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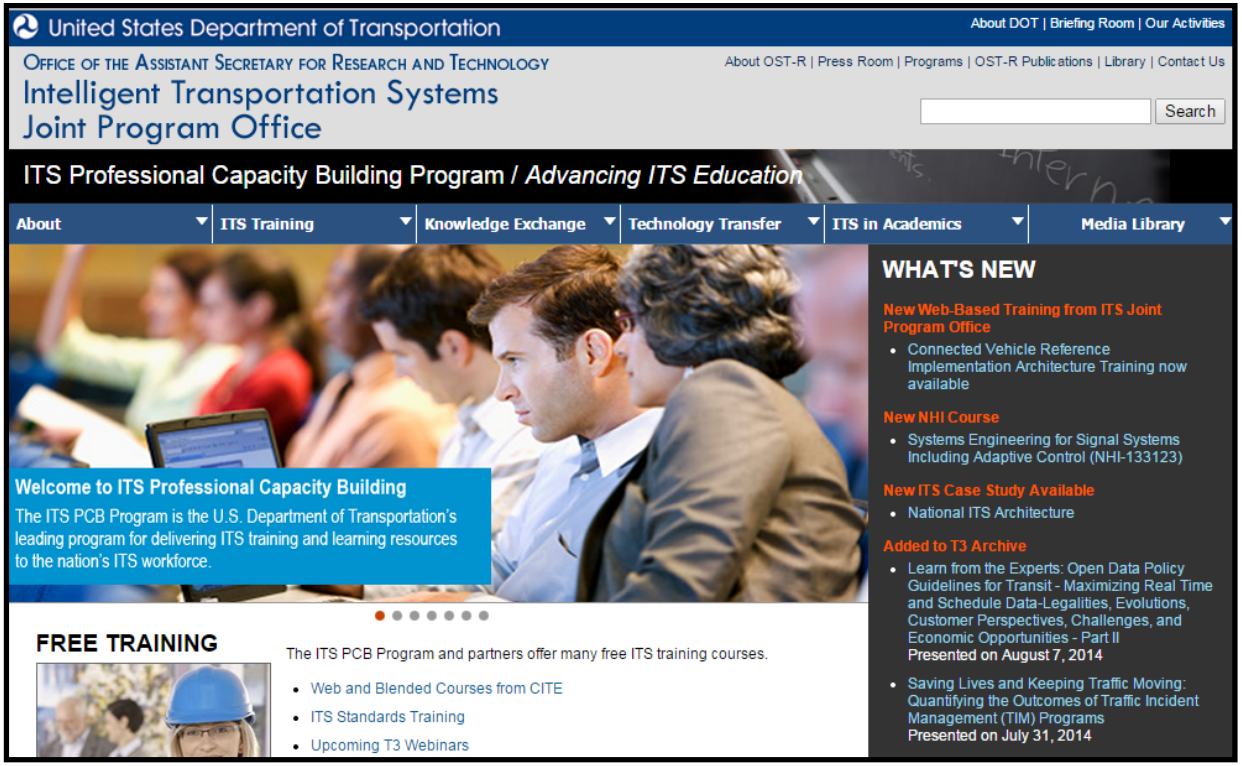

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ACTIVITY

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U.S. Department of Transportation
Office of the Assistant Secretary for
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A309b:
Understanding Requirements for Ramp Meter Control (RMC) Units Based on NTCIP 1207 Standard v02

Instructor

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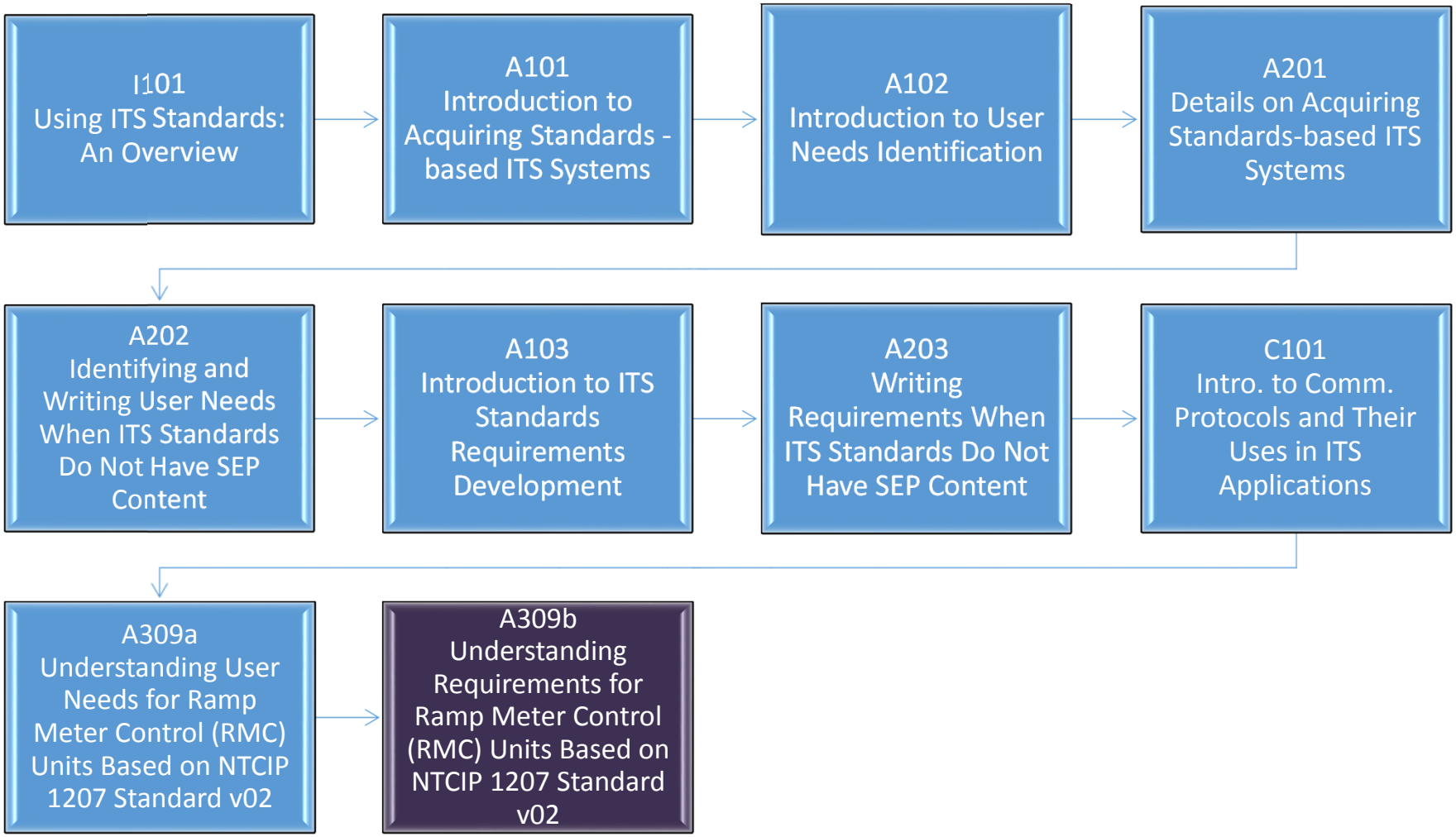
Target Audience

- Traffic management and engineering staff
- Traffic Management Center/operations staff
- Freeway and traffic signal maintenance staff
- System developers
- Private and public sectors users including manufacturers

Recommended Prerequisite(s)

