A309a: Understanding User Needs for Ramp Meter Control (RMC) Units Based on NTCIP 1207 v02 Standard
Instructor

Raman K. Patel, Ph.D., P.E.
President
RK Patel Associates, Inc.
New York City, NY, USA
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
Curriculum Path

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 SEP Content

A103 Introduction to ITS Standards Requirements Development

A203 Writing Requirements When ITS Standards Do Not Have SEP Content

C101 Intro. to Comm. Protocols and Their Uses in ITS Applications

A309a Understanding User Needs for Ramp Meter Control (RMC) Units Based on NTCIP 1207 Standard v02
Learning Objectives

1. Review the structure of the NTCIP 1207 v02 Standard
2. Identify RMC-specific operational needs
3. Prepare well-written user needs for RMC units
4. Explain how to evaluate conformance to the RMC Standard
Learning Objective #1: Review the Structure of the NTCIP 1207 v02 Standard

- Definition of a ramp meter, reference layout, and architecture
- The NTCIP family of standards
- Purpose of the NTCIP 1207 v02 Standard
- Components of the NTCIP 1207 v02 Standard
- What is new in the v02 Standard?
Terminology

- **Ramp Meter** is a traffic controller (Type 170 or 2070 or ATC) equipped with software/firmware and algorithms specific to a freeway ramp to control (to meter) traffic flow entering freeway lanes.

- **Ramp Metering** is a rate expressed in vehicle per hour per lane (vphpl), at which vehicles are allowed to proceed through the metered lane signal (release rate).

  Example: A ramp meter will allow 500 vph per lane (vphpl) release rate.
Ramp Metering Control (RMC) Unit

- **RMC** is a system in which the entry of vehicles onto a freeway from an on-ramp is controlled by a traffic signal, allowing a fixed number of vehicles to enter from each metered lane of the on-ramp during each cycle.

- **RMC Unit** consists of the field controller, its suite of sensors, its warning signs and signals, and stop bar pavement marking.
Traffic Management Data Dictionary (TMDD) and C2C Standards-NTCIP 2306 XML and NTCIP 2304 DATEX are deployed.

NTCIP
Subject matter of NTCIP 1207 – Ramp Meter Control Unit object definitions (THIS STANDARD)
ITS Architecture
Traffic Metering Service Package (ATMS04)

ATMS04 – Traffic Metering

Traffic Management
- traffic metering control
- traffic metering status
- traffic flow + traffic images
- traffic sensor control + video surveillance control
- roadway information system status
- roadway information system data

Roadway
- Roadway Traffic Metering
- Roadway Traffic Information Dissemination
- Roadway Basic Surveillance
- Roadway Equipment Coordination

Other Roadway
- roadway equipment coordination

Driver
- driver information

Traffic
- traffic characteristics

Traffic Operations Personnel
- traffic operator data
- traffic operator inputs

Source: National ITS Architecture v7 2012

NTCIP 1207 v02 Supports these Data Flows
NTCIP Framework

Source: NTCIP Guide
NTCIP 1207 v02 Standard Basics

- This standard assumes a mode of operation in which the RMC unit possesses intelligence, and data used for ramp management and data collection is \textbf{resident} at the RMC unit.

- We refer to the RMC unit’s status, control, and configuration data as the “controller database”; the standard specifies interfaces whereby this data can be manipulated by the central system.
Benefits of ITS Standards

- **Interoperability**
- **Interchangeability**

**NTCIP**

**Compatibility**

- New ATC
- Older Type 170 or 2070 or ATC Controller

**Sources:**
- NYCDOT
- FDOT
- ODOT
Components of the NTCIP 1207 v02 Standard

These sections provide general information about RMC units:

- **SECTION 1** General
  - Scope, references, terms, definitions
- **SECTION 2** Standard-Based RMC Systems
  - Benefits of standardization
- **SECTION 3** Management Information Base (MIB)
  - RMC objects by functions
  - Abstract Syntax Notation 1 (ASN.1) Format
What is New in the NTCIP 1207 v02 Standard?

