Welcome

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WWW.PCB.ITS.DOT.GOV/STANDARDSTRAINING
A321a
Understanding User Needs for Traffic Management Systems Based on TMDD v3.0 Standard
Target Audience

- Engineering and Planning Staff
- Emergency Management
- Public Safety
- Traffic Management Center (TMC) Operation Staff
- System Developers
- Public and Private Sectors
Instructor

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President
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Curriculum Path (SEP)

- 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
- A321a Understanding User Needs for Traffic Management Systems Based on TMDD v3 Standard
- Specifying Requirements:
  - A311b NTCIP 1203
  - A313b NTCIP 1204 v03
  - A321b TMDD v3.0
Curriculum Path (Non-SEP)

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

*A3xxa Understanding User Needs Based on NTCIP 12xx vxx Standard

*A3xxb Specifying Requirements Based on NTCIP 12xx vxx Standard

* Expected in year 2 training modules
Recommended Prerequisites

- 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
Recommended Prerequisites (cont.)

Basic knowledge of the following areas is helpful:

- Intelligent Transportation Systems (ITS)
- Managing ITS deployment projects
- Government procurement processes
- Benefits of standards
- Systems Engineering Process (SEP)
- Traffic Management Centers (TMCs)
Learning Objectives

1. Describe what problem TMDD is addressing
2. Identify regional operational and planning needs (specific to TMDD) for common system interface to support interagency communications
Learning Objectives (cont.)

3. Discuss the TMDD v3.0 standard structure and the content

4. Understand the role of NRTM and learn how to use it to select user needs and link them to requirements

5. Identify a requirement of institutional arrangement for implementing a system interface
What is the Traffic Management Data Dictionary (TMDD)?

- Provides high level definitions of user needs, requirements and data concepts
- Used in *System Interface* specification
- Supports Center-to-Center (C2C) communications needs
Centers

External Center (EC)

A center that uses services provided by another center

Owner Center (OC)

A center (TMC) that provides information and has direct control of field devices

Center-to-Center Communications (C2C)
Interoperability

“The ability of two or more systems or components to exchange information and to use the information that has been exchanged”

-IEEE Std 610
ACTIVITY
Why do centers desire to communicate with each other?

Type your response in the chat pod
Before Standardization
Each Center Requires Multiple Proprietary Interfaces
After Standardization
Each Center Requires One Standard-based Interface
What is a System Interface?

“a system interface is a shared boundary across which information is passed”
System Interface Implementation

SI Uses:
- Manage assets and other entities
- Manage information
- Monitor status
- Control devices
Specifying System Interface

**Specification Components Supplied by TMDD v3 standard**

**Description** of what the system interface must do to support operations

**Written** in “shall” language, specific requirements to satisfy user needs

**Use of** only standard-supplied design data concepts to fulfill the allocated requirements
Summary of Learning Objective 1

**What Problem is TMDD Addressing?**

- Recognizes a need for a *system interface* to exchange information among centers
- **System Interface** design uses ONLY standardized “building materials”
- Same set of user needs, requirements, and data concepts is to be included in specification to achieve interoperability among centers
What operational needs will a TMC have for information from another center?

_Type your response in the chat pod_
Operational Environment

Categories of User Needs

- Connection Management
- Support Authentication-Restrictions
- Provide Information on Organization
- Share Event Information
- Provide Roadway Network
- Provide Control of Devices
- Share Data for Archiving
- Accept Null Values
Example

2.3.1 Need for Connection Management

2.3.1.1 Verify Connection Active
Centers need to verify that a connection with another center is alive or active.

2.3.1.2 Need to Support Requests

2.3.1.3 Need to Support Subscriptions

2.3.1.4 Need to Support Error Handling
Example

2.3.4 Need to Share Event Information

2.3.4.6 Need for Current Event Information
External centers need to obtain current event information from owner centers such as a description, location, severity, and status of the event.

2.3.4.7 Need for Planned Event Information
.....need to obtain planning information.....
Example

2.3.5 Need to Provide Roadway Network Data

2.3.5.4 Need to Share Route Data

Centers need to share route data.
Example

2.3.6.4 Need to Share DMS Status and Control

2.3.6.4.4 Need to Display a Message on a Remote DMS

Centers need to request that a specific message be displayed on a DMS controlled by another center.
Example

2.3.7 Need to Share Data for Archiving

2.3.7.1 Need for Traffic Monitoring Data

Centers exchange traffic monitoring data, such as volume, occupancy, and speed for archival purposes.

