A306a: Understanding User Needs for ELMS Systems Based on NTCIP 1213 Standard v03

Table of Contents

1. Module Description

This participant supplement provides additional information for the Professional Capacity Building (PCB) Module A306a, Understanding User Needs for ELMS Systems Based on NTCIP 1213 Standard v03.

Module A306a will provide participants with information on how to identify the appropriate use of the NTCIP 1213 v03 standard and acquire an ELMS system based on what the user is seeking to accomplish with support from tools and resources such as a Protocol Requirements List (PRL) in following a systems engineering process (SEP).

This module helps the user understand the scope of the ELMS standard and its versions. It also assists in identifying the uses and associated needs of ELS systems. This module is to be placed in the context of SEP as well as in the acquisition curriculum path, with I101, A101, A102, A201, C101, and C201 being the prerequisites, and with A306b – Specifying Requirements for ELMS Systems Based on NTCIP 1213 v03 Standard following this module.

This participant supplement provides:

- Background of ELMS
- A history of the NTCIP 1213 v03 standard
- User needs supported by NTCIP 1213 v03 and its conformance statement
- A glossary of terms used in this module
- A list of reference materials for further reading or study

2. Introduction/Purpose

The purpose of this **updated** module is to incorporate necessary changes resulting from new user needs and capabilities such as connected vehicles, SMART Grid, and others included in the updated NTCIP 1213 standard v03 (from v02). NTCIP 1213 v03 defines the generic reference model and conformance requirements for traffic management centers (TMCs) that wish to provide interfaces to ELMS field devices. An ELMS is defined as any system capable of monitoring, controlling, and communicating certain electrical and lighting system parameters using NTCIP.

The effort to develop an NTCIP ELMS standard began with the International Technology Exchange Program's European Road Lighting Technologies scan tour in April 2001 (Report FHWA-PL-01-034 dated September 2001). This technology and implementation plan was further developed by the American Association of State Highway and Transportation Officials (AASHTO) Task Force for Highway Lighting and is being implemented as the Master Lighting Plan in the AASHTO publication entitled *Roadway Lighting Design Guide*. The Task Force's original desire was to define the features, functionality, and point of interoperability for ELMS equipment.

NTCIP 1213 v03 defines data elements in ASN.1 using the SNMP Object Type Macro for field devices that monitor and control electrical and lighting systems.

NTCIP 1213 v03 is an NTCIP Device Data Dictionary Standard. Device Data Dictionary Standards define management information in terms of objects (data elements, data frames, and messages) for use within NTCIP systems.

History

In 1992, the National Electrical Manufacturers Association (NEMA) 3-TS Transportation Management Systems and Associated Control Devices Section began development of the NTCIP. The Transportation Section's work was in response to user needs to include standardized systems communication in the NEMA TS 2 standard, *Traffic Controller Assemblies*. Under the guidance of the Federal Highway Administration's NTCIP Steering Group, the NEMA effort was expanded to include the development of communications standards for all transportation field devices that could be used in an Intelligent Transportation Systems (ITS) network.

In September 1996, an agreement was executed among AASHTO, ITE, and NEMA to jointly develop, approve, and maintain the NTCIP standards. In 2002, the Joint Committee on the NTCIP accepted the invitation from Karl Burkett (Texas DOT) to transfer the initial work of an ad hoc committee of the Illuminating Engineering Society of North America (IESNA), and formed the NTCIP ELMS Working Group to further develop the control objects based on NTCIP. The NTCIP ELMS Working Group's first meeting was in April 2003.

NTCIP 1213 v02 development started in 2002 under funding provided by the FHWA. NTCIP 1213 v01.03.

February 2004—Accepted as a User Comment Draft by the Joint Committee on the NTCIP.

March 2004—NTCIP Standards Bulletin B0090 distributed for user comment.

NTCIP 1213 v02. The ELMS Working Group incremented the major version number to indicate the substantial reorganization of content. Version v01 never advanced beyond the User Comment Draft stage.

NTCIP 1213 v02.19. December 2005—Accepted v02.19b as a Recommended Standard by the Joint Committee on the NTCIP.