- New SECTION 4 RMC BLOCK OBJECT DEFINITIONS (Special objects to achieve transmission efficiency)

- New Annexes:
  
  ANNEX A RMC UNIT OPERATIONS DESCRIPTION
  ANNEX B PROTOCOL REQUIREMENTS LIST (PRL) Conformance Groups (CGs)
  ANNEX C OBJECT TREE
  ANNEX D (FUTURE TEST PROCEDURES)
  ANNEX E DOCUMENT REVISIONS
What is **NOT** offered by the NTCIP 1207 v02 Standard?

**Information Needed for Specification**

- User identifies and writes user needs
- Based on user needs, user develops requirements
- MIB provides for design
ACTIVITY
Which of the following statements is **FALSE** as applied to the NTCIP 1207 v02 Standard?

**Answer Choices**

a) Standard is independent of the type of the ramp traffic controller  
b) MIB provides design objects for RMC functions  
c) RMC user needs are listed  
d) Ramp metering module resides in the traffic controller
Review of Answers

a) Standard is independent of the type of the ramp traffic controller

*Incorrect. The standard is independent of the type of controller used as a ramp meter.*

b) MIB provides design objects for RMC functions

*Incorrect. The MIB does provide design objects.*

c) RMC user needs are listed

*Correct! The statement is indeed a FALSE; RMC user needs are not listed.*

d) Ramp metering module resides in the traffic controller

*Incorrect. Each ramp meter has a metering module in it.*
Summary of Learning Objective #1

Review the Structure of the NTCIP 1207 v02 Standard

- Defined an RMC unit and the components, and have reviewed layout and system architecture
- Reviewed the NTCIP family of standards and benefits
- Reviewed the purpose, structure of the standard, and key components
- Reviewed what is new in the v02 Standard
Learning Objective #2: Identify RMC-Specific Operational Needs

- What are your operational needs and why?
- How does the RMC Standard cover operational needs for freeway management applications?
  - Command sources (manual, communications, interconnect, default) and priorities
  - Communications actions (fixed rate, traffic responsive, corridor-wide coordinated)
- Identify key features from NTCIP 1207 v02 Standard Annex-A: RMC Operational Description
What are your Operational Needs and Why?

Analyzing Concept of Operations (ConOps) for Needs

- ConOps document reveals a “big picture”:
  - What is the current situation or problem?
  - Who are the users? Who is affected?
  - What are the operational scenarios?
  - Are there any corridor-wide or regional aspects?
Sources of Operational Needs

- Agency documentation:
  - Development plan
  - Design documents
  - Architecture and subsystem requirements
Additional Sources of RM Practice Information


Operational Needs

Balance Freeway Capacity Demand by Controlling On-Ramp Traffic

- Achieving greater efficiency with:
  - Improved freeway flow
  - Increased freeway speed
  - Reduced overall travel time

- Achieving safety improvements with:
  - Reduction in overall freeway accidents
  - Providing smoother, safer merging

Source: WSDOT
Operational Needs (cont.)

- Improving Traffic Incident Management (TIM) practice with:
  - Reduced clearance time
  - Coordination within the corridor
  - Roadway closures and detours management

Source: FHWA
### Summary of Operational Outcomes/Benefits

#### Efficiency Benefits

<table>
<thead>
<tr>
<th>Operating Agency</th>
<th>Flow Volume Increase</th>
<th>Average Speed Increase</th>
<th>Travel Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detroit, MI</td>
<td>+14%</td>
<td>+8%</td>
<td></td>
</tr>
<tr>
<td>Long Island, NY</td>
<td>+9%</td>
<td>+35%</td>
<td>-20%</td>
</tr>
<tr>
<td>Minneapolis, MN</td>
<td>+25%</td>
<td>+16%</td>
<td>-6 to -16%</td>
</tr>
<tr>
<td>Portland, OR</td>
<td></td>
<td>+173%</td>
<td>-52%</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>+74%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: FHWA RM Handbook

