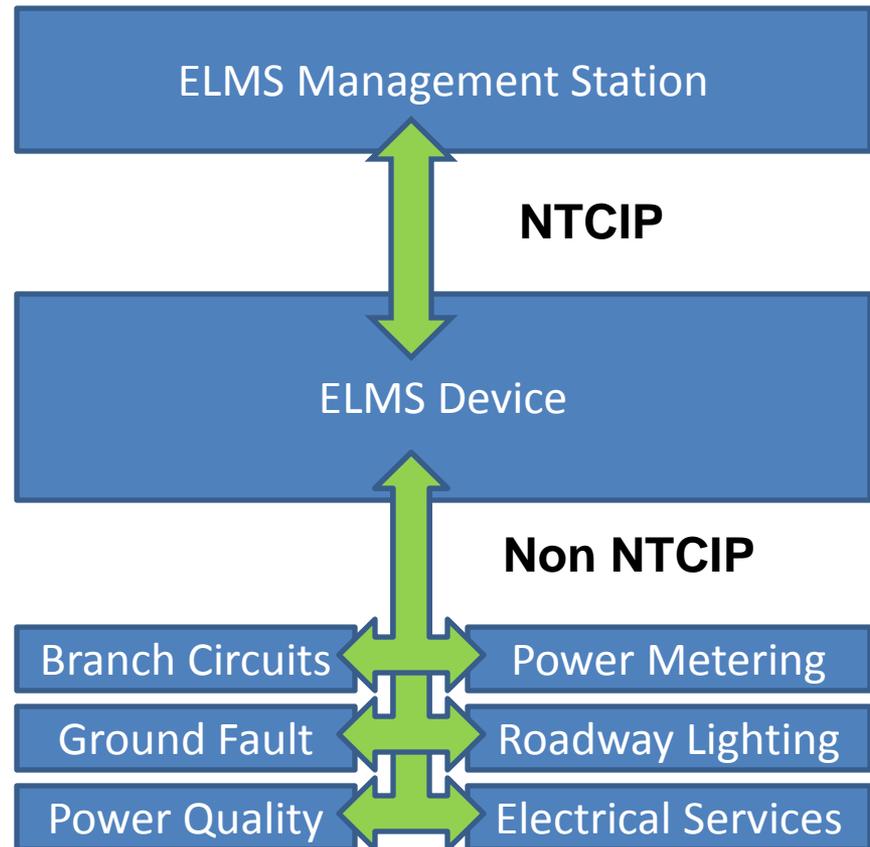
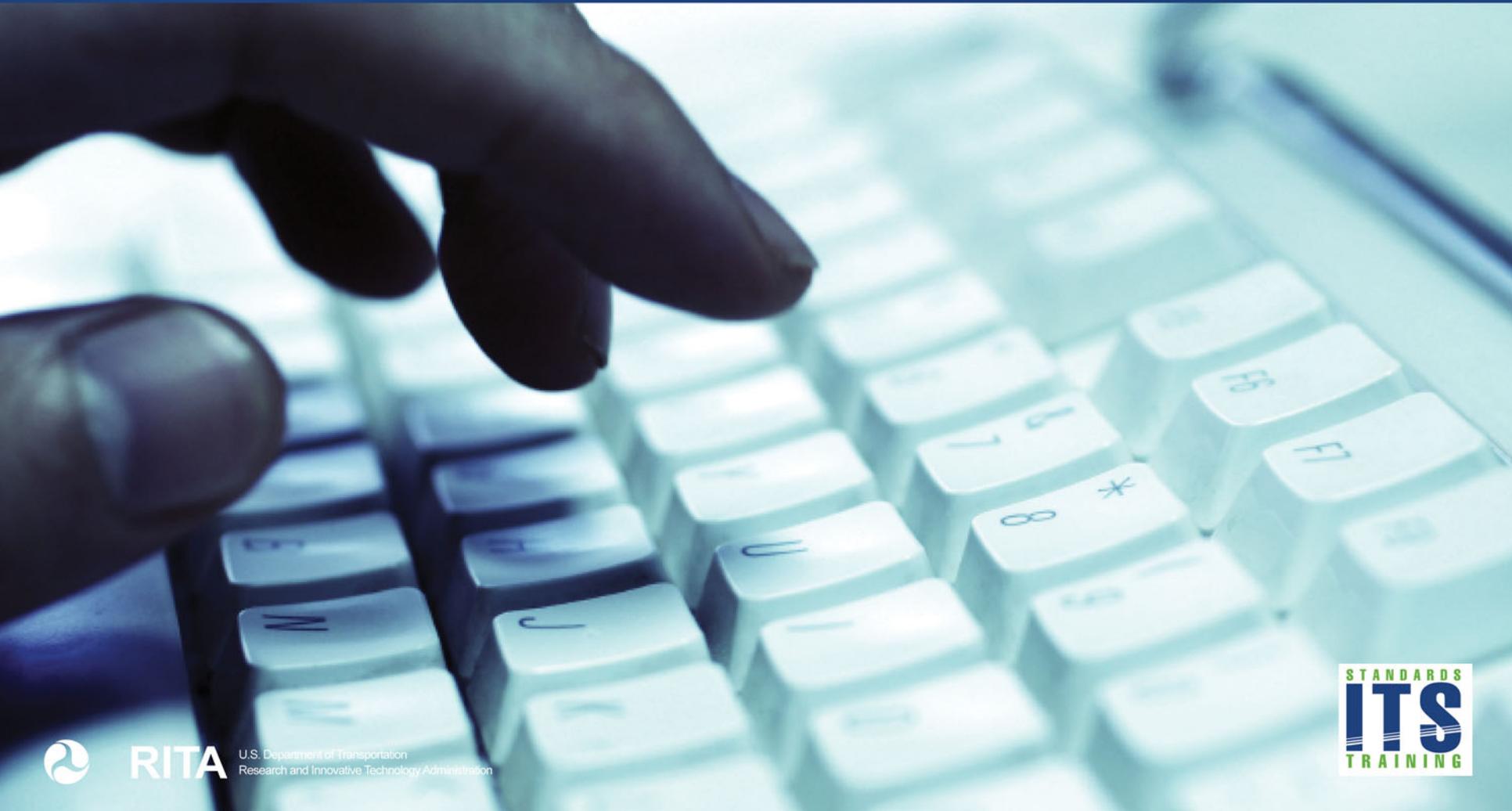


Figure 1, Page 9, NTCIP 1213 Standard

History of the ELMS NTCIP 1213 Standard

- NTCIP 1213 v01.03. February 2004: Accepted as a user comment draft
- NTCIP 1213 v02.19. December 2005: Accepted v02.19b as a recommended standard
- NTCIP 1213 v02.20. February 2011: Published

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Which of the following statements is true?

Answer Choices

- a) NTCIP 1213 is an information content standard.
- b) NTCIP 1213 is an application level standard.
- c) NTCIP 1213 is a transport level standard.
- d) NTCIP 1213 is a plant level standard.



Review of Answers



a) NTCIP 1213 is an information content standard.

Correct because NTCIP 1213 addresses the information level of interoperability.



b) NTCIP 1213 is an application level standard.

Incorrect because NTCIP 1213 does not address the application level.



c) NTCIP 1213 is a transport level standard.

Incorrect because NTCIP 1213 does not address the transport level.



d) NTCIP 1213 is a plant level standard.

Incorrect because NTCIP 1213 does not address the plant level.

Major Benefits of ELMS NTCIP 1213

- Defines user needs supported by the standard
 - Example: Monitor the status of the ELMS Luminaire Switch Status Message
- Defines functional requirements supported by the ELMS standard
 - Example: Monitor the ELMS Luminaire Current Status Message
- Requirements are traced to the user need "monitor the status of the ELMS message."

Advantages of ELMS NTCIP 1213

Enables Solutions that are:

- Easier to use
- Easier to specify
- Easier to test

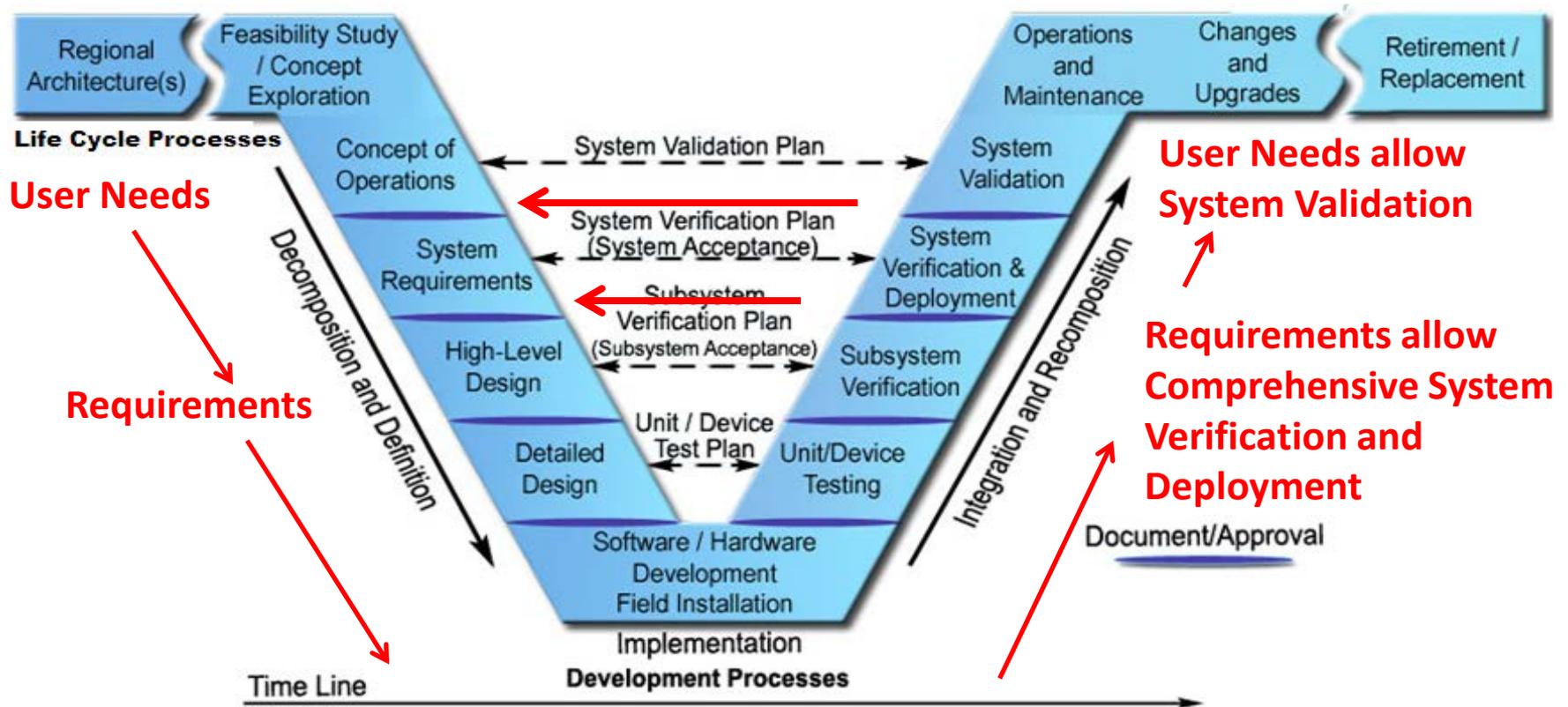
Advantages of SEP and ELMS NTCIP 1213

- Supports off-the-shelf interoperability
- Based on the requirements, the standard specifies the design, ensuring consistency between implementations
- Provides standardized user needs, requirements, and design content to fully support project engineering activities using the Systems Engineering Process (SEP)