Data collection for planning and research needs

Monitoring traffic volumes on another agency’s roadway
Illustration

How centers share and use current information

Transit

Bus driver is then informed accordingly

Traffic

Verified current event and route condition information is sent to external center
Illustration

How centers share field devices?

Request to display a specific message

Response (action taken)

Major ACCIDENT
5 MI  I-87 NB
ALT  RT  EXIT 9
Summary of Learning Objective 2

Operational Needs

1. Reviewed operational and planning needs to support interagency communications
Summary
Operational Needs (cont.)

2. User needs categories:
   2.3.1 Connection management
   2.3.2 Support Authentication-Restrictions
   2.3.3 Provide information on organizations
   2.3.4 Share event information
   2.3.5 Provide roadway network data
   2.3.6 Provide control of devices
   2.3.7 Share data for archiving
   2.3.8 Accept null values
Volume I
Concept of Operations and Requirements

What is to be done?

Section 1  Document Introduction
Section 2  User Needs
Section 3  Requirements
Section 4  Traceability to National ITS Architecture
Section 5  NRTM (pages 174-295)
Volume II-Design Content

How is it to be done?

Section 1  Document Introduction
Section 2  TMDD Dialogs and Messages
Section 3  TMDD ISO 14817 ASN.1 and XML Data Concepts Definitions
Section 4  Requirement Traceability Matrix (RTM) (pages 58-635)

ASN.1 and XML are Data Encoding Formats
Availability of Standardized Definitions by TMDD v3.0 standard

126 User Needs ➔ 134 Requirements ➔ 600 Data Concepts
- 124 Dialogs
- 85 Messages
- 187 Data Frames
- 207 Data Elements

System Interface Design
Understanding Relationship through NRTM and RTM

User Needs

NRTM

Requirements

RTM

Data Concepts
- Dialogs
- Messages
- Data Frames
- Data Elements

Volume I
TMDD v3.0 standard

Volume II
TMDD v3.0 standard
Summary of Learning Objective 3

TMDD Structure

- Provides NRTM for:
  - Mapping operational needs to user needs definitions
  - Tracing requirements to user needs
  - With the NRTM, the relationships between user needs and requirements is standardized
Summary
TMDD Structure (cont.)

- Provides RTM for:
  - Tracing requirements to data concepts
  - Relationship between requirements and data concepts (design) is standardized
- TMDD promotes “Off-the-shelf interoperability”
Where are User Needs located on “V”?

NRTM

STEP-2: Using the NRTM (pages 174-295 in the TMDD Standard Volume I, Section 5), select the user needs that address your operational needs. The user need description provided in the ConOps (pages 9-33 in TMDD Standard Volume 1) will help to better understand the intent and capability of the user needs.

Needs are located at ConOps stages of the V diagram; Requirements follow
Parts of NRTM

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
<th>Req. ID</th>
<th>Req.</th>
<th>Conformance</th>
<th>Support</th>
<th>Other Req.</th>
</tr>
</thead>
</table>

What needs to be done

User Needs

Details-specifics

Requirements

NRTM Structure has 8 Columns with Multiple Rows
NRTM Content

- Using the UN ID number (e.g. 2.3.6.4.5), the corresponding text from the standard allows you to determine if this UN is desired in your project.

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
<th>Req. ID</th>
<th>Req.</th>
<th>Conformance</th>
<th>Support</th>
<th>Other Req.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.6.4.5</td>
<td>YES</td>
<td>YES</td>
<td>3.3.6.1.4.2</td>
<td>M</td>
<td>YES</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For **Mandatory** (M) requirements stated in the standard, project must select **YES** only.
For **Optional** requirements (O), project decides if the requirement will be used.
NRTM Role

- With NRTM:
  - Requirements are traced to user needs (at least one)
  - Work is monitored at each stage of the system life cycle process (*Are we addressing user need?*)
  - Final check to validate user needs is made (*Did we build the right system?*)
ACTIVITY
Who do you think benefits from use of NRTM?

