NYSDOT Statewide ITS Program

Key ITS Standards for New York State Deployment and Testing Opportunities

(Initial Draft)

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by

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Revision History

Filename	Version	Date	Author	Comment
NYSDOT Key ITS Standards v0.01.doc	0.01	12/14/05	P. Chan	Initial Draft/Annotated Outline
NYSDOT Key ITS Standards v0.02.doc	0.02	01/14/06	M. Insignares	Initial Draft. Added ITS Standards Framework and Communications Packages.
NYSDOT Key ITS Standards v0.03.doc	0.03	01/18/06	M. Insignares	Initial Draft. Incorporated review comments from P. Chan. Added ITS Specification Development and Testing Framework.

Intended Audience

This Key ITS Standards Report is intended to be reviewed and used by technical specification writers and project managers from transportation agencies in the State of New York.

Relation to Project Scope

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.3, Key ITS Standards for NYS and Testing Opportunities, and is the third in a series of technical issue papers on ITS Standards to be delivered to NYSDOT for this project. The first technical issue paper presented a comprehensive overview and current status of the National ITS Standards Program, including standards testing initiatives. The second technical issue paper reviewed the life cycle of ITS Standards in the development and deployment of ITS projects in New York, starting with a project's genesis in a regional or Statewide ITS architecture, how to use the systems engineering process to determine functional requirements, then how to determine what ITS standards, if any, to use in an ITS project. The fourth and final technical issue paper will build upon this Best Practices Report and the Key ITS Standards Report to provide a guide for NYSDOT planners, project managers, and technical specification writers on how to specify ITS standards for ITS projects.

{NOTE: THIS TABLE NEEDS TO BE COMPLETED}

ABBREVIATIONS AND ACRONYMS	
AASHTO	American Association of State Highway and Transportation Officials
ADUS	Archived Data User Systems
ASCII	American Standard Code for Information Interchange
ASN	Abstract Syntax Notation
ASP	Active Server Pages (by Microsoft)
ATIS	Advanced Traveler Information Systems
C2C	Center to Center
CCTV	Closed Circuit Television
DATEX	Data Exchange
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
HTTPS	Secure Hypertext Transfer Protocol
ID	Identification
IEEE	Institute of Electrical and Electronic Engineers
IM	Incident Management
IP	Internet Protocol
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
NCBA	Nassau County Bridge Authority
NEMA	National Equipment Manufacturers Association
NTCIP	National Transportation Communication for ITS Protocol
NYSDOT	New York State Department of Transportation
OER	Octet Encoding Rules

ABBREVIATIONS AND ACRONYMS	
SAE	Society of Automotive Engineers
SDO	Standards Development Organization
SMTP	Simple Mail Transfer Protocol
SOAP	Simple Object Access Protocol
SSL	Secure Sockets Layer
Sync	Synchronized
TCIP	Transit Communications Interface Profiles
TCP/IP	Transmission Control Protocol and the Internet Protocol
TMDD	Transportation Management Data Dictionary
UDP	User Datagram Protocol
W3C	World Wide Web Consortium
WSDL	Web Services Description Language
XML	eXtensible Markup Language

1 Introduction

1.1 Report Overview

{NOTE: An Executive Summary will be added prior to the section to summarize recommendations and strategy goals defined in for the Key ITS Standards once these (defined in chapter 6) have been correctly identified and agreement with NYSDOT.}

New York State Department of Transportation (NYSDOT) and New York State are pioneers and strong supporter of the National ITS Standards program, and have implemented standards related to most areas of ITS. Fortunately for the National ITS Standards program, their experience has helped to develop, fine-tune, and provide lessons learned for other agencies with regard to ITS Standards deployment. NYSDOT and New York State have shown a strong commitment to ITS Standards and have implemented a wide range of standards, gaining valuable experience in the process.

At this time, however, the NYSDOT and other New York State agencies are asking:

- What is our strategy regarding ITS standards moving forward?
- How do we capture the lessons learned and experience of the “first generation projects” and apply them to the next generation of projects?
- How do we move from proof-of-concept, early deployment, small scale or laboratory environment projects to large ITS deployments? And, what are the risks involved?
- What testing and/or certification strategy should we implement to make sure that large deployments go smoothly?

The goal of this report is to help answer some of these questions and to focus on identifying Key ITS Standards and an ITS Standards Framework and Strategy to support future deployments and testing.

1.2 Report Organization

The document is organized into 5 chapters and 2 appendices as follows:

- **Chapter 1: Introduction.** Provides an overview of the report and document organization.
- **Chapter 2: Key ITS Standards – Review of Representative New York State ITS Deployments.** Provides and overview of representative projects that, take together, are the “first generation projects” applying the ITS standards broadly.
- **Chapter 3: Key ITS Standards – Identification and Assessment Methodology.** Discusses the methodology used to identify Key ITS Standards for the State of New York. This included a review of regional ITS architectures in New York State, and existing (or planned) New York State deployments that use ITS standards. The resulting

Key ITS Standards were reviewed for maturity and deployment relevance within the State of New York.

- **Chapter 4: Key ITS Standards – ITS Standards Framework and List of Standards.** Introduces an ITS Standards Framework for NYS. Based on the NTCIP Framework, the NYS ITS Standards Framework provides a way to categorize the list of Key ITS Standards based on the role played in ITS data communications. Five levels (or role-based categories) of standards are defined: information, application, transport, subnetwork, and plant. Taken together, the 5 levels define a "communications protocol stack" necessary for system deployment. **{NOTE: Hardware standards are not discussed in-depth in this document. These will be added – place holders have been identified – once the hardware standards have been identified.}**
- **Chapter 5: Key ITS Standards – ITS Standards Communications Packages.** Introduces the concept of ITS Standards Communications Packages. Based on the National ITS Architecture Communications layers – the sausages in the "sausage diagram" – this section bundles the Key ITS Standards (as defined in Chapter 3) into "communications packages" suitable for deployment. ITS Standards Communications Packages are defined for *Wireline Communications*, *Wide Area Wireless Communications*, and *WAVE/DSRC*.
- **Chapter 6: Key ITS Standards – Strategy and Recommendations for Deployment and Testing.** Covers topics relevant to defining and assessing ITS projects suitable for future testing and deployment of ITS standards. Included is a discussion and assessment of risk (low to high) of deploying the ITS Standard and discusses the possible mitigation strategies for reducing those risks, and potentials strategies for "phasing in" of ITS standards into project scopes. Also discussed are testing opportunities for ITS Standards.
- **Appendix A – ITS Architecture Assessment.** Lists architecture flows identified for regional ITS architectures for the State of New York and identifies the applicable ITS Standards for each flow.
- **Appendix B – Key ITS Standards Reference**. Provides a reference document covering each of the ITS Standards identified. This appendix is organized by standards development organization (SDO).

2 Key ITS Standards – Review of New York State ITS Deployments

New York State DOT is a pioneer and strong supporter of the National ITS Standards program, and has implemented standards related to most areas of ITS. Fortunately for the National ITS Standards program, their experience has helped to develop, fine-tune, and provide lessons learned for other agencies with regard to ITS Standards deployment. The following example projects are illustrative of the scope and depth of NYSDOT's valuable contribution.

There are several types of standards that may be used in an ITS deployment. These standards may include hardware, software, communications, performance, maintenance and practices. The focus of this paper is on ITS communications standards, with a focus on center-to-field (C2F), center-to-center (C2C), wide area wireless, and WAVE/DSRC (wireless access to the vehicular environment / dedicated short range communications) standards.

The next sections summarize representative ITS projects that are applying the ITS Standards.

2.1 Center-to-Field ITS Deployments

NYSDOT/NYSTA Freeway Management Systems (Region 5, Region 11, and Others)

NTCIP-based specifications and procurement documents have been developed for the following NYSDOT projects.

Region 5 – Phase 3 Western Expansion

The Phase 3 Expansion of the Western New York Advanced Traffic Management System (ATMS) project was initiated to continue to reduce recurring and non-recurring vehicle hours of delay and to reduce secondary incidents in a cost effective manner. As part of a Phased ITS Deployment Plan developed for the Niagara Region in 1996, this project will expand the existing Niagara Region ATMS along NY Route 5, NY Route 33, US Route 219, I-90 and I-290.

The proposed work will include the installation of Dynamic Message Signs (DMS), Closed Circuit Television (CCTV), TRANSMIT Readers, Advanced Traffic Controllers (ATC), and fiber optic communications. In addition to this work, the current Traffic Operations Center (TOC) central software will be upgraded to accommodate the expansion. The TOC is operated by the Niagara International Transportation Technology Coalition (NITTEC) and is located at 93 Oak Street in Buffalo. All work will be completed within Erie and Niagara Counties.

Region 11 - Western Queens Expansion Project (Long Island Expressway)

The Western Queens Expansion project will provide additional ITS system capabilities along the Long Island Expressway. It covers equipment and components in the field and in the Region 11 Joint Traffic Management Center (JTMC) to be furnished installed and integrated as a complete traffic surveillance and control system.

2.2 Wide Area Wireless ITS Deployments

NYSDOT Integrated Incident Management System (IIMS)

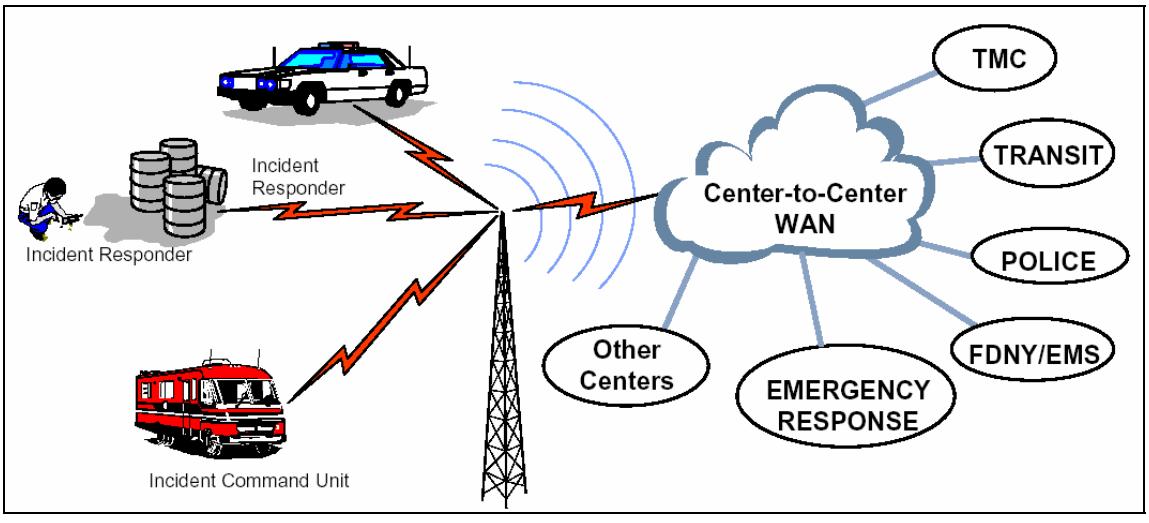
The IIMS project features the development and deployment of the IEEE 1512, XML Center-to-Center, and Wide Area Wireless communication standards, to help link public safety, maintenance, and DOT vehicles with centers for integrated incident response.

IIMS Project Description

The New York State Department of Transportation (NYSDOT) is deploying a real time incident management system that enhances the communication of incident data among incident managers at operations centers and incident response personnel at the incident scene. The Integrated Incident Management System (IIMS) is a multi-agency project managed and sponsored by the New York State Department of Transportation (NYSDOT), in partnership with New York City Department of Transportation (NYCDOT), the New York City Police Department (NYPD) and the Department of Emergency Management (NYCOEM). The United States Department of Transportation (USDOT) added support to IIMS as part of the ITS Public Safety Program. IIMS is being enhanced under USDOT funding to improve the dispatch of resources to the incident scene. This expanded initiative includes additional IIMS Field Operational Test evaluation, outreach to the Public Safety and ITS community, and support of ITS standards deployment and testing.

The IIMS Project Concept is shown in the figure below.

