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# Mac Lister



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- New Web-Based Training from ITS Joint Program Office
  - Connected Vehicle Reference Implementation Architecture Training now available
- New NHI Course
  - Systems Engineering for Signal Systems Including Adaptive Control (NHI-133123)
- New ITS Case Study Available
  - National ITS Architecture
- Added to T3 Archive
  - Learn from the Experts: Open Data Policy Guidelines for Transit - Maximizing Real Time and Schedule Data-Legalities, Evolutions, Customer Perspectives, Challenges, and Economic Opportunities - Part II  
Presented on August 7, 2014
  - Saving Lives and Keeping Traffic Moving: Quantifying the Outcomes of Traffic Incident Management (TIM) Programs  
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# Jeffrey Spencer



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A photograph of several people in a conference room setting, looking at a presentation on a screen. A laptop is visible on a table in the foreground.

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# **ITS Transit Standards Professional Capacity Building Program**

**Module 9:  
Arterial Management and Transit Signal Priority:  
Specifying Requirements for Signal Control Priority  
(SCP) Based on NTCIP 1211 Standard  
Part 2 of 2**



# A C T I V I T Y



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

# Instructor



**Patrick Chan, P.E.**  
**Senior Technical Staff**  
**Consensus Systems Technologies**  
**Flushing, NY, USA**

# Target Audience

- Transit planning, operations, and maintenance staff;
- Traffic management operations staff;
- Transit and traffic procurement staff;
- Specification writers;
- Transit electronic systems maintenance staff;
- Integrated Corridor Management project and operations team;
- Transit technology vendors; and
- Transit ITS contractors and consultants.

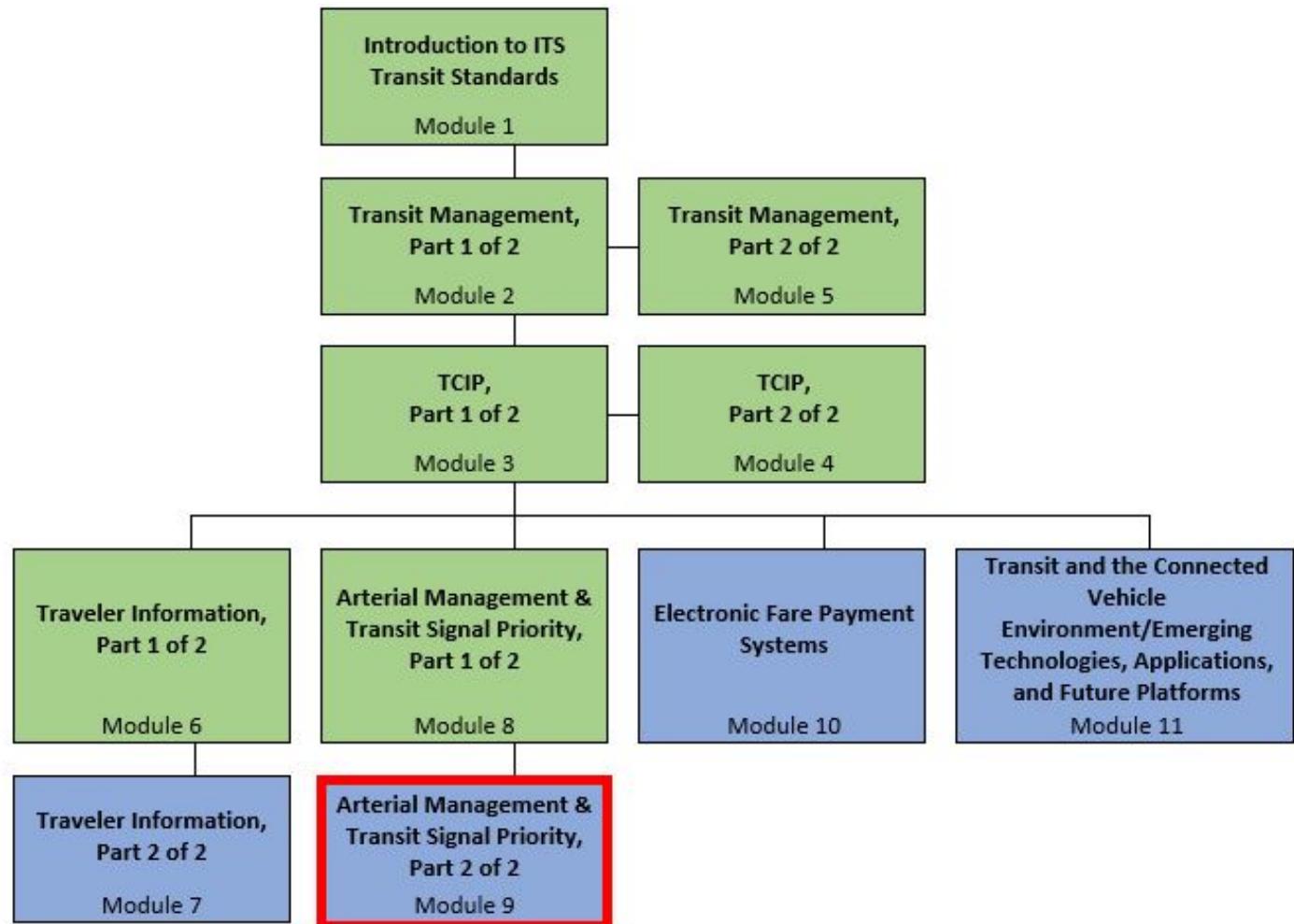


# Recommended Prerequisite(s)

	Decision-Maker	Project Manager	Project Engineer
<b>Module 1:</b> Introduction to ITS Transit Standards	N/A	✓	✓
<b>Module 2:</b> Transit Management Standards, Part 1 of 2	N/A	✓	✓
<b>Module 3:</b> Transit Communications Interface Profiles (TCIP), Part 1 of 2	N/A	✓	✓
<b>Module 4:</b> Transit Communications Interface Profiles (TCIP), Part 2 of 2	N/A	✓	✓
<b>Module 5:</b> Transit Management Standards, Part 2 of 2	N/A	✓	✓
<b>Module 8:</b> Arterial Management and Transit Signal Priority, Part 1 of 2	N/A	✓	✓



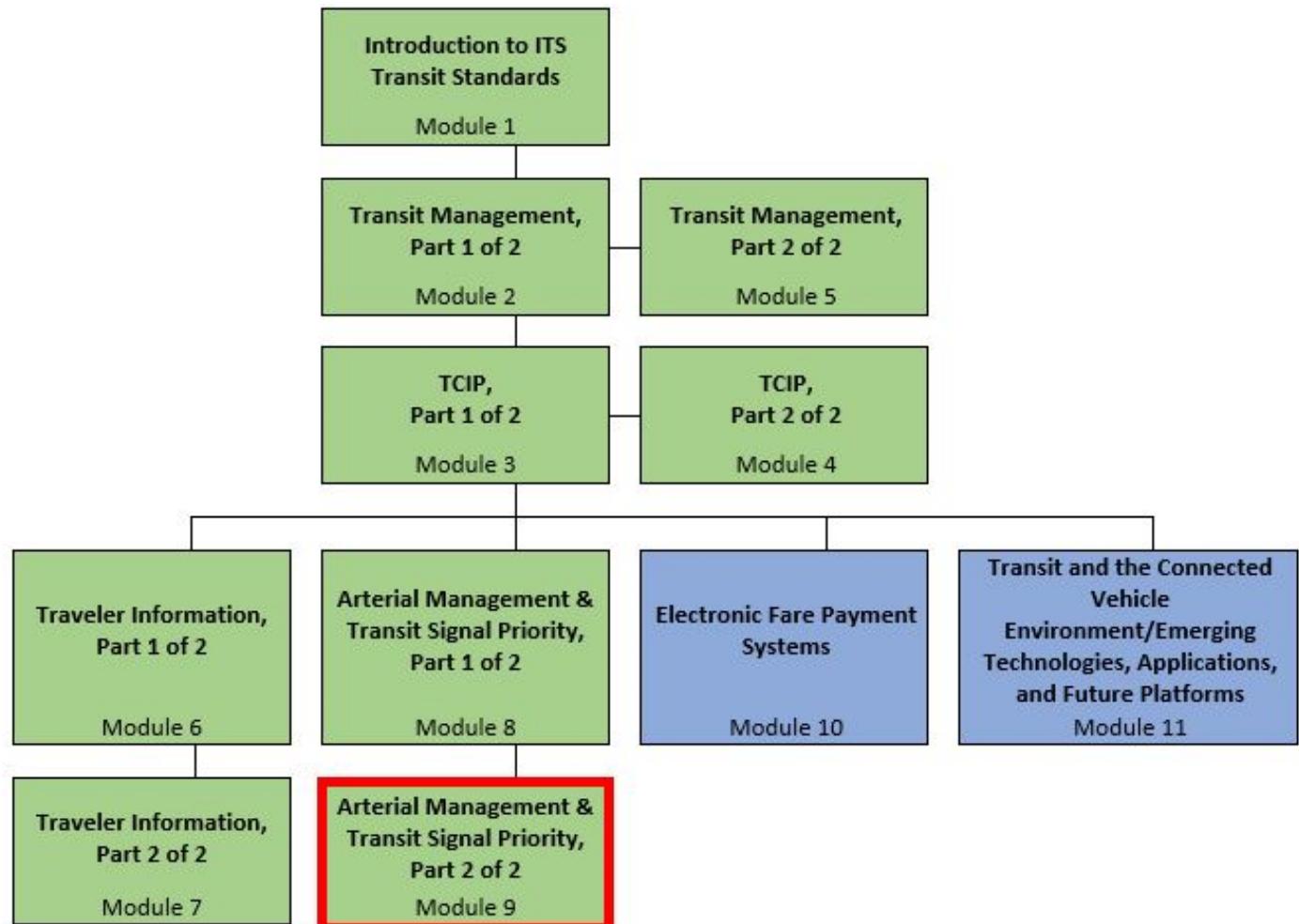
# Curriculum Path (Project Manager)



