Connected Vehicle Data Capture and Management (DCM) and Dynamic Mobility Applications (DMA)

Assessment of Relevant Standards and Gaps for Candidate Applications

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7. Author(s) Bryan Mulligan, Dan Lukasik, Elliot Hubbard, Ron Schaefer, Carole Cleary		**8. Performing Organization Report No.**
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16. Abstract

The Connected Vehicle Mobility Standards Coordination Plan project links activities in three programs (Data Capture and Management, Dynamic Mobility Applications, and ITS Standards). The plan coordinates the timing, intent and relationship of activities planned over the five-year period in these three programs. The plan shall assist all three programs to identify the appropriate scope of individual program project activity to maximize complementary activity and to ensure that programs are not pursuing duplicative, uncoordinated or contradictory efforts.

This document, Assessment of Relevant Standards and Gaps for Candidate Applications, fulfills Task 3, the gap analysis of existing standards. This document is the second of three documents for this project and performs the following activities:

- Assesses the relevant standards to each of the applicable DCM and DMA programs
- Determines if there are any gaps in the applicable standards

The candidate DCM applications include the Arterial Data Environment, Regional Data Environment, Freeway Data Environment and the Corridor Data Environment. Although not a part of the original DCM environments, Weather Data environment has also been added. Candidate bundles of DMA applications include Freight Advanced Traveler Information System (FRATIS), Enable Advanced Traveler Information System (EnableATIS), Integrated Dynamic Transit Operations (IDTO), Intelligent Network Flow Optimization (INFLO), Response, Emergency Staging and Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.), Integrated Corridor Management (ICM), Multi-Modal Intelligent Traffic Signal System (M-ISIG), the Smart Roadside Initiative, and Road Weather Applications. The Weather DMA applications include Vehicle Data Translator (VDT), Freight, Traveler Info, and Emergency Management System (EMS).

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1 Introduction

The United States Department of Transportation (USDOT) Intelligent Transportation Systems (ITS) Joint Program Office initiated the Real-Time Data Capture and Management (DCM) Program to assess the potential of a multi-source active acquisition data paradigm to enhance current operational practices and transform future transportation systems management. The key concept of the DCM program is the development of data environments which support the collection, management, integration and application of real-time transportation data. The objectives of the program are to enable systematic data capture from connected vehicles, mobile devices and infrastructure, to develop data environments that enable integration of data from multiple sources, to reduce costs of data management and to determine the required infrastructure for transformative applications implementation.

Likewise, the Dynamic Mobility Applications (DMA) Program was initiated to create, test, and demonstrate innovative mobility applications exploiting frequently collected and rapidly disseminated multi-source data drawn from connected travelers, vehicles, and the infrastructure. The DMAs focus on vehicle-infrastructure connectivity using Dedicated Short Range Communications (DSRC) and other wireless communications methods. The objective of the DMA program is to develop open source applications that use multi-source ITS data to transform surface transportation management and information.

There are hundreds of standards used across the transportation industry. Another USDOT program, the ITS Standards Program, oversees the development of ITS standards by working with state and location transportation agencies, non-profit organizations, and private industry to develop strategies for standards-based ITS deployments and by providing outreach, education and training to facilitate the use of ITS Standards. ITS standards are open-interface standards that define how ITS systems, products, and components can interconnect, exchange information and interact to deliver services within a transportation network.

Transportation-related standards defining the communications between vehicle-to-vehicle, vehicle-to-roadside, vehicle-to-center, roadside-to-center, and center-to-center have been developed in the U.S. and worldwide to address the need to provide communications between these entities. While some of these standards were developed to address vendor- or manufacturer-specific needs and are proprietary, most of the standards, or suites of standards, were developed as open standards. However, many of these standards may not address the needs of the DCM or DMA programs because the Connected Vehicle Initiative is relatively new.

The Connected Vehicle Data Capture and Management and Dynamic Mobility Applications Standards Coordination Plan project produces three documents. The first was the high level Standards Coordination Plan which was developed to coordinate the standards-related activities of the DCM, DMA and the broader ITS Standards programs. The Standards Coordination Plan will aid the USDOT in building on the existing standards and determining if any additional standards or any expansions to existing standards will be needed for the Connected Vehicle Initiative to be successful.

The next task in the coordination of standards is the assessment of the relevant standards for candidate DCM/DMA applications and the identification of any gaps in the standards which is documented in the second paper, Assessment of Relevant Standards and Gaps for Candidate Applications. The scope, the approach, and document overview of the gap analysis task are discussed in the following sections. The final task will be to create a focused standards coordination plan, the third and final document for this project.

1.1 Scope

This task fulfills Task 3 of this project: to develop an assessment of relevant standards and gaps for candidate (DCM/DMA) applications. The candidate DCM applications include the Arterial Data Environment, Regional Data Environment, Freeway Data Environment and the Corridor Data Environment. Although not a part of the original DCM environment, the Weather Data Environment has also been assessed. Candidate bundles of DMA applications include Freight Advanced Traveler Information System (FRATIS), Enable Advanced Traveler Information System (EnableATIS), Integrated Dynamic Transit Operations (IDTO), Intelligent Network Flow Optimization (INFLO), Response, Emergency Staging and Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.), Integrated Corridor Management (ICM), Multi-Modal Intelligent Traffic Signal System (M-ISIG), the Smart Roadside Initiative, and Road Weather Applications. The Weather DMA applications include Vehicle Data Translator (VDT), Freight, Traveler Info, and Emergency Management System (EMS). All of these DMA applications and the Smart Roadside Initiative are a focused subset of applications available within the larger Connected Vehicle program.

While it is understood that there is much more to the Connected Vehicle Initiative, this document will focus on the candidate DCM/DMA applications.

1.2 Approach

Several steps are taken to develop the assessment and identify the gaps in the standards. Initially a summary of the High Level Standards Coordination Plan (Task 2) is provided. The relationship between the Standards Coordination Plan and this task is identified and key points from the Standards Coordination Plan are discussed. A review of relevant standards is provided, along with a mapping of each standard to the applicable DMA application or the DCM environment. Next, the actual needs assessment of the DCM and DMA standards is conducted. The assessment addresses many items such as requirements for information accuracy, frequency, throughput and timeliness, types of mobile and stationary entities that collect, transmit, store and consume the data, along with types of telecommunications devices. The customer, end user and data providers are considered, along with security issues such as data ownership, standards ownership and privacy. The gaps identified are prioritized and finalized in a concise format for ease of use by project managers.

Note that the information contained in the assessment is obtained from a variety of documents provided by the various program managers. When information was not available, educated guesses were made as necessary to fill in informational gaps. This was done in the best attempt to provide as complete a document as possible.

1.3 Document Purpose and Overview

The purpose of this document is to provide an assessment of the relevant standards and identify gaps for the candidate applications within the Connected Vehicle DCM and DMA programs. This document is presented with the following sections:

- **Section 2, Standards Coordination Planning:** provides background information relating to the overall standards planning effort and the relationship between the SCP and this gap analysis document
- **Section 3, Review of Relevant Standards:** provides an overview of the standards that apply to the DCM and DMA programs
- **Section 4, Assessment of DCM and DMA Standards Needs:** provides the actual assessment of the DCM and DMA standards needs
- **Section 5, Review and Summary of Standards Gaps:** presents a summary of the standards gaps in a concise format
- **Section 6, References:** contains the document references
- **Appendix A**: contains a glossary of terms

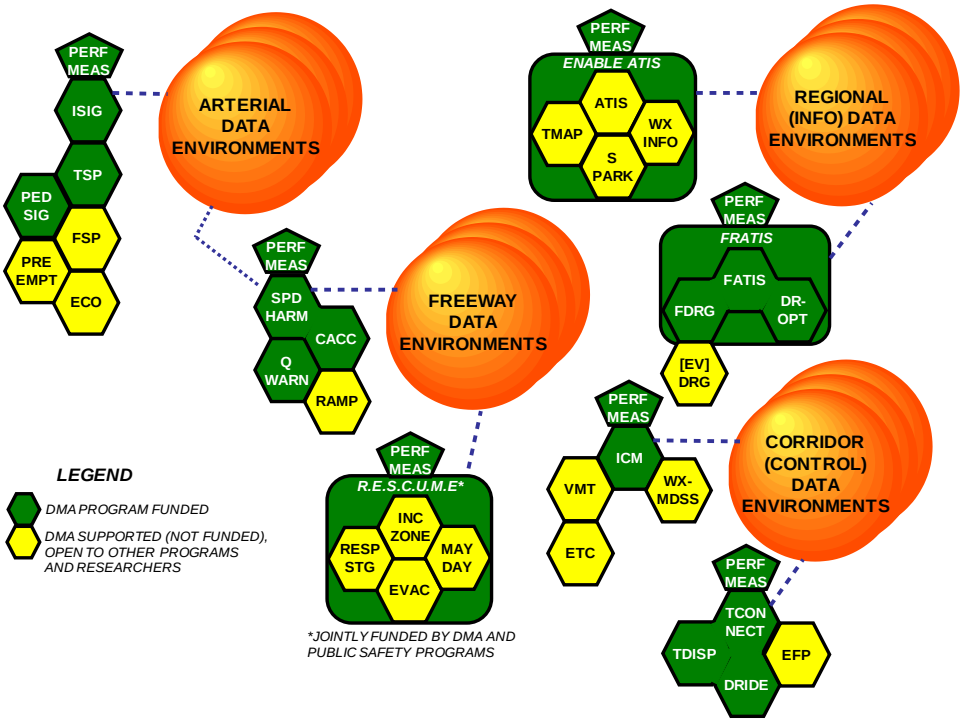
2 Standards Coordination Planning

This section provides the background and overview of Task 2 of the project, the creation of a high level Standards Coordination Plan.

Many ITS standards exist relating to the Connected Vehicle Initiative. The challenge is to build on this existing set of standards to determine if any additional standards, or if any modifications to the existing standards will be needed for the Connected Vehicle Initiative to be successful. The Connected Vehicle Data Capture and Management (DCM) and Dynamic Mobility Applications (DMA) Standards Coordination Plan (high level plan) was developed to assess the required standards-related work of the three programs (DCM, DMA, ITS Standards) and coordinate the activities of the three programs to avoid duplication of work, or initiating contradictory work.

In the effort to develop the Standards Coordination Plan, an initial assessment was conducted of the DCM, DMA and ITS Standards Programs. The current status of each program was determined. Figure 2-1 depicts those DCM and DMA applications which are deemed high priority.

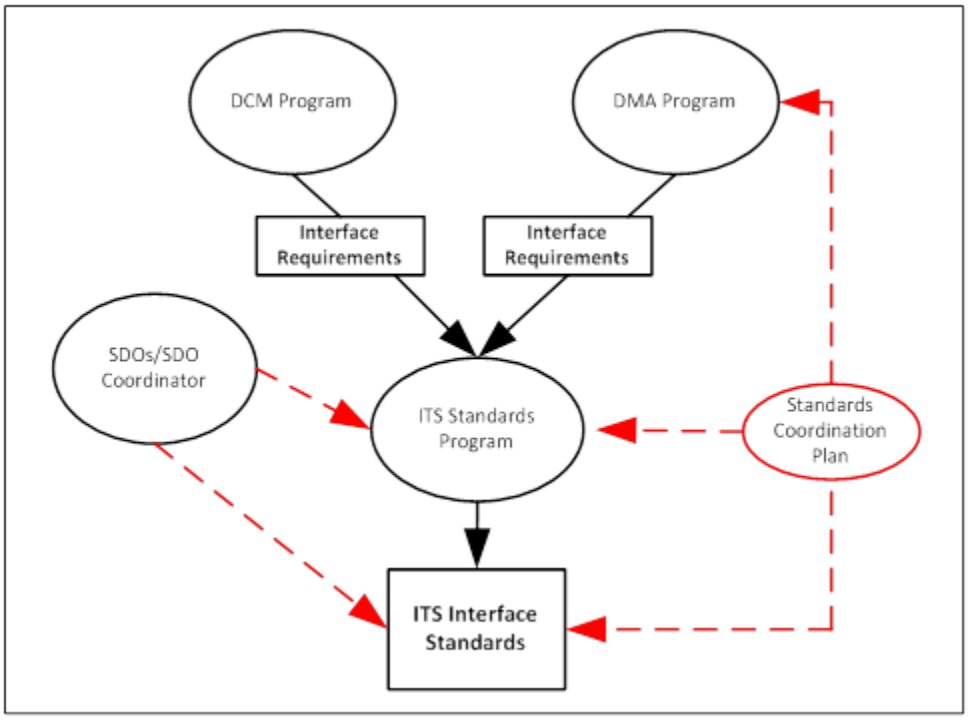
Figure 2-1. High Priority DCM/DMA Applications



[Source: ITS JPO Mobility Applications Program High-Priority Applications and Development Approach, http://www.its.dot.gov/press/2011/mobility_app.htm, Last Accessed October 18, 2012.]

The coordination between the DCM, DMA and ITS Standards programs, and the role of the Standards Coordination Plan was determined, and the relationship is shown in Figure 2-2.

Figure 2-2. DCM/DMA Programs – ITS Standards Program Relationship Diagram



[Source: Science Applications International Corporation (SAIC), February 24, 2012.]

In addition to the current assessment of the DCM, DMA and ITS Standards programs, other items were considered relating to the Standards Coordination Plan. Core Systems and other initiatives, such as the Safety Pilot Program, the Smart Roadside Initiative and the Real-Time Multimodal Decision Support System, were discussed.

Alternatives for standards development along with alternatives for the coordination of standards development efforts were explored. The alternatives explored for the standards development activities include using a Standards Development Organization (SDO) based standards development, a contracted standards development, or a partially funded standards development approach. The alternatives for the coordination activities include using an SDO-led effort, or using a USDOT-led standards coordination effort.

Other items considered in the development of the Standards Coordination Plan include international harmonization of Connected Vehicle standards, the adoption and promotion of the ITS interface standards, quality measures to support the Standards Coordination Plan, and quality control in standards development. The Connected Vehicle Certification Program was considered as well as standards relating to transit and freight management.

The High Level (or Task 2) Connected Vehicle Data Capture and Management (DCM) and Dynamic Mobility Application (DMA) Standards Coordination Plan was put forth that performs the following functions:

- Assess standards-related work activities of the DCM, DMA, and ITS Standards programs
- Identify opportunities, decision points and milestones on a joint standards roadmap combining inputs from all three program plans
- Investigate alternative mechanisms and processes that can be used by the Standards Development Organizations (SDOs) to develop new standards or enhance existing standards
- Identify quality control methods and processes that the SDOs will be required to apply to develop new standards or enhance existing standards
- Investigate test procedures and conformance statement content in new standards or the enhancement of existing standards that are required to satisfy Connected Vehicle certification requirements
- Address resource and scoping statements for identified coordination activities among the three programs
- Address standards relating to mobility applications for transit and freight management.
- Identify considerations relating to the ITS National Architecture
- Assess a number of other standards coordination considerations including other Connected Vehicle initiations (e.g., Smart Roadside), international standards harmonization along with transit and freight standards

As a result of the assessment of the DCM, DMA, and ITS Standards programs, along with addressing the considerations relating to the coordination of standards, the following are key recommendations for coordinating the standards:

- The USDOT should direct the Connected Vehicle Initiative leadership of the DCM and DMA programs to develop the interface requirements for each DCM and DMA application that are of following types: (1) functional requirements that describe what the interface will do, (2) Performance requirements describing what timing is to be met for the interface, and (3) non-function supporting requirements. This will help develop standards that follow standard Systems Engineering (SE) Process.
- The USDOT should fund selected standards development activities, with particular support of the document editing function (to ensure well written standards), and public sector travel (to ensure adequate public sector involvement).
- The USDOT should encourage the use of a common data presentation for interface standards and establish a policy.
- Standards Engineering Process (SEP) should be used for all new standards and standards modifications to ensure correct interface requirements are developed.
- The USDOT should coordinate with the SDOs to ensure they adhere to quality control and assurance procedures.
- Identify a list of key standards coordination stakeholders to help execute the plan itself.
- Perform outreach activities related to the new standards development and coordination processes including regular updates to the existing ITS standards website.

- Perform pilot testing of the new or modified standards.
- Conduct international standards harmonization coordination activities

One of the key activities described above is to develop the standards interface requirements. Application developers must prepare and provide interface requirements as part of the ConOps and Functional Requirements development work of the applications they are developing. The application developers shall provide these interface requirements to the standards coordination entity.

It is expected that the interface requirements describe the following information in detail:

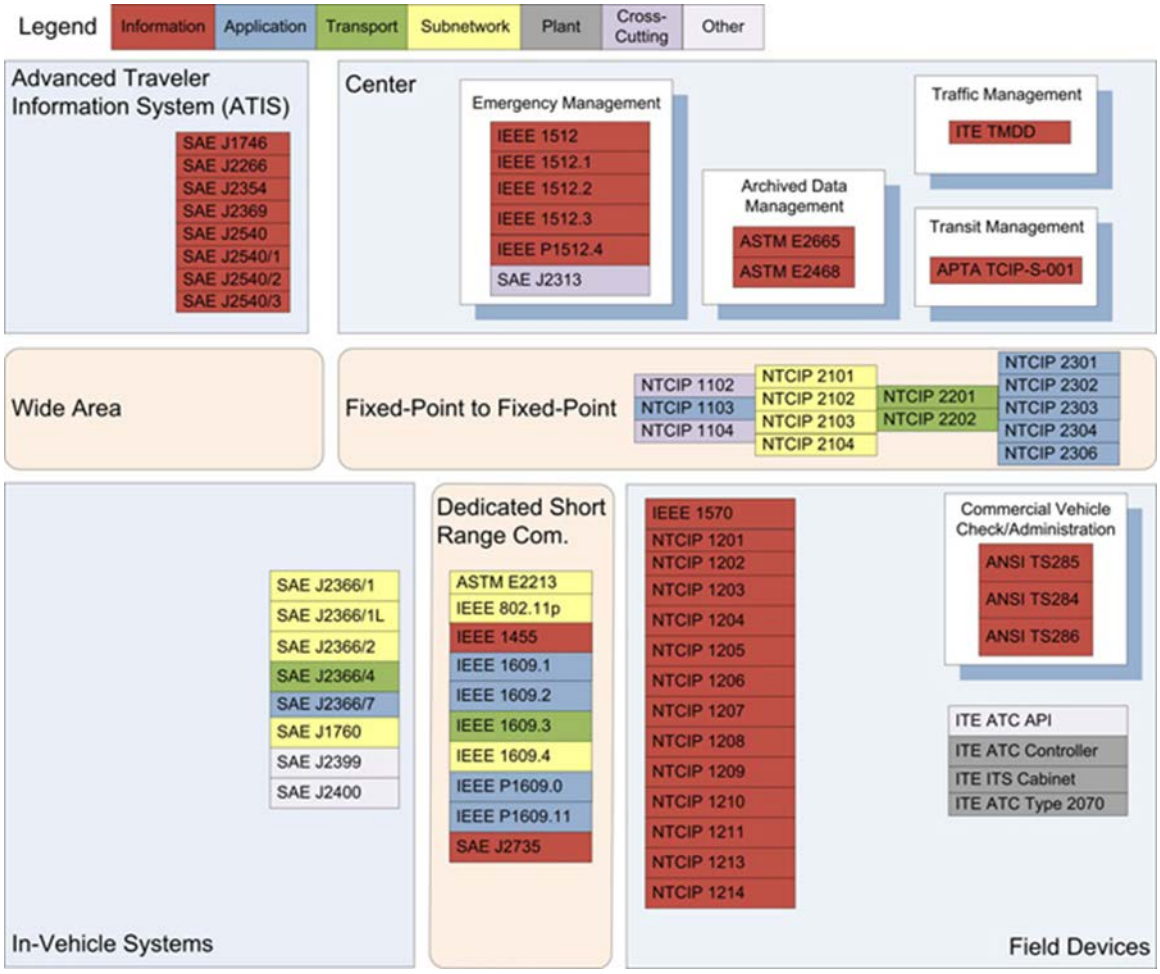
- Data Related Interface requirements, including:
  - Which data needs to be sent under which conditions for the application to deliver the required application functionality.
  - Which data needs to be sent together with other data to create a complete set of information, in order for the application to function correctly.
  - Which data should be available at the interface to allow a requesting entity to determine the state of the responding entity (the properties of the entity hosting the interface), so that the requesting application can function correctly. This should include requirements for the accuracy of the data as applicable, for example, the accuracy of the data such as geo-location data.
  - The data exchange transaction (also called "dialogs") which will allow a requesting entity application to request a control function which will change the state of the responding entity application (the methods of the entity hosting the interface). For example, this could include a request for priority at a traffic signal.
  - The data which should be transmitted by an entity without request. This data may be transmitted periodically, or on change, and could be broadcast or sent to a set of subscribing entities applications. These data are events raised by an entity application, and for example, could include the Basic Safety Messages broadcast from vehicles. The Concept of Operations should originate the process to identify the user needs, information flows and constraints.
- Performance Requirements related to data transmission, including:
  - How long it should take to transmit data from the sending entity until the receiving entity receives the data
  - Allowable latency in data transmissions
  - Reliability of data transmissions, including the requirements for high speed data throughput under severe or difficult conditions.

