ITS Standards Advisory
Traffic Management Data Dictionary Standard for Traffic Management Center-to-Center Communications
2013

Intelligent Transportation Systems (ITS) Standards Advisories provide the ITS transportation community with information and guidance on the consideration and use of ITS standards.

Traffic Management Data Dictionary (TMDD) Background

Center-to-center (C2C) communications spans the entire ITS domain, covering the exchange of data between computers physically located in different transportation management center facilities. Such facilities include: traffic management centers, transit management centers, public safety, incident management centers, parking management centers, and so forth). C2C standards enable this data exchange, specifying what information is exchanged, how and when it is exchanged, and the underlying transport mechanisms. C2C standards can be divided into two categories: (1) the message and data content, and (2) the rules for exchanging the messages and data. The two categories of standards work together to successfully exchange meaningful ITS-related information.

Consensus-based working groups from American Association of State Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers, (ITE) and National Electrical Manufacturers Association (NEMA) have been chartered with developing a set of underlying Center-to-Center (C2C) communications standards for the transportation community. The two categories for C2C communications standards are generally referenced as informational and protocol standards. The Traffic Management Data Dictionary (TMDD) is an information standard, while National Transportation Communications for ITS Protocol (NTCIP) standards address protocol standards. In general, NTCIP organizes its standards using a layered approach (as shown in Figure 1), similar to the ISO Open System Interconnection (OSI) framework model. While message/data standards address the Information Level, protocol standards primarily address the Applications, Transport, and Subnetwork Levels.

The TMDD for Traffic Management Center-to-Center Communication standards were developed by a joint ITE and AASHTO working group, which resulted in two types of Information Level encodings (XML and ASN.1). The type of encoding used affects the selection of possible protocol level standards. TMDD v3.03b is the latest version of the standard and it defines both types of encodings. The TMDD standard defines the information (messages) and sequence of messages (Dialogs) that are shared between centers, while using the NTCIP Application, Transport, and Subnetwork Levels to define how the information is to be carried.

The TMDD v3.03b Standard supports the exchange of messages and data meeting the rules found in NTCIP 2304 for DATEX/ASN formats and NTCIP 2306 for WSDL/XML formats.