- I101: Using ITS Standards: An Overview
- A101: Introduction to Acquiring Standards-based ITS Systems
- A102: Introduction to User Needs Identification
- A201: Details On Acquiring Standards-based ITS Systems
- A202: Identifying and Writing User Needs When ITS Standards Do Not Have SE Content
- A103: Introduction to ITS Standards Requirements Development
- A203: Writing Requirements When ITS Standards Do Not Have SE Content
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications
- A309a: Understanding User Needs for Ramp Meter Control (RMC) Units Based on NTCIP 1207 Standard v02

Curriculum Path



Acronyms Used

- ASN.1 Abstract Syntax Notation 1 Language (ASN.1)
- ATDM Active Traffic Demand Management
- CGs Conformance Groups
- ICM Integrated Corridor Management
- MDC Major Desired Capability
- MIB Management Information Base
- NTCIP National Transportation Communications ITS Protocol
- OID Object Identifier
- PDU Protocol Data Unit
- PRL Protocol Requirements List
- RMC Ramp Metering Control
- RTM Requirements Traceability Matrix
- SNMP Simple Network Management Protocol
- Vphpl Vehicle per hour per lane

Learning Objectives

1. Develop requirements using the NTCIP 1207 v02 RMC Units Standard
2. Establish Interoperability and vendor-independence
3. Prepare traceability tables for RMC
4. Incorporate requirements not supported by standardized objects
5. Develop an RMC specification

Learning Objective #1: Develop Requirements Using the NTCIP 1207 v02 RMC Unit Standard

- Review the structure of the NTCIP 1207 Standard v02
- Identify requirements from various sources
  - Based on the user needs developed in Module A309a
  - Derived from the Annex-A NTCIP 1207 Standard v02
  - RMC units configuration-control and monitoring perspectives
- Review criteria for well-formed requirements
- Develop sample requirements

Review the Structure of the NTCIP 1207 Standard v02

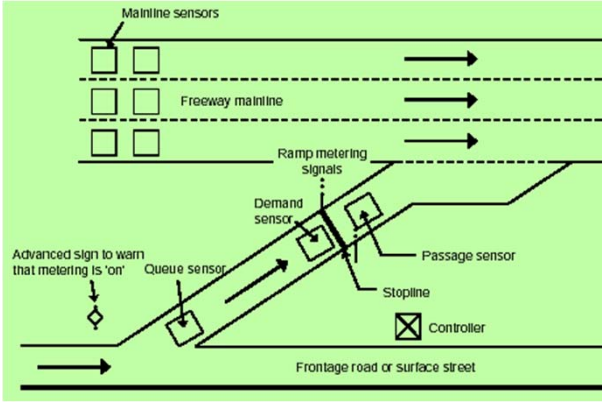
The Standard has Four Sections and Five Annexes:

Section 1 General: Scope, references, terms, definitions.

Section 2 Standards-Based RMC System: References to various standards.

The Ramp Meter Control (RMC) unit consists of the field controller, its suite of sensors (detectors), and its warning signs and signals.

The RMC System produces and implements a metering rate (release rate), e.g. 500 vehicles per hour per lane (vphpl).



Source: FHWA

Source: MTC-CA

Section 3: Management Information Base (MIB) Provides Design Data for RMC System

- MIB provides **structured** design objects for RMC functionality:
  - Mainline Detectors
  - Metered Lane
  - Metering Plan-Levels-Table
  - Sign Control
  - Input-Output
  - Scheduling
  - Block Objects

3.4.1.5.9 Requested Rate
rmcRequestRate OBJECT-TYPE
SYNTAX INTEGER (0..65535)
ACCESS read-only
STATUS mandatory
DESCRIPTION
"Indicates the metering rate that is requested if the rmcRequestAction-object has a value of 'fixedRate'. This value shall be expressed in 1-vph increments.
<Unit> vehicles per hour
<**Object Identifier**>
1.3.6.1.4.1.1206.4.2.2.3.1.8.1.9"
::={ rmcMeterStatEntry 9 }

New Additional Information

Section 4: RMC Block Object Definitions (Supports Efficiency)

Annex A RMC Unit Operations Description

Metering Plan

The RMC unit shall have a Metering Plan Table containing all of the Metering Plans…….a **Maximum Number of Metering Plans** parameter to indicate the number of metering plans (4-100) …… a **Number of Metering Plans** parameter to indicate how many metering plans are currently supported…… a **Metering Plan Number** parameter identifying which plan it represents……..

Each **Metering Level** shall consist of:

Occupancy Threshold

(0, 5.0-30.0 percent in 0.1-percent increments)

Flow Rate Threshold

(0, 1000-3600 vph in 1-vph increments)

Speed Threshold

(0, 15-100 km/h in 1-km/h increments)

→ **Metering Rate**

(0, 120-1800 vph in 1-vph increments)

Additional New Information (Annex B)

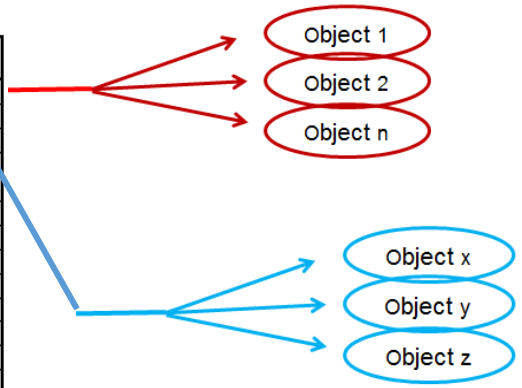
(Later, we will discuss how to use this information)

B.2 RMC UNIT REQUIREMENTS

The Conformance Group definitions for RMC units are defined in this clause. A RMC unit has multiple functions; thus, Conformance Groups are defined for each function.

The following table lists functional requirements for an RMC unit, and asks if the listed features have been implemented.

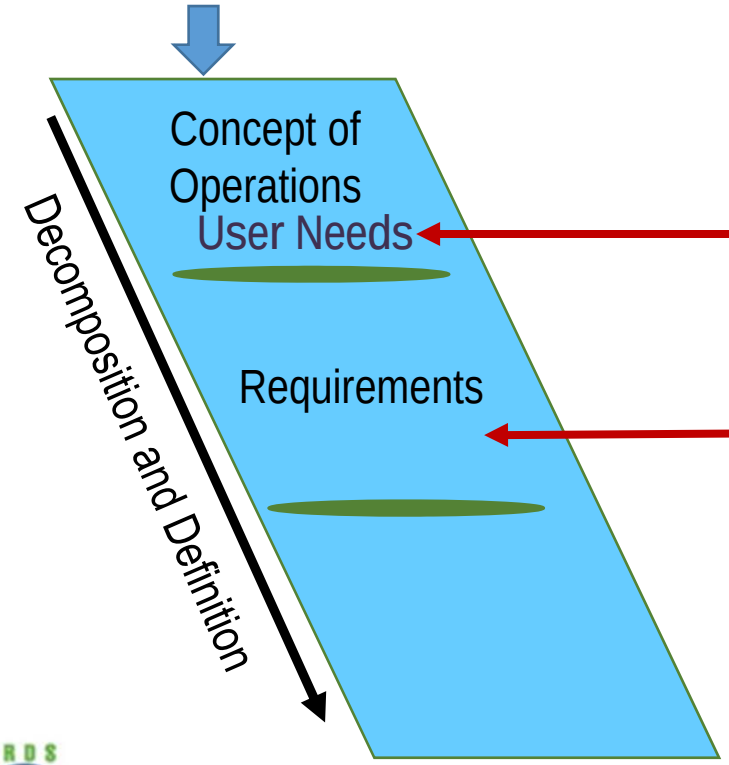
Ref	Areas	Clause of Profile	Status	Support
B.3	General Configuration Conformance Group	NTCIP 1207 – 3.2	O	Yes / No
B.4	Traffic Responsive Conformance Group	NTCIP 1207 – 3.3	O	Yes / No
B.5	Metered Lane Conformance Group	NTCIP 1207 – 3.3	M	Yes
B.6	Dependency Group Conformance Group	NTCIP 1207 – 3.4	O	Yes / No
B.7	Queue Detection Conformance Group	NTCIP 1207 – 3.4	O	Yes / No
	- Length Based Queue Detection		O	Yes / No
	- Occupancy Based Queue Detection		O	Yes / No
	- Quick Occupancy Based Queue Detection		O	Yes / No
	- Rate Adjusted Queue Adjustment		O	Yes / No
	- Level Adjusted Queue Adjustment		O	Yes / No
	- Fixed Rate Queue Adjustment		O	Yes / No
B.8	Passage Detection Conformance Group	NTCIP 1207 – 3.5	O	Yes / No
	- Long Stop	NTCIP 1207 – 3.5	O	Yes / No
B.9	Time Base Conformance Group	NTCIP 1207 – 3.6	O	Yes / No
	- Mainline Scheduling	NTCIP 1207 – 3.6	O	Yes / No
B.10	Physical I/O Conformance Group	NTCIP 1207 – 3.7	O	Yes / No
	- Metered Lane Output	NTCIP 1207 – 3.7	O	Yes / No
	- Dependency Group Output	NTCIP 1207 – 3.7	O	Yes / No
B.11	Block Object Conformance Group	NTCIP 1207 – 3.8	O	Yes / No
B.12	Configuration Conformance Group	NTCIP 1201 - 2.2	M	Yes