A key activity recommended in the Standards Coordination Plan is the assessment of existing standards to determine if any gaps exist in the standards. Section 3 provides an overview of the standards that are applicable to the DCM and DMA programs, along with detailed results of the gap analysis.

3 Review of Relevant Standards (Current and Planned)

Ninety- eight (98) ITS standards have been published or are currently in development to meet various user and architectural needs. Figure 3-1 is an illustration of the standards developed with USDOT support, aligned with the National ITS Architecture.

Figure 3-1. ITS Standards within the National ITS Architecture



[Source: Intelligent Transportation Systems (ITS) Standards Program Strategic Plan for 2011–2014, http://www.its.dot.gov/standards_strategic_plan/index.htm, Last Accessed October 18, 2012.]

Table 3-1 represents an analysis of the existing standards that apply across the DCM and DMA programs and other associated projects, e.g., Smart Roadside. Only those standards that apply to the Mobility Program are shown. An "X" indicates that the referenced standard has applicability to the indicated DCM data environment or DMA bundle. This was determined using the following criteria:

1. A standard was checked if the DCM and DMA program documentation was reviewed and there was reference to specific standards associated with the bundles or environments.
2. A comparison of the relevant current ITS standards were revised against the Dynamic Mobility Application and Data Capture Environment user needs, system requirements and operational scenarios. When it was apparent that a standard applied to an application or environment, the standard was checked.
3. When existing ITS standards and ITS Architecture documents made reference to connected vehicle applications, those standards referenced in these documents were checked as applied to the various bundles or environments
4. We identified standards that we knew applied to the bundles and environments using direct industry knowledge and expertise of the standards developed to date, e.g., through our direct involvement with standard development working groups and SDOs.

The applicable standards are discussed in more detail in Section 5, in particular those that require modification to support the Connected Vehicle Mobility program.

Table 3-1. ITS Standards Applicable to DCM and DMA

		Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
Standard	Description	Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
AASHTO/ITE																			
ITE TMDD v 3.0	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC). This standard contains data elements for roadway links and for incidents and traffic-disruptive roadway events. The standard 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. The standard also contains the message sets for communication between traffic management centers and other ITS centers, including information service providers, emergency management systems, missions management systems, and transit management systems.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
ITE TMDD v 3.02	Message Sets for External TMC Communication (MS/ETMCC). A message set standard for communication between traffic management centers and other ITS centers, including information service providers, emergency management systems, missions management systems, and transit management systems.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	A

[1] P: published; A: approved; B: in ballot; D: in development

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
AASHTO/ITE/NEMA																			
NTCIP 1103 v2	Transportation Management Protocols (TMP). Specifies a set of rules and procedures for exchanging information with a minimum of overhead to provide an interoperability standard for transportation-related devices that operate over bandwidth-limited communications links.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
NTCIP 1103 v 3	Transportation Management Protocols (TMP). Specifies a set of rules and procedures for exchanging information with a minimum of overhead to provide an interoperability standard for transportation-related devices that operate over bandwidth-limited communications links.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	p
NTCIP 1104	Center-to-Center Naming Convention Specification. Defines the standard mechanism to name entities within CORBA systems. CORBA is a distributed processor system, where information needed by one processor could be actually stored on some other computer, or several computers. To enable finding the required information, a common naming convention is required and used.	X	X	X	X	X													P
NTCIP 1201 v2	Global Object Definitions. This document defines those pieces of data that are likely to be used in multiple device types such as actuated signal controllers and dynamic message signs. Examples of this data include time, report generation, scheduling concepts, etc.						X	X	X			X							P
NTCIP 1201 v3	Global Object Definitions. This document defines those pieces of data that are likely to be used in multiple device types such as actuated signal controllers and dynamic message signs. Examples of this data include time, report generation, scheduling concepts, etc. Also includes Daylight Savings Time references						X	X	X			X							P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
NTCIP 1202 v2	Object Definitions for Actuated Traffic Signal Controller (ASC) Units. Specifications for objects that are specific to actuated signal controllers and definitions of standardized object groups that can be used for conformance statements.				X		X	X				X							P
NTCIP 1203 v3	Object Definitions for Dynamic Message Signs (DMS). Defines data that is specific to dynamic message signs including all types of signs that can change state, such as blank-out signs, changeable signs, and variable signs.				X			X	X			X							P
NTCIP 1204 v3	Object Definitions for Environmental Sensor Stations (ESS). Definitions of objects that are specific to environmental sensor stations (ESS) and object groups which can be used for conformance statements. The communication between remote entities and ESS is accomplished by using the NTCIP application layer services to convey requests to access or modify values of ESS objects.	X	X	X		X		X	X	X		X			X	X	X	X	P
NTCIP 1205	Object Definitions for Closed Circuit Television (CCTV) Camera Control. A database for closed circuit television systems. The format of the database is identical to other NTCIP devices and uses ASN.1 representation. Targeted devices include cameras, lenses, video switches, and positioning controls for aiming and identification, such as video text overlays. The standard will support various levels of conformance.	X	X		X							X							P
NTCIP 1206	Object Definitions for Data Collection and Monitoring (DCM) Devices. Specifies object definitions that may be supported by data collection and monitoring devices, such as roadway loop detectors.	X	X		X		X	X				X		X					P
NTCIP 1207 v2	Object Definitions for Ramp Meter Control (RMC) Units. This standard deals with the data required to control and monitor a ramp meter.				X			X				X							P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
NTCIP 1209 v2	Data Element Definitions for Transportation Sensor Systems (TSS). Object definitions that are specific to and guide the data exchange content between advanced sensors and other devices in an NTCIP network. Advanced sensors include video-based detection sensors, inductive loop detectors, sonic detectors, infrared detectors, and microwave/radar detectors.	X	X		X		X	X				X							P
NTCIP 1211 v2	Object Definitions for Signal Control and Prioritization (SCP). Defines the management information base for Signal Control and Prioritization (SCP) Systems. It defines individual parameters that represent the configuration, status, and control information that is unique to an SCP and also defines specific groupings of these parameters and others to address the operational configuration, monitoring, and control of the device/entity in a baseline system configuration.	X			X		X	X				X	X						P
NTCIP 2101	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile. A set of data link and physical layer protocols applicable to roadside devices. (Formerly TS 3.SP-PMPP232-1998)						X	X						X					P
NTCIP 2102	Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile. This standard defines how to communicate over twisted wire using FSK modems. It may be used with any Transport Profile. Ito provides the information necessary to establish a connection using the Point-to-MultiPoint Protocol (PMPP) via a 1200 bps frequency shift keying (FSK) modem interface. It is used to manage connected devices that coexist on a common channel.						X	X						X					P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
NTCIP 2103	Point-to-Point Protocol Over RS-232 Subnetwork Profile that defines requirements for the data link and physical layers of a communications stack. It specifies the rules and procedures for using the point-to-point protocol over RS-232 related circuits. The intent is to provide an interoperability standard for transportation-related devices that communicate over dial-up circuits. (Formerly TS 3.SP-PPP/RS232)						X	X						X					P
NTCIP 2104	Ethernet Subnetwork Profile that defines requirements for the data link and physical layers of a communications stack. It specifies the rules and procedures for using the IEEE Link Layer Control (802.2) and Media Access Control (802.3) protocols over coaxial, twisted pair, or fiber optic media. The intent is to provide an interoperability standard for transportation-related devices that communicate over local area network (LAN) interfaces. (Formerly TS 3.SP-Ethernet)						X	X						X					P
NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile. A set of transport and network layer protocols to provide connectionless and connection-oriented transport services.	X	X	X	X	X	X	X	X	X	X		X						P
NTCIP 2302	Trivial File Transfer Protocol (TFTP) Application Profile. Defines how to use the Trivial File Transfer Protocol within transportation networks. A common application profile providing connectionless file transfer services.			X						X	X								P
NTCIP 2303	File Transfer Protocol (FTP) Application Profile. A common application profile providing connection-oriented file transfer services.			X	X				X	X	X		X						P
NTCIP 2304	Application Profile for DATEX-ASN (AP-DATEX). Fulfills the need for a communications stack that supports routing, sequencing, and file transfer over point-to-point links, based on (sockets) TCP, IP, and PPP.		X		X				X			X							P

		Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
Standard	Description	Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
NTCIP 2306	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML). This standard allows transportation agencies and center managers the ability to specify and implement communications interfaces for transmitting information encoded in the Extensible Markup Language (XML) between their center and an external center.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
NTCIP 1210	Field Management Stations (FMS) - Part 1: Object Definitions for Signal System Masters. This document will define the objects necessary to manage a field master. A field management station would be used to implement a polling scheme whereby the field management station could be programmed by a central controller (or other management stations) to poll its agents. These agents could be Actuated Signal Controllers, Ramp Meters, Dynamic Message Signs, or other NTCIP conformant equipment.	X			X		X					X							UD
ANSI																			
ANSI TS284	Commercial Vehicle Safety Reports. An electronic data interchange (EDI) transaction set to allow authorized parties to electronically request and send reports on information related to the safe operation of commercial road vehicles, such as inspection reports, safety and compliance review reports, and hazardous material incident		X	X							X			X					P
ANSI TS285	Commercial Vehicle Safety and Credentials Information Exchange. An electronic data interchange (EDI) transaction set to permit enforcement officials, government administrators and other authorized parties to retrieve information electronically on the safety performance, regulatory compliance, and credentials status of commercial motor vehicles, carriers, and drivers		X	X							X			X					P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
ANSI TS286	Commercial Vehicle Credentials. An electronic data interchange (EDI) transaction set that can be used by owners, leasers, and drivers of commercial motor vehicles to apply electronically for credentials necessary to legally operate those vehicles, and by authorizing jurisdictions to electronically transmit credential data to applicants and other authorized entities.		X	X							X			X					P
APTA																			
APTA TCIP-S-001 v3.04	Standard for Transit Communications Interface Profiles. Its primary purpose is to define standardized mechanisms for the exchange of information in the form of data among transit business systems, subsystems, components and devices. The standardization of these interfaces is intended to reduce the cost of future procurements of transit computer based systems, and to facilitate a greater degree of automation and integration of those systems.	X			X		X					X	X						P
ASTM																			
ASTM E2213-03	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications. This standard describes a medium access control layer and physical layer specification for wireless connectivity using dedicated short range communications services.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
ASTM E2259-03	Standard Guide for Archiving and Retrieving ITS-Generated Data. 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.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
ASTM E2468-05	Standard Practice for Metadata to Support Archived Data Management Systems. Specifies how to annotate data for subsequent uses.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
ASTM E2665-08	Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data. Specifies a data dictionary for archiving traffic data.	X	X	X	X	X	X	X	X	X	X	X	X		X				P
IEEE																			
IEEE 1512-2006	Standard for Common Incident Management Message Sets for use by Emergency Management Centers. 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).	X	X	X	X			X	X	X		X							P
IEEE 1512.1-2006	Standard for Traffic Incident Management Message Sets for Use by Emergency Management Centers. 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.	X	X	X	X			X	X	X		X							P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
IEEE 1512.2-2004	Standard for Public Safety Traffic Incident Management Message Sets for Use by Emergency Management Centers. 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.	X	X	X	X			X	X	X		X							P
IEEE 1512.3-2006	Standard for Hazardous Material Incident Management Message Sets for Use by Emergency Management Centers. Enables consistent standardized communications among incident management centers, HAZMAT teams, police, local government, fire, special emergency and emergency management centers.	X	X	X	X			X	X	X		X							P
IEEE P1512.4	Standard for Common Traffic Incident Management Message Sets for Use in Entities External to Centers. This standard will address 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). This standard will be limited to common message sets for use by emergency management including transportation, fire/rescue, enforcement, HazMat, etc.								X										B
IEEE 1570-2002	Standard for the Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection. 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.				X						X								P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
IEEE P1609.0	Standard for Wireless Access in Vehicular Environments (WAVE) – Architecture. This standard describes the Wireless Access in Vehicular Environments (WAVE/DSRC) architecture and services necessary for multi-channel DSRC/WAVE devices to communicate in a mobile vehicular environment. The purpose of this standard is to describe the architecture of the DSRC/WAVE operations currently represented by the family of IEEE 1609 standards and IEEE P802.11p.						X	X	X		X			X	X	X	X	X	D
IEEE 1609.1-2006	Standard for Wireless Access in Vehicular Environments (WAVE) - Resource Manager. This standard describes a resource manager that arbitrates requests for transponder usage.						X	X	X		X			X	X	X	X	X	P
IEEE 1609.2-2006	Standard for Wireless Access in Vehicular Environments (WAVE) - Security Services for Applications and Management Messages. Secure message formats, and the processing of those secure messages, within the DSRC/WAVE system are defined. The standard covers methods for securing WAVE management messages and application messages, with the exception of vehicle-originating safety messages. It also describes administrative functions necessary to support the core security functions						X	X	X		X			X	X	X	X	X	P
IEEE 1609.3	Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services. Describes standard that supports higher layer communication stacks, including TCP/IP.						X	X	X		X			X	X	X	X	X	P
IEEE 1609.4-2010	Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operation. Describes various standard message formats for DSRC applications at 5.9 GHz.					X	X	X	X		X			X	X	X	X	X	P

		Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
Standard	Description	Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
IEEE 802.11-2012	Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks IEEE 802.11 is a set of standards for implementing wireless local area network (WLAN) computer communication in the 2.4, 3.6 and 5 GHz frequency bands. They are created and maintained by the IEEE LAN/MAN Standards Committee (IEEE 802.). This revision specifies technical corrections and clarifications to IEEE Std 802.11 for wireless local area networks (WLANS) as well as enhancements to the existing medium access control (MAC) and physical layer (PHY) functions. It also incorporates Amendments 1 to 10 published in 2008 to 2011. IEEE 802.11p has been rolled up into 802.11-2012.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	B
NEMA/AASHTO/ITE																			
ITE ATC Control-ler 5.2	Advanced Transportation Controller (ATC). Standard for advanced transportation controller (ATC) devices to support ITS data flows and standards that enable deployment of ITS. Capable of operating in the ATC cabinet and using the ATC application program interfaces.						X												P
SAE																			
SAE J1663	Truth-in-Labeling Standard for Navigation Map Databases. This standard defines consistent terminology, metrics, and tests for describing the content and quality of navigable map databases. (This standard does NOT specify the physical format of the database or minimum performance standards.) The focus of this document is to support the navigation applications that automotive manufacturers and suppliers are currently developing for marketplace delivery.	X	X	X	X			X		X	X	X							P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
SAE J1708	Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications. Defines a recommended practice for implementing a bi-directional, serial communication link among modules containing microcomputers. Defines those parameters of the serial link that relate primarily to hardware and basic software compatibility such as interface requirements, system protocol, and message format.										X			X					P
SAE J1746	ISP-Vehicle Location Referencing Standard. A referencing format for information service provider (ISP)-to-vehicle and vehicle-to-ISP references. This standard will reflect the cross-streets profile of the current location reference message specification (LRMS) document as expressed in the National Location Referencing Information Report (SAE J2374).	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
SAE J1757	Standard Metrology for Vehicular Displays. The scope of this SAE Standard is to provide methods to determine display optical performance in all typical automotive ambient light illumination - with focus on High Ambient Contrast Ratio, which is critical for display legibility in a sunshine environment. It covers indoor measurements and simulated outdoor lighting. It is not the scope of this document to set threshold values for automotive compliance, however some recommended values are presented for reference.						X	X	X		X	X	X	X	X	X	X	X	P
SAE J1760	ITS Data Bus Data Security Services. Specifies definition of data security requirements between devices on the ITS data bus (IDB) and definitions of device and message level security. Also includes a mechanism to discourage theft of data bus modules.						X	X	X	X	X	X	X	X	X	X	X	X	P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
SAE J2266	Location Referencing Message Specification (LRMS). The Location Referencing Message Specification (LRMS) standardizes location referencing for ITS applications that require the communication of spatial data references between databases. ITS databases may reside in central sites, vehicles, or devices on or off roads or other transportation links. The LRMS is applicable to both homogeneous (same database) and mixed database environments that may be implemented on wireless or landline networks. While developed for ITS applications, the LRMS may be used for non-ITS applications as well within the field of geographic information processing.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P
SAE J2313	On-Board Land Vehicle Mayday Reporting Interface. A general specification that prescribes protocol methods which enable vendors with different communication methods to communicate with response agencies in a standard format.		X						X										P
SAE J2354	Message Set for Advanced Traveler Information System (ATIS). 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.			X				X	X	X	X		X				X		P
SAE J2365	Calculation of the Time to Complete In-Vehicle Navigation and Route Guidance Tasks. Guidelines for the implementation of specific man-machine interface transactions and classes of transactions.				X								X						P

		Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
Standard	Description	Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
SAE J2366/1	ITS Data Bus - IDB-C Physical Layer. A physical interface device (connector) that will ensure compatibility between vehicles and aftermarket devices. Physical interface performance requirements, circuit identification and configuration, and electrical requirements for the physical						X	X	X		X		X	X	X	X	X	X	P
SAE J2366/1L	ITS Data Bus - Low Impedance Stereo Audio. This SAE Recommended Practice describes the Low Impedance Stereo Audio (LISA) bus, which may be used in conjunction with the Physical Layer of the IDB-C, as described in SAE J2366-1. The audio arbitration messages used to control access to the LISA bus are specified in SAE J2366-7. The IDB-C is a non-proprietary virtual token passing bus, designed to allow disparate consumer, vehicle, and commercial electronic components to communicate and share information.						X	X	X		X		X	X	X	X	X	X	P
SAE J2366/2	ITS Data Bus - Link Layer. Requirements for the link layer (layer 7 of the OSI model) for the ITS data bus. Requirements for the link layer (layer 7 of the OSI model) for the ITS data bus.						X	X	X		X	X	X	X	X	X	X	X	P
SAE J2366/4	ITS Data Bus - Thin Transport Layer. Requirements for the thin transport layer (Layer 4 of the OSI model) for the ITS data bus. Requirements for the thin transport layer (Layer 4 of the OSI model) for the ITS data bus						X	X	X		X	X	X	X	X	X	X	X	P
SAE J2366/7	ITS Data Bus - Application Message Layer. Requirements for the application layer (layer 7 of the OSI model) for the ITS data bus. Requirements for the application layer (layer 7 of the OSI model) for the ITS data bus.						X	X	X		X	X		X	X	X	X	X	P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
SAE J2369	Standard for ATIS Message Sets Delivered Over Reduced Bandwidth Media. A flexible waveform defined for the physical and data link layers for delivery of data to mobile and fixed users using a sub-carrier on a broadcast FM station. It supports: ATIS message sets (SAE J2369); differential GPS message sets defined by Radio Technical Commission for Maritime Services Special Committee No. 104; emergency alert system messages defined by CFR Title 47, Part 11; and Retransmission of Radio Broadcast Data System data.								X	X	X								P
SAE J2395	ITS In-Vehicle Message Priority. Specifies orderly temporal and spatial presentation of ITS information to the driver.						X	X	X		X	X		X	X	X	X	X	P
SAE J2399	Adaptive Cruise Control (ACC) Operating Characteristics and User Interface. This standard presents the minimum requirements for safety-related elements of the operating characteristics and user interface of vehicles equipped with adaptive cruise control (ACC). It also coordinates the operating characteristics and user interface with collision warning and avoidance, along with other driver systems.	X	X					X											P
SAE J2400	Human Factors in Forward Collision Warning Systems: Operating Characteristics and User Interface Requirements							X											P
SAE J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards. Describes the process used in various SAE ATIS message set standards to deliver textual strings and provides national tables used in the delivery of incident description.			X						X	X								P

