Technical Issue Paper

Task 2.A.1 - Review of National Standards and Testing Program

DRAFT

January 28, 2004

By

ConSysTec Corp.

POB 517, 17 Miller Ave.

Shenorock, NY 10587-0517

914-248-8466

Prepared for

New York State Department of Transportation

D015186 PIN S148.00

Technical Support and Strategic Plan Development Services for

NYSDOT Statewide ITS Program

Table of Contents

List of Tables

List of Figures

Revision History

Filename	Version	Date	Author	Comment
Task 2.A.1-PXCv1.doc	0.1	01/20/04	PChan	First draft
Task 2.A.1-PXCv2.doc	0.2	1/24/04	PChan	Second draft.
Task 2.A.1-PXCv3.doc	0.3	1/26/04	PChan	Third draft. Incorporates bse & rsj comments
Task 2.A.1-PXCv4.doc	0.4	1/28/04	PChan	Fourth draft.
Task 2.A.1-MSIv4.doc	0.4	1/28/04	M Insignares	Fourth draft. Incorporates msi comments and completion of Section 5.
Task 2.A.1-v5.doc	0.5	1/28/04	P. Chan/ M.Insignares	Submitted Draft.
Task 2.A.1-v6.doc	0.6	1/28/04	M. Insignares	Final QA/QC Review on Draft Doc.

1 Introduction

1.1 Background

In October 2003, Consensus Systems Technologies Corp. (ConSysTec), was sub-contracted by Gardner Engineering of New York, P.C., to provide technical support for New York State Department of Transportation's Statewide ITS Program. This work was performed under a contract between Gardner Engineering of New York, P.C. and New York State Department of Transportation, Contract D015186, PIN S148.00, Technical Support and Strategic Plan Development Services for NYSDOT Statewide ITS Program.

This Technical Issue Paper was prepared to satisfy the requirements of Task 2.A.1, Review of National Standards and Testing Programs.

1.2 Purpose

The purpose of this Technical Issue Paper is to present a high-level overview of the National ITS Standards Program and the Standards Testing Program. This paper provides a frank and credible vision of where the Standards Program current are, and where they are going. The document also provides a listing of the current ITS Standards activities and resources where more information can be these activities. Finally, this document provides an analysis on how the Standards Program affects the procurement and deployment of ITS Standards in New York State, and recommends ITS Standards that should be considered for use in the State.

1.3 Intended Audience

This document is written for high-level managers and project managers involved with the deployment of ITS Systems in the State of New York. It provides an introduction to the National Standards Programs, discussing its benefits, its status, its vision and its impact on New York State. For project managers, the document also provides resources on where additional information can be found on the specific ITS Standards, and provides guidance on how to test the ITS Standards.

1.4 Report Organization

This report has been prepared in support of the New York State ITS Strategic Plan. This Technical Issues Paper is broken into 6 chapters to facilitate the different types of implementer:

- **Chapter 1: Introduction** – This section provides introductory and background information about this document, its purpose and the organization of the paper.
- **Chapter 2: National ITS Standards Program** – This section presents an introduction to the National ITS Standards Program, including its origins, the current scope and vision of the program and how it is currently organized.

- **Chapter 3: Actors** – This section reviews the organizations that are currently leading the development of the ITS Standards, followed by a brief description of the ITS Standards, and its current activities.
- **Chapter 4: Standards Testing Program** – This section analyzes the current status of the Standards Testing Program and analyzes the current debates on how to perform testing.
- **Chapter 5: Impact on NYSDOT Programs** – This section reviews the impact of the National ITS Standards Program on the specifications, procurement and testing of ITS Systems in New York State. It also recommends some ITS Standards that may be relevant to the deployment of ITS Systems in New York.
- **Chapter 6: ITS Standards Resources** – This section provides a listing of resources and references where additional information can be found on the ITS Standards.

2 National ITS Standards Program

2.1 Introduction

What are ITS standards? ITS standards establish a common way in which systems and devices connect and communicate with one another. ITS standards are industry-consensus standards that define how ITS system components operate within a consistent framework, the National ITS Architecture. By specifying how systems and components interconnect, the standards promote interoperability, allowing transportation agencies to implement systems that cost-effectively exchange pertinent data and accommodate equipment replacement, system upgrades, and system expansion.

Standards benefit the traveling public by providing products that will function consistently and reliably throughout the region. ITS standards contribute to a safer and more efficient transportation system, facilitate regional interoperability, and promote an innovative and competitive market for transportation products and services.

Standards are an important tool that will allow efficient implementation of the regional ITS architecture over time. Establishing regional and national standards for exchanging information among ITS systems is important not only from an interoperability point of view; it also reduces risk and cost since a region can select among multiple vendors for deployment products. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances and new approaches evolve.

2.2 Origins

The U.S. Department of Transportation's (U.S. DOT) ITS Joint Program Office has been funding the development of ITS standards since 1996 in an extensive, multi-year program of accelerated standards development to strengthen and facilitate the successful deployment of ITS. From its beginning, this standards acceleration program has chosen to support, guide, and reinforce the existing consensus standards efforts in the U.S. by providing funding to existing Standards Development Organizations (SDOs). This "bottoms-up" approach was meant to allow U.S. DOT to leverage significant volunteer resources and to foster public-private partnerships in the deployment of ITS. The SDOs that are involved in the development of ITS standards are:

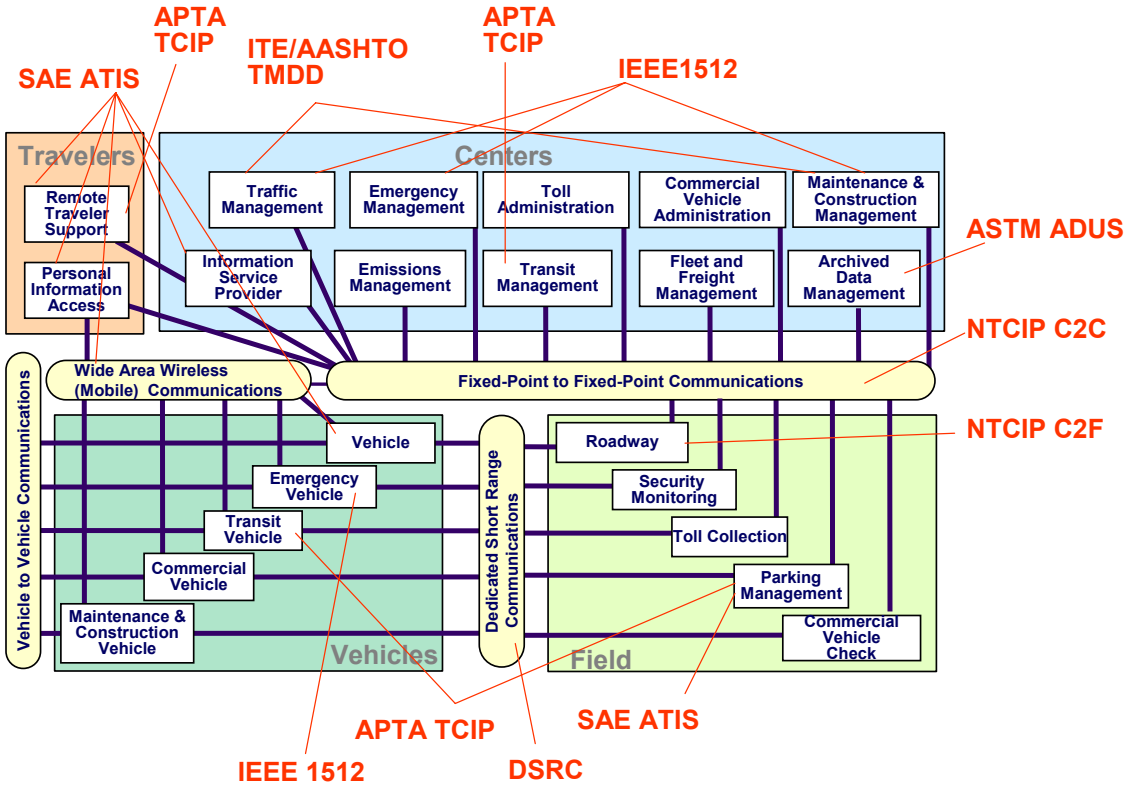
- American Association of State Highway and Transportation Officials (AASHTO)
- American Public Transportation Association (APTA)
- American Society for Testing & Materials (ASTM)
- Institute of Electrical and Electronics Engineers (IEEE)
- Institute of Transportation Engineers (ITE)
- National Electrical Manufacturers Association (NEMA)
- Society of Automotive Engineers (SAE)

The overall goal of the U.S. Department of Transportation's (U.S. DOT) ITS Standards Program has been to promote the widespread deployment of integrated ITS through robust, non-proprietary standards.

Through cooperative agreements with the standards development organizations (SDOs), the Standards Program is accelerating development of about 100 non-proprietary, industry-based, consensus ITS standards, and is encouraging public-sector participation in the development process.

The figure below shows the relation of the ITS standards activities to the National ITS Architecture.

Figure 1. Relation of National ITS Architecture to ITS Standards



2.3 Current Scope and Vision

What is the current scope and vision of the U.S. DOT's ITS Standards Program? The following paragraphs are excerpted from the ITS Standards Program 2002 Update.

"The ITS Standards Program is the U.S. DOT's primary vehicle for encouraging the use of open interface standards in publicly funded ITS deployments. It is an integral part of the DOT's overall effort to build safe, integrated, and interoperable transportation systems. In the six years since its inception, the Standards Program has grown into a robust and multifaceted program and is regarded as a leading source of ITS standards information and activity for both the domestic and international transportation communities.

The Program encompasses five key areas of standards activity: Development, Testing, Deployment, Technical Assistance, and Training and Outreach.

Initially, the Program identified 100 standards that should be given development priority. These standards were either essential for achieving device interoperability or were used in ITS applications designated as the top priorities necessary to achieve national transportation objectives.

Over the past 24 months, the Program has migrated its focus from standards development to standards deployment, aggressively building up resources—technical assistance, training, and outreach programs—that help state and local deployers implement standards- based ITS. This evolution is essential, given that standards need to be evaluated in real transportation applications if they are to gain widespread use. By focusing on deployment strategies, the Program is building upon the intensive standards development activities that took place in preceding years. [The program supports the following activities:]

Development Activities

- Establish cooperative agreements between the Program and standards development organizations (SDOs) to accelerate the development of standards
- Fund technical support for standards development working groups
- Support the participation of representatives from public agencies in the standards development process

Testing Activities

- Measure the operation, correctness, and completeness of ITS standards in realistic transportation settings
- Measure the degree of interoperability of ITS systems
- Provide testing results and information about the performance of standards

Deployment Activities

- Provide tools that help state and local deployers implement standards-based ITS

- Provide platforms that allow state and local deployers to exchange ideas and to discuss standards deployment-related issues

Technical Assistance Activities

- Deliver a comprehensive program of technical assistance to state and local deployers
- Increase the knowledge base of state and local deployers on ITS standards evaluation, procurement, deployment, and maintenance issues

Training and Outreach Activities

- Develop materials and resources that promote the awareness and use of ITS standards
- Offer comprehensive technical training in various ITS standards at locations throughout the country

And what is the status of the Program with regards to these activities? The following sections provide a recent update of the status.