Annex C: Object tree diagram; Annex D: Future test procedures;
Annex E: Documentation of revisions

What is NOT offered by the NTCIP 1207 Standard v02?

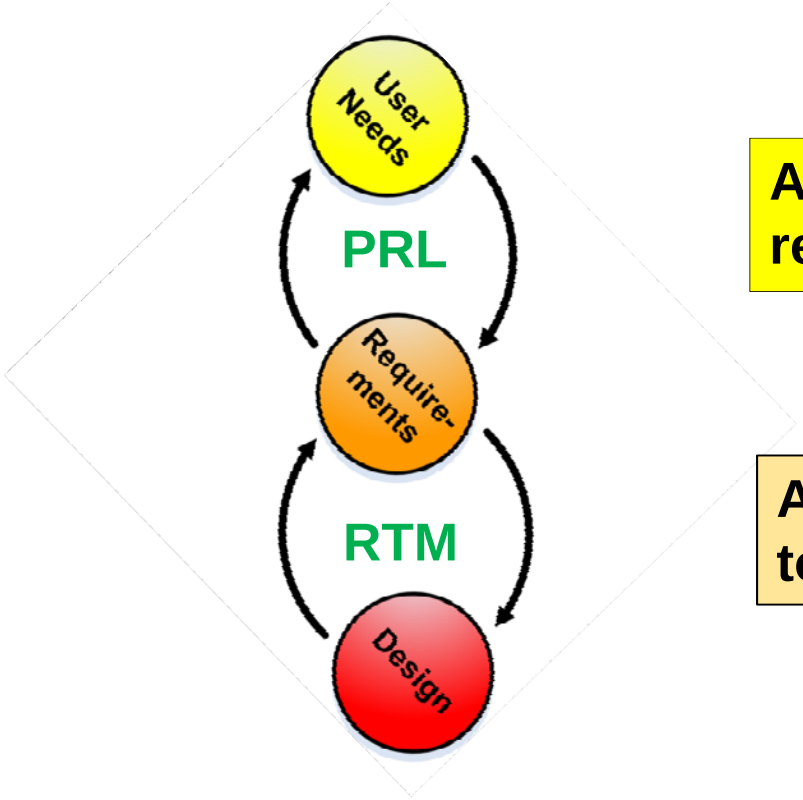
Information Needed for Specification, but is NOT Available



Users must identify and write user needs as discussed in A309a

Users must develop and write requirements as discussed in this module (A309b)

Traceability Tools NOT Offered by the NTCIP 1207 Standard v02



A project level PRL traces user needs to requirements. PRL must be prepared.

A project level RTM traces requirements to design. RTM must be prepared.

(We will discuss this further in LO 3)

PRL: Protocol Requirements List
RTM: Requirements Traceability Matrix

Definition of a 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**.*

-NTCIP 1203 v03 DMS Standard

User Needs' Relationship to Requirements

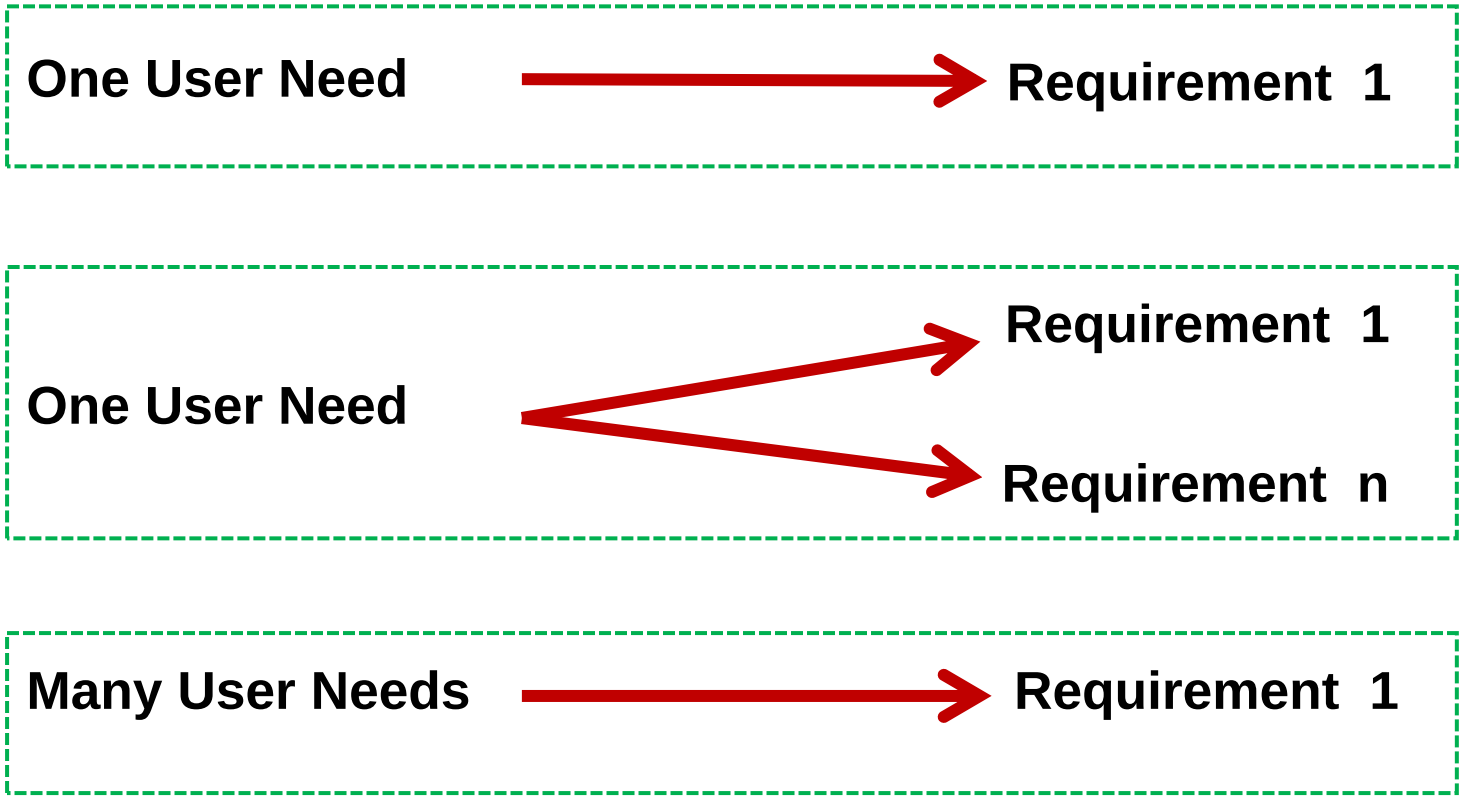


Illustration of the Relationship

User Need: TMC needs to control RMC functions remotely

Requirement: *"The RMC unit **shall** allow the management station to request implementation of an updated metering plan using communications command source…*