Type your response in the chat pod
Beneficiaries of NRTM

- The Specification Writer
- The Integrator
- The Supplier
- The User

Interoperability
- Requirements
- Capabilities

Risk Management
Ensuring Interoperability

- User needs are a first step towards achieving C2C interoperability

Both centers must select the same subset

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>n</td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

NRTM (Partial)
Understanding Mandatory User Needs

To conform to the standard, Mandatory user needs must be selected-YES

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1.1</td>
<td>Verify Connection Active</td>
<td>YES</td>
</tr>
<tr>
<td>2.3.1.2</td>
<td>Request Needs to Support</td>
<td>YES</td>
</tr>
<tr>
<td>2.3.1.4</td>
<td>Need to Support Error Handling</td>
<td>YES</td>
</tr>
<tr>
<td>2.3.5.1.1</td>
<td>Need for Node Inventory</td>
<td>YES</td>
</tr>
<tr>
<td>2.3.5.1.2</td>
<td>Need for Link Inventory</td>
<td>YES</td>
</tr>
<tr>
<td>2.3.8</td>
<td>Need to Accept Null Values</td>
<td>YES</td>
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</tbody>
</table>

Ref. page 174, Volume I, Table 4, 4th Column UN Selected
Understanding Optional User Needs

Select optional needs based on the project’s operational needs

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
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</thead>
<tbody>
<tr>
<td>2.3.1.3</td>
<td>Need to Support Subscriptions</td>
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</tr>
<tr>
<td>2.3.4.2</td>
<td>Need to Correlate an Event with Another Event</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3.4.5</td>
<td>Need to Provide Multilingual Event Descriptions</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3.4.6</td>
<td>Need for Current Event Information</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3.6.1.3</td>
<td>Need to Share Detector Status</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Example

Centers must select same set of user needs for interoperability

2.3.6.4.4 Need to Display a Message on a Remote DMS

Center need to request that a specific message be displayed on a DMS controlled by another center.
Preparing Project NRTM

User Needs → Requirements → Data Concepts

NRTM → RTM
Preparing a Project NRTM

Match project’s operational need to User Need ID number and corresponding text description. This action determines if this UN is desired in your system.

Example

2.3.6.4.5 Need to Verify DMS Control Status
The center that sends a request to display a specific message on a DMS operated by another center needs to confirm if the message was displayed. Possible statuses include that the message request was implemented, was queued, or was rejected.

DMS supports congestion (traffic) management
Preparing a Project NRTM (cont.)

### Step 2
**User Need Part**
Write UN ID, UN and Select YES

### Step 3
**Requirements Part**
Go to Section 5, Volume I, page 174, Table 4 to read allocated requirements

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
<th>REQ. ID</th>
<th>REQ.</th>
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<th>Other req.</th>
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<tr>
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<td>Need to Verify DMS Control Status</td>
<td>Yes</td>
<td>3.3.6.1.4.2</td>
<td>M</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
## Project NRTM (Partially Populated)

### Step 4
Find 2.3.6.4.5 on page 224
Read ten listed Req. in 4th column

10 requirements are allocated to a user need

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>UN Selected</th>
<th>Req. ID</th>
<th>Requirement</th>
<th>Conformance</th>
<th>Support</th>
<th>Other Req.</th>
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<tr>
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<td>Need to Verify DMS Control Status</td>
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<td>3.3.6.1.4.2</td>
<td>M</td>
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<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>3.3.6.1.4.2.2.1</td>
<td>O</td>
<td></td>
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<td>3.3.6.1.5.1</td>
<td>M</td>
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<tr>
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<td>3.3.6.5.4</td>
<td>M</td>
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<td>Yes</td>
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</tbody>
</table>
Summary of Learning Objective 4

- User needs are located at ConOps stage on “V” diagram
- Using NRTM Operational Needs are mapped to user needs in Section 2, Volume I
- NRTM traces requirements to at least one user need
- Mandatory UN must be selected YES
- Optional UN, if selected YES, associated requirements are Mandatory
Pre-Arrangement

- How do we implement a System Interface?
- Pre-Arrangement

24/7 operations

9-5, M-F

24/7 operations
Name some pre-arrangements before a system interface is implemented

Type your response in the chat pod
Types of Agreements

Memorandum of Understanding (MOU)

Example: Florida DOT District Four

Purpose: This ...MOU..... provides the framework to promote a collaborative effort to .....promote coordinated decision-making and information sharing in planning, design, deployment, operations, ....... .... Maximize communications between and among the network of traffic management centers .......

