

WHITE PAPER
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**Deploying
Intelligent Transportation Systems (ITS)
Standards for Transportation Management
and Homeland Security**

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An investigational Work Item of the NTCIP Security Task Force, a subdivision of the Joint Committee on the NTCIP. This document is intended for internal committee use and is not an official position of AASHTO, ITE, NEMA, or the U.S. DOT/FHWA.
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In August 2003, the Joint AASHTO / ITE / NEMA Committee on the NTCIP agreed to form a Transportation Security Coordination Task Force. The purpose of the Task Force was to establish liaison with transportation security organizations for the outreach and promotion of ITS standards, and in particular the NTCIP family of standards.

The Task Force authored this white paper as a deliverable work item, as identified in their work plan of January 2004. [NEMA Task Order TO-63, Work Item WI-002]

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Deploying Intelligent Transportation Systems (ITS) Standards for Transportation Management and Homeland Security

1. Intent of this Paper

This paper is developed to introduce the subject of ITS standards and the current status of key standards to the homeland security and emergency management community. The paper also provides links to other relevant standards not discussed in this paper. The intent is to familiarize readers with the availability of ITS standards for deployments in the fields of emergency and transportation security and transportation management.

The purpose of this paper is only to provide information, and it does not attempt to speak for or replace any policy statements by the US Department of Transportation (USDOT).

2. Standards Development Organizations (SDOs) for ITS Standards

There are a variety of SDOs involved in the development of ITS standards that bring to the effort experience from all aspects of transportation—from those who operate and maintain our nation's transportation infrastructure to those who develop and implement new equipment and systems that facilitate efficient use of that infrastructure. Presently the following SDOs are actively developing ITS standards in the United States with support from the USDOT:

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

These SDOs are working together and have developed domain specific communications standards to facilitate ITS deployments in the country. The standards pertain to data elements, messages, and common protocols to implement and communicate messages between systems and centers. For example, traffic management data dictionary (TMDD) standards have created a common vocabulary that is now used by all standards developing organizations for consistency and interoperability across ITS applications.

The overall intent of these standards is to provide interoperability for vehicle, travelers-user and centers who are engaged in transportation and emergency management applications and information exchange.

In order to facilitate transportation related applications and deployments, AASHTO, ITE and NEMA have jointly created a family of standards under the public-private sector National Transportation Communications for ITS Protocol (NTCIP) Joint Committee (JC) development process. The JC has created a task force to create a liaison activity with Department of Homeland security (DHS) and other organizations to exchange information for mutual benefits.

3. Purpose of the Security Task Force

Recognizing that there is a need to share current and future Intelligent Transportation System (ITS) standards information with various organizations involved in transportation security efforts, the NTCIP Joint Committee, representing the AASHTO, ITE and NEMA SDOs, has appointed a Security Task Force. The SDOs are developing communications standards which have potential applicability to security projects. However, security organizations may not be fully aware of these ITS communications standards development efforts and the SDOs are not fully informed of efforts being undertaken by security agencies. The purpose of this task force is to enhance communications and information exchange by examining security efforts and then offering current information on ITS communications standards to security organizations.

One of the goals of the Security Task Force is to liaise with agencies responsible for homeland security to provide awareness of ongoing standardization efforts in the ITS industry and bring an understanding of specific security needs to the ITS standards development efforts.

The objectives of the Security Task Force are as follows:

- The NTCIP JC believes that many data elements, messages set standards and communications protocols to exchange information among operation centers in transportation, including transit and emergency management operation centers (EOC), are suitable for current and future needs. The JC would like to provide information on ITS standards to eliminate duplicative efforts.
- The JC also wishes to learn about developments in the emergency management community.

4. Standards Development Committees and Their Functions

The SDOs directly responsible for the development of ITS standards have appointed committees to facilitate the development of standards in a variety of areas. A list of standards development committees and their functions are as follows:

- NTCIP JC – focuses on the development of communications standards for center to field and center to center applications.
- Advanced Transportation Controller (ATC) Joint Committee – focuses on the development of hardware and software standards for use in traffic control equipment.
- TMDD – focuses on the development of a common data dictionary for use in the exchange of information between centers.
- Incident Management – focuses on the development of common data dictionaries for use in the exchange of incident related information between transportation, emergency management services and public safety agencies, including HazMat standards.
- Advanced Traveler Information – focuses on the development of common data dictionaries and dialogs for the exchange of information between transportation agencies and information service providers.