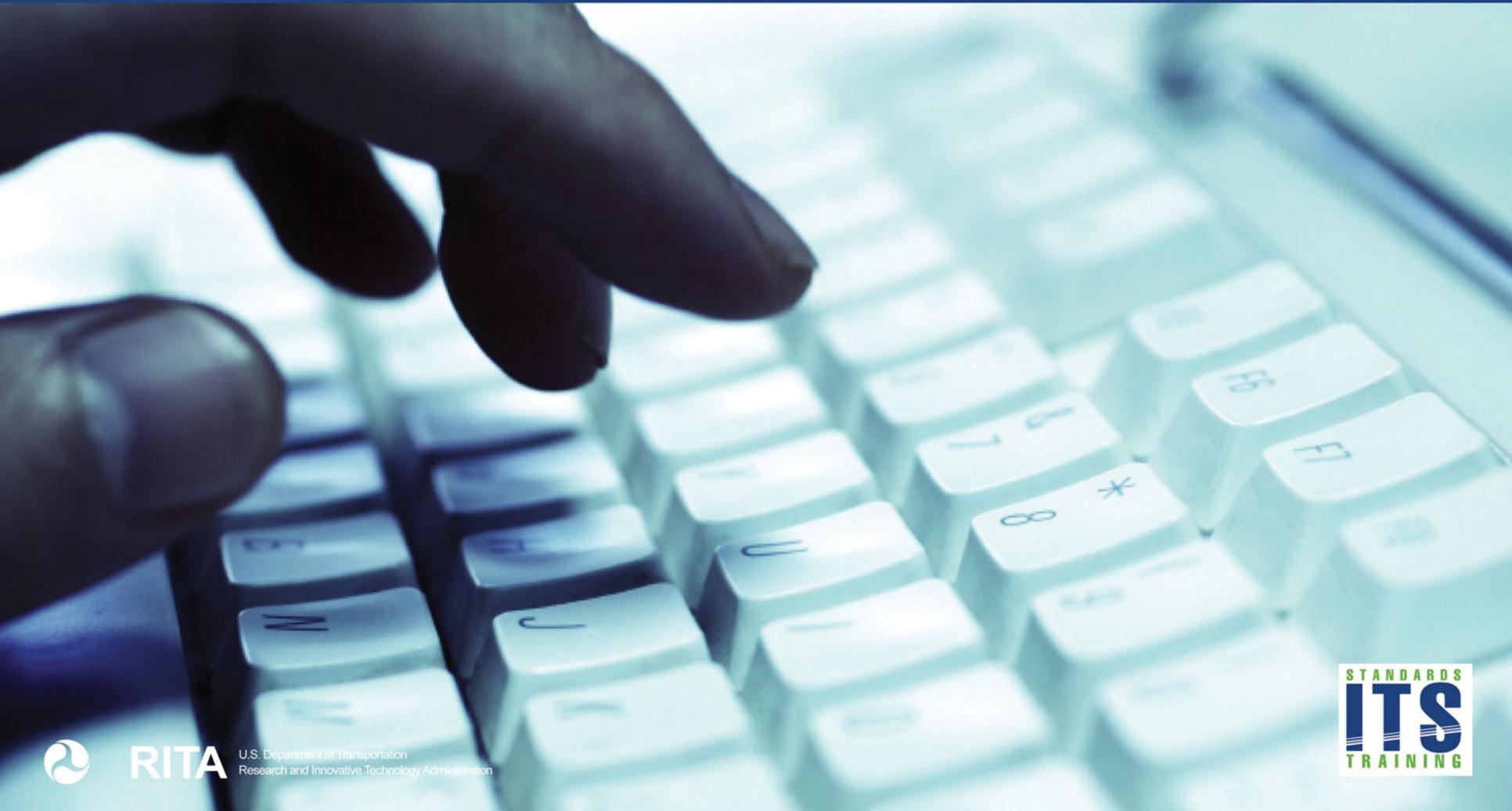


ELMS NTCIP 1213 and the Systems Engineering Process Life Cycle

The SEP "V" Model



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Which of the following is not an advantage of using the Systems Engineering Process for the ELMS NTCIP 1213 Standard?

Answer Choices

- a) Supports interoperability
- b) Allows multiple designs for each requirement
- c) Allows clear development of test procedures based on the requirements selected
- d) Determines what user needs are supported

Review of Answers



a) Supports interoperability

True, the NTCIP 1213 SEP process supports the information level of interoperability.



b) It allows multiple designs for each requirement

False, the NTCIP 1213 does define a unique design for each requirement.



c) Allows clear development of test procedures based on the requirements selected

True, the NTCIP 1213 describes clear test procedures.



d) Determines what user needs are supported

True, the NTCIP 1213 determines the user needs to be supported.

Summary of Learning Objective #1

Review the structure of the NTCIP 1213 v02 Standard

- Purpose and selection of the standard
- Identify components of the standard
 - ConOps
 - Requirements
 - Dialogs
 - MIB
 - PRL
 - RTM
- Location of user needs and standards on “V” diagram life-cycle process



Learning Objective #2 – Identify Specific ELMS User Needs

- Architecture of an ELMS
- Define ELMS terms and concepts
- User needs (expressed as features)



CASE STUDY



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ELMS Case Study – A City in Minnesota

The User Needs

During a downtown reconstruction project, these user needs were identified:

- ❑ Lighting system attributes must be monitored.
- ❑ Ground fault conditions must be communicated in near real-time.
- ❑ Selected lighting fixtures must be turned off during non-peak periods.



Image © 2012 Gridaptive Technologies

ELMS Case Study – A City in Minnesota

The Results

- Roadway lighting system attributes are monitored.
- Ground fault conditions are communicated in near real-time.
- Selected lighting fixtures are turned off during non-peak periods.

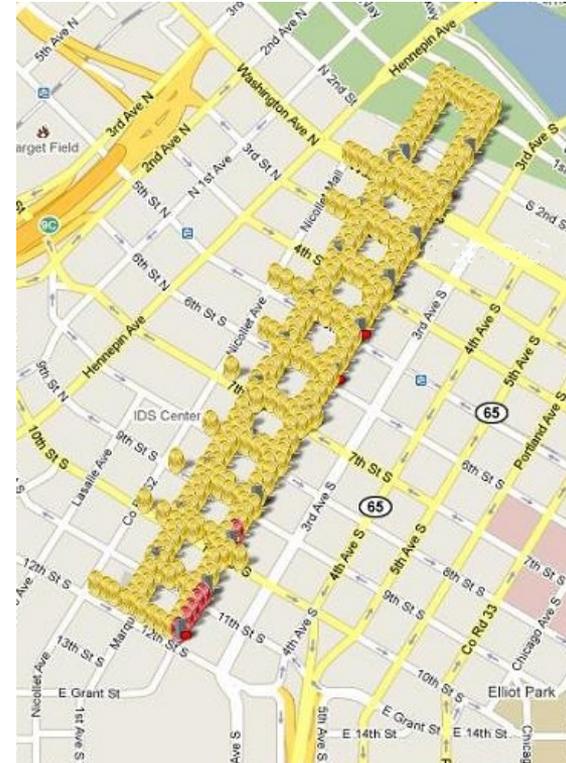


Image © 2012 Gridaptive Technologies

ELMS Case Study – A County in Florida

The User Needs

Due to severe and fatal injuries of people and animals, these user needs were recognized:

- ❑ Ground fault conditions must be communicated in near real-time.
- ❑ Data must be logged.
- ❑ Reports of alarms must be generated.



Image © 2012 Gridaptive Technologies

ELMS Case Study – A County in Florida

The Result

- Ground fault conditions are communicated in near real-time.
- Data is logged.
- Reports of alarms are generated.



Image © 2012 Gridaptive Technologies

ELMS Case Study – Washington State DOT

The User Needs

During a tunnel and bridge project these user needs were identified:

- ❑ Energy use must be controlled.
- ❑ Power outages must be communicated in near real-time.
- ❑ Adaptive control of lighting based on ambient light levels must be deployed.

