ITS Standards Development Plan

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TABLE OF CONTENTS

EDL# 5402 – “National ITS Architecture Documents: Implementation Strategy; U.S. Department of Transportation”

EDL# 5403 - "National ITS Architecture Documents: Standards Requirements; U.S. Department of Transportation"

EDL# 5404 – “National ITS Architecture Documents: Standards Development Plan; U.S. Department of Transportation”

EDL# 11863 - "National ITS Architecture Documents: Market Packages - A Tool for Viewing, Accessing and Utilizing the National ITS Architecture; U.S. Department of Transportation".

Table of Contents

EXECUTIVE SUMMARY

The Standards Development Plan identifies potential standards areas, reviews existing standards efforts, describes a general process to assist standards development, and suggests beneficial actions to support and encourage ITS deployment. This document is intended for use as a guide to using the architecture. It is directed toward standards development organizations, product developers, service providers, and public agencies at all levels.

Benefits, risks, and risk reduction are discussed. Standardization will produce benefits by promoting national compatibility, which insures multiple suppliers and a wide range of product or service functionality. Synergy across the Intelligent Transportation System (ITS) greatly reduces risk to public and private providers by assuring interoperability between ITS systems. Synergy and interoperability will increase ITS related development by preserving the investment of product or service providers and increasing potential market size.

Specific and potential standards needs for ITS have been identified. Candidates for standardization include interfaces as defined by the Physical Architecture. The Implementation Strategy is a prioritization guide for development and assures all the required elements are available for each system. Interoperability is of a national, regional, and product concern. Although the scope of this effort is National, International considerations need to be included in the process. International considerations are addressed and a relationship to Standards Requirements Packages is established. To get started using the National Architecture Products, a rational approach is to identify all of the important pieces, divide the work as appropriate to development organizations, prioritize based on urgency and need, and identify existing applicable standards. Standards organizations should be able to sort through the national architecture documentation and extract all the information they need for this process.

Standards development for the national architecture is guided by the ITS America Standards and Protocol Policy. ITS America will help identify requirements, promote development and encourage the use of ITS-related standards. ITS America has defined its role to be that of guidance, promotion and support rather than that of a standards development organization.

There are existing and on going standards implementation activities. One is "ITS Standards Development" as defined by solicitation (DTFH61-96-R-00004) which has evolved to multiple contract awards. The structure for that effort is defined in Section 4 of the Standards Development Plan.

1. INTRODUCTION

1.1 Purpose and Scope

The National Architecture is an important step in a larger process that is intended to promote national compatibility and interoperability across Intelligent Transportation System (ITS) deployments. Ultimately, to achieve national compatibility, standards consistent with the architecture framework must be identified or developed and adopted by the implementors of ITS. To support this crucial transition between architecture and standards, this Standards Development Plan:

- Identifies and assesses the potential standards areas associated with the National Architecture
- Briefly reviews existing standards efforts and their relationship with the architecture framework.
- Describes the general process by which the National Architecture can inform and assist standards development
- Suggests actions to encourage timely and beneficial standardization to support ITS deployment

This document is a key component of the Implementation Strategy deliverable and Standards Requirements deliverable which have been submitted under separate cover.

1.2 ITS Standards: Benefits and Risks

The National ITS Architecture brings significant benefits to the public. These benefits are delivered in large part by the standards that come out of the architecture effort.

How Standards Directly Produce Benefits from the National Architecture:

1) National Compatibility:
   The architecture identifies roughly 45 specific interfaces (out of 125) requiring nationwide compatibility (Appendix 1). An example is the dedicated short range interface between the vehicle and the roadside. A nationwide standard for this interface will allow travelers and commercial vehicles to use their compliant equipment anywhere within the U. S.
2) Multiple suppliers:
   The architecture identifies roughly 35 specific interfaces where a standard is not necessarily required to provide a traveler with seamless operation of his ITS services. These interfaces will benefit from standards in allowing multiple suppliers of equipment and software that will directly connect to other ITS subsystems.
3) Support for ranges of functionality:

The standard packages contain data flows that support several levels of service. For example, the *trip plan* data flow contains a large number of optional data fields. The standards developer is encouraged to maintain the flexibility in the data flow specifications to allow for multiple implementations.

4) Synergy:

The architecture began with a logical architecture that satisfied all of the 29 user services. Because of this logical beginning, functions and data flows that are common to several of the services have been localized down to specific process specifications and data flow primitive elements (Pel's). These primitives appear in several data flows and because they come from a single source they support synergy and consistency.

5) Risk reduction

The architecture reduces risk to public providers, private providers and consumers. For public providers, existence of standards means that equipment purchased one year will be likely to operate with new equipment purchased several years from now. This also means that agencies will not be locked into specific vendors since all vendors will be able to build to the same standard. For private providers, existence of standards means that they can gather information from multiple sources using well defined message sets and thereby increase the level of service to their customers. For consumers, products build to a particular standard will allow a user to select their service provider from a number of companies, not just the company that their equipment happens to be compatible with.

Defined standards are fundamental to the establishment of nationally compatible and interoperable ITS deployments. Standards will enable deployment of consistent, non-interfering, reliable systems on local, regional and national levels. Open standards will further benefit the consumer by enhancing competition for the range of products necessary to implement the ITS user services. Larger markets for specific products will reduce production costs through economy of scale. Producers benefit from standards because they assure a wide market over which the product can be sold. As deployment occurs, diverse systems will be developed to address the special needs of urban, suburban and rural environments. Standards must ensure interoperability across these implementations without impeding innovation as technology advances and new approaches evolve.

1.2.1 ITS Standards

Three types of ITS standards are considered in this plan: *regulatory*, *de facto*, and *voluntary*. A *regulatory standard* is established by a government agency (e.g., National Highway Transportation Safety Administration) to protect public welfare and safety. Examples would include standards ensuring consistent and safe integration of ITS capabilities into the driver's interface with the automobile. A *de facto standard* is established by someone in industry who successfully learns how to do something (e.g., design, build, and/or establish a product or service) which then

becomes an accepted industry practice. A *voluntary standard* is developed through voluntary consensus by people with common needs and interests so as to provide some degree of confidence in the marketplace for manufacturers, integrators, service providers, and consumers.

A regulatory standard can mandate degrees of interoperability and compatibility and mandate performance requirements. A voluntary standard is limited to elective compliance for interoperability and compatibility. In considering the potential options for promoting adoption of ITS standards intended to serve the public interests, a middle ground can be considered in which conditional funding is tied to adoption of the standard. In this scenario, adoption of the *voluntary* standard is incentivized providing additional impetus to the natural tendency for the market to support an accepted standard.

Almost all industry standards are voluntary standards. As will be described in Section 2, the majority of the standards identified by the architecture are anticipated to be of this type. In areas where there is not a strong case for standardization, a laissez-faire approach is recommended. In these areas, any standards that are ultimately adopted are likely to be de facto. At the other end of the spectrum, there are a few areas in which public safety considerations warrant development of regulatory standards. On occasion, standards which are voluntary may be adopted as regulatory standards by certain agencies.

De facto standards, when sufficiently open, can be effective in reducing costs to consumers and supporting product interoperability for technologies that are relatively mature. On the other hand, a de facto standard put forward by a company with its own interests in mind, may ignore customer requirements and overall system integration considerations.

All different types of standards will probably result as ITS services are deployed. Chapter 2 identifies areas where there is significant interest within the infrastructure to accelerate deployment (with the Intelligent Transportation Infrastructure and CVISN activities). Application layer standards will emerge from standards organizations as an aid to speeding this accelerated deployment.

Communication layer standards come mostly from the communication service providers in support of all types of communication. ITS will probably adopt those existing and emerging standards as *de facto.* Some of these may be proprietary and although the architecture teams feel that proprietary standards are not as good as open standards for the long term ITS, it is better to have some working system based on proprietary standards than non at all.

The third source of standards will be from product developers and may be open or proprietary. If the architecture is sufficiently flexible and is allowed to grow with these evolving standards activities, the end result can be a coherent National Architecture with supporting standards of all types.

1.2.2 Potential Benefits

Well chosen, well timed, and broadly accepted standards can provide the following frequently referenced benefits:

- *Interoperability between diverse systems.* This benefit facilitates cost-effective area-wide implementations that ultimately provide enhanced service to the consumer.
- *Preservation of investment.* Timely standards can reduce investments in multiple incompatible approaches, some of which will become casualties of natural selection in the market place.
- *Technology insertion.* Systems can be incrementally improved to take advantage of new technologies.
- *Creation of broader markets.* Interoperability standards set the stage for national and/or international markets. The lack of a standard may ultimately limit the size of the market.
- *Interchangeability.* Interchangeable equipment reduces capital costs through increased competition and reduces maintenance costs through smaller spares inventories of less expensive replacement parts.

Note that the adopted standards must be comprehensive to support interoperability. There are several examples (e.g., ATM and SONET standards) in which hastily developed and adopted standards have not included sufficient specification to guarantee interoperability between standard-compliant systems.

1.2.3 Potential Risks

Unfortunately, standardization is no panacea. In particular, accelerating standards ahead of tangible markets, promulgating standards for interfaces independent of need, or heavy handed standards adoption policies which undermine market forces will inevitably have negative repercussions. In addition, standards can have the following undesirable affects:

- *Hinder development of new and innovative technology.* Once a standard is developed and adopted; superior incompatible technology may not be vigorously pursued, or marketable once it has been developed. This problem is accentuated if conditional funding or regulation is tied to adoption of the standard. An order of magnitude improvement may be required to overcome the inertia surrounding the standard.
- *Jeopardize investments by early adopter's of incompatible approaches.* Advanced ITS implementations are several years ahead of the supporting standards. Incompatible equipment may be rendered obsolete by emerging standards and require costly retrofit or replacement.
- *Inhibit Market Competition.* The market is an extremely efficient selective force. Standards which are accelerated ahead of the market will not benefit from lesson's learned during initial, competitive efforts to satisfy the market and may miss the market that finally does materialize, or result in sub-optimal solutions.

The lack of a standard will not prevent entry into perceived markets with profit potential. However, the lack of a standard may limit the size of the market. Such entry or positioning by several different competitors is a harbinger for timely standardization.

1.2.4 Benefits and Risk Mitigation

The goal of this Standards Development Plan is to identify the standards, and the timing for those standards, that will provide the benefits described in this section. To minimize the incumbent risks associated with the aggressive standardization program being considered for ITS, careful selection of the standards to be pursued and promoted, and approaches for mitigating the risks associated with those standards, are addressed in the remaining sections of this plan. Note that standards need to be comprehensive to support interoperability. Otherwise, multiple compliant systems will not interoperate.

Even when standards are fully developed, a neutral agency to help "turn-key" deployment of standards may be needed to ensure quality and interpretation is uniform (e.g. ISO-9000 approved agents).

1.3 Glossary of Terms or Definitions

Because there are many standards development organizations developing standards for different purposes, there are a number of acronyms representing organizations and different uses of some common terms. This section to defines the appropriate uses of terms for the national architecture standards Development activities and provides a list of organizations.