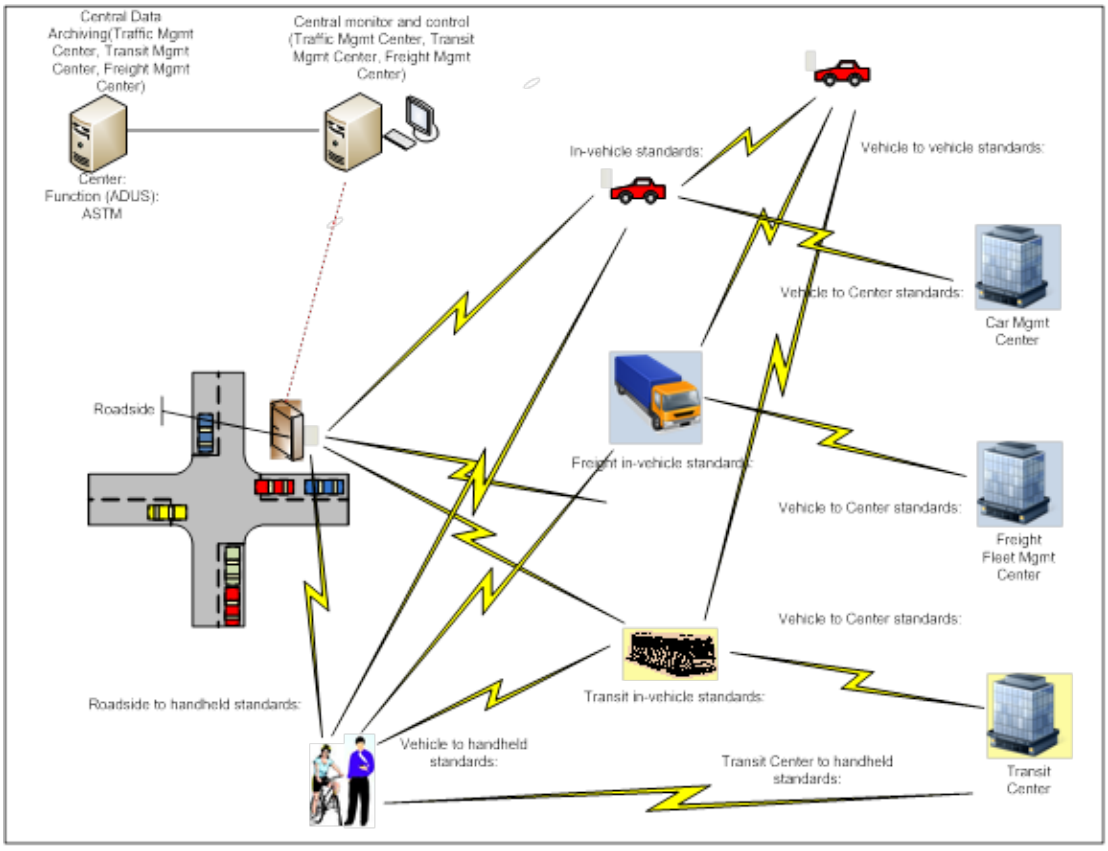
		Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
Standard	Description	Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
SAE J2540/1	RDS (Radio Data System) Phrase Lists. This SAE Standard provides a table of textual messages meeting the requirements for expressing "Radio Data Systems" (RDS) phrases commonly used in the ITS industry. They can be used both over the RDS subcarrier transmission media as part of a 37-bit long "Group 8a message" as well as being used to provide a common content list of phrases used in a wide number of other media and applications.						X	X	X	X	X	X	X	X	X	X	X	X	P
SAE J2540/2	ITIS (International Traveler Information Systems) Phrase Lists. This SAE Standard provides a table of textual messages meeting the requirements for expressing "International Traveler Information Systems" (ITIS) phrases commonly used in the ITS industry. The tables provided herein follow the rules of SAE J2540 and therefore allow a local representation in various different languages, media expressions etc., to allow true international use of these phrases. The phrases are predominantly intended for use in the description of traffic related events of interest to travelers and other traffic practitioners.		X	X					X		X	X	X						P
SAE J2540/3	National Names Phrase List. This SAE Standard provides a table of textual messages meeting the requirements for expressing the names of street and roads and some basic building blocks for phrases commonly used in the ITS industry.	X	X	X	X			X	X	X	X	X	X						P
SAE J2630	Converting ATIS Message Standards from ASN.1 to XML. This SAE Standard presents a set of rules for transforming an Abstract Syntax Notation (ASN.1) message set definition into an Extensible Markup Language (XML) schema. The result is intended to be a stand-alone XML Schema that is fully consistent with an existing ASN.1 information model.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	•	P

Standard	Description	Applicable DCM Data Environments					Applicable DMA Application Bundles								Weather Bundles				Status
		Arterial	Freeway	Regional	Corridor	Weather	M-ISIG	INFLO	R.E.S.C.U.M.E.	EnableATIS	FRATIS	ICM	IDTO	Smart Roadside	VDT	Freight	Traveler Info	EMS	P, A, B, D[1]
SAE J2735 v2009-11	Dedicated Short Range Communications (DSRC) Message Set Dictionary. 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.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	P

4 Assessment of DCM and DMA Standards Needs

Figure 4-1 represents the various actors in the Connected Vehicle area that need to communicate with each other to achieve the functions of the applications currently being designed in the Data Capture Management and Dynamic Mobility Application bundles. Each of the applications being designed will need to consider the data transfer, at the application interface, that will be required by the application in order to meet the functional requirements of the application, as defined in the ConOps and Requirement Specification for that particular application.

Figure 4-1. Connected Vehicle Standards Framework



[Source: Science Applications International Corporation (SAIC), July 19, 2012.]

Each of the communication paths in the diagram above (indicated with the yellow flash) will require one or more wireless transport standards, and a set of payload standards to describe the messages and dialogs required to implement the applications. From the diagram one can see that this is an

extensive and ongoing process, and will mainly fall to the program managers for each of the applications to ensure that the ConOps and Requirement Specification for each application adequately spells out the requirements at the application interface, which in turn will lead to a requirement for standards emerging.

Contained in this Section is a description of each DMA bundle or Data Capture Environment followed by specifics on the systems, subsystems, data types, and information types that must exchanged as well as the communication methods and data attributes needed for each bundle or environment. This information was obtained from the documentation listed in Appendix A or derived based on industry expertise. Section 5 will use the information contained in these tables to assess where there are gaps in existing standards and which specific holes should be filled in each.

4.1 Dynamic Mobility Applications

4.1.1 INFLO

Intelligent Network Flow Optimization (INFLO) is the DMA Bundle that includes the following three applications:

1. **Queue Warning (Q-WARN)** - The objective of queue warning is to provide a vehicle operator sufficient warning of impending queue backup in order to brake safely, change lanes, or modify route such that secondary collisions can be minimized or even eliminated.
2. **Dynamic Speed Harmonization (SPD-HARM)** - The objective of speed harmonization is to dynamically adjust and coordinate maximum appropriate vehicle speeds in response to downstream congestion, incidents, and weather or road conditions in order to maximize traffic throughput and reduce crashes. Research and experimental evidence have consistently demonstrated that by that reducing speed variability among vehicles, especially in near-onset flow breakdown conditions, traffic throughput is improved, flow breakdown formation is delayed or even eliminated, and collisions and severity of collisions are reduced.
3. **Cooperative Adaptive Cruise Control (CACC)** - The objective of cooperative adaptive cruise control (or CACC) is to dynamically and automatically coordinate cruise control speeds among platooning vehicles in order to significantly increase traffic throughput. By tightly coordinating in-platoon vehicle movements, headways among vehicles can be significantly reduced, resulting in a smoothing of traffic flow and an improvement in traffic flow stability. Additionally, by reducing drag, shorter headways can result in improved fuel economy and provides the environmental benefits of lowered energy consumption and reduced greenhouse gas emissions.

Based on the information available on the INFLO Bundle (e.g., Concepts of operations, research assessments, etc.) Table 4-1 depicts a summary of the standards needs and gaps.

Table 4-1. INFLO Standards Gaps Assessment

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
Customers and End Users:*	• Freeway Traffic Management Agencies • Arterial Traffic Management Agencies • Freeway Travelers/Commuters • Arterial Travelers/Commuters	**Data Capture Environments Involved:***	Freeway Data Environment Arterial Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Speed Harmonization (SPD-HARM)t	Freeway Data Environment	• Data with Roadway traffic detection, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and SPD-HARM Application Data with Traffic Management Entities • Weather data with 3rd party weather feeds	• Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber) • V2I communications	See attributes listed below
	Arterial Data Environment	• Data with Roadway traffic detection, Traffic Signal, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and SPD-HARM Application Data with Traffic Management Entities • Weather data with 3rd party weather feeds	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	See attributes listed below
	Roadway Traffic Detection subsystems	Volume, occupancy, speed and classification information	Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 85% accurate range or better
	Roadway Weather Detection Subsystems	Precipitation type precipitation levels surface conditions wind direction and speed air temperature	Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 Minute and 5 minutes. There is no stipulation on data accuracy

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
		surface temperature		
	Roadway Dynamic Message Signs	Current sign message and sign status (e.g., NTCIP)	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber)	Real-time DMS data should be fed within 30seconds of message being posted. The message should be 100% accurate
	3rd Party Weather Feeds	Precipitation type precipitation levels surface conditions wind direction and speed air temperature surface temperature weather location	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 Minute and 5 minutes. There is no stipulation on data accuracy
	Connected Vehicle Driver Interface	Recommended highway speeds User Interface Diagnostics	Wireless (Cellular, satellite or other) In-Vehicle communications	Data should be received and displayed on the user interface from the SPD-HARM application within 2 seconds
	On-Board Speed Harmonization Application	Receives data from various Roadway sensors, on-board sensors and traffic management entities related to current vehicle detection, weather and in-vehicle data vehicle; provided data on recommended speed to driver interface	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	On-Board Connected Vehicle Sensors	Provides pertinent data to the SPD-HARM data collection system.	Wireless (Cellular, satellite or other) In-Vehicle communications V2I communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	On-Board Connected Vehicle Data Collection Subsystem	Receives vehicle detection, roadway and weather data from on-board sensors, roadway subsystems, and, traffic management entities; feeds processes data to the SPD-HARM Application, feeds relevant speed and CV to other vehicles	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	Connected Vehicle Broadcast System	Speed, collision, weather and other relevant in-vehicle CV SPD-HARM data is fed to other vehicles via V2V communications	V2V Communications	V2V communication should take place in <1 second
	Connected Vehicle Weather Sensors	In-Vehicle CV Weather sensor data is fed to the CV data collection subsystem	Wireless (Cellular, satellite or other)	Transmission of information between in-vehicle systems

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
			In-Vehicle communications	should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	Performance Measurement System	• Number of Shockwaves formed • Length of shockwaves • Propagation speed of shockwaves • Recommended Vehicle Speeds • Level of Speed Compliance • Speed Variability • Average travel Times • Travel Time Reliability • Number of Primary and Secondary Crashes • Severity of Crashes • Emissions levels • Consumed Energy • Public Opinion Ratings • Speed Harmonization System Costs	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Not Applicable
	Traffic Management System SPD-HARM Application	Received data - from roadway subsystems including weather traffic data and DMS. Feeds data to data environment for relay to the CV	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission between the roadside and the data environment should take place in < 5 seconds
Queue Warning (Q-WARN)	Freeway Data Environment	• Data with Roadway traffic detection, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and Q-WARN Application Data with Traffic Management Entities • Weather data with 3rd party weather feeds	• Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber) • V2I communications	See attributes listed below
	Arterial Data Environment	• Data with Roadway traffic detection, Traffic Signal, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and Q-WARN Application Data with Traffic Management Entities • Weather data with 3rd party weather	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	See attributes listed below

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
		feeds		
	Roadway Traffic Detection subsystems	Volume, occupancy, speed and classification information. All traffic queue information if available	Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	Roadway Weather Detection Subsystems	Precipitation type precipitation levels surface conditions wind direction and speed air temperature surface temperature	Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 Minute and 5 minutes. There is no stipulation on data accuracy
	Roadway Dynamic Message Signs	Current sign message and sign status (e.g., NTCIP)	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber)	Real-time DMS data should be fed within w-minute of message being posted. The message should be 100% accurate
	3rd Party Weather Feeds	Precipitation type precipitation levels surface conditions wind direction and speed air temperature surface temperature weather location	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 Minute and 5 minutes. There is no stipulation on data accuracy
	Connected Vehicle Driver Interface	Notification of impending/downstream queue, queue length and distance to queue, User Interface Diagnostics	Wireless (Cellular, satellite or other) In-Vehicle communications	Data should be received and displayed on the user interface from the SPD-HARM application within 2 seconds
	On-Board Q-WARN Application	Receives data from various Roadway sensors, in vehicle sensors and traffic management entities related to current vehicle detection, weather and in-vehicle data vehicle; provided data on recommended speed to driver interface	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	On-Board Connected Vehicle Sensors	Provides pertinent data to the Q-WARN data collection system.	Wireless (Cellular, satellite or other) In-Vehicle communications I2V communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	On-Board Connected Vehicle Data Collection Subsystem	Receives vehicle detection, roadway and weather data from on-board sensors,	In-Vehicle communications V2I communications	Transmission of information between in-vehicle systems

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
		roadway subsystems, and, traffic management entities; feeds processes data to the Q-WARN Application, feeds relevant speed and CV to other vehicles		should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	Connected Vehicle Broadcast System	Queue, speed, collision, weather and other relevant in-vehicle CV Q-WARN data is fed to other vehicles via V2V communications	V2V Communications	V2V communication should take place in <1 second
	Connected Vehicle Weather Sensors	In-Vehicle CV Weather sensor data is fed to the VC data collection subsystem	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	Performance Measurement System	• Number of primary and secondary crashes • Severity of Crashes • Length of formed queues • Duration of formed queues • Number of shockwaves • Length of shockwaves • Propagation speed of shockwaves • Public Opinion Ratings • Number of false positive queue detection alerts • Number of non-detected queue detection alerts • Q-WARN System Costs	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Not applicable
	Traffic Management System Q_WARN Application	Received data from roadway subsystems including weather traffic data and DMS. Feeds data to data environment for relay to the CV as it relates to impending/ downstream queue, queue length and distance to queue	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission between the roadside and the data environment should take place in < 5 seconds
Cooperative Adaptive Cruise Control	Freeway Data Environment	• Data with Roadway traffic detection, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and CACC Application Data with Traffic Management Entities	• Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber) • V2V communications • V2I communications	Data should be transmitted between the freeway data environment and the CACC in-vehicle application should occur in <2 seconds

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
		• Weather data with 3rd party weather feeds		
	Arterial Data Environment	• Data with Roadway traffic detection, Traffic Signal, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and CACC Application Data with Traffic Management Entities • Weather data with 3rd party weather feeds	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Data should be transmitted between the data environment and the CACC in-vehicle application should occur in <2 seconds
	Roadway Traffic Detection subsystems	Volume, occupancy, speed and classification information.	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	Roadway Weather Detection Subsystems	Precipitation type precipitation levels surface conditions wind direction and speed air temperature surface temperature	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 Minute and 5 minutes. There is no stipulation on data accuracy
	Roadway Dynamic Message Signs	Current sign message and sign status (e.g., NTCIP)	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber)	Real-time DMS data should be fed within w-minute of message being posted. The message should be 100% accurate
	3rd Party Weather Feeds	Precipitation type precipitation levels surface conditions wind direction and speed air temperature surface temperature weather location	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 Minute and 5 minutes. There is no stipulation on data accuracy
	Connected Vehicle Driver Interface	Notification of activated CACC functions via in-vehicle displays	Wireless (Cellular, satellite or other) In-Vehicle communications	Data should be received and displayed on the user interface from the SPD-HARM application within 2 seconds
	On-Board CACC Application	Receives data from various Roadway sensors, in vehicle sensors and traffic management entities related to current	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds.

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
		vehicle detection, weather and in-vehicle data vehicle; provided data on recommended speed to driver interface		Transmission between the roadside and the data environment should take place in < 5 seconds
	On-Board Connected Vehicle Sensors	Provides pertinent data to the CACC data collection system	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5seconds
	On-Board Connected Vehicle Data Collection Subsystem	Receives vehicle detection, roadway and weather data from on-board sensors, roadway subsystems, and, traffic management entities; feeds processes data to the CACC Application, feeds relevant CACC fields and CV to other vehicles	In-Vehicle communications V2I communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	Connected Vehicle Broadcast System	Queue, speed, collision, weather and other relevant in-vehicle CV CACC data is fed to other vehicles via V2V communications	V2V Communications	V2V communication should take place in <1 second
	Connected Vehicle Weather Sensors	In-Vehicle CV Weather sensor data is fed to the CV data collection subsystem	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission of information between in-vehicle systems should take place in < 2 seconds. Transmission between the roadside and the data environment should take place in < 5 seconds
	Performance Measurement System	• Number of primary and secondary crashes • Severity of Crashes • Length of formed queues • Duration of formed queues • Number of shockwaves • Length of shockwaves • Propagation speed of shockwaves • Public Opinion Ratings • Number of false positive queue detection alerts • Number of non-detected queue detection alerts • CACC System Costs	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Not applicable

Intelligent Network Flow Optimization (INFLO) – Standards Gaps Assessment				
	Traffic Management System CACC Application	Received data from roadway subsystems including weather traffic data and DMS. Feeds data to data environment for relay to the CV as it relates to recommended CACC performance, e.g., notification of congestion levels, recommended headway distances, etc.	Wireless (Cellular, satellite or other) In-Vehicle communications	Transmission between the roadside and the data environment should take place in < 5 seconds
Data Ownership, Privacy, and Security	Of the data types listed above for INFLO, certain data and information is publically available via websites, smartphones, etc., so it is not a security concern. This includes roadside data information from 3rd party feeds and roadside devices that can be readily obtained via standard ATIS. Other data is considered secure and should be appropriately addressed in the standards. This includes all in-vehicle data and data transmitted between the driver and the roadside associated with these applications. In addition, security for interfaces with controllable ITS devices such as DMS and traffic signals must remain secure with the deployment of these applications			

*** Information retrieved from program materials**

**** Information based on industry practices or consultant experience**

4.1.2 IDTO

Integrated Dynamic Transit Operations (IDTO) is the DMA Bundle that includes the following three applications:

Connection Protection (T-CONNECT)

The goal of T-CONNECT is to improve rider satisfaction and reduce expected trip time for multimodal travelers by increasing the probability of intermodal or intra-modal connections. T-CONNECT will protect transfers between both transit (e.g., bus, subway and commuter rail) and non-transit (e.g., shared ride modes) modes, and will facilitate coordination between multiple agencies to accomplish the tasks. In certain situations, integration with other IDTO bundle applications (T-DISP and D-RIDE) may be required to coordinate connections between transit and non-transit modes.

Dynamic Transit Operations (T-DISP)

The goal of T-DISP is to expand transportation options by leveraging available services from multiple modes of transportation. Travelers would be able to request a trip via a handheld mobile device (or phone or personal computer) and have itineraries containing multiple transportation services (public transportation modes, private transportation services, shared-ride, walking and biking) sent to them via the same handheld device. A physical or virtual central system, such as a travel management coordination center (TMCC) would dynamically schedule and dispatch trips.

Dynamic Ridesharing (D-RIDE)

D-RIDE provides a means for drivers and riders to arrange carpooling trips within a relatively short time in advance of departure, enabling flexible, real-time transportation decisions. The two main goals for the D-RIDE application are to increase the use of non-transit ride-sharing options, including carpooling and vanpooling, and to improve the accuracy of vehicle capacity detection for occupancy enforcement and revenue collection on managed lanes. The key transit-related benefit of D-RIDE is its potential to help alleviate public transit capacity constraints during peak demand periods.

Based on the information available on the IDTO Bundle (e.g., Concept of Operations, research assessments, etc.) Table 4-2 summarizes the standards needs and gaps.

Table 4-2. IDTO Standards Gaps Assessment

Integrated Dynamic Transit Operations (IDTO) – Standards Gaps Assessment				
Customers and End Users:*	• Transit Operating Agencies • Transit Vehicle Operators • Transit Riders • Private Transportation Providers • Private Vehicle Drivers • Private Vehicle Riders	**Data Capture Environments Involved:***	• Corridor Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
T-CONNECT	Transit Agency Dispatch System	• Transfer requests • Operational status of vehicle (location, schedule adherence, real-time status, calculated ETA) • Vehicle schedule updates	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10 seconds.
	In-Vehicle Operator Interface	• Transfer requests • Real-time schedule adjustments	In-vehicle communication bus	Information exchange should occur in <1 second
	Transit Agency CAD/AVL System	• Vehicle location • Route and schedule adherence (RSA) status • Arrival predictions • Vehicle capacity	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10 seconds.
	Transit Rider's Personal Device/web app	• Transfer request • Transfer request status • User preferences • Travel plan updates	Wireless communications (Cellular, WiFi, WiMax)	Transmission of this information should take place in less than 10 seconds.
	T-CONNECT Management System	• Transfer requests • Operational status of vehicles (location, schedule adherence, real-time status, calculated ETA) • Vehicle schedule updates	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10 seconds.
	Arterial Data Environment	• Traffic conditions • Events • Road work and construction activities • Incidents	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10 seconds.