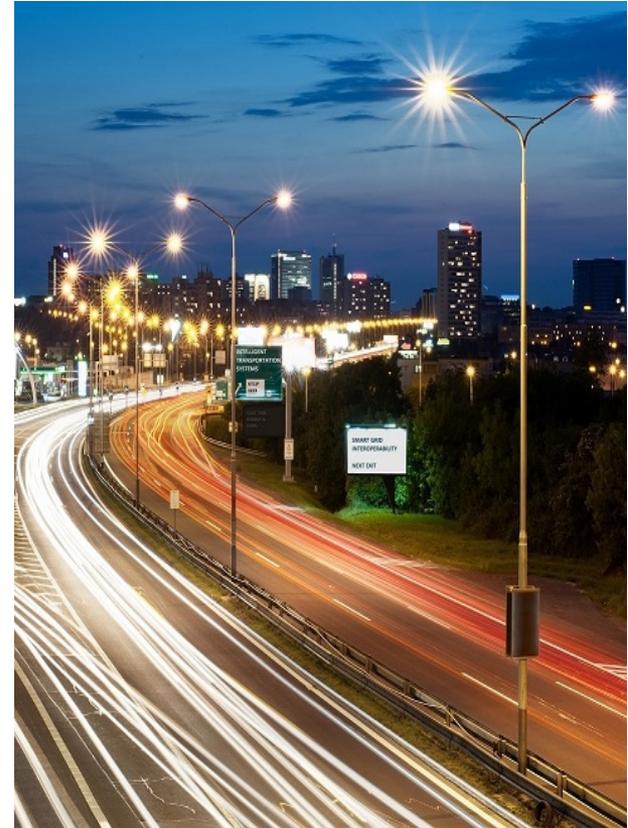


Image © 2012 Gridaptive Technologies

ELMS Case Study – Washington State DOT

The Results

- Energy use is controlled.
- Power outages are communicated in near real-time.
- Adaptive control of lighting based on ambient light levels is deployed.



Image © 2012 Gridaptive Technologies

ELMS NTCIP 1213 Concept of Operations

What is the Concept of Operations?

- Focus is on a system and its users
- Time frame is the life cycle of the system
- Defines the user needs supported by the standard
- Provides an operational context for the system



Primary Uses of ELMS NTCIP 1213 Systems

ELMS is used for control and monitoring of:

- Roadway lighting, including scheduling and zoning
- Safety: electrical leakage anomalies
- Revenue grade power metering, i.e. “billable” metering
- Integration with other systems including:
 - Vehicle-to-grid infrastructure
 - The electrical distribution network (the smart grid)
 - Electric vehicle charging infrastructure, traffic signal power usage, DMS power usage, etc.



What is a User Need?

Describes the major capability provided by a system to satisfy an operational need

- A system should not be procured or built without knowing what it is expected to do, such as:
 - Control roadway lighting
 - Monitor ground fault conditions
 - Monitor electrical power usage

Who and What Can Generate User Needs?

User needs describe the major capability provided by a system to satisfy an operational need.

- People have user needs
 - Travelers
 - TMC operators
 - Maintenance personnel

- In some contexts, a system may generate user needs: "the management station may need to modify operational parameters..."

ELMS NTCIP 1213 User Needs

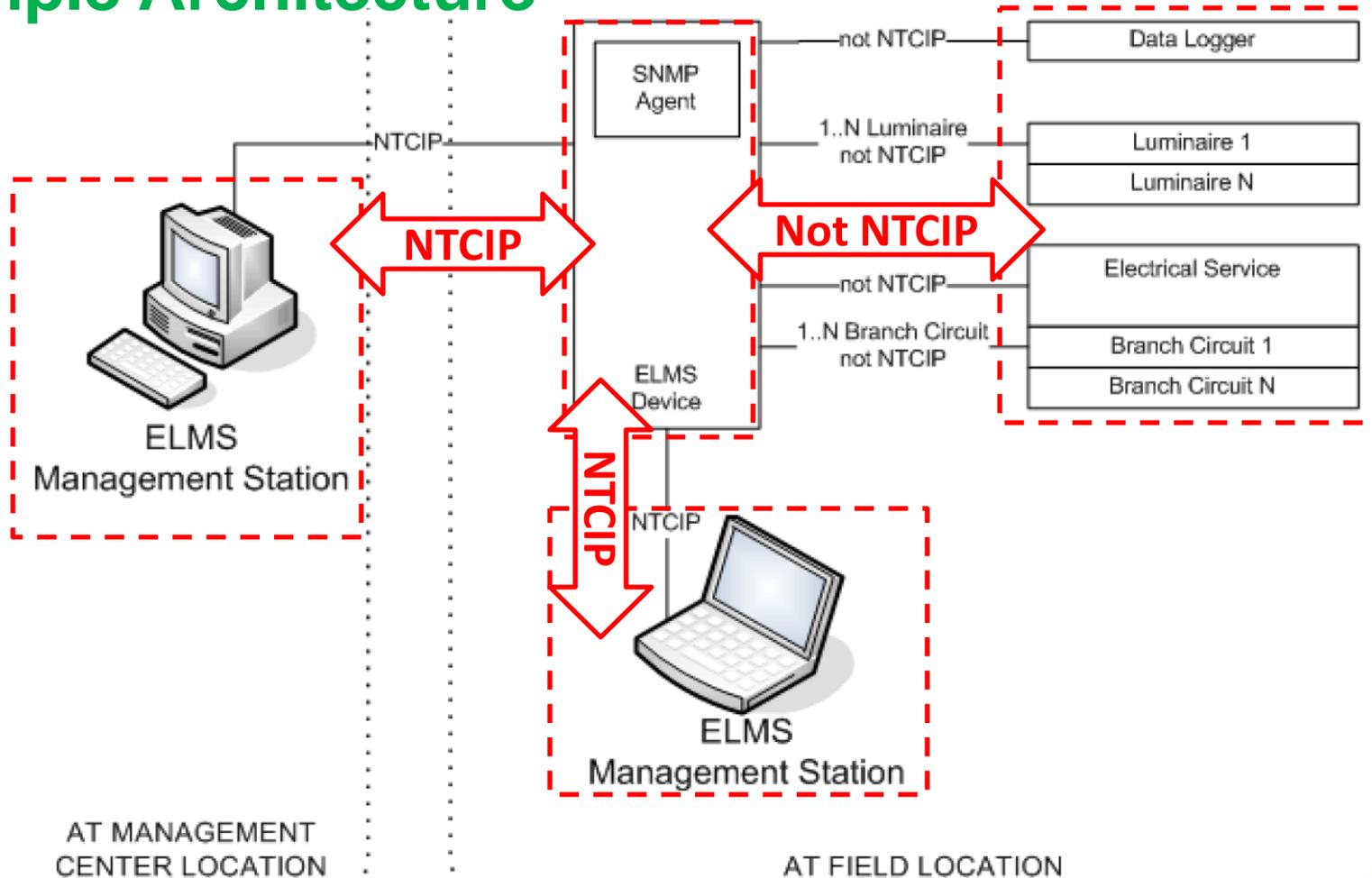
The ELMS Problem Statement

- Need to manage generic information (e.g., device ID)
- Need to detect/sense device information from sensors in the field
- Need to control field sensor attributes
- Need to integrate to other ELMS systems and other communications platforms