December 2006—NTCIP Standards Bulletin B0111 referred v02.19d for balloting. Approved by AASHTO in July 2008, approved by ITE in March 2008, and approved by NEMA in June 2007.

NTCIP 1213 v02.20. June 2010—Began editing publication. July 2010—discussed proposals for alternative Management Information Base (MIB) object definitions (astronomical clock);

November 2010—incorporated compilable alternative MIB object definitions and polled the NTCIP ELMS Working Group for approval.

NTCIP 1213 v02.20. December 2010—removed direct references to NTCIP 1103 v02 for trap support; addressed astronomical clock feature in supplied MIB modifications in Annex B. February 2011—completed editing and publication.

NTCIP 1213 v03. February 2017—maintains backwards compatibility with v02, adds support for connected vehicles, electric vehicle charging, and Smart Grid automated demand response.

Compatibility of Versions

To distinguish NTCIP 1213 v03 (as published) from previous drafts, the NTCIP 1213 v03 standard includes "NTCIP 1213 v03" on each page header. All NTCIP Standards Publications have a major and minor version number for configuration management. The version number syntax is 'v00.00a,' with the major version number before the period, and the minor version number and edition letter (if any) after the period.

NTCIP 1213 v02 is designated, and should be cited as, NTCIP 1213 v02. Anyone using NTCIP 1213 v02 should seek information about the version number that is of interest in any given circumstance. The MIB and, the PRL should all reference the version number of the standards publication that was the source of the excerpted material.

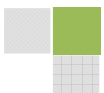
Compliant systems based on later, or higher, version numbers MAY NOT be compatible with compliant systems based on earlier, or lower, version numbers. Anyone using NTCIP 1213 v02 should also consult NTCIP 8004 v02 for specific guidelines on compatibility.

ELMS Types

There are many types of ELMS and they can be characterized in many ways. One way is by the capabilities the ELMS offers for terminal device support. This characterization places an ELMS into one of following major categories:

1. Power Control and Monitoring – this type of ELMS primarily addresses energy metering and power quality
2. Control and Monitoring of Roadway Lighting – this type of ELMS focuses upon control and monitoring of street and roadway lighting fixtures
3. Ground Fault Control and Monitoring – this type of ELMS is one in which the features deployed support detection and interruption of transient electrical currents commonly known as ground faults
4. Electric Vehicle Charging Management
5. Smart Grid Automated Demand Response
6. Connected Vehicle and Connected Pedestrian Support – for true adaptive roadway lighting

    - Forms/documents/checklists that practitioner can use in their scope of work
    - Additional References they can use to enhance their knowledge of the topic



3. Samples/Examples

For a comprehensive perspective on the broad capabilities of an NTCIP 1213 v03 compliant ELMS, please review the complete PRL listed below:

For a comprehensive perspective of the broad capabilities of a NTCUIP 1213 v03 compliant ELMS, please review the complete PRL listed below:

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	The ELMS device shall support at least _____ (1..255) events.
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	The ELMS device shall support at least _____ (1..255) classes.
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	The ELMS device shall support at least _____ (1..255) event types.

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**			
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	The ELMS device shall support a location name of at least _____ (8..255) Characters.
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O		

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found...1	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	Retrieve Electrical Service Pole Identifier	O	Yes / No	
		Error! Reference source not found.	Configure Electrical Service Location	M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O.1 (1..*)	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O.2 (1..*)	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O.3 (1..*)	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O.4 (1..*)	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	The ELMS Device shall support at least _____ (1..255) Actions.
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	The ELMS Device shall support at least _____ (1..255) Day Plans.

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	The ELMS Device shall support at least _____ (0..65535) Zones.
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	At least _____ (0..65535) ELMS devices shall be able to be assigned to a single zone.
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes	The ELMS device shall support a stagger interval with a maximum value of _____ (0..255) seconds.
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	The ELMS device shall support a stagger interval with a maximum value of _____ (0..255) seconds.
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	The ELMS device shall support a stagger interval with a maximum value of _____ (0..255) seconds.