Figure 2-1. IIMS Project Concept



2.3 Center-to-Center ITS Deployments

NYSDOT Transit Schedule Date Exchange Architecture (TSDEA)

The TSDEA Project brings forth the design and development of a transit schedule data exchange based on the TCIP and XML Center-to-Center communications standards.

TSDEA Project Description

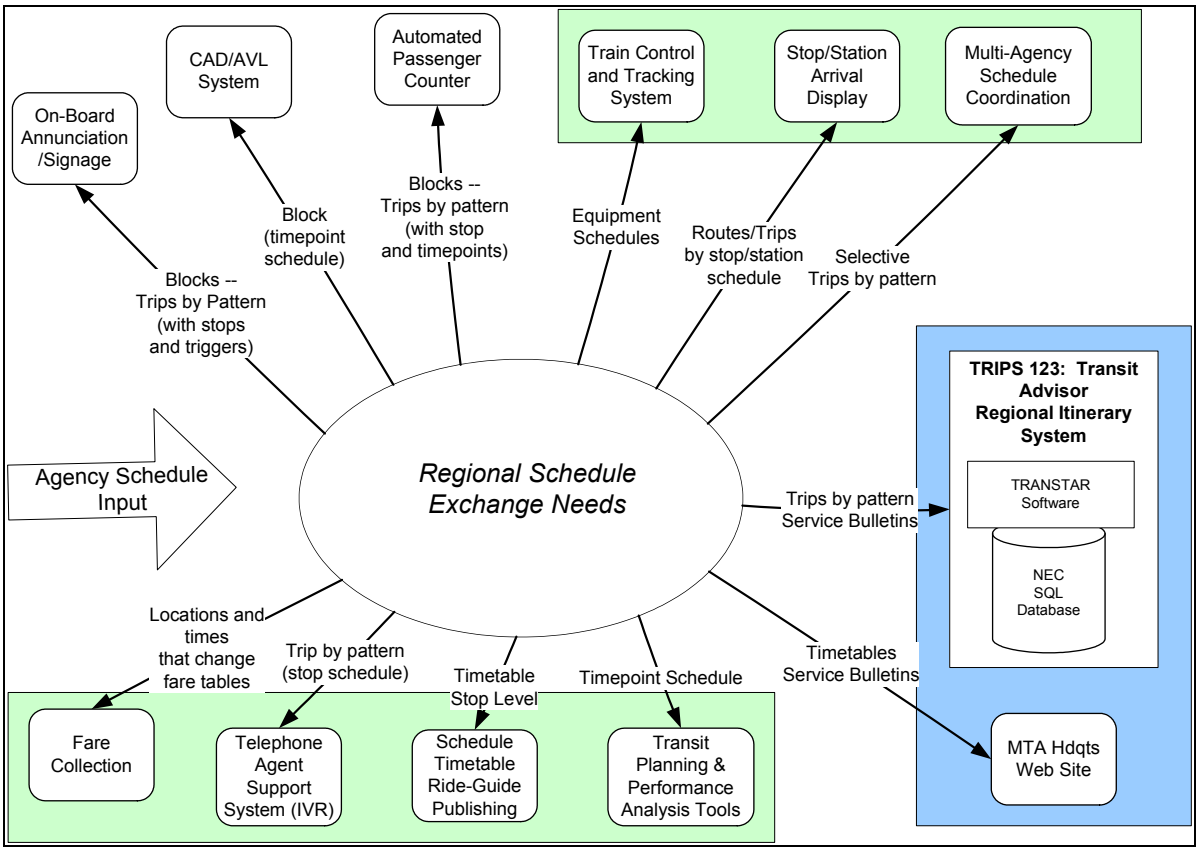
This project, managed by the New York State Department of Transportation, is seeking to provide an efficient, standards-based, framework for managing and exchanging schedule data among agencies and effectively communicating schedule information from multiple NY State transit providers to the public. The effort is focused on collaboratively defining a framework, as well as tools for data development, conversion and exchange, to support regional multi-agency initiatives that use schedule data, including TRIPS123. The project is intended to support transit agency requirements for managing the definition, organization and exchange of schedule data.

The product of this effort will be a published and open Schedule Data Profile, a language in which to describe transit schedule data in NY in a standardized manner. In addition, the project will demonstrate a framework for managing and exchanging schedule data through a technology deployment of the Transit Schedule Data Exchange Architecture.

The “Downstate” region of New York State is the focus of this initial phase of the TSDEA development given the extent and multi-agency nature of its transit services. This remarkable range of transit service options provides the greatest opportunity for testing and demonstrating the benefits of integration and coordination.

The TSDEA Project Concept is shown in the figure below.

Figure 2-2. TSDEA Project Concept



NYSDOT Information Exchange Network (IEN)

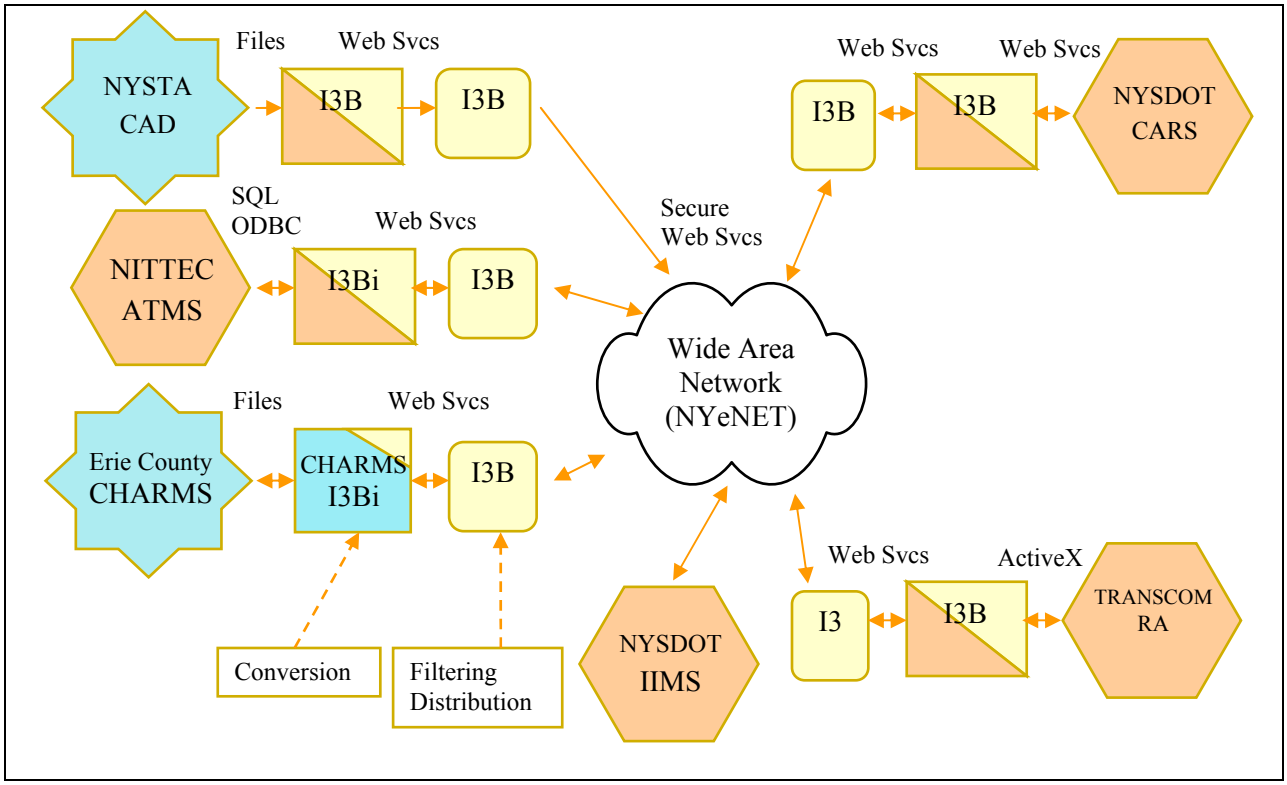
NYSDOT IEN Project Description

The NYSDOT IEN brings together the IEEE 1512, TMDD, and XML Center-to-Center communications standards to provide a center-to-center communications infrastructure for statewide interagency communications within New York State and with neighboring states. Specific project goals include:

- Provide an infrastructure that supports data exchange between dissimilar systems in real time
- Provide interfaces to legacy existing systems without requiring extensive reprogramming of legacy/existing systems
- Use eXtensible Markup Language (XML), Simple Object Access Protocol (SOAP)

The NYSDOT IEN Project Concept is shown in the figure below.

Figure 2-3. NYSDOT IEN Project Concept



2.4 WAVE/DSRC ITS Deployments

Atlantic Beach Bridge 5.9 GHz Demonstration Prototype

Atlantic Beach Bridge 5.9 GHz Prototype Project Description

The Long Island Nassau County Bridge Authority is developing a prototype system with the new 5.9GHz system at its Atlantic Beach Bridge on NY-878 just south of Kennedy Airport NY. The test at the bridge will demonstrate dual readers that can handle both E-ZPass, a 915MHz system, and the new 802.11p 5.9GHz transponders. It will be essential to demonstrate that the next generation of transponders work with 915MHz since the two would likely have to coexist for quite a number of years at toll plazas. All the New York toll authorities are now in the process of replacing their first generation 915 MHz Mark IV-built IAG transponders, some 5 million or so, with second generation 915 MHz Mark IV-built IAG systems.

IBTTA in July 2005 produced an "ETC Requirements Document" which specifies that the only acceptable way forward is "co-deployment" in which 915MHz and 5.9GHz operate together in the same toll systems for a number of years at least. The Atlantic Beach Bridge tests will be invaluable in proving this to everyone.

3 Key ITS Standards – Identification and Assessment Methodology

3.1 Introduction

This section discusses the methodology used for identifying Key ITS Standards for the State of New York, and summary information about Key ITS Standards, and its applicability for deployment.

3.2 Identification and Assessment Methodology

The methodology used to determine whether an ITS Standard is "key" for the State of New York is, to some extent, based on experience and engineering judgment. Therefore, the list of Key ITS Standards may expand or shrink over time depending on what makes sense and lessons learned from deployment experience. Given the evolving nature and relative recent emergence of the ITS standards, this represents a reasonable approach.

It is noteworthy that deployments of neighboring regional transportation agencies that operate within New York were also considered, in addition to those of the NYSDOT. This includes other New York State transportation agencies, such as New York State Thruway, New York State Bridge Authority, and the Metropolitan Transportation Authority; bi-state agencies such as the NITTEC and the Port Authority of New York and New Jersey, and city agencies such as New York City DOT.

Three factors were used to help identify whether an ITS standard is a "key" ITS Standard for New York. The criteria include:

- **ITS Architecture Assessment.** Identifies whether the standard is included in the regional ITS architectures of New York State
- **Maturity and Stability of Standard.** Gauges whether the ITS Standard is stable (after having gone through several revisions), or is still under development
- **Deployment Experience.** Assesses whether the ITS Standard has been previously deployed in New York State or by other transportation agencies.

The results of the ITS Architecture assessment is included in Appendix A. The List of Key ITS Standards together with an assessment of maturity and deployment experience is covered in the next chapter.

4 Key ITS Standards – An ITS Standards Framework and List of Key ITS Standards

This chapter provides an overview of Key ITS Standards, and assesses the current use of ITS standards in deployments, identifying those standards that are sufficiently mature for deployment or testing in the near term, and based on criteria (to be finalized with NYSDOT) recommends ITS Standards that should be used for New York State ITS deployments.

4.1 Introduction: An ITS Standards Framework for New York State

It is recommended that New York State adopt and ITS Standards Framework to cover ITS communications.