Integrated Dynamic Transit Operations (IDTO) – Standards Gaps Assessment				
	Freeway Data Environment	• Traffic conditions • Events • Road work and construction activities • Incidents	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10 seconds.
	Regional Trip Planner	• Transit Agency route and schedule information • Real-time status information • Service alerts	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10 seconds.
	Automated Vehicle Announcement (AVA) System	• Real-time schedule adjustments	Local Network (hardware or wireless)	Transmission of this information should take place in less than 10seconds.
T-DISP	CAD/AVL System	• Vehicle location data	Cellular or data radio communications	Every 30 sec. Transmission should occur in less than 10 seconds
	T-DISP Management System at the Travel Management Coordination Center (TMCC)	• Real-time traffic data • Real-time vehicle probe data • Rider request data	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10seconds.
	Rider's Personal Device/web app	• Trip request with origin, destination, and time (ODT) • Return trip request • Trip request status	Wireless communications (Cellular, WiFi, WiMax)	Transmission of this information should take place in less than 10seconds.
	TMCC Scheduling System	• Rider trip requests	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Transmission of this information should take place in less than 10seconds.
	In-Vehicle Operator Interface	• Manifests (sets of trips)	In-vehicle communication bus	Information exchange should occur in <1 second
D-RIDE	Personal Device for Requesting Ride-match	• Origin/destination • Time preference • Travel profile • Number of passengers with rider • Ride-match information • Meeting location	Wireless (cellular, satellite, other) or Internet-based connection with D-RIDE Management System	Transmission of information between Personal Device and D-RIDE Management System should take place in < 5 seconds
	Rideshare Data Entry System	User profile information, including: • Personal identification information	Phone center, web application, kiosk	Transmission of information between Data Entry System and

Integrated Dynamic Transit Operations (IDTO) – Standards Gaps Assessment				
		• Traveler preferences • User ID and password • Personal device information • Payment transaction information		D-RIDE Management System should take place in < 5 seconds
	D-RIDE Management System (D-RIDE Ride-match Application)	• Traffic information • Driver information • Rider information • HOV/HOT lane locations • Real-time location information	Wireless (cellular, satellite, other) or Internet-based connection with Personal Device for Requesting Ride-match, Rideshare Data Entry System, and In-Vehicle Rideshare System	Transmission of information between D-RIDE Management System and external devices should take place in < 5 seconds
	In-Vehicle Rideshare System	• Origin/destination • Time preference • Travel profile • Ride-match information Meeting location • In-vehicle occupancy information	Wireless (cellular, satellite, other) or Internet-based connection with D-RIDE Management System	Transmission of information between In-Vehicle Rideshare System and D-RIDE Management System should take place in < 5 seconds
	D-RIDE Management System – Data Center	User profile information, including: • Personal identification information • User history • Traveler preferences • User ID and password • Personal device information • Payment transaction information	Wireless (cellular, satellite, other) or Internet-based connection with D-RIDE Management System	Transmission of information should take place in < 5 seconds
	Managed Lane Payment System	• In-vehicle occupancy information • Vehicle information • Driver payment information	Wireless (cellular, satellite, other) connection with In-Vehicle Rideshare system and D-RIDE Management System	Transmission of information should take place in < 5 seconds
Data Ownership, Privacy, and Security	Of the data types listed above for IDTO, certain data (transit schedules and real-time vehicle status) is typically publically available and so does not present a security concern. Other data (including passenger location, payment information, and profile information) is considered secure and should be appropriately addressed in the standards.			

*** Information retrieved from program materials**

**** Information based on industry practices or consultant experience**

4.1.3 FRATIS

The Freight Advanced Traveler Information System (FRATIS) bundle is focused towards the development of freight-specific technology applications to improve freight operational efficiency. More specifically, the FHWA wishes to develop two FRATIS applications as follows:

1. **Freight-Specific Dynamic Travel Planning and Performance** – This application bundle will include traveler information, dynamic routing, and performance monitoring elements. The application will leverage existing data in the public domain, as well as emerging private sector applications, to provide benefits to both sectors.
2. **Intermodal Drayage Operations Optimization** – This application bundle will combine container load matching and freight information exchange systems to fully optimize drayage operations, thereby, minimizing bobtails/dry runs and wasted miles and spreading out truck arrivals at intermodal terminals throughout the day. These improvements would lead to corresponding benefits in terms of air quality and traffic congestion.

Based on the information available on the FRATIS Bundle (e.g., the Concepts of Operations), Table 4-3 depicts a summary of the standards needs and gaps.

Table 4-3. FRATIS Standards Gaps Assessment

Freight Advanced Traveler Information System (FRATIS) Standards Gap Assessment				
Customers and End Users:*	• FHWA • Private Travel Data Providers • Local/Regional Travel Information Systems • State Departments of Transportation • Drivers and Dispatchers • Logistics Intermediaries • Intermodal Terminals • Fleet Management and Routing System Vendors	**Data Capture Environments Involved:***	Regional Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
FRATIS Bundle	Regional Pre-Trip Planner for FRATIS	• Allow users to obtain regional truck trip planning information • Provide historical traffic pattern data along a designated truck route • Provide real-time traffic information along a designated truck route • Provide near real-time weather conditions along a designated truck route • Provide truck-specific route designations along a designated truck route • Provide truck-specific route restrictions along a designated truck route • Provide bridge heights along a designated truck route • Provide bridge weight restrictions along a designated truck route • Provide preferred freeway access paths along a designated truck route • Provide toll road information along a designated truck route	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	Information should be able to be transmitted/received every 1 minute. Information should be capable of being transmitted within 10 seconds, for each data type.

Freight Advanced Traveler Information System (FRATIS) Standards Gap Assessment				
		Provide construction zone information along a designated truck route		
	Dynamic Routing System	• Notify a user when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion • Provide a notification when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion • Provide an alternate route when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	When requested, information should be capable of being transmitted within 10 seconds, for each data type.
	Oversized Overweight Vehicle Routing System	• Exchange of information needed for automated Oversized Overweight (OSOW)permitting and routing by State systems • Submit requests for automated permitting for OSOW regional truck trips • Allow a user to retrieve the results of an automated permitting request for OSOW regional truck trips	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	When requested, information should be capable of being transmitted within 10 seconds, for each data type.
	Data Environment	• Allow users to obtain real-time information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region and along its borders • Provide real-time travel volumes for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Provide real-time average speeds for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., Leased telco or Fiber)	When requested, information should be capable of being transmitted within 10 seconds, for each data type.

Freight Advanced Traveler Information System (FRATIS) Standards Gap Assessment				
		• Provide real-time point-to-point travel time predictive information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Provide real-time incident information for incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Provide real-time estimated clearance time for congestion caused by incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Provide construction information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Provide extended arterial outage information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Provide special event traffic information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region • Support the real-time exchange of truck parking information • Allow users to obtain real-time information about truck parking locations and availability within and/or near the covered region • Allow users to place parking reservations in real-time		
	Freight/Marine Port Systems	• Allow users to obtain real-time intermodal terminal queue information	Wireless (Cellular, satellite or other) or hard line	When requested, information should be capable of being

Freight Advanced Traveler Information System (FRATIS) Standards Gap Assessment				
		• Provide queue length for intermodal terminal queues within the region • Provide estimated wait times from the back of the queue to the gate for intermodal terminal queues within the region • Allow users to match an empty (future or current) container with a truck expected to return to the terminal • Allow users to match an empty container for return only if the container is in reloadable condition • Allow users to match an empty container for return only if the trucking company determines that the value of the reload is sufficient to justify picking it up	telecommunication method (e.g., Leased telco or Fiber)	transmitted within 10 seconds, for each data type.
Data Ownership, Privacy, and Security	Data sources that have been excluded are Customs/security information (because it is hard to obtain) and enforcement data (it is treated separately under the Smart Roadside program). Personal and proprietary data from system users shall be protected and secured within the FRATIS system.			

*** Information retrieved from program materials**
**** Information based on industry practices or consultant experience**

4.1.4 EnableATIS

EnableATIS represents a unique application area within the USDOT DMA Program. EnableATIS refers not to specific applications or systems, but rather to a formalizing framework whereby multiple activities are envisioned to interact to support a diverse traveler information environment. The intent of the EnableATIS vision (as described in the EnableATIS Operational Concept) is not to be prescriptive in terms of specific applications or roles, but rather to serve as an overarching strategic summary of desired end-states for an EnableATIS environment. Therefore, the application summary table (Table 4-4) on the following page will address the systems and information types relevant to ATIS in a Connected Vehicle-enabled environment, rather than to a set of any specific EnableATIS applications, which have not been envisioned.

The key role of EnableATIS is to align its capabilities among the other emerging DMA and DCM program bundles and applications. In some instances, EnableATIS will coordinate with or leverage activities being carried out through initiatives such as FRATIS (freight-focused traveler information applications) and through the Data Capture and Management Program. The objectives of EnableATIS are to:

- Improve transportation system mobility and safety by better informing agency operational strategies as well as individual user decisions
- Foster multi-source data and information integration and delivery that will transform the user experience on the transportation network
- Advance planning, engineering, and research with new forms of data about traveler behavior and response to transportation operations Promote development of dynamic and transformative applications for real-time, multi-modal, and traveler information partnerships

Based on the information available on the EnableATIS Concept of Operations, Table 4-4 summarizes the standards needs and gaps.

Table 4-4. EnableATIS Standards Gaps Assessment

Enabling Advanced Traveler Information Services (EnableATIS) – Standards Gaps Assessment				
Customers and End Users:*	• Transit Operating Agencies • Transit Vehicle Operators • Transit Riders • Private Transportation Providers • Private Vehicle Drivers • Private Vehicle Riders • TMC Systems • Parking Systems • Transit Management Systems • CVO Systems	**Data Capture Environments Involved:***	• Freeway Data Environment • Arterial Data Environment • Regional (Information) Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Enable ATIS	Vehicle Systems	• Toll tag data • Connected vehicle data (speed, braking, windshield wiper activation, headlight activation, temperature, traction) • Probe data from Bluetooth and DSRC equipped vehicles	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	Infrastructure Systems	• Environmental road conditions • Bridge monitoring data • Maintenance & repair data • Weather conditions / forecasts • Crowd sourced social media data (i.e., equipment malfunctions)	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	Traffic Operations Systems	• Construction Data • Transportation video feeds • Speed, volume & occupancy data • Incident data • CLARUS Environmental Sensor Station data • Special events data • Probe-based speed data • Mobile-source data/traveler opted in data • Crowd sourced social media data	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better

Enabling Advanced Traveler Information Services (EnableATIS) – Standards Gaps Assessment				
	Parking Systems	• Parking facility utilization data • Parking availability data • Parking location data • Parking rate information • Crowd sourced social media data	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	Transit Operations Systems	• Vehicle diagnostic data • Situational awareness data (silent alarms & CCTV monitoring) • Vehicle headways • Passenger boarding & alighting counts • Automatic Vehicle Location (AVL) data • Transit vehicle location data & next transit vehicle arrival times • General Transit Feed Specification (GTFS) • Carpool & Vanpool data • Crowd sourced social media data • Airline data (location & arrival/departure schedules)	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	CVO Systems	• Vehicle registration data • Weigh in motion data • Freight operations data/records (private & DMV records) • Vehicle location & speed data • Historical manifest data	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
	Transportation Demand Management Systems	• Origin/Destination data (historical count) • Ramp meter monitoring data • Carpool / vanpool data • Telework availability/location • High Occupancy Toll (HOT) lane data (utilization & toll rates) • Bike sharing locations and availability • Origin/Destination data (mobile source based)	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better

Enabling Advanced Traveler Information Services (EnableATIS) – Standards Gaps Assessment	
Data Ownership, Privacy, and Security	Of the data types listed above for Enable ATIS, certain data, the majority is or will be publically available and so does not present a security concern. There is some origin destination data that is being required via this application and there are privacy concerns with making such information available. This should be addressed via the standards, if possible.

*** Information retrieved from program materials**

**** Information based on industry practices or consultant experience**

4.1.5 R.E.S.C.U.M.E.

Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) is a DMA application bundle consisting of four individual components: Emergency Communications and Evacuation, Incident Scene Pre-Arrival Staging Guidance for Emergency Responders, Incidents Scene Work Zone Alerts for Drivers and Workers, and Mayday Relay.

The R.E.S.C.U.M.E. bundle of Dynamic Mobility Applications, are not necessarily an integrated set of applications, but they do share a common trait: the necessity of broadening DMA stakeholders to include non-traditional Connected Vehicle partners. With this bundle, forming meaningful operational partnerships with the Public Safety and Emergency Management communities can become a reality. Connected Vehicle data will be obtained through the Real-Time Data Capture and Management program. A wide variety of data will be collected from various vehicles and subsystems including autos, commercial vehicles, transit vehicles, roadside infrastructure, roadside subsystems and other location data sources. These data will be collected into the correct data environments via the data capture subsystems and then be made available to the R.E.S.C.U.M.E. bundle of applications. Table 4-5 summarizes the standards needs and gaps.

Table 4-5. R.E.S.C.U.M.E. Standards Gaps Assessment

Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)				
Customers and End Users*	• Fire and Rescue • Law Enforcement • EMS • Towing and Recovery • DOT Maintenance and Construction • Public Transportation Providers • Motorists • Evacuees • Media • Non-Medical Facilities • Private Industry • Private Transportation Providers	**Data Capture Environments Involved:***	• Freeway Data Environment • Arterial Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Advanced Automatic Crash Notification Relay (AACN-Relay)	Crashed Vehicle Sensors → In-Vehicle AACN-RELAY Application	• Change in velocity • Vehicle orientation • Airbag status	In-vehicle communications/ communications bus	Real-time in-vehicle communication
	Crashed Vehicle In-Vehicle AACN-RELAY Application → Relay Vehicle In-Vehicle AACN-RELAY Application	• AACN message o Incident location o AACN data o Crash injury severity predictions o Number of victims	Wireless V2V communications (DSRC or other wireless)	Real-time data transmission between vehicles within V2V range
	Relay Vehicle In-Vehicle AACN-RELAY Application → Driver Interface System	• Incident alert (notification of a vehicle in distress in proximity)	In-vehicle communications/ communications bus	Real-time in-vehicle communication
	Relay Vehicle In-Vehicle AACN-RELAY Application → Roadside Equipment (RSE)	• AACN message	Wireless communications between vehicle and roadside (DSRC or other wireless, e.g., cellular)	Transmission of information from the vehicle to the roadside should occur within 5 seconds.
	RSE → TMC-based Information Broker System	• AACN message • HAZMAT transport vehicle identification information (license plate, shipper contact information) • Credentials to access HAZMAT contents • Vehicle occupant identification information (name, SSN)	Communications from roadside to TMC can be wireless or hard wire communications	Data should be transmitted within 30 seconds between roadside systems and the TMC.

Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)				
		• Credentials to access electronic medical records		
Application:	**Systems/System Interfaces Involved**	**Information that must be exchanged**	**Telecommunication Methods**	**Data Attributes (Frequency, Accuracy, Timeliness)**
Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)	Information Broker System → RESP-STG Application	• Correlated incident information (AACN data, crash severity predictions) • Electronic shipping papers • Vehicle occupant's electronic medical records • Weather data (rain, fog, smoke, etc.) • Traffic data near incident zone • Road sensor data (e.g., wet, icy, snow-covered) • Snow plow data (cleared roads, etc.) • CCTV • Traffic helicopter video • Medical care facility capabilities and availability (e.g., number of beds, trauma level)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	INC-ZONE Application → RESP-STG Application	• Video feeds (from emergency responders) • On-scene reports	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	RESP-STG Application → INC-ZONE Application	• Estimated time of arrival • Summary of equipment/personnel • Staging intentions • Arrival approach (directionality, route)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	RESP-STG Application → EVAC Application	• Estimated time of arrival • Summary of equipment/personnel • Staging intentions • Arrival approach (directionality, route)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	RESP-STG Application → Information Broker	• Estimated time of arrival • Summary of equipment/personnel	Local Area Network (LAN), Wide Area Network (WAN) or	Data should be transmitted within 30 seconds.

Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)				
		• Staging intentions • Arrival approach (directionality, route) • Route taken • Traffic/travel conditions encountered	Metropolitan Area Network (MAN)	
Application:	**Systems/System Interfaces Involved**	**Information that must be exchanged**	**Telecommunication Methods**	**Data Attributes (Frequency, Accuracy, Timeliness)**
Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)	Information Broker System → INC-ZONE Application	• Traffic data near incident zone • Road sensor data (e.g., wet, icy, snow-covered) • Weather data (e.g., rain, fog, smoke)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	INC-ZONE Deployed Equipment → INC-ZONE Application	• Characteristics of vehicles in incident zone (e.g., speed, trajectory)	Communications from roadside to TMC can be wireless or hard wire communications	Data should be transmitted within 30 seconds between roadside systems and the TMC.
	RESP-STG Application → INC-ZONE Application	• Estimated time of arrival • Summary of equipment/personnel • Staging intentions • Arrival approach (directionality, route)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	INC-ZONE Application → On-Scene Emergency Responders	• Alerts of vehicles present in incident zone • Personal warning device of oncoming dangerous vehicle • Routing instructions to medical care facility	Wireless I2V communications (DSRC or other wireless)	Data should be transmitted within 30 seconds.
	INC-ZONE Application → Traveling Public	• In-vehicle alerts and instructions • In-vehicle warnings and instructions	Wireless I2V communications (DSRC or other wireless)	Data should be transmitted within 30 seconds.
	INC-ZONE Application → Information Broker	• Traffic conditions in incident zone (e.g., speed) • Incident zone coordinates • Lane closures • Road diversions • Number of victims and status • On-scene assessment and need for more/fewer assets (e.g., helicopter, HAZMAT, additional responders)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	INC-ZONE Application → RESP-STG Application	• Incident zone coordinates • Lane closures • Road diversions	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network	Data should be transmitted within 30 seconds.

Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)				
		• Number of victims and status • On-scene assessment and need for more/fewer assets (e.g., helicopter, HAZMAT, additional responders)	(MAN)	
Application:	**Systems/System Interfaces Involved**	**Information that must be exchanged**	**Telecommunication Methods**	**Data Attributes (Frequency, Accuracy, Timeliness)**
Emergency Communications and Evacuation (EVAC)	INC-ZONE Application → EVAC Application	• Requests for evacuation transportation assistance • Requests for transportation routing guidance • Requests for shelter • Requests for roadside assistance • Status of responder assets	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	Information Broker → EVAC Application	• Special needs database (names, addresses, contact information) • Evacuation order (affected areas, staging of evacuation) • Utility status • Mass warning notifications • Evacuation plans (e.g., route selections, intersection controls, lane management, clearance lanes) • Road/traffic data (e.g., congestion, contraflow) • Traffic incident information (e.g., accident or disabled vehicle) • Road closures (current and planned)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	RESP-STG Application → EVAC Application	• Status of responder assets	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	EVAC Application → Special Needs Evacuees Communication Subsystem	• Pickup times and location options • Shelter options • Return home information (departure time, transportation pickup and location)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
	EVAC Application → Non-Special Needs Evacuees Communication Subsystem	• Routing information (departure time, what roads) • Roadside resources and routing (fuel,	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network	Data should be transmitted within 30 seconds.

Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)				
		cash machines, food) • Shelter options • Return home information (when, routing, traffic light function)	(MAN)	
	EVAC Application → Information Broker	• Dynamic dispatching and routing guidance for picking up and transporting special needs evacuees to shelters	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds.
Data Ownership, Privacy, and Security	Of the data types listed above for the R.E.S.C.U.M.E. applications, certain data and information is publically available via websites, smartphones, etc., so it is not a security concern. This includes roadside data information from 3rd party feeds, e.g., weather alerts. Other data is considered secure and should be appropriately addressed in the standards. This includes all in-vehicle data and data transmitted between the driver and the roadside associated with these applications, and in particular medical records of vehicle occupants.			

*** Information retrieved from program materials**
**** Information based on industry practices or consultant experience**

4.1.6 ICM

The Integrated Corridor Management (ICM) is a DMA bundle that aims to reduce surface transportation congestion along a corridor. Currently congestion is being managed by agencies on an individual basis. Through the Integrated Corridor Management Systems Initiative, the USDOT will provide guidance to assist agencies in implementing integrated corridor management in an effort to optimize the entire system. In an ICM corridor, multimodal management of infrastructure assets by institutional partners allows travelers to receive information that encompasses the entire transportation network. They could dynamically shift to alternative transportation options in response to changing traffic conditions.