2.3.1 Development Activities

While the emphasis on standards development has decreased in the past couple years, the U.S. DOT is still actively supporting a wide array of standards development activities. As of November 2003 the U.S. DOT reported the following statistics on standards development:

Table 1. U.S. DOT ITS Standards Status Levels

Status Level	Status Level Description
73 - Published	Standards that are available for purchase.
9 - Approved	Standards that have passed all necessary ballots and have been approved by a standards development organization, but not yet published.
5 - Ballot	Standards that are being voted upon by a committee or working group, or are undergoing other SDO procedures.
28 - Under Development	Standards that are being written, but are not yet ready for a formal ballot.

While these statistics seem to indicate that ITS standards development is fairly complete, the reality of the situation is far different. Most of the published standards have not been tested, and some of the key ones (e.g. transit and traffic management standards) are undergoing major rewrites as the originally published versions are considered inadequate for use. Section 3 will provide details of the individual standards efforts.

2.3.2 Testing Activities

The testing program was begun in 1999 and has had some success in testing and documenting center to field standards. To date no center to center standards have been tested. The current status and expected future activities of this program are covered in Section 4.

2.3.3 Deployment Activities

The ITS Standards Web site contains resources and tools that can help deployers learn about and implement standards-based ITS. Among the areas covered on the Web site are general information about ITS standards, testing information, standards development information, deployment contacts, training, and deployment assistance. The Web site can be found at www.standards.its.dot.gov.

For many agencies, deployment tools and resources are the most relevant to their daily activities. Included among the Web site's deployment resources are ITS Standards Advisories, which provide federal, state and local ITS deployers with a snapshot of the standards used in ITS deployments, including information about development status, testing results, deployment guidance, and training and technical assistance opportunities.

The currently available standards advisories include:

- ADUS (Archived Data User Service) Standards Advisory
- DSRC (Dedicated Short Range Communications) Standards Advisory
- ESS (Environmental Sensor Station) Standards Advisory
- DMS Standards Advisory

In two cases the web site has more detailed Standards Applications Packages (for Environmental Sensor Stations (ESS) and Dynamic Message Signs (DMS)), which contain both overview information for those new to standards, as well as more detailed technical materials. Packages also include information about the Standards Field Support Team for agencies needing more in-depth assistance with standards-related issues.

The Standards Contacts Database, a searchable database of standards deployers, is another resource available on the Web site and reflects a new generation of interactive Web site tools rolled out over the past 12 months.

To assist deployers in specifying standards, the USDOT is offering SpecWizard, which is software that helps deployers write NTCIP-based specifications for DMS, Actuated Traffic Signal Controllers, and ESS. The software walks deployers through a series of questions about various aspects and characteristics of their project and then generates a text file listing NTCIP requirements that deployers can then integrate into their specifications.

Technical Assistance Activities

The ITS Standards Field Support Team was launched in April 2002 and now serves as the Program's primary mechanism for delivering ITS standards technical assistance to public agencies. In general, an agency seeking assistance from the FST contacts a Federal Highway Administration (FHWA) Field Office (Division Office or Resource Center). The ITS Specialist at the Field Office makes an initial assessment of the agency's request and recommends a course of action. In some cases, the ITS Specialist may be capable of providing technical assistance; in other cases, the ITS Specialist will forward the case to the FST. In all cases, the Program attempts to provide the best possible technical assistance, which includes assessing who is best suited to provide the services.

Some examples of the types of services provided by the FST are:

- Assessment of existing state and local deployments and plans.
- Guidance and assistance in the development of project specifications.
- Review of existing contracts and specifications.
- Assistance identifying appropriate contracting and procurement mechanisms.
- Assistance developing testing plans.
- Evaluation of systems for compliance to contracts and conformance to specifications.

More information about the Field Support Team is available at www.standards.its.dot.gov/Documents/FSTflyer.pdf.

Training and Outreach Activities

The Standards Program has a wide range of training courses delivered by the Program's training partners. The following is an update on Program training activities that have taken place over the past 24 months:

ITE delivers standards training courses on behalf of the Standards Program at sites throughout the country. In the past 12 months, courses addressed the training and professional development needs of a broad range of ITS standards users—from professionals who were newcomers to standards to experienced project managers and systems engineers with extensive experience working with standards. A listing of current courses is available at ***www.ite.org.***

Transit Standards Consortium (TSC) provides training on selected transit ITS standards. In the past 12 months, the TSC created a series of transit standards technical training courses that were co-sponsored by the FTA and the ITS Standards Program. Courses were designed to bring together appropriate stakeholders, to build professional capacity, and to increase state and local deployers' confidence using ITS standards. The first courses were presented to transit professionals in March, April, and June of 2002. The courses, entitled "Incorporating TCIP into Existing Systems and Transit Vehicle Area Networks," dealt with all aspects of transit standards, from basic content to the procurement of transit equipment compatible with the standards. Additional courses are planned that will deal with ways to

increase transit market share and how to address technical questions raised as a result of implementing TCIP standards. Information about the TSC is available at ***www.tsconsortium.org***.

Application Area Workshops are intensive two-day workshops designed to help state and local agencies learn how to develop standards based procurement specifications and identify and manage risks associated with various procurement contract types. Agencies also learn how to access the many resources offered by the Standard Program, specifically the ITS Standards Field Support Team. The first two workshops were held in Springfield, Illinois and Baton Rouge, Louisiana in August and September 2002. In all, thirty-eight individuals attended the first two DMS workshops and feedback from attendees was positive, with most participants responding that the workshop met their expectations. The Program held DMS workshops in other locations in early FY2003, including Virginia, Pennsylvania, and Florida. Workshops for other ITS applications are being considered and will likely use the same format as the DMS workshop. All of these training resources have been designed to demystify the technical and institutional complexities of standards, raise the deployer's confidence level in procuring and deploying standards-based devices, build an understanding of the benefits of standards among those in decision-making roles, and generate demand for standards- based goods and services from the ground up (i.e., from state and local deployers).

2.4 Standards Conformance

One of the most common misconceptions regarding the USDOT Standards Program is that conformance to ITS standards is mandated by the program. The U.S. DOT has put in place a methodology for requiring conformance to ITS standards in the Final Rule for Architecture and Standards (Rule 940) and the corresponding FTA Final Policy. The Rule/ Policy state that "all ITS projects funded with highway trust funds shall use applicable ITS standards and interoperability tests that have been officially adopted through rulemaking by the DOT". To date no standards or interoperability tests have been officially adopted. To do so will require a Notice of Proposed Rulemaking, appropriate comment period, followed by issuance of a rule adopting the standard. To date not even the first step has been taken with any standard. The USDOT has stated repeatedly that they will not consider mandating a standard until it is tested and proven in deployments. Currently there are only two standards that even come close to this level of maturity. Therefore it is unlikely that any standards would be mandated in the next 12 to 24 months. Will some of the standards eventually be mandated? This could happen if the US DOT feels that state and local deployers are not implementing standards that they feel are tested and mature.

3 Actors (SDOs)

3.1 Relationship to the National ITS Architecture

The National ITS Architecture is a reference framework that spans all of ITS standards activities and provides a means of detecting gaps, overlaps, and inconsistencies between the standards. The Logical and Physical Architecture provide a starting point for the standards development activities by identifying the applicable architecture flows and data flows to be standardized in the National ITS Architecture and the way in which the information is exchanged across those interfaces. The National ITS Architecture databases provide a mapping of architecture flows to individual ITS standards. Since the architecture flows of the National ITS Architecture form the basis for information exchanges of regional or statewide ITS architectures, this mapping of interfaces to standards is available for these architectures as well.

3.2 ITS Standards

Standards application areas are deployment-oriented categories that focus on specific ITS services or systems. Each application area contains one or more interfaces in the National ITS Architecture.

- **C2R - Center-to-Roadside –** This category of application areas includes those standards that provide communication links between a transportation or traffic management center and roadside equipment that regulates the flow of traffic.
- **C2C - Center-to-Center –** This category of application areas includes those standards that facilitate communication between transportation management centers. This category includes communications necessary for transit use.
- **C2T - Center-to-Vehicle/Traveler –** This category of application areas includes those standards that facilitate communication between transportation management centers and the driver of a vehicle or a traveler planning a trip. This category also includes communications necessary for coordination between transit management centers and their vehicles.
- **R2V - Roadside-to-Vehicle –** This category of application areas includes those standards that facilitate wireless communication between roadside equipment and vehicles on the road.
- **R2R - Roadside-to-Roadside -** This application area category includes standards that facilitate communications between railroad wayside equipment and highway roadside equipment.

In general, each information flow has up to three types of standards that are relevant: a message set standard, a data element standard, and one or more communications protocol standards. This is summarized below:

- **C - Communications protocol –** are the rules to move information. The protocol may consist of rules regarding data formats, control information coordination, error handling, or timing.
- **D - Data Elements –** are the smallest entity of data. Sometimes labeled as data objects or object definitions, they are the building blocks for transferring bits of information.
- **M - Message Sets –** are strings of data elements put together to provide related, relevant information. A group of pre-defined messages can accomplish a function.
- **H – Human Interface –** are human interface standards provide standards for presentation of information to humans or address problems and issues related to human-machine dialog.

3.2.1 National Transportation Communications for ITS Protocol (NTCIP)

AASHTO, teamed with the National Electrical Manufacturers Association (NEMA) and the Institute of Transportation Engineers (ITE), is the lead standards development organization for developing and advising on the National Transportation Communications for ITS Protocol (NTCIP) standards. NEMA is one of the largest standards development organizations (SDOs) in the nation and represents over 600 member organizations. NEMA is a member organization of NTCIP and acts as the publisher of NTCIP standards.

Table 2. NTCIP Standards

Type	Document Number	Standard Title	Status	Description	Contact
C	NTCIP 1101	NTCIP Simple Transportation Management Framework (STMF) – TS3.2, Amendment 1	To be replaced by NTCIP 1102, NTCIP 1103, and NTCIP 8004	The STMF describes the simple transportation management framework used for managing and communicating information between management stations and transportation devices. It covers integrated management of transportation networks, networking devices, and transportation specific equipment attached to NTCIP-based networks.	Robert De Roche, Robert De Roche Consulting
C	NTCIP 1102	NTCIP - Octet Encoding Rules (OER) – v01.12	Recommended Standard	Defines the presentation layer data encoding rules that are used in conjunction with application layer protocols defined in other standards. serves as a replacement for part of NTCIP 1101 (STMF), but also defines additional features.	Robert De Roche, Robert De Roche Consulting
C	NTCIP 1103	NTCIP Transportation Management Protocol (TMP) – v01.15	User comment draft	Includes STMP (NTCIP 1101) wit additional definitions.	Robert De Roche, Robert De Roche Consulting