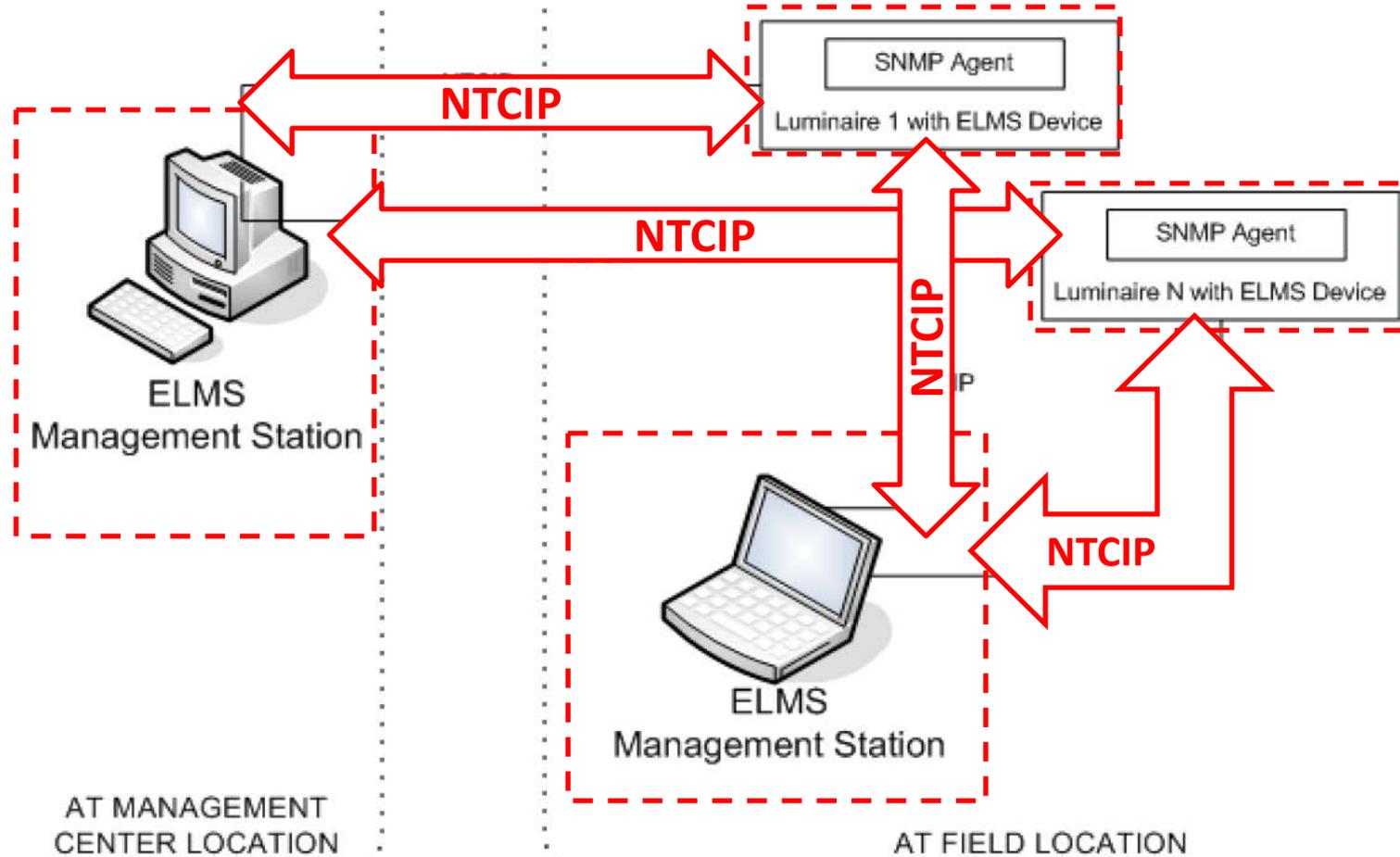
Scope of the ELMS NTCIP 1213 Standard

Simple Architecture



Scope of the ELMS NTCIP 1213 Standard

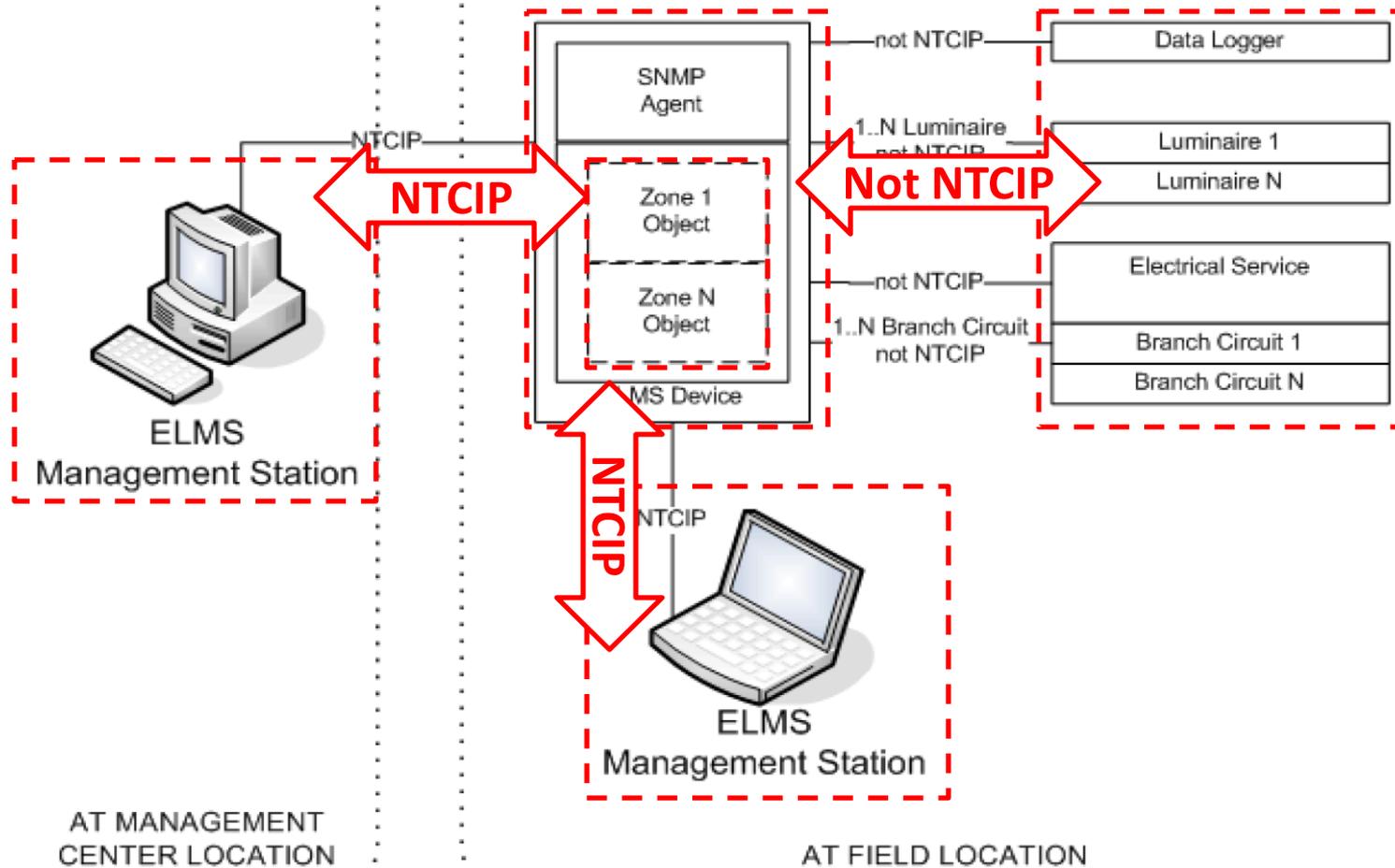
Alternate Architecture: ELMS within a Luminaire



Source Figure 1 , Page 9 NTCIP 1213 Standard

Scope of the ELMS NTCIP 1213 Standard

Alternate Architectures – Logical Zoning



ELMS NTCIP 1213 User Needs in Detail

- Section 2.4 describes the major user needs that are related to the definition of the interface between the management station and an ELMS field device.
- The user needs are considered to be the “high level” capabilities for NTCIP 1213 v02 and form the basis for defining the detailed functional requirements of the interface.



ELMS NTCIP 1213 User Needs in Detail

The user needs are organized as follows:

- Operational—defining the basic modes of operation for communication between the management station and field devices
- Features—describing essential data communication functions and message elements to be supported by the interface

ELMS NTCIP 1213 Operational User Needs

Provide Live Data (mandatory)

2.4.1.1 Provide Live Data

One operational environment allows the management system to monitor and control the device by issuing requests (e.g., requests to access information, alter information, or control the device). In this environment, the device responds to requests from the management station immediately (e.g., through the provision of live data, success/failure notice of information alteration, or success/failure of the command).



ELMS NTCIP 1213 Operational User Needs

Provide Off-line Logged Data

2.4.1.2 Provide Off-Line Log Data

Some operational environments do not have always-on connections (e.g., dial-up links). In such environments, a transportation system operator may wish to define conditions under which data is placed into a log, which can then be uploaded at a later time. For example, the operator may wish to manage the ELMS device so that it autonomously maintains a log of whenever a specific luminaire is turned on or off.

ELMS NTCIP 1213 Features

Relate to the informational needs of the users

Divided into three major functional categories

1. Control, monitor, and manage roadway lighting
2. Control, monitor, and manage electrical power
3. Control, monitor, and manage electrical safety



ELMS NTCIP 1213 Features: Manage Roadway Lighting

Managing Roadway Lighting includes several sub-needs:

- Implement lighting plan based on ambient light level
- Implement lighting plan based on time schedule
- Create zone
- Configure zone

ELMS NTCIP 1213 Features: Manage Roadway Lighting

Managing Roadway Lighting includes several sub-needs:

- Configure schedule
- Apply schedule to zone
- Configure Roadway Lighting Dim Level



ELMS NTCIP 1213 Features: Manage Roadway Lighting

Managing Roadway Lighting also includes luminaire sub-needs:

- Configuration of Luminaire Switch State Logging
- Configuration of Luminaire Lamp Condition Logging
- Configuration of Luminaire Burn Condition Logging
- Configuration of Luminaire Pole Condition Logging

ELMS NTCIP 1213 Features: Manage Roadway Lighting

Managing Roadway Lighting also includes Luminaire sub-needs:

- Configuration of Luminaire Switch State
- Configuration of Luminaire Identification
- Configuration of Luminaire Dim Level
- Control of Luminaire

ELMS NTCIP 1213 Features: Manage Electrical Power

Managing Electrical Power includes several sub-needs:

- Configure and monitor Power Meter Switch State
- Configure and monitor Power Meter Switch State Logging
- Configure and monitor Power Meter Condition Logging
- Configure and monitor Power Meter Periodic Measurement Logging

ELMS NTCIP 1213 Features: Manage Electrical Safety

Managing Electrical Safety includes several sub-needs:

- Configure and monitor Ground Fault Switch State Logging
- Configure and monitor Periodic Ground Fault Measurement Logging
- Configure and monitor electrical service



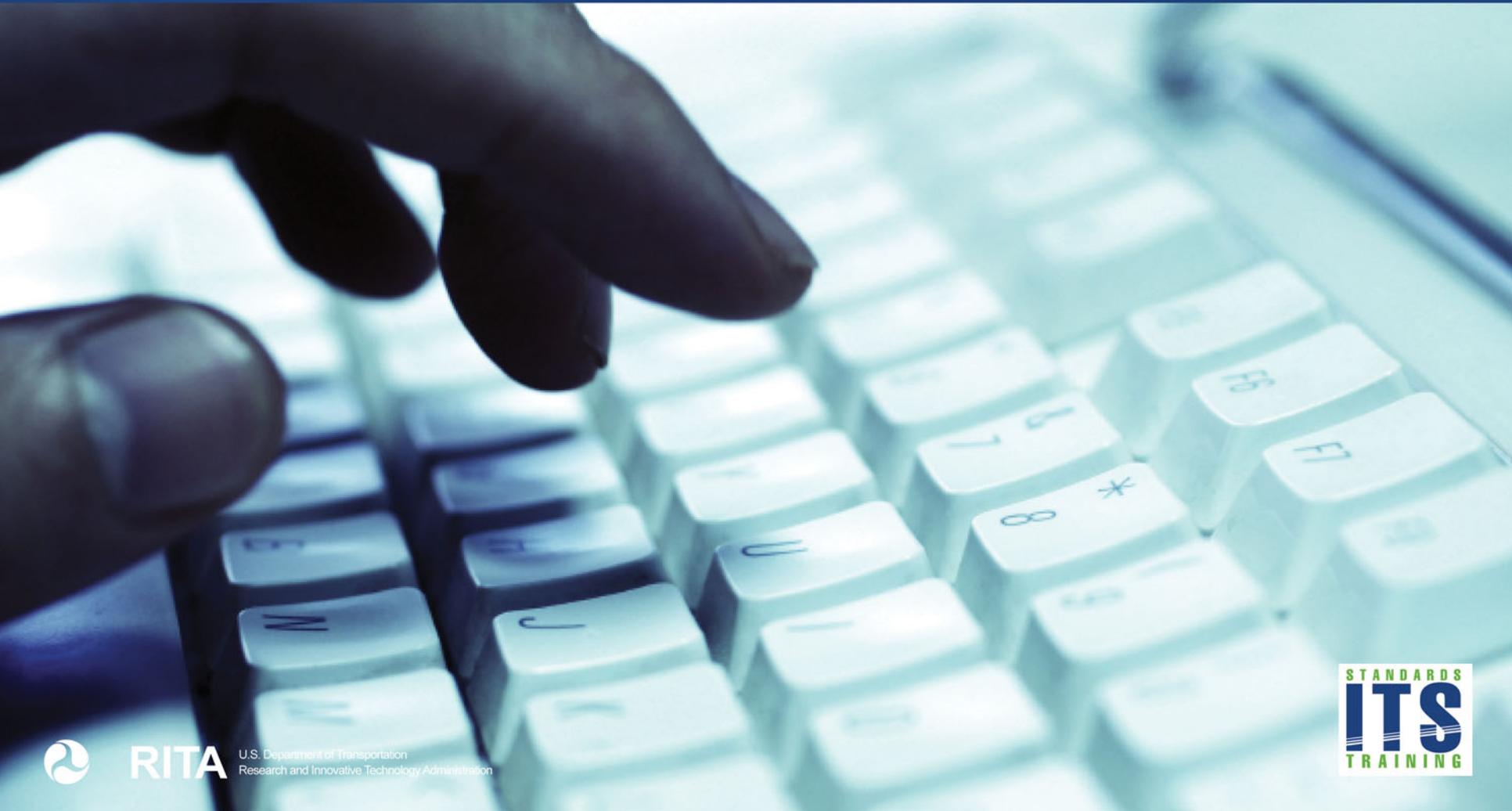
ELMS NTCIP 1213 Features: Manage Electrical Safety

Managing Electrical Safety includes several additional sub-needs:

- Configure and monitor circuit
- Monitor circuit breaker
- Monitor Arc Fault Status



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Which of the following user needs cannot be satisfied by an ELMS system?