Learning Objective #2
Summary of Safety Outcomes/Benefits

<table>
<thead>
<tr>
<th>Operating Agency</th>
<th>Merging Accident Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detroit, MI</td>
<td>-50%</td>
</tr>
<tr>
<td>Long Island, NY</td>
<td>-15%</td>
</tr>
<tr>
<td>Minneapolis, MN</td>
<td>-24%</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>-43%</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>-39%</td>
</tr>
</tbody>
</table>

Source: Ministry of Transportation, Canada

Source: FHWA RM Handbook
Operational Actions

Agencies Implement Metering Strategies to Influence Outcomes (Benefits)

- Balance demand (entering ramp traffic) and capacity (mainline flow)
- Implement metering actions:
  1. **Fixed rate** is a preplanned release rate determined using historical data or periodic field observations.
  2. **Traffic responsive** rate is calculated or selected based on the current measured conditions on the mainline
     - Local traffic responsive (one ramp)
  3. **System-wide traffic responsive** is a strategy to control ramps in a section-corridor using a central system algorithm (adaptive metering)
Fixed Rate Metering Action

Regulate Traffic On-Ramp Based on the Historical Data with Fixed Rate Metering (Time of Day or Pre-Timed)

ONE Metered Lane
240-900 vph for single lane

TWO Metered Lanes
400-1700 vph for dual-lane

Data Source: Freeway M&O Handbook
Traffic Responsive Action

Regulate **Traffic On-Ramp** with a Traffic Responsive Metering Plan, Developed Based on **Real-Time Data** *(Occupancy, Flow Rate, Speed)*
Traffic Responsive Terminology

- A **metering plan** is a preconfigured look up table
- Each plan contains several **metering levels**
- Each level provides the suitable **metering rate** to **respond** to the current condition

Mainline detectors report current **occupancy**

Current occupancy is compared with the stored threshold data set for **occupancy**, **flow rate**, and **speed**, providing a **metering rate**
Illustration of Traffic Responsive Scenario

8 AM

Average occupancy = 20%

Metering Rate = 8 x 60 = 480 vph

9 AM

Current occupancy = 31%

New metering rate = 4 x 60 = 240 vph

Summary: Example shows that RMC unit provided two metering levels. Levels are thus “Presets”.

Source: FHWA Freeway M&O Handbook
Based on TRB NCHRP Report 232, 1981-Chicago
How Does the RMC Standard Cover Operational Needs?

Provides for Management of Functions (Features)

- Measure Current Condition
- Display Intervals
- Control Cycle
- Metering
- Sign
- Control
- Store and Implement Plan
- Compute Metering Rate
- Using Module-Software

Request Action
Remote Command

Source: FHWA
Source: NYSDOT
Source: Caltrans
Credit: MARK RIGHTMIRE, ORANGE COUNTY REGISTER
Source: Caltrans
How Does the RMC Standard Cover Operational Needs? (cont.)

Provides for Mechanism to Request an Action from the RMC Unit though Command Sources

1. Manual (Highest Priority)
2. Communication Command (NTCIP)
3. Interconnect
4. Time Base Control (Scheduled-Holidays Special Events)
5. Default

Source: Caltrans
How Does the RMC Standard Cover Operational Needs? (cont.)

Using a Third Party Software, **Communications Command Source** Remotely Exchanges Data With the RMC Unit:

- To inquire about current *configuration* and change configuration
- To *control* functions-parameters (requests “action”)
- To *monitor* operations-conditions (requests “data”)

Accumulated data is available to the central software to further optimize operation.

Source: NYSDOT

Source: Caltrans URMS User Manual
Identify Key Features (User Needs) from the NTCIP 1207 Annex A

1. Freeway Segment:
   - Number of lanes
   - Lane’s ID number
   - Mainline detectors (volume, speed, occupancy)
   - Upstream station-Downstream station

2. ON-Ramp Operation:
   - Number of metered lanes
   - Lane’s ID number
   - Detectors (demand, queue, passage)
   - Advanced warning signs and control
   - Traffic responsive plans-N
   - Metering levels-N
   - Signal service-green/yellow/red
Identify Key Features (User Needs) from the NTCIP 1207 Annex A (cont.)