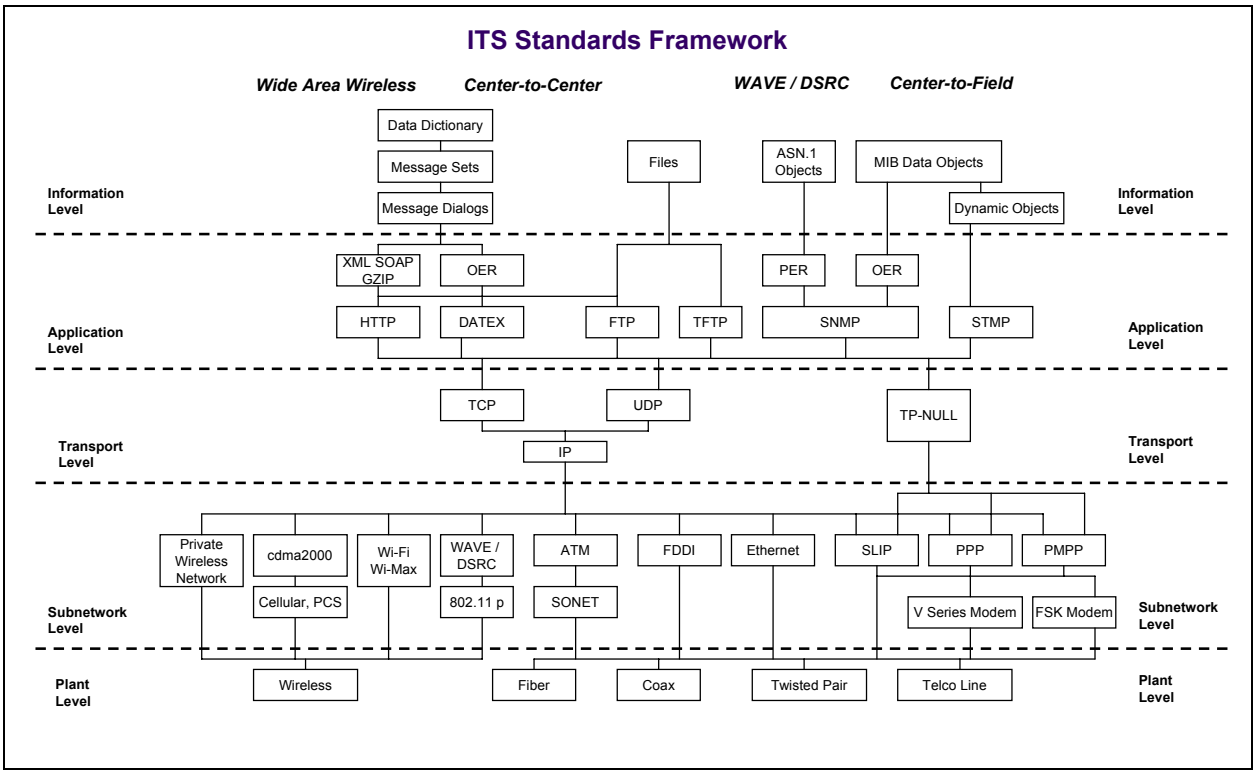
One such ITS Standards Framework, which may be used (and expanded to include other standards relevant to NYS), is the NTCIP Framework. The NTCIP Framework covers *wireline center-to-field* and *wireline center-to-center communications*. What will be discussed below is an "ITS Standards Framework", expanded to include both ITS and other industry standards to cover *wide area wireless* and *WAVE/DSRC* communications.

[Note: Much of the information presented in the remainder of this section was adapted based on the description of the NTCIP Framework contained in the NTCIP Guide.]

The ITS Standards Framework uses a layered or modular approach to communications standards, similar to the layering approach adopted by the Internet and the International Organization of Standards. In general, data communications between two computers or other electronic devices can be considered to involve the following primary layers, called "levels" in the ITS Standards Framework, to distinguish them from those defined by the International Organization of Standards Open Systems Interconnect (OSI) Basic Reference model ("OSI model").

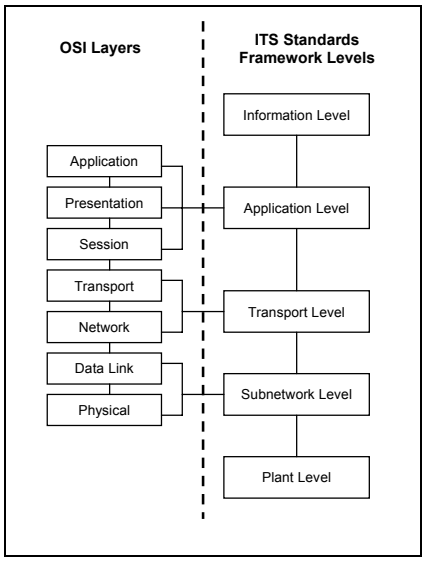
The OSI model was used to help define the ITS Standards Framework. The ITS Standards Framework is shown in the figure below.

Figure 4-1. An ITS Standards Framework for NYS



Although OSI communications protocols are not widely used, the layered model remains. The OSI model breaks the communications process into seven well-defined layers. Each layer has a defined purpose, generally independent of adjacent layers. The graphic below shows how the ITS Standards Framework Information, Application, Transport, Subnetwork, and Plant Levels relate to the OSI model.

Figure 4-2. Relation of the ITS Standards Framework to the OSI Model



Each of the ITS Standards Framework levels is described below:

- **Information Level Standards**. Information standards define the meaning of data and messages and generally deal with ITS information (rather than information about the communications network). This is similar to defining a dictionary and phrase list within a language. These standards are above the traditional OSI seven-layer model. Information level standards represent the functionality of the system to be implemented.
- **Application Level Standards.** Application standards define the rules and procedures for exchanging information data. The rules may include definitions of proper grammar and syntax of a single statement, as well as the sequence of allowed statements. This is similar to combining words and phrases to form a sentence, or a complete thought, and de fining the rules for greeting each other and exchanging information. These standards are roughly equivalent to the Session, Presentation and Application Layers of the OSI model.
- **Transport Level Standards.** Transport standards define the rules and procedures for exchanging the Application data between point 'A' and point 'X' on a network, including any necessary routing, message disassembly/re-assembly and network management functions. This is similar to the rules and procedures used by the telephone company to connect two remotely located telephones. Transportation level standards are roughly equivalent to the Transport and Network Layers of the OSI model.
- **Subnetwork Level Standards.** Subnetwork standards define the rules and procedures for exchanging data between two 'adjacent' devices over some communications media. This is equivalent to the rules used by the telephone company to exchange data over a cellular link versus the rules used to exchange data over a twisted pair copper wire. These standards are roughly equivalent to the Data Link and Physical Layers of the OSI model.
- **Plant Level Standards.** The Plant Level is shown in the ITS Standards Framework only as a means of providing a point of reference. The Plant Level includes the communications infrastructure over which communications standards are to be used and will have a direct impact on the selection of an appropriate Subnetwork Level for use over the selected communications infrastructure. The ITS standards do not prescribe any one media type over another.

To ensure a working system, deployments must specify and/or select one or more standards at each level.

4.2 List of Key ITS Standards

This subsection presents a list of the Key ITS Standards organized by level of the ITS Standards framework. In the next chapter, specific standards (taken from each level) are combined into "ITS communications packages" that can be used are potential alternatives for deployment. Appendix B contains reference material for each Key ITS Standard listed below.

Table 4-1. Key ITS Standards – Information Level Standards

Standards Usage	Standard	Status / Maturity	Deployment / Comment	Testing and Deployment Opportunity
Center-to-Field Device Communications	NTCIP 1201 – Global Objects	Stable	Widely Deployed.	
	NTCIP 1202 – Actuated Traffic Signal Controllers	Stable	Limited Deployment. Early versions of standard deployed in Arizona and North Carolina with challenges. Portions of standard deployed in New York City.	Yes
	NTCIP 1203 – Dynamic Message Signs	Stable	Widely Deployed. Standard is being specified and deployed in NYSDOT Regions 5, 11, and others.	Yes
	NTCIP 1204 – Environmental Sensor Stations	Stable	Limited Deployment.	Yes
	NTCIP 1205 – CCTV Cameras	Stable	Limited Deployment. Standard is being deployed in Florida.	Yes
	NTCIP 1206 – Data Collection	Requires Further Evaluation	Limited Deployment.	Yes
	NTCIP 1207 – Ramp Meter	Stable	Limited Deployment. Standard is being deployed in Salt Lake City, Utah.	
	NTCIP 1208 – Video Switches	Requires Further Evaluation	None	
	NTCIP 1209 – Transportation Sensor System	Requires Further Evaluation	None	
	NTCIP 1210 – Signal System Masters	Under Development	None	
	NTCIP 1211 – Signal Control Priority	Requires Further Evaluation	Limited Deployment	
	NTCIP 1212 – Network Camera Operation	Requires Further Evaluation	None	

Standards Usage	Standard	Status / Maturity	Deployment / Comment	Testing and Deployment Opportunity
Roadway Weather Information Systems	NTCIP 1301 – Weather Report Message Set	Under Development	None	
Advanced Public Transportation Systems	APTA TCIP-S-001 – Transit Communications Interface Profiles	Under Development	Limited Deployment. Portions of standard being deployed as part of NYSDOT TSDEA project.	Yes
Archived Data Management Systems	ASTM WK7604 – Archiving ITS-Related Traffic Monitoring Data	Requires Further Evaluation	None	Yes
Incident Management Systems	IEEE 1512.x – Incident Management Message Sets.	Stable	Limited Deployment. Portions of standard being deployed as part of NYSDOT IEN and IIMS projects. 1512.BASE, 1512.1 through 1512.3 version 2.0 balloted or ready for ballot. 1512.4 under development.	Yes
Highway Rail Intersection Systems (At Grade Crossings)	IEEE 1570 – Standard for the Interface Between the Rail Subsystem and the Highway Subsystem at the Highway Rail Intersection	Requires Further Evaluation		Yes
Advanced Traffic Management Systems	ITE/AASHTO – Traffic Management Center-to-Center Communications {Advanced Traffic Management Data Dictionary (TMDD) and Message Sets (MS)} version 2.1	Stable	Widely Deployed.	Yes
Advanced Traveler Information Systems	SAE-J2354 – Message Sets for Advanced Traveler Information Systems (ATIS) Revision 2.0	Stable	Limited Deployment.	Yes
WAVE/DSRC Systems	SAE-J2734 – Standard for Data Dictionary and Message Sets for DSRC	Under Development	None. WAVE/DSRC Roadside to Vehicle Alerts.	Yes
	OmniAir Consortium – Electronic Payment Systems.	Under Development	None. WAVE/DSRC Electronic Payment Systems.	Yes
Support Standard	SAE-J2266 – Location Referencing Message Specification		This standard is referenced by other Information Level standards.	
	SAE-J2529 – Rules for Standardizing Street Names		This standard is referenced by other	

Standards Usage	Standard	Status / Maturity	Deployment / Comment	Testing and Deployment Opportunity
	and Route IDs		Information Level standards.	
	SAE-J2540-2 - ITIS (International Traveler Information Systems" Phrase List		This standard is referenced by other Information Level standards.	
	NTCIP 1104 – C2C Naming Convention		This standard is referenced by other Information Level standards.	
Guidance Document	ASTM WK7592 – Practice for Metadata to Support ADMS			
	ASTM E2259-03 – Standard Guide for Archiving and Retrieving ITS-Generated Data			
	IEEE 1512 Guide			
	NTCIP 9001 – NTCIP Guide			
	NTCIP 9010 – XML in ITS Center-to-Center Communications			
	NTCIP 9012 – Testing Guide for Users			

Table 4-2. Key ITS Standards – Application Level Standards

Standards Usage	Standard	Status / Maturity	Deployment	Testing and Deployment Opportunity
Center-to-Field Device Communications	NTCIP 1101 – STMF	Stable	Widely Deployed. Defined SNMP-based Communications between a manager (typically a center) and agent (typically a device).	Yes
	NTCIP 1102 – OER	Stable	Limited Deployment. Recently Approved.	Yes
	NTCIP 1103 – STMP	Stable	Limited Deployment. Recently Approved. Extension of SNMP, developed primarily to support traffic signal controllers and devices that communicate using event-driven communications initiated by a subscription.	Yes
	NTCIP 2301 – STMF	Stable	Widely Deployed	Yes
	NTCIP 2302 – TFTP	Stable	Limited Deployment.	
	NTCIP 2303 – FTP	Stable	Limited Deployment	
Center-to-Center Communications	NTCIP 2304 – Application Profile for DATEX Communications	Stable	Limited Deployment. Deployed by TRANSCOM. Interface being deployed by NYSDOT as part of the IEN project.	
	NTCIP 2306 – Applications Profile for XML Center-to-Center Communications	Version 1.0 Ready for Ballot.	Limited Deployment. Being deployed by NYSDOT as part of the IEN project, and possibly TSDEA.	Yes
WAVE/DSRC	IEEE P1609.1 – WAVE Application Resource Manager	Version 1.0 Ready for Ballot.	U.S. 5.9 GHz Prototype Program	Yes
	IEEE 1609.2 – WAVE Application Services Manager (Radio Security Service)	Under Development	None	Yes