5. List of ITS Standards Currently Available

Numerous ITS standards, as shown in Figure 1, have been developed and are in use. These standards include data dictionaries, message sets, and protocols for both center to center and center to field communications. Table 1 identifies available ITS standards. Additional information is provided in Appendix A for each of the standards listed in Table 1. Further information regarding any of the ITS standards may be found at <http://www.standards.its.dot.gov>.

Figure 1 – ITS Framework

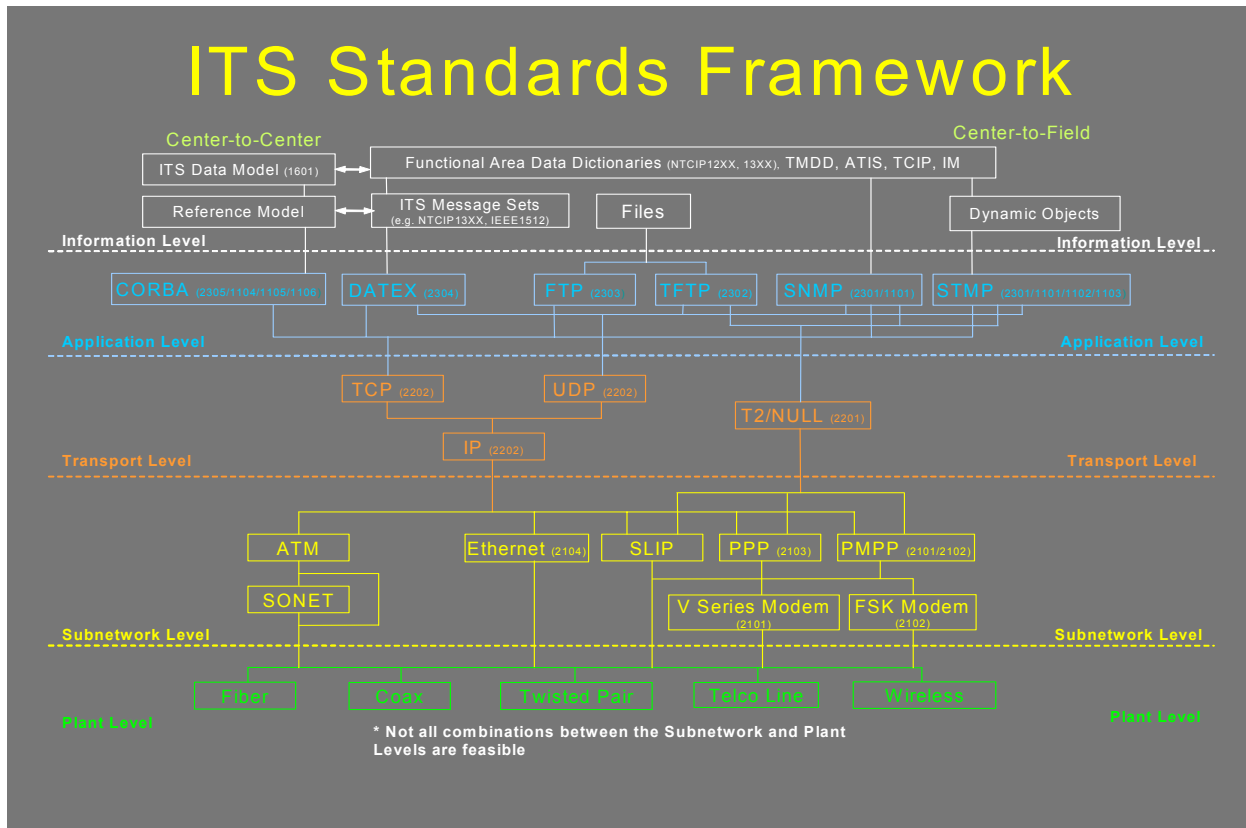


Table 1 – Identification of Available ITS Standards

Center to Center Related Standards
Data Dictionaries
<ul style="list-style-type: none"> ITE-AASHTO TM1.03 Standard for Functional Level Traffic Management Data Dictionary (TMDD)
Message Sets (Please note that some ITS standards, including LRMS, are developed by IEEE and SAE, more details at their websites)
<ul style="list-style-type: none"> ITE-AASHTO TM2.01 Message Sets for External Traffic Management Center Communications (MS/ETMCC) Other ITS standards being used in the transportation community: <ul style="list-style-type: none"> IEEE 1512-2000 - Transportation Management Center (TMC) to Emergency Management System (EMS) Incident Management Message Sets IEEE 1512.1-2003 - Traffic Incident Management Message Sets for Use by Emergency Management Centers IEEE P1512.2 - Public Safety Incident Management Message Sets for Use by Emergency Management Centers IEEE 1512.3-2002 - Hazardous Materials Incident Management Message Sets for Use by Emergency Management Centers SAE J2266 - Location Referencing Message Specification (LRMS) SAE J2313 - On-Board Land Vehicle Mayday Reporting Interface SAE J2354 - Advanced Traveler Information Systems (ATIS) Message Sets SAE J2369 - Standards for ATIS Message Sets Delivered Over High Speed FM Subcarriers SAE J2540 – Messages for Handling Strings and Look-Up Tables in ATIS Standards SAE J2630 – Converting ATIS Message Standards from ASN.1 to XML
Protocols
<ul style="list-style-type: none"> NTCIP 1104 - CORBA Naming Convention Specification

Table 1 – Identification of Available ITS Standards

<ul style="list-style-type: none"> • NTCIP 1105 - CORBA Security Service Specification • NTCIP 2304 - Application Profile for Data Exchange ASN.1 • NTCIP 2303 - Application Profile for File Transfer Protocol • NTCIP 2202 - Internet (TCP/IP and UDP/IP) Transport Profile • NTCIP 2104 - Ethernet Subnetwork Profile • NTCIP White Paper – XML Protocols for Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL) • Other ITS standards being used in the transportation community: <ul style="list-style-type: none"> ○ SAE J2266 - Location Referencing Message Specification (LRMS)