3. Command Sources:
   - Manual
   - Communications
   - Interconnect
   - Time-base control
   - Default

4. Command Actions:
   - Fixed rate
   - Traffic responsive
   - Rest-in-dark
   - Rest-in-green
Which of the following is a FALSE statement related to traffic responsive operation?

**Answer Choices**

a) A TMC operator can remotely retrieve traffic flow data
b) Communications command source has the highest priority
c) Metering levels are part of a metering plan table
d) RMC-module is located within the RMC unit
Review of Answers

a) A TMC operator can remotely retrieve traffic flow data
   
   Incorrect. The statement is true.

b) Communications command source has the highest priority
   
   Correct! The statement is FALSE. Manual command source has the highest priority, followed by the communications source command.

c) Metering levels are part of a metering plan table
   
   Incorrect. The statement is true.

d) RMC-module is located within the RMC unit
   
   Incorrect. The statement is true.
Summary of Learning Objective #2

Identify RMC-Specific Operational Needs

- We have reviewed the RMC-specific operational needs and why
- Reviewed how the standard covers priority-based mechanism for command sources such as manual or communications for controlling an RMC unit
- Discussed communications actions including fixed rate, traffic responsive, and corridor-wide
- Identified key RMC user needs from the Annex A operational descriptions
Learning Objective #3: Prepare Well-Written User Needs for RMC Units

- User needs do not exist for the RMC Standard and agencies must develop them for the acquisition process

- Explain how user needs are extracted and written for RMC procurement

- Discuss what to do if certain user needs are not met by the RMC Standard
What is a User Need?

- A user need is a description (a statement in a specification) of what the RMC system should do to support operations: Features/Functions
  - **Example**: A TMC operator needs to make a request to the RMC unit to change the current ramp metering rate…

- As a first step, users must first identify this user need and then write it for an RMC unit specification
Criteria for Writing a “Well-Written” User Need

When writing a user need, one must remember that it addresses an operational problem and describe it using the following recommended criteria:

1. Provide a structure by assigning a unique number and title to make it uniquely identifiable.

2. Identify (one or more) major desired capability (MDCs) by including a function(s) or feature(s) you desire from the device/system.

3. Capture the rationale by stating why it is needed by the user.

4. Keep it solution-free: Do not get into how to meet it (design).
Applying the Criteria: Example

**UN #1 Change a Metering Rate  uniquely identifiable**

A TMC operator (management station) has a need to make a request to the RMC unit to **change the current ramp metering rate** to a new **Major Desired Capability** metering rate in order to **meet current traffic flow conditions** on a freeway segment.

*This should be done by providing ......*  

**Solution-Free**
Where Do We Find RMC User Needs?

- **Explore** the following sources for user needs:
  
  - Operational needs: Agency metering policy and freeway traffic management ConOps
  - NTCIP 1207 v02 **Annex A** RMC unit operations description (provides functionality-key features details)
  - NTCIP 1207 v02 **Annex B** conformance groups (provides groupings of related objects)
  - Common (generic) architectural user needs from the SEP-based NTCIP 1204 v03 ESS Standard (Annex F)
Advice on How to Use Information Sources

Annex B CGs Cover RMC Functionality

- Read the annex to gain an insight into RMC features (functions)
- Understand how CGs act as a traceability tool for user needs and functionality
- Note how each CG lists design objects needed for a specification

Annex A Descriptions Explain RMC Operations

- Read the annex to gain better understanding of the RMC operational parameters
- Operations descriptions are inconsistent with SEP-based user needs, but they do discuss RMC parameters which we need for a specification
Suggestion for User Needs Organization

Types of RMC User Needs
- **Architectural** user needs for general communication capabilities
- **Features** (Functions) desired from the RMC unit
- **Special** local project needs not addressed above

### RMC User Needs

#### 2.0 Background Information

#### 2.1 Architectural User Needs (generic)
- 2.1.1 Provide Live Data Exchange
- 2.1.2 Provide Off-Line Logged Data
- 2.1.3 Provide Retrieval Capability

#### 2.2 Features (Functions)
- 2.2.1 Managing Configuration
- 2.2.2 RMC unit Control
- 2.2.3 Monitoring Status

#### 2.3 Supplemental Needs
- 2.3.1 (if applicable)

Note: Section 2 and UN ID are shown as illustration
Approach to Architectural User Needs

Based on NTCIP 1204 v03 ESS Standard Annex F

UN 2.1.1: Provide Live Data Exchange
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 2.1.2: Provide Logged Data Exchange
A management station has a need to **log data** and to **retrieve data** at a later time from the RMC unit in a situation when communication is lost or is not always on communication (e.g. dial-up links).