1) Terms - The following terms can be found in this and related documents.

- Conformance and Certification - In the context of the national architecture, conformance and certification are defined for each standard by the standard development organization. Conformance specifies the appropriate tests that must be applied to a to determine whether a particular standard is adhered to. Certification specifies the those organizations and procedures that determine whether a system conforms to the appropriate standard.

- Interoperability - The capability of two systems to operate with each other, exchange information efficiently, and utilize the capabilities in each of the systems effectively.

- Standard - As used by the architecture program, most standards will be developed based on data flows and interfaces defined in the architecture documents. The spectrum of definition runs between the

precise definition provided by ISO and the more consensus oriented description provided by ASTM.

Definition of standards from International Standards Organization (ISO) - Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose. For example, the format of the credit cards, phone cards, and "smart" cards that have become commonplace is derived from an ISO International Standard. Adhering to the standard, which defines such features as an optimal thickness (0,76 mm), means that the cards can be used worldwide.[1]

Definition of standard from ASTM - As used in ASTM, a standard is a document that has been developed and established within the consensus principles of the Society and that meets the approval requirements of ASTM procedures and regulations.[2]

- Profile - although not used in this document, various profiles may be developed to collect different standards together in useable packages. The definition from ISO - Each Profile is a set of one or more base standards, and, where applicable, the identification of chosen classes, subsets, options and parameters of those base standards, necessary for accomplishing a particular function. Profiles define combinations of base standards for the purpose of: 1) identifying the base standards, together with appropriate classes, subsets, options and parameters, which are necessary to accomplish identified functions for purposes such as interoperability; 2) providing a system of referencing the various uses of base standards which is meaningful to both users and suppliers; 3) providing a means to enhance the availability for procurement of consistent implementations of functionally defined groups of base standards, which are expected to be the major components of real application systems; 4) promoting uniformity in the development of conformance tests for systems that implement the functions associated with the Profiles.[3]

- ISO 9000 - The ISO 9000 set of standards defined by the ISO/TC271 set the basic rules for quality systems - from concept to implementation - whatever the product or service. They are a set of rules for manufacturing a product or delivering a service. They should ensure that a supplier has the capability to produce the required goods or services, showing him how to proceed to make sure that what

[1] http://www.iso.ch/infoe/intro.html
[2] http://www.astm.org/FAQ/2.html
[3] http://www.iso.ch/dire/jtc1/directives.html

he delivers fully meets customer expectations. An ISO 9000 compliant quality assurance system includes up to 20 system elements documented in a pyramid of inter-connected policies, procedures and work instructions.[4]

2) Standards Development Organizations - Independent organizations that develop standards. Each organization is typically responsible to some specific community. Because ITS spans such a large number of agencies, producers, and technologies, there are a number of standards development organizations that of interest.

ANSI - ANSI (American National Standards Institute) provides a forum where peers and competitors can come together for mutual benefit. In the U.S., ANSI offers leadership in strategic standardization activities, plus an objective roundtable where groups can meet to iron out differences and reach a consensus. The ANSI Federation, organized in 1918, is made up of both manufacturing and service businesses, professional societies and trade associations, standards developers, academia, government agencies, and consumer and labor interests, all working together to develop voluntary national consensus standards.[5]

- SAE - SAE (Society of Automotive Engineers) is a non-profit educational and scientific organization dedicated to advancing mobility technology to better serve humanity. Nearly 70,000 engineers and scientists, who are SAE members, develop technical information on all forms of self-propelled vehicles including automobiles, trucks and buses, off-highway equipment, aircraft, aerospace vehicles, marine, rail, and transit systems. SAE disseminates this information through its meetings, books, technical papers, magazines, standards, reports, professional development programs, and electronic databases.[6]

- ITE - The Institute of Transportation Engineers (ITE) is an international educational and scientific association of transportation and traffic engineers, transportation planners and other professionals who are responsible for meeting mobility and safety needs. The Institute facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development and management for any mode of transportation by promoting professional development of members, supporting and encouraging education, stimulating research, developing public awareness, and exchanging professional

[4] http://www.iso.ch/9000e/news.html
[5] http://www.ansi.org/broch1.html
[6] http://www.sae.org/ABOUT/vision.htm

information; and by maintaining a central point of reference and action.[7]

- IEEE - The Institute of Electrical and Electronics Engineers (IEEE) is the world's largest technical professional society. Founded in 1884 by a handful of practitioners of the new electrical engineering discipline, today's Institute is comprised of more than 320,000 members who conduct and participate in its activities in 147 countries. The men and women of the IEEE are the technical and scientific professionals making the revolutionary engineering advances which are reshaping our world today.[8]

- ASTM - Organized in 1898, ASTM (the American Society for Testing and Materials) has grown into one of the largest voluntary standards development systems in the world. ASTM is a not-for-profit organization that provides a forum for producers, users, ultimate consumers, and those having a general interest (representatives of government and academia) to meet on common ground and write standards for materials, products, systems, and services.[9]

- (AASHTO) American Association of State Highway and Transportation Officials

- ISO - The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from some 100 countries, one from each country. ISO is a non-governmental organization established in 1947. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity. ISO's work results in international agreements which are published as International Standards.[10]

[7] http://www.ite.org/whatite.htm
[8] http://www.ieee.org/i3e_blb.html
[9] http://www.astm.org/FAQ/1.html
[10] http://www.iso.ch/infoe/intro.html

2. STANDARDS NEEDS FOR ITS

The potential standards for ITS can be derived from the National Architecture definition in several different ways. This section reviews the architecture from three perspectives.

1. The interfaces defined by the Physical Architecture are candidates for standardization.
2. The incremental deployments defined by the Implementation Strategy as Market Packages suggest message sets that may deserve prioritization for each interface.
3. A review of the Logical and Physical Architecture data dictionaries identify elements that span multiple physical interfaces and services. These elements are candidates for foundational standards.

The Standards Requirements Document provides additional detail on the identified standards areas and suggested prioritization for each area.

2.1 Interface Interoperability Requirements.

The approach that has garnered the most attention and analysis to date is to review each of the subsystem interfaces defined by the Physical Architecture as potential candidates for standardization. At this level of identification, the rationale for standardizing each interface can be discerned:

1. *National Interoperability.* Interfaces to the mobile subsystems (Vehicle Subsystems, Personal Information Access Subsystems) in the architecture support national interoperability since the same mobile subsystem should be able to roam the nation and use the local infrastructure to support ITS services. National interoperability is specified for all interfaces to mobile subsystems except where both the mobile subsystem and interfacing infrastructure are owned and operated by the same user. Examples of these include the Information Service Provider to Personal Information Access Subsystem, Toll Collection Subsystem to Vehicle Subsystem, and the Commercial Vehicle Subsystem to Commercial Vehicle Check Subsystem.

2. *Regional Interoperability.* Interfaces connecting subsystems that may be operated by different agencies (interfaces that can span jurisdictional and/or regional boundaries) can be standardized to facilitate the sharing of information between agencies. National standards mitigate issues that may arise as boundaries change and new requirements for information sharing develop over time. Regional interoperability is specified where the underlying coordination issues are regional, rather than national, in scope. For instance, there is no real requirement for a Traffic Management Subsystem in California to be able to communicate and coordinate with a Traffic Management Subsystem in New York. Two different regional dialects for Traffic Management Subsystem communications could be implemented in the two geographically isolated

subsystems, without significant impact to national interoperability goals. Examples of these include the Traffic Management Subsystem to Transit Management Subsystem, Traffic Management Subsystem to Information Service Provider, and Traffic Management Subsystem to Traffic Management Subsystem.

3. *Product Interoperability.* Interfaces between subsystems that are operated and maintained by a single stakeholder (e.g. company or agency) do not require standardization to achieve national interoperability. The data formats and communications mechanisms that are used for these interfaces are largely transparent to the remainder of the architecture. In some cases, national standards are still very beneficial (and hence still attainable through the consensus standard process) since they may consolidate a market to achieve economy of scale efficiencies (e.g. Traffic Management Subsystem to Roadway Subsystem). Such standards may also support an optional level of interoperability by enabling various cooperative control options to be implemented based on regional preference.

4. *No Interoperability Requirement.* In other cases, the sheer range of application-specific interfaces precludes efficient national standardization and no standard is suggested. For instance, a national standard is not recommended for the interface between the Fleet Management and Commercial Vehicle subsystems since the nature of the interface is so dependent on fleet type. From the National Architecture perspective, standardization for these interfaces is not suggested. Examples include the Fleet Management Subsystem to Commercial Vehicle Subsystem.

Note that there is a distinction between the "rationale" for standardization that is itemized above and the priority of the standard which relates to urgency (time criticality) and importance (the level of economic benefit that is anticipated from the standard by interested stakeholders).

As a minimum, the key application data that is communicated across each of the identified interfaces is specified by the national architecture. This degree of specification preserves the choice of communications media/frequency and protocols for the implementing agencies. Required standard interfaces to mobile subsystems must be more fully specified to ensure the mobile subsystem can communicate with the local ITS infrastructure or other mobile subsystems regardless of where it is located.

Interoperability ratings for each architecture interface are provided in Appendix 1, Table A1.1 of this document. A diagram indicating all digital communication interfaces defined in the architecture along with the appropriate interoperability rating is provided in Figure 2.1-1.