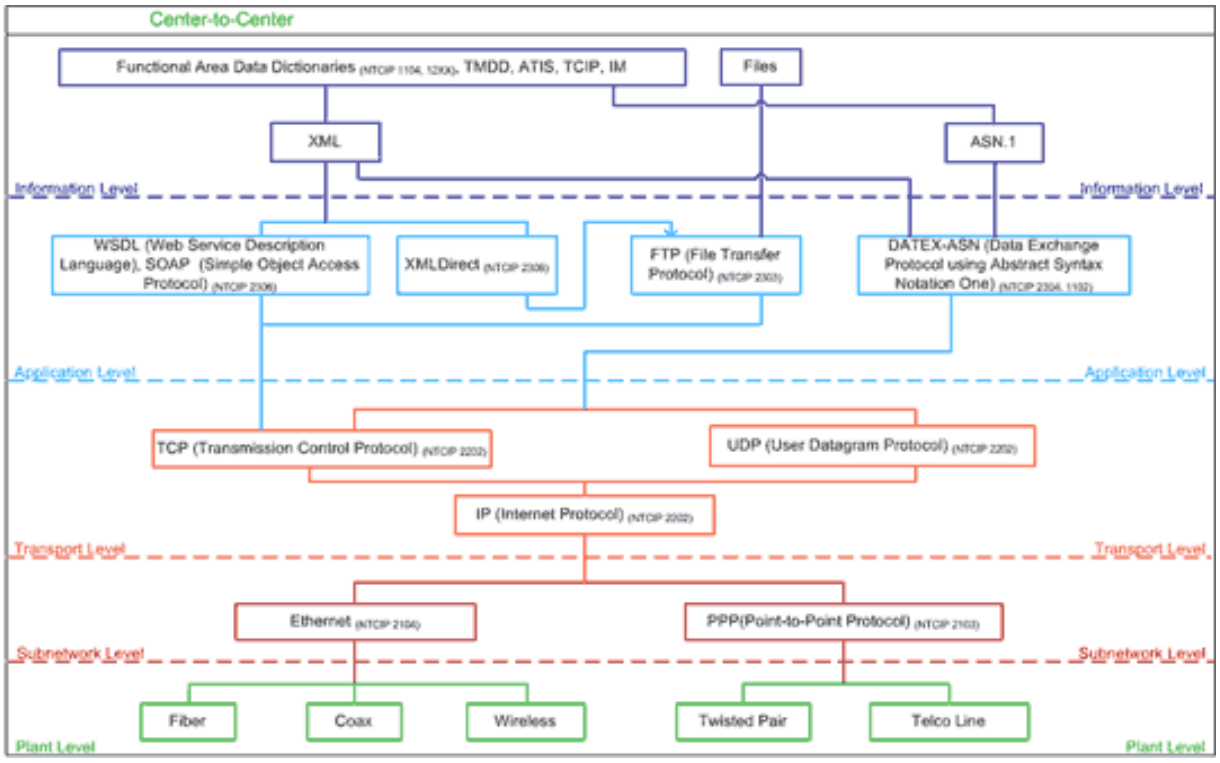

Figure 1: NTCIP Organization

History

The first version of the TMDD Standard (v1.0) focused on the development of a ***data dictionary*** for traffic management systems. It further used those data elements in the construction of message sets, called *Message Set for External Traffic Management Center Communications* (MS/ETMCC) to exchange information regarding traffic conditions, devices, and incidents, as well as support for shared control of ITS devices between systems. Consequently, version 1 contained 2 parts: (1) the TMDD and (2) the MS/ETMCC. Version 2.1 corrected deficiencies in the Standard and applied the Systems Engineering process[1] by identifying user operational needs and developing requirements and dialogs. Version 2.1 also combined the TMDD and MS/ETMCC standards into one standard.

This new TMDD v3.03b reflects the Systems Engineering process approach, restructures the design for the standard, and has added new features. In addition, the TMDD V3.03b has been used as the basis for the development of a *reference implementation* that can be used by agencies and developers to verify conformance to the TMDD standard. During that development, the TMDD standard was adjusted to correct ambiguities, missing entries in the various tables for consistency, and clarification of the conformance statements.

[1] More detail can be found at: http://ops.fhwa.dot.gov/int_its_deployment/sys_eng.htm.

Changes Since Last TMDD Standard Advisory

The v3.03b Standard includes the following changes from v2.1:

1. Corrects the deficiencies from v2.1 as identified in a systematic review, including a verification and validation effort on all needs, requirements and design concepts (dialogs, messages, data frames, and data elements) in the document.
2. Adds user needs, requirements and design concepts in a manner consistent with the Systems Engineering process as requested by:
    a. The Clarus Initiative (Weather related data),
    b. The Condition Acquisition and Reporting System (CARS) states, and
    c. Archive Data User Services (ADUS).
3. Assesses issues and integrates lessons learned from actual deployments, specifically CARS, United States Transportation Command (TRANSCOM), FDOT and TXDOT into the Standard Concept of Operations (ConOps), requirements and design.
4. Links the Standard to a Systems Engineering Process to ensure traceability and logical consistency of the Standard, and enhance its usability.
5. Ensures the Standard conforms to ISO 14817, the international standard for Transport Information and Control Systems (TICS) - Requirements for an ITS/TICS Central Data Registry and ITS/TICS Data Dictionaries. ISO 14817 provides a common way to define the information data concepts used in TMDD so all users will know how to interpret the data concepts.
6. Develops a TMDD V3.03b Web Service Description Language (WSDL) and Single Object Access Protocol (SOAP) specific model in addition to the DATEX ASN.1 model. This allows developers to use tools now available to develop WSDL and SOAP interfaces and reduces the cost of a development.
7. Develops a detailed conformance statement that addresses backwards compatibility and provides clear and unambiguous instruction on how to extend the standard.