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	Configure Branch Circuit Location	O	Yes / No	
		Error! Reference source not found.	Configure Branch Circuit Pole Identifier	O		
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	D
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**Location	M	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
		Error! Reference source not found.	**Error! Reference source not found.**	O		
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			M	Yes	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	Units are in tenths of degrees Celsius
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	Retrieve Electrical Service Arc Fault Status	O	Yes / No	
Error! Reference source not found.	**Error! Reference source not found.**			O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

Protocol Requirements List (PRL) Table						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
		Error! Reference source not found.	**Error! Reference source not found.**	M	Yes	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	
		Error! Reference source not found.	**Error! Reference source not found.**	O	Yes / No	

4. Reference to Other Standards

- *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 [Online] – http://www.fhwa.dot.gov/cadiv/segb/
- *Recommended Practice for Software Requirements Specifications*, IEEE 830, 1998
- *The NTCIP Guide*, Version 04, NTCIP 9001, 2009
- *Using ITS Standards: An Overview,* ITE PCB Module I101, 2011 [Online] – http://www.pcb.its.dot.gov/standardstraining/Modules.aspx
- *Introduction to Acquiring Standards-Based ITS Systems*, ITE PCB Module A101, 2011 [Online] – http://www.pcb.its.dot.gov/standardstraining/Modules.aspx
- *Introduction to User Needs Identification*, ITE PCB Module A102, 2011 [Online] – http://www.pcb.its.dot.gov/standardstraining/Modules.aspx
- *Details On Acquiring Standards-Based ITS Systems*, ITE PCB Module A201, 2011 [Online] – http://www.pcb.its.dot.gov/standardstraining/Modules.aspx
- *Object Definitions for Electrical and Lighting Management Systems,* Version 3.00, NTCIP March 2011
- AASHTO / ITE / NEMA NTCIP 1103 v02 Transportation Management Protocols published July 2010
- AASHTO / ITE / NEMA NTCIP 1201 v03 Global Object (GO) Definitions published March 2011
- AASHTO / ITE / NEMA NTCIP 2301 v02 Simple Transportation Management Framework (STMF) Application Profile (AP (AP-STMF) published July 2010
- AASHTO / ITE / NEMA NTCIP 8004 v02 Structure and Identification of Management Information (SMI) published June 2010
- ISO/IEC 8824-1 ed4.0 (2008-12) Information Technology—Abstract Syntax Notation One (ASN.1): Specification of Basic Notation
- IAB STD 16 (RFC 1155) Structure and Identification of Management Information for TCP/IP-based Internets, M. Rose; K. McCloghrie; May 1990, (RFC 1212) Concise MIB Definitions, M. Rose; K. McCloghrie; March 1991
- SAE J2374 Location Referencing Message Specification 1.2.2
- IAB STD 15 (RFC 1157) A Simple Network Management Protocol (SNMP), May 1990
- IAB STD 17 (RFC 1213) Management Information Base for Network Management of TCP/IP-based Internets: MIB-II, March 1991

- Perkins, David, and McGinnis, Evan, Understanding SNMP MIBs, New Jersey, Prentice Hall PTR, 1997, ISBN 0-13-437708-7
- Booch, Grady, Rumbaugh, James, and Jacobson, Ivar, The Unified Modeling Language User Guide, 2nd Edition, Addison-Wesley Professional, May 29, 2005, ISBN 0-201-57168-4
- ANSI/IES DG-28-2015, The Guide for Selection, Installation, Operations and 1 Maintenance of Roadway Lighting Control Systems, Illuminating Engineering Society of North America