Center to Field Related Standards
Data Dictionaries
<ul style="list-style-type: none"> • NTCIP 1201 - Global Object (GO) Definitions • NTCIP 1202 - Object Definitions for Actuated Traffic Signal Controller (ASC) • NTCIP 1203 - NTCIP Object Definitions for Dynamic Message Signs (DMS) • NTCIP 1204 - NTCIP Object Definitions for Environmental Sensor Stations (ESS) • NTCIP 1205 - NTCIP Objects for Closed Circuit Television (CCTV) Camera Control • NTCIP 1206 - Object Definitions for Data Collection and Monitoring (DCM) Devices • NTCIP 1207 - Object Definitions for Ramp Meter Control (RMC) Units • NTCIP 1208 - Object Definitions for Video Switching • NTCIP 1209 - Data Element Definitions for Transportation Sensor Systems (TSS) • NTCIP 1210 - Object Definitions for Signal System Masters
Protocols
<ul style="list-style-type: none"> • NTCIP 1101 - Simple Transportation Management Framework (STMF) • NTCIP 1102 - Octet Encoding Rules (OER) Base Protocol • NTCIP 1103 - Transportation Management Protocol (TMP) • NTCIP 2301 - Simple Transportation Management Framework Application Profile • NTCIP 2302 - Trivial File Transfer Protocol Application Profile • NTCIP 2303 - Application Profile for File Transfer Protocol • NTCIP 2201 - Transportation Transport Profile • NTCIP 2202 - Internet (TCP/IP and UDP/IP) Transport Profile • NTCIP 2101 - Point to Multi-Point Protocol Using RS-232 Subnetwork Profile • NTCIP 2102 - Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile • NTCIP 2103 - Point-to-Point Protocol over RS-232 Subnetwork Profile • NTCIP 2104 - Ethernet Subnetwork Profile
Roadside to Vehicle Related Standards
Message Sets (Please note that some ITS standards, including DSRC, are developed by ASTM and IEEE, more details at their websites)
<ul style="list-style-type: none"> • IEEE 1455-1999 - Standard for Message Sets for Vehicle/Roadside Communications • IEEE P1609.4 - Standard for Data Dictionary and Message Sets for Dedicated Short Range Communications
Protocols
<ul style="list-style-type: none"> • ASTM 2213-03 - Standard Specification for Telecommunications and Information Exchange between Roadside and Vehicle Systems: 5.9 GHz DSRC • IEEE P1556 - Standard for Security and Privacy of Vehicle/Roadside Communications Including Smart Card Communications • IEEE P1609.1 - Standard for Dedicated Short Range Communications Resource Manager • IEEE P1609.2 - Standard for Dedicated Short Range Communications Application Layer • IEEE P1609.3 - Standard for IP Interface for Dedicated Short Range Communications