TARGET

Source: Caltrans

ACTION

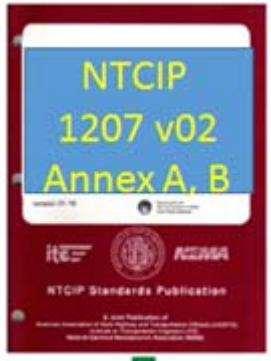
ACTOR

Source: NYCDOT

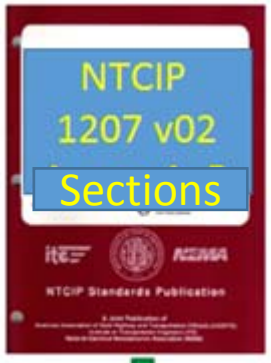
RMC Requirements are to be Identified from Various Sources

SEP standards such as ESS has content which can be adapted NTCIP 1204 v03

RMC user needs have been developed in the PCB Module A309a



Standard Provides CGs and corresponding objects in Annex A and B



Standard Provides Configuration-Control and Monitoring perspectives and methods

RMC Requirements Must be Well-Formed Using a Criteria

Provide a Structure to a Requirement:

1. **Actor** identifies who requests the action.
2. **Action** identifies what is to happen.
3. **Target** identifies who or what receives the action.
4. **Constraint** identifies how to measure the success or failure of the requirement.
5. **Localization** identifies the circumstances under which the requirement applies.

Not all requirements will have both.

Review Criteria for Well-Formed Requirements

Applying Characteristics:

1. **Necessary**: Must be useful and traceable to needs.
2. **Concise**: Minimal, understandable, and expressed as a ***shall*** statement.
3. **Attainable**: Realistic to achieve within available resources and time.
4. **Standalone**: Stated completely in one place.
5. **Consistent**: Does not contradict itself, nor any other stated requirement.
6. **Unambiguous**: Susceptible to only one interpretation.
7. **Verifiable**: Requirement can be verified through inspection, analysis, demonstration, or test.

Applying the Criteria to Types of RMC Requirements

Architectural Requirements

Supports
general communication capabilities

SNMP Interface

Data Exchange Requirements

Supports
device feature-functions

Traffic responsive

Supplemental Requirements

Not covered above

Special project need

Local

Organizing Requirements for a Project Specification

Sample Format to Follow in this Module

Section 3 RMC Unit Requirements

3.1 General Background Information

3.2 Architectural Requirements

3.2.1 Provide Live Data

3.2.2 Provide Off-Line Logged Data

3.3 Data Exchange Requirements

3.3.1 Managing Configuration

3.3.2 RMC Unit Control

3.3.3 Monitoring Status

3.4 Supplemental Requirements

3.4.1 Traffic Controller Firmware (if applicable)

See Student Supplement for Details

Identifying Requirements Based on User Needs Developed in Module A309a

UN 2.1: Provide Live Data Exchange (Clause F.1.1.1)

A management station (central software) has a need to conduct a live data exchange with the RMC unit to retrieve any set of data at any time.

UN 2.2: Provide Logged Data Exchange (Clause F.1.1.3)

A management station has a need to retrieve logged-data at a later time from the RMC unit in a situation when communication is lost or not-always on communications (e.g. dial-up links).

UN 2.3: Provide Capability to Retrieve RMC Identity (Clause F.1.2.1)

A TMC Operator desires to inquire basic information about the RMC unit such as its location, make, model and version of the device components.

See list of RMC user needs in Student Supplement

We need to translate UNs into requirements

3.2 Architectural Requirements

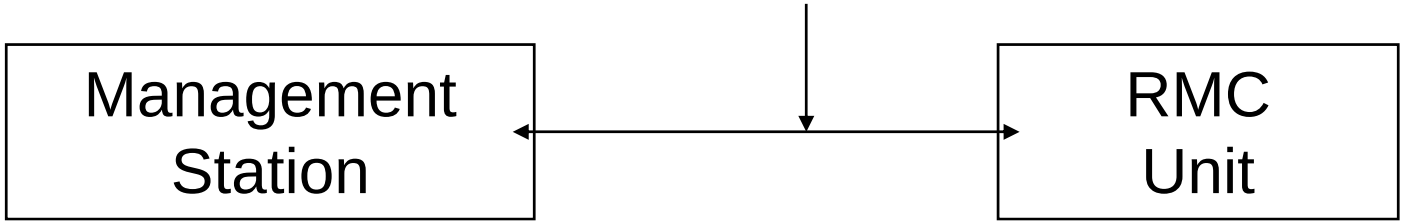
3.2.1 Provide Live Data

3.2.1.1 Retrieve Data

The **RMC unit** (**TARGET**) shall allow the **management station** (**ACTOR**) to **retrieve data** **(ACTION)** from the RMC unit.

3.2.1.2 Deliver Data

The RMC unit shall allow the management station **to deliver data** (e.g. configuration data; commands.)



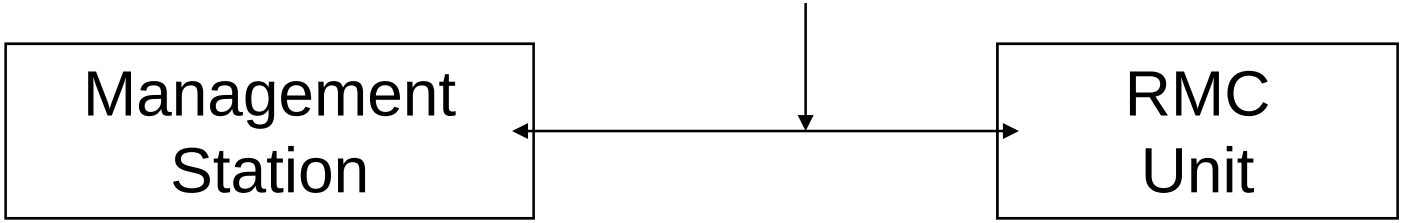
Provide Live Data:
Monitor-Control RMC Unit System when connected.

3.2 Architectural Requirements (cont.)

3.2.2 Provide Off-Line Logged Data

3.2.2.3 Retrieve Logged Data Collected During Off-Line Situations

The RMC unit shall allow the management station to retrieve one or more available logged data from the event log gathered during certain off-line conditions such as loss of communications and a dial-up link.



3.2.2.4 Clear Log

The RMC unit shall allow the management station to clear any or all log entries of a given event class.

3.3 Data Exchange Requirements

Background

Module A309a identified the data exchange user needs to:

- Manage the RMC unit **configuration** (e.g., set metering table)
- **Control** the RMC unit functions (e.g., operations)
- **Monitor** the Status of the RMC unit (e.g., detector data)

Source: NYCDOT

Center-to-Field Communications

Source: Caltrans

Data Exchange Requirement (Configuration)

Configuration Management

ACTOR ACTION

The management station *shall be able to* ***retrieve information***

about the configuration of the ***RMC unit*** **.** TARGET

- ✓ *Necessary*
- ✓ *Attainable*
- ✓ *Standalone*
- ✓ *Verifiable*
- ✓ *…….*

Data Exchange Requirement (Monitor and Control)

ACTOR TARGET

*The **central system** **shall** be able to make a request to the **RMC unit***

ACTIONS

*with the communications command source (priority 2) to **exchange data***

to inquire about the current configuration.