Table 4-3. Key ITS Standards – Transport Level Standards

Standards Usage	Standard	Status / Maturity	Deployment	Testing and Deployment Opportunity
Center-to-Field Device Communications	NTCIP 2201 – Transportation Transport Profile	Yes	Widely Deployed.	Yes
Center-to-Field Device Communications	NTCIP 2202 – Internet Profile	Yes	Limited Deployment. References IETF TCP, UDP, and IP standards. Being specified and deployed by NYSDOT in Regions 5, 11, and others.	Yes
Center-to-Center Communications	IETF TCP and IP Standards	Yes	Widely Deployed. Being specified and deployed by NYSDOT as part of the IEN project, and possibly TSDEA.	Yes
Wide Area Wireless Communications	IETF TCP and IP Standards	Yes	Limited Deployment. Being specified and deployed by NYSDOT as part of the IIMS project.	Yes
WAVE/DSRC	IEEE P1609.3 – WAVE Network Services Manager	Under Development	U.S. 5.9 GHz Prototype Program	Yes

Table 4-4. Key ITS Standards – Subnetwork Level Standards

Standards Usage	Standard	Status / Maturity	Deployment	Testing and Deployment Opportunity
Center-to-Field Device Communications	NTCIP 2101 – PMPP/RS232	Stable	Widely Deployed.	Yes
	NTCIP 2102 – PMPP/FSK	Stable	Limited Deployment.	Yes
	NTCIP 2103 – PPP/RS232	Stable	Limited Deployment.	Yes
	NTCIP 2104 - Ethernet	Stable	Limited Deployment.	Yes
Center-to-Center Communications	Various Non-ITS Industry and Telecommunications Standards may apply.	Stable	Widely Deployed. Possible Non-ITS Standards Applicable.	Yes
Wide Area Wireless Communications	Various Non-ITS Industry and Telecommunications Standards may apply.	Stable	Limited Deployment. Non-ITS Standards Applicable.	Yes
WAVE/DSRC	IEEE P1609.4 – WAVE Media Access Control (MAC) Extension Service	Under Development	U.S. 5.9 GHz Prototype Program	Yes
	IEEE 802.11 p	Under Development		Yes

{HARDWARE STANDARDS}

5 Key ITS Standards – ITS Standards Communications Packages

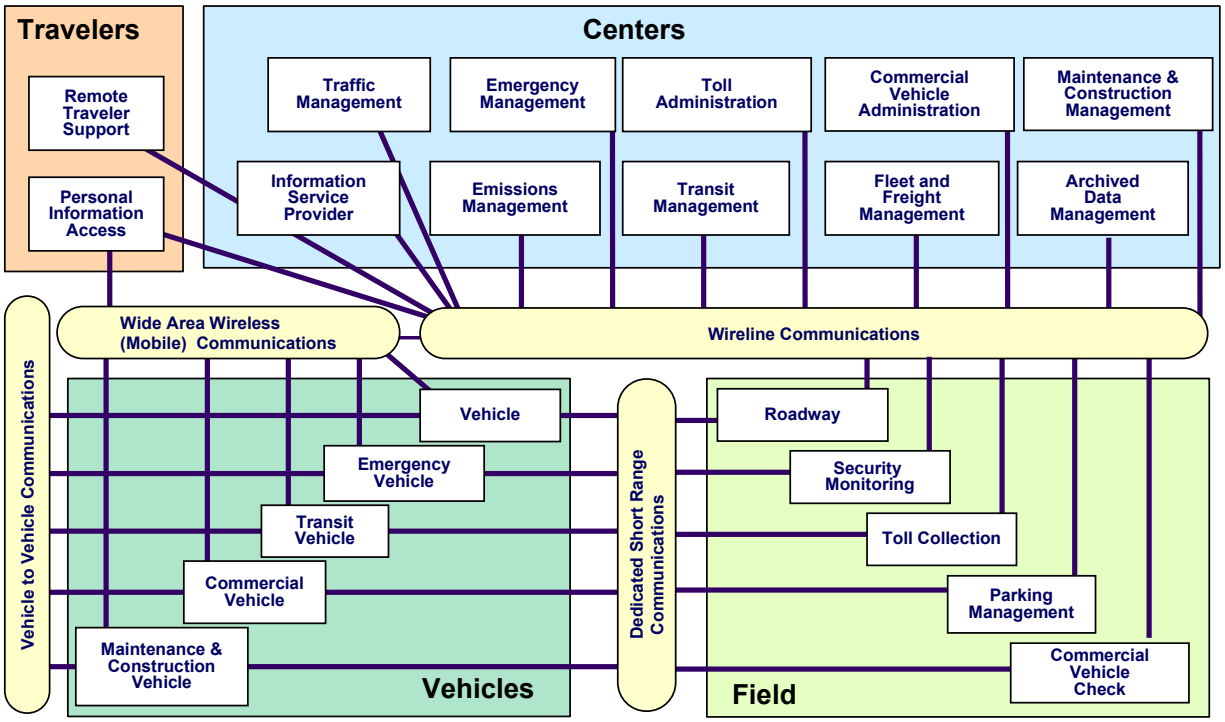
5.1 Introduction: ITS Standards Communications Packages

This chapter discusses applying the ITS Standards Framework and introduces the concept of an ITS Standards Communication Package. As shown in the previous chapter, the ITS Standards Framework provides an organized way to think about which standards (both ITS and industry standards) need to be specified together to provide deployment level detail for ITS systems. In particular, the ITS Standards Framework was applied to show standards that relate to 3 of the 4 methods of communications described in the National ITS Architecture. These are:

- Wireline Center-to-Field and Center-to-Center Communications,
- Wide Area Wireless Communications, and
- WAVE / DSRC

The fourth communications method described in the National ITS Architecture (Vehicle-to-Vehicle) was not identified as a requirement for NYSDOT and is not included in this analysis.

Figure 5-1. National ITS Architecture Communications Methods



In this chapter we introduce the term “ITS Standards Communications Packages,” roughly equivalent to the concept of a “communications protocol stack”.

An ITS Standards Communication Package combines specific standards (taken from all of the levels in the ITS Standards Framework) into alternatives for deployment of: 1) Wireline Communications, 2) Wide Area Wireless Communications, and 3) WAVE / DSRC.

Ten ITS Standards Communications Packages in all are introduced in the sections below.

5.2 Using the ITS Standards Communications Packages

The ITS Standards Communication Packages (CPs) are intended to be representative rather than mandatory. They represent re-usable communications stacks, or generic templates, that together define all of the levels of communications required for ITS deployments. Others are possible, but these represent a starting point to ease ITS communications architecture and design. This should help project developers a head start in understanding which ITS standards to apply in developing an ITS communications solution.

The communications packages may also be thought of as a checklist to be used in developing procurement specifications, and can be used to show a high level communications design, suitable as introductory material when describing a complete ITS communications solution.

5.3 ITS Standards Communications Packages

Based on ITS Standards Framework 10 ITS Standards Communications Packages have been developed, addressing wireline, wide area wireless, and WAV/DSRC communications. These are illustrated in the text and figures below.

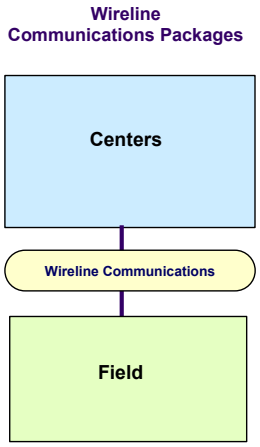
As is shown, the communications packages relate directly to information contained in the National and Regional ITS Architectures. Therefore, the communications packages directly bridge ITS Architectures and ITS Standards for deployments.

5.3.1 Wireline Communications Packages

The Wireline Communications Packages cover Center-to-Field and Center-to-Center communications.

Wireline Communications Packages

- Wireline CP 1 - Center-to-Field Communications over IEEE 802 IP Networks
- Wireline CP 2 - Center-to-Field Communications Point-to-Point or Point-to-MultiPoint
- Wireline CP 3 - XML Messaging for Center-to-Center Communications

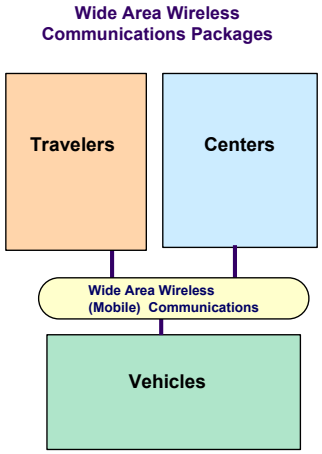


5.3.2 Wide Area Wireless Communications Packages

The Wide Area Wireless Communications Packages provide communications support between a) fixed resources (e.g., centers, kiosks) and mobile resources (e.g., vehicles and PDAs), and b) between mobile resource (or mobile-to-mobile).

Wide Area Wireless Communications Packages

- Wide Area Wireless CP 1 - Mobile XML Messaging over Cellular Networks
- Wide Area Wireless CP 2 - Mobile XML Messaging over Wi-Max Networks
- Wide Area Wireless CP 3 - Mobile XML Messaging over Private IP Networks
- Wide Area Wireless CP 4 - Mobile XML Messaging over Private non-IP Networks
- Wide Area Wireless CP 5 - Mobile XML Messaging over Wi-Fi Local Area Networks

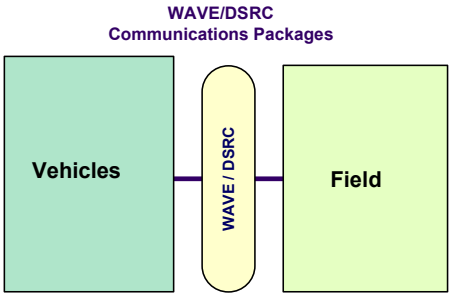


5.3.3 WAVE/DSRC Communications Packages

The WAVE/DSRC Communications Packages provide communications support between vehicles and field devices. The U.S. FCC has assigned a spectrum in the 5.9 GHz range for this purpose.

WAVE/DSRC Communications Packages

- WAVE/DSRC CP 1 - Resource Manager Applications
- WAVE/DSRC CP 2 - IP Applications



5.4 Wireline Communications Packages

5.4.1 Wireline CP 1 - Center-to-Field Communications over IEEE 802 IP Networks

This communications package is used in ITS applications to connect center systems and field devices using an IEEE 802 IP-based network. The communications media may include privately installed (DOT owned) fiber and coaxial communications, or a leased IP-network.

Table 5-1. Wireline CP 1 - Center-to-Field Communications over IEEE 802 IP Networks

ITS Standards Framework	Technology/Implementation	Standards
Information Level	NTCIP MIB Objects	NTCIP 1200 Series MIBs
Application Level	SNMP	NTCIP 2301
Transport Level	TCP IP	NTCIP 2202 identifies the use of these IETF Standards
Subnetwork Level	Layer 2 – Data Link IEEE 802 Networks, Token Ring, FDDI, HDLC, Frame Relay, ATM, Fibre Channel Layer 1 - Physical T1, E1, 10BASE-T, 100BASE-TX, ISDN, SONET, DSL	NTCIP 2104 defines framework for IEEE 802 Networks.
Plant Level	Fiber, Coax	

5.4.2 Wireline CP 2 - Center-to-Field Communications Point-to-Point or Point-to-MultiPoint

This communications package is used in ITS applications to connect center systems and field devices within a point-to-point or point-to-multipoint network configuration using serial communications. The communications media may include privately installed (DOT owned) communications, dial-up, or leased line.