5. Glossary

action	An element of a day plan schedule.
adaptive	Allow control by inputs of schedule, astronomical clock, ambient light, and connected vehicle information.
Agency specification	A document that has been prepared by an agency to define requirements for a subject item or process when procured by the agency.
ambient light level	The amount of light surrounding the luminaire location.
Astronomical clock	Allow control by sunrise and sunset time as calculated by latitude, longitude, and day of year.
Automated Demand Response (ADR)	System functions that monitor and control the ELMS device in response to load and cost signals from the electric utility provider.
branch circuit	A local electrical circuit that provides power to the luminaires.
candela	An SI unit of measure for luminous intensity, abbreviated cd.
compatibility	The ability of two or more systems or components to exchange information. Note: See IEEE *Standards Dictionary, Glossary of Terms and Definitions,* October 2008.
Compliance	A condition that exists when an item meets all of the requirements of an agency specification.
Concept of Operations	A document that describes the purpose for a system project, including a description of the current and proposed system, as well as key user needs that the new system is required to address.
Conformance	A condition that exists when an item meets all of the mandatory requirements as defined by a standard. It can be measured on the standard as a whole, which means that it meets all mandatory (and applicable conditional) requirements of the standard or on a feature level (i.e., it conforms to feature X as defined in

	section X.X.X), which means that it meets all mandatory (and applicable conditional) requirements of the feature.
"connected vehicle" sensor and status information	Includes vehicle, bicycle and pedestrian data objects.
consistent	The ability of two or more systems or components to exchange information and use the supported information that has been exchanged and gracefully reject any unsupported information according to defined rules.
Configure	The process of setting parameters within the ELMS device during installation. Note: These are typically set at time of installation and system commissioning.
Control	The process of setting or resetting parameters within the ELMS device, during operation. Note: These are typically set as needed either manually or through external inputs, for example, electricity price information received automatically from the electric utility on a periodic basis.
data	Elements of information exchanged between a management station and an ELMS device used to configure, control, or monitor the operation of the ELMS device.
data logger	A unit that collects and stores information on the state and operation of ELMS devices.
day plan	A standard device schedule element that contains a set of at least one or more actions to be performed for a device on a given day.
determine	To read information from a device.
dialogs	A sequence of information or message exchanges.
dim levels	The setting for the intensity of the light generated by the luminaire.
download	To transfer information from the central computer into the referenced field device.
electrical service	The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served. NOTE: See National Electrical Code (NEC).
Electrical and Lighting Management Systems (ELMS)	Any system capable of monitoring and controlling electrical and lighting systems using the National Transportation Communications for ITS Protocol (NTCIP).

ELMS device	A device, module, or piece of equipment that contains an SNMP Agent, and is the interface between a component of an illumination system and the NTCIP communication system. The device may be integral to a component of the illumination system.
ELMS management station	One or more host computing platforms that controls the field devices. Note: Management station(s) may be installed in a local Transportation Management Center (TMC), or can be field based.
feature	A behavior of an ELMS device.
Informative	Information that identifies a document, introduces its content, and explains its background, its development and its relationship with other documents; or information that provides additional information intended to assist the understanding or use of the document (see normative).
interchangeable	A condition that exists when two or more items possess such functional and physical characteristics as to be equivalent in performance and durability, and are capable of being exchanged one for the other without alteration of the items themselves, or adjoining items, except for adjustment, and without selection for fit and performance. Note: See National Telecommunications and Information Administration, U.S. Department of Commerce
interface	A named set of operations that characterizes the behavior of an element. Note: See Unified Modeling Language specification
interoperability	The ability of two or more systems or components to exchange information and use the information that has been exchanged. Note: See IEEE *Standards Dictionary, Glossary of Terms and Definitions*, October 2008.
live data	A specific operational network configuration between a management station and the ELMS device whereby the information exchange can be performed without the need for initiating and terminating a physical network connection between a management station and ELMS device. Note: From a network perspective, this