Recommended Prerequisite Modules

Optional Modules

# Curriculum Path (Project Engineer)



Recommended Prerequisite Modules

Optional Modules



# Learning Objectives

1. Describe requirements included in the National Transportation Communications for ITS Protocol (NTCIP) 1211 Standard
2. Use the Protocol Requirements List (PRL) to specify requirements
3. Show how to achieve interoperability and interchangeability using the Requirements Traceability Matrix (RTM)
4. Explain the NTCIP 1211 Simple Network Management Protocol (SNMP) interface and dialogues
5. Explain how to incorporate requirements not covered by the NTCIP 1211 Standard
6. Identify a case study specifying requirements for an SCP system



# Learning Objective #1: Describe Requirements Included in the NTCIP 1211 Standard

- Summarize the components and structure of the NTCIP 1211 Standard
- Use a Protocol Requirements List (PRL) to identify requirements desired or supported
- Describe the organization and decomposition of requirements of the NTCIP 1211 Standard



# Components and Structure of NTCIP 1211

## Signal Control Priority

- An operational strategy that provides preferential treatment (priority) to facilitate the movement of fleet (transit) vehicles through signalized intersections
- Provides preferential treatment for pre-identified vehicles at signalized intersections without degrading the overall performance of the traffic network
- Provides more efficient use of the street network by improving the throughput of travelers and goods
- Improves on-time performance and scheduled adherence of public transportation



# Components and Structure of NTCIP 1211

## Recall the Components of a Signal Control Priority (SCP) System

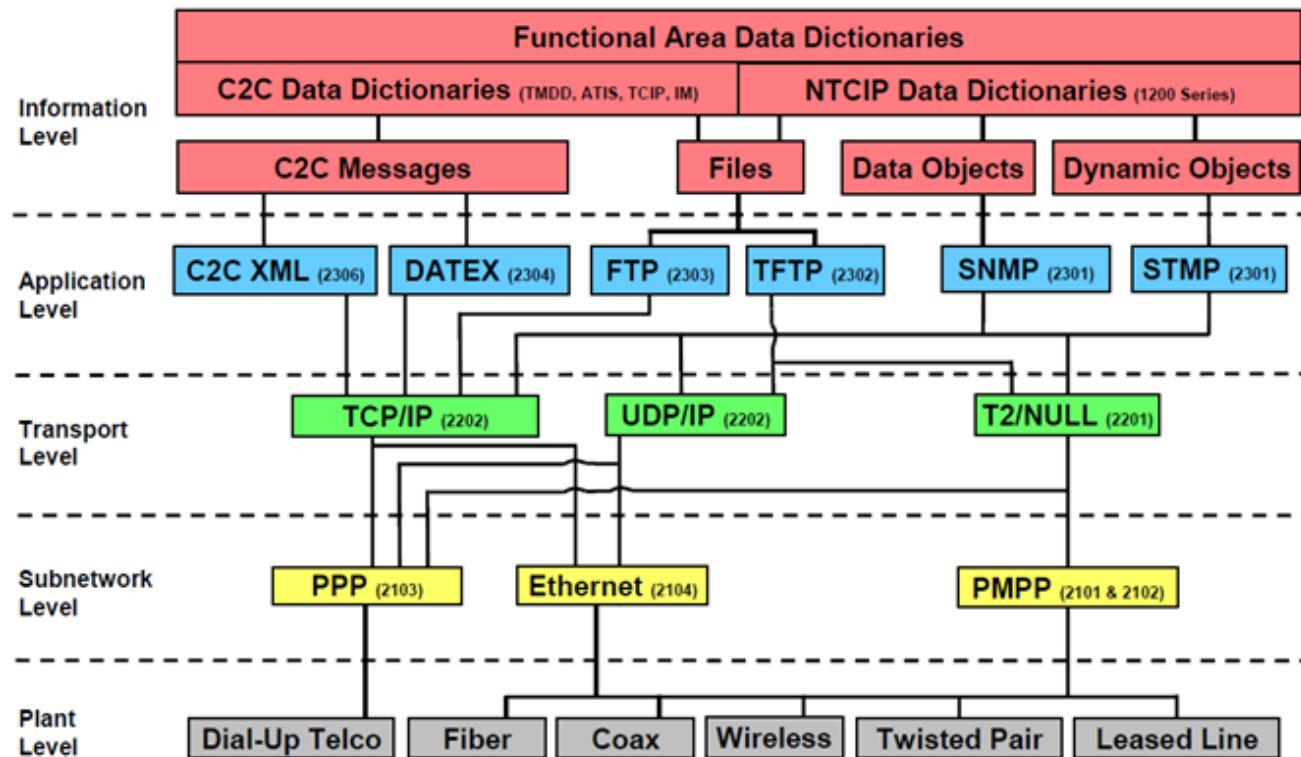
- Priority Request Generator (PRG) – Sends a request for signal priority to the Priority Request Server (PRS)
- Priority Request Server (PRS) – Prioritizes different priority requests and forwards the service requests to the Coordinator (CO)
- Coordinator (CO) – Implements the requested priority strategy
- Management Station – A computing platform that manages the NTCIP field components, such as a PRS or a CO



# Components and Structure of NTCIP 1211

## NTCIP: A Family of Standards

- Information-level (content) standards – data to be exchanged
- Underlying standards (protocols) – how data are exchanged



# Components and Structure of NTCIP 1211

## What Is NTCIP 1211?

- A communications interface, information-level standard for SCP systems
  - Between a management station and a Priority Request Server (PRS);
  - Between a management station and a Coordinator (CO);
  - Between a Priority Request Generator (PRG) and a PRS; and
  - Between a PRS and a CO.



# Components and Structure of NTCIP 1211

## History of NTCIP 1211

- Version 01: Published May 2008
- Version 02:
  - Published September 2014
  - Added the systems engineering process
    - Defines the user needs supported by the standard
    - Based on those user needs, defines the functional requirements supported by the standard
    - Based on those functional requirements, defines a single design for each requirement
  - Fixed a time reference problem
  - Corrected errors and clarified ambiguities in NTCIP 1211 v01

# Components and Structure of NTCIP 1211

## Structure of the Standard

- Section 1: General
- Section 2: Concept of Operations
- Section 3: Functional Requirements
- Section 4: Dialogs
- Section 5: Management Information Base (MIB)



# Components and Structure of NTCIP 1211

## Structure of the Standard

- Annex A: Requirements Traceability Matrix (RTM)
- Annex B: Object Tree
- Annex C: Test Procedures
- Annex D: Documentation of Revisions
- Annex E: User Requests
- Annex F: SCP Tutorial
- Annex G: SNMP Interface
- Annex H: NTCIP 1201 v03 Derived User Needs, Functional Requirements, and Dialogs



# Use a Protocol Requirements List (PRL) to Identify Requirements Desired or Supported

## Protocol Requirements List

- A table in NTCIP that maps user needs to requirements
- Can be used to:
  - Specify the standard
  - Assist deployments by providing a checklist
  - Serve as the basis of selecting test procedures
  - Identify capabilities supported by an implementation
    - For example, a vendor can complete a PRL to describe its product
    - An agency can archive with project documentation
  - Compare two implementations for interoperability

# Use a Protocol Requirements List (PRL) to Identify Requirements Desired or Supported

## Protocol Requirements List

- **User Need ID** references a precise clause for a user need in the standard
- **User Need** provides the name or title of the user need

Protocol Requirements List (PRL)							
	User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4		Architectural Needs					
2.4.1		Integral Entities		C	Yes / NA		Where two entities are integral to the same physical device, the interface between these entities is implementation-specific.
2.4.2		Provide Live Data		M	Yes		
		3.4.1.1	Provide Data	M	Yes		
		3.4.1.2	Receive Data	M	Yes		
		3.4.1.3	Explore Data	M	Yes		
		3.6.1	Response Time for Requests	M	Yes		The Response Time for all requests shall be _____ milliseconds (25-500: Default=100).
2.4.3		Support Multiple Instances of an Entity		M	Yes		
		3.4.1.1	Provide Data	M	Yes		An agent shall be capable of providing data to at least _____ (1-10:Default=10) managers at any time.
		3.4.1.2	Receive Data	M	Yes		An agent shall be capable of receiving data from at least _____ (1-10:Default=10) managers at any time.
		3.4.1.3	Explore Data	M	Yes		An agent shall be capable of dynamically providing data to at least _____ (1-10:Default=10) managers at any time.
2.4.4		Provide Compressed Data					
2.4.4.1		Provide Compressed Data between a Management Station and a PRS		M	Yes		

# Use a Protocol Requirements List (PRL) to Identify Requirements Desired or Supported

## Protocol Requirements List

- **User Need ID** references a precise clause for a user need in the standard
- **User Need** provides the name or title of the user need

2.5.3.1

Exchange Priority Requests

A PRG needs to send priority requests to a PRS. A priority request consists of the class of the vehicle requesting priority, strategy selected, time of service desired and the estimated time of departure. This feature provides a PRS with the information necessary to determine if a priority request should be granted.