- ✓ *Necessary*
- ✓ *Attainable*
- ✓ *Standalone*
- ✓ *Verifiable*
- ✓ *…….*

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Which of the following is a well-formed requirement?

Answer Choices

a) TMC shall be allowed to retrieve the plan from the RMC unit

b) TMC needs to retrieve information from the RMC unit

c) TMC needs to monitor metering operations

d) The RMC unit shall comply with all requests

Review of Answers

a) TMC shall be allowed to retrieve the plan from the RMC unit

Correct! The requirement statement meets the criteria—Actor/Action/Target; standalone…necessary….

b) TMC needs to retrieve information from the RMC unit

Incorrect. This is a user need, not a requirement.

c) TMC needs to monitor metering operations

Incorrect. This is also a user need, not a requirement.

d) The RMC unit shall comply with all requests

Incorrect. This statement is not well-formed as it does not include an actor and action, and is NOT a standalone.

Summary of Learning Objective #1

Develop Requirements Using the NTCIP 1207 v02 RMC Unit Standard

- Reviewed the structure of the standard
- Learned how to identify types of RMC requirements from various sources including user needs and Annex A and B
- Discussed criteria for writing well-formed requirements
- Developed sample requirements using the criteria

Learning Objective #2: Establish Interoperability and Vendor-Independence

- Understand SNMP Interface and Dialogs
- Understand NTCIP Objects:
  - OID (Object Identifier)
  - Value
  - varBinding, PDU (Protocol Data unit)
- Develop Sample Dialogs:
  - F.3.1 Get
  - F.3.2 GetNext
  - F.3.3 Set

Achieving Interoperability with SNMP Interface

Parts of SNMP Interface

- SNMP (Discussed in Module C101)
- Messages (Data Content for Actions by RMC unit)
- Dialogs (Conversations)

Types of SNMP Messages

	Message	Operation	Action
1	GetRequest	READ	Retrieves Data from a Device
2	GetNextRequest	READ	Retrieves More Data
3	SetRequest	WRITE	Controls-Modifies a Function
4	GetResponse	READ	Reply-Status

Each message contains a PDU.

Object's Structure Provides Content for a PDU

varBinding= {OID, value}

3.4.1.1 Maximum Number of Metered Lanes
rmcMaxNumMeteredLanes OBJECT-TYPE
SYNTAX INTEGER (**1..255**)
ACCESS read-only
STATUS mandatory
DESCRIPTION
"Indicates the maximum **number of metered lanes** that can be stored in the Metered Lane Configuration Table, and, by association, in all other metered lane tables.
<Unit> number
<**Object Identifier**> **1.3.6.1.4.1.1206.4.2.2.3.1.1**
REFERENCE
"See Clause A.2.2"
::={ rmcMeterMain 1 }

Value

For example, 3 metered lanes

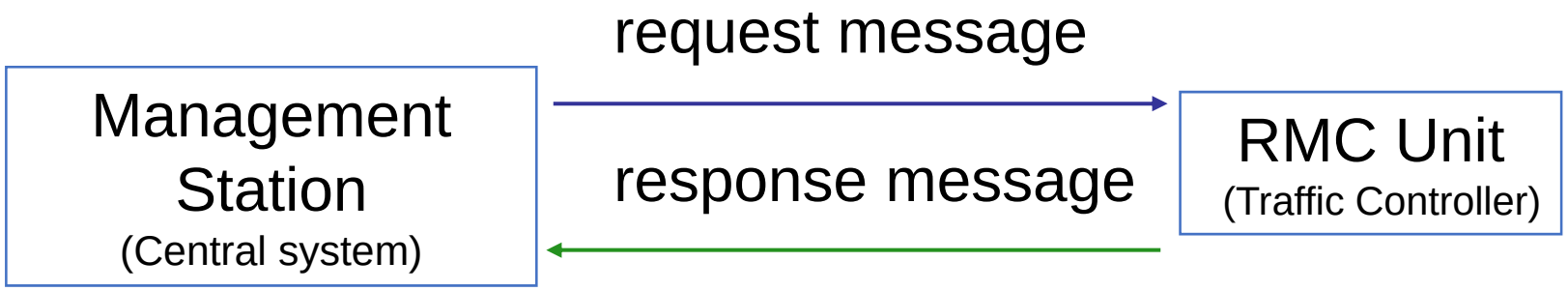
OID

A.2.2 Metered Lanes
The RMC unit shall have a maximum number of metered lanes parameter to indicate the number supported by the RMC unit.

Developing Sample SNMP Dialogs

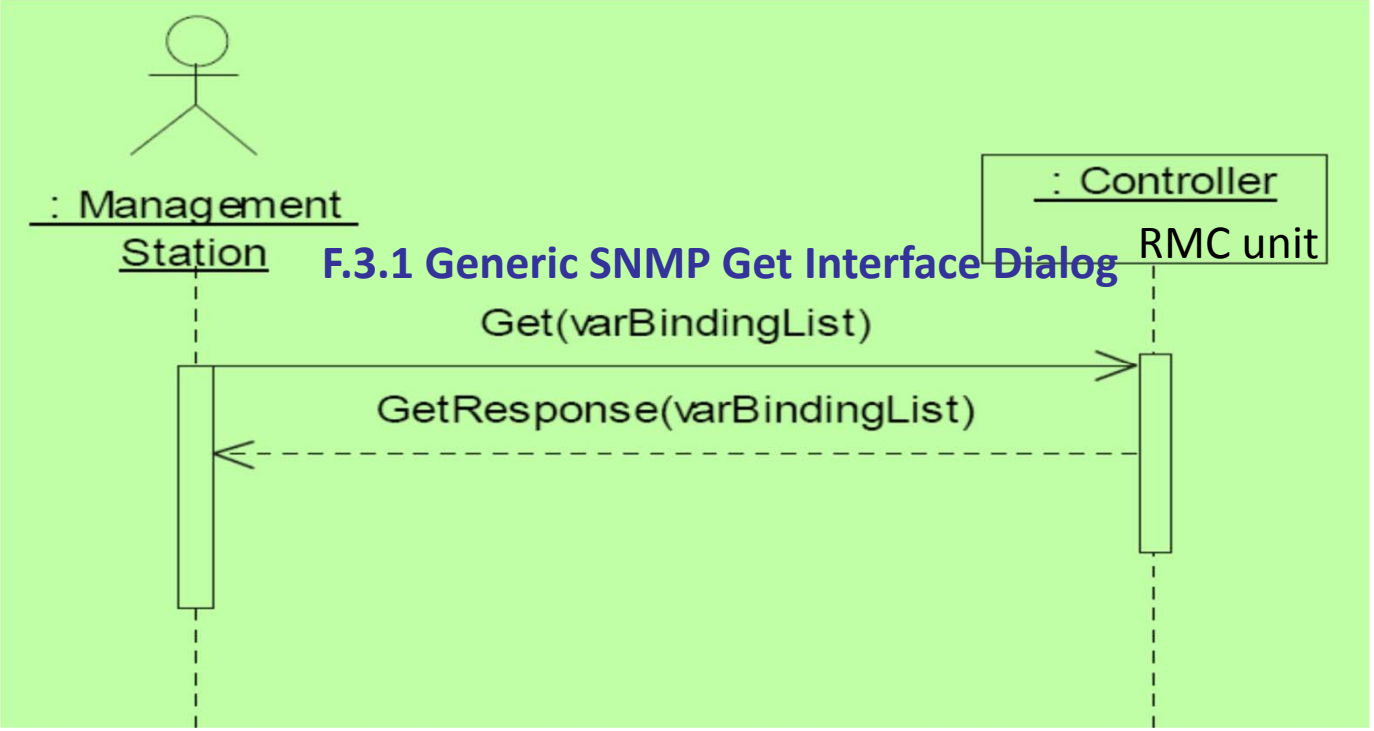
Generic SNMP Dialogs are Adopted from NTCIP 1204 v03 ESS (Annex, Section 3.5)