Needs to Requirements Traceability Matrix (NRTM)

TMDD v3.03b ascribes a Systems Engineering Process to the Standard. A linkage is created between user-identified operational needs and the system requirements to support those needs. This Systems Engineering Process enhances the usability of the Standard to create comprehensive specifications for procurements.

The key to this activity is the NRTM; a sample is shown in Figure 2. The matrix steps the user through identification of operational needs, indicates whether those needs are mandatory or optional, and shows the various requirements to support the selected need(s).

The NRTM makes it easier for implementers to procure systems using TMDD v3.03b. The process to use the NRTM for TMDD procurement is described in online modules provided as

part of the United States Department of Transportation's (USDOT) Professional Capacity Building program (PCB). See the Training section on Page 6.

UN ID	User Need	UN Selected	Requirement ID	Requirement	Conformance	Support	Other Requirements
2.3.1.1	Verify Connection Active	Mandatory	3.3.1.1.1	Send Center Active Upon Verification Request	M	Yes	
			3.3.1.1.2	Publish Center Active Verification Information	Subscription: O	Yes/No/NA	The owner center shall begin sending the updated response message within ____ ms (millisecond) after the information is updated in the owner center
			3.3.1.1.3	Subscribe to Center Active Verification Information	Subscription: O	Yes/No/NA	
			3.3.1.1.4	Contents of the Center Active Verification Request	M	Yes	
			3.3.1.1.4.1	Required Center Active Verification Request Content	M	Yes	
			3.3.1.1.4.2.1	External Center Organization	O	Yes/No	
			3.3.1.1.5	Contents of the Center Active Information	M	Yes	
			3.3.1.1.5.1	Required Center Active Information	M	Yes	
			3.3.1.1.5.2.1	Owner Organization	O	Yes/No	
2.3.1.2	Need to Support Request	Mandatory	3.3.1.2	Support Request-Response	M	Yes	
2.3.1.3	Need to Support Subscriptions	Yes/No	3.3.1.3.1	Support Periodic Updates	O.1 (1..*)	Yes/No	
			3.3.1.3.2	Support Event-Driven Updates	O.1 (1..*)	Yes/No	

Figure 2: Needs to Requirements Traceability Matrix

USDOT Guidance on TMDD Standards

The USDOT offers the following guidance regarding NTCIP TMDD Standards:

> *USDOT strongly encourages State and local agencies to use the TMDD v3.03b Standard. The Standard is mature and offers immediate benefits for agencies by enabling interoperability between centers. Additionally, TMDD v3.03b supports both the NTCIP 2304 Standard covering DATEX/ASN implementations and the NTCIP 2306 Standard covering WSDL/XML implementations. Check the resources in the "Standards Resources" section below for help with systems assessment, migration, integration, and procurement. In particular, assistance is available to help implement standards-based TMDD v3.03b.*

A web-based reference implementation called the Center-to-Center Reference Implementation (RI) is being developed to assist users in use of the Standard in implementations. This tool can be used to verify system conformance to the Standard. It is anticipated to be available in early 2014.

Training

Professional Capacity Building (PCB) training for ITS Standards specific for TMDD v3.0 procurements and testing is being developed. This training will be modular and is available on the PCB/Standards and ITE sites. Specific modules and anticipated availability are as follows:

Module	Scheduled Completion
• A321a: Understanding User needs for ITE Traffic Management Data Dictionary (TMDD) v3 Standard (M)	Available now
• A321b: Specifying Requirements for TMDD v3 Standard (M)	Available now
• T321: Applying Your Test Plan to the TMDD Standard	December 2013

Currently available modules can be found at http://www.pcb.its.dot.gov/standardstraining/.

TMDD Standards in Use

Region-wide distribution of transportation management information is a key function at the core of a transportation agency's ability to generate benefits from ITS. Agencies are executing C2C projects across the country primarily using the WSDL/XML. Therefore, TMDD v3.03b is extremely beneficial to users. It will also support DATEX/ASN as the underlying communication protocols, however; most systems today are using the web services approach identified in NTCIP 2306.