Answer Choices

- a) Need to inform TMC manager of electrical leakage
- b) Need to control traffic flow at an intersection
- c) Need to inform TMC manager of energy usage
- d) Need to control lighting levels by dimming

Review of Answers



- a) Need to inform TMC manager of electrical leakage
Incorrect, NTCIP 1213 supports the communications of electrical leakage information.



- b) Need to control traffic flow at an intersection
Correct, NTCIP 1213 does not support traffic flow.



- c) Need to inform TMC manager of energy usage
Incorrect, NTCIP 1213 supports the communications of energy usage information.



- d) Need to control lighting levels by dimming
Incorrect, NTCIP 1213 supports the communications of dimming information.

Summary of Learning Objective #2

- Identified specific ELMS user needs
- What are you trying to do as ELMS? (problem definition)
- Introduced generic architecture model



Learning Objective #3 – Use the Protocol Requirements List (PRL) to Select User Needs and Link to Requirements

- Understand the parts of the PRL
- Use the PRL as a tool for project-specific implementations
- Reduce the risk of failure



ELMS NTCIP 1213 Functional Requirements

Section 3 of the ELMS standard defines the requirements based on the user needs identified in Section 2, and the interrelationship of user needs and functional requirements.

- The Protocol Requirements List (PRL)
- Operational environment requirements
- Functional requirements
- Supplemental requirements



The Purpose of the ELMS Protocol Requirements List

The PRL's purpose is to:

- Be a table that maps the user needs to the requirements
- Be part of the agency's specification
- Reference the standard to define the communication interface
- Help define what you want the interface to do
- Identify what requirements will be selected to address a specific set of user needs



The ELMS Protocol Requirements List

3.2.5 Protocol Requirements List (PRL)

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.1	Operational User Needs			M	Yes	
2.4.1.1	Provide Live Data			M	Yes	
		3.3.1.1	Retrieve Data	M	Yes	
		3.3.1.2	Deliver Data	M	Yes	
		3.3.1.3	Data Retrieval and Data Delivery Action Performance	M	Yes	
		3.5.5.1	Live Data Response Time	M	Yes	
2.4.1.2	Provide Off-line Log Data			O	Yes / No	
		3.3.2.1	Retrieve Configuration of Logging service	M	Yes	
		3.3.2.2	Configure Logging Service	M	Yes	
		3.3.2.4	Clear Log	M	Yes	
		3.3.2.5	Retrieve Capabilities of Event Logging Services	M	Yes	
		3.3.2.6	Retrieve Number of Events Currently Logged	M	Yes	
		3.3.2.7	Set Time	M	Yes	
		3.3.2.8	Retrieve Current Time	M	Yes	
		3.3.2.9	Set Daylight Saving Time Mode	M	Yes	
		3.3.2.10	ELMS Pre-defined Event Configurations	M	Yes	
		3.3.2.10.1	Supported Event Classes	M	Yes	
		3.5.4	Supplemental Requirements for Event Logs	M	Yes	
2.4.1.2.1	Provide Luminaire Switch State Logging			O	Yes / No	
		3.3.2.10.2	Luminaire Switch State Log	O	Yes / No	
2.4.1.2.2	Provide Luminaire Lamp Condition Logging			O	Yes / No	
		3.3.2.10.3	Luminaire Lamp Condition Log	O	Yes / No	
2.4.1.2.3	Provide Luminaire Burn Condition Logging			O	Yes / No	
		3.3.2.10.4	Luminaire Burn Condition Log	O	Yes / No	

ELMS User Needs in the PRL

3.2.5 Protocol Requirements List (PRL)

User Need ID	User Need	PR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
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2.4.1.1	Provide Live Data			M	Yes	
		3.1.1	Retrieve Data	M	Yes	
		3.1.2	Deliver Data	M	Yes	
		3.1.3	Data Retrieval and Data Delivery Action Performance	M	Yes	
		3.5.1	Live Data Response Time	M	Yes	
2.4.1.2	Provide Off-line Log Data			O	Yes / No	
		3.2.1	Retrieve Configuration of Logging service	M	Yes	
		3.2.2	Configure Logging Service	M	Yes	
		3.2.4	Clear Log	M	Yes	
		3.2.5	Retrieve Capabilities of Event Logging Services	M	Yes	
		3.2.6	Retrieve Number of Events Currently Logged	M	Yes	
		3.2.7	Set Time	M	Yes	
		3.2.8	Retrieve Current Time	M	Yes	
		3.2.9	Set Daylight Saving Time Mode	M	Yes	
		3.2.10	ELMS Pre-defined Event Configurations	M	Yes	
		3.2.10.1	Supported Event Classes	M	Yes	
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2.4.1.2.1	Provide Luminaire Switch State Logging			O	Yes / No	
		3.2.10.2	Luminaire Switch State Log	O	Yes / No	
2.4.1.2.2	Provide Luminaire Lamp Condition Logging			O	Yes / No	
		3.2.10.3	Luminaire Lamp Condition Log	O	Yes / No	
2.4.1.2.3	Provide Luminaire Burn Condition Logging			O	Yes / No	
		3.2.10.4	Luminaire Burn Condition Log	O	Yes / No	

ELMS Functional Requirements in the PRL

3.2.5 Protocol Requirements List (PRL)

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		3.3.1.2	Deliver Data	M	Yes	
		3.3.1.3	Data Retrieval and Data Delivery Action Performance	M	Yes	
		3.5.5.1	Live Data Response Time	M	Yes	
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		3.3.2.6	Retrieve Number of Events Currently Logged	M	Yes	
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		3.3.2.8	Retrieve Current Time	M	Yes	
		3.3.2.9	Set Daylight Saving Time Mode	M	Yes	
		3.3.2.10	ELMS Pre-defined Event Configurations	M	Yes	
		3.3.2.10.1	Supported Event Classes	M	Yes	
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		3.3.2.10.2	Luminaire Switch State Log	O	Yes / No	
2.4.1.2.2	Provide Luminaire Lamp Condition Logging			O	Yes / No	
		3.3.2.10.3	Luminaire Lamp Condition Log	O	Yes / No	
2.4.1.2.3	Provide Luminaire Burn Condition Logging			O	Yes / No	
		3.3.2.10.4	Luminaire Burn Condition Log	O	Yes / No	

ELMS Conformance in the PRL

3.2.5 Protocol Requirements List (PRL)

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.1	Operational User Needs			M	Yes	
2.4.1.1	Provide Live Data			M	Yes	
		3.3.1.1	Retrieve Data	M	Yes	
		3.3.1.2	Deliver Data	M	Yes	
		3.3.1.3	Data Retrieval and Data Delivery Action Performance	M	Yes	
		3.5.5.1	Live Data Response Time	M	Yes	
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		3.3.2.10.1	Supported Event Classes	M	Yes	
		3.5.4	Supplemental Requirements for Event Logs	M	Yes	
2.4.1.2.1	Provide Luminaire Switch State Logging			O	Yes / No	
		3.3.2.10.2	Luminaire Switch State Log	O	Yes / No	
2.4.1.2.2	Provide Luminaire Lamp Condition Logging			O	Yes / No	
		3.3.2.10.3	Luminaire Lamp Condition Log	O	Yes / No	
2.4.1.2.3	Provide Luminaire Burn Condition Logging			O	Yes / No	
		3.3.2.10.4	Luminaire Burn Condition Log	O	Yes / No	

ELMS Project Requirements in the PRL

3.2.5 Protocol Requirements List (PRL)

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.1	Operational User Needs			M	Yes	
2.4.1.1	Provide Live Data			M	Yes	
		3.3.1.1	Retrieve Data	M	Yes	
		3.3.1.2	Deliver Data	M	Yes	
		3.3.1.3	Data Retrieval and Data Delivery Action Performance	M	Yes	
		3.5.5.1	Live Data Response Time	M	Yes	
2.4.1.2	Provide Off-line Log Data			O	Yes / No	
		3.3.2.1	Retrieve Configuration of Logging service	M	Yes	
		3.3.2.2	Configure Logging Service	M	Yes	
		3.3.2.4	Clear Log	M	Yes	
		3.3.2.5	Retrieve Capabilities of Event Logging Services	M	Yes	
		3.3.2.6	Retrieve Number of Events Currently Logged	M	Yes	
		3.3.2.7	Set Time	M	Yes	
		3.3.2.8	Retrieve Current Time	M	Yes	
		3.3.2.9	Set Daylight Saving Time Mode	M	Yes	
		3.3.2.10	ELMS Pre-defined Event Configurations	M	Yes	
		3.3.2.10.1	Supported Event Classes	M	Yes	
		3.5.4	Supplemental Requirements for Event Logs	M	Yes	
2.4.1.2.1	Provide Luminaire Switch State Logging			O	Yes / No	
		3.3.2.10.2	Luminaire Switch State Log	O	Yes / No	
2.4.1.2.2	Provide Luminaire Lamp Condition Logging			O	Yes / No	
		3.3.2.10.3	Luminaire Lamp Condition Log	O	Yes / No	
2.4.1.2.3	Provide Luminaire Burn Condition Logging			O	Yes / No	
		3.3.2.10.4	Luminaire Burn Condition Log	O	Yes / No	

ELMS Supplemental Requirements

Supplemental Requirement ID	Supplemental Requirement	Conformance	Project Requirement	Additional Project Requirements
3.5	Supplemental Requirements	M	Yes	
3.5.1	Supplemental Requirements for Scheduled Operations	M	Yes	
3.5.1.1	Support a Number of Actions	M	Yes	The ELMS Device shall support at least ____ (1..255) Actions.
3.5.1.2	Support a Number of Day Plans	M	Yes	The ELMS Device shall support at least ____ (1..255) Day Plans.
3.5.1.3	Perform Action at Scheduled Time	M	Yes	
3.5.2	Supplemental Requirements for Zones	M	Yes	
3.5.2.1	Define Number of Zones Supported by an ELMS Device	O	Yes / No	The ELMS Device shall support at least ____ (0..65535) Zones.
3.5.2.2	Define Number of ELMS Devices for a Zone	O	Yes / No	At least ____ (0..65535) ELMS devices shall be able to be assigned to a single zone.
3.5.3	Supplemental Requirements for Dim Levels	M	Yes	
3.5.3.1	Define Dim Levels as a percentage of maximum brightness	O	Yes / No	
3.5.4	Supplemental Requirements for Event Logs	M	Yes	
3.5.4.1	Configure Number of Events in Event Log	O	Yes / No	The ELMS device shall support at least ____ (1..255) events.
3.5.4.2	Configure Number of Event Classes	O	Yes / No	The ELMS device shall support at least ____ (1..255) classes.
3.5.4.3	Configure Number of Event Types	O	Yes / No	The ELMS device shall support at least ____ (1..255) event types.