	configuration is an “always on” connection, where a management station has access to the “current” information available in the ELMS device.
location referencing message specification (LRMS)	Location referencing as specified in SAE J2735 SE standard.
logged data	A specific operational network configuration between a management station and the ELMS device, whereby a management station is required to execute a procedure for establishing a physical connection between a management station and the ELMS device prior to being able to exchange data with the ELMS device. Note: In this configuration, information generated by the ELMS device, which is expected to be retrieved by a management station, is stored external to a management station until such time as a management station initiates the network connection to access the stored (logged) data from the ELMS device.
lumen	The unit of luminous flux emitted in a solid angle of one steradian by a uniform point source that has an intensity of one candela.
luminaire	The light fixture and possibly associated sensors. Note: Luminaires may be organized into zones. Management functions can be performed on individual luminaires or on zones of luminaires (e.g., dimming).
luminance	The intensity of light per unit area at its source. Usually measured in candela per square foot or candela per square meter.
lux	A measurement of light. A unit of luminance produced on a surface area of one square meter by a luminous flux of one lumen uniformly distributed over the surface (1 lux = 1 lumen per square meter).
Management Information Base (MIB)	A management information base (MIB) is a virtual database used for managing the entities in a communications network. Most often associated with the Simple Network Management Protocol (SNMP), the term is also used more generically in contexts such as in OSI/ISO Network management model. While intended to refer to the complete collection of management information available on an entity, it is often used to refer to a particular subset, more correctly referred to as MIB-module.

	Objects in the MIB are defined using a subset of Abstract Syntax Notation One (ASN.1) called "Structure of Management Information Version 2 (SMIv2)" RFC 2578. The software that performs the parsing is an MIB compiler. The database is hierarchical (tree-structured) and entries are addressed through object identifiers. Internet documentation RFCs discuss MIBs, notably RFC 1155, "Structure and Identification of Management Information for TCP/IP based Internets," and its two companions, RFC 1213,"Management Information Base for Network Management of TCP/IP-based internets."
Normative	Information that describes the scope of the document and that sets out provisions (ISO). Normative elements are considered to be a prescriptive part of the standard (see informative).
object	A data structure used to monitor or control one feature, attribute, or controllable aspect of a manageable device.
operator	An individual who needs to interact with the device by either controlling or monitoring its operations.
photo sensor	A light-measuring device used to quantify the ambient light conditions at the luminaire. Also referred to as photo cell or photoelectric cell.
point-to-multipoint	A communications architecture that supports communications between a central system and many devices. Also called multi-drop communication.
point-to-point	A communications architecture that supports dedicated communications exclusively between two devices.
pole	Pole supporting a luminaire, electrical service, or branch circuit. Note: Poles may be categorized by their constituent material types and/or design configurations.
protocol	A specific set of rules, procedures, and conventions defining the format and timing of data transmissions between devices that are required to be accepted and used to understand each other.

Protocol Requirements List (PRL)	A table mapping user needs with their associated requirements. This table allows procurement personnel to specify the desired features of an ELMS or can be used by a manufacturer to document the features supported by their implementation.
requirement	A description of a condition or capability to which a system is obligated to conform; either derived directly from user needs, or stated in a contract, standard, specification, or other imposed document. A desired feature, property, or behavior of a system.
requirements traceability	The ability to follow or study the logical progression among the needs, requirements, and design details in a step-by-step fashion.
Requirements Traceability Matrix (RTM)	The table that graphically represents the logical progression among the needs, requirements, and design details.
return	Data sent to the requester (in the context of device requirements for providing data requested by an external system).
schedule	A mechanism by which an operator can define times in the future at which the luminaire performs actions. Note: Refer to NTCIP 1103 v02 for information on global objects that support scheduling operations.
Simple Network Management Protocol (SNMP)	Simple Network Management Protocol (SNMP) is an "Internet-standard protocol for managing devices on IP networks." Devices that typically support SNMP include routers, switches, servers, workstations, printers, modem racks, and more. [1] It is used mostly in network management systems to monitor network-attached devices for conditions that warrant administrative attention. SNMP is a component of the Internet Protocol Suite as defined by the Internet Engineering Task Force (IETF). It consists of a set of standards for network management, including an application layer protocol, a database schema, and a set of data objects.[2] SNMP exposes management data in the form of variables on the managed systems, which describe the system configuration. These variables can then be queried (and sometimes set) by managing applications.
Simple Transportation Management Framework (STMF)	Describes the organization of the information within devices and the methods of retrieving or modifying any information within the device.