Since there has been no activity associated with the preliminary design of the ICM DMA, no analysis can be offered at this time

4.1.7 M-ISIG

The Multi-Modal Intelligent Traffic Signal System (M-ISIG) bundle of DMA applications relates to transformative signal operations and utilizes the data for multiple transportation modes within the connected vehicle environment, including general passenger vehicles, transit, emergency vehicles, freight vehicles, and pedestrians. The five applications within the M-ISIG bundle are described below.

Intelligent Traffic Signal System (ISIG)

This application will make use of high-fidelity data collected from vehicles through wireless communications to accurately predict lane-specific platoon flow, platoon size, and other driving characteristics. The ISIG application also plays the role of an over-arching system optimization application, accommodating transit or freight signal priority, preemption, and pedestrian movements to maximize overall arterial network performance.

Transit Signal Priority (TSP)

The proposed TSP application provides a mechanism by which transit vehicles equipped with on-board equipment can communicate information such as passenger count data, service type, scheduled and actual arrival time, and heading information to roadside equipment via DSRC in order to determine transit vehicle priority.

Mobile Accessible Pedestrian Signal System (PED-SIG)

This application will integrate information from roadside or intersection sensors and new forms of data from wirelessly connected pedestrian-carried mobile devices, and then wirelessly communicate with the traffic signal controller to obtain real-time Signal Phase and Timing (SPaT) information, which will then be used to inform the visually impaired pedestrian as to when to cross and how to remain aligned with the crosswalk.

Emergency Vehicle Preemption (PREEMPT)

The proposed application will be functionally similar to current signal preemption systems but may be viewed as a replacement of optical, 900 MHz, and other technologies used for signal preemption with integrated V2V and V2I communication systems. The application would adjust preemption and signal recovery cycles to account for non-linear effects of multiple emergency responses through the same traffic network.

Freight Signal Priority (FSP)

Freight Signal Priority concept provides signal priority along an arterial corridor near a freight facility based upon current and projected freight movements into and out of the freight facility. The goal of freight signal priority application is to reduce delays and increase travel time reliability for freight traffic, and enhance safety at intersections around the freight facility.

Based on the information available on the M-ISIG project, Table 4-6 summarizes the standards needs and gaps.

Table 4-6. M-ISIG Standards Gaps Assessment

Multi-Modal Intelligent Traffic Signal System (M-ISIG) – Standards Gaps Assessment – See Note 1 below				
Customers and End Users:*	• Arterial Traffic Management Agencies • Arterial Travelers • Transit Operating Agencies • Transit Vehicle Operators • Pedestrians • Emergency Vehicle Operators • Emergency Operations Management • Freight Vehicle Operators • Freight Operations Management	**Data Capture Environments Involved:***	• Arterial Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Intelligent Traffic Signal System (ISIG)	Arterial Data Environment	• Arterial traffic data • Connected vehicle data (location, speed, braking, windshield wiper activation, headlight activation, temperature, traction)	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Transmission to the data environment should take place in < 5 seconds
	Arterial Traffic Management Systems	• Signal Phase and Timing (SPaT) information • Connected Pedestrian movement data • Transit Vehicle movement data and TSP information • Emergency Vehicle movement data and preemption priority information • Freight Vehicle movement data and priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Center to Field Device communication should take place in < 5 seconds
	Traffic Signal Controllers	• Signal Phase and Timing (SPaT) information • Connected Pedestrian movement data • Transit Vehicle movement data and TSP information • Emergency Vehicle movement data and preemption priority information • Freight Vehicle movement data and priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	V2I communication should take place in <1 second

Multi-Modal Intelligent Traffic Signal System (M-ISIG) – Standards Gaps Assessment – See Note 1 below				
	Connected Pedestrian Mobile Devices	• SPaT information • Crosswalk alignment information • Automated pedestrian call messages • Pedestrian movement and alignment information	• Wireless (Cellular or other)	Wireless communication with infrastructure should take place in <2 seconds
	Transit Vehicle Systems	• Passenger count data • Service type • Scheduled and actual arrival time • Heading information • Vehicle headways • SPaT information	• Wireless (Cellular, satellite or other) • V2I, V2V communications	V2I communication should take place in <1 second
	Emergency Vehicle Systems	• Response type and priority • Heading information • SPaT information	• Wireless (Cellular, satellite or other) • V2I, V2V communications	V2I communication should take place in <1 second
	Freight Vehicle Systems	• Scheduled, actual, and projected freight movements • Heading information • SPaT information	• Wireless (Cellular, satellite or other) • V2I, V2V communications	V2I communication should take place in <1 second
Transit Signal Priority (TSP)	Arterial Traffic Management Systems	• Signal Phase and Timing (SPaT) information • Transit Vehicle movement data and TSP information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Center to Field Device communication should take place in < 5 seconds
	Traffic Signal Controllers	• Signal Phase and Timing (SPaT) information • Transit Vehicle movement data and TSP information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	V2I communication should take place in <1 second
	Transit Vehicle Systems	• Passenger count data • Service type • Scheduled and actual arrival time • Heading information • Vehicle headways • SPaT information	• Wireless (Cellular, satellite or other) • V2I, V2V communications	V2I communication should take place in <1 second
Mobile Accessible Pedestrian	Arterial Traffic Management Systems	• Signal Phase and Timing (SPaT) information • Connected Pedestrian movement data	• Wireless (Cellular, satellite or other) or hardline telecommunication method	Center to Field Device communication should take place in < 5 seconds

Multi-Modal Intelligent Traffic Signal System (M-ISIG) – Standards Gaps Assessment – See Note 1 below				
Signal System (MAPSS)			(e.g., leased telco or Fiber)	
	Traffic Signal Controllers	• Signal Phase and Timing (SPaT) information • Connected Pedestrian movement data	• Wireless (Cellular, satellite or other) • V2I communications	Wireless communication with connected pedestrian device should take place in <2 seconds
	Connected Pedestrian Mobile Devices	• SPaT information • Crosswalk alignment information • Automated pedestrian call messages • Pedestrian movement and alignment information	• Wireless (Cellular or other)	Wireless communication with infrastructure should take place in <2 seconds
Emergency Vehicle Preemption (PREEMPT)	Arterial Traffic Management Systems	• Signal Phase and Timing (SPaT) information • Emergency Vehicle movement data and preemption priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Center to Field Device communication should take place in < 5 seconds
	Traffic Signal Controllers	• Signal Phase and Timing (SPaT) information • Emergency Vehicle movement data and preemption priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	V2I communication should take place in <1 second
	Emergency Vehicle Systems	• Response type and priority • Heading information • SPaT information	• Wireless (Cellular, satellite or other) • V2I, V2V communications	V2I communication should take place in <1 second
Freight Signal Priority (FSP)	Arterial Traffic Management Systems	• Signal Phase and Timing (SPaT) information • Freight Vehicle movement data and priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Center to Field Device communication should take place in < 5 seconds
	Traffic Signal Controllers	• Signal Phase and Timing (SPaT) information • Freight Vehicle movement data and priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	V2I communication should take place in <1 second
	Freight Vehicle Systems	• Scheduled, actual, and projected freight movements • Heading information	• Wireless (Cellular, satellite or other) • V2I, V2V communications	V2I communication should take place in <1 second

Multi-Modal Intelligent Traffic Signal System (M-ISIG) – Standards Gaps Assessment – See Note 1 below				
		• SPaT information		
Data Ownership, Privacy, and Security	Of the data types listed above for M-ISIG, certain data (transit schedules, incident locations, real-time traffic conditions, etc.) is typically publically available and so does not present a security concern. Other data (including specific vehicle or pedestrian location and identification) is considered secure and should be appropriately addressed in the standards.			

*** Information retrieved from program materials**
**** Information based on industry practices or consultant experience**

Note 1: There was little documentation and information available related to the M-ISIG bundle (e.g., ConOps, Research Assessments, Requirements, Stakeholder inputs, etc.) at this time, so the gap analysis in the above table represents educated guesses on the applicable systems, subsystems, telecommunications, information exchanges and applicable standards. After further information is available, these sections can be revisited and modified.

4.1.8 Road Weather Connected Vehicle Applications

The Road Weather Connected Vehicle Applications take advantage of new sources of road weather information from connected vehicles to enhance existing systems, to create new strategies, tools, and systems focused on the road weather information needs of stakeholders, and to bring additional capabilities to other connected vehicle safety, mobility, and environmental applications.

The four key road weather applications—Motorist Advisories and Warnings, Information for Freight Carriers, Information and Routing Support for Emergency Responders, and Vehicle Data Translator (VDT)—are discussed below. Table 4-7 summarizes the standards needs and gaps. Table 4-8 summarizes key Variables and Desired Resolutions and Ranges.

Motorist Advisories and Warnings

Road weather information made available from connected vehicles enables motorists to receive segment-specific information on deteriorating road and weather conditions in near-real time. In combination with observations and forecasts from other sources and with additional processing, medium-term advisories of the next two to twelve hours to long-term advisories for more than twelve hours into the future can also be provided to motorists.

Information for Freight Carriers

Road weather information made available from connected vehicles enables freight shippers to plan and respond to the impacts of severe weather events and poor road conditions. Information on deteriorating road and weather conditions on specific roadway segments can be pushed to both truck drivers and their dispatchers. In combination with observations and forecasts from other sources and with additional processing, medium to long-term advisories can also be provided to dispatchers to support routing and scheduling decisions. Since these decisions must consider a variety of other factors, such as highway and bridge restrictions, hours-of-service limitations, parking availability, delivery schedules, and, in some instances, the permits held by the vehicle, it is envisioned that the motor carrier firms or their commercial service providers will develop and operate the systems that use the road-weather information generated through this concept.

Information and Routing Support for Emergency Responders

Emergency responders, including ambulance operators, paramedics, and fire and rescue companies, have a compelling need for the short, medium, and long time horizon road-weather alerts and warnings. An Emergency Management System (EMS) can help drivers safely operate their vehicles during severe weather events and under deteriorating road conditions. Emergency responders also have a particular need for information that affects their dispatching and routing decisions. Information on weather-impacted travel routes, especially road or lane closures due to snow, flooding, and wind-blown debris, is particularly important. Low latency road-weather information from connected vehicles for specific roadway segments, together with information from other surface weather observation systems, such as flooding and high winds, will be used to determine response routes, calculate response times, and influence decisions to hand-off an emergency call from one responder to another responder in a different location.

Vehicle Data Translator

The Vehicle Data Translator (VDT) is a weather-related mobility application which gathers and processes weather data already resident on the vehicle, along with ancillary weather data (e.g., radar). In support of the Road Weather Management Program (RWMP), VDT obtains all vehicle-based data from the Original Equipment Manufacturer (OEM) sensors, or from after-market sensors. VDT uses this data, combined with data from fixed sources (e.g., *Clarus*), and outputs segment-based weather and road conditions to support weather-related applications. Table 4-9 summarizes the standards needs and gaps.

Table 4-7. Weather EMS, Freight and Traveler Info Standards Gaps Assessment

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
Customers and End Users:*	• Vehicle Operators • Traffic and Maintenance Operations Personnel • Public Agency Traveler Information Providers • Commercial Service Providers • Truck Drivers • Truck Dispatchers • Emergency Vehicle Drivers • Emergency Vehicle Dispatchers	**Data Capture Environments Involved:***	Regional Data Environment Weather Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Motorist Advisories and Warnings	Connected Vehicle CAN Bus → Connected Vehicle V2I Communication System	• External air temperature • Barometric pressure • Wiper status • Headlight status (exterior lights) • Accelerometer (lateral, longitudinal) • Anti-lock braking system status • Traction control • Stability control • Rate of change of steering wheel • Vehicle velocity • Date • Time • Location • Vehicle heading • Yaw rate • Differential wheel speed • Brake status • Brake boost • Impact sensor • Ambient noise level • Elevation • Rain (rain sensor) • Sun (sun sensor)	In-vehicle communications/ communications bus	Data should be transmitted once every 30 seconds to be made available to/from the road side environment.

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
		• Hours of operation • Adaptive cruise control radar • Short-range wide beam radar • Atmospheric Pressure • Spot Wind Direction • Spot Wind Speed • Air Temperature • Dew point Temperature • Surface Temperature • Solar Radiation • Total Radiation • Precipitation Indicator (yes/no) • Rainfall or Water Equivalent of Snow • Precipitation Type • Roadway Water Level Depth • Adjacent Snow Depth • Roadway Snow Depth • Roadway Ice Thickness • Visibility • Detected Friction		
	Connected Vehicle V2I Communication System → Roadside Equipment (RSE)	• (CAN Bus information listed above)	Wireless communications between vehicle and roadside (DSRC or other wireless, e.g., cellular)	Transmission of information from the vehicle to the roadside should occur within these timeframes: • 25 mph 26.8 seconds • 30 mph 22.3 seconds • 35 mph 19.1 seconds • 40 mph 16.7 seconds • 45 mph 14.9 seconds • 50 mph 13.4 seconds • 55 mph 12.2 seconds • 60 mph 11.1 seconds • 65 mph 10.3 seconds • 70 mph 9.6 seconds • 75 mph 8.9 seconds
	RSE → Remote Vehicle Data Translator (VDT)	• Aggregated connected vehicle CAN Bus information (listed above) for given road segment	Communications from roadside to VDT can be wireless or hard wire communications	Data should be transmitted within 30 seconds between roadside systems and the data environment.
	Environmental Sensor Station (ESS)/other remote sensor	Fixed location data on: • Atmospheric conditions (air	Local Area Network (LAN), Wide Area Network (WAN) or	Data should be transmitted within 30 seconds between remote

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
	systems → VDT	temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, air quality) • Surface conditions (pavement temperature, pavement freeze point, pavement condition [wet, icy, flooded], pavement chemical concentration) • Subsurface conditions (soil temperature) • Water level conditions (tide levels [hurricane storm surge], stream/ river/ lake levels near roads)	Metropolitan Area Network (MAN)	sensor systems and the data environment.
	Weather Exchange Data Sources → VDT	• Regional forecast and other meteorological model output data	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between weather exchange data sources and the data environment.
	VDT → Traveler Information Entity-based Motorist Advisory Application	• VDT-processed road segment data • VDT-processed forecast and meteorological model output data	Wireless or hard wire communications from data environment to Traveler Information Entity	Data should be transmitted in near-real time (within 30 seconds) and should be polled at a frequency not greater than once every 2 minutes.
	Traveler Information Entity-based Motorist Advisory Application → RSE → Connected Vehicle In-Vehicle System	• Motorist Advisory Application-generated short time horizon advisories and warnings for given road segments	• Wireless or hard wire communications from Traveler Information Entity to RSE • Wireless communications between RSE and vehicle (DSRC or other wireless, e.g., cellular)	Data should be transmitted within 30 seconds between the Motorist Advisory Application, RSE, and Connected Vehicles.
	Traveler Information Entity-based Motorist Advisory Application → Traveler Information Entity Traffic Manager Interface	• Medium (next 2-12 hrs) and long (next 12+ hrs) time horizon advisories and warning approval requests	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between the data environments and roadside systems. Frequency of polling should be every 5 minutes.
	Traveler Information Entity-based Motorist Advisory Application → Data Environment → Information Distribution Entity	• Regional medium and long time horizon advisories and warnings	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between the Motorist Advisory Application and Information Distribution Entity.
Information for Freight	Connected Vehicle CAN Bus → Connected Vehicle V2I	• External air temperature • Barometric pressure	In-vehicle communications/ communications bus	Data should be transmitted once every 30 seconds to be made

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
Carriers	Communication System	• Wiper status • Headlight status (exterior lights) • Accelerometer (lateral, longitudinal) • Anti-lock braking system status • Traction control • Stability control • Rate of change of steering wheel • Vehicle velocity • Date • Time • Location • Vehicle heading • Yaw rate • Differential wheel speed • Brake status • Brake boost • Impact sensor • Ambient noise level • Elevation • Rain (rain sensor) • Sun (sun sensor) • Hours of operation • Adaptive cruise control radar • Short-range wide beam radar • Atmospheric Pressure • Spot Wind Direction • Spot Wind Speed • Air Temperature • Dew point Temperature • Surface Temperature • Solar Radiation • Total Radiation • Precipitation Indicator (yes/no) • Rainfall or Water Equivalent of Snow • Precipitation Type • Roadway Water Level Depth • Adjacent Snow Depth • Roadway Snow Depth • Roadway Ice Thickness		available to/from the road side environment.

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
		• Visibility • Detected Friction		
	Connected Vehicle V2I Communication System → Roadside Equipment (RSE)	• (CAN Bus information listed above)	Wireless communications between vehicle and roadside (DSRC or other wireless, e.g., cellular)	Transmission of information from the vehicle to the roadside should occur within these timeframes: • 25 mph 26.8 seconds • 30 mph 22.3 seconds • 35 mph 19.1 seconds • 40 mph 16.7 seconds • 45 mph 14.9 seconds • 50 mph 13.4 seconds • 55 mph 12.2 seconds • 60 mph 11.1 seconds • 65 mph 10.3 seconds • 70 mph 9.6 seconds • 75 mph 8.9 seconds
	RSE → Remote Vehicle Data Translator (VDT)	• Aggregated connected vehicle CAN Bus information (listed above) for given road segment	Communications from roadside to VDT can be wireless or hard wire communications	Data should be transmitted within 30 seconds between roadside systems and the data environment.
	Environmental Sensor Station (ESS)/other remote sensor systems → VDT	Fixed location data on: • Atmospheric conditions (air temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, air quality) • Surface conditions (pavement temperature, pavement freeze point, pavement condition [wet, icy, flooded], pavement chemical concentration) • Subsurface conditions (soil temperature) • Water level conditions (tide levels [hurricane storm surge], stream/ river/ lake levels near roads)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between remote sensor systems and the data environment.
	Weather Exchange Data Sources → VDT	• Regional forecast and other meteorological model output data	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between weather exchange data sources and the data environment.
	VDT → Traveler Information Entity-based Freight Carrier	• VDT-processed road segment data • VDT-processed forecast and	Wireless or hard wire communications from data	Data should be transmitted in near-real time (within 30

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
	Application	meteorological model output data	environment to Traveler Information Entity	seconds) and should be polled at a frequency not greater than once every 2 minutes.
	Traveler Information Entity-based Freight Carrier Application → RSE → Truck Connected Vehicle In-Vehicle System	• Freight Carrier Application-generated short time horizon advisories and warnings for given road segments	• Wireless or hard wire communications from Traveler Information Entity to RSE • Wireless communications between RSE and vehicle (DSRC or other wireless, e.g., cellular)	Data should be transmitted within 30 seconds between the Motorist Advisory Application, RSE, and Connected Vehicles.
	VDT → Freight Carrier Entity-based Freight Carrier Application	• VDT-processed road segment data	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	
	Other Internal Carrier Data Systems → Freight Carrier Entity-based Freight Carrier Application	• Schedule restrictions • Highway and bridge restrictions • Hours-of-service limitations • Parking availability • Delivery schedules • Vehicle permit type/status • Other routing restrictions	Local Area Network (LAN)	
	Freight Carrier Entity-based Freight Carrier Application → Freight Carrier Dispatchers/Drivers	• Freight Carrier Application-generated medium time horizon advisories and warnings • Freight Carrier Application-generated long time horizon advisories and warnings • Specific routing and scheduling instructions	Wireless communications between Freight Carrier Entity and Trucks (radio or other wireless, e.g., cellular)	
Information and Routing Support for Emergency Responders	Connected Vehicle CAN Bus → Connected Vehicle V2I Communication System	• External air temperature • Barometric pressure • Wiper status • Headlight status (exterior lights) • Accelerometer (lateral, longitudinal) • Anti-lock braking system status • Traction control • Stability control • Rate of change of steering wheel	In-vehicle communications/ communications bus	Data should be transmitted once every 30 seconds to be made available to/from the road side environment.