UN 2.1.3: Provide Capability to Retrieve RMC Identity
A TMC Operator **desires to inquire** basic information about the RMC unit such as its location, make, model, and version of the device components.
Approach to Finding User Needs from Annex A

Step 1: Identify sections

- A. 5.1 Fixed rate
- A. 8.3 Metering operation, signal intervals
- A. 9 Queue override

- A. 5.2 Traffic responsive metering
- A. 7.1 Metering plan
- A. 7.2 Metering rate
- A. 8.3 Metering operation-signal intervals
- A. 2, A. 4 Mainline Detectors

Step 2: Use writing criteria: Provide ID, MDC, rationale, and solution-free
**UN 2.4 Fixed Rate**

The agency desires to implement a **fixed metering** rate selected by the central system (or locally) based on a Time of Day Schedule to **control ramp traffic** for each metered lane. Currently, the agency intends to assign the left lane as priority (HOV) lane and the right lane as a common lane.
UN 2.5 Queue Override

The agency desires to implement a queue override operation, in the event that the occupancy of a queue detector reaches a certain threshold by increasing (faster) metering rate to flush the ramp traffic to cut delays.
Finding User Needs from Annex A and Applying Writing Criteria (cont.)

**UN 2.6 Traffic Responsive**

The agency needs to implement a traffic responsive metering mode based on the plan selection that includes metering rate and metering levels based on occupancy thresholds to respond to change in traffic conditions as reported by the mainline and ramp detectors.
Deriving User Needs from the State Diagram

Learning Objective #3

Source: NTCIP 1207 v02
UN 2.7 Signal Service

The agency needs to adhere to transitioning from a non-metering state to a metering state within the intervals of alert, warning, green-yellow-red intervals, and during a non-metering state control of an advanced warning sign.
UN ID 2.8 Transitioning

During a non-metering state, the RMC unit ceases all metering and signalized control. Advanced warning signs and all signal lamps are to be dark while in this state. This mode is implemented at the end of a metering cycle green interval. Detector monitoring continues without interruption in processing while the controller is in the non-metering state.
Finding User Needs from the Conformance Groups (Annex B)

A CG is a Grouping of Related Objects that Supports a User Need(s)

B.3 General Configuration
Basic Set Up of the Device

B.4 Traffic Responsive
Implement Metering Plan

B.5 Metered Lane-Demand Detector
Metering Operation (Action)

B.6 Dependency Group
Relationship to other Lanes

B.7 Queue Detection
Measure Ramp Volume

B.8 Passage Detection
Checkout-Vehicle has Passed

B.9 Time Base
Global Scheduling

B.10 Physical I/O
Assignments-Sign Control

B.11 Block Object
String of Objects to Move Data
Content of (B.5) Metered Lane Conformance Group (page 189)

This CG is **Mandatory** and Generates Minimum Set of User Needs

- Functions (actions) performed (as requested by a command source):
  - Fixed rate
  - Traffic responsive
  - Dark
  - Rest-in-green, rest-in-red
  - Emergency green
  - Vehicle per green

- Demand detection
How to Apply a Generic Process for Extracting MDC from a CG

1. Conformance groups
2. RMC MIB
3. Categories of functions they represent

- MDC
Example: Applying a Generic Process

**B.4 Traffic Responsive CG** listed on page 187

2. On page 15, find clause

3.3.2 Maximum Number of Mainline Lanes

```plaintext
rmcMaxNumML  OBJECT-TYPE
SYNTAX     INTEGER  (1..255)
ACCESS     read-only
STATUS     mandatory
```