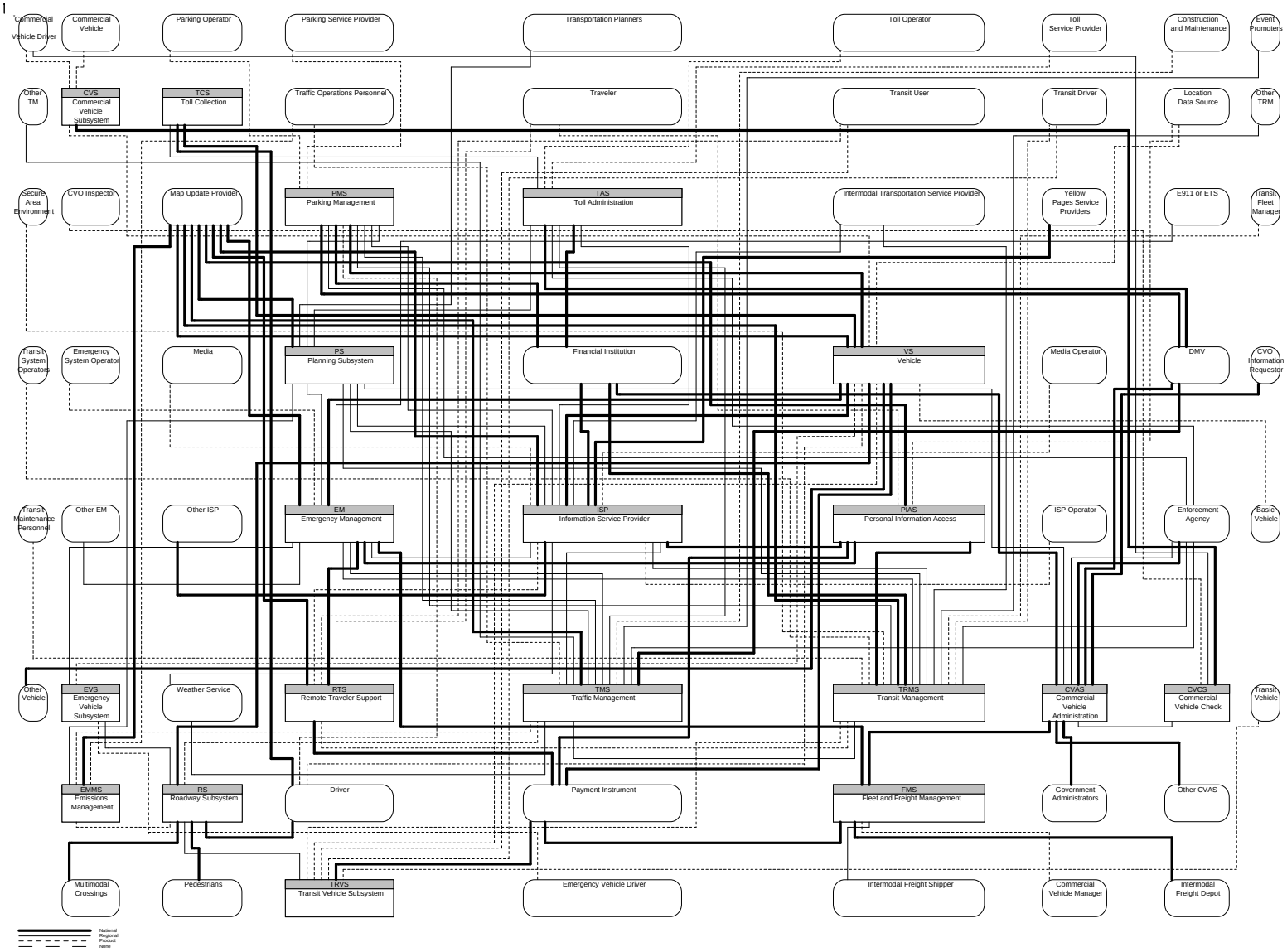

Figure 2.2-1 Architecture Interconnect Ratings

2.2 International Considerations

The scope of the National ITS Architecture program is, obviously, national. It would be unfortunate, however, to miss an opportunity to develop internationally accepted standards. Predicting how markets will develop and systems will deploy is difficult; early decisions to seek standardization at less than international levels can limit the size of the market that a product producer or integrator can address.

In some cases, it is possible that the U. S. ITS efforts can be "internationalized" with relatively little effort beyond what would be required for a domestic-only standard. This would most likely be the case in situations where there are no competing entrenched technologies. In these situations it may be worthwhile to initiate the standards process through an international standards body from the start, rather than trying to later promote a U. S. standard into an international one. A non-ITS example of this type of situation is the development of the Asynchronous Transfer Mode (ATM) standards.

For areas where there are established competing ideas, standardization can be difficult. One problem is that standardization will almost inevitably establish winners and losers between different options. While this clarification of preferred technology can stimulate a market, the process of making the selection and creating the standard can be arduous. In these situations, expanding the scope of the standard from national to international may be impossible from the start. A non-ITS example of this type standard is the emerging U. S. digital television standard.

The current National ITS Architecture interoperability ratings do not explicitly consider "international" interoperability needs. There are, however, subsets of the interfaces rated as requiring "national" or "product" interoperability that would benefit from an internationally recognized standard.

One should realize that the European markets treat standards in a very different manner than does the U. S. market. In general, in Europe, if there is a "voluntary industry" standard on a particular item, sale of that item is contingent on the item conforming to the standard. Failure to meet all applicable "voluntary industry" standards may leave a manufacturer in a very tenuous legal situation with regard to consumer safety and acceptance.

At the application level, a lot of effort is being put into message lists to make the output non-specific to language. In other words, a message would translate the same to English, Spanish and French (the user selects his language, or installs the correct chip set). Unfortunately, this doesn't always work in a linear manner. The Norwegian language has 17 different forms of snow, each of which is translated to just snow in English.

While there are numerous philosophies being stated, a national architecture that will support national standards efforts has been developed. If national standards are presented as candidates for international standardization, we can support the international effort.

The interfaces rated as requiring "national" interoperability could be rated as "international" in situations where there would be benefit from full North American interoperability. These fall in two categories:

1. Dedicated short range communications (DSRC)
    - Tolling
    - Border clearance
    - In-vehicle signage

2. Advanced Vehicle Safety / Automated Highway Systems
    - Vehicle-roadside communications (a possible application of DSRC)
    - Vehicle-to-vehicle coordination

The key idea is that vehicles will move across the North American borders relatively freely. This suggests that there can be significant benefit from having the interfaces to the vehicle be internationally compatible.

In the "product" interoperability category, there are two issues that affect the market. The first is the buyer's desire for multiple suppliers that all support a standard. This provides price competition and investment security. The second issue is the seller's desire to have access to as large a potential market as possible. Both of these suggest that an international product standard is desirable in all cases.

The catch for product standards for interfaces is that the owners and operators of the subsystems on each side of the interface may vary for different countries. While in the U. S. a parking lot and an information service provider might both be separate private companies, in Britain they might both be owned by a government transport agency. Because of these different institutional arrangements, the nature of the interface may change dramatically. This could make a single international standard very difficult to achieve.

In general, the "product" interoperability rated interfaces that pertain to travelers, such as interfaces to personal information access devices and kiosks, are the most likely candidates for international standardization. In general, “product” interoperability rated interface standards are of interest to the private sector product producers. Other interfaces, like the one between emergency management and traffic management, will vary so widely between countries that attempting to achieve an international standard might simply delay the availability of a standard without achieving any net benefit. These standards are of interest to the public sector in the specific country and therefore not as reliant on international cooperation.

2.3 Using the Architecture and Other Activities to Build ITS Standards

To provide visibility into the service options that will be considered by the ITS implementor, a set of *market packages* have been defined. The market packages provide an accessible, service oriented perspective to the national architecture. They

are tailored to fit, separately or in combination, real world transportation problems and needs. They address the specific service requirements of traffic managers, transit operators, travelers, and other ITS stakeholders. The market packages were defined with sufficient granularity to support specific benefits analysis with clear ties to transportation problems.

Several different market packages are defined in each major application area which provides a range of service options at various costs. Market packages are also structured to segregate services that are likely to encounter technical or non-technical challenges from lower risk services. This approach yields a subset of market packages that are likely early deployments. Many of the market packages are also incremental so that more advanced packages can be efficiently implemented by building on common elements that were deployed earlier.

To provide separable sets of data elements for use by standards organizations, a set of *standards packages* has been developed (Appendix 2, Table A2.2). Eleven packages have been defined that cover most near-term applications. Certain interfaces that require standards have been separately identified as either already having existing standards, having proprietary standards, or as part of the Automated Highway System. These packages select specific interfaces from the architecture that have common data elements. For example, map databases and location information are used in multiple places in the architecture. One would expect that they would all conform to the same standard. A standards package focuses on these data elements wherever they appear in the architecture. It is natural that a single standards package may cross over multiple applications and have impact on several different stakeholders.

The standards packages were defined based on input from a standards workshop in Schaumburg, Illinois, 1995. The workshop provided interfaces and messages that were, in their opinion, of highest priority. Therefore, the standards packages define a relatively independent set of activities that are considered high priority. It is anticipated that organizations can develop in parallel, a complete set of ITS standards that will support interoperable applications based on these packages.

2.4 Focusing on Early Deployment

ITS services envisioned as being deployed in the near term have the most immediate need for standards. Specific early deployments supported by the public sector have been identified in Operation timeserver as being the Intelligent Transportation Infrastructure (ITI) deployment for urban areas and Commercial Vehicle Information Systems Network (CVISN) for commercial vehicle credentialing. The ITI elements are presented in Figure 2.4-1. Each ITI element is supported by one or more architecture Market Packages[11]. It is not surprising that each market package spans several standards packages. Figure 2.4-1 provides only the major connections between market packages and standards packages.

[11] . One exception is the Highway-Rail Intersection element that has not as yet been included in the architecture.

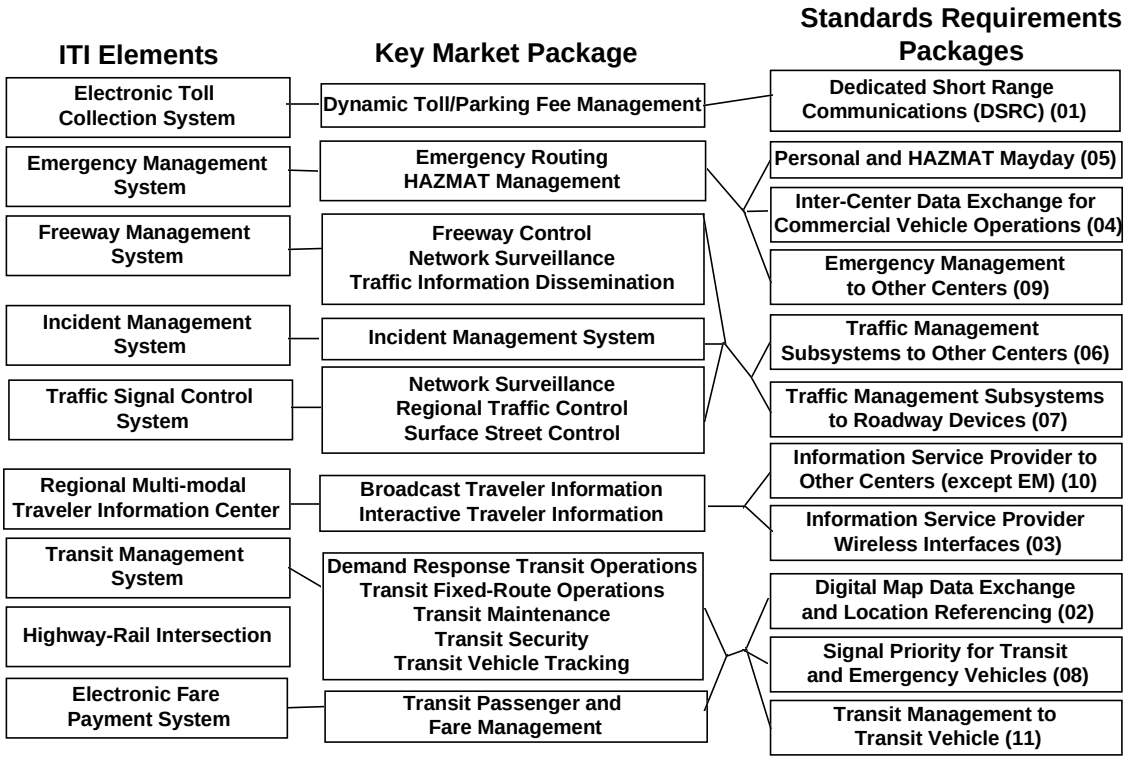

Figure 2.4-1 Mapping of ITI Elements to Standards Packages

Architecture Support for ITI Related Standards

Each of the ITI elements in Figure 2.4-1 maps into one or more National Architecture early market packages (see Implementation Strategy, Chapter 2). Each market package uses one or more architecture flows (as described in the Appendix to the Implementation Strategy). Finally, each flow has been assigned to one or more standards packages. Appendix 2, Table A2.1 shows all of the flows, and standards packages relevant to ITI and other priority deployments.