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
		• Vehicle velocity • Date • Time • Location • Vehicle heading • Yaw rate • Differential wheel speed • Brake status • Brake boost • Impact sensor • Ambient noise level • Elevation • Rain (rain sensor) • Sun (sun sensor) • Hours of operation • Adaptive cruise control radar • Short-range wide beam radar • Atmospheric Pressure • Spot Wind Direction • Spot Wind Speed • Air Temperature • Dew point Temperature • Surface Temperature • Solar Radiation • Total Radiation • Precipitation Indicator (yes/no) • Rainfall or Water Equivalent of Snow • Precipitation Type • Roadway Water Level Depth • Adjacent Snow Depth • Roadway Snow Depth • Roadway Ice Thickness • Visibility • Detected Friction		
	Connected Vehicle V2I Communication System → Roadside Equipment (RSE)	• (CAN Bus information listed above)	Wireless communications between vehicle and roadside (DSRC or other wireless, e.g., cellular)	Transmission of information from the vehicle to the roadside should occur within these timeframes: • 25 mph 26.8 seconds • 30 mph 22.3 seconds

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
				• 35 mph 19.1 seconds • 40 mph 16.7 seconds • 45 mph 14.9 seconds • 50 mph 13.4 seconds • 55 mph 12.2 seconds • 60 mph 11.1 seconds • 65 mph 10.3 seconds • 70 mph 9.6 seconds • 75 mph 8.9 seconds
	RSE → Remote Vehicle Data Translator (VDT)	• Aggregated connected vehicle CAN Bus information (listed above) for given road segment	Communications from roadside to VDT can be wireless or hard wire communications	Data should be transmitted within 30 seconds between roadside systems and the data environment.
	Environmental Sensor Station (ESS)/other remote sensor systems → VDT	Fixed location data on: • Atmospheric conditions (air temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, air quality) • Surface conditions (pavement temperature, pavement freeze point, pavement condition [wet, icy, flooded], pavement chemical concentration) • Subsurface conditions (soil temperature) • Water level conditions (tide levels [hurricane storm surge], stream/ river/ lake levels near roads)	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between remote sensor systems and the data environment.
	Weather Exchange Data Sources → VDT	• Regional forecast and other meteorological model output data	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Data should be transmitted within 30 seconds between weather exchange data sources and the data environment.
	VDT → Traveler Information Entity-based Emergency Response Application	• VDT-processed road segment data • VDT-processed forecast and meteorological model output data	Wireless or hard wire communications from data environment to Traveler Information Entity	Data should be transmitted in near-real time (within 30 seconds) and should be polled at a frequency not greater than once every 2 minutes.
	Traveler Information Entity-based Emergency Response Application → RSE → Emergency Connected Vehicle In-Vehicle System	• Emergency Response Application-generated short time horizon advisories and warnings for given road segments	• Wireless or hard wire communications from Traveler Information Entity to RSE • Wireless communications	Data should be transmitted within 30 seconds between the Motorist Advisory Application, RSE, and Connected Vehicles.

Weather EMS, Freight and Traveler Info – Standards Gaps Assessment				
			between RSE and vehicle (DSRC or other wireless, e.g., cellular)	
	VDT → Emergency Responder Entity-based Emergency Response Application	• VDT-processed road segment data	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	
	Other Internal Emergency Responder Data Systems → Emergency Responder Entity-based Emergency Response Application	• Schedule restrictions • Routing restrictions (response times, availability of emergency responders in neighboring jurisdictions)	Local Area Network (LAN)	
	Emergency Responder Entity-based Emergency Response Application → Emergency Dispatchers/Drivers	• Emergency Response Application-generated medium time horizon advisories and warnings • Emergency Response Application-generated long time horizon advisories and warnings • Specific routing and scheduling instructions	Wireless communications between Emergency Responder Entity and Emergency Vehicles (radio or other wireless, e.g., cellular)	
Data Ownership, Privacy, and Security	Of the data types listed above for Road Weather Connected Vehicle Applications, certain data and information (e.g., travel times, roadway conditions, incident information etc.) is publically available via websites, smartphones, etc., so it is not a security concern.			

*** Information retrieved from program materials**
**** Information based on industry practices or consultant experience**

Table 4-8. List of Key Variables and Desired Resolutions and Ranges for Weather Related Connected Vehicle CAN Bus Observations

(as indicated in the Vision for Use of Connected Vehicle Data in Practical Road Weather Applications document).

Variable	Valid Range	Data Resolution	Temporal Resolution
Atmospheric Pressure	650.0 – 1200.0 mb	INTEGER (0..65535)	Once every 20 sec
Spot Wind Direction	0 – 359 deg	INTEGER (0..361)	Once every second
Spot Wind Speed	0.0 – 250.0 m/s	INTEGER (0..65535)	Once every second
Air Temperature	-100.0 – 100.0 deg C	INTEGER (-1000..1001)	Once every 20 sec
Dewpoint Temperature	-100.0 – 100.0 deg C	INTEGER (-1000..1001)	Once every 20 sec
Surface Temperature	-100.0 – 200.0 deg C	INTEGER (-1000..2001)	Once every second
Solar Radiation	0 – 700 W/m^2	INTEGER (0,701)	Once every 20 sec
Total Radiation	0 – 1000 W/m^2	INTEGER (0,1001)	Once every 20 sec
Visibility	0.0 – 20000.0 m	INTEGER (0..200001)	Once every 20 sec
Precipitation Indicator	1 – 3	INTEGER { precip (1), noPrecip (2), error (3)}	Once every second
Rainfall or Water Equivalent of Snow	0.0 – 11.0 $g/m^2/s$	INTEGER (0..65535)	Once every second
Precipitation Situation	1 – 15	INTEGER { other (1), unknown (2), noPrecipitation (3), unidentifiedSlight (4), unidentifiedModerate (5), unidentifiedHeavy (6), snowSlight (7), snowModerate (8), snowHeavy (9), rainSlight (10), rainModerate (11), rainHeavy (12), frozenPrecipitationSlight (13) , frozenPrecipitationModerate (14), frozenPrecipitationHeavy (15)}	Once every second
Roadway Water Level Depth	0 – 255 cm	BYTE (0..256)	Once every second
Adjacent Snow Depth	0 – 255 cm	BYTE (0..256)	Once every second
Roadway Snow Depth	0 – 255 cm	BYTE (0..256)	Once every second
Roadway Ice Thickness	0 – 255 cm	BYTE (0..256)	Once every second
Detected Friction	0 – 255 cm	BYTE (0..256)	Once every second

Table 4-9. Weather VDT Standards Gaps Assessment

Weather VDT – Standards Gaps Assessment Table				
Customers and End Users:*	Other DMA applications which benefit the following: • Everyday vehicle driver • Freight-haulers and truckers • Emergency medical personnel • Road maintenance community	**Data Capture Environments Involved:***	Weather Data Exchange Environment	
Application:	**System/Subsystem or Data Type***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Vehicle Data Translator	Vehicle Sensor Data -> Data Environment	Vehicle sensor information: • external air temperature • barometric pressure • wiper status • headlight status • accelerometer • anti-lock braking system status • traction control • stability control • rate of change of steering wheel • vehicle velocity • date • time location • vehicle heading • yaw rate • brake status • brake boost • impact sensor • elevation • rain falling • ambient noise level	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real time data should update every 20 seconds
	Infrastructure Systems	Advanced weather conditions / forecasts	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals of 20 seconds

Weather VDT – Standards Gaps Assessment Table				
	Road Weather Data	Weather sensor data: • atmospheric pressure • spot wind direction • spot wind speed • air temperature • dewpoint temperature • surface temperature • solar radiation • total radiation • precipitation indicator • rainfall or water equivalent of snow • precipitation type • roadway water level depth • adjacent snow depth • roadway snow depth • roadway ice thickness • visibility • detected friction	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real time data should update every second
	Radar Weather Data	Radar Weather data: • Storm Locations • Storm Size • Storm Velocity • Storm Severity • Rainfall levels • Tornado Warnings • Thunderstorm Warnings • Flashflood Warnings	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real time data should update every second
Data Ownership, Privacy, and Security	Weather data is typically publically available and so does not present a security concern. Other data (including individual vehicle location information, or vehicle speed) is considered secure and should be appropriately addressed in the standards.			

*** Information retrieved from program materials**

**** Information based on industry practices or consultant experience**

4.2 Data Capture Management

The USDOT Intelligent Transportation Systems Joint Program Office (ITS JPO) initiated the Data Capture and Management (DCM) Program as part of the Mobility program "to assess the potential of a multi-source, active-acquisition data paradigm to enhance current operational practices and transform future surface transportation systems management." The objectives of the program are to:

- Enable systematic data capture from vehicles, mobile devices, and infrastructure
- Develop data environments that enable the integration of data from multiple sources for use in transportation management and performance measurement
- Reduce costs of data management and eliminate technical and institutional barriers to the capture, management, and sharing of data

The four data environments that comprise the DCM program—the Arterial Data Environment, the Freeway Data Environment, the Corridor Data Environment, and the Regional Data Environment—relate directly to the Dynamic Mobility Application (DMA) bundles described in Section 4.2. Also included is a Weather Data Environment. Their purpose is to aggregate, organize, and disseminate key transportation data that may be useful to any number of safety and mobility applications.

The data environments and the key information that is exchanged in each are described in Tables 4-10, 4-11, 4-12, 4-13, and 4-14.

4.2.1 Arterial Data Environment

Table 4-10. Arterial Data Environment Applications

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
Intelligent Network Flow Optimization (INFLO)	• Data with Roadway traffic detection, Traffic Signal, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and CACC Application Data with Traffic Management Entities • Weather data with 3rd party weather feeds	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
Multi-Modal Intelligent Traffic Signal System (M-ISIG)	• Signal Phase and Timing (SPaT) information • Arterial traffic data • Connected vehicle data (location, speed, braking, windshield wiper activation, headlight activation, temperature, traction) • Connected Pedestrian movement data • Transit Vehicle movement data and TSP information • Emergency Vehicle movement data and preemption priority information • Freight Vehicle movement data and priority information	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better

**** Information based on industry practices or consultant experience**

4.2.2 Freeway Data Environment

Table 4-11. Freeway Data Environment Applications

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
Intelligent Network Flow Optimization (INFLO)	• Data with Roadway traffic detection, weather sensors and DMS • Data with Connected Vehicle systems and subsystems • Performance Measures and SPD-HARM Application Data with Traffic Management Entities • Weather data with 3rd party weather feeds	• Wireless (Cellular, satellite or other) or hard line telecommunication method (e.g., leased telco or Fiber) • V2I communications	Real-time data should be fed at regular intervals between 1 and 2 minutes. Data is expected to be in the 90% accurate range or better
Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)	Information related to the nature of the emergency situation: • Event location type, severity, impact, number and type of responders, etc. This information is exchanged between the TMCs, Public Safety Answering Point (PSAPs), connected vehicles, Computer Aided Dispatch / Automatic Vehicle Location (CAD/AVL) systems and emergency responders.	• Wireless or direct hard line communications	All emergency data should be transmitted within 5 seconds of it being confirmed. Updates should be provided every 2 minutes. Traffic management information should be updated every minute.

**** Information based on industry practices or consultant experience**

4.2.3 Regional Data Environment

Table 4-12. Regional Data Environment Applications

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
Enabling Advanced traveler Information Services (EnableATIS)	• Toll tag data • Connected vehicle data (speed, braking, windshield wiper activation, headlight activation, temperature, traction) • Transfer requests • Environmental road conditions • Bridge monitoring data • Maintenance & repair data • Weather conditions / forecasts	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber) • V2I communications	

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
	• Crowd sourced social media data (i.e., equipment malfunctions) • Construction Data • Transportation video feeds • Incident data • CLARUS Environmental Sensor Station data • Special events data • Mobile-source data/traveler opted in data • Parking facility utilization data • Parking availability data • Parking location data • Parking rate information • Vehicle diagnostic data • Situational awareness data (silent alarms & CCTV monitoring) • Transit vehicle headways • Transit passenger boarding & alighting counts • Transit Automatic Vehicle Location (AVL) data • Transit vehicle location data & next transit vehicle arrival times • General Transit Feed Specification (GTFS) • Carpool & Vanpool data • Airline data (location & arrival/departure schedules) • Vehicle registration data • Weigh in motion data • Freight operations data/records (private & DMV records) • Freight historical manifest data • Ramp meter monitoring data • Carpool / vanpool data • Telework availability/location • High Occupancy Toll (HOT) lane data (utilization & toll rates) • Bike sharing locations and availability • Bike sharing origin/destination data (mobile source based)		
Freight Advanced Traveler Information System (FRATIS)	• Real-time data on freeways, port/terminal regions, and major freight arterials • Real-time data on length and wait times for truck queues at freight terminals		

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
	• Regional truck trip pre-plan information • Traffic information for congestion avoidance dynamic routing for trucks • Intermodal terminal container load-matching status • Real-time route-specific weather conditions and forecast data		

**** Information based on industry practices or consultant experience**

4.2.4 Corridor Data Environment

Table 4-13. Corridor Data Environment Applications

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
Integrated Corridor Management (ICM)	• Data with corridor-wide traffic detection • Traffic signal • DMS • CCTV • Ramp meters • Transit routes • Transit schedules • Transit vehicle location	Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals of 30 seconds
Integrated Dynamic Transit Operations (IDTO)	• Transfer requests • Operational status of vehicles (location, schedule adherence, real-time status, calculated ETA) • Vehicle schedule updates	Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real-time data should be fed at regular intervals of 30 seconds

**** Information based on industry practices or consultant experience**

4.2.5 Weather Data Environment

Table 4-14. Weather Data Environment Applications

Related Application Bundle	Information Exchanged**	Telecommunication Methods**	Data Attributes (Frequency, Accuracy, Timeliness)**
Vehicle Data Translator (VDT)	• Vehicle sensor data • Advanced weather conditions / forecasts • Radar weather sensor data • Satellite weather sensor data • Weather station weather sensor data	• Wireless (Cellular, satellite or other) or hardline telecommunication method (e.g., leased telco or Fiber)	Real time data should update every second

**** Information based on industry practices or consultant experience**

4.3 Smart Roadside

The Smart Roadside Initiative (SRI) is a collection of tools, methods and standards designed for the delivery of capabilities related to wireless roadside inspections, electronic screening/virtual weigh stations, universal electronic commercial motor vehicle (CMV) identification and truck parking.

The "SRI system" is not an individual system, but rather a collection of tools, methods, and standards that together have the potential to transform the way CMV operators, safety enforcement personnel, and other authorized users access, apply, and manage information. The SRI system and the components that will be developed under its umbrella will effectively do three things:

- Streamline the methods and mechanisms used to locate and access information, thereby accelerating and improving the accuracy of decision making processes;
- Provide an electronic means both to identify CMVs at highway speeds and to manage the exchange of information between vehicles and infrastructure-based systems; and
- Enable the delivery of a broad variety of applications that enhance safety and mobility.

The foundational element of the SRI system is the establishment of open standards-based connectivity to the variety of systems that are currently in place at the Federal, State, and local levels, both within government and among current and future commercial systems. This connectivity is essential to the timely information exchange that underpins the SRI system. One of the key reasons for this is to enable system users the flexibility to implement components/modules of the system suited to the needs of the user and to enable previous automated tools to be integrated into the SRI system.

The second major element is the mechanism by which users will access information. This information, which will be used to facilitate a broad range of operational and policy decisions, must be presented to users in a concise, consolidated fashion. These user interfaces are intended to be single points of access that will use standardized information access mechanisms, although presentation formats will be user-customizable.

The third major element is the communications link between the moving CMV and the rest of the SRI network. The ultimate goal is to provide for electronic identification of the vehicle, carrier, and driver, and to allow for the information exchanges necessary to support a variety of location-based services. The system must be "technology agnostic," meaning that it must accommodate any communications channel that provides the requisite performance, reliability, and information security. Table 4-15 summarizes the standards needs and gaps.

Table 4-15. Smart Roadside Standards Gaps Assessment

Smart Roadside – Standards Gaps Assessment				
Customers and End Users:*	CMV Enforcement Officers CMV Drivers Motor Carriers CMV Enforcement Supervisors MCSAP Lead Agency Manager FMCSA Personnel FHWA Size and Weight Personnel	Data Capture Environments Involved:*	Regional Data Environment	
Application:	**Systems/System Interfaces Involved***	**Information that must be exchanged***	**Telecommunication Methods****	**Data Attributes (Frequency, Accuracy, Timeliness)****
Smart Roadside System	Commercial Motor Vehicle (CMV) On-Board Systems	Credential and permit status Vehicle identity Carrier identity Vehicle weight Vehicle dimensions HAZMAT cargo Driver identity HOS status Vehicle condition Travel time Parking availability Road Condition Data Environmental conditions Types and locations of accidents CDL endorsements	In vehicle communications/ communications bus	Data should be transmitted once every 30 seconds to be made available to/from the road side environment.
	Back Office Systems	Road Condition Data Travel time Parking availability CDL endorsements	Wireless or hard wire communications from data environment/portal to the back end office systems	Data should be transmitted within 30 seconds between the data environments and roadside systems. Frequency of polling

Smart Roadside – Standards Gaps Assessment				
		Credential and permit status Vehicle identity Carrier identity Driver identity Environmental conditions Vehicle weight Vehicle dimensions HAZMAT cargo Credential status: carrier, driver, vehicle Safety history: carrier, driver, vehicle Policy and operations guidance information Travel time Parking availability Roadside enforcement results Driver reports Change in driver status Monthly trooper performance data Types and locations of accidents State performance data		should be every 5 minutes
	Roadside Data Environment/Regional Data Environment	Road Condition Data Travel time CDL endorsements Credential and permit status Vehicle identity Carrier identity Driver identity Environmental conditions Vehicle weight Vehicle dimensions HAZMAT cargo Credential status: carrier, driver, vehicle Safety history: carrier, driver, vehicle Travel time Parking availability Roadside enforcement results Driver reports Change in driver status	Wireless communications between commercial vehicle and roadside (DSRC or other wireless, e.g., cellular). Communications from roadside to back office can be wireless or hard wire communications	Transmission of information from the commercial vehicle to the roadside should occur within these timeframes: 25 mph 26.8 seconds 30 mph 22.3 seconds 35 mph 19.1 seconds 40 mph 16.7 seconds 45 mph 14.9 seconds 50 mph 13.4 seconds 55 mph 12.2 seconds 60 mph 11.1 seconds 65 mph 10.3 seconds 70 mph 9.6 seconds 75 mph 8.9 seconds

Smart Roadside – Standards Gaps Assessment				
		Monthly trooper performance data State performance data		
	External Systems (e.g., business systems, government systems, etc.)	Road Condition Data CDL endorsements Credential and permit status Secure/Filtered Vehicle ID info Environmental conditions Vehicle weight Vehicle dimensions HAZMAT cargo Credential status: carrier, driver, vehicle Policy and operations guidance Travel time Parking availability Types and Locations of Incidents	Wireless or hard wire communications from data environment/portal to the back end office systems	Data should be transmitted within 30 seconds and should be polled at a frequency not greater than once every 2 minutes.
	CMV Driver Application	HOS status Vehicle condition Travel time Parking availability Road conditions Environmental conditions CDL endorsements Credential and permit status	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Information should be transmitted from the SRI portal, data environment, or SRI system components within 5 seconds of the information request
	CMV Enforcement Officers Back Office Application(s)	Vehicle identity Carrier identity Driver identity Credential status: carrier, driver, vehicle Safety history: carrier, driver, vehicle Policy and operations guidance Vehicle weight Vehicle dimensions HAZMAT cargo	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Information should be transmitted from the SRI portal, data environment, or SRI system components within 5 seconds of the information request

Smart Roadside – Standards Gaps Assessment				
	Motor Carrier Back Office Application(s)	HOS status Vehicle condition Travel time Parking availability Road conditions Environmental conditions CDL endorsements Credential and permit status Roadside enforcement results Driver reports Change in driver status	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Information should be transmitted from the SRI portal, data environment, or SRI system components within 5 seconds of the information request
	MCSAP Lead Agency Manager Back Office Application (s)	Monthly trooper performance data Types and locations of accidents Policy guidance/ updates Reporting timeliness Program reviews	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Information should be transmitted from the SRI portal, data environment, or SRI system components within 5 seconds of the information request
	FMCSA Personnel Back Office Application(s)	Monthly trooper performance data Types and locations of accidents Policy guidance/ updates Reporting timeliness Program reviews	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Information should be transmitted from the SRI portal, data environment, or SRI system components within 5 seconds of the information request
	FHWA Size and Weight Personnel Back office Application(s)	State performance data Policies Available funding Program reviews	Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN)	Information should be transmitted from the SRI portal, data environment, or SRI system components within 5 seconds of the information request
Data Ownership, Privacy, and Security	Of the data types listed above for Smart Roadside, certain data and information (e.g., travel times, roadway conditions, incident information etc.) is publically available via websites, smartphones, etc., so it is not a security concern. There is specific driver, carrier, CMV, inspection and certification information that should be kept secure to the back office applications and should be protected from transmission outside these secure systems.			