Table 5-2. Wireline CP 2 - Center-to-Field Communications Point-to-Point or Point-to-MultiPoint

ITS Standards Framework	Technology/Implementation	Standards
Information Level	NTCIP MIB Objects	NTCIP 1200 Series MIBs
Application Level	SNMP	NTCIP 2301
Transport Level	TP (null)	NTCIP 2201
Subnetwork Level	Layer 2 - Data Link SLIP, PPP, PMPP Layer 1 - Physical RS-232, V.35, V.34	NTCIP 2103 (PPP) NTCIP 2101 /2102 (PPP/PMPP) V Series Modem FSK Modem
Plant	Twisted pair, Leased line (also fiber and coax)	

5.4.3 Wireline CP 3 - XML Messaging for Center-to-Center Communications

This communications package is used to support XML messaging over IP-based networks between ITS center systems (center-to-center). A wide variety of network configurations are supported, including connection of centers via the Internet. Communications media may include privately installed (DOT owned) communications, leased IP communications networks (e.g., frame relay), dial-up, or leased line.

Table 5-3. Wireline CP 3 - XML Messaging for Center-to-Center Communications

ITS Standards Framework	Technology/Implementation	Standards
Information Level	XML Schema WSDL	IEEE 1512.x APTA TCIP TMDD SAE J2354
Application Level	Gzip, XML, SOAP	NTCIP 2306 - Application Profile for Message Encoding and Transport. Defines encoding rules for WSDL, XML messages, and Gzip compression. References IETF and W3C Standards for XML, SOAP, WSDL, and and the Gzip standards.
Application Level	HTTP/ FTP HTTPS	NTCIP 2306 references the following standards: IETF RFC 2612 (HTTP) IETF RFC 959 (FTP)
Transport Level	TCP IP	IETF RFC 793 (TCP) IETF RFC 791 (IP)
Subnetwork Level	Layer 2 – Data Link IEEE 802 Networks, Token Ring, FDDI, SLIP, PPP, HDLC, Frame Relay, ATM, Fibre Channel Layer 1 - Physical RS-232, V.35, V.34, T1, E1, 10BASE-T, 100BASE-TX, ISDN, SONET, DSL	NTCIP 2104 defines framework for IEEE 802 Networks. NTCIP 2103 identifies PPP.
Plant	Twisted pair, Leased line, Fiber, Coax	

5.5 Wide Area Wireless Communications Packages

5.5.1 Wide Area Wireless CP 1 - Mobile XML Messaging over Cellular Networks

This communications package is used in ITS applications to connect centers and vehicles, centers and traveler information devices (e.g., PDA, cellular telephone). Communications between mobile command center vehicles and other vehicles may also be supported. This communications package supports compressed XML messaging over cellular and PCS IP-based networks using the 3G (third generation) wireless digital communications technologies such as cdma2000 and IP-based interfaces (together IP-based wide area wireless networks are being developed – e.g., 1xRTT, and 1xEV-DO).

Table 5-4. Wide Area Wireless CP 1 - Mobile XML Messaging over Cellular Networks

ITS Standards Framework	Technology/Implementation	Standards
Information Level	XML Schema WSDL	IEEE 1512.x APTA TCIP TMDD SAE J2354
Application Level	Gzip, XML	NTCIP 2306 - Application Profile for Message Encoding and Transport. Defines encoding rules for WSDL, XML messages, and Gzip compression. References IETF and W3C Standards for XML, SOAP, WSDL, and and the Gzip standards.
Application Level	HTTP/ HTTPS	NTCIP 2306 references the following standards: IETF RFC 2612 (HTTP) IETF RFC 959 (FTP)
Transport Level	TCP IP	IETF RFC 793 (TCP) IETF RFC 791 (IPv4) IETF RFC 2460 (IPv6)
Subnetwork Level	3GPP2 P.R0001 - Wireless IP Architecture Based on IETF Protocols cdma2000 • 1xRTT • 1xEV-DO	Standards of the 3G Wireless Partnership (3GPP2)and TIA (Telecommunications Industry Association).
Plant Level	E.g., Spread Spectrum Radio 800 Mhz (Cellular) / 1900 Mhz (PCS)	FCC

5.5.2 Wide Area Wireless CP 2 - Mobile XML Messaging over Wi-Max Networks

This communications package can be used to accomplish wide area wireless communications in ITS applications similar to those described in Wide Area Wireless CP 1. The difference between the two approaches is found in the wireless subnetwork and plant levels, which outline the use of the IEEE 802 Wi-Max standards.

Table 5-5. Wide Area Wireless CP 2 - Mobile XML Messaging over Wi-Max Networks

ITS Standards Framework	Technology/Implementation	Standards
Information Level	XML Schema WSDL	IEEE 1512.x APTA TCIP TMDD SAE J2354
Application Level	Gzip, XML	NTCIP 2306 - Application Profile for Message Encoding and Transport. Defines encoding rules for WSDL, XML messages, and Gzip compression. References IETF and W3C Standards for XML, SOAP, WSDL, and and the Gzip standards.
Application Level	HTTP/ HTTPS	NTCIP 2306 references the following standards: IETF RFC 2612 (HTTP) IETF RFC 959 (FTP)
Transport Level	TCP IP	IETF RFC 793 (TCP) IETF RFC 791 (IPv4) IETF RFC 2460 (IPv6)
Subnetwork Level	802.2 802.16 (Wi-Max)	NTCIP 2104 defines framework for IEEE 802 Networks.
Plant Level	Microwave	FCC Licensed and Unlicensed

5.5.3 Wide Area Wireless CP 3 - Mobile XML Messaging over Private IP Networks

This communications package can be used to accomplish wide area wireless communications in ITS applications similar to those described in Wide Area Wireless CP 1. The difference between the two approaches is found in the wireless subnetwork and plant levels. While Wide Area Wireless CP1 and CP2 outline the use of leased (or public) wireless IP networks, this communications profile would be used for those applications that will be installing their own private wireless IP-based communications networks. Example private wireless networks are used extensively to communicate between public safety dispatch and vehicle systems – for example, 700/800 MHz and AMPS cellular systems with an IP service module included.

Table 5-6. Wide Area Wireless CP 3 - Mobile XML Messaging over Private IP Networks

ITS Standards Framework	Technology/Implementation	Standards
Information Level	XML Schema WSDL	IEEE 1512.x APTA TCIP TMDD SAE J2354
Application Level	Gzip, XML	NTCIP 2306 - Application Profile defines Message Encoding and Transport. Defines encoding rules for WSDL, XML messages, and Gzip compression.
Application Level	HTTP/ HTTPS	NTCIP 2306 references the following standards: IETF RFC 2612 (HTTP) IETF RFC 959 (FTP)
Transport Level	TCP IP	IETF RFC 793 (TCP) IETF RFC 791 (IP)
Subnetwork Level	Vendor Specific	Project or Vendor Specific
Plant Level	700/800 MHz, AMPS Cellular	

5.5.4 Wide Area Wireless CP 4 - Mobile XML Messaging over Private non-IP Networks

This communications package can be used to accomplish wide area wireless communications in ITS applications similar to those described in Wide Area Wireless CP 1 with subnetwork communications and plant being privately (agency) owned and operated. The difference between this communications package and CP 3 is the lack of support for the TCP/IP at the transport level. Example private wireless networks are used extensively to communicate between public safety dispatch and vehicle systems – for example, 700/800 MHz and AMPS cellular systems.

Table 5-7. Wide Area Wireless CP 4 - Mobile XML Messaging over Private non-IP Networks

ITS Standards Framework	Technology/Implementation	Standards
Information Level	XML Schema WSDL	IEEE 1512.x APTA TCIP TMDD SAE J2354
Application Level	Gzip, XML	NTCIP 2306 - Application Profile for Message Encoding and Transport. Defines encoding rules for WSDL, XML messages, and Gzip compression. References IETF and W3C Standards for XML, SOAP, WSDL, and and the Gzip standards.
Transport Level	Vendor Specific	Project or Vendor Specific
Subnetwork Level	Vendor Specific	Project or Vendor Specific
Plant Level	700/800 MHz, AMPS Cellular	

5.5.5 Wide Area Wireless CP 5 - Mobile XML Messaging over Wi-Fi Local Area Networks

This communications package is used to support XML messaging between center systems and mobile resources (vehicles, traveler systems, etc.) over wireless Wi-Fi (IEEE 802.11b,g) IP-based local area networks. ITS applications may include connecting vehicle and garage systems, maintenance crew PDAs and maintenance centers, etc.

Table 5-8. Wide Area Wireless CP 5 - Mobile XML Messaging over Wi-Fi Local Area Networks

ITS Standards Framework	Technology/Implementation	Standards
Information Level	XML Schema WSDL	IEEE 1512.x APTA TCIP TMDD SAE J2354
Application Level	Gzip, XML	NTCIP 2306 - Application Profile for Message Encoding and Transport. Defines encoding rules for WSDL, XML messages, and Gzip compression. References IETF and W3C Standards for XML, SOAP, WSDL, and and the Gzip standards.
Application Level	HTTP/ HTTPS	NTCIP 2306 references the following standards: IETF RFC 2612 (HTTP) IETF RFC 959 (FTP)
Transport Level	TCP IP	IETF RFC 793 (TCP) IETF RFC 791 (IP)
Subnetwork Level	802.2 802.11 b, g (Wi-Fi)	IEEE 802 Network Standards
Plant Level	2.4 Ghz Radio	Unlicensed

5.6 WAVE/DSRC Communications Packages

5.6.1 WAVE/DSRC CP 1 - Resource Manager Applications

This communications package is used to support messaging between vehicle onboard units (OBUs) and roadside units (RSUs). ITS applications (on OBUs and RSUs) must conform with the IEEE 1609.1 Resource Manager specifications, which bridges communications to the lower levels and the IEEE 802.11 p (5.9 GHz). The OBU is an SNMP Agent application and the RSU is an SNMP Manager. ITS Application level standards are being developed for the Electronic Payment System (EPS), and a portion of the spectrum is reserved for public/vehicle safety applications, include Wireless Short Messages.

Table 5-9. WAVE/DSRC CP 1 - Resource Manager Applications

ITS Standards Framework	Technology/Implementation	Standards
Information Level	ASN.1	OmniAir EPS Applications Committee
Application Level	PER – Packed Encoding Rules SNMP	IEEE 1609.1 – Application Resource Manager
Application Level	Radio Security Service (Infrared, PKI Security, RF-ID Security)	IEEE 1609.2 – WAVE Application Services
Transport Level	IEEE 1609.3 • TCP/UDP (IETF) • ISO 21210 (Mobile IP) • IETF 3095 (ROHC)	IEEE 1609.3 – WAVE Network Services
Subnetwork Level	IEEE 1609.4 MAC Extension IEEE 802.2 IEEE 802.11 p	IEEE 1609.4 – WAVE Media Access Control (MAC) Extension Services IEEE 802.2 IEEE 802.11 p
Plant Level	5.9 Ghz	FCC Licensed

5.6.2 WAVE/DSRC CP 2 - IP Applications

This communications package is used to support ITS applications that communicate between vehicle onboard units (OBUs) and roadside units (RSUs). IP-based ITS applications bypass the upper layer IEEE 1609.1 & IEEE 1609.2 specifications and communicate directly with the IEEE 1609.3 network services layer, which bridges communications to the lower levels and the IEEE 802.11 p (5.9 GHz). The OBU is an SNMP Agent application and the RSU is an SNMP Manager. ITS Application level standards are being developed for the Roadside to Vehicle Alerts (SAE-J2734).

Additional IP applications may be developed to support Commercial Vehicle Operations and Transit Signal Priority.