# Use a Protocol Requirements List (PRL) to Identify Requirements Desired or Supported

## Protocol Requirements List

- User needs describe **what** features a component needs to support and **why**
- Functional requirements refine the user needs into detailed, **measurable** specifications
- Within the PRL, the relationships between user needs and functional requirements are standardized
  - User needs justify and explain requirements
  - Requirements refine needs to measureable concepts
  - Promotes interoperability

# Use a Protocol Requirements List (PRL) to Identify Requirements Desired or Supported

## Protocol Requirements List

- **FR ID** references a precise clause for a functional requirement in the standard
- **Functional Requirement** provides the name or title of the functional requirement

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4	Architectural Needs					
2.4.1	Integral Entities			C	Yes / NA	Where two entities are integral to the same physical device, the interface between these entities is implementation-specific.
2.4.2	Provide Live Data			M	Yes	
		3.4.1.1	Provide Data	M	Yes	
		3.4.1.2	Receive Data	M	Yes	
		3.4.1.3	Explore Data	M	Yes	
2.4.3	3.6.1	Response Time for Requests		M	Yes	The Response Time for all requests shall be _____ milliseconds (25-500: Default=100).
	Support Multiple Instances of an Entity			M	Yes	
		3.4.1.1	Provide Data	M	Yes	An agent shall be capable of providing data to at least ____ (1-10:Default=10) managers at any time.
		3.4.1.2	Receive Data	M	Yes	An agent shall be capable of receiving data from at least ____ (1-10:Default=10) managers at any time.
		3.4.1.3	Explore Data	M	Yes	An agent shall be capable of dynamically providing data to at least ____ (1-10:Default=10) managers at any time.
2.4.4	Provide Compressed Data					
2.4.4.1	Provide Compressed Data between a Management Station and a PRS			M	Yes	

# Use a Protocol Requirements List (PRL) to Identify Requirements Desired or Supported

## Protocol Requirements List

- **FR ID** references a precise clause for a functional requirement in the standard
- **Functional Requirement** provides the name or title of the functional requirement

### 3.5.3.1.1 **Initiate a Priority Request**

A PRG shall send a priority request message to a PRS to initiate a new priority request. The priority request information consists of a unique priority request identification number, the identification number of the vehicle making the request, the class type of the vehicle making the request, the class level of the vehicle making the request, the strategy number requested, the time of service desired (in seconds), the estimated time of departure (in seconds), and the absolute time reference used by the PRG.

# A C T I V I T Y



## What can the PRL NOT be used for?

### Answer Choices

- a) Specify the standard
- b) Map user needs to requirements
- c) Identify the user needs supported by the standard
- d) Identify the most qualified vendor

## Review of Answers



- a) Specify the standard

*Incorrect. The PRL can be used to specify the standard for an implementation.*



- b) Map user needs to requirements

*Incorrect. The PRL maps user needs to requirements.*



- c) Identify the user needs supported by the standard

*Incorrect. The PRL includes the user needs supported by the standard.*



- d) Identify the most qualified vendor

***Correct! The PRL can identify if a vendor supports a user need, but not its qualifications.***

# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Requirements

- NTCIP 1211 contains three types of requirements:
  - Architectural Requirements
  - Data Exchange and Operational Environmental Requirements
  - Supplemental Non-Communications Requirements

# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Well-Formed Requirements

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

- **Actor** – Identifies who or what does the action
- **Action** – Identifies what is to happen
- **Target** – Identifies who or what receives the action

#### 3.5.3.1.1 Initiate a Priority Request

A PRG shall send a priority request message to a PRS to initiate a new priority request. The priority request information consists of a unique priority request identification number, the identification number of the vehicle making the request, the class type of the vehicle making the request, the class level of the vehicle making the request, the strategy number requested, the time of service desired (in seconds), the estimated time of departure (in seconds), and the absolute time reference used by the PRG.



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Well-Formed Requirements

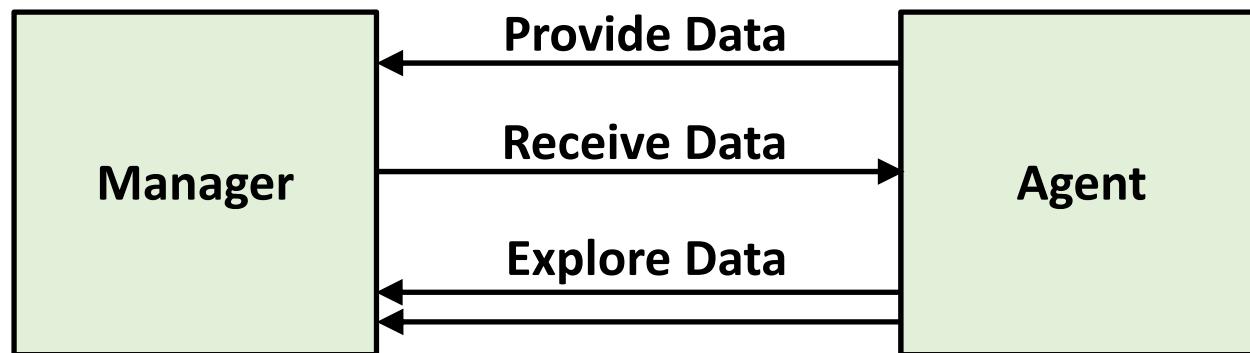
[Actor] [Action] [Target] [Constraint] [Localization]

- Optional
  - **Constraint** – Identifies how to measure success or failure of the requirement
  - **Localization** – Identifies the circumstances under which the requirement applies.
    - For example, upon request, the management station shall retrieve from the CO the default coordination pattern to be used

# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Architectural Requirements

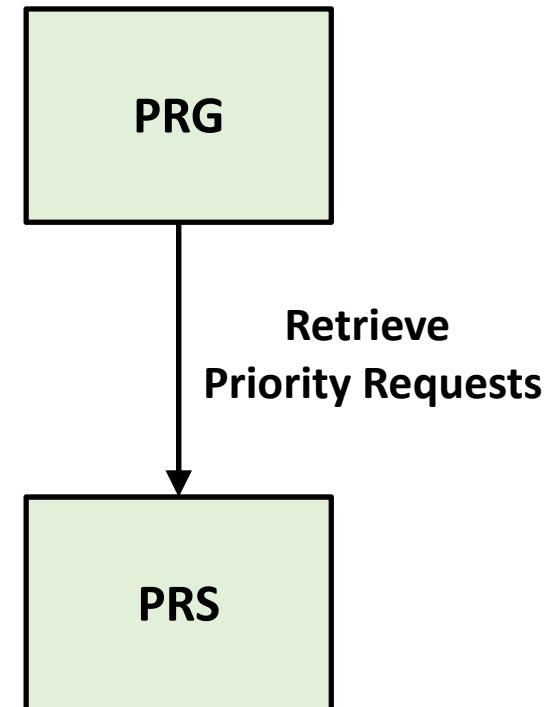
- Architectural requirements support communications from multiple entities:
  - Provide Data
  - Receive Data
  - Explore Data



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Data Exchange and Operational Environmental Requirements

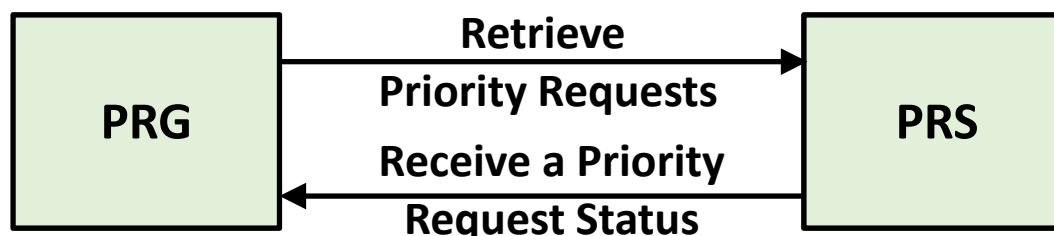
- PRG to PRS
  - Retrieve Priority Requests
    - **Initiate a Priority Request**
      - Priority Request Identifier
      - Vehicle Identifier
      - Vehicle Class Type (1-10)
      - Vehicle Class Level (1-10)
      - Service Strategy Number
      - Time of Service
      - Time of Estimated Departure
      - Time of Request



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Data Exchange and Operational Environmental Requirements Interface

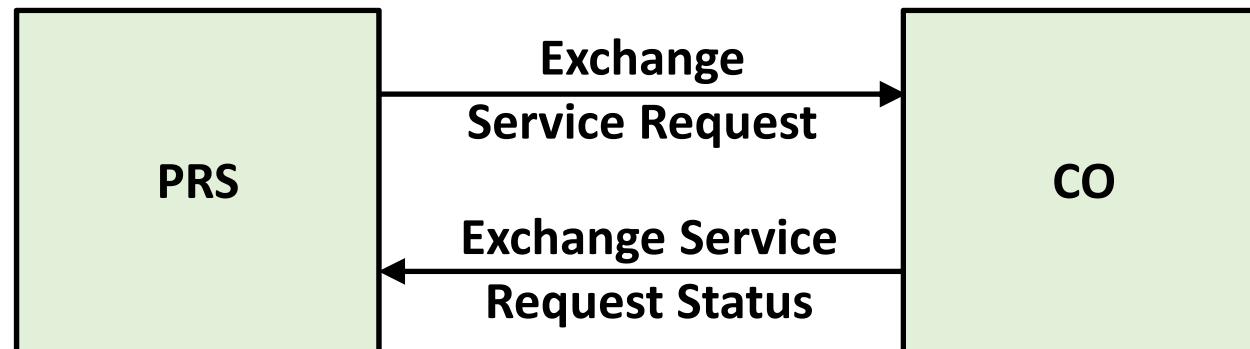
- PRG to PRS
  - Retrieve Priority Requests (Continued)
    - **Send a Priority Request Update**
    - **Send a Cancel Priority Request Update**
    - **Send a Clear Priority Request**
    - **Initiate a Priority Request – NTCIP 1211 v01.**  
Did not include time of request.
    - **Send a Priority Request Update – NTCIP 1211 v01**
  - **Receive a Priority Request Status**