Type	Document Number	Standard Title	Status	Description	Contact
	NTCIP 1104	NTCIP CORBA Naming Convention Specification	User comment draft	Defines the naming Defines the naming service for CORBA 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.	Manny Insignares, Consensus Systems Technologies Corp.
	NTCIP 1105	NTCIP CORBA Security Service Specification	User comment draft	Defines the standard security feature for CORBA NTCIP systems	Manny Insignares, Consensus Systems Technologies Corp.
	NTCIP 1106	NTCIP CORBA Near Real-Time Data Service Specification	Approved work item	Defines the standards way in which real-time data should be exchanged within CORBA systems.	Manny Insignares, Consensus Systems Technologies Corp.
C2C D, M	NTCIP 1201	NTCIP - Global Object Definitions – Version 1, Amendment 1	Version 2 in user comment draft (v02.26)	Defines the pieces of data that are likely to be used in multiple device types, such as time, schedules, report generation	Ken Vaughn, Trevilon Corp.
C2C D, M	NTCIP 1202	NTCIP - Object Definitions for Actuated Traffic Signal Controller Units – Version 1, Amendment 1	Version 2 in user comment draft (v02.13)	Defines the data that are frequently found in actuated traffic signal controllers.	Peter Ragsdale, McCain Traffic Supply, Inc. Beth Ramirez, City of Dallas
C2C D, M	NTCIP 1203	NTCIP - Object Definitions for Dynamic Message Signs – Version 1, Amendment 1	Version 2 submitted for balloting	Defines the data that are found in dynamic message signs, including blank-out signs, changeable message signs, and variable message signs.	Chris Bates, Trevilon Corporation
C2C D, M	NTCIP 1204	NTCIP - Object Definitions for Environmental Sensor Stations – Version 1, Amendment 1	Version 2 in draft	Defines the data that are found in road weather information stations and air quality sensors.	
C2C D, M	NTCIP 1205	NTCIP - Object Definitions for Closed Circuit Television Camera Control – Version 1	Recommended Standard	Defines the data that are used to control video cameras	Michael Forbis, Washington State Department of Transportation
C2C D, M	NTCIP 1206	NTCIP – Object Definitions for Data Collection – User Comment Draft - v01.21	Version 1 submitted for balloting	Deals with the data stored in roadside count stations.	Rick Stalowski, Peek Traffic Systems. Inc.
C2C D, M	NTCIP 1207	NTCIP - Object Definitions for Ramp Meter Control – Version 1	Recommended Standard	Defines the data that are found in ramp meters	Brian Simi, CalTrans

Type	Document Number	Standard Title	Status	Description	Contact
	NTCIP 1208	NTCIP - Object Definitions for Video Switches – User Comment Draft – v01.04	Version 1 submitted for balloting	Defines the data to control a video switch to enable multiple monitors to view multiple video feeds.	Michael Forbis, Washington State Department of Transportation
C2C D, M	NTCIP 1209	NTCIP - Object Definitions for Transportation Sensor Systems – Version 1	Recommended Standard	Deals with the data collected by various types of detectors used by real-time management systems.	Curtis G. Herrick, Herrick Consulting
C2C D, M	NTCIP 1210	NTCIP – Objects for Signal System Masters – User comment draft – v01.14	Resolving user comments	Defines the data used to control a field master	Richard Denney, Iteris, Inc.
C2C D, M	NTCIP 1211	NTCIP – Objects for Signal Control and Prioritization – User comment draft – v01.26	Resolving user comments	Defines the data for controlling traffic signal systems in priority applications	Ronald Atherley, King Count DOT – Metro Transit
	NTCIP 1212	NTCIP – Objects for Network Camera Operations – Working Group Draft	In development	Defines the data that are used with digital image cameras	Michael Forbis, Washington State Department of Transportation
C2C D, M	NTCIP 1213	NTCIP – Objects for Electrical and Lighting Management Systems – Working Group Draft	In development	Defines the data for roadside electrical and lighting management systems	Karl Burkett, Texas DOT
C2C D,M	NTCIP 1301	NTCIP Weather Report Message Set for ESS – Working Group Draft	In development	Defines the message set to exchange weather and pavement data between centers	E.A. (Gene) Martin, Virginia DOT
C2C	NTCIP 1602	NTCIP - Generic Reference Model	In development	Defines a UML-based model for traffic management center communications	Manny Insignares, Consensus Systems Technologies Corp.
	NTCIP 2001	NTCIP - Class B Profile – Version 1, Amendment 1	To be rescinded by NTCIP 2201, NTCIP 2301, NTCIP 2101, and NTCIP 2102	Defines the low bandwidth NTCIP protocol.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2002	NTCIP - Class A and Class C Profile	Withdrawn	Withdrawn.	
	NTCIP 2101	NTCIP - Point-to-Multipoint Protocol/RS232 Subnetwork Profile – Version 1	Recommended Standard	Defines how to communicate over a multi-drop serial communications link.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2102	NTCIP - Point-to-Multipoint Protocol/FSK Subnetwork Profile – Version 1	Recommended Standard	Defines how to communicate over twisted wire using FSK modems.	Robert De Roche, Robert De Roche Consulting

Type	Document Number	Standard Title	Status	Description	Contact
	NTCIP 2103	NTCIP - Point-to-Point Protocol/RS232 Subnetwork Profile – Version 1	Recommended Standard	Defines how to communicate over a dial-up link or other serial point-to-point link.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2104	NTCIP - Ethernet Subnetwork Profile – Version 1	Recommended Standard	Defines how to communicate over ethernet links.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2201	NTCIP Transport Profile – Version 1	Recommended Standard	Defines a bandwidth efficient mechanism to transit data when the subject devices are directly connected and do not require network services.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2202	NTCIP - Internet (TCP/IP & UDP/IP) Transport Profiles – Version 1	Recommended Standard	Defines how to communicate using the Internet suite of protocols.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2301	NTCIP – Simple Transportation Management Framework Application Profile – Version 1	Approved	Defines how to exchange data between a management system and a field device.	Robert De Roche, Robert De Roche Consulting
	NTCIP 2302	NTCIP - Trivial File Transfer Protocol - Application Profile – Version 1	Approved	Defines how to use the Trivial File Transfer Protocol within transportation networks	Robert De Roche, Robert De Roche Consulting
	NTCIP 2303	NTCIP - File Transfer Protocol - Application Profile – Version 1	Approved	Defines how to use the File Transfer Protocol within transportation networks	Robert De Roche, Robert De Roche Consulting
	NTCIP 2304	NTCIP - Application Profile - Data Exchange (DATEX)	Recommended Standard	Defines how to use the DATEX-ASN protocol within US-based transportation networks.	Manny Insignares, Consensus Systems Technologies Corp.
	NTCIP 2305	NTCIP - Application Profile - CORBA	User Comment Draft – Further development on hold	Defines how to use the Common Object Request Broker Architecture protocol within transportation networks.	Manny Insignares, Consensus Systems Technologies Corp.
	NTCIP 7001	NTCIP InP-DATEX – Working Group Draft	Development on hold	Defines what services are required within DATEX centers to determine what messages and data the center supports	Manny Insignares, Consensus Systems Technologies Corp.
	NTCIP 7002	NTCIP InP-CORBA – Working Group Draft	Development on hold	Defines what CORBA services are required in ITS systems.	Manny Insignares, Consensus Systems Technologies Corp.

Type	Document Number	Standard Title	Status	Description	Contact
	NTCIP 9000	NTCIP Guide	Recommended Standard	General information guide for NTCIP. Focus is primarily on center to field communications	Curtis Herrick, G.C. Herrick Associates
C2C	NTCIP 9010	NTCIP Information Report – Using XML in Center-to-Center Communications	User Comment Draft	General information report describing future XML-based standards development efforts.	Manny Insignares, Consensus Systems Technologies Corp.

3.2.2 American National Standards Institute (ANSI)

The American National Standards Institute (ANSI), the U.S. administrator and coordinator of private sector voluntary standardization, does not itself develop standards. An ANSI committee [the Accredited Standards Committee (ASC) X12] was chartered to develop standards to facilitate electronic data interchange (EDI) for business transactions. This committee is in the process of developing ITS-related standards involving commercial vehicle operations (CVO).

Table 3. ANSI Standards

Type	Document Number	Standard Title	Status	Description	Contact
	ANSI TS284	Commercial Vehicle Safety Reports	Accepted	Defines the format and data to request and send reports on the safe operation of commercial road vehicles	The John Hopkins University Applied Physics Laboratory
	ANSI TS285	Commercial Vehicle Safety and Credentials Information Exchange	Accepted	Defines the format and data to request and send information on safety and credentials information.	The John Hopkins University Applied Physics Laboratory
	ANSI TS286	Commercial Vehicle Credential	Accepted	Defines the format and data to apply for required credentials.	The John Hopkins University Applied Physics Laboratory

3.2.3 American Public Transportation Association (APTA)

APTA is an international organization that represents and promotes all aspects of the transit industry, including bus, rapid transit and commuter rail systems, as well as the organizations responsible for planning, designing, constructing, financing and operating transit systems. The organization has recently assumed the lead role in the development of standards for the transit community. A suite of Transit Communications Interface Profiles (TCIP) standards were originally developed and published by ITE (through the NTCIP effort). These standards, which covered most of the interfaces to the Transit Management Subsystem of the National ITS Architecture, defined data and messages for the interfaces. However the standards failed to define a sequenced set of messages (or dialogs) that would be needed

to actually implement systems using TCIP. An effort to develop these dialogs was begun by ITE, but was terminated prior to completion. The effort was passed to APTA in 2003 and they currently have a contractor team developing the dialogs and revising the standard to provide a usable result.

TCIP is divided into 9 areas as follows:

1. TCIP Framework
2. Common Public Transportation (CPT)
3. Incident Management (IM)
4. Passenger Information (PI)
5. Scheduling/Runcutting (SCH)
6. Spatial Representation (SP)
7. On-board (OB) Objects
8. Control Center (CC) Objects
9. Fare Collection (FC) Objects

Table 4. TCIP Standards

Type	Document Number	Standard Title	Status	Description	Contact
D, M	TCIP 3.0	Transit Communications Interface Profiles	Under Development	A single standard is being developed that covers the multiple business areas of the previous suite of standards. The initial draft for ballot is expected in December 2004.	Isaac K. Takyi, Ph.D., MTA
D, M	UTFS-xxx	Universal Transit Farecard Standard	Under Development	This standard will define the interfaces needed for regional fare cards.	Tom Parker, BART

3.2.4 ASTM International

ASTM International provides a forum for producers, users, consumers, and others who have interests in standard test methods, specifications, practices, guides, classifications, and terminology. ASTM leads efforts in ITS standards concerning dedicated short range communications (DSRC). Standards for DSRC at the 5.9 GHz frequency range are being developed through a cooperative agreement between the Federal Highway Administration and ASTM International to support both public safety and other non-governmental operations in roadside-to-vehicle and vehicle-to-vehicle communication environments.

Table 5. ASTM Standards

Type	Document Number	Standard Title	Status	Description	Contact
	E17.54.02.1	Standard Specification for Metadata Content for ITS-Generated Data	In development	Specifies how to annotate data for subsequent uses.	Rich Margiotta, Cambridge Systematics
	E17.54.02.2	Standard Specification for Archiving ITS-Related Traffic Monitoring Data	In development	Specifies a data dictionary for archiving traffic data.	Rich Margiotta, Cambridge Systematics
	E2158-01	Std. Spec. for Ded Short Range Comm. (DSRC) Physical Layer Using Microwave in the 902-928 MHz Band	Published Standard	Specification for the RF characteristics (physical layer) for DSRC operating in the range of 902-928 MHz. Supports both active and backscatter transponders.	Dan Smith, ASTM
	E2213-02	Std. Spec. for Telecomm. and Info. Exchange between Roadside and Vehicle Systems: 5.9 GHz DSRC	Published Standard	A medium access control layer (MAC) and physical layer (PHY) specification for wireless connectivity using dedicated short-range communications (DSRC) services.	Dan Smith, ASTM
	E2259-03	Standard Guide for Archiving and Retrieving ITS-Generated Data-	Published Standard	This guide covers desired approaches to be considered and followed in planning, developing, and operating specific ADMS for the archiving and retrieval of ITS-generated data	Rich Margiotta Cambridge Systematics
	PS105-99	Standard Specification for DSRC - Data Link Layer	Published Standard	Specification for the protocol (data link) communications. Supports both synchronous and asynchronous modes for operations.	Daniel Smith, ASTM

3.2.5 Electronics Industries Alliance (EIA)/Consumer Electronics Association (CEA)

The Consumers Electronics Association (CEA) is a sector of the Electronic Industries Alliance (EIA). Two ITS standards have been developed under the auspices of CEA, both having to do with traveler information radio and subcarrier systems.