Table 5-10. WAVE/DSRC CP 2 - IP Applications

ITS Standards Framework	Technology/Implementation	Standards
Information Level	ASN.1	SAE-J2734
Application Level	PER SNMP	SAE DSRC committee is also investigating the use of byte-encoded compressed XML
Transport Level	TCP/UDP (IETF) ISO 21210 (Mobile IP) IETF 3095 (ROHC)	IEEE 1609.3
Subnetwork Level	IEEE 1609.4 MAC Extension IEEE 802.2 IEEE 802.11 p	IEEE 1609.4 MAC Extension IEEE 802.2 IEEE 802.11 p
Plant	5.9 Ghz	FCC

6 Key ITS Standards – Strategy and Recommendations for Deployment and Testing

{NOTE: The information and recommendations contained in this section are preliminary and have not been reviewed by NYSDOT.}

6.1 Introduction

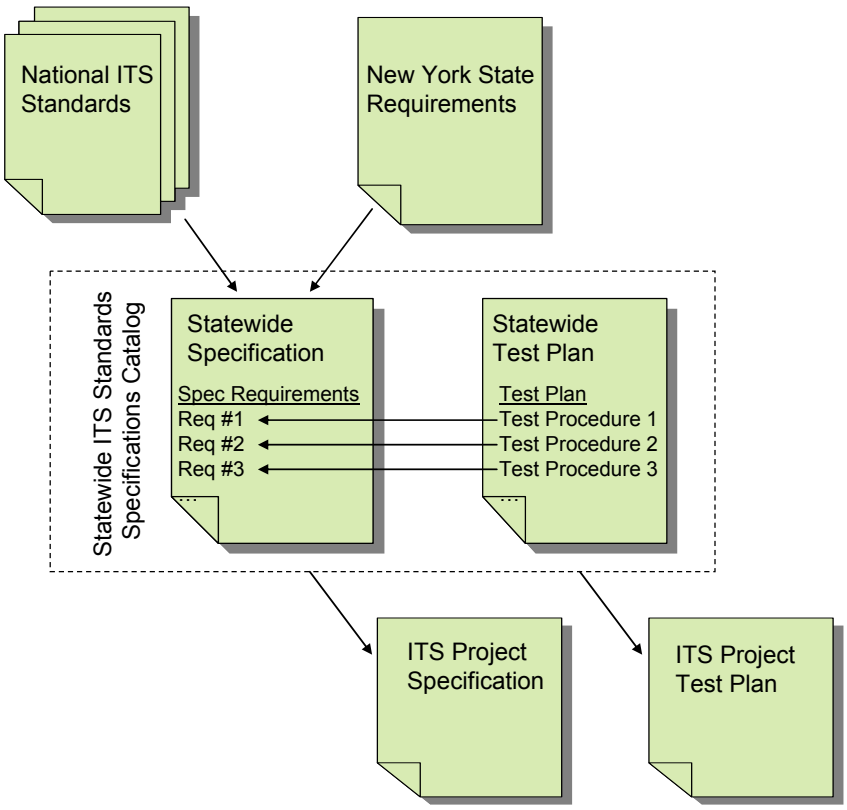
In chapter 2, this report reviewed some of the ITS deployments shaping the application of ITS Standards in New York State. These projects, and others, taken together represent the "first generation projects" deploying the ITS standards. NYSDOT and New York State have remained committed to ITS Standards and have implemented a wide range of standards, gaining valuable experience in the process.

As a pioneer in ITS standards deployment NYSDOT is now asking questions such as:

- What is our strategy regarding standards moving forward?
- How do we capture the lessons learned and experience of the "first generation projects" and apply them to the next generation of projects?
- How do we move from proof-of-concept, early deployment, small scope, laboratory environment projects to large ITS deployments? What are the risks involved?
- What testing strategy should we implement to make sure that large deployments go smoothly?

The focus of the next few sections of this chapter is to help answer some of these questions. The key elements of the strategy and plan, however, are summarized succinctly in the figure below.

Figure 6-1. ITS Standards Specification Development and Testing Framework



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6.2 Key ITS Standards: Action Plan

While NYSDOT has been an active supporter of the ITS Standards program and developed significant experience, many project planners and designers are unfamiliar with ITS, standards, and communications technologies. Several things can be done to help the "second generation" of ITS deployers to learn from the early pioneers, and focused help (in the form of example and sample specifications) can be developed to aid in the process of ITS standards-based communications specification development. Three key action points are defined below:

1. Develop Guidance and Courses on ITS Standards-based Deployments
2. Develop a Statewide ITS Standards Specification Catalog
3. Encourage Agency and Consultant Participation in ITS Standards Committees

It is noteworthy that these action items fully support the Key ITS Standards Strategy for Deployment and Testing outlined in the next section.

Action Plan Item 1: Develop Guidance and Courses on ITS Standards-based Deployments

Support projects (such as Task 2A) to develop Guidance and Courses for ITS designers and engineers specifically targeted towards specification development and ITS standards-based deployment.

Action Plan Item 2: Develop a Statewide ITS Standards Specification Catalog

An ITS Standards Specifications Catalog would define the following (as a minimum):

- Sample **functional requirements** and **concepts of operation** for field devices, incident information sharing, and WAVE/DSRC ITS applications. This will define the information needed to support development of the information level specifications.
- Sample detailed specifications included filled in **PICS** (protocol implementation conformance specification) and **MIBs** (management information base) for field device communications (information level specifications).
- Sample **message and dialog specifications for center-to-center** communications (information level specifications).
- Sample specifications to support **specific ITS Standards Communications Packages** ("a complete communications protocol stack") for application, transport, subnetwork, and plant level standards).

Given these pre-defined specifications, ITS engineers could quickly pull together draft ITS specifications, draft feasibility studies for alternatives for deployment of ITS communications, and project systems engineering analysis reports.

Action Plan Item 3: Encourage Agency and Consultant Participation in ITS Standards Committees

Continue to support and encourage agency and consultant participation in ITS Standards Committees. The knowledge gained at ITS Standards Committees and speaking directly with the standards developers greatly helps designers and engineers assess the status of standards and deployments (both early successes and pitfalls).

6.3 Key ITS Standards: Strategy for Deployment and Testing

This section will discuss specific risks in specifying the key standards identified above. Risks for each key ITS standard will be reviewed. Mitigation strategies for reducing risks will also be discussed.

6.3.1 Strategy Goals for Deployment and Testing

Starting from the tables of Key ITS Standards in chapter 4, which identified standards as potential deployment and testing opportunities, four strategy goals were developed:

1. Broaden Experience and Deployment of Center-to-Center Communications

2. Broaden Experience and Deployment of Center-to-Field Device Communications
3. Broaden Experience and Deployment of WAVE/DSRC Communications
4. Assess Hardware Standards for Project Deployment

Goal 1: Broaden Experience and Deployment of Center-to-Center Communications

NYSDOT has developed experiences across many of the information level standards for center-to-center, including: IEEE 1512 Incident Management, TMDD Traffic Management, and TCIP Transit Management standards. Other information level standards that may be applicable to NYSDOT operations include:

- SAE-J2354 Message Sets for Advanced Traveler Information Systems. Specific areas for consideration may include: weather and roadway weather information dissemination for travelers.
- Archived Data Management Systems. These message sets are still under development, but NYSDOT may assess application of the ASTM standards for archiving information, which could then be shared with planners.
- Broaden use, based on project needs, of IEEE 1512, TMDD, and TCIP. Currently, these standards are being apply in projects, but all three standards have broad scopes, a small part of which, is actually being deployed.

Risk Mitigation Strategy – Leverage existing system deployments that have deployed a center-to-center infrastructure.

Goal 2: Broaden Experience and Deployment of Center-to-Field Device Communications

NYSDOT has successfully specified and deployed ITS projects based on the NTCIP field device communication standards. Most notable Dynamic Message Signs.

Others neighboring agencies have also deployed NTCIP-based center-to-field communications. Monroe County has deployed and NTCIP-based CCTV control system, and New York City is deploying NTCIP-based traffic signal control.

NYSDOT should consider the following devices, as they play a major role in freeway management:

- CCTV
- Data Collection Devices
- Environmental Sensor Stations

Risk Mitigation – Focus on standards that have been deployed by others. Deploy only few devices, and consider using the testing services of a laboratory, university, or research institutions.

Goal 3: Broaden Experience and Deployment of WAVE/DSRC Standards

The WAVE/DSRC device and communication standards are still emerging. No large deployments are planned at this time, but the U.S. has a National Prototype Program in place, and a trial project is underway in Long Island, New York. Because of the potential importance long-term of WAVE (vehicle-to-roadside and vehicle-to-vehicle) communications technologies, NYSDOT may wish to become involved early on to help assess how best to develop a solid knowledge base and experience prior to embarking on deployments.

ITS applications of potential interest to NYSDOT long-term include: parking management and payment, commercial vehicle operations, electronic toll collection, in-vehicle roadside alert, emergency vehicle preemption, transit signal priority, electronic border crossing, and port operations.

Specific activities may include:

- Participate in the development of the SAE-J2734 Roadside Alerts information level standard. The approaches developed with this standard will likely influence the development of information level standards in other areas using WAVE IP applications, though which ones is unknown at this time.
- Join WAVE/DSRC Consortium (e.g., OmniAir) and participate in the development of the OmniAir EPS Committee standards.
- Participate in the development of the IEEE 1609 specifications (covers application, transport, and portions of the subnetwork level standards).
- Volunteer as an early deployment (trial) test project site (for example, similar to the 915 MHz/5.9 MHz prototype in Long Island).

Risk Mitigation – Focus on participation and development of the WAVE/DSRC standards. These will likely support NYSDOT interests, long-term.

6.4 Discussion: Testing Program Approaches

It is recommended that New York State develop adopt an ITS Standards Testing Framework.

{NOTE: After review and discussion about a testing program, authors may add text related to: Benefits, disadvantages, and risks with each method for testing ITS standards. Also, the possibility of a centralized testing section or laboratory for New York State, and a qualified products list.}

One such testing framework is documented in the NTCIP 9012 – Testing and Conformity Assessment Users Guide. Though, this document covers only the topic of center-to-field communications, many of the concepts translate to other areas, such as center-to-center and WAVE/DSRC. Also, the OmniAir Consortium has initiated a certification testing program for WAVE/DSRC products.

6.5 Summary of Key Points from NTCIP 9012

Introduction

A successful system deployment is dependent on the availability of "good" specifications. Moreover, an agency cannot develop a good testing plan without clearly defining what is required of the device (or system) in a clear, concise and testable manner. It is important to note that a "good" specification is more than the invocation of a list of standards. When developing the specifications the Agency must examine what the system is supposed to accomplish, how the devices will fit into that system and which standards should be invoked to help make the system meet the Agency's requirements.

Procurement Specifications

The procurement specifications must include:

- List of Standards to be used for the device – both NTCIP and device specific standards
    - Protocol requirements list (PRL) for the device should be included with the standards called-out
    - This list must be specific as to version, date of issue, etc. as the standards have changed over time and will continue to change.
    - Value ranges for all of the objects to clearly identify such parameters as the size of event logs, the number of messages to be supported, and the number of special functions managed.
- Specification of any optional parts of the reference standards that must be included; many of the standards include both mandatory and optional data elements; it is the responsibility of the agency to identify the optional elements which must be supported and the value ranges for those optional data elements (Objects) where appropriate.
- Functional requirements that are not covered by the standards; although the NTCIP standards include a description of the data objects (in ASN.1 format), the agency must review the standards and clearly articulate any specific functionality required or expected from the product understanding that different vendors may interpret the standard differently.

- Performance requirements for the device that are not covered by the standards. The agency must determine what performance requirements to include based on their communications infrastructure, the demands of their central system, and their concept of operations for the ATMS applications. Examples of considerations: the number of units to a channel; the time lag allowed when setting all devices; the poll rate for monitoring status.
- Environmental requirements for the device that are not covered by the *NTCIP* standards. These requirements are generally part of the NEMA TS 2 or TS 4 documents or generic agency specifications.

Interchangeability of Devices

One approach for an agency to obtain interchangeable devices from a specification is to examine the standards and resolve the following, as a minimum:

a. Which optional conformance groups for the device must be supported
b. Which optional objects for the device must be supported
c. Specify minimum support values for certain capabilities (i.e. the minimum number of plans in a traffic signal controller, the minimum number of phases, size of event logs, number of fonts supported, etc)
d. Interpret objects to have a consistent implementation for the device (i.e. *patternTableType* from NTCIP 1202:1996)

A second approach to obtaining interchangeable devices is exemplified by the Florida DOT (FDOT) dynamic message sign procurement. The FDOT approach uses an agency developed management information block (MIB) describing agency-required objects and how they function to supplement the standard MIB objects. Notice that the agency described the functionality (specific power supplies to be monitored) and the custom NTCIP objects to support that "feature". When the functionality is clearly described (in a measurable and observable manner), then devices that use the same objects to manage the same well-defined functionality will be interchangeable (if they are constructed to conform).