Efforts to develop standard interfaces do not have to start from scratch. Appendix 1, Table A1.1 contains a catalog developed by ITS America listing many of the standards related to ITS. Those standards that have most immediate and direct bearing on ITS interfaces are provided in Figure 2.4-2. Although these defined standards activities are related and have direct bearing on specific interfaces, they do not as yet map directly into the architecture nor do they fit easily with each other. A continued effort will be required to bring the existing standards, standards under development, and new activities together. The natural mechanism to do this is the National Architecture. The reader is encouraged to browse the table in Appendix 1 for additional relevant activities.

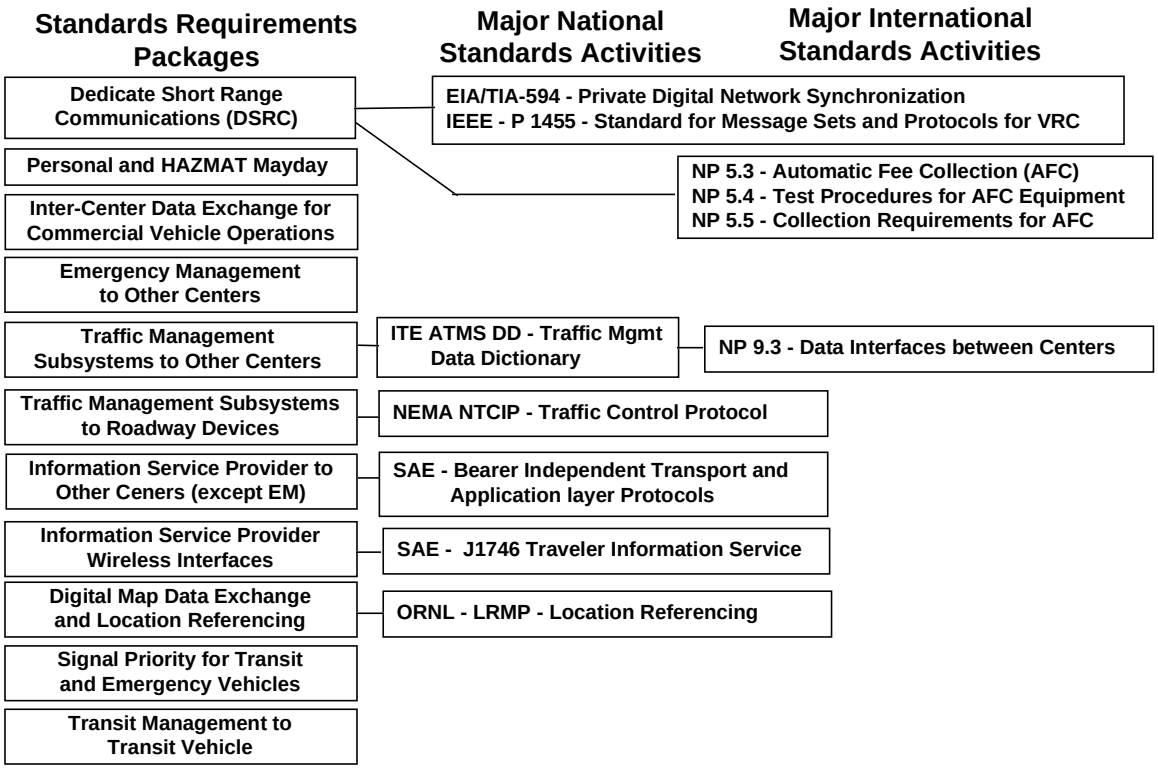

Figure 2.4-2 Major Existing Standards Activities Related to ITI

Requirements for Compliance between the National Architecture and existing standards organizations must be decided by implementors. Some of the standards listed in Appendix 1 are enabling standards. Examples are standards for fiber-optic technology, TCPIP, and cellular radio. In keeping with the National Architecture emphasis on making the maximum use of existing infrastructure, these will be used by implementors in developing their systems. Other standards that are currently under development that are more directly related to data flows and application level information exchange for ITS services will evolve along with the architecture. Examples are those listed in Figure 2.4-2. Although there is not currently a one-to-one mapping between any of these standards and architecture data flows, it is anticipated that standards organizations developing these standards will cooperate with the architecture teams to fit some subsets of messages to the architecture structure.

Specific interface types are addressed to varying degrees by the activities listed in Appendix 1:

Electronic Toll Collection System - This system depends on both standards for the Dedicated Short Range Communications interface (DSRC) as well as ETTM activities. The architecture has recommended that a single DSRC standard be developed to support nationwide interoperability. A single standard would mean users would only have to purchase one tag system to handle all DSRC toll, parking, signing, and credentials applications. The standards requirements document identifies the types of data that would be needed for each of these areas. The

architecture team has not provided a technology or spectrum recommendations. Standards organizations may choose to provide such recommendations.

Regional Multi-modal Traffic Information Center - Several traveler information message standards are currently under development with different areas of specialty. The SAE International Traveler Information Interchange System (ITIIS) Bearer Independent Format (BIF) deals with transport layer issues, the ITIIS Bearer Application Protocol (BAP) deals with network layer issues, while J1756 specifies detailed messages between a vehicle and infrastructure. As with the DSRC, the architecture does not make specific technology recommendations for transmitting traveler information. Standards for FM Radio Protocols (Radio Broadcast Data System RBDS, and a Hi-Speed FM Subcarrier) are either currently available or under construction.

Traffic Control - The current National Traffic Control/ITS Communications Protocol (NTCIP) has a great deal of interest. It deals primarily with interfaces between the Traffic Management Subsystem and the roadway, but may include TMS to Other TMS type interfaces.

Other ITI areas have relatively little substantial standards activity. Specifically, Emergency Management coordination, standards dealing with HAZMAT, and transit are noticeably poorly represented.

Architecture Support for CVISN Standards

The situation is similar with the commercial vehicle operations portion of the architecture. The CVISN elements can be mapped to standards packages and existing standards activities as shown in Figure 2.4-3. The three major standards areas are DSRC, credentials enrollment and screening, and International Border Crossing.

DSRC - This has significant potential overlap with the ITI Toll Collection DSRC activities. It would be desirable to only require one type of transponder on commercial vehicles.

Credentialling - There are two competing standards, the X.12 EDI standard, which is primarily a United States standard, and the EDIFAC standard, that is more international.

Border Crossing - New activity through the North American Trade Automation Prototype, developed by the Information Exchange and Automation Working Group, in consultation with the North American Trade Community, provides guidance to current capabilities, timelines for operational tests, and interested parties.

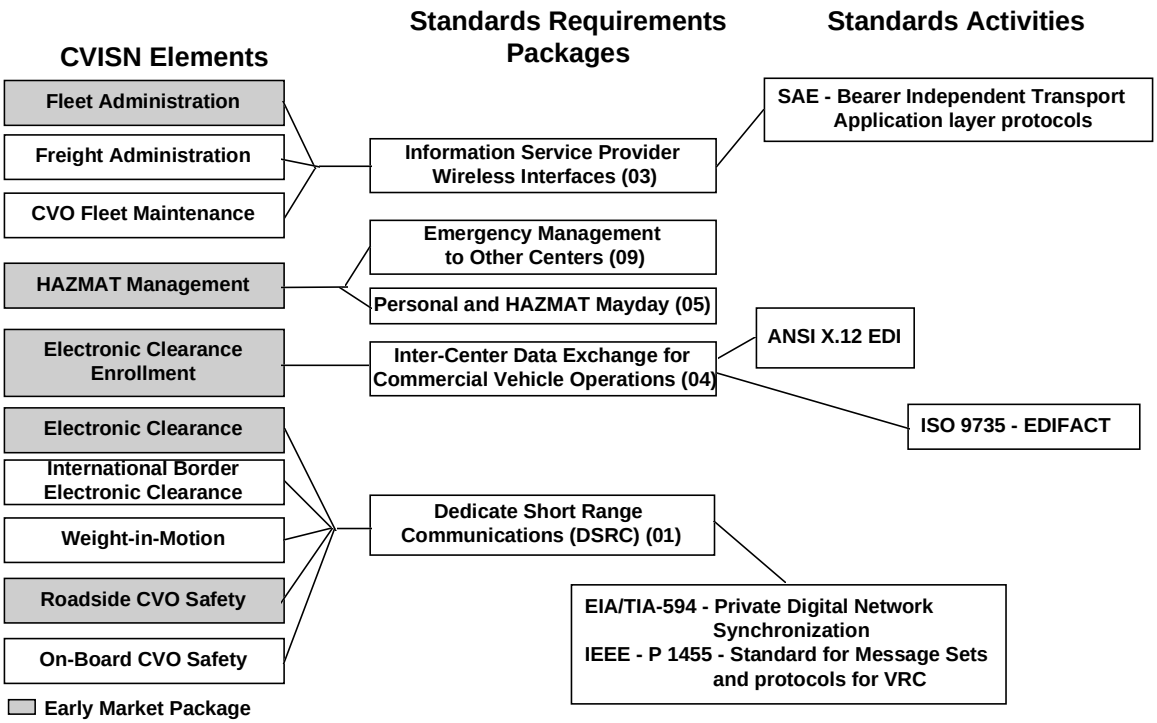

Figure 2.4-3 Major Existing Standards Activities for CVISN

2.5 Priority Standards

Examining Figure 2.4-2, there are several areas where standards organizations have made significant progress in developing standards and there are also areas where there has evidently been less attention paid to developing standards. Because each of the ITI features involves near term deployments, existing standards activities identified in Figure 2.4-2 should be considered priority. Areas with standards packages that have no major standards activity identified may require a little more attention. Figure 2.4-3 tells a similar story for Commercial Vehicle Operations.

Priority for existing activities

Traveler Information (Information Service Provider to other centers) - is currently supported by several activities including ITIIS, BIF, BAP, and J1746. Continued support for these areas is needed to encourage traveler information market packages.

Traffic Control (Traffic Management to Roadway and Traffic Management to other centers) - has a real boost from the NTCIP activity. A large collection of current

data dictionaries used in a number of traffic management implementations has also been distributed.

Digital Short Range Communication (DSRC and priority for transit and emergency vehicles) - The ETTM applications and CVO applications have had a significant level of activity as indicated in the existence of the ISO and IEEE activities cited. Messages for transit and emergency vehicle priority and for in-vehicle signing are not explicitly part of ITI. Messages for intersection collision warning are also not part of ITI.