3. Infer MDC, **N** lanes to be covered in the traffic responsive plan, for the direction of flow
Extracting MDCs from Multiple CGs

These two CGs offer several **objects** that will be examined for extracting MDCs to develop the user need.
Example: Applying User Needs Writing Criteria

**UN 2.9: Configure a RMC Unit**

A TMC operator, with access to a management station, has a **need to retrieve information** about the configuration of the RMC unit to properly communicate with the device. The controlling entity may also need to alter the configuration to produce expected operations.
**UN 2.10: Command Source Priority**

The TMC operator, with access to the RMC system, has a need to allow for **five priority-based** mechanisms to control the RMC unit to **take metering** action(s). The sources desired in priority order are: manual (local at front panel), communications from a central location (TMC), interconnect (from peer to peer communications from a filed master controller), time base control (TBC for special events) and default. Default mode is placed in effect after skipping all other commands due to loss failures.
Example: Applying User Needs Writing Criteria (cont.)

**UN 2.11: Command Source Parameters**

Each metering command source has **four parameters** to complete metering functions: **Action**, **metering rate**, **metering plan**, and **vehicle per green**.
User Needs Translates to RMC Unit “Actions”

User Need

“TMC operator has a need to request an Action using a third party software on TOD or 24/7 basis”

Function

Functional Requirements

Action

- dark
- fixedRate
- restInGreen
- trafficResponsive
- emergencyGreen
The RMC unit performs five metering operations that includes: Dark, rest-in-green, fixed rate metering, traffic responsive metering, emergency green. The primary metering focus of the agency is to implement a fixed rate metering to manage recurring congestion.
Summary of RMC User Needs Examples

Note: Titles of local user needs may change somewhat during specification preparation.

- UN 2.1  Provide Live Data Exchange
- UN 2.2  Provide Logged Data Exchange
- UN 2.3  Provide Capability to Retrieve RMC Identity
- UN 2.4  Fixed Rate
- UN 2.5  Queue Override
- 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
What to Do If Certain User Needs Are Not Met by the RMC Standard

- If an agency has a situation that translates to an unmet user need, consider the following:
  - Establish whether any non-standard capabilities are really needed
  - Are you expanding metering to other local ramp corridors using the same central control software?
  - Consider cost implications of extended features: specification, testing, and maintenance of a proprietary solution
- If a proprietary-custom solution is warranted due to additional needed functionality, the user needs driving the solution should be documented in the ConOps
What is the best source of user needs?

Answer Choices

a) Freeway Traffic Management Concept of Operations (ConOps)
b) Regional ITS Architecture Ramp Metering Service Package
c) NTCIP 1207 v02 Standard Documentation
d) All of the above sources
Review of Answers

a) Freeway Traffic Management Concept of Operations
   Incorrect. Exploring the ConOps is an important source but is only partially true.

b) Regional ITS Architecture Ramp Metering Service Package
   Incorrect. Architecture is framework-only and is a partial source at best.

c) NTCIP 1207 v02 Standard Documentation
   Incorrect. The standard offers design solutions—CGs and operational description, but it is not sufficient from users’ operational needs perspective, which emerges from ConOps.

d) All of the above sources
   Correct! All of the above sources have links to user needs. Assessment of each will ensure our purpose to identify user needs.
Summary of Learning Objective #3

Prepare Well-Written User Needs for RMC Units

- We have realized that RMC user needs are not available and we must develop them for the acquisition process
- Discussed how to extract user needs and write them for procurement using a criteria
- Discussed what to do if certain user needs are not met by the standard
Learning Objective #4: Explain How to Evaluate Conformance to the RMC Standard

- What are the minimum conformance requirements?
- Explain how to address backward compatibility issues
What are the Minimum Conformance Requirements?