Table 6. EIA Standards

Type	Document Number	Standard Title	Status	Description	Contact
	EIA-794	Data Radio Channel (DARC) System	Published Standard	Specifies the DARC FM Subcarrier waveform for the delivery of traveler information, messages and data services to mobile, portable and fixed receivers.	Jean Johnson, CEA

Type	Document Number	Standard Title	Status	Description	Contact
	EIA-7945	Subcarrier Traffic Information Channel (STIC) System	Published Standard	A flexible waveform defined for the physical and data link layers for delivery of data to mobile and fixed users using a sub-carrier on a broadcast FM station.	Jean Johnson, CEA

3.2.6 Institute of Electrical and Electronics Engineers (IEEE)

The Institute of Electrical and Electronics Engineers (IEEE) develops and disseminates voluntary, consensus-based industry standards involving all types of electrotechnology. ITS-related standards being developed by IEEE include message sets and data dictionaries. The Institute for Electrical and Electronic Engineering sponsors a Standards Coordinating Committee 32 (SCC32) responsible for coordinating, developing, and maintaining standards, recommended practices, and guidelines related to Intelligent Transportation Systems (ITS) within the scope of IEEE interests. SCC32 works with other national and international standards writing bodies to coordinate area of involvement and has had a role in establishing the ITS Data Registry.

The USDOT ITS Standards Program made the decision in late 2003 to operate the ITS Data Registry (ITS-DR) in house, and to focus the ITS-DR on being a support tool to ITS standards developers. This realignment of the purpose of the ITS-DR fits with a new strategic plan to accelerate the completion and deployment of specific standards applications to field settings within the next three years. In conjunction with these goals, the ITS-DR will undergo a redesign to make it more user friendly and better parallel the standards development process, reuse, and harmonization activities.

This relocation and redesign effort requires a shut down of the ITS-DR for about a month in early 2004. We currently understand that the ITS-DR will be shut down from April - June of 2004, although these dates have not yet been confirmed. During the shut down time, the physical server and website will be relocated from IEEE in Piscataway, NJ to the U.S. DOT's Volpe Center in Cambridge, MA, and run through a set of security checks before linking it to the Internet. The ITS-DR will have a new URL address when in returns to the Internet. It's access will be limited to those consultants who are aligned with the Standards Development Organization's to develop ITS standards.

The ITS-DR will look and operate in a similar manner for the first couple of months. Based on a prototype, testing, and user input, the ITS Standards Program is estimating that a redesigned site will be available in Summer 2004. The redesign will be based on a set of interviewers with users that will occur during the months of January and February 2004. It is expected that the redesigned ITS-DR will operate more in parallel with the development working groups and harmonization committee processes.

Table 7. IEEE Standards

Type	Document Number	Standard Title	Status	Description	Contact
	Bks 1-6: SH94633-SH 94638	The Survey and Analysis of Existing Standards and those Under Development Applicable to the Needs of the ITS Communications Technologies	Published Standard	The survey and analysis of existing standards (and those under development) that include requirements for both wireline and wireless transmissions.	Anita C. Ricketts, IEEE
	P1512.1	Standard for Traffic Incident Management Message Sets for Use by EMCs	Published Standard	Enables consistent standardized communications among Incident Management centers, fleet and freight management centers, information service providers, emergency management centers, planning subsystems, traffic management centers and transit management centers.	Anita C. Ricketts, IEEE
	P1512.2	Standard for Public Safety Incident Management Message Sets for Use by EMCs	Balloting	A comprehensive set of messages required for incident management that is unique to public safety communications. These message sets will be generated and transmitted among the emergency management subsystem to all the other subsystems and public safety providers.	Anita C. Ricketts, IEEE
	P1556	Standard for Security and Privacy of Vehicle/Roadside Communication Including Smart Card Communications	Balloting	Identifies security methods to be used in DSRC message transmission at specific frequencies, and develops a single standard methodology for the protection of information between the vehicle and the roadside.	Anita C. Ricketts, IEEE
	P1609.1	Standard for Dedicated Short Range Communications Resource Manager	Balloting	This standard describes a resource manager that arbitrates requests for transponder usage.	Tom Kurihara, TKstd Management
	P1609.2	Standard for Dedicated Short Range Communications Application Layer	In development	Describes an application layer standard to be used for 5.9 GHz DSRC.	Tom Kurihara, TKstd Management
	P1609.3	Standard for IP Interface for Dedicated Short Range Communications	In development	Describes standard that supports higher layer communication stacks, including TCP/IP.	Tom Kurihara, TKstd Management
	P1609.4	Standard for Data Dictionary and Message Sets for Dedicated Short Range Communications	In development	Describes various standard message formats for DSRC applications at 5.9 GHz.	Anita C. Ricketts, IEEE

Type	Document Number	Standard Title	Status	Description	Contact
	Std 1404-1998	Guide for Microwave Communications System Development	Published Standard	A guide that addresses all the requirements for microwave system design, procurement, construction, maintenance, and subsequent operations	Anita C. Ricketts, IEEE
	Std 1488-2000	Standard for Message Set Template for Intelligent Transportation Systems	Published Standard	A standard for an ITS message set template. Approved for trial use through June 2002.	Anita C. Ricketts, IEEE
	Std 1489-1999	Standard for Data Dictionaries for Intelligent Transportation Systems - Part 1 Functional Area Data Dicitionaries	Published Standard	A set of meta entities and meta attributes for ITS data dictionaries, as well as associated conventions and schemas, that enable describing, standardizing, and managing all ITS data.	Anita C. Ricketts, IEEE
	Std 1512.3-2002	Standard for Hazardous Material Incident Management Message Sets for Use by Emergency Management Centers	Published Standard	Enables consistent standardized communications among incident management centers, HAZMAT teams, police, local government, special emergency and emergency management centers.	Anita C. Ricketts, IEEE
	Std 1512-2000	Standard for Common Incident Management Message Sets for use by Emergency Management Centers	Published Standard	Standards describing the form and content of the incident management messages sets for emergency management systems (EMS) to traffic management systems (TMS) and from emergency management systems to the emergency telephone system (ETS) or (E911).	Anita C. Ricketts, IEEE
	Std 1570-2002	Standard for the Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection	Published Standard	This standard defines the logical and physical interfaces, and the performance attributes for the interface between the rail subsystem and the highway subsystem at a highway rail intersection.	Anita C. Ricketts, IEEE

3.2.7 Institute of Transportation Engineers (ITE) and American Association of State Transportation Officials (AASHTO)

The Institute of Transportation Engineers (ITE) is one of the largest professional transportation organizations in the world. ITE members include traffic engineers, transportation planners, and other professionals who are responsible for planning, designing, implementing, operating and maintaining surface transportation systems worldwide. ITE is involved in the development of NTCIP, TCIP, and other ITS standards. The Institute of Transportation Engineers is one of five standards development

organizations designated by the U.S. Department of Transportation (U.S. DOT) to develop ITS standards under a cooperative agreement with the U.S. DOT. The US DOT has recognized the potential value of NTCIP standards for reducing deployment costs and increasing opportunities for regional integration. Because of these benefits, the US DOT has funded both the development and testing of ITS standards by contract with SDO and private contractors.

Table 8. ITE and AASHTO Standards

Type	Document Number	Standard Title	Status	Description	Contact
	9603-1	Application Program Interface (API) Standard for the Advance Transportation Controller (ATC)-	Recommended Standard	An advanced transportation controller (ATC) software application program interfaces (APIs) that support ITS data flows and standards enabling the deployment of ITS functions.	James Cheeks, ITE
	9603-2	Advanced Transportation Controller (ATC) Cabinet	Balloting	Functional physical design requirements for an advanced transportation controller (ATC) cabinet that supports the deployment of multiple ITS functions in a single cabinet.	James Cheeks, ITE
	9603-3	Advanced Transportation Controller (ATC)	Balloting	Standard for advanced transportation controller (ATC) devices to support ITS data flows and standards that enable deployment of ITS.	James Cheeks, ITE
	TM 1.03	Standard for Functional Level Traffic Management Data Dictionary (TMDD)- working on amendment	Published Standard	This document contains data elements for roadway links and for incidents and traffic-disruptive roadway events. Includes data elements for traffic control, ramp metering, traffic modeling, video camera control traffic, parking management and weather forecasting, as well as data elements related to detectors, actuated signal controllers, vehicle probes, and dynamic message signs.	James Cheeks, ITE
	TM 2.01	Message Sets for External TMC Communication (MS/ETMCC)- working on amendments	Published Standard	A message set standard for communication between traffic management centers and other ITS centers, including information service providers, emergency management systems, missions management systems, and transit management systems	James Cheeks, ITE

3.2.8 Society of Automotive Engineers (SAE)

This organization is made up of more than 75,000 engineers, business executives, educators, and students who share information and exchange ideas for advancing the engineering of mobility systems. Information about SAE's ITS standards activities can be found within the "Technical Committee" section of this Web site. The Society of Automobile Engineers ITS Program office, coupled with industry representatives and SAE ITS Staff Program Team work together to develop and promote ITS based standards nationally and globally. The SAE ITS Division is comprised of committees that address Advanced Traveler Information Systems, ITS Data Bus architecture and Safety and Human Factors research.

Table 9. SAE Standards

Type	Document Number	Standard Title	Status	Description	Contact
	SAE-J1663	Truth-in-Labeling Standard for Navigation Map Databases	Published Standard	This standard defines consistent terminology, metrics, and tests for describing the content and quality of navigable map databases.	Jack Pokrzywa, SAE
	SAE-J1708	Serial Data Comm. Between MicroComputer Systems in Heavy-Duty Vehicle Applications	Published standard	Defines a recommended practice for implementing a bi-directional, serial communication link among modules containing microcomputers. Defines those parameters of the serial link that relate primarily to hardware and basic software compatibility such as interface requirements, system protocol, and message format.	Jack Pokrzywa, SAE
	SAE-J1746	ISP-Vehicle Location Referencing Standard	Published standard	referencing format for information service provider (ISP)-to-vehicle and vehicle-to-ISP references. This standard will reflect the cross-streets profile of the current location reference message specification (LRMS) document as expressed in the National Location Referencing Information Report (SAE J2374).	Jack Pokrzywa, SAE
C, D, M	SAE-J1760	ITS Data Bus Data Security Services Recommended Practice	Published standard	Specifies definition of data security requirements between devices on the ITS data bus (IDB) and definitions of device and message level security. Also includes a mechanism to discourage theft of data bus modules.	Jack Pokrzywa, SAE
	SAE-J1761	Information Report on ITS Terms and Definitions	Published standard	A dictionary of terminology in the ITS field, with a focus on the vehicle and interfaces to the vehicle.	Jack Pokrzywa, SAE