Map Data Bases and Position Determination - The Oak Ridge LRMP protocol has received a significant amount of attention as has the issue of a map database standard. These are both areas for continued standards consideration.

Commercial Vehicle Operations - The commercial vehicle center to other centers messages have a good basis in the EDI and EDIFAC standards. Additional messages need to be added to support new ITS features.

Priority for New Standards Activities

Emergency Management to other centers - A standard for on-board land-vehicle mayday reporting interface (SAE) is a very new activity that may include emergency-emergency center interfaces. (Feb. 1, 1996 - draft). National emergency number association should also be consulted.

Mayday - Although Mayday is not a formal part of ITI, it is certainly a early market package. The above SAE activity also addresses Mayday along with Emergency Management to other centers messages.

Transit - Although there are some standards activities in Europe that could be applicable, they have not as yet made a significant positive impact in the U. S.

HazMat - This appears to be a new area for standards activity crucial to both CVISN and ITI.

2.6 How do We Get Started Using the National Architecture Products?

The architecture products contain a wealth of information about ITS data elements and their interfaces. The architecture organizes functions into subsystems to simplify the interfaces under consideration. But looking at an architecture diagram, one can see that eventually, every box is connected either directly or indirectly to every other box. How does one define where to begin defining standard messages if there is so much overlap?

A rational approach is to lay down a specific set of criteria to simplify the job. The architecture development program has done a lot of this work already. The standards developers should be able to utilize the organizational efforts already documented in getting started.

1. Identify all of the important pieces - Identify those things that are worth working on. The architecture provides a large collection of data elements in the logical architecture. Those that are exchanged between subsystems are brought forward through the physical architecture. Those data that are passed between subsystems are expected to be the elements that make systems interoperable.

2. Divide the work into pieces that are as independent as possible - Make it easy to distribute the work to multiple organizations so that it can later be reassembled into a coherent product. This was done in development of standards packages, each of which is relatively independent.

3. Prioritize the areas based on urgency and need - Every group has its own list of priorities. However, several groups of stakeholders have identified early deployment areas that depend to varying degrees on standards.

4. Identify existing standards work in progress or completed - A standards catalog was developed by ITS America and has been mapped to the architecture features.

Standards Organizations should be able to sort through the national architecture documentation to extract information they need by following a set of steps:

1) Pick a Standards Package
   - Pick a package related to SDO Expertise (e.g. Traffic Management to Roadway Devices).
2) Identify Existing Activities
   - Identify existing standards activities that may have already done some of the work (e.g., NTCIP). (Appendix 1 and Figure 2.4-2, 2.4-3 of Standards Development Plan).
3) See What the Architecture Says about Interfaces in the Standards Package.
   - Examine the Standards Requirements Document message sets and interfaces. The SRD provides all of the messages for a given package to support all 29 User Services.
4) Prioritize Interfaces and Data Flows
   - Select data flows for initial study that are part of an early deployment (e.g. ITI or CVISN) (Refer to Appendix 2, Standards Development Plan) (vehicle probe data, for example, is a data flow between the roadway and TMC but is not in ITI.) The SRD provides operational description of subsets of data flows.
   - Develop workplan for complete set of messages (including both early and future message sets).
5) Construct a Message Set.
   - For this priority set of messages, focus on the information content of the dictionary entries rather than the specific structure.
6) Apply SDO Expert Domain Knowledge.
   - Evaluate the impact of sending these messages over alternative technologies. Apply appropriate protocols.
7) Coordinate with Other SDO Organizations.
   - Coordinate with other standards package development activities as indicated in the Standards Requirements Document cross references.
8) Publish for Review and Consensus
   - One good method is to include the message set in a revision of the Standards Requirements Document

3. STANDARDS DEVELOPMENT AND NATIONAL ARCHITECTURE

3.1 ITS America Standards Efforts

3.1.1 ITS America Standards and Protocol Policy

In 1995, ITS America formed a Standards Policy Task Force to make recommendations for a Standards and Protocol Policy. The Task Force examined at length the possible advantages of ITS America becoming a full-fledged standards developing organization (SDO) as a means of accelerating the development and implementation of ITS standards. The Task Force determined that progress is being made in the development of ITS Standards under the current practice of leaving standards writing to traditional SDOs (e.g., SAE, IEEE, ASTM, ITE, NEMA, TIA, etc.), with ITS America serving as broker and coordinator. Accordingly, the task force felt it was unnecessary for ITS America to become an SDO. However, the task force recommended several actions and policies be implemented to expedite the process of standards development.

On August 15, 1995, the ITS America Board of Directors approved the ITS America Standards Policy, formalizing a framework for ITS America to become more active in coordinating and accelerating the ITS standards development policy. The policy states:

> 1) The U. S. Department of Transportation should, where appropriate, accelerated ITS standards development by (a) continuing to be an active participant in the process; (b) funding research and draft standards writing resources during the development of both user requirements and standards; (c) requesting and funding the participation of state, regional and local agencies; (d) defraying costs of representing the United States in international standards forums; and (e) working with ITS America and the SDOs to develop priority standards needs and plans for accelerating development of high priority consensus standards, building on the emerging architecture.
>
> 2) ITS America shall identify requirements, promote development and encourage the use of ITS-related standards.
>
> 3) Standards-related activities shall continue to be conducted in a manner that is fair, open, and inclusive.
>
> 4) ITS America shall support U. S. participation in international standards by continuing to serve as the U. S. Technical Advisory Group Administrator of International Standards Organization Technical Committee 204 (Transport Information and Control Systems).
>
> 5) ITS America shall recognize and promote appropriate standards emerging from ITS relevant standards development organizations.

6) ITS America shall expand the function of the Council of Standards Organizations (CSO) to provide liaison on standards issues to the ITS Architecture Development Program, field operational tests and deployment activities.

7) ITS America shall facilitate balanced representation in the development of standards requirements.

3.1.2 Plan for Creating Standards Requirements

In conjunction with the development of the ITS America Standards and Protocol Policy, the ITS America Standards and Protocols Committee started to develop the necessary procedures to quickly implement the policy and provide necessary direction and assistance to the traditional standards developing organizations. A Standards and Protocols White-Paper Task Force was organized to develop the Process for Creating Standards Requirements:

1. Identify Needs. Based on inputs from its members, other ITS America Technical Committees, other ITS stakeholders, and the National ITS System Architecture program, the S&P (ITS America Standards and Protocols Committee) recognizes and documents the need for an ITS standard. In the medium term, this identification and documentation will be systematized through the evolving Standards and Protocols Catalog, which will contain, among other things, the then-current vision of a multi-year program of ITS standards development. The Catalog will also help recognize situations in which an ITS standard need has already been met, in whole or in part, by existing standards. S&P acknowledges the importance of a wide range of sources as well as the fact that the membership of standards subcommittees and task forces will come from the ranks of this diverse ITS community

2 Requirements Drafting Subcommittee. The Subcommittee will typically be formed by S&P, in cooperation with and drawing membership from interested ITS America committees and other parties. In some cases, the Requirements Drafting Subcommittee will be formed by another Technical Committee of ITS America, with notification to the S&P Chair and support from S&P as requested.

The subcommittee may be limited to a well-defined set of "users" in cases where the purpose of the Subcommittee is to define the particular requirements of these users. More than one such subcommittee is possible where multiple well-defined user groups exist. If so, S&P will strive to harmonize and coordinate the results of these groups. In any case, such a user group is still expected to circulate its interim results, and seek and incorporate comments, from the larger ITS community.

A plan for developing the Requirements Statement is defined by the Subcommittee and reviewed by the Chair and Steering Committee of S&P (and of the initiating committee, if other than S&P).

3. Coordination and Policy Issues. S&P informs the Coordinating Council of newly formed Requirements Drafting Subcommittees and their development plans via S&P periodic Status Reports. S&P will request that the Coordinating Council review and approve particular development plans at the Council's next meeting. If a standards area appears to have particular policy implications for ITS America, the S&P Chair promptly informs the Chairs of the Coordinating Council, affected Technical Committees, and the Board of Directors, regardless of Status Report timing. To assure timeliness, Subcommittee work proceeds in parallel with this review and approval process, but adapts as necessary to the guidance received from it.

4. Draft Requirements. The Subcommittee drafts the statement of requirements in accordance with the approved plan. ITS America staff monitors the requirements development process for progress and conformance with the plan. The S&P Chair reports regularly on progress to the Coordinating Council.

5. Circulate/Refine/Finalize Draft. The Draft Requirements Statement is circulated to interested parties, including S&P, for comment. The Subcommittee refines the Requirements Statement incorporating the comments received. The comment/refinement cycle may repeat several times. On its completion, the Subcommittee will prepare a final draft reflecting consensus among the membership. In general, at least a 70% affirmative vote of the Subcommittee is required to evidence consensus.

6. Solicit SDO Interest. The Subcommittee, in coordination with S&P's Council of Standards Organizations, solicits the interest of appropriate SDOs for developing standards responsive to the requirements. For the sake of timeliness, this generally occurs before the requirements are finalized. ITS America staff assists in establishing the liaison with SDOs for developing the proposed standards.

7. Seek Approval. The S&P Chair provides information copies of the Requirements Statement and a synopsis of the process followed to the Chairs of the Coordinating Council and Board of Directors and to the Executive Director. The S&P Chair will ask the Coordinating Council to approve the Requirements Statement, signifying the Council's agreement that the process, previously approved, has been properly followed.

8. Transmit Requirements to SDO. Following this approval, the Executive Director transmits the Requirements Statement to the SDOs.

9. Monitor Progress. S&P will request status from the SDOs on the progress of standards development, will be available for consultation and support, and will make suggestions as appropriate. S&P will note progress on standards development in the S&P Catalog, which will be available through ITS Americas Clearing house.

10. Recognize Standards. S&P will recognize ITS Standards and assist in their promulgation, in part by incorporating them into the evolving S&P Catalog. There will be variations on this process depending on circumstances. For example, some activities of the National ITS System Architecture program may result directly in the creation of fairly detailed standards requirements statements. Where these requirement statements come already reviewed and refined in cooperation with the larger community, they could proceed directly to considerations by SDOs. In other cases, where some review and refinement of requirements is still needed, an abbreviated version of the outlined process can be followed.

3.2 Standards Development Organizations and the Development Process

The following is an example process for how a Standards Development Organization (SDO) creates a standard. This applies to the publicly reviewed consensus-based voluntary standards most common in industry. It is loosely based on an amalgam of several SDOs' processes and is purposely simplified. The following are the main steps in standardization (keep in mind that there is a fair amount of iteration within and between these steps):

1. An individual or group brings to the attention of an SDO committee the need for a standard and submits a proposal for that standard.

2. The SDO committee discusses the proposal and holds a vote to assess interest among the membership.

3. If there is interest, the SDO committee seeks volunteers to form a working group to draft the standard.

4. If needed, subject matter experts outside of the SDO committee are sought to participate in the working group. These experts typically come from professional organizations such as the Society of Mechanical Engineers (SME), Society of Automotive Engineers (SAE), or Institute of Electrical and Electronics Engineers (IEEE).