Other User Needs Not in the PRL

Other Operational Needs: User Needs Not Supported by NTCIP 1213

- The standard, like the entire suite of NTCIP protocols, allows for extensions.
- Proprietary extensions are not desired (interoperability problems), but are sometimes necessary.
- Extensions might become part of a future version of the standard.
- The standard supports interoperability for all contained features.



Summarizing the ELMS PRL

3.2.5 Protocol Requirements List (PRL)

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.1	Operational User Needs			M	Yes	
2.4.1.1	Provide Live Data			M	Yes	
		3.3.1.1	Retrieve Data	M	Yes	
		3.3.1.2	Deliver Data	M	Yes	
		3.3.1.3	Data Retrieval and Data Delivery Action Performance	M	Yes	
		3.5.5.1	Live Data Response Time	M	Yes	
2.4.1.2	Provide Off-line Log Data			O	Yes / No	
		3.3.2.1	Retrieve Configuration of Logging service	M	Yes	
		3.3.2.2	Configure Logging Service	M	Yes	
		3.3.2.4	Clear Log	M	Yes	
		3.3.2.5	Retrieve Capabilities of Event Logging Services	M	Yes	
		3.3.2.6	Retrieve Number of Events Currently Logged	M	Yes	
		3.3.2.7	Set Time	M	Yes	
		3.3.2.8	Retrieve Current Time	M	Yes	
		3.3.2.9	Set Daylight Saving Time Mode	M	Yes	
		3.3.2.10	ELMS Pre-defined Event Configurations	M	Yes	
		3.3.2.10.1	Supported Event Classes	M	Yes	
		3.5.4	Supplemental Requirements for Event Logs	M	Yes	
2.4.1.2.1	Provide Luminaire Switch State Logging			O	Yes / No	
		3.3.2.10.2	Luminaire Switch State Log	O	Yes / No	
2.4.1.2.2	Provide Luminaire Lamp Condition Logging			O	Yes / No	
		3.3.2.10.3	Luminaire Lamp Condition Log	O	Yes / No	
2.4.1.2.3	Provide Luminaire Burn Condition Logging			O	Yes / No	
		3.3.2.10.4	Luminaire Burn Condition Log	O	Yes / No	

Agency Use of the ELMS PRL

The ELMS PRL can be used by:

- A user or agency specification writer to indicate which requirements are to be implemented in a project specific implementation
- The protocol implementer, as a checklist to reduce the risk of failure to conform to NTCIP 1213



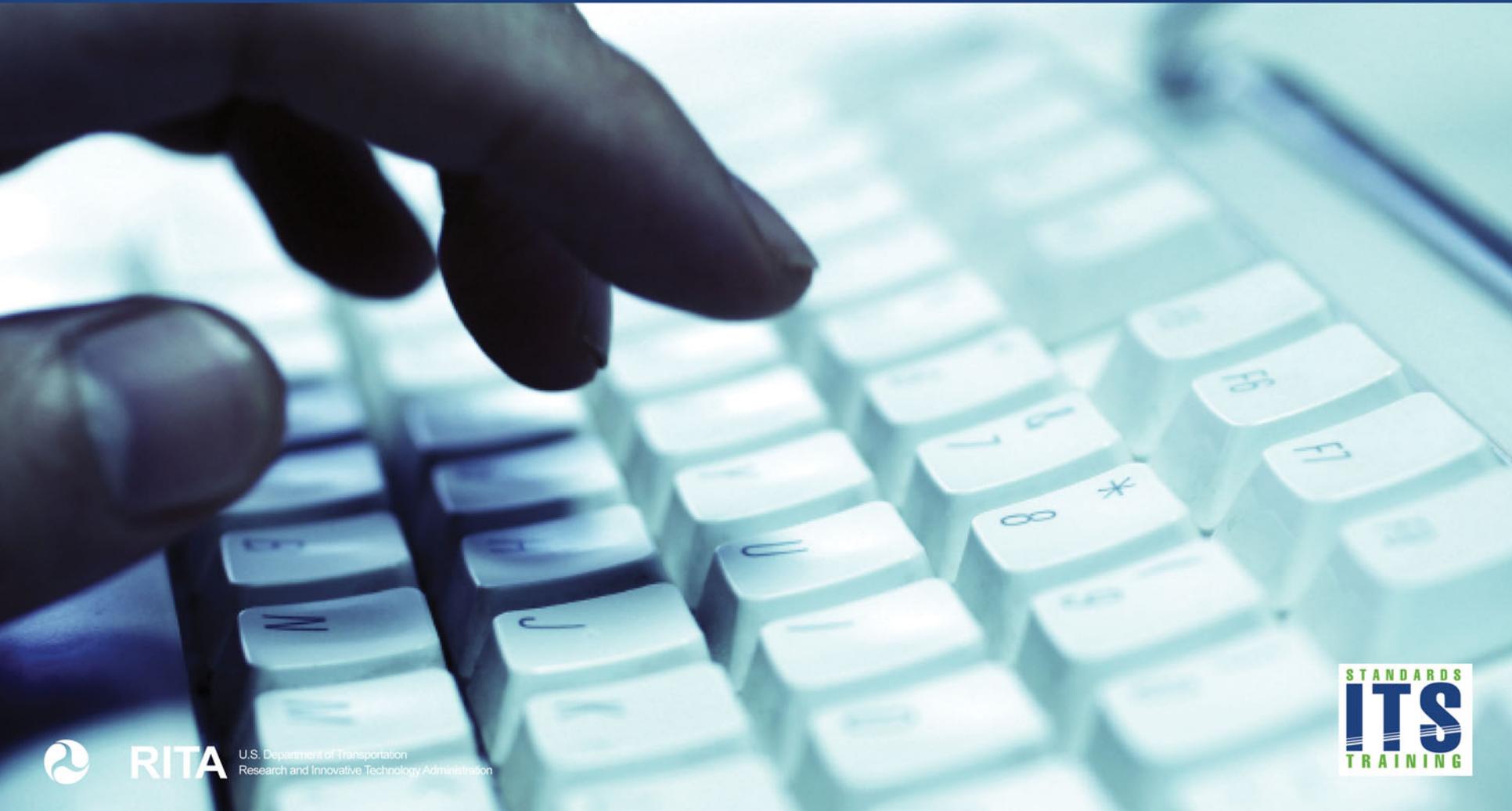
Supplier and User Use of the ELMS PRL

The ELMS PRL can also be used by:

- The supplier and user, as a detailed indication of the capabilities of the implementation
- The user, as a basis for initially checking potential interoperability with another implementation



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Which of the following is a True statement?

Answer Choices

- a) ELMS user needs do not describe what features the device needs to support and why.
- b) ELMS functional requirements are not specifications.
- c) Within the ELMS PRL, the relationships between user needs and functional requirements are not standardized.
- d) The ELMS PRL promotes interoperability.



Review of Answers



a) User needs do not describe what features the device needs to support and why.

Incorrect, user needs do describe supported features.



b) Functional requirements are not specifications.

Incorrect, functional requirements do not support specifications.



c) Within the PRL, the relationships between user needs and functional requirements are not standardized.

Incorrect, relationships between user needs and functional requirements are standardized.



d) The PRL promotes interoperability.

Correct, the PRL does support interoperability.

Selecting User Needs through the PRL

Using the ELMS User Need ID number 2.4.2.2.2, the corresponding text allows determination if the user need “Control Electrical Service” is desired in your system.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement
2.4.2.2.2	Control Electrical Service			O	Yes / No
		3.4.2.2.1	Control Electrical Service by Permanent/Continuous Override	M	Yes
		3.4.2.2.2	Control Electrical Service by Transitory Override	O	Yes / No
		3.4.2.2.3	Control Electrical Service by Timed Override	O	Yes / No
		3.4.2.3.4	Control Electrical Service in Stagger Mode	O	Yes / No

Selecting User Needs through the PRL

ELMS User Need 2.4.2.2.2 “Control Electrical Service” is defined on page 14 of the ELMS Standard as:

A management station may need to control an electrical service directly or by enabling/disabling the stagger mode for branch circuits served by the electrical service. A management station may need to control the electrical service to allow or disallow the schedule control by one of three states:

- a) **Continuous control**—not allowing the schedule to control current settings for electrical service
- b) **Transitory control**—not allowing the schedule to control the electrical service until the next event in the schedule
- c) **Timed control**—not allowing the schedule to control the electrical service until after a period of time specified in the timed control dialog for the electrical service

The ELMS PRL and Conformance

Conformance Mandatory vs. Optional

- Examine the “Conformance” column
- Conformance: Identifies if the user need (or requirement) is mandatory or optional

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement
2.4.2.2.2	Control Electrical Service			O	Yes / No
		3.4.2.2.1	Control Electrical Service by Permanent/Continuous Override	M	Yes
		3.4.2.2.2	Control Electrical Service by Transitory Override	O	Yes / No
		3.4.2.2.3	Control Electrical Service by Timed Override	O	Yes / No
		3.4.2.3.4	Control Electrical Service in Stagger Mode	O	Yes / No