Type	Document Number	Standard Title	Status	Description	Contact
	SAE-J1763	A Conceptual ITS Architecture: An ATIS Perspective	Published standard	This Information Report describes a general reference architecture for integration of multiple advanced traveler information system (ATIS) devices.	Jack Pokrzywa, SAE
D, M	SAE-J2313	On-Board Land Vehicle Mayday Reporting Interface	Published standard	A general specification that prescribes protocol methods which enable vendors with different communication methods to communicate with response agencies in a standard format.	Jack Pokrzywa, SAE
	SAE-J2352	Mayday Industry Survey Information Report	Published standard	A summary of information obtained by way of a survey conducted in 1997 of MAYDAY system manufacturers. The information is limited to technical data as it pertains to vehicle and on-board MAYDAY system operations.	Jack Pokrzywa, SAE
	SAE-J2353	Data Dictionary for Advanced Traveler Information Systems (ATIS)	Published standard	A minimum set of medium-independent data elements needed by potential information service providers to deploy ATIS services and provide the basis for future interoperability of ATIS devices.	Jack Pokrzywa, SAE
M	SAE-J2354	Message Set for Advanced Traveler Information System (ATIS)	Published standard	A basic message set using the data elements from the ATIS data dictionary needed by potential information service providers to deploy ATIS services and to provide the basis for future interoperability of ATIS devices.	Jack Pokrzywa, SAE
	SAE-J2355	ITS Data Bus Architecture Reference Model Information Report	Published standard	A reference model for an in-vehicle data bus. The ITS data bus (IDB) will enable manufacturers, dealers, and vehicle owners to install a wide range of electronics equipment reliably and safely in a vehicle at any time during the vehicle lifecycle.	Jack Pokrzywa, SAE
C	SAE-J2366-2	ITS Data Bus Protocol - Link Layer Recommended Practice	Published standard	Requirements for the link layer (layer 7 of the OSI model) for the ITS data bus.	Jack Pokrzywa, SAE
C	SAE-J2366/1	ITS Data Bus Protocol - Physical Layer Recommended Practice	Published standard	A physical interface device (connector) that will ensure compatibility between vehicles and aftermarket devices. Physical interface performance requirements, circuit identification and configuration, and electrical requirements for the physical layer of the ITS data bus.	Jack Pokrzywa, SAE

Type	Document Number	Standard Title	Status	Description	Contact
C	SAE-J2366/4	ITS Data Bus Protocol - Thin Transport Layer Recommended Practice	Published standard	Requirements for the thin transport layer (Layer 4 of the OSI model) for the ITS data bus.	Jack Pokrzywa, SAE
C, D, M	SAE-J2366/7	ITS Data Bus Protocol - Application Layer Recommended Practice	Published standard	Requirements for the application layer (layer 7 of the OSI model) for the ITS data bus.	Jack Pokrzywa, SAE
C, D, M	SAE-J2367	ITS Data Bus Gateway Recommended Practice	Published standard		Jack Pokrzywa, SAE
C, D, M	SAE-J2369	Standard for ATIS Message Sets Delivered Over Bandwidth Restricted Media	Published standard	A general framework allowing transmission of traveler information via bandwidth reduced media such as found in wireless applications. Creates a uniform coding and message structure for link travel times, incident text, weather and transit for broadcast delivery.	Jack Pokrzywa, SAE
	SAE-J2372	Field Test Analysis Information Report	Published standard	This information report presents the results of field tests on location-referencing standards.	Jack Pokrzywa, SAE
	SAE-J2372	Stakeholders Workshop Information Report	Published standard	Results of workshops to solicit and discuss stakeholder requirements for location referencing standardization.	Jack Pokrzywa, SAE
	SAE-J2374	Location Referencing Message Specification	Published standard	A basis for location referencing standardization activities by various application communities and SDOs.	Jack Pokrzywa, SAE
H	SAE-J2395	ITS In-Vehicle Message Priority	Published standard	Specifies orderly temporal and spatial presentation of ITS information to the driver.	Jack Pokrzywa, SAE
H	SAE-J2396	Measurement of Driver Visual Behavior Using Video Based Methods (Def. & Meas.)	Published standard	Procedures for collecting, reducing, analyzing, and reporting on driver-eye glance data in a manner suitable for evaluating ITS systems and comparing alternative designs for a particular system in terms of visual demand. Helps insure that systems minimize the time a driver's eyes are off the road.	Jack Pokrzywa, SAE

Type	Document Number	Standard Title	Status	Description	Contact
H	SAE-J2399	Adaptive Cruise Control: Operating Characteristics and User Interface	Published standard	This standard presents the minimum requirements for safety-related elements of the operating characteristics and user interface of vehicles equipped with adaptive cruise control (ACC). It also coordinates the operating characteristics and user interface with collision warning and avoidance, along with other driver systems.	Jack Pokrzywa, SAE
H	SAE-J2400	Forward Collision Warning: Operating Characteristics and User Interface	Published standard	Minimum safety and human factor requirements for front collision warning (FCW) operating characteristics and driver interfaces to ensure consistency across vehicles so that drivers can quickly understand and safely use a FCW-equipped vehicle.	Jack Pokrzywa, SAE
M	SAE-J2529	Rules for Standardizing Street Names and Route IDs	Published standard	Specifies the rules for standardizing street names for use in ATIS and other ITS applications.	Jack Pokrzywa, SAE
	SAE-J2539	Comparison of GATS Messages to SAE ATIS Standards Information Report	Published standard	An overview and comparison of Global Automotive Telematics Standard (GATS) messages developed for use on global system mobile (GSM) cellular phone systems (European).	Jack Pokrzywa, SAE
M	SAE-J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards	Published standard	Describes the process used in various SAE ATIS message set standards to deliver textual strings and provides national tables used in the delivery of incident description.	Jack Pokrzywa, SAE
D, M	SAE-J2540-1	RDS (Radio Data System) Phrase List	Published standard		Jack Pokrzywa, SAE
D, M	SAE-J2540-2	ITIS (International Traveler Information Systems) Phrase Lists	Published standard		Jack Pokrzywa, SAE
D, M	SAE-J2540-3	National Names Phrase List	Published standard		Jack Pokrzywa, SAE
	SAE-J2630	Converting ATIS Message Standards from ASN.1 to XML	Published standard		Jack Pokrzywa, SAE

4 Standards Testing Program

Testing is important in the deployment of technology projects, such as ITS, because it serves a validation and confirmation that an implementation is correct. In Standards, testing is an important step because it provides information to procurers on the reliability, functionality, and performance of the ITS system based upon the applicable standards.

This section provides a review of the current status of FHWA's ITS Standards Testing activities. It provides an introduction to the issues regarding standards testing, an evaluation of the different philosophies on standards testing, then summarizes some of the activities that are on-going in the area of standards testing.

The bulk of the discussion in this section revolves around the testing of NTCIP standards, but many of the philosophies discussed are applicable to the other ITS Standards.

4.1 Testing Philosophy

Testing of devices to determine NTCIP compliance to a project specification has been an issue since the available of the initial draft release of an NTCIP Standard in 1995 by NEMA. There are different philosophies to testing, which are continuously being debated by the ITS Standards community. These different philosophies revolve around the questions:

- What is being tested? Is it the functional specifications, performance specifications, environmental specifications, and/or communications specifications?
- How to determine if an implementation conforms to the ITS Standard? Who should perform the testing?

This section addresses these basic questions.

4.1.1 Compliance versus Conformance

The primary difficulty with testing ITS Standards is the misconception of what ITS Standards are and are not. ITS Standards ARE:

- communications protocols
- data elements, and/or
- message sets

ITS Standards are NOT:

- functional requirements – that is, it does not define how an ITS device performs a function
- performance requirements – that is, it doe not define how quickly an ITS device should perform a function

This common misconception leads to differences in the goals of testing. These goals can be classified into two areas, compliance to the project specifications, and conformance to the ITS Standards

- Compliance to Specifications – The use of standards may be a requirement of a project specification or part of the functional requirements. Although it may be determined that an ITS System "conforms" to a Standard, it does not mean that the ITS System performs the functions, or in the manner, that the procuring agency requires it to. Compliance to the specifications involves meeting any functional, environmental, or performance requirements that are required in the project specifications. This is a different type of testing, and may include functional, performance, and/or environmental testing.
- Conformance to Standards – ITS Standards specifies the manner and format that a device or subsystem communicates with other devices or subsystems. These Standards do not specify how that device or subsystem is implemented (i.e., is not technology prescriptive), but does express the minimum requirements for the assertion of "conformance".

The NTCIP Standards, for example, simply specify a consistent manner that information is transferred between components of a system, such as a center and field devices. They do NOT specify what functions will the device perform, nor do they specify how the device will implement a process to perform a function.

However, while defining how the information is expressed when developing the NTCIP Standards, it was necessary to describe what piece of information was being defined and what was it used for. Inadvertantly, these descriptions became a description, in effect, to be a functional description of how a devices used the piece of information and its effect on the operation of the components. Since there are currently no equivalent functional standard (description) of many of these devices, the NTCIP field device standards became the de facto functional standards.

Thus, by default, many users equate the test for conformance to the standard, correctly or incorrectly, to a test for compliance for specifications or functional requirements. One opinion is to clearly distinguish Standards testing and functional testing, however, BOTH testing must be performed for the device to work properly with respect to the project specifications.

For example, the NTCIP Standards defines the communications protocols and the data element formats to be transferred between devices. Although the data elements may transferred properly (conforms to the standard), the sequence and processes that are performed will affect if the device performs the desired functions properly. For a DMS, a brightness value of 10 may have a different meaning to Vendor A than to Vendor B.

Thus, when deploying ITS systems, the goals of testing should be two-fold, achieving conformance to the applicable standards, and compliance to project deployment specifications.

The NTCIP Standards also lack any discussion of performance requirements, which can be an important issue for the implementation of NTCIP devices, particularly those with low bandwidth communications devices (e.g., 1200 baud dial-up modems). There are also no current efforts from the NTCIP Working Groups to further define functional requirements in the Standards. However, ITE and NEMA are sponsoring several on-going activities to define functional requirements for traffic signal controllers and dynamic message signs.

The remaining discussion in this section will focus on Conformance to Standards. Although testing for Compliance to Specification are important, particularly to the procuring agency, the topic is outside the scope of this Technical Issue Paper. However, it is important to distinguish the difference between the two types of test.

4.1.2 Certification Testing

From the various surveys on testing users have indicated their desire for a certification laboratory to certify that products conform to the appropriate or desired ITS Standards. There are several benefits to this approach. Savings in costs to perform testing is one example. Otherwise, multiple agencies will be performing the same tests repeatedly. Arguably, once a manufacturer/systems integrator properly "communicates" a data element or message set correctly, it will always do so, unless there is a significant change in its software. Why have multiple agencies pay again to perform the same test multiple times?

However, there are several institutional issues that are still being addressed. Who will certify the third-party to perform the certification testing? What tools are acceptable and allowable to be used during the testing? Who will approve the procedures to be used in the Standards testing? Where will the funding come from?

From an implementation point of view, requirements will be different from agency to agency, one agency may request only a certain subset of the appropriate ITS Standard, while another may request the entire set. A vendor may "pass" the certification test if the entire subset is implemented, but it might also "fail" the certification test for a specific implementation if only a subset is required by a procuring agency. While it may be simple to request the entire set of the Standard, it may also significantly increase the cost of the implementation.

Also, while it is possible to test that the data elements are communicated in a "standard" manner, as defined by the ITS Standard, the laboratory cannot certify that the data elements are used in the manner intended by the procuring agency, nor can it certify that the performs the functions required.

For example, a DMS manufacturer may properly transmit the data elements for controlling the scheduler on a DMS, but it may use a proprietary (non-standard) object or data element to actually implement one of the scheduler functions. This use of a proprietary data element

to implement the scheduler function highlights a potential deficiency, although the DMS manufacturer properly transferred the data elements involving the scheduler, and thus arguably passed the test for conforming to the Standard, the DMS manufacturer should have failed because it did not follow the intent of the standard. However, the certification test did not test the functionality or the implementation of the scheduler, it only tested that the data elements were properly transferred.