- F.3.1 SNMP Get Interface Retrieves Data from a Device
- F.3.2 SNMP Get-Next interface Retrieves More Data
- F.3.3 SNMP Set Interface Sends Data to the Device



Example: Metered Lanes (Based on Annex A.2.2)

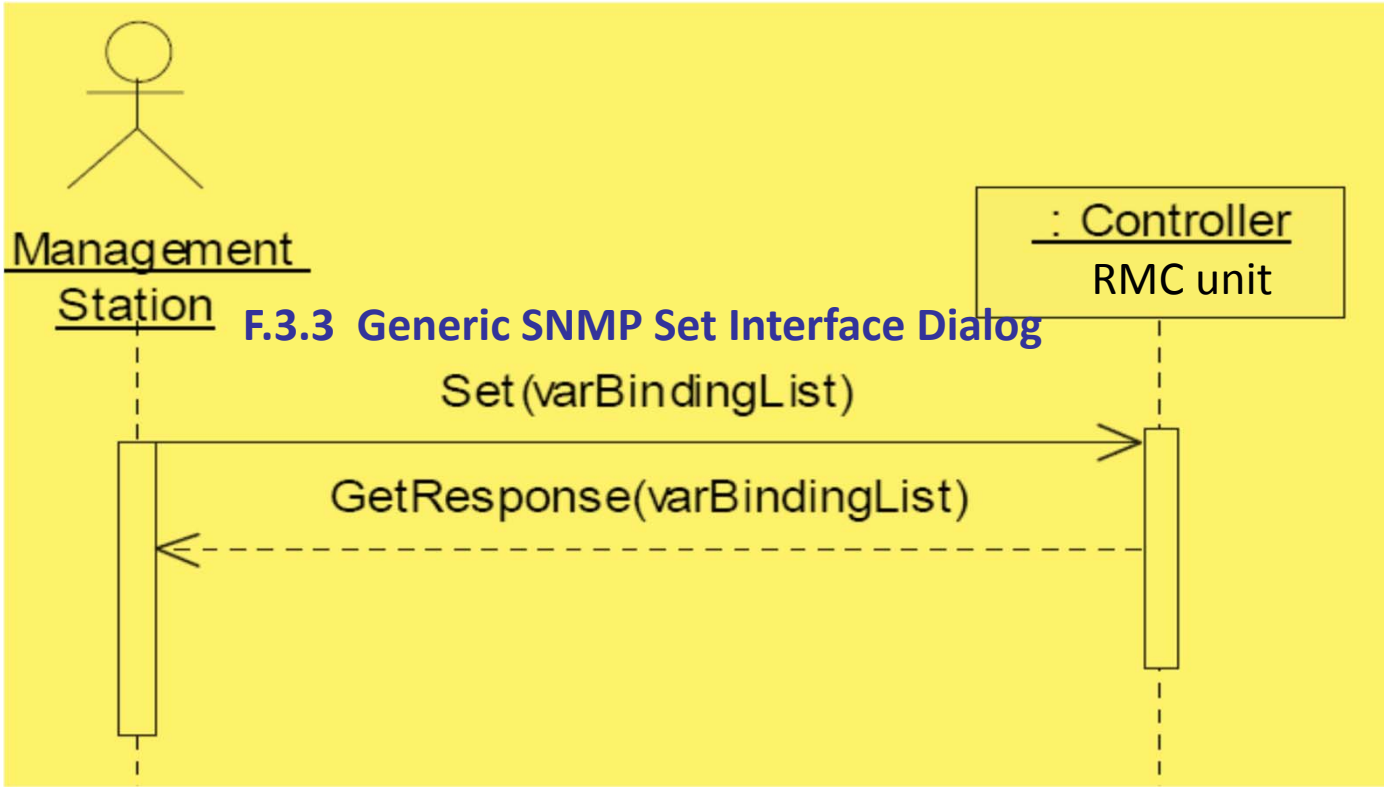
Management station retrieves metered lane data from the RMC unit with a **GetRequest** (Get), and receives a **GetResponse** indicating number of lanes currently metered. (1, 2 or 3 lanes metered)



[F3.2 GetNext Dialog follows this sequence also, but for more data to be retrieved from table content.]

Example: Metered Lanes (Based on Annex A.7.1)

Management station requests the RMC unit with a **SetRequest** (Set) to selected metering plan, numbered as XX, and receives a confirmed action reply though **GetResponse** with a metering plan number being implemented



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Source: WSDOT

TMC

Source: WSDOT

RMC unit

Which SNMP interface will modify the current metering plan?

Answer Choices

a) GET interface

b) GETNext Interface

c) SET Interface

Review of Answers

a) GET Interface

Incorrect. Get operation ONLY retrieves (READ) the metering plan from the RMC unit.

b) GetNext Interface

Incorrect. GetNext Interface retrieves multiple data from the RMC unit.

c) SET Interface

Correct! ONLY SET operation modifies (WRITE) the current metering plan in effect.

Summary of Learning Objective #2

Establish Interoperability and Vendor-Independence

- Discussed SNMP interface and dialogs for communications
- Reviewed NTCIP object structure and message content, varBinding value, OID pair, and PDU
- Developed sample Get, GetNext, and Set dialogs

Learning Objective #3: Prepare Traceability Tables for RMC

- **Protocol** Requirements List (PRL)
  - User needs to requirements traceability
  - Benefits of PRL
- Requirements Traceability Matrix (RTM)
  - Requirements to design traceability within the context of a dialog
  - Benefits of RTM

What is Traceability and How is it Achieved?

Traceability *is the ability to follow or study the logical progression among the need, requirements, and design details in a step-by-step fashion."* (*NTCIP 1204 v03 ESS*)

User Needs to Requirements with **PRL**

Requirements to Design with **RTM**

PRL and RTM for RMC System are NOT available

Users develop project-level PRL and RTM by adopting formats from the NTCIP 1204 v03 ESS Standard

Protocol Requirements List (PRL)

(Format adopted from SEP ESS standard)

A table that maps the user needs to the requirements…

UN ID	User Need	FR. ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.1	RMC Configuration	3.1	RMC Configuration	M	YES	
2.N						

Designed to help specify what you want the interface to do

…must be part of agency's RMC unit specification.

Steps for Developing a PRL for RMC System

- **Step 1:** Develop **user needs** as per Module A309a's discussion and assign them under Section 2 clause; e.g., 2.1 to 2.N and enter them in column 1 and 2.
- **Step 2:** Develop requirements as per this module's (A309b) discussion and assign them under Section 3; e.g., 3.1 to 3.N and enter them in column 3 and 4.
- **Step 3**: Select [Mandatory-M or Optional-O] and [YES/NO] in column 5 and 6 for conformance.
- **Step 4**: Insert project specific requirements if necessary

UN ID	User Need	FR. ID	Functional Requirement	Conformance	Project Requirement	Additional Project Requirements
2.1	RMC Configuration	3.1	RMC Configuration	M	YES	
				O	YES/NO	
2.N		3. N				

Organize User Needs and Requirements for Project Level PRL

UN 2.1	Provide Live Data
UN 2.2	Provide Logged Data
UN 2.3	Provide Capability to Retrieve RMC Identity
UN 2.4	Fixed Rate
UN 2.5	Queue Override
UN 2.6	Traffic Responsive
UN 2.7	Signal Service
UN 2.8	Transitioning
UN 2.9	Configure a RMC Unit
UN 2.10	Command Source Priority
UN 2.11	Command Source Parameters
UN 2.12	Metering Action