5. The working group establishes a schedule for the drafting process.

6. The working group begins to develop the draft standard, considering *all* contributions and subjecting all decisions to the parent SDO's consensus requirements.

7. The SDO committee reviews the draft.

8. When a satisfactory draft is available, it is released for a formal public request-for-comment (RFC) period.

9. The working group resolves all formally submitted comments to create a final draft.

10. The SDO committee reviews and votes on the final draft.

11. If approved, the final draft is submitted to the SDO executive committee for approval as a standard.

12. The SDO issues the standard.

It should be emphasized that whatever group is to vote on the standard, whether it be the SDO committee or a separately formed balloting committee, the group should have a balance of interests; for example, producer, user and general interest. Neither of the first two should constitute more than 50% of the votes.

As the standard is developed, it is iterated through a series of reviews. In general, the early reviews are intended to ensure technical adequacy. Those later in the process are oriented towards ensuring that the process itself was followed and all contributions were adequately considered.

The time required for the development of a voluntary standard is directly related to the interest in the standard, the complexity of the issues, and the number and range of contentious viewpoints that must be considered in the process. Time estimates range from a minimum of 18 months, for carefully scoped standards in well-defined areas, to five years for complex standards in highly contentious areas with potentially large markets. Many standards considered for ITS will tend towards the upper end of this range.

In terms of cumulative man-hours of effort, steps 1-5 are probably 10% of the effort, step 6 is 60%, and the remaining steps 7-12 are 30% of the effort. However, because of the nature of the process (lots of people on the committee, few people in the drafting subcommittee, long comment periods for the public), the breakdown of elapsed time is probably more like 1%-80%-19%. These rough allocations will vary widely for individual standards.

In some cases, particularly where an industry member of an SDO has a technology they wish to establish as a standard, this process can be accelerated. The particular company may develop essentially a draft standard on their own, performing steps 1-5. This is then brought before the SDO committee as a “contribution" (in standards parlance, any written submission to a standards drafting effort is referred to as a contribution). At this point, the standard SDO consensus and voting process would take over, but the company is still likely to support the remaining steps (probably by doing all the subcommittee grunt work), to expedite the effort. Even in the most optimistic scenario, it is unlikely that a standard can be developed and approved in less than one year.

It should be emphasized that the structure of the standards drafting process is put in place to insure fairness. All are entitled to comment on the work and all submitted comments must be considered. Therefore it is difficult for a single company to create a national or international standard, unless they can build a broad industry consensus to support them.

3.3 How the National Architecture Supports the Process

The National Architecture products have the potential to streamline the outlined process to something midway between the full twelve step process and the full draft contribution-based scenario. The standards requirements from the Architecture will cover steps 1-5 and provide an “outline" of the draft for step 6. The drafting subcommittee will still need to make the consensus-based decisions on how the detailed implementation meets the requirements. If people involved with the Architecture program can be made available as subject matter experts, that may also expedite step 6. Again, an important issue is insuring that there is sufficient SDO member interest to ensure that steps 2-6 (discuss proposal and hold a vote, seek volunteers to create a draft, enlist outside experts, establish schedule, and develop the draft) are successfully passed and that steps 7-12 (final standard approval) occur.

The products from the National Architecture are intended to support the development of better standards in an expedited manner. It is hoped that these standards will in turn stimulate public and private sector interest in ITS, by creating a perception of lowered deployment risk and better protection of investments.

The Architecture can support better standards because it has planned a system that covers a full 29 user services (as described in the National Program Plan) over a twenty year timeframe. Taking a rigorous system engineering perspective in this process is a luxury few standards efforts would be able to afford. As a result, the Architecture provides a snapshot of a total system in its standards requirements, and not just a piece of the picture. Given this data, a committee developing a standard might not choose to address all the requirements, but at least they would understand all that had bearing on their task and the implications of their actions.

As an example, a standard to support communications between a Traffic Management Center (TMC) and a field controller might neglect an expansion capability to provide status on railroad crossings or communication with beacons for transit signal priority, if the standards developers were not aware of a long term need for these capabilities. By pointing out the need and the benefits of addressing additional requirements, the Architecture can help produce a standard that will allow a standards-compliant TMC to be upgraded easily over time.

The second benefit, that the Architecture can expedite the standards process, is based on the stimulus the standards requirements can give to the standardization process. Because standards committees are primarily populated by industry volunteers, it is difficult to get the first piece of work done that creates a strawman draft. Once that draft is created, however, it is usually easier to find committee members willing to work on the review and tuning process. The standards requirements generated by the Architecture provide a framework for developing a draft, as well as some of the specific information required for the draft. This is a substantial boost to the process. If there is genuine industry interest in a specific

standard, then the standards requirements information will help get a draft formulated and circulating much more quickly.

As shown in Figure 3.2-1, this Standards Development Plan, and the companion Standards Requirements Document, may be viewed as the culmination of the technical effort for the National Architecture program. The Standards Development Plan follows, and supports, the Implementation Strategy. It presents a plan for developing standards based on the Standards Requirements Document. The Standards Requirements Document prioritizes standards and provides the most detailed view of the standard interface requirements generated as part of the National Architecture effort. This Standards Development Plan describes a plan for utilizing these standards requirements in development of standards and other activities intended to expedite the development of good standards for ITS.

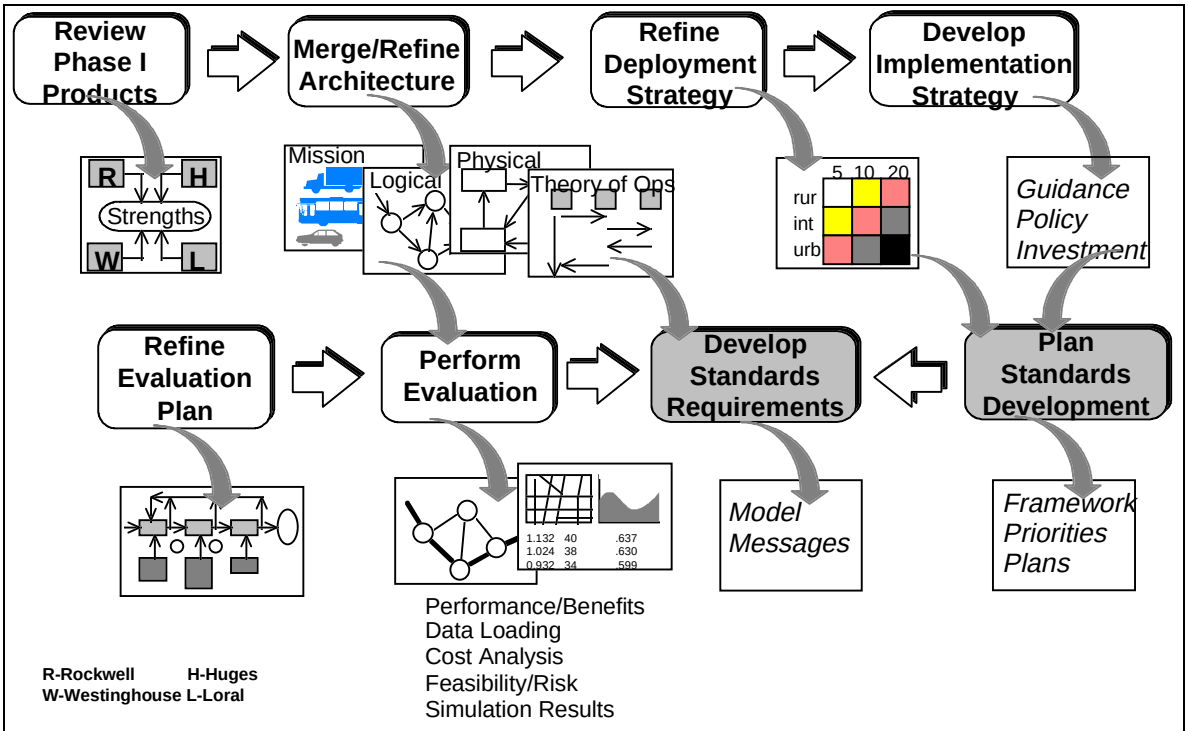

Figure 3.2-1: Architecture Products and Standards Development

3.4 Standards Requirements

A standards requirement, in the context of the Architecture program, is the "Statement of a need that should be reflected in the final standard".

3.4.1 Constructing a Standards Requirements Package

The intent of creating a Standards Requirements Package is to facilitate efforts to standardize some subset of the National ITS Architecture. The "packaging" process involves abstracting and reorganizing information from other documents, primarily

the Logical and Physical Architectures. We have gone through a number of iterations to try and achieve a format that is understandable and useful for SDO's. In the end, while there is not a universal consensus, we have tried to address the substance of most of the comments received.

The Standards Requirements package has four main components:

- General introduction to the scope and intent of this package
- Decomposition of the interfaces
- Message transaction sets
- Data dictionary element (DDE) definitions and sizes

General introduction: This is self explanatory, scope and intent of the standards requirements package.

Introduction Specific description regarding the appropriate standards requirements package (e.g. specific content of the ISP Wireless package)

Message Transaction Sets: In order to accomplish a given activity, a series of messages usually have to be exchanged between two or more subsystems. These messages, as a group, constitute a message transaction set. The sequence of the messages is shown via an ISO-style message sequence chart. Typically the highest level logical architecture data flows represent individual messages.

Interface Decomposition This is the hierarchy of items that constitute an interface. It starts with the interface between two subsystems, which is then decomposed into physical architecture flows. Each of the physical architecture flows is then decomposed into its constituent logical architecture data flows, which in turn are decomposed until we reach primitive data elements. The physical architecture data flows are labeled with the type of communications technology appropriate for that flow. Figure 3.4.1-1 shows an example of an interface decomposition.

Communications Layer Requirements Discussion of the types of communication technologies required to support the interface transaction sets.

Constraints Assessment of special constraints that may be required for special transaction over and above those provided by a commercial communications carrier.

Data Dictionary Elements: Abstracts that describe the composite and primitive logical architecture data elements. This is a brief description of each data item and its use. For a more in depth examination of a data flow and the functions that use it, it is necessary to refer to the logical architecture documentation.

In some cases the Architecture can provide similar detail to that found in a standards draft. However, information at the standards-draft level of detail in the Architecture should probably be considered as an example implementation. Typically this information has been reviewed and evaluated to determine that it is realistic enough to support the data loading analyses, but not to ensure that it is the

optimal technical approach. Additional options may need to be evaluated by the SDO in order to create a definitive standard.