4.2 ITS Standards Testing Program

4.2.1 Introduction

In March 1999 the U.S. Department of Transportation (USDOT) contracted with Battelle to test ITS standards that have been approved and published, or are currently under development by the Standards Development Organizations (SDOs). The purpose of this Program was to build confidence in the maturity and quality of the ITS Standards that have been developed. The Program hopes to prove that:

- Deploying Standards are effective and will lead to interoperability and interchangeability
- Standards supports the core functionality and capabilities of the relevant technology
- Standards are unambiguous, complete, and consistent
- Standards are stable

The Program is intended to be an objective assessment and evaluation of deployed, operational systems, with the focus on field test sites as opposed to laboratory testing. Each field test site will be evaluated for the effectiveness, usability, and performance of the implementation using an ITS Standard. To date, two testing evaluations of ITS Standards have been completed:

- An NTCIP 1203 - Dynamic Message Sign (DMS) implementation (formerly NTCIP TS3.6), with variable message signs from two different sign vendors
- An NTCIP 1204 – Environmental Sensor Station (ESS) implementation,

A summary of the test reports is provided in Section 4.2.3. The full test reports are available at the US DOT Standards web site.

4.2.2 Testing Process

The Battelle ITS Standards Testing process is comprised of four major parts:

- Establish the Standards Baseline – Examines the implementation to determine the standards content. Does the implementation faithfully follows the standard, or does the implementation make any non-conforming use of the standard? Does the implementation use any proprietary or non-standard protocols, data elements or

message sets? This analysis of the implementation provides the basis for the next phase of the process, the interviews.

- Conduct Interview(s) – Gathers information from the procuring agency, the systems integrator, the manufacturer, the user/operators and the maintainers on the experience in procuring, specifying, testing, and using the standard. The interviews are conducted using questionnaires, with follow-ups via face-to-face or telephone interviews. The experiences collected include the perceived benefits, problems, and effectiveness of using the standard, including lessons learned. Weaknesses, strengths, and problems with of the standard are also derived from these interviews.
- Examine the Integrity and Purity of External Interface(s) – Since the Battelle Testing Program only focuses on the NTCIP suite of communications protocol, examines the data packets between the two components of the system. Review the data packets for conformance with the syntax and format of the Standard, and search for the use of data elements not specified in the Standard.
- Perform Field Testing – Performs controlled field testing of the field device at an operational site. These controlled field tests includes examining the core functions and features of the technology and testing for exception or "non-standard" conditions.

Battelle then produces a Standards Test Report that identifies the "Findings" and associated recommendations about how to make the subject standard better. The reports focus only on the findings relative to the features of the standards and does not critique the implementation or the host site.

4.2.3 Test Reports

This section summarizes the test reports that were produced as a result of the two field evaluation tests performed to date by the ITS Standards Testing team.

Dynamic Message Signs

Examined an implementation of NTCIP 1203 in March 2000, with two (2) different vendors. Reviewed 19 core functions and features in the Standard. Found an ambiguity in the Standard that resulted in two different implementations of the Scheduler function by two different vendors.

Beyond this one major exception and several minor exceptions, the conclusion of the test team is that NTCIP 1203 is effective and makes a positive contribution to the interoperability of DMS systems. Please note that an amendment to the NTCIP 1203 has been approved since the time of the report, and Version 2 of the Standard is being balloted.

Environmental Sensor Stations

Examined an implementation of NTCIP 1204 in May 2001. Reviewed 52 core functions and features in the Standard. Found that the implementation had created four (4) custom

objects to provide functionality needed by the procuring agency that were not supported by the Standard. These functions were support to

- Save historical data for a longer period of time
- Use a CCTV camera to collect a snapshot of current weather conditions
- Collect solar radiation data at 10 minute intervals
- Measure subsurface soil moisture levels

Beyond the four custom objects, the conclusion of the test team is that NTCIP 1204 is effective and makes a positive contribution to the interoperability of ESS systems. Please note that an amendment to the NTCIP 1204 has been approved since the time of the report, and the Working Group is drafting Version 2 of the Standard.

4.3 Testing and Conformity Assessment (TCA) NTCIP Working Group

4.3.1 Introduction

The Testing and Conformity Assessment (TCA) NTCIP Working Group was created in the Summer of 2002 to address the issues of how to test the NTCIP suite of standards that were being developed. The technical work activities of the working group under its initial work plan will help achieve the following goals and benefits:

- Develop testing guidance for the NTCIP Work Groups to utilize in order to develop testing artifacts for the standards they develop.
- Develop testing guidance for users (e.g. vendors, DOTs, system integrators) of the NTCIP standards. This guidance will address how testing should be addressed by the end users of the standards.
- Develop a high-level ITS testing framework that should be used for ITS Standards Testing.
- Provide “testing input” to the NTCIP Guide.
- Develop a paper that describes the state of the practice in NTCIP testing. The paper will focus on philosophy of testing, testing methodologies, and testing tools.
- Develop a paper that will discuss potential testing strategies the NTCIP community should consider utilizing.

The working group plans to issue the following reports that will address and provide guidance on the testing issues:

- NTCIP 8007 – Process, Control, and Information Management Policy – Testing and Conformity Assessment Documentation within NTCIP Standards.
- NTCIP 9011 - Information Report – Guide on NTCIP Testing Certification
- NTCIP 9012 – Information Report – NTCIP Testing Guide for Users

- NTCIP 9013 – Information Report – Case Study on NTCIP Testing, State of the Practice

4.3.2 NTCIP 8007 – Testing and Conformity Assessment Documentation with NTCIP Standards Publications

This document provides rules and guidelines for the NTCIP working groups on how to develop the test documentation for the NTCIP standards. The results of this document is intended to promote a consistent look and feel for testing documentation throughout the NTCIP standards development effort. This document is not intended for direct use by manufacturers or public agencies to develop their testing procedures when building or procuring NTCIP equipment. However, agencies and other end users indirectly benefit because there will be a single approach to the testing documentation for all NTCIP standards.

The rules and guidelines to develop NTCIP Test Specifications consists of three major activities:

- Develop Requirements – Ensure that there are well-defined requirements. These requirements shall be the basis for the other activities.
- Develop NTCIP Test Cases – An NTCIP Test Case describes what is to be accomplished by performing the test and identifies the inputs to the test and the expected outputs, but does not define the exact process to be followed.
- Develop NTCIP Test Procedures – The NTCIP Test Procedure describes the exact sequence of steps to be followed to execute the associated NTCIP Test Case.

For each activity, the Guide defines the process, the rules, and the guidelines for completing that activity.

This document was released for user comment in October 2003.

4.3.3 NTCIP 9011 – Guide on NTCIP Testing Certification

This is a white paper originally intended to discuss the topic of conformity assessment and certification. It discusses the issues and challenges in certifying third-parties to perform testing and certify that a specific deployment conforms to the tested Standard. The document considers how to certify third-parties to perform testing, how to test the Standard, how to test the tools, and the possibility of developing a qualified product list. This document is currently in a working group user draft.

4.3.4 NTCIP 9012 – NTCIP Testing Guide for Users

This document considers issues such as types of testing, testing requirements, testing extended functionality, and testing documentation. This document is currently in a working

group user draft, although no significant progress has been made on this document recently until other issues are resolved.

4.3.5 NTCIP 9013 – Case Study on NTCIP Testing State of the Practice

The purpose of this document is to report on the various aspects and issues facing agencies and vendors regarding testing the NTCIP Standards. The document addresses the various philosophies of testing, and the different processes currently employed. The document considers the different types of testing, what test tools are being employed, what is missing from current practices and the testing techniques utilized. The document also focuses on user comments and feedback from a user workshop (NTCIP Standards Testing Requirements Workshop) held in April 2003. This document is currently in a working group user draft.

4.4 Other Activities

4.4.1 FHWA

Beyond the above mentioned activities, the FHWA continues to actively sponsor studies and projects to assist vendors and agencies in testing their ITS Standards-based projects. For example, the FHWA recently produced a document entitled "NTCIP Testing Study:State of the Practice". This study presents the current "State of the Practice" of testing in the NTCIP community, and includes the results of a survey on Standards testing from several state transportation agencies, a summary of the available testing tools, a discussion on testing philosophies, and several white papers on testing standards.

The ITS Standards Testing Team is also working with other ongoing or planned standards testing and validation efforts. For example, the John Hopkins University/Applied Physics Laboratory is performing tests on the Electronic Data Interchange (EDI) standards in the Commercial Vehicle Operation (CVO) applications.

Currently, FHWA has indicated interest in procuring a consultant to perform a feasibility study on whether certification testing related to ITS Standards is practical. The proposed scope of the study will consider several areas relevant to certification testing, including technical feasibility, business feasibility, and institutional feasibility. Other areas include defining requirements for certification organizations, conformance testing tools, and certified products.

4.4.2 ENTERPRISE

The ENTERPRISE Program is a coalition of various state agencies and organizations that have pooled their resources and experiences to deploy and implement ITS projects. Some of their activities include developing NTCIP specifications, deploying ITS projects, and developing and maintaining test plans. One activity of the Enterprise program was the INCH (Integrating NTCIP Compliant Hardware) project. This project consisted of three major components:

- Developing a procurement specification guide
- Developing test procedures
- Performing an initial round of testing

5 Impact on NYSDOT

5.1 Specifications and Procurement

5.1.1 Center to Field

With the exception of Dynamic Message Signs (emerging as a mature standard with deployment experience), most of the standards are in various states of development. The NTCIP 1203 standard (for Dynamic Message Signs) includes a list of functional requirements that were used as a basis for developing the standard. With a mindset towards procurement and testing, the working group developed a form that allows an agency to identify mandatory requirements and to check off optional requirements. An excerpt from the draft DMS standard Version 2 is shown in the table below (the FR ID column translates to an NTCIP Object in the DMS standard):

Table 10. Example DMS Functional Requirements

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
2.4	Features			M	Yes	
2.4.1	Manage the DMS Configuration			M	Yes	
2.4.1.1	Determine the DMS Identity			M	Yes	
		3.4.1.1.2	Determine Sign Type and Technology	M	Yes	
		NTCIP1201.3.4.2	Determine Device Component Information	O	Yes / No	
		NTCIP1201.3.4.5	Determine Supported Standards	O	Yes / No	
2.4.1.2	Determine Sign Display Capabilities			O	Yes / No	
		3.4.1.2.1.1	Determine the Size of the Sign Face	M	Yes	
		3.4.1.2.1.2	Determine the Size of the Sign Border	M	Yes	
		3.4.1.2.1.3	Determine Beacon Type	M	Yes	
		3.4.1.2.1.4	Determine Sign Access and Legend	M	Yes	
		3.4.1.2.2.1	Determine Sign Face Size in Pixels	Matrix: M	Yes	
		3.4.1.2.2.2	Determine Character Size in Pixels	Matrix: M	Yes	

User Need ID	User Need	FR ID	Functional Requirement	Conformance	Support	Additional Specifications
		3.4.1.2.2.3	Determine Pixel Spacing	Matrix: M	Yes	
		3.4.1.2.3.1	Determine Maximum Message Length	VMS: M	Yes	
		3.4.1.2.3.2	Determine Maximum Number of Pages	VMS: M	Yes	
		3.4.1.2.3.3	Determine Supported Color Schemes	VMS: M	Yes	
		3.4.1.2.3.4	Determine Message Display Capabilities	VMS: M	Yes	
		3.4.1.3.1	Determine Number of Fonts	Fonts: M	Yes	
		3.4.1.3.3	Determine Supported Characters	Fonts: M	Yes	
		3.4.1.3.4	Retrieve a Font Definition	Fonts: M	Yes	
		3.4.1.3.7	Validate a Font	Fonts: M	Yes	
		3.4.1.4.1	Determine Maximum Number of Graphics	Graphics: M	Yes	
		3.4.1.4.4	Retrieve a Graphic Definition	Graphics: M	Yes	
		3.4.1.4.7	Validate a Graphic	Graphics: M	Yes	
		3.4.1.4.8	Determine Graphic Spacing	Graphics: M	Yes	
		3.4.2.3.2.1	Determine Default Message Display Parameters	VMS: M	Yes	
		3.4.3.2.1	Monitor Information about the Currently Displayed Message	O	Yes / No	
		3.4.3.2.2	Monitor Dynamic Field Values	Fields: M	Yes	
		3.5.5	Supplemental Requirements for Message Definition	VMS: M	Yes	

Each requirement can then be traced to one or more NTCIP Objects (formally written using ASN.1 – Abstract Syntax Notation, an ISO standard). For example, functional requirement 3.4.1.1.2 Determine Sign Type and Technology translates into NTCIP Objects 5.2.2

dmsSignType and 5.2.9 dmsSignTechnology. NTCIP Object 5.2.2 is shown in the figure below.