Test Plan Development

During the development of a specification or a Request for Proposals (RFP), issues related to testing should be incorporated into project documentation in the form of a test plan. The actual test plan details, at this stage, do not have to be spelled out. However, it should describe who is responsible for developing the test plan, the stages during which testing activities will take place, and who are the responsible parties for executing the testing process.

The principle is to define at least one test procedure for each requirement and then exercise those features in the context of how they should react in terms of normal system operation.

6.6 Discussion: Risk Factors and Mitigation Strategy

Two factors influence the deployment of ITS Standards above others: the maturity and stability of the standard, and deployment experience. Each is described

6.6.1 Risk Factor: Maturity and Stability of Standard

Maturity of an ITS Standard may be an important factor. If an ITS Standard is not yet mature, meaning the ITS Standard is still under development or subject to significant changes, the deployment of an immature ITS Standard can lead to significant risks. These risks may include significantly higher development costs, particularly to upgrade an existing system to comply with the ITS Standard once the its development is complete, incompatibility or interoperability issues, and the risk that the ITS Standard may be incomplete.

6.6.2 Risk Factor: Deployment Experience

An ITS Standard that has not been widely deployed may pose high risk. ITS Standards that have been widely deployed leads to experience in the industry, familiarity, lessons learned, and perhaps proof of concept that the ITS Standard is stable and mature. Weaknesses in the ITS Standard are likely to have been exposed with wide deployments, further reducing the risk of the unknown for New York State.

6.6.3 Risk Mitigation

The following represent ways to manage the risks of standards maturity and stability and deployment experience. These are compiled into “Low Risk” and “High Risk”

{NOTE: The section below, if relevant, needs to be fleshed out.}

Lower Risk Activities

- Low Cost
- Deploying with relatively few numbers of devices
- Deploy in a concentrated geographic area (e.g., Urban Area)
- Deploy using standards that have gone through several revisions, are stable, and have been deployed elsewhere
- Participate in standards development until the time is right
- Incremental Deployment where experience and infrastructure are in place

Higher Risk

- High Cost
- Deploying large numbers of devices
- Deploying across large geographic areas (e.g., Rural Areas, Statewide)
- Deploy using newly available communications standards and products
- Be the first to deploy, with little experience, and infrastructure (especially communications infrastructure and hardware) need to be put in place

A Appendix A – ITS Architecture Assessment

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.

As part of the Key ITS Standards assessment, the consultants 1) reviewed the ITS Standards currently deployed and under development in the United States, and 2) reviewed the list of applicable ITS Standards based on the existing regional ITS architectures in New York. While this analysis did not include a review of every regional ITS architecture in New York, it does represent a comprehensive review of regions with significant ITS deployment (both existing and planned).

The list of New York State regional ITS architectures reviewed is shown in the table below.

Table A-1. Regional ITS Architectures In New York State

NYSDOT Region	Regional ITS Architecture	National ITS Architecture	Included for Analysis
New York Statewide	New York Statewide ITS Services	Version 3	Yes
Region 1	Capital District Region	Version 4	Yes
Region 2	Utica Region		No
Region 3	Syracuse Region		No
Region 4	Rochester Region		No
Region 5	Buffalo-Niagara Bi-National Region	Version 5.1	Yes
Region 6	Region 6 – Hornell		No
Region 7	North County Region		No
Region 8	Hudson Valley		Yes
Region 9	Binghamton Region		No
Region 10	Nassau / Suffolk Counties	Version 4.0	Yes
Region 11	New York City Sub-Region	Version 4.0	Yes

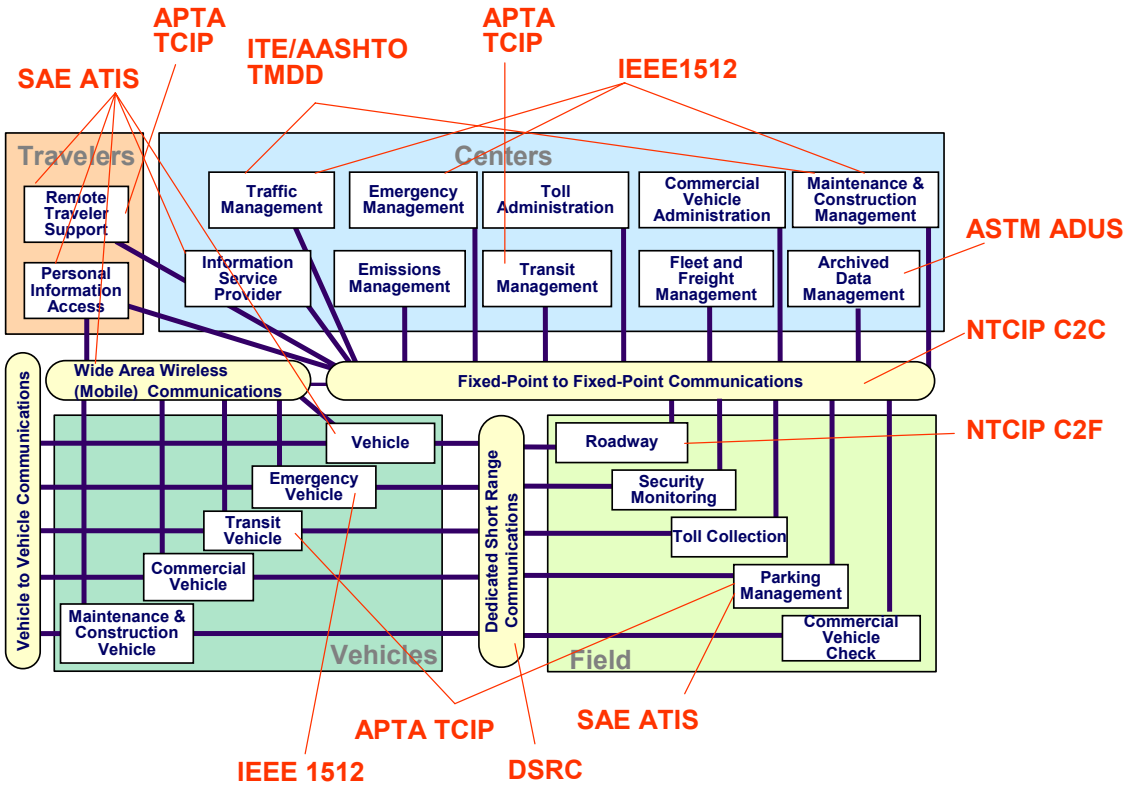
B Appendix B – ITS Standards Documents Reference by SDO

The ITS Standards Development Program are supported and guided by several existing Standards Development Organizations (SDOs). The SDOs that are currently involved in the development of ITS standards include:

- National Transportation Communications for ITS Protocol (NTCIP). A joint venture of American Association of State Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA).
- American Public Transportation Association (APTA)
- ASTM International (formerly, the American Society for Testing & Materials - ASTM)
- Institute of Electrical and Electronics Engineers (IEEE)
- Institute of Transportation Engineers (ITE)
- Society of Automotive Engineers (SAE)

Each SDO has focused its efforts on specific areas of communications within the ITS industry. APTA, for example, focuses on communications between transit management centers, between transit management centers and transit vehicles, and between transit management centers to remote traveler devices such as kiosks. ASTM, as another example, focuses only on archiving data activities. Figure B-1 shows the relation of the ITS standards activities to the National ITS Architecture.

Figure B-1. Relation of ITS Standards to the National ITS Architecture



B.1 NTCIP – National Transportation Communications for ITS Protocol

The NTCIP suite of standards is developed and supported jointly by AASHTO, ITE, and NEMA. The NTCIP suite defines the protocols and profiles to support the operation and control of traffic management devices. The NTCIP suite provides communications standards for two different types of ITS communications:

- **Center-to-Field Communications.** Exchange of information between a management center and roadside control and monitoring devices, and,
- **Center-to-Center Communications.** Exchange of information and data between multiple central management centers.

Each will be discussed separately.

B.1.1 Center-To-Field Standards

When specifying the NTCIP center-to-field standards, both the base standard and protocol (communications protocol) and the primary standard (data elements) must be specified.

B.1.1.1 NTCIP 1100 Series

The NTCIP 1100 series of standards consists of the base standards. This series consists of the basic rules on how to use and deploy the NTCIP ITS standards. The 1100 series of standards for center-to-field communications consists of the following standards:

Document Number	Standard Title	Status	Description
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.
NTCIP 1102	NTCIP - Octet Encoding Rules (OER) – v01.14	Recommended Standard – to be published January 2006.	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.
NTCIP 1103	NTCIP Transportation Management Protocol (TMP) – v01.26a	Recommended Standard – to be published 2006.	Includes STMP (NTCIP 1101) with definitions of traps and fixed messages.

NTCIP 1101 is considered mature and has been widely deployed. NTCIP 1102 and 1103 were developed to replace NTCIP 1101 by clarifying definitions and concepts based on lessons learned from earlier deployments of NTCIP center-to-field standards. Since NTCIP 1102 and NTCIP 1103 are replacements for the mature NTCIP 1101 standard, and were approved by AASHTO, ITE, and NEMA, both NTCIP Standards should be included and referenced in all specifications requiring implementation of the NTCIP standard.

B.1.1.2 NTCIP 2100 Series

The NTCIP 2100 series of standards are Subnetwork standards define the rules and procedures for exchanging data between two 'adjacent' devices over some communications media. These standards are roughly equivalent to the Data Link and Physical Layers of the seven (7) layer Open Systems Interconnect (OSI) model. The 2100 series of standards for consists of the following standards:

Document Number	Standard Title	Status	Description
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.
NTCIP 2102	NTCIP - Point-to-Multipoint Protocol/FSK Subnetwork Profile – Version 1	Recommended Standard – to be published December 2005.	Defines how to communicate over twisted wire using FSK modems.
NTCIP 2103	NTCIP - Point-to-Point Protocol/RS232 Subnetwork Profile – Version 1	Recommended Standard – to be published December 2005.	Defines how to communicate over a dial-up link or other serial point-to-point link.
NTCIP 2104	NTCIP - Ethernet Subnetwork Profile – Version 1	Recommended Standard – to be published December 2005.	Defines how to communicate over ethernet links.

NTCIP 2101 and 2103 are considered mature and has been widely deployed. NTCIP 2102 and 2104 are not as widely deployed. NTCIP 2102 may be considered mature.

When specifying an implementation of an ITS system requiring the use of the NTCIP center-to-field standard, at least one of the NTCIP 2100 series of standard should be specified. Which 2100 standard will depend on the communications infrastructure to be used to communicate with the field device. For example, if dial-up modems are to be used for communicating between the management center to the field device, NTCIP 2102 should be specified. If in the future, ethernet will be used to communicate between the management center to the field device, NTCIP 2104 should also be specified.

B.1.1.3 NTCIP 2200 Series

The NTCIP 2200 series of standards are Transport standards that define the rules and procedures for exchanging the Application data between point 'A' and point 'X' on a network, including any necessary routing, message disassembly/re-assembly and network management functions. Transportation level standards are roughly equivalent to the Transport and Network Layers of the seven (7) layer Open Systems Interconnect (OSI) model. The 2200 series of standards consists of the following standards:

Document Number	Standard Title	Status	Description
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.
NTCIP 2202	NTCIP - Internet (TCP/IP & UDP/IP) Transport Profiles – Version 1	Recommended Standard	Defines how to communicate using the Internet suite of protocols.

NTCIP 2201 is considered mature and has been widely deployed. NTCIP 2202 is also considered mature but not as widely deployed.

When specifying an implementation of an ITS system requiring the use of the NTCIP center-to-field standard, one of the NTCIP 2200 series of standards should be specified. Which 2200 standard will depend on the communications infrastructure to be used to communicate with the field device. For example, if the communications infrastructure is using Internet protocols (e.g., IP addressing), then NTCIP 2202 should be specified.