TRMS --> RTS (Subsystem to Subsystem Interface)
transit and fare schedule W (Physical Architecture Data Flow)
Specification schedules from transit management (Description of Physical Architecture Data Flow)

(1) confirm_roadside_fare_payment (Logical Architecture Data Flow)
(2) confirmation_flag
(1) other_services_roadside_response
(2) credit_identify
(2) other_services_data
(2) traveler_indentify
(1) request_transit_user_image
(1) transit_roadside_fare_data (Logical Architecture Data Flow Decomposition Level; the indent and increasing numeric value indicate finer levels of decomposition of a given Data Flow)
(2) transit_fares
(3) transit_route_number
(3) transit_route_segment_cost
(3) transit_route_segment_list
(3) transit_route_segment_number
(3) transit_route_use_time
(3) transit_route_category
(1) transit_roadside_fare_payment_debited
(2) confirmation_flag
(1) transit_roadside_fare_payment_request
(2) transit_fare
(1) transit_services_for_kiosks
(2) kiosks_identify
(2) transit_services
(1) transit_services_for_roadside_fares
(1) transit_services_for_travelers
(2) transit_services
(2) traveler_identify
(1) transit_vehicle_arrival_time

RTS --> TRMS
transit requests **W** **(**Communications link designation for the Physical Architecture Data Flow - in this case, W is for wireline)
Request for special transit routing real-time schedule information, availability information
(1) fare_collection_roadside_violation_information
(2) transit_route_number
(2) transit_route_segment_number
(2) transit_user_roadside_image
(2) transit_user_roadside_tag_identity
(3) credit_identity
(3) traveler_indentity
(1) request_roadside_fare_payment

- - - -

Figure 3.4.1-1 Parts of an Interface Decomposition

4. STANDARDS IMPLEMENTATION ACTIVITIES

This section considers public sector activities that can be undertaken to enable achievement of national interoperability and compatibility goals through development of appropriate standards for ITS. Recognizing that reaching these goals extends beyond standards development, the Implementation Strategy addresses activities that: 1) Encourage beneficial adoption of standards by stakeholders, 2) Enable stakeholders to assess compatibility, and 3) Maintain the national architecture. Refer to the Implementation Strategy for this material.

The most apparent and near-term activity that is supported by the National Architecture is subsequent development of the identified priority standards. In this regard, the United States Department of Transportation (US DOT) has already performed a series of steps intended to expedite this effort. A solicitation entitled "ITS Standards Development" (DTFH61-96-R-00004) was issued and multiple contracts (five) awarded to facilitate the standards development effort. Figure 4.1-1 illustrates the structure of that standards development effort.

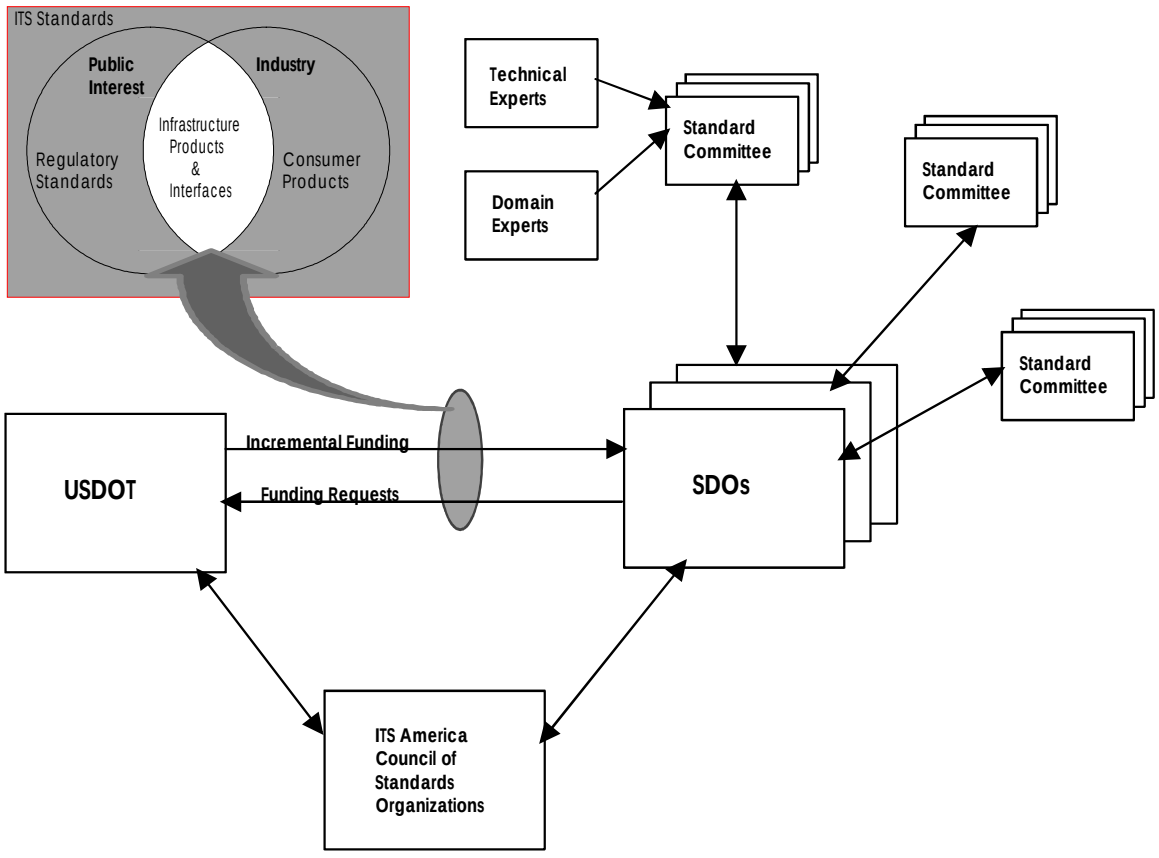

Figure 4.1-1 ITS Standards Development (Draft Solicitation Structure Overview)

This section is intended to complement the existing plan of action described in the draft solicitation with emphasis on the national architecture products and their

most appropriate application in supporting ITS standards development. The net impact of the planned solicitation on standards development can be considered as yielding the three primary benefits highlighted in the following outline .

- Promote a National Strategy
  - Prioritize standards efforts *
  - Coordinate Between National Standards Efforts *
  - Coordinate between National and International Standards Efforts
  - Coordinate with R&D, Operational Tests, and Early Deployments
- Expedite Standards Development
  - Develop initial draft standards *
  - Assess consistency with architecture requirements *
  - Support test and evaluation support
- Encourage Participation to Improve Standard Quality and Relevance
  - Facilitate participation by technical experts
  - Enable local agency participation

Rather than repeat the tasks descriptions and plans included in the draft solicitation, those tasks, with specific implications for the national architecture (designated with "*" above), are addressed in the following paragraphs.

4.1 National Strategy

The Federal Highway Administration's (FHWA) plan to facilitate ITS standards development directly through provision of multiple task order contracts provides the US DOT direct influence that helps to ensure priority standards are expedited and concurrent, inter-related standards development efforts are coordinated. Together, these efforts extend a national strategy from the architecture to standards development. This section highlights the ways in which the national architecture supports this process.

Prioritize Standards Efforts

The national architecture is unique in its wide spread functional scope and its national deployment perspective. One measure of standards priority is the near term deployments planned by FHWA. Appendix 2 summarizes the architecture flows needed to implement the near term deployments for infrasturcture (ITI), CVO (CVISN) and for in-vehicle (Other). Those flows assigned to the Early category are the flows that standards activities can begin with. Another comprehensive assessment of priority interfaces across multiple disciplines was collected from Standards Development Workshop breakout groups hosted by ITS America in June 1995. Appendix 3, Table A3.1 lists standards needs areas, and the standards packages affected. These packages have been previously discussed and are documented in Appendix 2, Table A2.2.

As can be seen from the table, these priority standards are currently receiving different levels of attention from the standards community. As suggested in the

draft solicitation, relatively higher emphasis can be placed on encouraging development of the standards of predominately public sector interest. Private sector standards can and should be left primarily to industry based on their perspective on the need for standards.

The Implementation Strategy discusses the issues involved in implementing standards. Specifically, that document addresses the dependencies of market packages on other market packages, technology, standards development, and other items. Because the existence of standards and compliance with standards ultimately results in benefits for implementors, the Implementation Strategy contains tables of detailed benefits that can be expected for each stakeholder.

Coordination Between Standards Efforts

As the number of interrelated ITS standards developments increases, the potential for disconnects also increases. The National Architecture is a framework that spans the individual standards efforts providing a common reference to improve consistency between these concurrent efforts.

Fortunately, the National Architecture framework is not uniformly connected. The framework that has evolved is actually composed of several loosely coupled subarchitectures. Within each of these subarchitectures, the interactions are strongly interlinked and coordination is very important. Between subarchitectures, however, there is a reduced number of interactions which makes changes in one subarchitecture largely transparent to the remaining portions of the national model.

Closely related standards, i.e. those within a common application area, should be addressed by a single committee or a closely coordinated set of committees, since many of the committee decisions will be interconnected and must be coordinated with respect to potential impacts to associated standards. This will improve the integrity of the final set of standards without continuous national-level monitoring. Common allocation of the most closely related efforts may be a natural by-product of the tendency for the same organizations to work areas of common interest that require common expertise.

4.2 Technical Support

As described in Section 3, one of the key steps in the development of consensus standards is in development of an initial draft standard. The National Architecture directly supports this effort for the designated priority standards in the Standards Requirements Document (SRD). For those areas not specifically covered in the SRD, the Physical and Logical Architecture deliverables serve as alternative sources for initial standards requirements. Specifically, the data dictionaries contained in these two documents provide initial definitions of all flows required to support all 29 user services. This information can be used by the ITS Standards Development contractors as initial inputs supporting development of draft standards for those areas not covered by the SRD.

Appendix 1 - Standards Catalog[12]

Table A1.1 ITS America Catalog40

Number	Title		
	Association User	Applications	Projected Completion Date Status
	Abstract		

ITIIS Bearer Application Protocol (BAP)

Society of Automotive Engineers		Dec 1995
Communications	ATIS, APTS, other	Draft

Network level protocol for International Travelers Information Interchange System (ITIIS) message transmission by a specified communications system. Each communications system would use a separate network application protocol.

Recommended Practice for Location Reference System.

Society of Automotive Engineers		Dec 1995
Navigation	ATIS, APTS, CVO, Vehicles	Proposed

Recommended practice for a Geodetic location reference system for spatial data transfer between different digital map databases.

ITIIS Bearer Independent Format (BIF) Protocol

Society of Automotive Engineers		Dec 1995
Communications	ATIS, APTS others	Draft

Transport layer message protocols, formats and contents for transmission of traffic data from traffic management/information center to vehicle, traveler or driver.

Preliminary Human Factors Guidelines for Crash Avoidance Warning Devices

COMSIS CORP		1995
Human Factors	Vehicles	Draft

Provides preliminary NHTSA guidelines to cover human factors aspects of in-vehicle crash avoidance devices. Both generic and device specific guidelines.

Traffic Signal Communication Protocol

CALTRANS		Complete
Traffic Control	ATMS	Approved

Asynchronous communications protocol for model 170 controller.

Information Report, 9 1 1 Message List

[12] This catalog is a complete copy of Catalog40 dated March 1996. The catalog was produced by JPL for ITS America.