6. Incident Management Standards

Coordination among the emergency management centers of agencies that respond to traffic-related incidents can be aided by a common set of established procedures and operational methods for exchanging vital data concisely, unambiguously, and rapidly. Typically, each involved agency has responsibilities that vary over time, based upon the type of incident, local custom, and agreed-upon responding resource allocations, which may be determined at the incident scene or at dispatching points within each agency.

IEEE has developed an incident management communications standard, IEEE Standard 1512 - 2000, for Common Incident Management Message Sets for Use by Emergency Management Centers. This standard is part of a family of related standards that address the communication needs of emergency and traffic management agencies that are involved in highway incident management and that need to exchange information with each other. It gives local agencies the ability to determine the level of cooperation and the messages that best meet their needs. In addition to the framework standard, subordinate standards have been developed to specifically provide incident management messages for traffic management, public safety and hazardous materials.

The incident management family of standards is intended to be used as the basis of mutual agreements among emergency management agencies to exchange information during incidents using messages comprised of agreed-upon data elements. The messages have been structured so that centers can continue to use different legacy systems. These standards also provide an overview of the relationships between the messages and examples of use with other ITS message sets.

7. Next Steps

To date, the Security Task Force has learned that the DHS has adopted Extensible Markup Language (XML) for the exchange of data between the department and law enforcement agencies. Such data exchange is focused on homeland security-related information. The DHS has also been involved in the development of many equipment-related standards for use by first responders (i.e. flame retardant clothing, body armor, first responder radios, etc.). The transportation and homeland security communities need to establish technical liaison now to start using ITS standards in 2005 and beyond.

In an effort to better position the ITS community to facilitate future interaction with the DHS, it is recommended that a high priority be placed on the adoption and implementation of XML data definitions and protocols for center to center communications. It is believed that the use of XML standards in the ITS community would serve to reduce the likelihood of perceived technological communication barriers in the future. Additionally, continued liaison between the ITS community and the DHS would serve to establish a working relationship that fosters awareness of the needs and resources that both sides have to offer. Thus, benefit may be gained through the presentation of this paper through formal meetings between the DHS and the Security Task Force.

8. References and Resources

A variety of references and resources are available for those desiring more information on ITS standards. Table 3 provides a list of references and resources that are available.

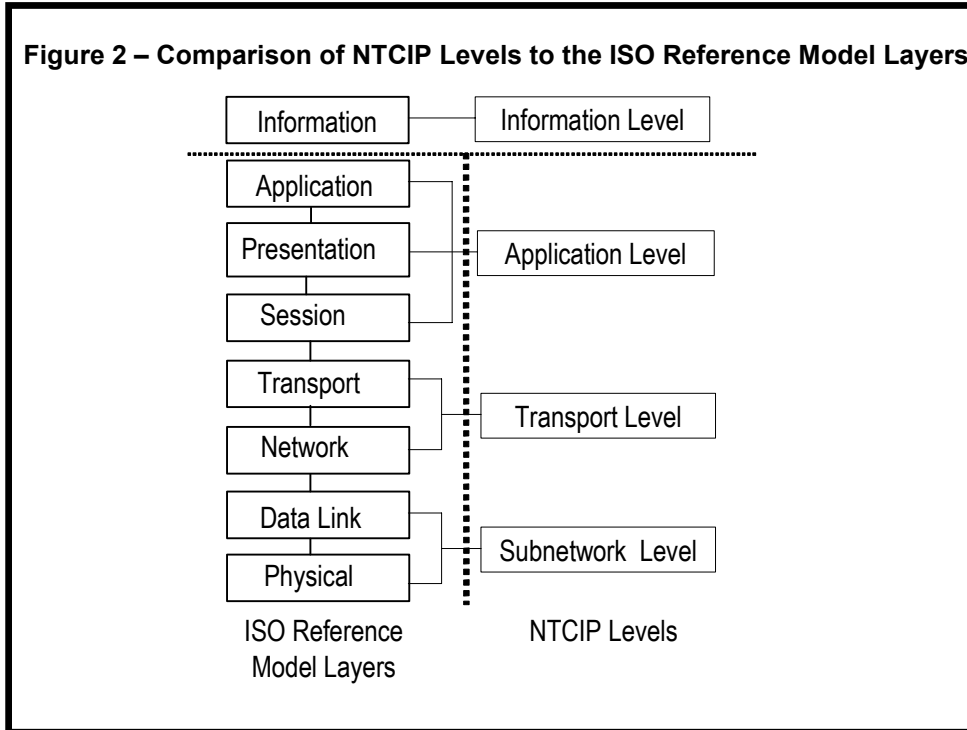
Table 3 – References and Resources for ITS Standards