3.2 Architectural Requirements

3.2.1 Provide Live Data

3.2.2 Provide Off-Line Logged Data

3.3 Data Exchange Requirements

3.3.1 Configuration

3.3.2 RMC Unit Control

3.3.3 Monitoring Status

3.4 Supplemental Requirements

3.4.1 Traffic Controller Firmware (if applicable)

A Project Level PRL Mapping

Example of a Project PRL for a RMC System

M-Mandatory **O**-Optional

UN ID	User Need	RQ. ID	Requirement	Conformance	Project Requirement	Additional Project Requirements
2.1	Provide Live Data	3.2.1	Provide Live Data	M	YES	
2.2	Provide Logged Data	3.2.2	Provide Off-Line Logged Data	M	YES	
2.3	Retrieve Identity	3.3.1	General Configuration	M	YES	NTCIP 1207 v02 Annex B, CG B.3
2.9	Configure RMC unit	3.3.1	Configuration of Device	M	YES	NTCIP 1201, CL 2.2
2.4	Fixed Rate	*3.3.2*	Metered Lane	M	YES	NTCIP 1207-3.3
2.5	Queue Override	3.3.3	Queue Override	O	YES/NO	Not widely used
2.N	Block Objects	3.N		O	Yes/No	Undecided, per agency need

Users may modify entries in rows to suit local project needs, but <u>columns</u> should not be changed to remain consistent with SEP.

Benefits of the Project PRL

- **For Users**
  - The project PRL shows **relationship** of user needs (features) to requirements (*what capabilities we need and why)*
  - The project PRL becomes a **checklist** in a validation process: *"**Does the system meet my needs**?*
  - Within the agency, PRL Forms a **basis** for potential interoperability with another implementation-regional context
- **For Users, Developers, and Vendors**
  - PRL **connects** all concerned parties on the project's objectives, and help eliminate "guess-work"
  - Overall reduces risk of failure **to conform** to the standard

Requirements to Traceability Matrix (RTM)
(Format adopted from SEP ESS standard, including Dialogs)

RTM associates each requirement

to

first to a standardized dialog and then to associated objects (design)

Req.ID	Dialog (From ESS Annex F)	Requirement (Section 3 from a Specification)	Object ID (Section 3 from NTCIP 1207 v02)	Additional Requirements/Objects
3.1	F.3.1		3.2.1	NTCIP 1207 v02 clause
	F.3.2			
4.1	F.3.3			

Steps for Developing a RTM for RMC System

Step 1 Requirements: enter in column 1, 3

Step 2 Generic Dialog: enter in column 2

Step 3 Objects: using Annex B enter in column 4 associated objects or in some cases user maps requirement directly to pertinent objects (Sec.3)

Step 4 Project Specific Requirements: enter in column 5

Req.ID	Dialog (From ESS Annex F)	Requirement (Section 3 from a Specification)	Object ID (Section 3 from NTCIP 1207 v02)	Additional Requirements/Objects
3.1	F.3.1		3.2.1	NTCIP 1207 v02 clause
	F.3.2			
4.1	F.3.3			

Example of a Project RTM for RMC System

Req.ID	Dialog (From ESS Annex F)	Requirement (Section 3 from a Specification)	Object ID (Section 3 from NTCIP 1207 v02)	Additional Requirements/Objects
3.2.1	F.3.1	Provide Live Data		NTCIP 1204 v03 ESS Annex F
3.2.2	F.3.1	Provide Off-Line Logged Data		NTCIP 1204 v03 ESS Annex F
3.3.1	F.3.1	General Configuration		
3.3.1	F.3.1	Configuration of Device		
3.3.2		**Metered Lane**		
3.3.3		Queue Override		Some agency may have override queue policy
3.3.X	F.3.3	Retrieve Current Time	NTCIP 1201 v03 sec.2.4.1	GlobalTime

Benefits of the Project RTM

- **For Users**
  - RTM shows relationship of requirements to the specific design items of the interface (dialogs and data objects)
  - Helps in system acceptance: "*Did they build the RMC system right?" /"Does my interface deliver the desired functionality?"*
- **For Agencies, System Developers, Vendors, and Testers**
  - Requirements are traced to dialogs and then to objects. This order is key to interoperability needs, a great benefit to designers
  - Testing of RMC functions becomes easier for system acceptance

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Which of the following ensures precise objects necessary to fulfill a requirement?

Answer Choices

a) The Project PRL table

b) The Project RTM table

c) Generic SNMP Get Interface

d) Major Desired Capability (MDC)

Review of Answers

a) The Project PRL table

Incorrect. PRL traces user needs to requirements, not objects.

b) The Project RTM table

Correct! RTM identifies objects necessary to fulfill a requirement.

c) Generic SNMP Get Interface

Incorrect. Generic SNMP Get interface does not contain objects.

d) Major Desired Capability (MDC)

Incorrect. MDC is part of a user need.

Summary of Learning Objective #3

Understand Traceability

- Discussed how to develop a project PRL to trace user needs to RMC unit requirements
  - Reviewed benefits of PRL
- Discussed how to develop a project RTM to trace requirements to dialogs and objects (design) within the context of a dialog
  - Reviewed benefits of RTM

Learning Objective #4: Incorporate Requirements Not Supported by Standardized Objects

- Context and conditions for extending the standard
- Example of extending the standard

Context and Conditions for Extending the Standard

- Context of Missing Requirements:
  - Current standard (v02) provides for common requirements anticipated by the NTCIP effort for ramp metering
  - However, there may be some features and requirements specific to certain application, e.g., corridor-wide metering

- Conditions for Extension:
  - Adding new objects to RMC MIB is possible if it is documented and made available to anyone (agency, other vendors, developers)
  - RMC design objects are based on ASN.1 format and must be complied with for the structure
  - Private objects impact interoperability/interchangeability

Technical Conditions for Extension

- When a new requirement associates a design object, behavior of the device may be affected
- ASN.1 based objects must support READ operation for retrieval and WRITE operation for control functions without restrictions
- Syntax must be a non-negative integer/bytes
- Object must have an OID within the current MIB node
- Only SNMP interface will be allowed (as per NTCIP 1103 rules)

Extensions - Drawbacks

- Interoperability may be compromised:
  - Other management stations that do not support the new objects will be unable to exercise the new capabilities
  - If the agency is not consistent on defining how the requirement is fulfilled, interoperability cannot be achieved without custom integration for each deployment

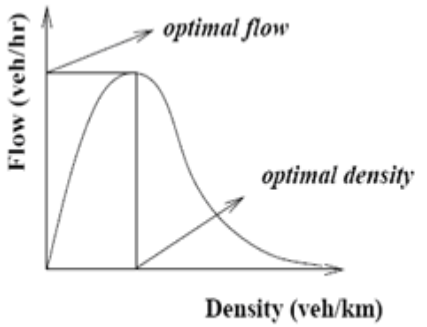
Example of Extending the Standard

Standard Requirement: Each **metering level** shall consist of:

- ✓ *Metering Rate* *(0, 120-1800 vph in 1-vph increments).*
- ✓ *Occupancy Threshold* *(0, 5.0-30.0 percent in 0.1-percent increments).*
- ✓ *Flow Rate Threshold* *(0, 1000-3600 vph in 1-vph increments).*
- ✓ *Speed Threshold* *(0, 15-100 km/h in 1-km/h increments).*

Extended Requirement

*"The RMC system shall support **density-based** for ramp metering to maintain saturation density.*



The Fundamental Diagram: Flow vs. Density

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Which of the following answers is FALSE?