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Data Exchange and Operational Environmental Requirements Interface

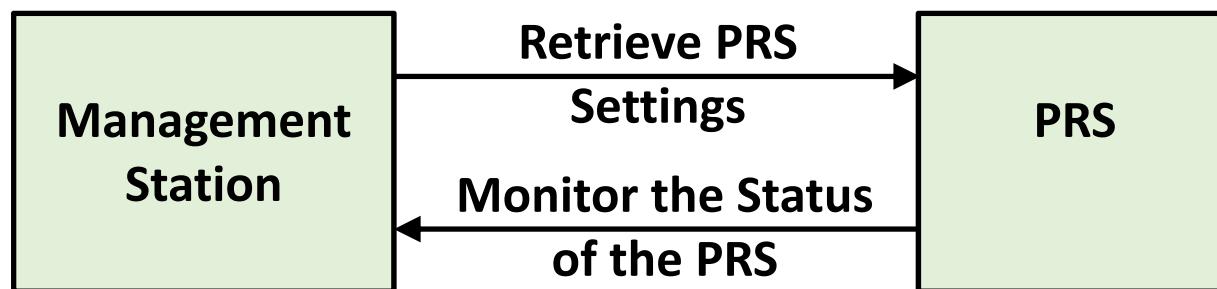
- PRS to CO
  - Exchange Service Request
  - Exchange Service Request Status



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Data Exchange and Operational Environmental Requirements Interface

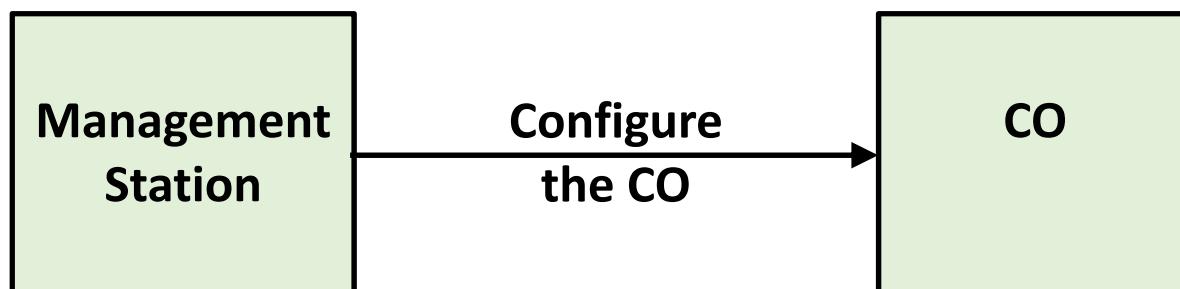
- Management Station to PRS
  - **Set Reservice Period**
  - **Set Time to Live Period**
  - **Retrieve Priority Request Server Settings**
    - Retrieve Priority Request Settings
    - Retrieve Reservice Period for Vehicle Class
    - Retrieve Priority Request Time to Live Value
  - **Monitor the Status of the PRS**



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Data Exchange and Operational Environmental Requirements Interface

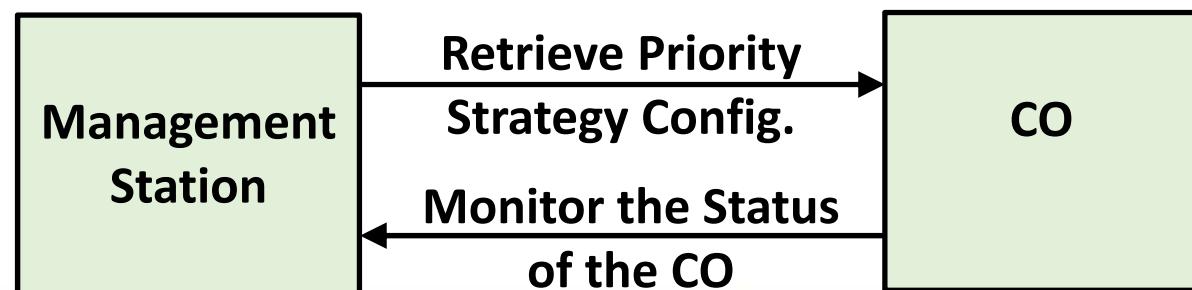
- Management Station to CO
  - Configure the CO
    - Set Priority Strategy Configuration
    - Define Default Coordination Pattern
    - Define Maximum Priority Strategies Supported
    - Define Maximum Service Requests to Consider



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Data Exchange and Operational Environmental Requirements Interface

- Management Station to CO (Continued)
  - Retrieve Priority Strategy Configuration
    - **Retrieve Priority Strategy Settings**
    - **Retrieve Priority Strategies**
    - **Retrieve Priority Splits**
    - **Retrieve Default Coordination Pattern**
    - **Retrieve Maximum Priority Strategies Supported**
    - **Retrieve Maximum Service Requests to Consider**
  - **Monitor the Status of the CO**



# Describe the Organization and Decomposition of Requirements of the NTCIP 1211 Standard

## Supplemental Non-Communications Requirements

- **Response Time for Requests**
- Process Priority Requests
  - **Support Multiple Priority Requests**
  - **Clear Expired Priority Requests**
  - **Support Multiple Priority Requests – NTCIP 1211 v01**
  - **Process Service Requests**



# Summary of Learning Objective #1

## Describe Requirements Included in the NTCIP 1211 Standard

- NTCIP is a family of standards; NTCIP 1211 is a communications interface standard for signal control priority systems
- NTCIP 1211 v02 incorporates a systems engineering process
- The Protocol Requirements List (PRL) is a table that maps user needs to requirements
- Besides general architectural requirements, NTCIP 1211 v02 organizes functional requirements by interface



## Learning Objective #2: Use the Protocol Requirements List (PRL) to Specify Requirements

- Select the user needs and link to requirements
- Explain the use of optional requirements and constraints within the PRL
- Specify performance criteria for functional requirements within the PRL
- Specify limits or ranges for functional requirements within the PRL
- Use the PRL in a project specification for transit signal priority



# Select the User Needs and Link to Requirements

## PRL - Conformance

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.5.1.1	Set Reservice Period	M	Yes	
2.5.1.1.4	Configure Time To Live Period			M	Yes	
		3.5.1.2	Set Time To Live Period	M	Yes	
		3.6.2.2	Clear Expired Priority Requests	M	Yes	
2.5.1.1.5	PRS Clock Synchronization			C	Yes / No / NA	Note: This may be NA if the PRS is internal to the traffic signal controller and the traffic signal controller already supports clock synchronization.
		H.2.5.1	Set Time	M	Yes	
		H.2.5.2	Set Time Zone	M	Yes	
		H.2.5.3	Set Daylight Savings Mode	M	Yes	
		H.2.5.4	Verify Current Time	M	Yes	
2.5.1.2	Determine Priority Request Criteria			M	Yes	
		3.5.1.3.1	Retrieve Priority Request Settings	M	Yes	
		3.5.1.3.2	Retrieve Reservice Period for a Vehicle Class	M	Yes	
		3.5.1.3.3	Retrieve Priority Request Time To Live Value	M	Yes	
2.5.1.3	Monitor the PRS			O	Yes / No	
		3.5.1.4	Monitor the Status of the PRS	M	Yes	

# Select the User Needs and Link to Requirements

## PRL - Support

- For each user need, select whether the need must be supported (Yes), does not need to be supported (No), or is Not Applicable (NA)

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.5.1.1	Set Reservice Period	M	Yes	
2.5.1.1.4	Configure Time To Live Period			M	Yes	
		3.5.1.2	Set Time To Live Period	M	Yes	
		3.6.2.2	Clear Expired Priority Requests	M	Yes	
2.5.1.1.5	PRS Clock Synchronization			C	Yes / No / NA	Note: This may be NA if the PRS is internal to the traffic signal controller and the traffic signal controller already supports clock synchronization.
		H.2.5.1	Set Time	M	Yes	
		H.2.5.2	Set Time Zone	M	Yes	
		H.2.5.3	Set Daylight Savings Mode	M	Yes	
		H.2.5.4	Verify Current Time	M	Yes	
2.5.1.2	Determine Priority Request Criteria			M	Yes	
		3.5.1.3.1	Retrieve Priority Request Settings	M	Yes	
		3.5.1.3.2	Retrieve Reservice Period for a Vehicle Class	M	Yes	
		3.5.1.3.3	Retrieve Priority Request Time To Live Value	M	Yes	
2.5.1.3	Monitor the PRS			O	Yes / No	
		3.5.1.4	Monitor the Status of the PRS	M	Yes	

# Explain the Use of Optional Requirements and Constraints within the PRL

## PRL – Associated Requirements

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

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.5.1	Backward Compatible with NTCIP 1211 v01			O	Yes / No	Note: These object definitions have not been deprecated to address interoperability issues with NTCIP 1211 v01. The associated objects were deprecated and replaced by newer objects that have a wider scope or that have been changed to ease implementation. Pay close attention to the implementation and interoperability of these objects.
		3.5.3.1.5	Initiate a Priority Request – NTCIP 1211 v01	C	Yes / NA	If the PRG and PRS are integral to the same physical device, the interface between these entities is implementation-specific.
		3.5.3.1.6	Send a Priority Request Update – NTCIP 1211 v01	C	Yes / NA	If the PRS and CO are integral to the same physical device, the interface between these entities is implementation-specific.
		3.6.2.3	Support Multiple Priority Requests – NTCIP 1211 v01	M	Yes	The PRS shall be capable of supporting at least ____ (1-10:Default=10) and no more than ____ (1-10:Default=10) priority requests.