*** Information retrieved from program materials**
**** Information based on industry practices or consultant experience**

4.4 Potential New Standards

The tables in the previous two sections seek to identify any gaps in *existing* standards. It is possible that entirely new standards must be considered. During the assessment of the above standards, it was identified that the following could potentially become a new standard:

4.4.1 Connected Vehicle Performance Measures

Performance measures are essential to the Connected Vehicle program. While there does exist individual performance measures within currently existing standards, the vastness of the Connected Vehicle program warrants an assessment at a higher, more encompassing level. For each of the DMAs, performance goals, performance measures, and transformative performance targets have been or are being identified associated with how connected vehicle applications can dramatically change transportation system performance, some rather extensively.

It seems logical for this to be another ASM standard, potentially.

4.4.2 Connected Vehicle Application Updates

In-vehicle applications are a key component of the Connected Vehicle program. As with any system, there will be a need for updates or patches to be made to the system over time. There are currently no standards that address how the updates will be applied. The following are some considerations that need to be assessed for a potential new standard:

- Types of updates:
  - Mandatory – vehicle can no longer use the application without the update
  - Optional – vehicle can be updated at a later date
- How to apply the updates:
  - Manually when the vehicle is in for maintenance service
  - Wirelessly as the vehicle passes by the infrastructure requiring the update
  - Via the internet or other service-oriented mechanism
- When to apply the updates:
  - In conjunction with infrastructure updates
  - In conjunction with other vehicle/fleet updates
  - Will the time of day or day of week affect the update
- Who can apply the update:
  - Service technicians
  - Automatically
  - Owner of vehicle (individual or agency)
- Other factors:
  - Backwards compatibility
  - How to inform drivers or operators of new features

Since the Society of Automotive Engineers (SAE) has existing standards for in-vehicle systems, it would be the most likely candidate for investigating a new standard for the in-vehicle updates.

5 Results of Standards Gap Assessment

The final section presented below is a summary of the completed standards gaps assessment, organized by program. Gaps were identified through the following process:

1. Examining the details of the applicable standards, recommended practices and specifications associated to the mobility applications and data environments listed in Section 3.
2. Comparing the systems, subsystems, information and data attributes needs identified in Section 4, against the actual standards themselves.
3. Listing the specific informational or other gaps in the tables below, based on our comparisons.

The gaps are presented on a bundle-by-bundle, environment-by-environment basis. For each gap that is presented, attributes are assigned that include priority and complexity. Three different levels have been assigned to the priority attribute:

- High Priority – Standards Gaps that should be addressed first.
- Medium Priority – Standards Gaps that should be addressed second.
- Low Priority– Standards Gaps that should be addressed last.

Three different levels have been assigned to complexity:

- High Complexity - Standard modification is deemed to require a lot of work.
- Medium Complexity - Standard modification is deemed to require a moderate amount of work.
- Low Complexity - Standard modification is deemed to require a small amount of work.

5.1 Mobility Application Standards Gaps

Table 5-1 identifies standards for which one or more gaps were found, by application. As can be seen, certain standards gaps only apply to one DMA or environment, but in other cases existing standards will need to be modified to address gaps for several applications.

Table 5-1. Standards with Gaps by Application or Environment

	INFLO	IDTO	FRATIS	Enable ATIS	R.E.S.C.U.M.E.	M-ISIG	Weather	Arterial Data Environment	Freeway Data Environment	Regional Data Environment	Corridor Data Environment	Weather Data Environment	Smart Roadside
ITE TMDD v3.0 - Traffic Management Data Dictionary (TMDD) and	X	X	X	X	X	X	X	X	X	X	X	X	X

	INFLO	IDTO	FRATIS	Enable ATIS	R.E.S.C.U.M.E.	M-ISIG	Weather	Arterial Data Environment	Freeway Data Environment	Regional Data Environment	Corridor Data Environment	Weather Data Environment	Smart Roadside
Message Sets for External Traffic Management Center Communications (MS/ETMCC)													
IEEE 1512-2006 - Standard for Common Incident Management Message Sets for use by Emergency Management Centers	X			X	X			X	X	X	X		
IEEE 1512-1-2004 - Standard for Common Incident Management Message Sets for use by Emergency Management Centers	X			X	X			X	X	X	X		
IEEE 1512-2-2004 - Standard for Common Incident Management Message Sets for use by Emergency Management Centers	X			X	X			X	X	X	X		
IEEE1512.3-2006 - Standard for Common Incident Management Message Sets for use by Emergency Management Centers	X			X	X			X	X	X	X		
SAE J2354 - Message Set for Advanced Traveler Information System (ATIS).	X	X	X	X	X		X						
SAE J2395 - ITS In-Vehicle Message Priority.	X				X	X	X						
SAE J2735 - Dedicated Short Range Communications (DSRC) Message Set Dictionary	X	X	X	X	X	X	X						X
NTCIP2306 - Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML)	X			X	X	X	X	X	X	X	X	X	X
ASTM 2665 - Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data	X				X	X	X						X
NTCIP 1202v2 - Object Definitions for Actuated Traffic Signal Controller (ASC) Units						X							
NTCIP 1204v3 - Object Definitions for Environmental Sensor Stations (ESS)	X						X						
NTCIP 1206 - Object Definitions for Data Collection and Monitoring (DCM) Devices						X							

	INFLO	IDTO	FRATIS	Enable ATIS	R.E.S.C.U.M.E.	M-ISIG	Weather	Arterial Data Environment	Freeway Data Environment	Regional Data Environment	Corridor Data Environment	Weather Data Environment	Smart Roadside
NTCIP 1209v2 - Data Element Definitions for Transportation Sensor Systems (TSS)						X							
NCTIP 1210v0.1 - Field Management Stations (FMS) - Part 1: Object Definitions for Signal System Masters						X							
SAE J2313 - On-Board Land Vehicle Mayday Reporting Interface					X								
SAE J2400 - Human Factors in Forward Collision Warning Systems	X												
SAE J2399 - Adaptive Cruise Control (ACC) Operating Characteristics and User Interface.	X												
APTA TCIP-S-001v3 - Standard for Transit Communications Interface Profiles		X				X							
ITE ATC Controller - Standard for advanced transportation controller (ATC) devices to support ITS data flows and standards that enable deployment of ITS.						X							

The sections below and Tables 5-2 through 5-13 outline the specifics of these gaps in more detail. It is strongly suggested that these gaps are revisited after system requirements and interface requirements have been finalized under each program as well system design stages.

5.1.1 INFLO Gap Summary

Table 5-2. INFLO Gap Summary

Gap	Priority	Complexity
NTCIP 2306 should be modified to accommodate additional functions such as dialog specific functions, call backs, quality of service and transaction rollback which may be required to support the more sophisticated C2C messages for INFLO, e.g., in-vehicle speed and Q-Warn recommendations. **Note: Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.**	Medium	Low
ITE TMDD v3 standards should be modified to include the following: • **Speed target and advisory messages for SPD-HARM**	**High**	**High**

Gap	Priority	Complexity
• **Number of shockwaves formed, length of shockwaves, propagation speed of shockwaves, level of speed compliance, speed variability, travel time reliability, number of primary and secondary crashes, severity of crashes, emission levels, consumed energy, duration of formed queues.** • **Queue prediction notification and queue prediction message for Q-WARN**		
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 standards should be modified to include the following: • **Notification of activated CACC functions as a result of incident response** • **Duration of formed queues, Queue detection message and queue prediction notifications** • **Vehicle Classification information to both inform fleet and freight management agencies related to known incidents related to different vehicles classifications as well as to more clearly identify the type of vehicle involved in incidents**	Medium	Medium
The Performance Measurement aspects of INFLO require storage and retrieval of ITS data, so the ASTM E2665-08 standards for data archiving will need to be modified to accommodate storage and reporting for the following information: • **Number of Shockwaves formed** • **Length of shockwaves** • **Propagation speed of shockwaves** • **Recommended Vehicle Speeds** • **Level of Speed Compliance** • **Speed Variability** • **Average travel Times** • **Travel Time Reliability** • **Number of Primary and Secondary Crashes** • **Severity of Crashes** • **Length of formed queues** • **Duration of formed queues** • **Number of false positive queue detection alerts** • **Number of non-detected queue detection alerts**	Low	Medium
SAE J2354 standards should be modified to include the following: • **Number and location of primary and secondary crashes** • **Variable Speed Limit sign messages and locations.**	Medium	Low
SAE J2395 is a recommended practice for addressing in-vehicle message priorities. Both SPD-HARM and Q-WARN as well as potentially CACC will relay messages to and within the vehicle and these messages will need to be prioritized as well, so the recommended practice will need to be modified as necessary to accommodate these messages within the priority queue.	Medium	Low
SAE J2399 is a standard for vehicle self-contained adaptive cruise control (ACC) defining a minimum set of parameters and some formulae for designing ACC systems. This standard should be modified to accommodate the CACC application specifically for safety related elements of the CACC characteristics, operating characteristics and user interfaces.	Medium	Medium
SAE J2400 addresses Human Factors in Forward Collision Warning Systems. Since Q-WARN relates to forward collision warning and CACC also addresses this to some degree, SAE J2400 should be modified to address the additional human factor needs of these applications, as appropriate, including the appropriate means to display and alert the driver of pending queues and slow downs approaching backup areas due to fixed	Medium	High

Gap	Priority	Complexity
queue points (e.g., border crossings, construction zones, wait areas, etc.) and other unplanned queue events (e.g., traffic incidents, weather events, etc,). The standard does not address data types, so gap is identified for this specifically.		
SAE J2735 standards should be modified to include the following: • **Classification and traffic queue information for roadway traffic detection subsystems** • **Presence and location of shockwaves, travel time reliability, location of traffic queues, length of formed queues, and duration of formed queues,** • **Information on the number of primary and secondary crashes, severity of crashes, location of crashes** • **Notification of activated CACC functions**	High	High
• **Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.**	Low	High
• **Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.**	High	High

5.1.2 IDTO Gap Summary

Table 5-3. IDTO Gap Summary

Gap	Priority	Complexity
APTA TCIP-S-001 v3 defines standardized mechanisms for the exchange of information in the form of data among transit business systems, subsystems, components and devices. This standard should be modified to include the following information: • **Number of passengers** • **Personal device information** • **Driver information** • **Rider information** • **HOV/HOT lane locations** • **Ride-match information Meeting location**	High	Medium
SAE J2354 standards should be modified to include the following: • **Transfer requests, operational status of vehicle** • **Route and schedule adherence (RSA) status and Vehicle capacity for Transit Agency CAD/AVL System** • **Number of passengers with rider and Ride-match information for Personal Device for Requesting Ride-match** • **Ride-match information, Meeting location, In-vehicle occupancy information for In-Vehicle Rideshare System**	Medium	Low
SAE J2735 standards should be modified to include the following:	High	High

Gap	Priority	Complexity
• **Transfer requests, operational status of vehicle, vehicle schedule updates, real-time schedule adjustments** • **Route and schedule adherence (RSA) status, Arrival predictions for Transit Agency CAD/AVL System** • **Transit Agency route and schedule information , Real-time status information and Service alerts for Regional Trip Planner** • **Real-time schedule adjustments for Automated Vehicle Announcement (AVA) System** • **Trip request with origin, destination, and time (ODT), Return trip request, Trip request status for Rider's Personal Device/web app** • **Rider trip requests for TMCC Scheduling System** • **Manifests for In-Vehicle Operator Interface** • **Origin/destination, Time preference, Travel profile, Number of passengers with rider, Ride-match information, Meeting location for Personal Device for Requesting Ride-match** • **Personal identification information, Traveler preferences, User ID and password, Personal device information, Payment transaction information for Rideshare Data Entry System** • **In-vehicle occupancy information, Vehicle information, Driver payment information for Managed Lane Payment System**		
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

5.1.3 FRATIS Gap Summary

Table 5-4. FRATIS Gap Summary

Gap	Priority	Complexity
SAE J2354 standards should be modified to include the following: • **Historical traffic pattern and preferred freeway access paths long a designated truck route for Regional Pre-Trip Planner** • **Real-time intermodal terminal queue information, queue length for intermodal terminal queues , estimated wait times, match an empty container with a truck, match an empty container for return only if the container is in reloadable condition, match an empty container for return only if it is determined that the value of the reload is sufficient to justify picking it up, all for Freight/Marine Port Systems**	Medium	Low
SAE J2735 standards should be modified to include the following: • **Regional truck trip planning information and the following data along a designated truck route - historical traffic pattern, real-time traffic, truck-specific route designations, truck-specific route restrictions, bridge heights, bridge weight restrictions, preferred freeway access paths, toll road information, construction zone information for Regional Pre-Trip Planner**	High	High

Gap	Priority	Complexity
• **Notification to a user when the current/planned route is estimated for predicted congestion** • **Information needed for automated OSOW permitting and routing by State systems, Submit requests (for automated permitting) and request results for Oversized Overweight Vehicle Routing System** • **Parking reservations for Data Environment System** • **Real-time intermodal terminal queue information, queue length for intermodal terminal queues , estimated wait times, match an empty container with a truck, match an empty container**		
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

5.1.4 EnableATIS Gap Summary

Table 5-5. EnableATIS Gap Summary

Gap	Priority	Complexity
NTCIP 2306 should be modified to accommodate additional functions such as dialog specific functions, call backs, quality of service and transaction rollback which may be required to support aspects of the EnableATIS Bundle. **Note: Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.**	Medium	Low

Gap	Priority	Complexity
ITE TMDD v3 standards should be modified to include the following: • **Confidence information associated with crown sourced social media data, e.g., the number of crowd source responses or a "confidence value" on the reported information** • **Airline data for Transit Operations Systems** • **Vehicle registration data, Weigh in motion data, Freight operations data/records, Historical manifest data for CVO Systems** • **Origin/Destination data, Carpool / vanpool data, Telework availability/location, High Occupancy Toll (HOT) lane data, Bike sharing locations and availability, Origin/Destination data for Transportation Demand Management Systems**	High	High
SAE J2354 standards should be modified to include the following: • **Crowd sourced social media data for Infrastructure Systems and Parking Systems** • **Transportation video feeds, Probe-based speed data, Mobile-source data/traveler opted in data, Crowd sourced social media data for Traffic Operations Systems** • **Vehicle diagnostic data, Vehicle headways, Transit vehicle location data & next transit vehicle arrival times, General Transit Feed Specification (GTFS), Carpool & Vanpool data, Crowd sourced social media data for Transit Operations Systems** • **Carpool / vanpool data, Telework availability/location, Bike sharing locations and availability for Transportation Demand Management Systems**	Medium	Low
SAE J2735 standards should be modified to include the following: • **Toll tag data for Vehicle Systems** • **Airline data for Transit Operations Systems** • **Vehicle registration data, Weigh in motion data, Freight operations data/records, Historical manifest data for CVO Systems** • **Origin/Destination data, Carpool / vanpool data, Telework availability/location, High Occupancy Toll (HOT) lane data, Bike sharing locations and availability, Origin/Destination data for Transportation Demand Management Systems** **The Origin/Destination data for Transportation Demand Management Systems is a privacy issue. The policy issue regarding its use must be resolved by Intelligent Transportation Systems Joint Program Office (ITS-JPO).**	High	High
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

5.1.5 R.E.S.C.U.M.E. Gap Summary

Table 5-6. R.E.S.C.U.M.E. Gap Summary

Gap	Priority	Complexity
The ITE TMDDv3 standards should be modified to include the following: • **Estimated time of arrival, Route taken** • **Alerts of vehicles present in incident zone, Personal warning device of oncoming dangerous vehicle, Routing instructions to medical care facility** • **In-vehicle alerts and instructions, In-vehicle warnings and instructions for INC-ZONE Application / Traveling Public** • **Road diversions, Number of victims and status, On-scene assessment information** • **Evacuation order, Utility status, Mass warning notifications, Evacuation plans**	High	High
NTCIP 2306 should be modified to accommodate specific additional functions such as dialog specific functions, call backs, quality of service and transaction rollback which may be required to support the more sophisticated C2C messages for R.E.S.C.U.M.E that result from the data made available from connected vehicle communications. **Note: Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.**	Medium	Low
The Performance Measurement aspects of R.E.S.C.U.M.E. require storage and retrieval of ITS data, so the ASTM E2665-08 standards for data archiving will need to be modified to accommodate storage and reporting for of certain information which may include: • **Estimated Vehicle arrival time** • **Actual vehicle arrival time** • **Incident clearance time** • **Evacuation time** • **Recovery time**	Low	Medium
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 standards should be modified to include the following: • **AACN message information, HAZMAT transport vehicle identification information , Credentials to access HAZMAT contents, vehicle occupant identification information, Credentials to access electronic medical records, Incident location, Crash injury severity predictions, Number of victims for Crashed Vehicle** • **Correlated incident information, Electronic shipping papers, Vehicle occupant's electronic medical records, and Medical care facility capabilities** • **Alerts of vehicles present in incident zone, Personal warning device of oncoming dangerous vehicle, Routing instructions to medical care facility** • **Requests for evacuation transportation assistance, Requests for transportation routing guidance, Requests for shelter, Requests for roadside assistance** • **Utility status** • **Shelter options, Return home information** • **Dynamic dispatching and routing guidance for picking up and transporting special needs evacuees to shelters for EVAC Application / Information Broker**	Medium	Medium
SAE J2354 standards should be modified to include the following: • **Pickup times and location options, Shelter options, Return home information**	Medium	Low

Gap	Priority	Complexity
• **Routing information, Roadside resources and routing, Shelter options, Return home information**		
SAE J2735 standards should be modified to include the following: • **AACN message - Incident location, AACN data, Crash injury severity predictions, Number of victims, HAZMAT transport vehicle identification information, Credentials to access HAZMAT contents, Vehicle occupant identification information, Credentials to access electronic medical records for RSE / TMC-based Information Broker System** • **Correlated incident information, Electronic shipping papers, Vehicle occupant's electronic medical records, Traffic data near incident zone, Snow plow data, Medical care facility capabilities and availability** • **Estimated time of arrival, Summary of equipment/personnel, Staging intentions, Arrival approach** • **Route taken, Traffic/travel conditions encountered** • **Characteristics of vehicles in incident zone** • **Incident zone coordinates, Lane closures, Road diversions, Number of victims and status, On-scene assessment and need for more/fewer assets Requests for evacuation transportation assistance, Requests for transportation routing guidance, Requests for shelter, Requests for roadside assistance, Status of responder assets** • **Status of responder assets** • **Pickup times and location options, Shelter options, Return home information, routing information** • **Dynamic dispatching and routing guidance**	High	High
SAE J2395 is a recommended practice for addressing in-vehicle message priorities. R.E.S.C.U.M.E. will relay messages to and within the vehicle and these messages will need to be prioritized as well, so the recommended practice will need to be modified as necessary to accommodate these messages within the priority queue.	Medium	Low
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

5.1.6 M-ISIG Gap Summary

Table 5-7. M-ISIG Gap Summary

Gap	Priority	Complexity
NTCIP 2306 should modified to accommodate specific additional functions such as dialog specific functions, call backs, quality of service and transaction rollback which may be required to support the more sophisticated C2C messages for M-ISIG that result from the data made available from connected vehicle communications	Medium	Low

Gap	Priority	Complexity
Note: Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.		
ITE TMDD v3 Standards should be modified to include the following: • **Connected vehicle data (location, speed, braking, windshield wiper activation, headlight activation, temperature, traction), for Arterial Data Environment.** • **Emergency Vehicle movement data and preemption priority information, Freight Vehicle movement data and priority information for Traffic Signal Controllers.**	High	High
Assess NTCIP 1202 to include connected vehicle object definitions for Actuated Traffic Signal Controller units. Within this bundle, it is feasible for dynamic traffic signal controller modification triggers to come from connected vehicles or connected vehicle data made available to the signal system and controller via these applications. In turn, the standard should be Modified to include: • **Object Definitions and dialogs in support of SPaT** • **Connected vehicle data (location, speed, braking, windshield wiper activation, headlight activation, temperature, traction)** • **Transit Vehicle, Emergency Vehicle , Freight Vehicle and Connected Pedestrian movement data** • **Transit Vehicle movement data and TSP information** • **Emergency Vehicle movement data and preemption priority information** • **Freight Vehicle movement data and priority information** • **Passenger count data, Service type, Scheduled and actual arrival time, Heading information, Vehicle headways** • **Response type and priority** • **Scheduled, actual, and projected freight movements** • **Transit Vehicle movement data and TSP information** • **Heading information**	Medium	Medium
NTCIP 1209 should be modified to include: • **Connected vehicle and connected pedestrian object definitions for Transportation Sensor Systems** • **Connected vehicle data (location, speed, braking, windshield wiper activation, and headlight activation** • **Connected Pedestrian movement data** • **Automated pedestrian call messages** • **Pedestrian movement and alignment information**	Medium	Medium
NTCIP 1206:2005 Standards should be modified to include the following: • **Connected vehicle data (location, speed, braking, windshield wiper activation, headlight activation, temperature, traction), for Arterial Data Environment.** • **Connected pedestrian object definitions for data collection and monitoring**	Medium	Medium
SAE J2735 Standards should be modified to include the following: • **Pedestrian movement data for Arterial Traffic Management Systems and Traffic Signal Controllers.** • **Pedestrian call messages for Connected Pedestrian Mobile Devices.** • **Passenger count data, Service type, Scheduled and actual arrival time, Vehicle headways for Transit Vehicle Systems.** • **Response type and priority for Emergency Vehicle Systems.** • **Scheduled, actual, and projected freight movements for Freight Vehicle Systems.** • **Connected Pedestrian movement data for Arterial Traffic Management Systems and Traffic Signal Controllers.**	High	High