Figure 2. Example NTCIP Object ASN.1 for DMS

```
5.2.2 Sign Type Parameter
dmsSignType  OBJECT-TYPE
SYNTAX  INTEGER{
                other (1),
                bos (2),
                cms (3),
                vmsChar (4),
                vmsLine (5),
                vmsFull (6),
                portableOther (129),
                portableBOS (130),
                portableCMS (131),
                portableVMSChar (132),
                portableVMSLine (133),
                portableVMSFull (134)}
ACCESS  read-only
STATUS  optional
DESCRIPTION
"<Definition> Indicates the type of sign.  The descriptions are:
  other:  Device not specified through any other definition, refer to
     device manual,
  bos: Device is a Blank-Out Sign,
  cms : Device is a Changeable Message Sign,
  vmsChar : Device is a Variable Message Sign with character matrix
     setup,
  vmsLine :  Device is a Variable Message Sign with line matrix setup,
  vmsFull: Device is a Variable Message Sign with full matrix setup.
  Same is true for all portable signs.

<DescriptiveName>DMS.signType:code

<DataConceptType>Data Element"
::= { dmsSignCfg 2 }
```

Taken as a collection, the NTCIP Objects (written as ASN.1) can be compiled into a MIB (Management Information Base). The MIB provides a standardized interface for communications over the SNMP (Simple Network Management Protocol) between a center system and a field element, such as a sign. Because SNMP, ASN.1, and the MIB are open standards, one can, at some future time, test field elements and center systems separately using a center simulator and a sign simulator.

One of the objectives of the Task 2A is to identify and recommend how to incorporate the identification of functional requirements, standardized MIBs, and testing into NYSDOT Engineering Process (e.g., design report, PS&E, installation, acceptance test).

5.1.2 Center to Center

Center to Center Message Sets

Unlike communications with field devices using NTCIP, center to center communications focuses on entire messages, and not individual data elements that are set and retrieved (get) from the field device (this is simply how SNMP works and not a limitation of the ASN.1 as discussed below).

Center to center communications is message oriented. A message is built up from a standardized set of lower level data element definitions (a data element being the most basic structure defined). The center-based standards have defined Message Sets which identify messages used to support some center function. Messages themselves (or a message template) are defined either in ASN.1 or XML Schema (often both).

The key to building center systems is to specify (and later test) center functions and which messages are used to invoke the center function (e.g., request information from the other center, or request that the other center perform a command on a field device). The following is a short list of standards reaching a maturity level such that center system interfaces can be specified based on the standards. Nonetheless, these standards have not been deployed and early implementers will likely have experience challenges working with the still evolving standards. The overarching problem is that of the standards reaching a ballot and then quickly being superseded as new functionality creates changes to the previously adopted standard. Therefore, it is recommended that NYSDOT focus on standards that have already been balloted as version 1 and now reaching maturity as version 2.

Table 11. Center-based Standards Message Sets in Version 2 of Development

ITS Functional Area	SDO	Message Set	Version Status
Traffic Management	ITE/AASHTO	Message Set for External TMC Communications	Version 2 nearing completion
Incident Management	IEEE	1512 BASE, 1512.1 (Traffic Incidents), 1512.3 (HAZMAT)	Version 2 nearing completion
Traveler Information	SAE	J2354 – ATIS Message Set	Version 2 development commencing soon
Transit	APTA	TCIP	Version 2 under development

Center to Center Communications Protocol

Message Sets specify what information is being communicated, but now how the information is transferred from one center to another. Currently, the only standard balloted is DATEX. However, the lack of available software development tools and the complexity of encoding and decoding messages for transport has limited the widespread adoption of DATEX. An emerging communications protocol that is gaining widespread acceptance in the IT community is that of XML. It is the expectation of the NTCIP Center-to-Center

Working Group to deliver an interim draft standard for an XML-based communications protocol mid 2004. The working group has also develop an Information Report (NTCIP 9010) which outlines the general scope and issues related to standards development. The XML-based standards will include a profile for using the World Wide Web consortium's Simple Object Access Protocol (SOAP), and the Web Service Description Language (WSDL) which formally defines the relationship between messages, and center functions. the interfaces. The XML-based standard will also include a simple protocol (called XMLDirect) which specifies how to make XML content files available for retrieval (e.g., web site).

In order to specify an interface for a center-to-center communications, the agency must identify which functions (called 'operations' in center-to-center standards jargon) the center will make available to other centers. In essence the center is exposing its capabilities through a standardized interface. Next, the operations are correlated with individual messages. The latter will be standardized as part of the center-to-center standard, and therefore the agency need only modify the list.

This concept is summarized in the example below (the information is based on the July 2004 draft of the TMDD).

Table 12. Example Services Summary Table for TMDD-based Center Interfaces

Ref	Service	Ref	Operation	Input Message	Output Message
2.3	SVC_Administrative Data	2.3.1	OP_ShareAgency Information	MSG_RequestAgencyInfo	MSG_InfoAgency
		2.3.2	OP_ShareContact Information	MSG_RequestContactInfo	MSG_InfoContact
		2.3.3	OP_ShareOrganization Information	MSG_RequestOrganizationInfo	MSG_InfoOrganization
2.5	SVC_Event	2.5.1	OP_ShareCurrentEvents	MSG_RequestEventCurrentInfo	MSG_InfoEventCurrent
		2.5.2	OP_SharePlannedEvents	MSG_RequestEventPlannedInfo	MSG_InfoEventPlanned
		2.5.3	OP_ShareSpecialEvents	MSG_RequestSpecialEventInfo	MSG_InfoSpecialEvenInfo
		2.5.4	OP_ShareForecastEvents	MSG_RequestEventForecastInfo	MSG_InfoEventForecast
2.6	SVC_DMS	2.6.1	OP_ShareDMSInventory	MSG_RequestDMSInventory	MSG_InfoDMSInventory
		2.6.2	OP_ShareDMSLibrary	MSG_RequestDMSLibrary	MSG_InfoDMSLibrary
		2.6.3	OP_ShareDMSStatus	MSG_RequestDMSStatus	MSG_InfoDMSStatus
		2.6.5	OP_ShareDMSControl	MSG_RequestDMSControl	MSG_ResultDMSControl
2.7	SVC_CCTV	2.7.1	OP_ShareCCTVInventory	MSG_RequestCCTVInventory	MSG_InfoCCTVInventory
		2.7.2	OP_ShareCCTVStatus	MSG_RequestCCTVStatus	MSG_InfoCCTVStatus
		2.7.4	OP_ShareCCTVControl	MSG_RequestCCTVControl	MSG_ResultCCTVControl
2.8	SVC_VideoSwitch	2.8.1	OP_ShareVSInventory	MSG_RequestVSInventory	MSG_InfoVSInventory
		2.8.2	OP_ShareVSStatus	MSG_RequestVSStatus	MSG_InfoVSStatus

Ref	Service	Ref	Operation	Input Message	Output Message
		2.8.3	OP_ShareVSControl	MSG_RequestVSControl	MSG_ResultVSControl
2.9	SVC_ESS	2.9.1	OP_ShareESSInventory	MSG_RequestESSInventory	MSG_InfoESSInventory
		2.9.2	OP_ShareESSStatus	MSG_RequestESSStatus	MSG_InfoESSStatus

Given the table above, one can develop a description using the Web Services Description Language (WSDL). The table above also serves a general template for testing of center interfaces based on the NTCIP XML-based standard. Specifically, one can develop a plan that lists which message to send to the center and which message to expect back.

As with the center to field discussion, one of the objectives of Task 2A is to identify and recommend how to incorporate the identification of functional requirements, standardized messages and center-to-center communications protocol, and testing into NYSDOT Engineering Process.

5.2 ITS Systems Testing

Section 5.1 above included a brief discussion regarding an approach to testing. This is summarized below:

1. Center to Field. Because SNMP, ASN.1, and the MIB are open standards, one can test field elements and center systems separately. A center simulator (or client test software) can be used to test the interfaces to the sign (without having to have a production center system connected to the sign.) A field device simulator can be used to unit test center-based software that will ultimately communicate with a some field device.
2. Center to Center. Given a services summary table (such as the example shown in Table 3), one can develop a general template for testing of center interfaces based on the NTCIP XML-based standard. Specifically, one can develop a plan that lists which message to send to the center and which message to expect back.

5.2.1 Center to Field

Test Plan Development Process

For center to field communications based on the NTCIP one can develop a test plan from the information contained in the standard. The NTCIP standard maps functional requirements to NTCIP Objects, but more importantly, the standard includes a section on Dialogs which indicates which NTCIP Objects must be set and retrieved to enable a specific device function.

(Note: Theoretically, NYSDOT could create a standardized MIB (for NYSDOT's use). NYSDOT could then require that a device manufacturer show that the MIB, running under

the SNMP agent of the device manufacturer, is able to respond to a series of commands outlined in a test plan.)

Tools

SNMP and MIBs are used throughout network communications. For example, most network routers and communications network devices are monitored using SNMP. As a result a number of companies exist that provide 3rd party off-the-shelf MIB compilers and SNMP monitoring tools. The primary tools required for testing of field devices are therefore:

- SNMP-based testing software (e.g., NTCIP Exerciser) for testing of client-side (center) and field-side functionality, and
- MIB Compiler to check the validity of the written (ASN.1) form of the MIB

5.2.2 Center to Center

Test Plan Development Process

Test plans for center-based services can be developed from the services summary table (see Table 3). The general approach to testing would be to use test software that would send a message to the center software being testing and then evaluating the return message. The services summary table would allow a tester to methodically test all such message exchanges being specified for the center system. In addition the test plan would evaluate the center's ability to handle improperly formatted messages (and thus returning a fault), and, if required, more complex patterns of message exchanges such as publish and subscribe.

Tools

Testing of the center interfaces specified would involve tools for evaluating the validity of a sample of XML messages and the transport mechanism for moving the XML content from an external center (in this case the test client) to the NYSDOT center software being tested. Therefore, the primary tools for testing of center-based communications would be:

- XML Message Validity Checker
- External center system simulator. Assuming that NYSDOT continues the direction of deployment based on the XML-based standards, the external center system simulator might be accomplished using a thin client web browser.