SDO Websites for information on specific development initiatives	
<ul style="list-style-type: none"> • www.ite.org • www.aashto.org • www.nema.org • www.astm.org 	<ul style="list-style-type: none"> • www.apta.com • www.ieee.org • www.sae.org
Other useful websites for information on standards development initiatives	
<ul style="list-style-type: none"> • www.ntcip.org – information specific to NTCIP development • www.tmdd.org – information specific to TMDD development • www.standards.its.dot.gov/appl_areas.htm – information on all ITS standards development activities 	
Information Reports	
<ul style="list-style-type: none"> • NTCIP 9001 Guide – guidance and information on the NTCIP 	

Table 3 – References and Resources for ITS Standards

<ul style="list-style-type: none">• TMDD Guide – <i>guidance and information on the TMDD</i>• NTCIP Case Studies – <i>early implementation information for NTCIP standards</i>• White Papers and ITE Articles – <i>early development information on ITS standards</i>• NTCIP Testing Reports by Battelle Team – <i>standards testing information</i>• Standards Fact Sheets by FHWA - <i>high-level information on ITS standards</i>• ATC Overview Document – <i>high-level information on the ATC family of standards</i>• FHWA circulars – <i>high-level information guidance and deployment information</i>
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Appendix A – ITS Standards Overview



A.1 INFORMATION LEVEL STANDARDS

NTCIP 1201 - Global Object (GO) Definitions provides the vocabulary—commands, responses and information—necessary for general device management, including those objects required for device identification, time-based schedule configuration, and event log configuration.

NTCIP 1202 - Object Definitions for Actuated Traffic Signal Controller (ASC) provides the vocabulary—commands, responses and information—necessary for the management, control and monitoring of actuated traffic signal controller units

NTCIP 1203 - NTCIP Object Definitions for Dynamic Message Signs (DMS) provides the vocabulary—commands, responses, and information—necessary for traffic the management of dynamic message signs, which are used to advise and inform vehicle operators of current highway conditions.

NTCIP 1204 - NTCIP Object Definitions for Environmental Sensor Stations (ESS) provides the vocabulary—commands, responses and information—necessary for the management of environmental sensor stations, including Road Weather Information Systems (RWIS) and air quality monitoring systems.

NTCIP 1205 - NTCIP Objects for Closed Circuit Television (CCTV) Camera Control provides the vocabulary—commands, responses and information—necessary for the management of closed circuit television cameras, lenses, and pan/tilt units.

NTCIP 1206 - Object Definitions for Data Collection and Monitoring (DCM) Devices provides the vocabulary—commands, responses and information—necessary for the management of a data collection and monitoring unit which embraces a range of devices from traditional traffic counters to scale-houses for weigh stations.

NTCIP 1207 - Object Definitions for Ramp Meter Control (RMC) Units provides the vocabulary—commands, responses and information—necessary for the management of a ramp meter control unit consisting of a field controller, its suite of sensors, and associated warning signs and signals.

NTCIP 1208 - Object Definitions for Video Switching provides the vocabulary—commands, responses and information—necessary for the management of closed circuit television switching devices that control the association of video inputs to outputs, including the block switching of input and output groups, time-sequenced programming of multiple inputs, title/label generation by the video switch, and discrete input/output and switch status monitoring.

NTCIP 1209 - Data Element Definitions for Transportation Sensor Systems (TSS) provides the vocabulary—commands, responses and information—necessary for the management of a transportation sensor system which embraces a range of devices from smart inductive loop amplifiers to state-of-the-art technologies, such as machine vision and microwave.