# Explain the Use of Optional Requirements and Constraints within the PRL

## PRL – Associated Requirements

- If a user need is selected, for each requirement indicate whether the requirement is to be supported (Yes), does not need to be supported (No), or is Not Applicable (NA)

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.5.1	Backward Compatible with NTCIP 1211 v01			O	Yes / No	Note: These object definitions have not been deprecated to address interoperability issues with NTCIP 1211 v01. The associated objects were deprecated and replaced by newer objects that have a wider scope or that have been changed to ease implementation. Pay close attention to the implementation and interoperability of these objects.
		3.5.3.1.5	Initiate a Priority Request – NTCIP 1211 v01	C	Yes / NA	If the PRG and PRS are integral to the same physical device, the interface between these entities is implementation-specific.
		3.5.3.1.6	Send a Priority Request Update – NTCIP 1211 v01	C	Yes / NA	If the PRS and CO are integral to the same physical device, the interface between these entities is implementation-specific.
		3.6.2.3	Support Multiple Priority Requests – NTCIP 1211 v01	M	Yes	The PRS shall be capable of supporting at least ____ (1-10:Default=10) and no more than ____ (1-10:Default=10) priority requests.

# Specify Performance Criteria for Functional Requirements within the PRL

## Protocol Requirements List – Additional Specifications

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4	Architectural Needs					
2.4.1	Integral Entities			C	Yes / NA	Where two entities are integral to the same physical device, the interface between these entities is implementation-specific.
2.4.2	Provide Live Data			M	Yes	
	3.4.1.1	Provide Data		M	Yes	
	3.4.1.2	Receive Data		M	Yes	
	3.4.1.3	Explore Data		M	Yes	
	3.6.1	Response Time for Requests		M	Yes	The Response Time for all requests shall be _____ milliseconds (25-500: Default=100).

- Used to enter additional notes and requirements
  - For example, defining performance criteria or to specify limits or ranges for functional requirements
- Used to provide further details about an implementation

# Specify Limits or Ranges for Functional Requirements within the PRL

## Protocol Requirements List – Additional Specifications

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.5.3.1.4	Send a Clear Priority Request	M	Yes	The PRS shall be capable of supporting at least ___ (1-10:Default=10) and no more than ___ (1-10:Default=10) priority requests.
		3.6.2.1	Support Multiple Priority Requests	M	Yes	
2.5.3.2	Exchange Priority Request Status				M	Yes
		3.5.3.2	Receive Priority Request Status	M	Yes	

# Use the PRL in an SCP Specification

## Part of the Interface Specification

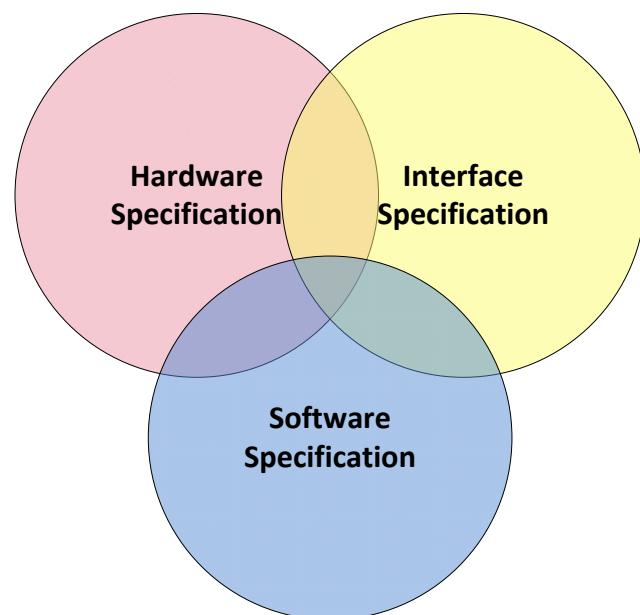
- A transit agency's completed PRL specifies the needs and requirements for the NTCIP interface
- When combined with the communication specification, it forms an interface specification
- A vendor may “exceed the specification”
  - Support features not selected
  - Allows vendors to bid on more projects with a single model
- A deployment may need multiple interface specifications
  - Management systems that support multiple devices
  - May need support for legacy protocol



# Use the PRL in an SCP Specification

## Consistency

- The interface specification must be consistent with the remainder of the specification
- Management Station – PRS and Management Station – CO interfaces have requirements to set the time
  - Implies existence of clocks in the PRS and the CO
  - Requires software logic to update the clock



## Use the PRL in an SCP Specification

### Sample Text for using the PRL in a Specification

- The PRL should be properly introduced within the specification
- Copyright disclaimer should appear with the PRL



# A C T I V I T Y



## **Which of the following elements is NOT a purpose of the PRL?**

### **Answer Choices**

- a) Associate user needs with requirements
- b) Specify the requirements for a specific project
- c) Determine which objects to use
- d) Determine the minimum requirements for conformance



## Review of Answers



- a) Associate user needs with requirements

*Incorrect. This is one of the key purposes of the PRL.*



- b) Specify the requirements for a specific project

*Incorrect. The PRL allows the agency to specify the user needs and requirements for a project.*



- c) Determine which objects to use

***Correct! The PRL does not help determine which objects to use for an implementation.***



- d) Determine the minimum requirements for conformance

*Incorrect. The PRL indicates what user needs and requirements are mandatory to conform to the standard.*

## **Summary of Learning Objective # 2**

### **Use the Protocol Requirements List (PRL) to Specify Requirements**

A PRL is a tool in the standard to:

- Select user needs and requirements for a project implementation;
- Specify performance criteria and ranges for requirements; and
- Determine the capabilities of an implementation.



## **Learning Objective #3: Show How to Achieve Interoperability and Interchangeability Using the Requirements Traceability Matrix (RTM)**

- Explain how the RTM traces to a single design
- Demonstrate how to compare for interoperability



# Explain How the RTM Traces to a Single Design

## Interoperability

- Ability of different components, or for the purpose of this module, transit signal priority components from different vendors, to exchange information and to use the information that has been exchanged
- Interoperability is a key objective for using the standards
  - Interoperability reduces risks and, by extension, costs
- Interchangeability
  - Ability of one component to be used in place of or be replaced by another component



# Explain How the RTM Traces to a Single Design

## Annex A Contains a Requirements Traceability Matrix

- Describes the (standard) design for fulfilling a requirement
  - Requirements can be traced in a standardized way
  - Reduces design work
- Design consists of a dialog (sequence of data exchanges) and object(s) to be exchanged
- To conform to a requirement, a transit signal priority (TSP) system must support the standardized dialogs and objects specified in NTCIP 1211 v02, with the expected result
- Results in interoperability – all systems shall satisfy a specified requirement ***the same way***



# Explain How the RTM Traces to a Single Design

## Requirements Traceability Matrix

- **FR ID** references a precise clause for a functional requirement in the standard
- **Functional Requirement** provides the name or title of the functional requirement

Requirements Traceability Matrix (RTM)						
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications	
		4.2.1.1				
3.5.1.2	Set Time To Live Period		5.1.2.7	prsProgramData		
		4.2.1.1				
3.5.1.3	Retrieve Priority Request Server Settings		5.1.2.7	prsProgramData		
3.5.1.3.1	Retrieve Priority Request Settings					
		G.1				
3.5.1.3.2	Retrieve Reservice Period for a Vehicle Class		5.1.2.7	prsProgramData		
		G.1				
			5.1.1.5	priorityRequestReserviceClass1Time		
			5.1.1.6	priorityRequestReserviceClass2Time		
			5.1.1.7	priorityRequestReserviceClass3Time		
			5.1.1.8	priorityRequestReserviceClass4Time		
			5.1.1.9	priorityRequestReserviceClass5Time		
			5.1.1.10	priorityRequestReserviceClass6Time		
			5.1.1.11	priorityRequestReserviceClass7Time		
			5.1.1.12	priorityRequestReserviceClass8Time		
			5.1.1.13	priorityRequestReserviceClass9Time		
			5.1.1.14	priorityRequestReserviceClass10Time		
3.5.1.3.3	Retrieve Priority Request Time To Live Value					

# Explain How the RTM Traces to a Single Design

## Requirements Traceability Matrix

- The third column defines the associated dialogs that fulfill the requirements
  - A dialog is a sequence of events
  - A requirement traces to only one dialog