Source: www.smartsunguide.com/pdf/MOU.doc
Types of Agreements

Operational Agreement Covers:

- Networks (system admin.)
- Authentication, Security
- Standard Operating Procedures (SOPs) for:
  - Current conditions on road networks
  - Sharing devices (DMS, CCTV, ...)
  - Sharing event Information (Traffic Incidents, emergency...)
  - Sharing data (Archiving)
Example: Agreement

STARNET
Sacramento Area Council of Governments

7 Formal Agreements
The Sacramento Region ITS Partnership Memorandum of Understanding for Participation in the Regional ITS Deployment Strategy, although not a binding agreement, provides a framework for cooperation between key STARNET stakeholders, especially for sharing of regional funds.

Example
Puget Sound Regional Council

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  5.2 Elements of an Agreement ............................................................................................... 48

Source: psrc.org/assets/543/regarch.pdf
TMDD’s Relationships to Architecture

- External Traffic Management Center
- Information Service Provider
- Event Promoter
- Maintenance and Construction Operations
- Weather Service
- Surface Transportation Weather Service
- Emergency Management
- Toll Administration
- Transit Management
- Archive Data Management
- Media

* Only a portion of the interface is covered by the standard
Example of TMDD’s Support

Information Service Provider
Private Sector Traveler Information Services + State 511 System

Traffic Management
City Traffic Management Center (TMC)

Roadway Subsystem
City Field Equipment

Traffic images
Pan Tilt Zoom camera control
Traffic flow

Center to Center C2C
Center to Field C2F

Road network conditions
Request for road network conditions
Related C2C Standards

SI Implementation Requires:

1. TMDD v3 standard:
   - User Needs, Requirements and ISO 14817 Based Data Concepts
   - Centers must have a common specification

2. Application Protocol:
   - NTCIP 2306 C2C XML or NTCIP 2304 C2C DATEX
   - Centers must select one as a common protocol for Interoperability
CASE STUDY
Case Study

**TMC-A** has 24/7 traffic management operations, which includes 50 traffic signals, 7 DMSs, and 15 CCTV cameras, and has received approval from FHWA to develop an ITS project to add a system interface capability to exchange information with the adjoining TMC B.

Both TMCs have agreed to coordinate traffic management in the region and share event information and field devices.

A system interface is to be procured soon. **What Next?**
1. The project will be guided by the SEP to develop the system interface desired by the TMCs.
2. The TMDD v3.0 standard will be used to develop the system interface for both TMCs.
3. In this case study the Owning Center is TMC A and the External Center is TMC B
Please type in response in the chat room

4. Which tool will you use to map the operational need? **NRTM**

5. How do we go about preparing project user needs? **Prepare Project NRTM**

6. Both TMCs must prepare a **specification** common with same set of user needs, requirements and data concepts to achieve off-the-shelf interoperability.
Case Study  Exercise

7. The overall *Operational Need* driving this development can be stated as *traffic (congestion) management*

8. The standardized user needs definitions can be found in **TMDD v3.0 standard, Volume I Section 2**

9. Information exchange related user needs are: *roadway network*, *event sharing*, *device sharing* and *data archiving*. Additional four are related to network authentication management etc.
Case Study Exercise (Cont.)

10. What pre-arrangement should TMCs have in place for implementation of the SI?

   MOU-SOPs-Agreement

11. NTCIP 2306-C2C XML is selected as a common protocol to support the system interface.
What did we learn today?

- TMDD addresses the need for system interface capability for C2C “information exchange” [LO #1]
- Supports eight categories of operational needs [LO #2]
- Standardized definitions are available for use in a specification: [LO #3]
  - Volume I contains *User Needs and Requirements and NRTM*
  - Volume II contains *design concepts and RTM*
What did we learn today? (cont.)

- Learned how to prepare a project NRTM [LO#4]
- Required pre-arrangement to implement a system interface [LO#5]
- The Case Study examination confirmed key concepts
- Prepared for the A321b module on the requirements
Next Steps:

Module A321b

Specifying Requirements for Traffic Management Systems Based on TMDD v3 Standard

- Requirements and their link to Data Concepts through RTM will be discussed in details to complete preparation of a system interface specification
Where to Find More Information

- TMDD v3 standard and TMDD Guide:  
  http://www.ite.org/standards/distribution.asp

- NTCIP Guide:  www.ntcip.org/library

- Systems Engineering Guidebook for ITS  
  FHWA-Caltrans, v3.0 2009:  

- Systems Engineering for Intelligent Transportation Systems, FHWA, 2007:  