NTCIP 1210 - Object Definitions for Signal System Masters provides the vocabulary—commands, responses and information— necessary for traffic management and operations personnel to control, manage, and monitor a traffic signal system master, which in turn manages a group of traffic signal controllers.

A.2 APPLICATION LEVEL STANDARDS

NTCIP 1101 - Simple Transportation Management Framework (STMF) specifies a set of rules and protocols for organizing, describing and exchanging transportation management information between transportation management applications and transportation equipment such that they interoperate with each other.

NTCIP 1102 - Octet Encoding Rules (OER) Base Protocol is a presentation layer standard that defines encoding rules for NTCIP objects i.e., the exact digital representation of the value of an object that is to be transmitted over various transfer services.

NTCIP 1103 - Transportation Management Protocol (TMP) is a composition of three distinct protocols all providing nearly identical services, but designed to meet different data exchange and processing requirements. The three component protocols are as follows: Simple Network Management Protocol (SNMP), Simple Fixed Message Protocol (SFMP), and Simple Transportation Management Protocol (STMP).

NTCIP 1104 - CORBA Naming Convention Specification defines the naming service for Common Object Request Broker Architecture (CORBA) for use in center-to-center communications within the transportation domain, as well as other environments that reference this standard, and lists the requirements for establishing names for management systems and for the objects managed by those systems.

NTCIP 1105 - CORBA Security Service Specification specifies the protocols and application interfaces needed to implement a CORBA based NTCIP center-to-center security interface, providing password protection to traffic data and device control at each center.

NTCIP 2301 - Simple Transportation Management Framework Application Profile specifies the requirements for information management and information transfers to and from devices in a networked environment by specifying the requirements for identifying, organizing, and describing the information to be

transferred, specifying the methods for exchanging that information between an end-application and the communication protocol, and defining the procedures for encoding the information for transmission by a transport profile.

NTCIP 2302 - Trivial File Transfer Protocol Application Profile specifies the requirements for a simple, defined as those that do not provide authentication, block or file transfer mechanism to and from devices in a networked environment.

NTCIP 2303 - Application Profile for File Transfer Protocol specifies the requirements for reliable and full-featured file transfers in a networked environment by describing requirements for interactive access, formatting data, and authentication control.

NTCIP 2304 - Application Profile for Data Exchange ASN.1 specifies the requirements for communications between management systems in the United States using DATA EXchange - Abstract Syntax Notation (DATEX)-ASN.

A.3 TRANSPORT LEVEL STANDARDS

NTCIP 2201 - Transportation Transport Profile specifies the requirements for connectionless data communications transport services in a non-networked environment, consisting of an end system directly connected to a subnetwork and another compatible end system on the same subnetwork.

NTCIP 2202 - Internet (TCP/IP and UDP/IP) Transport Profile specifies the requirements for connectionless and connection-oriented data communications transport services over a connectionless network. Transmission Control Protocol (TCP) is used to specify the format of data and acknowledgements that two devices exchange to achieve a reliable transfer of information. User Datagram Protocol (UDP) specifies the format of data exchange needed to achieve such a transfer, but does not provide end-to-end acknowledgements of each piece (packet) of information. Both transport layers define a common mechanism for multiplexing information to and from multiple applications layers. Internet Protocol (IP) is used to specify the format of data and procedures to provide a connectionless, node-to-node information packet delivery service and routing.

A.4 SUBNETWORK LEVEL STANDARDS

NTCIP 2101 - Point to Multi-Point Protocol Using RS-232 Subnetwork Profile specifies the requirements for data transfers to and from devices in either a networked or direct-connect environment using an EIA/TIA-232 interface.

NTCIP 2102 - Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile specifies the requirements for unbalanced connectionless communications over an asynchronous, half-duplex or full-duplex dedicated twisted wire digital circuit using a 1200 bps Frequency-Shift Keying (FSK) modem interface.

NTCIP 2103 - Point-to-Point Protocol over RS-232 Subnetwork Profile specifies the requirements for data transfers to and from processors in direct-connect or circuit-switched environments using an EIA/TIA-232 interface and/or a dial-up modem.

NTCIP 2104 - Ethernet Subnetwork Profile specifies the requirements for data transfers to and from devices in either a networked or direct-connect environment based on the functions and operations defined in the "Ethernet" family of standards for peer-to-peer access over coaxial cable, twisted pair wire, or fiber-optic media operating at communication rates of 10 megabits per second.