- RMC Unit Standard Conformance Group (CG) Table States Requirements as:
  
  - **Mandatory (M) CGs** are very basic types and are required for conformance to the NTCIP 1207 v02 Standard (also include the Configuration CG from the NTCIP 1201 v02 Global Standard, which is required for conformance)
  
  - **Optional (O) CGs** are selected by the agency specification to meet local user needs
## RMC Unit CG Table

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

- All ramp metering specification must select **YES**

- Implementation will include metering lane(s)

- For **CONFORMANCE** to the standard, this CG is required
Example of Optional CG

- If the traffic responsive metering is to be implemented, agency specification must select **YES**

- Implementation will include Metering Plan

- For **compliance** to the specification, this CG is required
Traceability with Conformance Groups

Identified RMC user needs can ONLY be traced to the CGs in this standard.

<table>
<thead>
<tr>
<th>User Need</th>
<th>Conformance Group</th>
<th>Requirement</th>
<th>Object Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN 1 Configure RMC Unit</td>
<td>B.3 General Configuration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B.5 Meter Lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNs</td>
<td>B.4 Traffic Responsive</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: We will learn more on handling traceability in the next module, A309b.
Interoperability

- Interoperability issues:
  - RMC units are remotely accessed and may be controlled by management stations located at the TMC or other operation centers
  - To achieve interoperability, agencies must select the same user needs and design solutions, and must use common protocols (compatibility)
  - Ramp metering is a component of a freeway management system and may be shared by multiple agencies; use of common C2C Standards may be needed
Addressing Backward Compatibility

- NTCIP 1207 v02 is backwards compatible with NTCIP 1207 v01 and standard text advises readers where changes have been made:
  - Some objects have a 1-255 value range instead of a 0-255 range
  - Dialogs (a mechanism to communicate messages with the device) have NOT been defined in RMC; consistency may be an issue
  - Although technically RMC can mix ATC and 2070-170 in the same corridor, local interface constraints may remain; a check may be needed on firmware
ACTIVITY
Which of the following is a **FALSE** statement related to the NTCIP 1207 RMC v02 Standard?

**Answer Choices**

a) Only Metered Lane CG is required to conform to the standard
b) Traffic Responsive CG is optional
c) V02 Standard is **NOT** compatible with the previous version
d) A CG represents one or more RMC unit function
Review of Answers

a) Only Metered Lane CG is required to conform to the standard

Incorrect. The statement is true. It is a mandatory CG.

b) Traffic Responsive CG is optional

Incorrect. The statement is true. It is required only when an agency desires to implement metering based on real-time traffic data.

c) v02 Standard is NOT compatible with the previous version

Correct! The statement is FALSE. V02 is compatible with the previous version.

d) A CG represents one or more RMC unit function

Incorrect. A CG is a grouping of objects that represent a function.
Summary of Learning Objective #4

Explain How to Evaluate Conformance to the RMC Standard

- We have reviewed the RMC Standard conformance requirements as stipulated in Table B.2, including mandatory CGs
- We also reviewed interoperability and backwards compatibility issues
What We Have Learned

1) NTCIP 1207 v02 Non-SEP Standard does not have **user needs** and we must **identify** and **write** them using a criteria.

2) RMC unit user needs can be found in **ConOps**, **conformance groups** and **operation descriptions**.

3) A user need must be **uniquely identifiable**, and defines **major desired capability**, provides a **rationale** and is **solution-free**.
What We Have Learned (cont.)

4) Types of metering include fixed rate metering, traffic responsive, and corridor-wide metering adaptive.

5) Highest priority command source in RMC is manual, followed by communications.

6) All mandatory CGs must be included in the specification for conformance to the standard.
Next Course Module

A309b:
Understanding Requirements for Ramp Meter Control (RMC) Units Based on
NTCIP 1207 v02 Standard
Resources

- NTCIP Standards available at [www.ntcip.org](http://www.ntcip.org):
  - NTCIP 1201 v03 Global Object Definitions
  - NTCIP 1207 v02 Ramp Meter Control (RMC) Units


- Participant Student Supplement
  - Overview of RMC Practice
  - List of RMC User Needs
  - References on Ramp Metering Practice

- Kansas City SCOUT-Video on Ramp Metering (4 min.)
  - [http://www.kcscout.net/RMWatchTheVideo.aspx](http://www.kcscout.net/RMWatchTheVideo.aspx)