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
		4.2.1.1	5.1.2.7	prsProgramData	
3.5.1.2	Set Time To Live Period				
		4.2.1.1	5.1.2.7	prsProgramData	
3.5.1.3	Retrieve Priority Request Server Settings				
3.5.1.3.1	Retrieve Priority Request Settings				
		G.1	5.1.2.7	prsProgramData	
3.5.1.3.2	Retrieve Reservice Period for a Vehicle Class				
		G.1	5.1.1.5	priorityRequestReserviceClass1Time	
			5.1.1.6	priorityRequestReserviceClass2Time	
			5.1.1.7	priorityRequestReserviceClass3Time	
			5.1.1.8	priorityRequestReserviceClass4Time	
			5.1.1.9	priorityRequestReserviceClass5Time	
			5.1.1.10	priorityRequestReserviceClass6Time	
			5.1.1.11	priorityRequestReserviceClass7Time	
			5.1.1.12	priorityRequestReserviceClass8Time	
			5.1.1.13	priorityRequestReserviceClass9Time	
			5.1.1.14	priorityRequestReserviceClass10Time	
3.5.1.3.3	Retrieve Priority Request Time To Live Value				

# Explain How the RTM Traces to a Single Design

## Requirements Traceability Matrix

- The fourth and fifth columns define the associated objects that fulfill the requirements
  - All objects that trace to the requirement must be supported to fulfill the requirement

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
		4.2.1.1	5.1.2.7	prsProgramData	
3.5.1.2	Set Time To Live Period				
		4.2.1.1	5.1.2.7	prsProgramData	
3.5.1.3	Retrieve Priority Request Server Settings				
3.5.1.3.1	Retrieve Priority Request Settings				
		G.1	5.1.2.7	prsProgramData	
3.5.1.3.2	Retrieve Reservice Period for a Vehicle Class				
		G.1	5.1.1.5	priorityRequestReserviceClass1Time	
			5.1.1.6	priorityRequestReserviceClass2Time	
			5.1.1.7	priorityRequestReserviceClass3Time	
			5.1.1.8	priorityRequestReserviceClass4Time	
			5.1.1.9	priorityRequestReserviceClass5Time	
			5.1.1.10	priorityRequestReserviceClass6Time	
			5.1.1.11	priorityRequestReserviceClass7Time	
			5.1.1.12	priorityRequestReserviceClass8Time	
			5.1.1.13	priorityRequestReserviceClass9Time	
			5.1.1.14	priorityRequestReserviceClass10Time	
3.5.1.3.3	Retrieve Priority Request Time To Live Value				

# Explain How the RTM Traces to a Single Design

## Requirements Traceability Matrix

- The sixth column provides additional notes on how the design can be implemented to fulfill the requirement.
  - This column is informative and has no normative standing

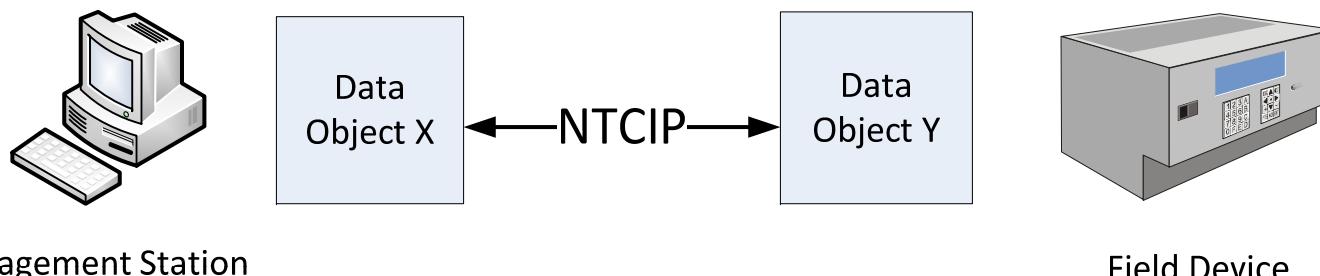
Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.4.1	Exchange Service Request			The following mapping is only applicable if the PRS is the manager.	This dialog and objects between the PRS and CO shall be supported unless the PRS and the CO are implemented as an integral part of the same physical device.
		4.2.4.1.2	5.2.2.1	prsServiceRequest	
			5.1.1.1.6	priorityRequestServiceStrategyNumber	
			5.1.1.1.9	priorityRequestStatusInPRS	
			5.1.1.1.12	priorityRequestTimeOfServiceDesiredInPR S	
			5.1.1.1.13	priorityRequestTimeOfEstimatedDeparturel nPRS	
			5.1.1.2	prsBusy	
			5.2.1.2.2	priorityStrategyRequested	
			5.2.1.2.3	priorityStrategyRequestedTimeOfServiceDe sired	
			5.2.1.2.4	priorityStrategyRequestedTimeOfEstimated Departure	
			5.2.1.2.5	priorityStrategyRequestedStatusInCO	
			5.2.1.3	coBusy	

# Demonstrate How to Compare for Interoperability

## Compare PRLs for Interoperability

- RTM provides interoperability at individual requirement level
- PRL indicates which requirements are supported/required
- Comparisons of PRLs allow quick determination of interoperability

### Interoperability



# Demonstrate How to Compare for Interoperability

## Compare PRLs for Interoperability

- Both the manager and the agent support a requirement
  - Interoperability provided for that requirement
- The manager supports but the agent does not
  - The manager can still support the requirement (typically)
  - The manager can still interoperate with other agents that support the requirement
- The agent supports, but the manager does not
  - Feature could be used by other/future managers
  - Feature can potentially be used manually

# A C T I V I T Y



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## **Which of the following are not part of the RTM?**

### **Answer Choices**

- a) User needs supported by the standard
- b) Requirements supported by the standard
- c) Standardized dialogs to fulfill requirements
- d) Data objects to fulfill requirements

## Review of Answers



- a) User needs supported by the standard

***Correct! User needs are not included in the RTM.***



- b) Requirements supported by the standard

*Incorrect. Each requirement supported by the standard is listed in the RTM.*



- c) Standardized dialogs to fulfill requirements

*Incorrect. Each requirement includes a standardized dialog to fulfill the requirement.*



- d) Data objects to fulfill requirements

*Incorrect. Each requirement includes one or more data objects to fulfill the requirement.*

# Summary of Learning Objective #3

## Show How to Achieve Interoperability and Interchangeability Using the Requirements Traceability Matrix (RTM)

The Requirements Traceability Matrix:

- Maps each requirement to a specific design consisting of a dialog and data objects
- Supports interoperability and interchangeability
- The PRL allows for easy checks for interoperability



## Learning Objective #4: Explain the NTCIP 1211 SNMP Interface and Dialogs

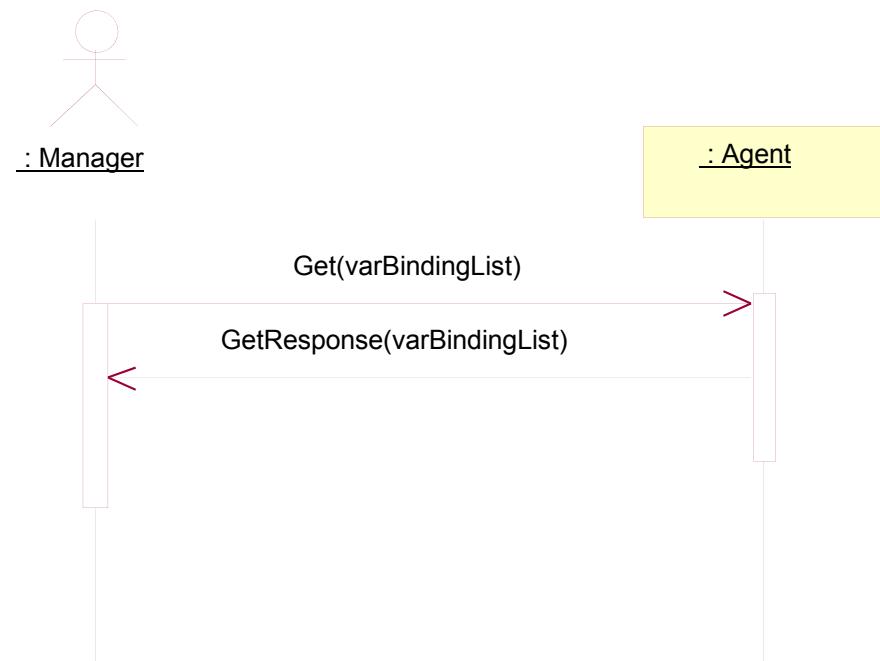
- Describe a typical Simple Network Management Protocol (SNMP) dialog
- Describe an example of an NTCIP 1211 dialog



# Describe a Typical SNMP Dialog

## Dialogs

- Standardized NTCIP dialogs
  - GET request
  - SET request
  - GET-NEXT request



# Describe an Example of an NTCIP 1211 Dialog

## Dialogs

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

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.2	Interface – Management Station to CO	3.5.2.1.1	5.1.1.1.12	priorityRequestTimeOfServiceDesiredInPRS	
			5.1.1.1.13	priorityRequestTimeOfEstimatedDepartureInPRS	
			5.1.1.2	prsBusy	
3.5.2.1	Configure the CO				
3.5.2.1.1	Set Priority Strategy Configuration				
		4.2.2.1	5.2.4.1	coStrategyPlanBlock	
			5.2.4.2	coStrategySplitsBlock	
			5.2.1.7	priorityStrategyDefaultCoordPattern	
			NTCIP 1201 v03 Sec.2.3.1	dbCreateTransaction	



# Describe an Example of an NTCIP 1211 Dialog

## Example Dialog

### 4.2.2.1 Set the Priority Strategy Configuration

#### 4.2.2.1.1 Standardized Dialog

The following is the standardized dialog for a management station to configure the priority strategy settings in a CO. The management station shall use 'dbCreateTransaction', as defined in NTCIP 1201 v03 Section 2.3.1, to SET this object. The CO shall NOT allow a normal SNMP SET. The use case diagram for 'dbCreateTransaction' is depicted in Figure 8.