	STMF also explains how to generate and use computer readable information organization descriptions.
Smart Grid device	A terminal device which provides electrical load information to the utility.
SNMP agent	This is a logical entity that is hosted on an ELMS device (e.g., a data logger) that manages the communications between a management station and other ELMS devices in the system.
Specification	A document that specifies in a complete, precise, and verifiable manner the requirements, design, behavior, or other characteristics of a system or component, and often the procedures for determining whether these provisions have been satisfied.
stagger interval	The amount of time, in seconds, between switching individual luminaires, electrical services, or branches assigned to a given branch circuit. Note: The intent of the stagger interval is to minimize peak demand.
subfeature	A specialization of a more generic feature.
Systems Engineering	An interdisciplinary approach and means to enable the realization of successful systems. (INCOSE). An interdisciplinary collaborative approach to derive, evolve, and verify a lifecycle balanced system solution, which satisfies customer expectations and meets public acceptability. (IEEE)
Traffic Management Center (TMC)	The location of the central computer and equipment that allows operations staff to monitor and manage roadside lighting through field devices.
upload	To transfer information from the referenced field device to the central computer, or an attached portable computer.
user	A person who uses the system that is developed.
user needs	The business or operational problem (opportunity) to be fulfilled to justify procurement or use. Note: “User need,” as understood within the NTCIP community, reflects needs of all stakeholders.

validate	To ensure that an item of interest is as intended. For example, to ensure that the data associated with a set operation have been stored in a device without any errors.
zone	A logical grouping of luminaires and/or circuits; used for control and reporting purposes.

6. References

Technical

Building Quality Intelligent Transportation Systems Through Systems Engineering
FHWA-OP-02-046, April 2002.
http://ntl.bts.gov/lib/jpodocs/repts_te/13620.html
Accessed March 23, 2016

Details On Acquiring Standards-Based ITS Systems, ITE PCB Module A201, 2011
http://www.pcb.its.dot.gov/standardstraining/Modules.aspx

IEEE Std 1362-1998, IEEE Guide for Information Technology – System Definition Concept of Operations (ConOps) Document, IEEE, 1998.

Introduction to Acquiring Standards-Based ITS Systems, ITE PCB Module A101, 2011
http://www.pcb.its.dot.gov/standardstraining/Modules.aspx

Introduction to User Needs Identification, ITE PCB Module A102, 2011
http://www.pcb.its.dot.gov/standardstraining/Modules.aspx

NTCIP Guide, Information Report 9001
http://www.pcb.its.dot.gov/PageRedirect.asp?RedirectedURL=http://ntcip.org/

The NTCIP Guide, Version 04, NTCIP 9001, 2009

Object Definitions for Electrical and Lighting Management Systems, Version 2.20, NTCIP March 2011.

Recommended Practice for Software Requirements Specifications, IEEE 830, 1998.

Systems Engineering for ITS-An Introduction for Transportation Professionals, FHWA
http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf

Systems Engineering Guidebook for Intelligent Transportation Systems, Version 3.0,
United States Department of Transportation, November 2009 http://www.fhwa.dot.gov/cadiv/segb/

Systems Engineering Guidebook, Caltrans and FHWA, February 2005
http://www.dot.ca.gov/newtech/docs/se guidebook ver1-12 14 05.pdf

Systems Engineering Handbook, International Council on Systems Engineering (INCOSE), v3.2, 2010.
http://www.incose.org/ProductsPublications/sehandbook

Systems Engineering Handbook, Version 3.2,
International Council on Systems Engineering, January 2010

The NTCIP Guide, Version 04, NTCIP 9001, 2009

US DOT ITS NTCIP 1213 ELMS V2.20
http://www.ntcip.org/library/documents/pdf/1213v0219d.pdf

US DOT ITS NTCIP 1213 ELMS V2.20 Management Information Base
http://www.ntcip.org/library/standards/default.asp?documents=yes&qreport=no&standard=1213

USDOT Standards Program
http://www.standards.its.dot.gov/

USDOT, FHWA, Freeway Operations and Management
http://ops.fhwa.dot.gov/freewaymgmt/frwy_ops.htm