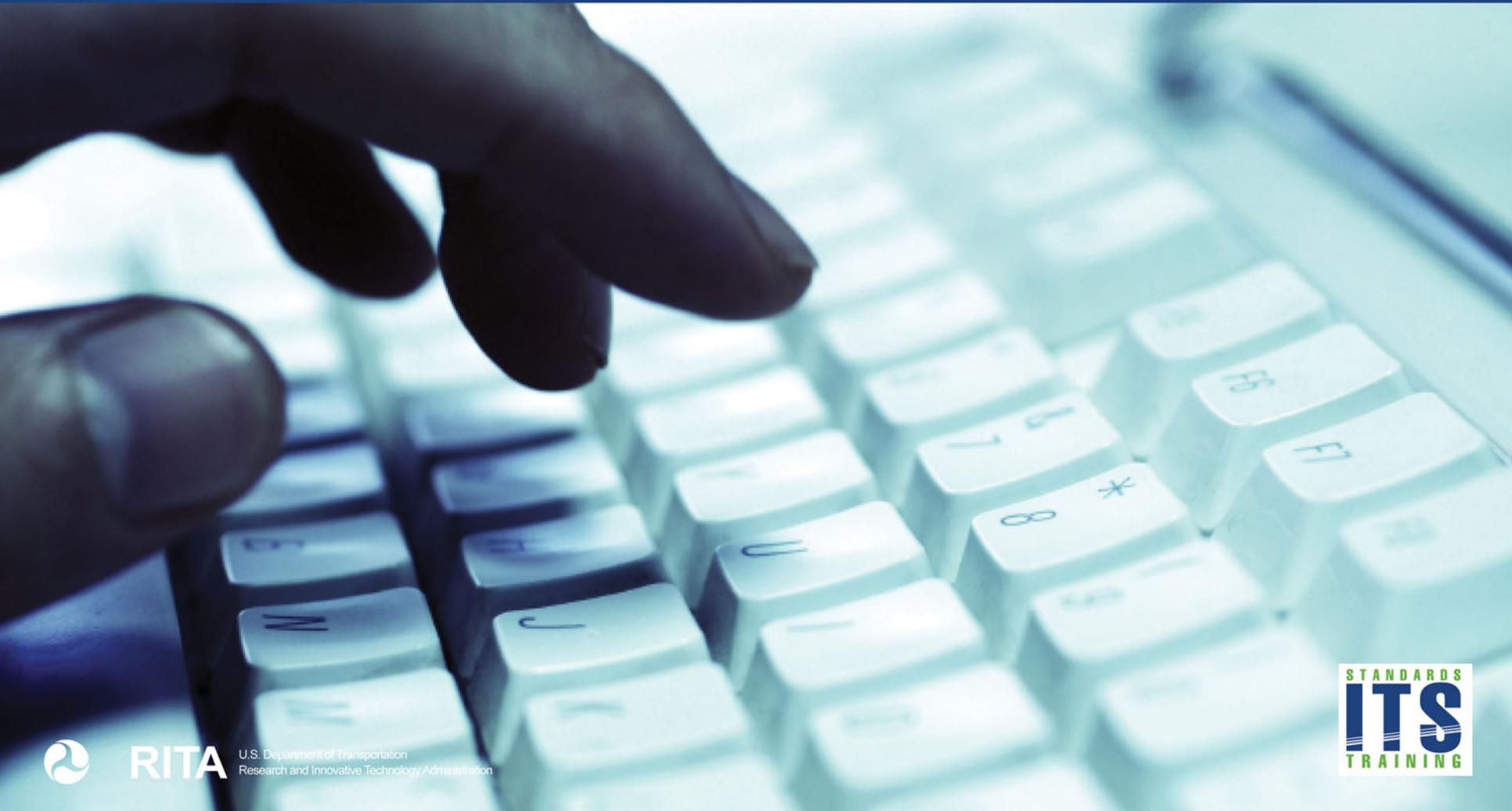
The ELMS PRL and Conformance

Conformance Mandatory vs. Optional

- Conformance: Identifies if the user need (or requirement) is mandatory or optional
- Thus, if User Need 2.4.2.2.2 “Control Electrical Service” is required, 3.4.2.2.1 is mandatory, others are optional

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement
2.4.2.2.2	Control Electrical Service			O	Yes / No
		3.4.2.2.1	Control Electrical Service by Permanent/Continuous Override	M	Yes
		3.4.2.2.2	Control Electrical Service by Transitory Override	O	Yes / No
		3.4.2.2.3	Control Electrical Service by Timed Override	O	Yes / No
		3.4.2.3.4	Control Electrical Service in Stagger Mode	O	Yes / No

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Which of the following descriptions of the PRL is a false statement?

Answer Choices

- a) Options for conformance are mandatory or optional.
- b) Options for project requirements are yes or no.
- c) Optional user needs are dependent on project requirements.
- d) Optional functional requirements are not dependent on project requirements.

Review of answers



a) Options for conformance are mandatory or optional.
True statement; the only valid entries for Conformance are mandatory and optional.



b) Options for project requirements are yes or no.
True statement; the only valid entries for project requirements are yes and no.



c) Optional user needs are dependent on project requirements.
True statement; selection of project requirements drives the inclusion/exclusion of optional UN.



d) Optional functional requirements are not dependent on project requirements.

False; selection of project requirements drives the inclusion/exclusion of optional FRs.

ELMS User Needs Hierarchical Relationship

- User Need 2.4.1.2 is optional, thus if the project definition requires this user need, then
 - 3.3.2.1, 3.3.2.2, and 3.3.2.4 are mandatory

2.4.1.2	Provide Off-line Log Data	O	Yes / No	
	3.3.2.1 Retrieve Configuration of Logging service	M	Yes	
	3.3.2.2 Configure Logging Service	M	Yes	
	3.3.2.4 Clear Log	M	Yes	

The ELMS PRL User Needs - Project Requirements Relationship

Supported Project Requirements

Agency/Specifier to circle **Yes** or **No** to indicate the agency's user needs for the proposed implementation.

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
		3.4.1.10.2.1	Configure Branch Circuit Location	0	Yes / No	
		3.4.1.10.2.2	Configure Branch Circuit Pole Identifier	0	Yes / No	

Importance of the ELMS PRL's User Needs and Functional Requirements Relationship

- User needs describe required features.
- Functional requirements refine the user needs into detailed specifications.
- Within the PRL, the relationships between user needs and functional requirements are standardized.
- Use of the PRL's user needs and dependent functional requirements promotes interoperability.

The ELMS PRL's User Needs/Functional Requirements Relationship in Detail

Functional Requirement Identifier (FR ID) - Section Number of the Functional Requirement

- Functional Requirement (FR) - Title (description of the functional requirement)

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.4.2.1.3	Configure for Light-Activated Operation			O	Yes / No	
		3.4.1.3.1	Configure Luminaire for Light Activated Operations	M	Yes	
		3.4.1.3.2	Configure Electrical Service for Light Activated Operations	O	Yes / No	
		3.4.1.3.3	Configure Branch Circuit for Light Activated Operations	O	Yes / No	
		3.4.1.3.4	Configure Devices in Zone for Light Activated Operations	O	Yes / No	

The ELMS PRL's User Needs/Functional Requirements Relationship in Detail

- Requirements associated with a user need are found under that user need.
- Each user need will have at least one requirement associated with it.
- Each requirement in the standard is associated with at least one user need.
- Result: The standard has no unnecessary requirement, and all user needs are satisfied by at least one requirement.

The ELMS PRL's User Needs/Functional Requirements Relationship in Detail

Mandatory vs. Optional

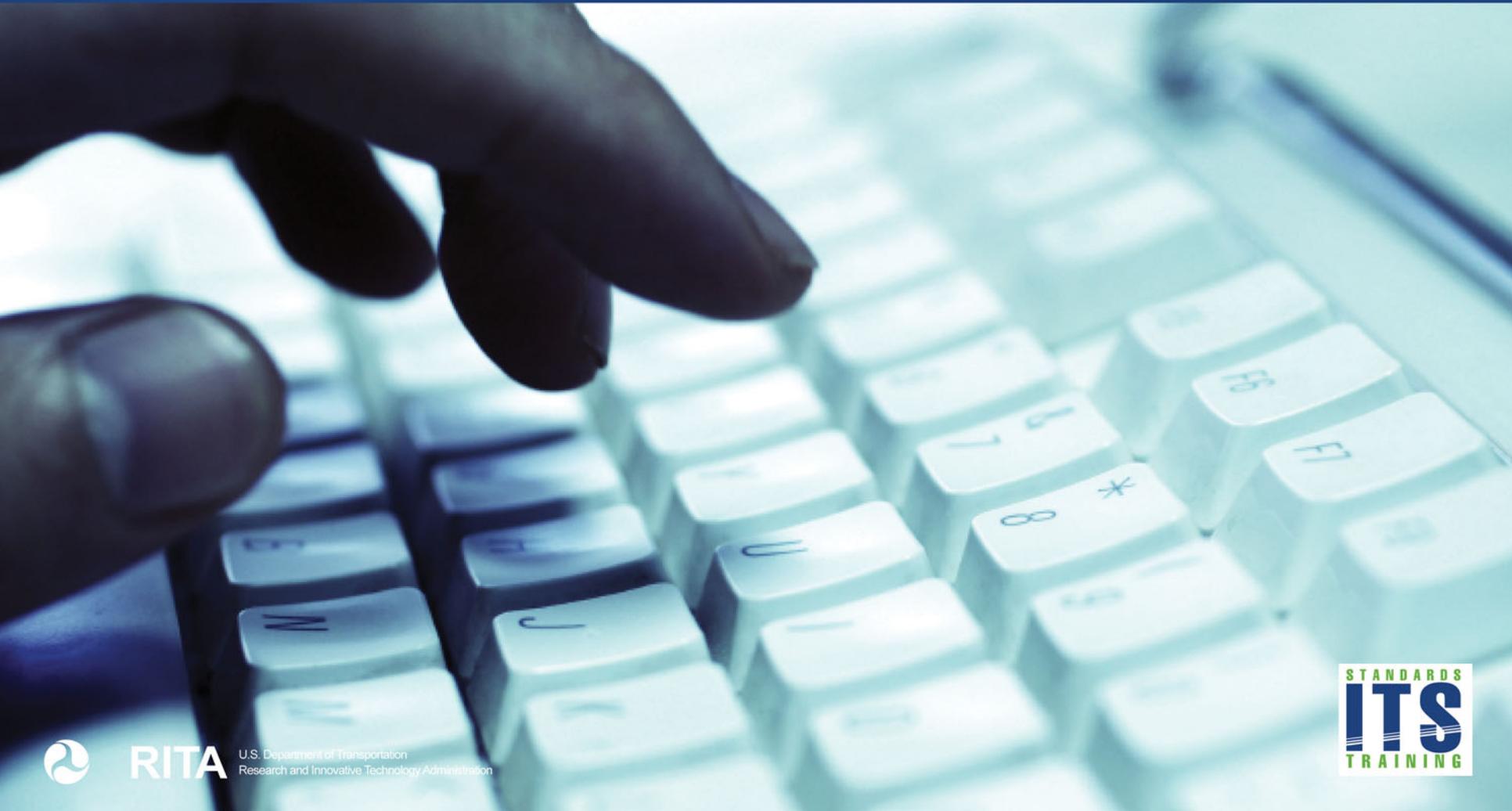
- A “mandatory” requirement is only mandatory if an associated user need is selected.
- If an optional user need is not selected, its associated requirements are not necessary, unless they are required by another user need selection.
- Example: “3.4.1.3.4 - Configure devices in zone for light activated operation”