Gap	Priority	Complexity
• **Freight Vehicle movement data and priority information for Arterial Traffic Management Systems.**		
NTCIP 1210 should be modified to include: • **Objects related to connected vehicle-based detection of lane-specific platoon flow, platoon size, and other driving characteristics for Field Management Stations (FMS)**	Medium	Medium
Assess APTA TCIP-S-001 to accommodate new Priority Request Generator rules in the TSP business area of M-ISIG.	Medium	Medium
The Performance Measurement aspects of M-ISIG require storage and retrieval of ITS data, so the ASTM E2665-08 standards for data archiving will need to be modified to accommodate storage and reporting needs of this bundle	Low	Medium
Assess ITE ATC Controller 5.2 standard to accommodate V2I communications and the API as it relates to ITSS, TSP, MAPSS, PREEMPT and FSP.	Medium	High
SAE J2395 addresses in-vehicle message priorities. The M-SIG applications of ITSS, TSP, PREEMPT and FSP may relay messages to the vehicle, these will need to be prioritized as well, so the standard will need to be modified to accommodate the M-ISIG messages as well.	Medium	Low
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

5.1.7 Road Weather Applications Gap Summary

Table 5-8. Weather VDT, EMS, Freight and Traveler Info Gap Summary

Gap	Priority	Complexity
ITE TMDD v3 Standards should be modified to include the following: • **Regional forecast and other meteorological model output data for Weather Exchange Data Sources / VDT**	High	High
ASTM E2665-08 (Standard Specification for Archiving ITS-Generated Traffic Monitoring Data) does not reflect the road weather condition data that can be gathered by Road Weather Application-enabled connected vehicles. A roadway condition dataframe add would provide useful information to support the ADMS operational scenarios as described in Section 7.2. Modification of ASTM E2468-05 should include a description of data elements related to the capture and storage of roadway condition information.	Low	Medium
SAE J2354 defines and describes standardized messages applicable to ATIS. However, ATIS Message weather information (Element: weatherReport) does not reflect weather predictions of the kind that can be produced by the Vehicle Data Translator (VDT) in conjunction with Road Weather Application-enabled connected vehicles. Modification of SAE J2354 to include: • **Weather prediction elements and types**	Medium	Low

Gap	Priority	Complexity
• **Schedule restrictions and Routing restrictions based on weather**		
SAE J2395 (Surface Vehicle Recommended Practice ITS In-Vehicle Message Priority) provides recommended practice for in-vehicle message priority to help insure the orderly presentation of ITS information to the driver, considering both temporal and spatial restraints. This recommended practice should be modified or expanded to include the correct priority for weather related driver alerting.	Medium	Low
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

5.2 Data Capture Management

5.2.1 Arterial Data Environment

Table 5-9. Arterial Data Environment Gap Summary

Gap	Priority	Complexity
ITE TMDD v3 standards should be modified to include the following: • **Speed target User interface diagnostics and notification of activated CACC functions** • **Number of shockwaves formed, length of shockwaves, propagation speed of shockwaves, level of speed compliance, speed variability, travel time reliability, number of primary and secondary crashes, severity of crashes, emission levels, consumed energy, duration of formed queues.** • **Queue prediction notification and queue prediction message for Q-WARN**	High	High
ITE TMDD v3 standards should be modified to include the following: • **Airline data for Transit Operations Systems** • **Vehicle registration data, Weigh in motion data, Freight operations data/records, Historical manifest data for CVO Systems** • **Origin/Destination data, Carpool / vanpool data, Telework availability/location, High Occupancy Toll (HOT) lane data, Bike sharing locations and availability, Origin/Destination data for Transportation Demand Management Systems**	High	High
The ITE TMDDv3 standards should be modified to include the following: • **Change in velocity, Vehicle orientation, Airbag status for Crashed Vehicle Sensors/In-Vehicle AACN-RELAY Application** • **AACN message information- AACN data, Crash injury severity predictions, Number of victims for Crashed Vehicle In-Vehicle AACN-RELAY Application / Relay Vehicle In-Vehicle AACN-RELAY**	High	High

Gap	Priority	Complexity
Application, Relay Vehicle In-Vehicle AACN-RELAY Application / Roadside Equipment (RSE), • **AACN message , , credentials to access HAZMAT contents, Vehicle occupant identification information, Credentials to access electronic medical records for RSE / TMC-based Information Broker System** • **Correlated incident information, Vehicle occupant's electronic medical records, medical care facility capabilities and availability** • **Estimated time of arrival** • **Alerts of vehicles present in incident zone, Personal warning device of oncoming dangerous vehicle, Routing instructions to medical care facility** • **Number of victims and status, On-scene assessment information** • **Requests for evacuation transportation assistance, Requests for transportation routing guidance, Requests for shelter, Requests for roadside assistance, Status of responder assets** • **Evacuation order, Utility status, Mass warning notifications, Evacuation plans** • **Pickup times and location options, Shelter options, Return home information** • **Roadside resources and routing, Shelter options, Return home information for EVAC Application / Non-Special Needs Evacuees Communication Subsystem** • **Dynamic dispatching and routing guidance for picking up and transporting special needs evacuees to shelters**		
ITE TMDD v3 Standards should be modified to include the following: • **Emergency Vehicle movement data and preemption priority information, Freight Vehicle movement data and priority information for Traffic Signal Controllers.** • **Response type and priority for Emergency Vehicle Systems.**	High	High
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 standards should be modified to include the following: • **Notification of activated CACC functions as a result of incident response**	Medium	Medium
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 standards should be modified to include the following: • **AACN message information, HAZMAT transport vehicle identification information , Credentials to access HAZMAT contents, vehicle occupant identification information, Credentials to access electronic medical records, Incident location, Crash injury severity predictions, Number of victims for Crashed Vehicle** • **Correlated incident information, Electronic shipping papers, Vehicle occupant's electronic medical records, and Medical care facility capabilities** • **Alerts of vehicles present in incident zone, Personal warning device of oncoming dangerous vehicle, Routing instructions to medical care facility** • **Requests for evacuation transportation assistance, Requests for transportation routing guidance, Requests for shelter, Requests for roadside assistance** • **Utility status** • **Shelter options, Return home information** • **Dynamic dispatching and routing guidance for picking up and transporting special needs evacuees to shelters for EVAC Application / Information Broker**	Medium	Medium
NTCIP 2306 should be modified to accommodate additional functions such as dialog specific functions, call backs, quality of	Medium	Low

Gap	Priority	Complexity
service and transaction rollback which may be required to support the more sophisticated C2C messages for INFLO (in-vehicle speed and Q-Warn recommendations), EnableATIS, R.E.S.C.U.M.E., and M-ISIG. **Note: Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.**		

5.2.2 Freeway Data Environment

Table 5-10. Freeway Data Environment Gap Summary

Gap	Priority	Complexity
ITE TMDD v3 standards should be modified to include the following: • **Speed target and advisory messages for SPD-HARM** • **User interface diagnostics and notification of activated CACC functions** • **Number of shockwaves formed, length of shockwaves, propagation speed of shockwaves, level of speed compliance, speed variability, travel time reliability, number of primary and secondary crashes, severity of crashes, emission levels, consumed energy, public opinion ratings, duration of formed queues.** • **Queue prediction notification and queue prediction message for Q-WARN**	High	High
ITE TMDD v3 standards should be modified to include the following: • **Vehicle registration data, Weigh in motion data, Freight operations data/records, Historical manifest data for CVO Systems** • **Origin/Destination data, Carpool / vanpool data, Telework availability/location, High Occupancy Toll (HOT) lane data, Bike sharing locations and availability, Origin/Destination data for Transportation Demand Management Systems** • **Airline data for Transit Operations Systems**	High	High
The ITE TMDDv3 standards should be modified to include the following: • **Change in velocity, Vehicle orientation, Airbag status for Crashed Vehicle Sensors/In-Vehicle AACN-RELAY Application** • **AACN message information- AACN data, Crash injury severity predictions, Number of victims for Crashed Vehicle In-Vehicle AACN-RELAY Application / Relay Vehicle In-Vehicle AACN-RELAY Application, Relay Vehicle In-Vehicle AACN-RELAY Application / Roadside Equipment (RSE),** • **AACN message , HAZMAT transport vehicle identification information, credentials to access HAZMAT contents, Vehicle occupant identification information, Credentials to access electronic medical records for RSE / TMC-based Information Broker System** • **Correlated incident information, Vehicle occupant's electronic medical records, medical care facility capabilities and availability** • **Estimated time of arrival, Route taken** • **Alerts of vehicles present in incident zone, Personal warning device of oncoming dangerous vehicle, Routing instructions to medical care facility**	High	High

Gap	Priority	Complexity
• **In-vehicle alerts and instructions, In-vehicle warnings and instructions for INC-ZONE Application / Traveling Public** • **Road diversions, Number of victims and status, On-scene assessment information** • **Requests for evacuation transportation assistance, Requests for transportation routing guidance, Requests for shelter, Requests for roadside assistance, Status of responder assets** • **Evacuation order, Utility status, Mass warning notifications, Evacuation plans** • **Pickup times and location options, Shelter options, Return home information** • **Routing information, Roadside resources and routing, Shelter options, Return home information for EVAC Application / Non-Special Needs Evacuees Communication Subsystem** • **Dynamic dispatching and routing guidance for picking up and transporting special needs evacuees to shelters**		
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 standards should be modified to include the following: • **Notification of activated CACC functions as a result of incident response** • **Anti-lock braking system status, traction control, stability control, rate of change of steering wheel, differential wheel speed, brake boost for the on-board connected vehicle sensors** • **Duration of formed queues, Queue detection message and queue prediction notifications** • **Vehicle Classification information to both inform fleet and freight management agencies related to known incidents related to different vehicles classifications as well as to more clearly identify the type of vehicle involved in incidents**	Medium	Medium
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 standards should be modified to include the following: • **AACN message information, HAZMAT transport vehicle identification information , Credentials to access HAZMAT contents, vehicle occupant identification information, Credentials to access electronic medical records, Incident location, Crash injury severity predictions, Number of victims for Crashed Vehicle** • **Correlated incident information, Electronic shipping papers, Vehicle occupant's electronic medical records, and Medical care facility capabilities** • **Alerts of vehicles present in incident zone, Personal warning device of oncoming dangerous vehicle, Routing instructions to medical care facility** • **Requests for evacuation transportation assistance, Requests for transportation routing guidance, Requests for shelter, Requests for roadside assistance** • **Utility status** • **Shelter options, Return home information** • **Dynamic dispatching and routing guidance for picking up and transporting special needs evacuees to shelters for EVAC Application / Information Broker**	Medium	Medium
NTCIP 2306 should be modified to accommodate specific additional functions such as dialog specific functions, call backs, quality of service and transaction rollback which may be required to support the more sophisticated C2C messages for INFLO, EnableATIS, and R.E.S.C.U.M.E that result from the data made available from connected vehicle communications.	Medium	Low

Gap	Priority	Complexity
Note: Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.		

5.2.3 Regional Data Environment

Table 5-11. Regional Data Environment Gap Summary

Gap	Priority	Complexity
ITE TMDD v3 standards should be modified to include the following: • **Following data along a designated truck route - historical traffic pattern, truck-specific route designations, truck-specific route restrictions, bridge heights, bridge weight restrictions, preferred freeway access paths, toll road information for Regional Pre-Trip Planner** • **Notification to a user when the current/planned route is estimated to coincide with newly discovered or predicted congestion along with alternate route information in such a case for Dynamic Routing System** • **Information needed for automated OSOW permitting and routing by State systems, Submit requests (for automated permitting) and request results for Oversized Overweight Vehicle Routing System** • **Real-time point-to-point travel time predictive information for freeways, port and terminal intermodal connectors and major freight arterials for Data Environment System** • **Truck parking reservations for Data Environment System** • **Match an empty container with a truck, match an empty container for return only if the container is in reloadable condition, match an empty container for return only if it is determined that the value of the reload is sufficient to justify picking it up, all for Freight/Marine Port Systems**	High	High
ITE TMDD v3 standards should be modified to include the following: • **Airline data for Transit Operations Systems** • **Vehicle registration data, Weigh in motion data, Freight operations data/records, Historical manifest data for CVO Systems** • **Origin/Destination data, Carpool / vanpool data, Telework availability/location, High Occupancy Toll (HOT) lane data, Bike sharing locations and availability, Origin/Destination data for Transportation Demand Management Systems**	High	High
ITE TMDD v3 Standards should be modified to include the following: • **Regional forecast and other meteorological model output data for Weather Exchange Data Sources / VDT**	High	High
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 Standards should to be modified to include the following: • **HAZMAT cargo, Driver identity, HOS status, Vehicle condition, Vehicle weight, Vehicle dimensions, Credential status: carrier, driver, vehicle, Safety history: carrier, driver, vehicle**	Medium	Medium
NTCIP 2306 should be modified to include the required functionality to transport the weather data required to support EnableATIS, Smart Roadside, VDT and the other weather applications.	Medium	Medium

Gap	Priority	Complexity
Note: NTCIP 2306 Defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries supplied by schemas are defined under other standards.		

5.2.4 Corridor Data Environment

There are no gaps identified for the Corridor Data Environment.

5.2.5 Weather Data Environment

Table 5-12. Weather Data Gap Summary

Gap	Priority	Complexity
ITE TMDD v3 Standards should be modified to include the following: • **Regional forecast and other meteorological model output data for Weather Exchange Data Sources / VDT**	High	High

5.3 Smart Roadside

Table 5-13. Smart Roadside Gap Summary

Gap	Priority	Complexity
The IEEE 1512-2006, IEEE 1512.1, IEEE 1512.2 and IEEE 1512.3 Standards should to be modified to include the following: • **HOS status, Credential status: vehicle, Safety history: carrier, driver, vehicle**	Medium	Medium
SAE J2735 Standards should to be modified to include the following: • **Credential and permit status, Carrier identity, Driver identity, HOS status, Travel time, Parking availability, Road Condition Data, Types and locations of accidents and CDL endorsements for Commercial Motor Vehicle (CMV) On-Board Systems** • **Travel time, Parking availability, CDL endorsements, Credential and permit status, Carrier identity, Driver identity, Credential status: carrier, driver, vehicle, Safety history: carrier, driver, vehicle, Policy and operations guidance information, Travel time, Parking availability, Roadside enforcement results, Driver reports, Change in driver status, Types and locations of accidents**		
NTCIP 2306 should be modified to accommodate specific additional functions such as dialog specific functions, call backs, quality of service and transaction rollback which may be required to support the more sophisticated C2C messages for Smart Roadside that result from the data made available from connected vehicle communications. **Note: NTCIP 2306 defines SOAP and WSDL wrappers for XML data exchange. Data dictionaries and schemas are defined under other standards.**	Medium	Low
The Performance Measurement aspects of Smart Roadside require	Low	Medium

Gap	Priority	Complexity
storage and retrieval of ITS data, so the ASTM E2665-08 standards for data archiving will need to be modified to cover the attributes and performance measures for Smart Roadside which include performance measures for roadside CMV inspections, electronic screening/ virtual weigh stations, universal electronic commercial motor vehicle (CMV) identification and truck parking.		
Performance measures are essential to the Connected Vehicle Initiative, and although some performance measures could be covered under the ASTM standards, the Connected Vehicle Initiative comes with a wealth of its own unique performance measures. The USDOT should consider the possibility of adopting a new performance measure standard unique to Connected Vehicle.	Low	High
Updates or patches will need to be installed for in-vehicle applications. There are currently no standards that address how the updates will be applied. Factors such as what updates to apply, when to apply, and how to apply the updates will need to be addressed. The USDOT should consider the possibility of adopting a new standard to address these in-vehicle application updates.	High	High

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APPENDIX A. List of Acronyms

AACN-Relay	Advanced Automatic Crash Notification Relay
ACC	Adaptive Cruise Control
ANSI	American National Standards Institute
AP-DATEX	Application Profile for DATEX-ASN
APTA	American Public Transportation Association
ASC	Actuated Traffic Signal Controller
ASTM	American Society for Testing and Materials
ATC	Advanced Transportation Controller
ATIS	Advanced Traveler Information System
AVA	Automated Vehicle Announcement
AVL	Automatic Vehicle Location
C2C XML	Center-to-Center communications
CACC	Cooperative Adaptive Cruise Control
CAD	Computer Aided Dispatch
CCTV	Closed Circuit Television
CMV	Commercial Motor Vehicle
ConOps	Concept of Operations
COTM	Contracting Officer Task Manager
CMV	Commercial Motor Vehicle
DCM	Data Collection and Monitoring
DCM	Data Capture Management
DMA	Dynamic Mobility Application(s)
DMS	Dynamic Message Sign
D-RIDE	Dynamic Ridesharing
DR-OPT	Intermodal Drayage Operations Optimization
DSRC	Dynamic Short Range Communications
EDI	Electronic Data Interchange
EMS	Emergency Management System
Enable ATIS	Enable Advanced Traveler Information System
ESS	Environmental Sensor Station
ETS	Emergency Telephone System
EVAC	Emergency Communications and Evacuation
FMS	Field Management Stations

FRATIS	Freight Advanced Traveler Information System
FSK	Frequency shift keying
FSP	Freight Signal Priority
FTP	File Transfer Protocol
GTFS	General Transit Feed Specification
HOT	High Occupancy Toll
INFLO	Intelligent Network Flow Optimization
ICM	Integrated Corridor Management
IDB	ITS Data Bus
IDTO	Integrated Dynamic Transit Operations
IEEE	Institute of Electrical and Electronics Engineers
ISIG	Intelligent Traffic Signal System
INC-ZONE	Incident Scene Work Zone Alerts for Drivers and Workers
ISP	Information Service Provider
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
ITS-JPO	Intelligent Transportation Systems Joint Program Office
ITSS	Intelligent Traffic Signal System
LAN	Local Area Network
LISA	Low Impedance Stereo Audio
LRMS	Location Reference Message Specification
MAC	Medium Access Control
MAN	Metropolitan Area Network
MAPSS	Mobile Accessible Pedestrian Signal System
M-ISIG	Multi-Modal Intelligent Traffic Signal System
MS/ETMCC	Message Sets for External Traffic Management Center Communications
NTCIP	National Transportation Communications for ITS Protocol
ODT	Origin, Destination, and Time
OSOW	Oversized Overweight
PED-SIG	Mobile Accessible Pedestrian Signal System
PMPP	Point-to-Multipoint protocol
PREEMPT	Emergency Vehicle Preempt
PSAP	Public Safety Answering Point
QA	Quality Assurance
QC	Quality Control

Q-WARN	Queue Warning
RDS	Radio Data System
R.E.S.C.U.M.E.	Response, Emergency Staging and Communications, Uniform Management, and Evacuation
RESP-STG	Incident Scene Pre-Arrival Staging Guidance for Emergency Responders
RMC	Ramp Meter control
RSA	Route and schedule adherence
RSE	Roadside Equipment
RWMP	Roadway Weather Management Program
SAE	Society of Automobile Engineers
SCP	Signal and Control Prioritization
SCP	Standards Coordination Plan
SDO	Standards Development Organization
SE	Systems Engineering
SEP	Standards Engineering Process
SOAP	Simple Object Access Protocol
SPaT	Signal Phase and Timing
SPD-HARM	Dynamic Speed Harmonization
SRI	Smart Roadside Initiative
T-CONNECT	Connection Protection
T-DISP	Dynamic Transit Operations
TFTP	Trivial File Transfer Protocol
TMCC	Travel Management Coordination Center
TMDD	Traffic Management Data Dictionary
TMP	Transportation Management Protocols
TMS	Traffic Management System
TSP	Transit Signal Priority
TSS	Transportation Sensor System
USDOT	United States Department of Transportation
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
VDT	Vehicle Data Translator
WAVE	Wireless Access in Vehicular Environment
WSDL	Web Services Definition Language
XML	eXtensible Markup Language

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U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
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