NTCIP White Paper - XML Protocols for Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL) provides an approach for the implementation of XML-based communications in the exchange of information between ITS centers.

A.5 OTHER RELATED STANDARDS

ASTM 2213-03 - Standard Specification for Telecommunications and Information Exchange between Roadside and Vehicle Systems: 5.9 GHz DSRC provides the medium access control layer (MAC) and physical layer (PHY) specifications for wireless connectivity using dedicated short-range communications (DSRC) services.

IEEE 1455-1999 - Standard for Message Sets for Vehicle/Roadside Communications provides the messages for commercial vehicle, electronic toll, and traffic management applications.

IEEE 1512-2000 - Transportation Management Center (TMC) to Emergency Management System (EMS) Incident Management Message Sets addresses the messages communicated among different agencies' emergency management centers during and after the occurrence of an emergency incident. This document also provides a framework for more specific message sets.

IEEE 1512.1-2003 - Traffic Incident Management Message Sets for Use by Emergency Management Centers provides the messages communicated among different agencies' emergency management centers during and after the occurrence of an emergency incident. This document provides messages for traffic management message exchanges.

IEEE P1512.2 - Public Safety Incident Management Message Sets for Use by Emergency Management Centers provides the messages communicated among different agencies' emergency management centers during and after the occurrence of an emergency incident. This document provides messages for public safety message exchanges.

IEEE 1512.3-2002 - Hazardous Materials Incident Management Message Sets for Use by Emergency Management Centers provides the messages communicated among different agencies' emergency management centers during and after the occurrence of an emergency incident. This document provides messages for hazardous material message exchanges.

IEEE P1556 - Standard for Security and Privacy of Vehicle/Roadside Communications Including Smart Card Communications provides security methods to be used in DSRC message transmission at specific frequencies, and provides a single standard methodology for the protection of information between the vehicle and the roadside.

IEEE P1609.1 - Standard for Dedicated Short Range Communications Resource Manager defines a resource manager that arbitrates requests for transponder usage.

IEEE P1609.2 - Standard for Dedicated Short Range Communications Application Layer defines a communications application layer standard to be used for 5.9 GHz DSRC.

IEEE P1609.3 - Standard for IP Interface for Dedicated Short Range Communications defines a communications protocol that supports higher layer communications stacks, including TCP/IP.

IEEE P1609.4 - Standard for Data Dictionary and Message Sets for Dedicated Short Range Communications defines various message and data formats for DSRC applications at 5.9 GHz.

ITE-AASHTO TM1.03 Standard for Functional Level Traffic Management Data Dictionary (TMDD) defines the data elements for information exchange between ITS centers that manage traffic.

ITE-AASHTO TM2.01 Message Sets for External Traffic Management Center Communications (MS/ETMCC) provides the messages to be used for information exchange between ITS centers that manage traffic.

SAE J2266 - Location Referencing Message Specification (LRMS) specifies a variety of possible profiles for describing location in ITS applications.

SAE J2313 - On-Board Land Vehicle Mayday Reporting Interface specifies the messages that would be provided from on-board vehicle systems to public or private call center, and then passed along to centers to respond to an incident.

SAE J2354 - Advanced Traveler Information Systems (ATIS) Message Sets specifies the messages that are exchanged among information providers, traffic management centers, and other ITS centers.

SAE J2369 - Standard for ATIS Message Sets Delivered Over Bandwidth Restricted Media specifies the message set for the transmission of advanced traveler information system (ATIS) messages over bandwidth-restricted media such as high speed FM Subcarriers and other wireless devices.

SAE J2540 - Standard for Messages for Handling Strings and Look-Up Tables in ATIS Standards specifies methods and messages to efficiently translate sequences of text and other types of data into and out of indexed values and look-up tables for effective transmission. The family of related standards include: J2540-1 for Radio Data Systems (RDS) Phrase Lists, J2540-2 for International Traveler Information System (IT IS) Phrase Lists, and J2540-3 National [Street] Names Phrase List.

SAE J2630 - Information Report for Converting ATIS Message Standards from ASN.1 to XML describes a set of rules for transforming an Abstract Syntax Notation (ASN.1) message set definition into an eXtensible Markup Language (XML) schema.

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