As with the center-to-field case, because the center-to-center standard is based on open standards that are widely adopted by the IT community, software development tools and testing tools are available.

5.2.3 General Recommendations

The following represent some final thoughts for this section and best practices:

- Each technical specification developed for procuring ITS Systems should clearly indicate that two types of tests will be performed; functional testing and standards testing.
- For standards testing, clearly indicate which standards will be used, how the standard will be tested, and what tools will be used for testing.
- Consider discovery testing. The purpose of the testing was not to certify the DMS's NTCIP implementation or to perform full functional testing. Rather discovery testing was performed, that is, to explore the capabilities and configuration of the DMS program to look for potential integration problems
- Allow time for testing. Testing may take one or two weeks, but thorough testing in controlled conditions will avoid implementation problems in the field.
- As standards are deployed and more common, manufacturers likely have performed basic standards testing prior to deployment. Consider avoiding exhaustive tests on all basic functions, perhaps by analyzing prior test results, and focus on specific needs of the agencies.
- Keep updated on the national standards.
- If the national standards do not support a state-specific need, develop a state-specific standard to supplement the national standard. This will allow consistent use and interoperability across the state.

6 ITS Standards Resources

6.1 Standards Development Organizations (SDOs)

www.ite.org

www.aashto.org

www.nema.org

www.ansi.org

www.astm.org

www.eia.org

www.standards.ieee.org

http://stdsbbs.ieee.org/groups/scc32/index.html

www.sae.org

www.ntcip.org

www.tmdd.org

www.its-standards.net

www.iso.ch

www.tcip.org

Commercial Vehicle Information Systems Network

Consumer Electronics Association

6.2 Standards Testing

www.standards.its.dot.gov –

http://www.standards.its.dot.gov/Documents/ITSStandards_annual.pdf

http://www.its.dot.gov/itsweb/guide.html

ITS Standards Advisories

ITS Standards Advisories provide federal, state and local ITS deployers with a snapshot of the standards used in ITS deployments, including information about development status, testing results, deployment guidance, and training and technical assistance opportunities.

- ADUS (Archived Data User Service) Standard - http://www.standards.its.dot.gov/Documents/ADUS_Advisory.pdf
- DSRC (Dedicated Short Range Communications) Standard - http://www.standards.its.dot.gov/Documents/dsrc_advisory.pdf
- ESS (Environmental Sensor Station) Standard - http://www.standards.its.dot.gov/Documents/ess_advisory.pdf

- DMS (Dynamic Message Sign) Standard - http://www.standards.its.dot.gov/Documents/dms_advisory.pdf

DMS:

http://www.standards.its.dot.gov/Documents/dms_advisory.pdf

DMS standards status:

VDOT – Version 2

Testing – results from Battelle – Executive Summary

http://www.nawgits.com/icdn/ISHTA_ExecSumm.html

http://www.standards.its.dot.gov/Documents/DMSLesson.pdf

Sample specifications:

http://www.standards.its.dot.gov/Documents/genDMSSpec.pdf

Dynamic Message Sign (DMS) Application Area Package: A package of printed technical assistance products is now available from the U.S. DOT ITS Joint Program office. It contains a wide variety of products specifically tailored to the DMS deployer and can be either downloaded or printed copies can be mailed.

http://www.standards.its.dot.gov/AA-DMS.htm

Profiles:

http://www.standards.its.dot.gov/Documents/glassman.pdf

http://www.standards.its.dot.gov/Documents/haukom.pdf

http://www.standards.its.dot.gov/Documents/agah.pdf

Case Studies:

http://www.ntcip.org/library/documents/pdf/9002_090999.pdf

http://www.ntcip.org/library/documents/pdf/9003_090999.pdf

ESS:

http://www.standards.its.dot.gov/Documents/ess_advisory.pdf

For information about the testing program:

http://www.standards.its.dot.gov/testESS.htm

FHWA Road Weather Management Program has published a brochure, An Introduction to Standards for Road Weather Information Systems (RWIS): Siting Standards, Calibration Standards, Communications Standards. The brochure is available at http://ops.fhwa.dot.gov/weather/publications/rwis_brochure.pdf

Environmental Monitoring Application Area Package:

http://www.standards.its.dot.gov/AA-Environmental_Monitoring.htm

Profiles:

http://www.standards.its.dot.gov/Documents/Early%20Depl%20FLEEGE.pdf

http://www.standards.its.dot.gov/Documents/Early%20Depl-%20SENN.pdf

http://www.standards.its.dot.gov/Documents/Early%20Depl%20-COGBURN.pdf

Meterological Standards Reference Sheet: A list of references to resources on other standards and guidelines for deploying environmental sensor stations.

http://www.standards.its.dot.gov/Documents/MetStdsRefSht.pdf

DSRC:

http://www.standards.its.dot.gov/Documents/dsrc_advisory.pdf

Web resources:

http://www.itsonline.com/dsrc_tbl.html

Traffic Signals:

Advanced Traffic Controller (ATC):

http://www.ite.org/standards/atc/index.asp

Case Studies:

http://www.ntcip.org/library/documents/pdf/9004_090999.pdf

Published Standards Documents

http://www.standards.its.dot.gov/Documents/publish.pdf

http://www.standards.its.dot.gov/Documents/approved.pdf

http://www.standards.its.dot.gov/Documents/inballot.pdf

http://www.standards.its.dot.gov/Documents/underdev.pdf

Testing

http://www.standards.its.dot.gov/Documents/Testing_FS%201.pdf

http://www.standards.its.dot.gov/Documents/Testing%20FS%202.pdf

http://www.standards.its.dot.gov/Documents/Testing%20FS%203.pdf

ITS Standards Taxonomy Report:

http://public.bdo.battelle.org/webprojs/its/

Standards (55) identified for testing:

http://www.standards.its.dot.gov/Documents/testlst.htm

Testing Tools

NTCIP Exerciser – http://www.ntcip.org

6.3 Impact on NYSDOT Programs

6.3.1 Specifications and Procurement

List of case studies or example specifications can be found at the NTCIP web site, www.ntcip.org.

6.3.2 Systems Testing

Florida

http://rite.eng.fsu.edu/techtrans/products/tecnote8.pdf - Newsletter describing "Lessons Learned", testing procedures and MIBs for Florida's NTCIP testing program.

http://www11.myflorida.com/trafficoperations/fdot_dms_info.htm - Information on Florida DOT's DMS Qualification Program

http://rite.eng.fsu.edu/ntcip/products.shtml - Information on Florida DOT's DMS NTCIP testing requirements.

6.3.3 Other Resources

American Public Transportation Association (APTA) - APTA is an international organization that represents and promotes all aspects of the transit industry, including bus, rapid transit and commuter rail systems, as well as the organizations responsible for planning, designing, constructing, financing and operating transit systems. The organization has assumed a lead role in the development of Transit Communications Interface Profiles (TCIP), a suite of data interface standards for the transit industry. www.apta.com

Architecture and Standards Conformity Rule - A final rule has been issued by U.S. DOT to implement the TEA-21 requirement that ITS projects funded through the highway trust fund conform to the National ITS Architecture and applicable standards. This rule requires that the National ITS Architecture be used to develop regional ITS architectures. www.its.dot.gov/aconform/aconform.htm.

Commercial Vehicle Information Systems Network (CVISN): The scope of commercial vehicle operations, of which CVISN is a part, includes the operations and regulations associated with moving goods and passengers via commercial vehicles. It includes activities related to safety assurance, commercial vehicle credentials and tax administration, roadside operations, freight and fleet management, and vehicle operation.

Enterprise Program: Established in 1991, the members of the Enterprise Program are departments of transportation from North America and Europe. The program seeks to share

technological and institutional experiences gained from ITS projects.

Integrating NTCIP Compliant Hardware (INCH) Project: A project of the Enterprise Program, INCH aims to facilitate the ability of public agencies to specify, procure, install, and test NTCIP-compliant hardware.

I-95 Corridor Coalition: The I-95 Corridor Coalition is a regional partnership of major public and private transportation agencies, toll authorities and industry associations serving the Northeastern and Mid-Atlantic United States from Maine to Virginia. It seeks to build cooperation, consensus, and coordination among the 35 member organizations, and works to encourage the use of ITS solutions to address shared transportation problems and challenges.

ITS America: The Intelligent Transportation Society of America fosters public/private partnerships to increase the safety and efficiency of surface transportation through the application of advanced technologies. This site contains many excellent resources for basic information on ITS and related topics.

ITS Cooperative Deployment Network (ICDN): The ICDN is an Internet resource sponsored by the National Associations Working Group for ITS (NAWG) and containing up-to-date news, insight, and resources for transportation professionals and agencies alike. The ICDN Newsletter contains late-breaking news related to ITS deployment topics.

IDB Forum: The IDB Forum is an independent, not-for-profit trade association that promotes the global integration of IDB (ITS data bus) networking in vehicles. The ITS data bus is described by a set of standards and specifications approved by the Society of Automotive Engineers (SAE) that provides an open architecture for implementing in-vehicle consumer and automotive electronics.

ITS Data Registry : The ITS Data Registry is a centralized repository for all ITS data elements and other data concepts that are specified for use with standardized ITS systems. It is a national collaboration among the standards development organizations involved in developing ITS standards that has been managed by the Institute of Electrical and Electronics Engineers (IEEE).

National Electrical Manufacturers Association (NEMA): NEMA is one of the largest standards development organizations (SDOs) in the nation and represents over 600 member organizations. NEMA is a member organization of NTCIP and acts as the publisher of NTCIP standards.

National Transportation Communications for ITS Protocol (NTCIP) - The primary objective of the NTCIP is to provide communication standards that ensure the interoperability and interchangeability of traffic control and intelligent transportation systems (ITS) devices. The NTCIP is the first protocol for the transportation industry that provides a communications interface between disparate hardware and software products.

Oak Ridge National Laboratory (ORNL) - Oak Ridge National Laboratory's Intelligent Transportation Systems (ITS) Research Program provides technical assistance and program support to the FHWA in the following subject areas: traffic simulation, signal optimization, real-time control, human factors, automation and systems engineering, operations research, traffic models, and management information systems.

Security Industry Association (SIA) - The SIA was formed in 1969 to promote growth and expansion in the access control, auto security, biometrics, burglar alarm, CCTV, lock hardware, monitoring, outdoor protection, perimeter protection, personal response systems and personal security product industries. SIA has recently begun to investigate the need for ITS-related standards.

Transit Standards Consortium (TSC) - The Transit Standards Consortium is a public/private, non-profit organization that facilitates the development, testing, maintenance, education, and training related to transit standards. The organization includes transit agencies, standards bodies, vendors, and other interested parties.

U.S. DOT Intelligent Transportation Systems Program - The U.S. Department of Transportation is following a five-pronged strategy for encouraging the development of integrated and coordinated intelligent transportation systems: showcasing the benefits of ITS; creating funding incentives; establishing technical standards; building professional knowledge; and carrying out research. To implement this strategy, the ITS Joint Program Office (JPO) was established in May 1994.

Volpe National Transportation Systems Center - The John A. Volpe National Transportation Systems Center (Volpe Center), located in Cambridge, MA, is an organization of the Federal Government whose principal role is to serve as a national center of transportation and logistics expertise. As such, it provides research, analytic, management, and engineering support to the U.S. Department of Transportation, other Federal agencies, and state and local governments