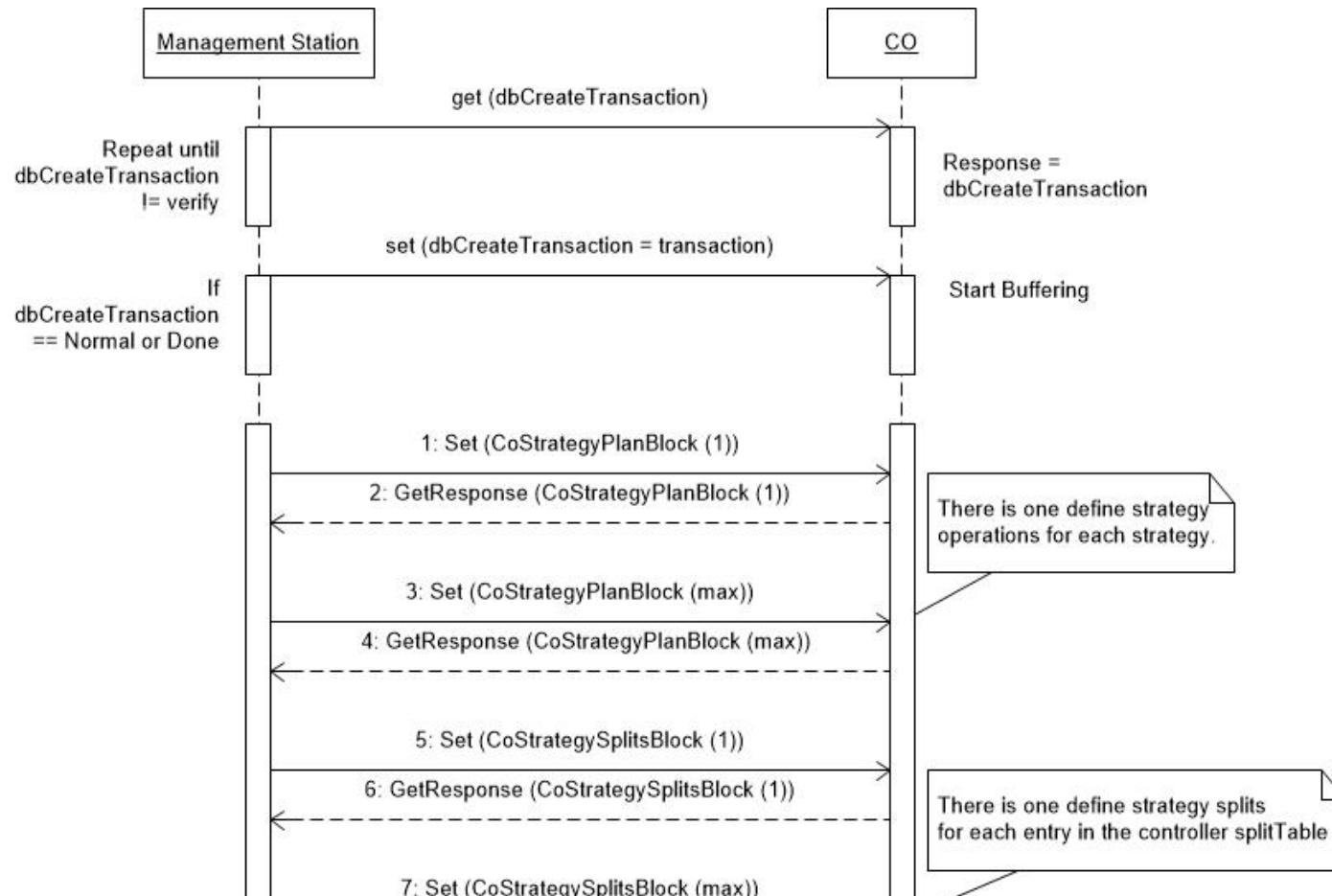
The standardized dialog to configure the priority strategy settings in a CO is:

- a) The traffic signal controller shall be in transaction mode (See Section 4.2.2.1.3).
- b) The management station shall SET coStrategyPlanBlock.x.
- c) The management station shall SET coStrategySplitsBlock.x.
- d) The management station shall SET priorityStrategyDefaultCoordPattern.
- e) The consistency checks to be performed on downloaded data when the "verify" state is commanded is defined in Section 4.2.2.1.2.
- f) The controller shall exit transaction mode.



# Describe an Example of an NTCIP 1211 Dialog

## Sequence of Events in a Dialog



# Describe an Example of an NTCIP 1211 Dialog

## Consistency Check

### 4.2.2.1.2 Consistency Check

Consistency checks assure that certain critical objects are checked "in context" and treated as interrelated values rather than separate non-related data items.

When data is downloaded to a CO and the controller is operating in the "transaction" mode, as defined by the dbCreateTransaction object defined in NTCIP 1201 v03, consistency checks shall be performed on downloaded data when the "verify" state is commanded. The consistency checks that shall occur and corresponding error messages are described below. Error messages, if any, may be examined by reading the dbTransactionError object once the CO has entered the "done" mode.

The following rules shall apply to the consistency check:

- a) The consistency checks defined in NTCIP 1202:2005 Annex B shall also be performed.
- b) The following objects define functionality related to phase assignments. Consistency checks insure that phases specified by these objects may operate concurrently and are defined only once in each string parameter. The value "xx" corresponds to priorityStrategyNumber.

Priority Strategy Service Phases (priorityStrategyServicePhases)

Priority Strategy Phase Omits (priorityStrategyPhaseOmits)

SCP Split Coordinated Phases (splitCoordPhase)

- c) When more than one service phase is specified and the defined phases CANNOT time concurrently, the error message, "STRATEGY xx PHASE CG FAULT" shall be returned.
- d) When more than one service phase is specified and the defined phases are in the same ring, the error message, "STRATEGY xx PHASE RING FAULT" shall be returned.
- e) When a defined service phase is in the string parameter more than once, the error message, "STRATEGY xx PHASE MULTI FAULT" shall be returned.
- f) When a defined service phase is disabled, the error message "STRATEGY PHASE DISABLE FAULT" shall be returned.

Note: The order of the checks is not defined. Therefore, for a given set of 'bad' data, the Error Message between different units may be inconsistent.



# A C T I V I T Y



## What does the following table mean?

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.2.2.3	Retrieve Priority Splits				
	G.1		5.2.1.6	priorityStrategyExtensionToSplitTable	
			5.2.1.6.1	priorityStrategyMaximumReductionTime	
			5.2.1.6.2	priorityStrategyMaximumExtensionTime	

## Answer Choices

- a) To fulfill requirement 3.5.2.2.3, use all objects
- b) To fulfill requirement 3.5.2.2.3, use one of the objects
- c) To fulfill requirement 3.5.2.2.3, use dialog G.1 and all objects
- d) To fulfill requirement 3.5.2.2.3, use dialog G.1 and one object

## Review of Answers



- a) To fulfill 3.5.2.2.3, use all objects

*Incorrect. The objects must be supported as defined by dialog G.1.*



- b) To fulfill 3.5.2.2.3, use one of the objects

*Incorrect. All objects must be supported using dialog G.1.*



- c) To fulfill 3.5.2.2.3, use dialog G.1 and all objects

***Correct! All objects must be supported by the implementation only if the requirement is specified.***



- d) To fulfill 3.5.2.2.3, use dialog G.1 and one object

*Incorrect. All objects must be supported using dialog G.1.*

## Summary of Learning Objective #4

### Explain the NTCIP 1211 SNMP Interface and Dialogs

The NTCIP 1211 standard includes dialogs, which are sequences of data exchanges and events that must be implemented to fulfill a requirement

- The RTM defines which dialogs and objects should be used or referenced to fulfill the requirement
- The most basic dialog is to GET, SET and GET-NEXT objects
- Dialogs may include consistency checks



## **Learning Objective #5: Explain How to Incorporate Requirements Not Covered by the NTCIP 1211 Standard**

- Demonstrate how to check for conformance to the NTCIP 1211 Standard
- Identify the conditions and context for extending the NTCIP 1211 Standard
- Describe an example of extending the NTCIP 1211 Standard



## Demonstrate How to Check for Conformance to the NTCIP 1211 Standard

**Conformance Shall Minimally Fulfill the Mandatory Requirements as Identified in the PRL**

- A conformant device should:
  - Satisfy the mandatory user needs and fulfill the mandatory requirements identified in the PRL
  - Enforce the dialogs and use the objects as defined by the standard
  - Satisfy optional features and fulfill optional requirements as defined by the standard



# Identify the Conditions and Context for Extending the NTCIP 1211 Standard

## Extending the Standard Complicates Interoperability and Interchangeability

- Extensions are custom solutions
  - Increased specification costs
  - Increased development costs
  - Increased testing costs
  - Increased integration costs
  - Longer deployment time frame
  - Increased maintenance costs
- There are benefits
  - Allows procurers to use the NTCIP family of standards and still support operational or user needs not supported by the family

# Identify the Conditions and Context for Extending the NTCIP 1211 Standard

## Extending the Standard Complicates Interoperability and Interchangeability

- The NTCIP standards support extensions
- Extensions should only be considered when:
  - NTCIP features are inadequate to meet need
  - Benefits of extension outweigh the added costs
- For user needs not supported by the standard:
  - May result in user-specific requirements
  - Procurers and agencies should specify the dialogs and objects to fulfill the user-specific requirements
- Implementers may NOT define new dialogs or objects for requirements already supported by the standard

# Identify the Conditions and Context for Extending the NTCIP 1211 Standard

- For extended equipment to conform to NTCIP 1211 v02
  - Will still be interoperable for those user needs and requirements supported by the equipment
- For extensions to be interoperable
  - New user needs, requirements, dialogs, and data objects should be documented
  - Do not add new enumerations to standard objects
- Properly register new objects with the NTCIP coordinator
- Recommend that the agency “own” the data objects



# Describe an Example of Extending the NTCIP 1211 Standard

## Example Extension

UNExt1: Need to Share the Current Time of the PRG

The PRG needs to send the current time on the PRG to the PRS. This time is needed so the PRS can make the proper adjustments to the time of estimated service and the time of departure received in a priority request.