TMDD v3.0 is currently being implemented in San Diego, CA as the basis for the C2C system implementation as part of the Integrated Corridor Management (ICM) project. For more information about this implementation on the web see: http://www.its.dot.gov/icms/pioneer_sdiego.htm.

Relevance to USDOT Research Initiatives, the National ITS Architecture

USDOT Research Initiatives

C2C communications support the following USDOT Research Initiatives:

- Emergency Transportation Operations
- Integrated Corridor Management Systems
- Clarus
- Mobility Services for All Americans
- Real-Time System Management Information Program (RTSMIP). In response to Section 1201 of the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), U.S. Code of Federal Regulations (CFR) 23 Part 511 was developed, and requires each state to establish and operate a RTSMIP for the sharing of basic traffic information by all centers.

Relevance to the National ITS Architecture

The TMDD v3.03b standards are common across many C2C interfaces in the National ITS Architecture.

Standards Resources

The following C2C Standards resources are recommended for learning more about ITS C2C communications standards:

- **The ITS Joint Program Office (JPO) Standards Program Website** is the first stop for information on the TMDD standard. The site contains a wealth of information on ITS standards, including the current status of the TMDD standard. Visit http://www.standards.its.dot.gov.
- **ITS Standards Fact Sheets** are concise, "Plain Language" descriptions of ITS standards. They are available at http://www.standards.its.dot.gov/factsheets.asp.
- **An ITS Specialist** is available at each of the four Federal Highway Administration (FHWA) Resource Centers to provide guidance on issues related to ITS standards. Visit http://www.fhwa.dot.gov/field.html for contact information.
- **The ITS Field Support Team** is a major new technical assistance program sponsored by the Standards Program. The ITS Field Support Team offers intensive consultation and support on a broad range of standards-related issues, including:
  - Assessment of current system
  - Development of project specifications
  - Review of existing contracts and specifications
  - Identification of appropriate contracting and procurement mechanisms
  - Development of test plans
  - Evaluation of systems for contract compliance and conformance to specifications

Visit http://www.ops.fhwa.dot.gov/int_its_deployment/standards_imp/stdsteam.htm for more details.

- **ITS Peer-to-Peer** is a FHWA, Federal Transit Administration (FTA), and Federal Motor Carrier Safety Administration (FMCSA) Technical Assistance program that provides public sector transportation stakeholders with a convenient method to tap into the growing knowledge base of ITS experience and receive short-term assistance. To learn more visit http://www.its.dot.gov/peer/.
- **Standards Development Organization Websites** are a source of not only the TMDD standard, but also other ITS and transportation standards.
- **The Institute of Transportation Engineers (ITE)** website is http://www.ite.org/. The Standard is located under the heading "TECHNICAL INFORMATION", under the link for "Standards" and then the link for "TMDD."
- **The American Association of State Highway and Transportation Officials (AASHTO)** website is http://www.transportation.org.
- **ITS Help Line (866-367-7487)** to reach trained staff who will assist with locating resources, websites, and documents that relate to Operations and ITS.

Available Documents/Guides

The TMDD Guide is located at: http://www.ite.org/standards/TMDDstandardv03Guide.pdf. Chapter 16, "Regional Integration," of the FHWA's Freeway Management and Operations Handbook (September 2003) contains basic information on the application of C2C technology to freeway operations. It is available at: http://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/.

Getting Involved

The ITE TMDD Steering Committee brings together transportation professionals regarding the TMDD Standard. Information on the activities of this committee can be found at http://www.ite.org/standards/tmdd/. Point of contact is Siva Narla at ITE at snarla@ite.org.

The NTCIP C2C Working Group brings together transportation professions regarding C2C communication standards development. Please consult the NTCIP Library website, http://ntcip.org/library/documents/ to learn more about the status of these documents.

Standards Available Free

The Institute of Transportation Engineers (ITE) website is http://www.ite.org/. The TMDD Standard is available at http://www.ite.org/standards/tmdd. Note that earlier versions are also shown on this web site, and the potential users are directed to use the latest version currently known as 3.03b.