The ELMS PRL's User Needs/Functional Requirements Relationship in Detail

Additional Project Requirements Column

- Used to enter additional notes and requirements
- Used to provide further details about the implementation

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Which of the following is a false statement?

Answer Choices

- a) User Needs describe what features the device needs to support.
- b) Functional Requirements refine the User Needs into specifications.
- c) Relationships between User Needs and Functional Requirements are standardized.
- d) The ELMS PRL does not promote interoperability.



Review of Answers

-  a) User Needs describe what features the device needs to support.
True statement, user needs describe what features are required.
-  b) Functional Requirements refine the user needs into specifications.
True statement, Functional Requirements do refine user needs into detailed, measurable specifications.
-  c) Relationships between User Needs and Functional Requirements are standardized.
True statement, the PRL defines standardized relationships.
-  d) The PRL does not promote interoperability.
False, the PRL does promote interoperability.

Using the ELMS PRL to Check Interoperability

Use of the ELMS PRL supports interoperability of selected attributes with:

- The ITS Management Center
- Other ELMS systems, on site or remote
- Smart Grid systems
- Vehicle to Infrastructure (V2I) communications systems



Summary of Learning Objective #3

Use the ELMS PRL to select the user needs and link them to requirements to:

- Indicate how to select user needs that can be traced to requirements
- Reduce the risk of failure to conform to NTCIP 1213 v02
- Provide a detailed indication of the implementation capabilities
- Check interoperability with another ELMS system, as part of the V2I system or as part of the interoperable smart grid



Learning Objective #4

Explain how the ELMS PRL table of the NTCIP 1213 Standard fits into the development of ELMS project specifications and contract documents



Integrating the ELMS PRL into an ELMS Specification

From a vendor's perspective

- Even if a user need and resulting requirement(s) is not mandatory, a vendor may optionally fulfill the user need and provide the feature.
- Vendors can provide a PRL for their standard products to show what user needs they support.



Integrating the ELMS PRL into an ELMS Specification

From an agency's perspective

- A completed PRL must become part of the overall specification.
- A completed PRL indicates the requirements for the communications interface.
- Agency provides language in the specification that all selected requirements must be implemented as per the standard in order to support off-the-shelf interoperability.

Integrating the ELMS PRL into an ELMS Specification

ELMS Contract Documents

A completed ELMS PRL is part of the overall project specification, in addition to the hardware and software specifications

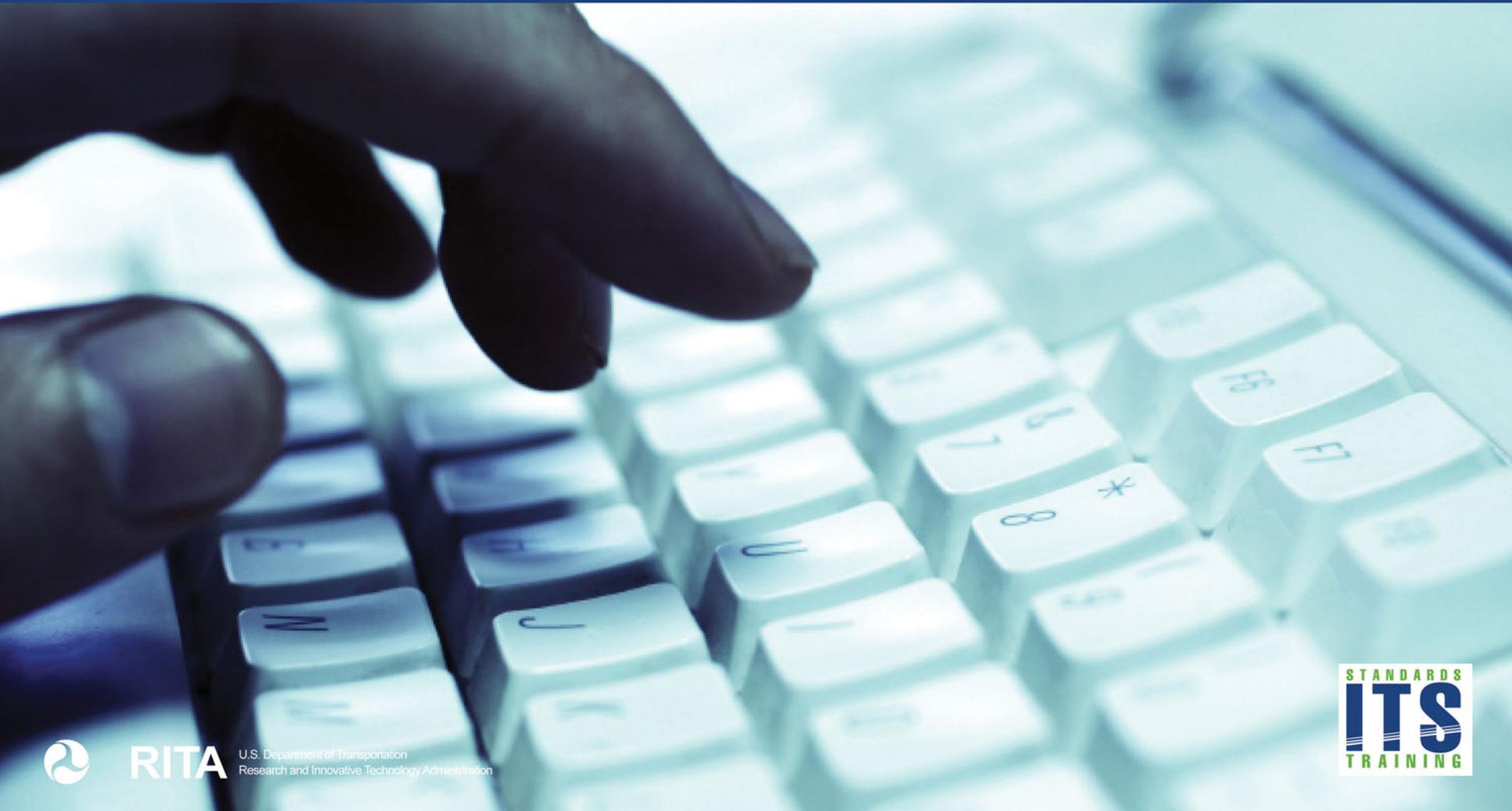
Contract Documents		
Product Specifications		
Hardware Specifications	Software Specifications	Communications Interface Specifications
Functional Requirements	Functional Requirements	Functional Requirements
Performance Requirements	Performance Requirements	Performance Requirements
Structural Requirements		Protocol Requirements
Mechanical Requirements		
Electrical Requirements		
Environmental Requirements		

Integrating the ELMS PRL into an ELMS Specification – Conformance vs. Compliance

- Conformance
 - Meets a specified standard
- Compliance
 - Meets a specification (e.g., for a specific project)



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Which of the following is a false statement?

Answer Choices

- a) Vendors can provide an ELMS PRL for their standard products to show what user needs they support
- b) A completed ELMS PRL must become part of the overall specification
- c) A completed ELMS PRL indicates the requirements for the communications interface
- d) A completed ELMS PRL describes the entire project specification



Review of Answers

-  a) Vendors can provide an ELMS PRL for their standard products to show what user needs they support.
True statement, products can be evaluated for standardization
-  b) A completed ELMS PRL must become part of the overall specification.
True statement, project specifications includes communications, hardware, and software specifications
-  c) A completed ELMS PRL indicates the requirements for the communications interface.
True statement, the PRL defines the communications interface
-  d) A completed ELMS PRL describes the entire project specification.
False, it only describes the communications interface

Summary of Learning Objective #4

- Explained how the PRL table of the NTCIP 1213 Standard fits into the ELMS specification
- Emphasized user needs-requirements link



What We Have Learned

- 1) NTCIP 1213 defines the concept of operations and user needs for *Electrical and Lighting Management Systems*.
- 2) NTCIP 1213 follows the *SEP* approach.
- 3) ELMS has three major categories of functionalities.
 - a) Control *Roadway Lighting*
 - b) Monitor *Ground Fault Conditions*
 - c) Monitor *Electrical Power Usage*
- 4) A *Protocol Requirements List* is used to link user needs to functional requirements.
- 5) PRL table of the ELMS standard fits into an ELMS *project specification*.



Resources

- *Systems Engineering Handbook, Version 3.2*, International Council on Systems Engineering, January 2010.
- *Systems Engineering Guidebook for Intelligent Transportation Systems, Version 3.0*, United States Department of Transportation, November 2009.
- *The NTCIP Guide, Version 04, NTCIP 9001*, 2009.
- *Object Definitions for Electrical and Lighting Management Systems, Version 2.20b*, NTCIP March 2011.
- A306a Participant Student Supplement.



QUESTIONS?



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Next Course Module

A306b: Specifying Requirements for Electrical and Lighting Management Systems (ELMS) Based on NTICP 1213 Standard



Curriculum Path (SEP)