USDOT, FHWA, Operations
http://ops.fhwa.dot.gov/

USDOT, RITA, ITS-JPO
http://www.its.dot.gov/index.htm(Fact sheets)

Using ITS Standards: An Overview, ITE PCB Module I101, 2011
http://www.pcb.its.dot.gov/standardstraining/Modules.aspx

Application

LED Adaptive Lighting & The Smart Grid
http://www.iaei.org/magazine/2010/11/led-adaptive-lighting-and-the-smart-grid/
The Magazine of the International Association of Electrical Inspectors
December 2010

Smart Transportation and The Smart Grid
http://pwmag.com/industry-news.asp?sectionID=760&articleID=1250011
Public Works Magazine, published by Hanley Wood, ISSN: 0033-3840
April 2010

Saving Energy & The Environment with New Street and Area Lighting Technology
http://www.imsasafety.org/journal/so09/20.pdf
International Municipal Signal Association Journal
September 2009

Electrical Lighting & Management Systems, Intelligent Transportation Systems & Interagency Communications

http://www.imsasafety.org/journal/nd08/7.pdf
International Municipal Signal Association Journal
November 2008

Maintaining Roadway Lighting and The Environment
http://www.imsasafety.org/journal/so08/21.pdf
International Municipal Signal Association Journal
September 2008

Saving Time, Energy & Lives Using ELMS Technology: How to Better Manage Electrical Infrastructure
http://www.imsasafety.org/journal/ja08/ja08.pdf
International Municipal Signal Association Journal
July 2008

Smart Cities: Intelligent Transportation and Smart Grid Standards for Electrical and Lighting Management Systems
http://www.imsasafety.org/
International Municipal Signal Association Journal
May 1, 2012

Smart Cities: Vehicle to Infrastructure and Adaptive Roadway Lighting Communication Standards
http://www.imsasafety.org/
International Municipal Signal Association Journal
September 1, 2012

7. Study Questions

These quiz/poll questions and answer choices as presented in the PowerPoint slide allow students to follow along with the recording. Three additional quiz questions are also provided to reinforce learning. See the webinar archive for answers.

1. **Which of the following statement is true?**
    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

2. **Which of the following is <u>not</u> an advantage of using the systems engineering process for the ELMS NTCIP 1213 standard?**
    a) Supports interoperability
    b) It 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

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

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

4. **Which of the following is a true statement?**

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

5. **Which of the following descriptions of the PRL is a false statement?**

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

6. **Which of the following is a false statement?**

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.

7. **Which of the following is a false statement?**

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

8. **Who and what can generate User Needs?**

a) People but not systems

b) Systems but not people

c) People and systems

d) Neither people nor systems

Answer: C – people, including travelers, TMC operators, as well as systems can generate User Needs.

9. **Which of the following organizations can integrate the PRL into a specification?**

a) Vendors

b) Agencies

c) Both

d) Neither

Answer: C – Both Vendors and Agencies can use the PRL in specifications and contract documents

10. **Which of the following describes the relationship between User Needs and Functional Requirements within the PRL?**

a) User Needs describe what features are required

b) Functional Requirements refine the user needs into detailed, measurable specifications

c) Within the PRL, the relationships between User Needs and Functional Requirements are standardized

d) All of the above

Answer: C – Within the PRL

8. Icon Guide

The following icons are used throughout the module to visually indicate the corresponding learning concept listed below, and/or to highlight a specific point in the training material.

1) **Background information:** General knowledge that is available elsewhere and is outside the module being presented. This will be used primarily in the beginning of the slide set when reviewing information readers are expected to already know.

2) **Tools/Applications:** An industry-specific item a person would use to accomplish a specific task, and application of that tool to fit the need.

3) **Remember:** Used when referencing something already discussed in the module that is necessary to recount.

4) **Refer to Student Supplement:** Items or information that are further explained/detailed in the Student Supplement.

5) **Example:** Can be real-world (case study), hypothetical, a sample of a table, etc.

6) **Checklist:** Used to indicate a process that is being laid out sequentially.