Answer Choices

a) An extended requirement is non-conformant to the standard

b) An extended requirement will break the interoperability

c) Only SNMP interface is permitted in the RMC system

d) The project RTM may contain private objects

Review of Answers

a) An extended requirement is non-conformant to the standard

Incorrect. The statement is true.

b) An extended requirement will break the interoperability

Incorrect. The statement is true.

c) Only SNMP interface is permitted in the RMC system

Incorrect. The statement is true.

d) The project RTM may contain private objects

Correct! The statement is FALSE. Project RTM does not reference a private object for an extended requirement.

Summary of Learning Objective #4

Incorporate Requirements Not Supported by Standardized Objects

- Reviewed context and conditions for extending the RMC unit standard, including technical conditions
- Discussed an example of extending the standard

Learning Objective #5:
Develop RMC Specification

- How the RMC unit specification fits in the specification package
- Checklist of key elements that must be present in a specification

Plans-Specifications and Estimates (PS&E)

1. **General contractual requirements during system development, testing, deployment, integration, and operations/maintenance.**

   Hardware specification; Functional requirements; Performance requirements; Electrical-Mechanical-Environmental requirements

2. **Software specification; Functional requirements; Performance requirements**

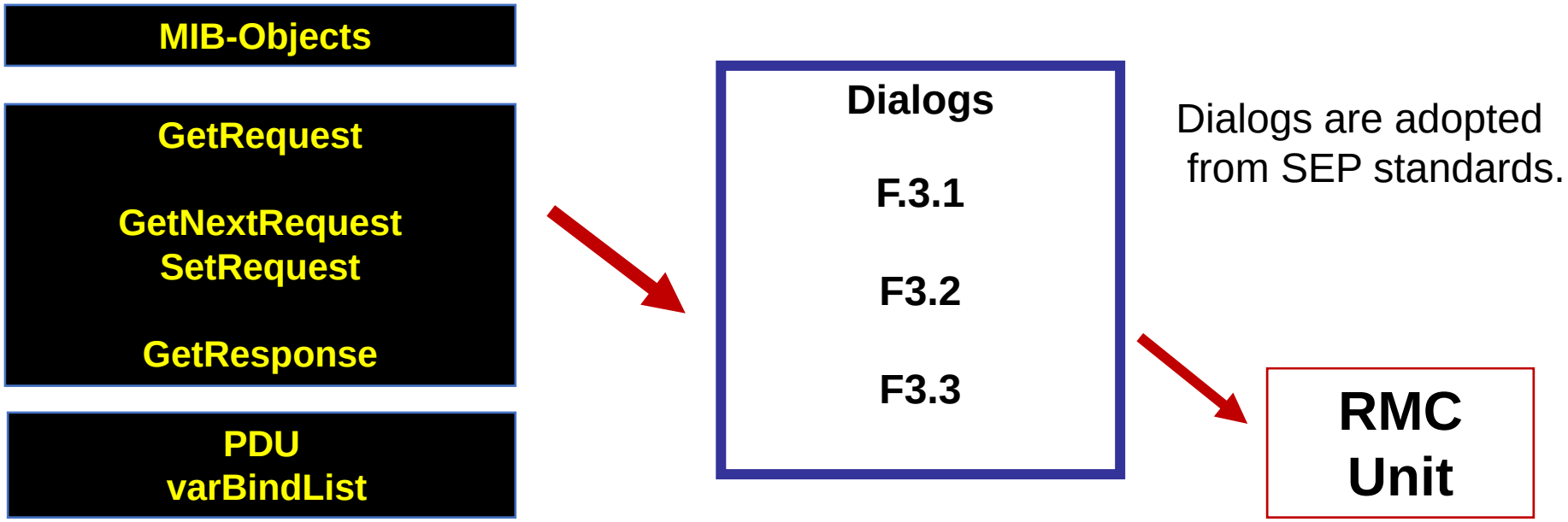
3. **RMC Specification**
   Communication Interface Specifications
   Architectural Requirements
   Data Exchange Requirements
   Project PRL and RTM

RMC Specification

- **Minimum** required sections:
  - Communication Interface Specifications
  - Architectural Requirements
  - Data Exchange Requirements
  - Project PRL and RTM
- **Checklist of key elements** that must be present:
  1. Address Interoperability Issues
  2. Integrate Project PRL and RTM in the Specification
  3. Coordination Requirements
  4. Controller Type/Mainline Detector Station

1. Addressing Interoperability Issues

Agencies Seeking Interoperability (Specifications) Must Select the Same User Needs/Requirements; Objects-Messages-PDUs and Dialogs



2. Integrating PRL in the Project Specification

- A project PRL defines data exchange requirements for the communications interface
- Underlying communications standards need to also be specified (protocols at various levels)
- Reference to interface standards must be specific to the version and publication date
- Include the completed PRL with object value ranges for all the objects to clarify parameters

3. Coordination of Requirements

- The requirements for the communications interface must be consistent with the RMC unit system specification
- Include statement to use standardized design solutions as specified in the project RTM
- Include a completed copy of the PRL plus the RTM as a source for the design of the system and the test plan

4. Controller Types/Mainline Detectors Station

- Go over hardware/firmware details, versions, upgrades, etc.
  - Please consult PCB modules on ASC and ATC for technical details
- Need for **mainline detectors station** for traffic responsive metering
- Need for **ramp** detectors (demand-passage, queue, etc.) for metering capability

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Which of the following statements is FALSE?

Answer Choices

a) The Project RTM specifies the objects and dialogs

b) RMC unit can be readily replaced with a traffic controller

c) RMC unit can also control an advanced warning sign

d) SNMP must be specified to conform to NTCIP 1207 standard v02

Review of Answers

a) The Project RTM specifies the objects and dialogs

Incorrect. The statement is true.

b) RMC unit can be readily replaced with a traffic controller

Correct! This is a FALSE statement. RMC is a special controller equipped for Ramp Operations.

c) RMC unit can also control an advanced warning sign

Incorrect. The statement is true. RMC unit has outputs that turn signs ON during ramp operation and turn OFF when no metering condition is in effect.

d) SNMP must be specified to conform to NTCIP 1207 standard v02

Incorrect. The statement is true.

Summary of Learning Objective #5

Develop a RMC Unit System Specification

- Discussed how an RMC system specification fits in the overall project specification package
- Discussed a checklist of key elements for a specification

What We Have Learned

1. RMC unit standard does not provide requirements and users must identify and write them for project specification.

2. A requirement is a translation of a user need and has a structure and certain characteristics.

3. Requirements are linked to interoperability and vendor-independence.

Specifically at the project level:

4. Each requirement is traced to at least one user need in the project PRL.

5. Requirements should be traced to objects and dialogs in the project RTM.

What We Have Learned (cont.)

6. To retrieve data (reading operation) from the RMC unit device, SNMP GET interface is used.

7. To control an RMC unit (writing operation), SNMP SET interface is used.

8. To support the same features, the Management station and a RMC unit device must have the same MIB, and must use the same dialogs.

Resources

- Student Supplement
- NTCIP Documentation available at www.ntcip.org:
  - NTCIP 1201 v03 Global Object Definitions
  - NTCIP 1207 v02 RMC Units
  - NTCIP 9001: Guide v04
- PCB Training Modules Available at www.pcb.its.dot.gov/stds_training.aspx
  - Module A103: Introduction to ITS Standards Requirements Development) to review “well-formed” requirements:
  - Module A203: Writing Requirements When ITS Standards Do Not Have SE Content
  - Module A309a: Understanding Requirements for Ramp Meter Control (RMC) Units Based on NTCIP 1207 v02 Standard

Next Course Module

T309:
Applying Your Test Plan to the Ramp Meter Control (RMC) Units Based on the NTCIP 1207 v02 Standard

- The key objective is to assists user agencies in their efforts to create **test plans** specific to their RMC needs based on the NTCIP 1207 Standard v02.

QUESTIONS?

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