Published NTCIP standards and some of those jointly approved by AASHTO/ITE/NEMA and awaiting formal publishing are available for free download for 12 months through a FHWA-sponsored special offer. For more information on the NTCIP 2304 AP-DATEX-ASN Standard and the NTCIP 2306 Application Profile for XML in ITS Center-to-Center Communications (AP-C2CXML) Standard, visit http://www.ntcip.org/order/specialoffer.asp or http://www.ntcip.org/library/documents/.

The following resources are recommended for learning more about ITS Standards:

- **ITS Standards Website** http://www.standards.its.dot.gov/.
- **ITS Standards Field Support Team** is a technical assistance program sponsored by FHWA Operations. The ITS Field Support Team offers consultation and support on a broad range of standards-related issues. The team is on the web at http://www.ops.fhwa.dot.gov/int_its_deployment/standards_imp/stdsteam.htm.

C2C TMDD Communication Standards

The following Table lists C2C TMDD communication standards. For further information on C2C TMDD standards, their most recent status, how to obtain a copy of the standards, and the standards development process, see http://www.standards.its.dot.gov/.

Table 1: C2C TMDD Communication Standards

Standard Doc #	Document Title	Description	Type	Status as of November 2013
TMDD v3.03b	Traffic Management Data Dictionary Standard For Traffic Management Center-To-Center Communications	The Traffic Management Data Dictionary Standard For Traffic Management Center-to-Center Communication, commonly known as the TMDD v3.03b, defines the specific message/data content for center-to-center communications.	Communications: Information Level	In Ballot
NTCIP 1104	Base Standard: Center-to-Center Naming Convention Specifications	Defines the naming service for use in center-to-center communications in the transportation domain and lists the requirements for establishing names for management systems and for the objects managed by those systems. Standards may reference this document in order to define how certain items should be named.	Communications: Information Level	Approved
NTCIP 2104	Ethernet Subnetwork Profile	Defines how data is transmitted over ethernet links.	Communications: Subnetwork Level	Approved
NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile	Defines how to exchange data over a network using the Internet suite of protocols.	Communications: Transport Level	Approved
NTCIP 2304	Application Profile for DATEX-ASN (AP-DATEX)	Defines how to use the DATEX-ASN protocol within US-based transportation networks.	Communications: Application Level	Approved
NTCIP 2306	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications	Specifies communications interfaces (message form, message use, and transport) encoded in the Extensible Markup Language (XML) between a center and an external center. Message content is defined in other standards, such as the AASHTO/ITE TMDD and MSTMCC, the APTA TCIP, the SAE Message Sets for ATIS, or the IEEE 1512 IM.	Communications: Application Level	Approved

Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADUS	Archive Data User Services
AP-C2CXML	Application Profile for XML in ITS Center to Center Communications
CARS	Condition Acquisition and Reporting System
C2C	Center To Center
DATEX/ ASN	Data Exchange- Abstract Syntax Notation
FAQs	Frequently Asked Questions
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FTA	Federal Transit Administration
ICM	Integrated Corridor Management
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
LAN	Local Area Network
MDSS	Maintenance Decision Support System
MIB	Management Information Base
MS/ETMCC	Message Set for External TMC Communications
NEMA	National Electrical Manufacturers Association

NRTM	Needs to Requirements Traceability Matrix
NTCIP	National Transportation Communications for ITS Protocol
OER	Octet Encoding Rules
OSI	Open System Interconnection
PCB	Professional Capacity Building
RFP	Request For Proposal
RPU	Remote Processing Unit
RTM	Requirements Traceability Matrix
RTSMIP	Real-Time System Management Information Program
RWIS	Road Weather Information System
SOAP	Single Object Access Protocol
SDO	Standards Developing Organization
SMI	Structure of Management Information
STMF	Simple Transportation Management Framework
STMP	Simple Transportation Management Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TMDD	Traffic Management Data Dictionary
USDOT	United States Department of Transportation
UDP/IP	User Datagram Protocol/Internet Protocol
WSDL/XML	Web Service Description Language/ Extensible Markup Language