B.1.1.4 NTCIP 2300 Series

The NTCIP 2300 series of standards are application layer standards that define the rules and procedures for exchanging information data. The rules may include definitions of proper grammar and syntax of a single statement, as well as the sequence of allowed statements. These standards are roughly equivalent to the Session, Presentation, and Application Layers of the seven (7) layer Open Systems Interconnect (OSI) model. The 2300 series of standards for center-to-field communications consists of the following standards:

Document Number	Standard Title	Status	Description
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.
NTCIP 2302	NTCIP - Trivial File Transfer Protocol - Application Profile – Version 1	Approved	Defines how to use the Trivial File Transfer Protocol within transportation networks
NTCIP 2303	NTCIP - File Transfer Protocol - Application Profile – Version 1	Approved	Defines how to use the File Transfer Protocol within transportation networks

NTCIP 2301 is considered mature and has been widely deployed. When specifying an implementation of an ITS system requiring the use of the NTCIP center-to-field standard, one of the NTCIP 2300 series of standards should be specified. Currently, only NTCIP 2301 is applicable for center-to-field communications, and should be specified. NTCIP 2302 and NTCIP 2303 are relevant and should be specified only if file transfers are required.

B.1.1.5 NTCIP 1200 Series

The NTCIP 1200 series of standards are mainly primary standards that define the data elements (objects) for transmitting specific pieces of information between a management center and a field device. The data element definitions may include syntax, allowable ranges, and may also include valid sequences for transmitting data elements. NTCIP 1201, Global Objects, is considered a supporting standard, not a primary standard, because it can be used for multiple types of field devices.

Document Number	Standard Title	Status	Description
NTCIP 1201	NTCIP - Global Object Definitions – Version 2	Recommended Standard – to be published January 2006	Defines the pieces of data that are likely to be used in multiple device types, such as time, schedules, report generation
NTCIP 1202	NTCIP - Object Definitions for Actuated Traffic Signal Controller Units – Version 2	Recommended Standard – to be published January 2006	Defines the data that are frequently found in actuated traffic signal controllers.
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.
NTCIP 1204	NTCIP - Object Definitions for Environmental Sensor Stations – Version 2	Recommended Standard	Defines the data that are found in road weather information stations and air quality sensors.
NTCIP 1205	NTCIP - Object Definitions for Closed Circuit Television Camera Control – Version 1	Recommended Standard. Amendment 1 submitted for balloting	Defines the data that are used to control video cameras
NTCIP 1206	NTCIP – Object Definitions for Data Collection – Version 1	Recommended Standard – to be published January 2006	Deals with the data stored in roadside count stations.
NTCIP 1207	NTCIP - Object Definitions for Ramp Meter Control – Version 1	Recommended Standard	Defines the data that are found in ramp meters
NTCIP 1208	NTCIP - Object Definitions for Video Switches – User Comment Draft – v01.04	Recommended Standard – to be published January 2006	Defines the data to control a video switch to enable multiple monitors to view multiple video feeds.
NTCIP 1209	NTCIP - Object Definitions for Transportation Sensor Systems – Version 1	Recommended Standard – to be published January 2006	Deals with the data collected by various types of detectors used by real-time management systems.
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
NTCIP 1211	NTCIP – Objects for Signal Control and Prioritization – User comment draft – v01.37b	In balloting.	Defines the data for controlling traffic signal systems in priority applications
NTCIP 1212	NTCIP – Objects for Network Camera Operations – Working Group Draft	In development	Defines the data that are used with digital image cameras
NTCIP 1213	NTCIP – Objects for Electrical and Lighting Management Systems – v01.03b	Recommended Standard	Defines the data for roadside electrical and lighting management systems

B.1.2 Center-To-Center Standards

When specifying the NTCIP center-to-center standards, both the base standard and protocol (communications protocol) and the primary standard (messages) must be specified.

B.1.2.1 NTCIP 1100 Series

The NTCIP 1100 series of standards consists of the base standards. This series consists of the basic rules on how to use and deploy the NTCIP ITS standards. The 1100 series of standards for center-to-center communications consists of the following standards:

Document Number	Standard Title	Status	Description
NTCIP 1104	NTCIP Center-to-Center Naming Convention Specification – v01.08c	Recommended Standard	Defines the naming convention for use in center-to-center communications in the transportation domain, and lists the requirements for establishing names for center resources.

The NTCIP 1104 standard was developed to aid in the unique assignment of identifiers to center resources. This standard is intended as a supporting standard.

B.1.2.2 NTCIP 2300 Series

The NTCIP 2300 series of standards are application layer standards that define the rules and procedures for exchanging information data. The rules may include definitions of proper grammar and syntax of a single statement, as well as the sequence of allowed statements. These standards are roughly equivalent to the Session, Presentation, and Application Layers of the seven (7) layer Open Systems Interconnect (OSI) model. The 2300 series of standards for center-to-center communications consists of the following standards:

Document Number	Standard Title	Status	Description
NTCIP 2304	NTCIP - Application Profile - Data Exchange (DATEX)	Recommended Standard	Defines how to use the DATEX-ASN protocol within US-based transportation networks.
NTCIP 2306	Application Profile for XML in ITS Center to Center Communications (AP-C2CXML)	User Comment Draft	Specifies communications interfaces (message form, message use, and transport) encoded in the Extensible Markup Language (XML) between a center and an external center.

It is important to note that the Application Profiles cover only message transport and message encoding options. The content of the messages themselves have been developed by the message set standards working groups.

When specifying an implementation of an ITS system requiring the use of the NTCIP center-to-center standard, one of the NTCIP 2300 series of standards should be specified. If the implementation of the center-to-center communications will use DATEX, NTCIP 2304 should be specified. However, it is expected that future implementations of center-to-center communications will use XML, and those implementations should specify NTCIP 2306.

B.1.2.3 NTCIP 1300 Series

The NTCIP 1300 series of standards are mainly primary standards that define the messages for transmitting specific pieces of information between management centers. The message set definitions provides the information definition (semantics) and format (syntax) to handle individual information exchanges on specific topics.

Currently, only one message set standard has been developed by auspices of the NTCIP family of standards, NTCIP 1301, Weather Reports. However, other message sets have been developed by other standards development organizations, including IEEE (IEEE 1512 for Incident Management).

Document Number	Standard Title	Status	Description
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

As indicated in the table, NTCIP 1301 is still under development, and there are no known implementations of the standard. It is not considered a key standard for New York State.

B.1.2.4 NTCIP 9000 Series

The NTCIP 9000 series of standards are information reports. The documents in this series are not standards, but are papers that provide guidance to users on how to use, deploy, and implement the NTCIP family of standards.

Document Number	Standard Title	Status	Description
NTCIP 9001	NTCIP Guide	Approved	Guide on the NTCIP Family of Standards.
NTCIP 9010	XML in ITS Center-to-Center Communications	Recommended Information Report	General information report describing XML-based standards development efforts.
NTCIP 9012	Users Guide to Testing	User Commend Draft	General guide for those interested in developing testing programs (whether private or public institutions) for NTCIP-based field device communications.

B.2 APTA – American Public Transportation Association

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.

Document Number	Standard Title	Status	Description
NTCIP 1400	TCIP Framework Standard	Approved Standard	Defines how the various NTCIP 1400 series of standards work together.
NTCIP 1401	TCIP Common Public Transportation (CPT) Objects	Approved Standard	This standard defines those data elements and data frames that are generic to multiple TCIP Business areas.
NTCIP 1402	TCIP Incident Management (IM) Bus. Area Std.	Approved Standard	This standard defines data elements and messages used for exchanging information on incident management operations.
NTCIP 1403	TCIP Passenger Information (PI) Bus. Area Std.	Approved Standard	This standard defines data elements and messages used for passenger information data exchanges.
NTCIP 1404	TCIP Scheduling/Runcutting (SCH) Bus. Area Std.	Approved Standard	This standard defines data elements and messages used to exchange information about transit schedules and runcutting information.
NTCIP 1405	TCIP Spatial Representation (SP) Bus. Area Std.	Approved Standard	This standard defines data elements and messages used to exchange location and spatial concepts.
NTCIP 1406	TCIP On-Board (OB) Objects	Approved Standard	This standard defines data elements and messages used to exchange data about devices and operations on-board the transit vehicle.
NTCIP 1407	TCIP Control Center (CC) Objects	Approved Standard	Defines data elements and messages for exchanges between control centers.
NTCIP 1408	TCIP Fare Collection (FC) Objects	Approved Standard	This standard defines data elements and messages used to exchange information about fare collection operations.
APTA TCIP-S-001	TCIP Dialogs – Transit Communications Interface Profile	In Development	Allows TCIP components to communicate with one another in a standardized manner.

B.3 ASTM International

ASTM International, originally known as the American Society for Testing and Materials (ASTM), provides a forum for producers, users, consumers, and others who have interests in standard test methods, specifications, practices, guides, classifications, and terminology.

Document Number	Standard Title	Status	Description
ASTM WK7592	Standard Practice for Metadata to Support Archived Data Management Systems	In development	Specifies how to annotate data for subsequent uses.

Document Number	Standard Title	Status	Description
ASTM WK7604	Standard Specification for Archiving ITS-Related Traffic Monitoring Data	In development	Specifies a data dictionary for archiving traffic data.
ASTMA 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

B.4 IEEE – Institute of Electrical and Electronics Engineers

Document Number	Standard Title	Status	Description
IEEE P1512.BASE	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).
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.
IEEE P1512.2	Standard for Public Safety Incident Management Message Sets for Use by EMCs	Balloted	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.
IEEE P1512.3	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.
IEEE P1512.4	Standard for Common Traffic Incident Management Message Sets for Use in Entities External to Centers	Working Group Draft	Addresses Traffic Incident Management Message Sets which will be exchanged by and between mobile data terminals in response vehicles including mobile command posts and to their respective response and/or dispatch centers such that the exchange of information will be standard and produce the needed response(s). Limited to common message sets for use by emergency management including transportation, fire/rescue, enforcement, HazMat, etc.
IEEE 1570	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.
IEEE P1609.1	Standard for Wireless Access in Vehicular Environments (WAVE) – Application Resource Manager	Under Development	This standard describes a resource manager that arbitrates requests for transponder usage.

Document Number	Standard Title	Status	Description
IEEE P1609.2	Standard for Wireless Access in Vehicular Environments (WAVE) – Application Services	Under Development	Describes application services, notably radio security, used in conjunction with the resource manager.
IEEE P1609.3	Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services	Under Development	Describes standard that supports higher layer communication stacks, including TCP/IP.
IEEE P1609.4	Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operations	Under Development	Describes extension services for the Media Access Control (MAC), channel delegation, and interface to 802.11 p standard formats for WAVE/DSRC applications at 5.9 GHz.

B.5 ITE – Institute of Transportation Engineers

Document Number	Standard Title	Status	Description
ITE TM 2.1	ITE/AASHTO – Traffic Management Center-to-Center Communications {Advanced Traffic Management Data Dictionary (TMDD) and Message Sets (MS)} version 2.1	Published Standard	A message set standards for communication between traffic management centers and other centers. This document contains messages and 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.
ITE 9603-1	Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC)	Under Development	An advanced transportation controller (ATC) software application program interfaces (APIs) that support ITS data flows and standards enabling the deployment of ITS functions. The APIs provide a template for API programming for specific functionality associated with equipment and market packages defined by the National ITS Architecture.

{HARDWARE STANDARDS}

B.6 SAE – Society of Automotive Engineers

Document Number	Standard Title	Status	Description
SAE-J2354	Message Sets for Advanced Traveler Information Systems (ATIS) Revision 2.0	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.
SAE-J2734	Standard for Data Dictionary and Message Sets for Dedicated Short Range Communications (DSRC)	Under development	This standard will assure that DSRC applications will be interoperable. Applications such as collision avoidance, emergency vehicle warnings, and signage require this standard before they can be effective.

SAE-J2529	Rules for Standardizing Street Names and Route IDs	Recommended Standard	Specifies the rules for standardizing street names for use in ATIS and other ITS applications.
SAE-J2266	Location Referencing Message Specification	Recommended Standard	Specifies rules for encoding various forms of geographic information.
SAE-J2540-2	ITIS (International Traveler Information Systems" Phrase List	Recommended Standard	Specifies rules for encoding and list of standardized identifiers and accompanying phrases used in the descriptions of transportation and ITS information.