FRExt1:Send the Current Time on the PRG

A PRG shall send its current time to the PRS when it sends a priority request message to the PRS.

# Describe an Example of Extending the NTCIP 1211 Standard

## Example Extension

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
UNExt1	Need to Share the Current Time of the PRG			Mandatory	Yes	
		FRExt1	Send the Current Time on the PRG	M	Yes	

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
FRExt1	Send the Current Time on the PRG				
	G.1		5.3.1	prgCurrentTime	

- Include the new user needs and requirements in the PRL
- Include the new requirements and the design (dialog and objects) in the RTM



# Describe an Example of Extending the NTCIP 1211 Standard

## Example Extension

### 5.3 PRG Current Time

```
prgCurrentTime OBJECT-TYPE
    SYNTAX      INTEGER (0..4294967295)
    ACCESS      read-only
    STATUS      mandatory
    DESCRIPTION
        "<Definition> The current time in the PRG's clock, measured in
seconds since 00:00:00 January 1, 1970 UTC."
```

As this standard has been developed long after 1970, a value a 0 for time should indicate to the management station that the data received is suspect.

```
<DescriptiveName> NTCIP-1211Extension::SCP.prgCurrentTime
<DataConceptType> Data Element"
::= { prgExtension 1 }
```



# A C T I V I T Y



## **Which of the following is a reason to extend a standard?**

### **Answer Choices**

- a) There is an unmet need that justifies the added cost
- b) The existing system uses a nonstandard design
- c) To develop a specification to favor a specific vendor
- d) The standardized solution is too complex



## Review of Answers



- a) There is an unmet need that justifies the added cost

***Correct! Sometimes you just have to accept the added costs.***



- b) The existing system uses a nonstandard design

*Incorrect. Doing this will prolong the expensive customized approach for another generation.*



- c) To develop a specification to favor a specific vendor

*Incorrect. This opens the project up to a lawsuit and potentially traps you in a proprietary design.*



- d) The standardized solution is too complex

*Incorrect. Even if a simpler solution would work, the life-cycle costs of implementing a nonstandard solution are significant.*

# Summary of Learning Objective #5

## Explain How to Incorporate Requirements Not Covered by the NTCIP 1211 Standard

- Extending the standard complicates interoperability and interchangeability
- Extending the standard is allowed to support user needs and requirements not addressed by the standard
- Extended equipment should be designed to appropriately integrate with NTCIP-only deployments
- Extensions should be documented



# CASE STUDY



U.S. Department of Transportation  
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# Learning Objective #6: Identify a Case Study Specifying Requirements for an SCP System

## Current Situation

- The Alphaville Transit Agency
  - Experiencing increasing travel times on one of its routes due to recurring and nonrecurring congestion
  - Transit signal priority (TSP) will help improve travel time reliability
  - Vehicles already equipped with automatic vehicle location (AVL) and radio communications
  - Far-side and near-side transit stops



# Identify a Case Study Specifying Requirements for an SCP System

## Current Situation

- Traffic agency
  - Planning to upgrade the signal controllers
  - Concerned about maintaining traffic flow but willing to provide signal priority
  - On the city's fiber optic network
  - Existing communications links with each controller



# Identify a Case Study Specifying Requirements for an SCP System

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5	Features					
2.5.1	Interface – Management Station to PRS	M	Yes			
2.5.1.1	Manage the PRS	M	Yes			
2.5.1.1.1	Determine PRS Identity	C	Yes	No / NA		Note: This may be NA if the PRS is integral to the traffic signal controller and the traffic signal controller already supports Device Identity.
	H.2.1	Determine Device Component Information	M	Yes		
	H.2.3	Determine Supported Standards	M	Yes		
	H.2.4	Determine System Name	O	Yes / No		
2.5.1.1.2	Determine PRS Configuration	C	Yes / No	No / NA		Note: This may be NA if the PRS is integral to the traffic signal controller and the traffic signal controller already supports Device Configuration.
	H.2.2	Determine Device Configuration Identifier	M	Yes		
2.5.1.1.3	Configure Reservice Period	M	Yes			
	3.5.1.1	Set Reservice Period	M	Yes		
2.5.1.1.4	Configure Time To Live Period	M	Yes			
	3.5.1.2	Set Time To Live Period	M	Yes		
	3.6.2.2	Clear Expired Priority Requests	M	Yes		
2.5.1.1.5	PRS Clock Synchronization	C	Yes	No / NA		Note: This may be NA if the PRS is internal to the traffic signal controller and the traffic signal controller already supports clock synchronization.
	H.2.5.1	Set Time	M	Yes		

# Identify a Case Study Specifying Requirements for an SCP System

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.1.2	Determine Priority Request Criteria	H.2.5.2	Set Time Zone	M	Yes	
		H.2.5.3	Set Daylight Savings Mode	M	Yes	
		H.2.5.4	Verify Current Time	M	Yes	
				M	Yes	
2.5.1.3	Monitor the PRS	3.5.1.3.1	Retrieve Priority Request Settings	M	Yes	
		3.5.1.3.2	Retrieve Reservice Period for a Vehicle Class	M	Yes	
		3.5.1.3.3	Retrieve Priority Request Time To Live Value	M	Yes	
				O	Yes/No	
2.5.1.4	Retrieve Log Data from the PRS	3.5.1.4	Monitor the Status of the PRS	M	Yes	
						Note: This may be NA if the PRS is integral to the traffic signal controller and the traffic signal controller already supports event logging
				C	Yes/No/NA	
		H.2.5.1	Set Time	M	Yes	
		H.2.5.2	Set Time Zone	M	Yes	
		H.2.5.3	Set Daylight Savings Mode	M	Yes	

# Identify a Case Study Specifying Requirements for an SCP System

Protocol Requirements List (PRL)						
User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.5.2	Interface – Management Station to CO			M	Yes	
2.5.2.1	Configure Priority Strategies			M	Yes	Note: The definition and selection of the strategy is system- and implementation- specific and may vary from system to system. The user should be aware that differences in definition and selection may result in an interoperability issue.
	3.5.2.1.1	Set Priority Strategy Configuration		M	Yes	
	3.5.2.1.2	Define Default Coordination Pattern		M	Yes	
	3.5.2.1.3	Define Maximum Priority Strategies Supported		O	Yes / No	
	3.5.2.1.4	Define Maximum Service Requests To Consider		O	Yes / No	
2.5.2.2	Determine Priority Strategies			M	Yes	
	3.5.2.2.1	Retrieve Priority Strategy Settings		M	Yes	
	3.5.2.2.2	Retrieve Priority Strategies		M	Yes	
	3.5.2.2.3	Retrieve Priority Splits		M	Yes	
	3.5.2.2.4	Retrieve Default Coordination Pattern		M	Yes	
	3.5.2.2.5	Retrieve Maximum Priority Strategies Supported		O	Yes / No	Support 10 Priority Strategies.
	3.5.2.2.6	Retrieve Maximum Service Requests To Consider		O	Yes / No	Support 10 Service Requests.
2.5.2.3	Monitor the CO			M	Yes	
	3.5.2.3	Monitor the Status of the CO		M	Yes	



# What We Have Learned

- 1) The PRL can be used to trace user needs to requirements.
- 2) The “Additional Specifications” column in the PRL can define performance criteria and limits or ranges for functional requirements.
- 3) The RTM traces each requirement to a single design solution, thereby providing for interoperability.
- 4) The design solution consists of a single dialog and one or more objects.
- 5) Developing custom features entails significant effort and risk.



# Resources

- NTCIP 1202 v2.19 – Object Definitions for Actuated Signal Controllers (ASC): <http://www.ntcip.org/>
- NTCIP 1211 v02 – Object Definitions for Signal Control and Prioritization: <http://www.ntcip.org/>
- NTCIP 9001 v4 – The NTCIP Guide: <http://www.ntcip.org/>
- Transit Communications Interface Profiles (TCIP) Standard Development Program: <http://www.aptatcip.com/>
- Transit Signal Priority (TSP): A Planning and Implementation Handbook: <http://www.fta.dot.gov/documents/TSPHandbook10-20-05.pdf>
- Transit Communications Interface Profiles (TCIP) Standard Development Program: <http://www.aptatcip.com>
- TCIP Volume 1: <http://www.aptatcip.com/Documents.htm>



## **Next Course Modules**

**ITS Transit Standards Professional Capacity Building  
(PCB) Program**

**Module 10:  
Electronic Fare Payment Systems**

and

**Module 11:  
Transit and the Connected Vehicle  
Environment/Emerging Technologies, Applications,  
and Future Platforms**



# Thank you for completing this module.

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*(insert exact location for feedback for each module as well as link to Transit ITS Standards – page to be developed as part of standards training site)*



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