Society of Automotive Engineers 1995
Communications ATIS, ATMS, APTS, ARTS Proposed

Message list for cellular telephone 9 1 1 calls. Appropriate for two-way signaling using very short tone bursts. May be part of mayday protocol. Companion to Jxxxx.

ITIIS Data Dictionary

Society of Automotive Engineers Dec 1995
Traveler Information ATIS Proposed

Data dictionary for International Travelers Information Interchange System (ITIIS) message list.

Advanced Traffic Signal Controller

CALTRANS Unknown
Traffic Control ATMS Draft

Specifications for a general purpose control computer designed for complex transportation applications. Includes advanced traffic control software specification.

R. P. for Traveler Information System (TIS) Data Dictionary.

Society of Automotive Engineers UNK
Traveler Information ATIS, APTS, CVO, ARTS, ATMS, etc Proposed

Data dictionary for the overall Intelligent transportation System (ITS) traveler information system message list. To be at the bit level detail. Companion to J1746.

Specification and performance requirements for connectors and wiring on non-drive train Transit applications of SAE J1708

Society of Automotive Engineers 1996
Vehicle Area Network APTS, Vehicles Draft

Standardized wiring plan and connector standard for all devices proposed for installation on transit revenue vehicles for universal power and signal wiring.

AIAA/ANSI G-035 Guide for Human Performance Measurement

American Institute of Aeronautics and Astronautics Complete
Human Factors ATMS, Vehicles Approved

Methods for measuring human performance for the purpose of scientific research and system evaluation.

ANSI D20.1 State's Model Motorist Data Base: Data Element Dictionary

American National Standards Institute Complete
Architecture All Approved

ANSI TI.105-88 Digital hierarchy optical interface.

American National Standards Institute Complete
Communications ATMS Approved

ANSI TI.206-88 Digital Circuits.

American National Standards Institute Complete
Computers ATMS Approved

Digital circuit requirements and standards.

ANSI TI.401-88 **Interfaces to analog switched access.**

American National Standards Institute		Complete
Interface	ATMS	Approved

ANSI TI.407-90 **Interfaces, analog special access.**

American National Standards Institute		Complete
Interface	ATMS	Approved

ANSI X3.135 **Structured Query Language.**

American National Standards Institute		Complete
Database Queries	ATIS, ATMS, APTS, CVO.	Approved

Structured Query Language is a standardized set of commands for accessing and updating databases.

ANSI X3.17 **Optical Character Recognition Equipment (OCRE).**

American National Standards Institute		Complete
Data Input	ATMS, ATIS	Approved

Optical character recognition characters and equipment.

ANSI X3.4 **American National Standard Code for Information Interchange (ASCII).**

American National Standards Institute		Complete
Computers	ATMS, ATIS, APTS, ARTS, CVO	Approved

Computer eight bit code for 256 character set of printing and control characters. (See FIPS-1)

ANSI/IEEE 1003.1 **Portable Operating System Interface (POSIX) for Computer Environments**

Institute of Electrical and Electronics Engineers		Complete
Operating System	ATIS, ATMS, APTS.	Approved

Standard for UNIX. Compatible with multiple, different computer hardware systems.

ASTM E-1318-90 **Standard Specification for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Method.**

American Society for Test and Materials		Complete
Weigh In Motion	ATMS. CVO	Approved

Highway weigh in motion.

ASTM Exx.xx Communications **Standard for Dedicated, Short Range Two-Way Vehicle to Roadside Equipment**

American Society for Test and Materials		1995
Communications	ATMS, ETC, Vehicles, APTS	Draft

Draft standard and protocol for beacon to vehicle and return communications.

C95.1-1992 **Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHZ to 300 GHz.**

Joint ANSI/IEEE		Nov 1992
Communications	ATIS, APTS, CVO, ATMS	Approved

Standard specifies maximum power densities tolerable in a 30 minute time period.

CAN **Controller Area Network**

Bosch/Phillips Components/Intel		Complete
Vehicle Area Network	Vehicles	Approved

Proprietary open standard for automotive network. Chips available from Motorola, Intel, etc. Used chiefly in Europe for automobiles and lorries. High cost of application? Also ISO 11898.

CEN GDF **Geographic Data File.**

Committee for European Normalisation		Complete
Digital Maps	ATIS, ATMS, APTS, CVO.	Approved

Geographic data file structure and transfer standard for European geographic digital maps.

Circular 412 **Intelligent Vehicle-Highway System (IVHS) Primer**

Transportation Research Board		Complete
Architecture	All	Approved

The primer is a dictionary of IVHS terms and acronyms and a compendium of IVHS operation and test systems. Additionally provides information on system and component design.

CMS **Specifications for Changeable Message Sign System.**

CALTRANS		Complete
Traffic Control	ATMS, ATIS, APTS	Approved

CSS 7 **CCITT Specification for Signaling System 7**

Consultative Committee for International Telegraph and Telephone		1984
Communications	ATIS	Approved

A common-channel signalling system, using packet switching and tailored to the ISO OSI, provides data-handling referred to as Integrated Service Data Network - includes layers 4 to 7 of the OSI model.

DANA **IVHS Location Referencing System: Dynamic Assignment of Network Attributes Specification.**

Oak Ridge National Laboratory		Unknown
Navigation	ATMS, ATIS, APTS, CVO, ARTS	Draft

Draft Version B of a proposed Intelligent Transportation System (ITS) Location Reference System.

DoD 5200.28-STD **Department of Defense Trusted Computer System Evaluation Criteria (TCSEC)**

United States Department of Defense		Dec 1985
Security	APTS, ATMS, ETC, CVO	Approved

Defines the basic security features of a trusted computer system and the assurance levels required for protecting information. Various levels and complexities of computer security and

protection of information are discussed in detail.

EIA-170 **Electrical Performance Standards for Monochrome Television Studio Facilities.**

Telecommunications Industry Association — Nov. 1957
Television — ATIS, ATMS. — Approved
Basic standard for black and white 525 line television.

EIA-210 **Terminating and Signaling Equipment for Microwave Communication Systems, Part 1: Telephone Equipment.**

Telecommunications Industry Association — August 1958
Communications — ATMS — Approved
Standards included for terminating and signaling equipment to be used in telephone service.

EIA-310-D **Cabinets, Racks, Panels, and Associated Equipment.**

Electronics Industries Association — Sept. 1992
Equipment Design — ATMS — Approved
Overall design requirements for Cabinets, Panels, Racks and Subracks.

EIA-330 **Electrical Performance Standards for Closed Circuit Television Camera 525/60 Interlaced 2:1.**

Electronics Industries Association — Nov. 1966
Television — ATMS, APTS — Approved
Basic TV Camera, 525 lines per screen, 60 frames per second, two scans per frame.

EIA-336 **Color Coding for Chassis Wiring.**

Electronics Industries Association — April 1967
Equipment Design — ATMS — Approved
Standard for wiring color codes inside a chassis.

EIA-352 **One-Half-Inch (12.7mm) Magnetic Tape Reel for Computer Use (Requirements for Interchange).**

Electronics Industries Association — April 1968
Computers — ATMS — Approved

EIA-363 **Standard for Specifying Signal Quality of Transmitting and Receiving Data Processing Terminal Equipment using Serial Data Transmission at the interface with Non- synchronou**

Telecommunications Industry Association — May 1969
Data Interchange — ATMS — Approved
Standard for specifying signal quality of transmitting and receiving data processing terminal equipment using serial data transmission at the interface with non synchronous data communication equipment.

EIA-366-A **Interface Between Data Terminal Equipment and Automatic Calling Equipment for Data Communication.**

Telecommunications Industry Association — March 1979
Data Interchange — ATMS — Approved
Defines electrical signal characteristics, interface mechanical characteristics, functional descriptions of interchange circuits, standard interfaces, and includes recommendations and explanatory notes.

EIA-385 **Preferred Values**

Electronics Industries Association — Dec. 1970
Equipment Design — ATMS — Approved
Establishes six series of numbers which may be used as preferred values in the design of electronic equipment, systems, or components.

EIA-404-A **Standard for Start-Stop Signal Quality for Non-Synchronous Data Terminal Equipment.**

Telecommunications Industry Association — Jan. 1986
Data Interchange — ATMS — Approved
Specifies the quality of serial binary data signals employing start-stop (asynchronous) format at a data terminal equipment interface.

EIA-423-A **Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits**

Telecommunications Industry Association — Dec 1978
Data Interchange — ATMS — Approved
Standard for parallel unbalanced data transfer.

EIA-439 **Engineering Specifications Format for Color CCTV Camera Equipment**

Electronics Industries Association — Nov. 1976
Communications — ATMS, APTS — Approved
List the electrical, mechanical, and environmental specifications which should be provided for color CCTV equipment.

EIA-440-A **Fiber Optic Terminology**

Electronics Industries Association — Jan. 1989
Communications — ATMS — Approved
Definitions of terms used with fiber optic communications systems, fiber, transmitters, receivers, cables, connectors and splices.

EIA-462 **Electrical Performance Standards for Television Broadcast Demodulators.**

Electronics Industries Association — May, 1979
Communications — ATMS, APTS — Approved
Television receivers, performance standards.

EIA-465 **Group 3 Facsimile Apparatus of Document Transmission.**

Telecommunications Industry Association — May 1981
Communications — ATMS — Approved
Basic and optional characteristics of a group 3 Facsimile (FAX) machine. Adopted for DoD use. Adopted as FIPS 1062.

EIA-466 **Procedures for Document Facsimile Transmission.**

Telecommunications Industry Association — May 1981
Communications — ATMS — Approved
Defines procedures (protocols) for document facsimile transmission on voiceband analog circuits. Adopted as a DoD standard. Adopted as FIPS 1063.

EIA-470-A **Telephone Instruments with Loop Signaling.**

Telecommunications Industry Association — July 1987
Communications — ATMS — Approved

Telephone communications loop signaling requirements.

EIA-485 **Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.**

Telecommunications Industry Association — April 1983
Data Interchange — ATIS,CVO. — Approved
Specifies the electrical characteristics of generators and receivers that may be employed when specified for the interchange of binary signals in multipoint/multidrop interconnection of digital equipment.

EIA-499 **Call Sequencer Interface to 1A1/1A2 Generic Key Telephone System.**

Telecommunications Industry Association — March 1986
Data Interchange — ATMS — Approved
Telephone auxiliary equipment.

EIA-511 **Manufacturing Message Specification-Service Definition and Protocol**

Electronics Industries Association — April 1989
Communications — ATMS — Approved
Standardizes services required to control and monitor plant floor devices, such as computer numerical control equipment, and robotics equipment.

EIA-548 **Electronic Design Interchange Format (EDIF) Version 2 0 0.**

Electronics Industries Association — May 1988
Data Interchange — ATMS — Approved
Standardized interchange format for CAE/CAD systems, support of data types and manipulation of files using any programming language.

EIA-563 **Standard Baseband (Audio/Video) interface between NTSC Television Receiving Devices and Peripheral Devices.**

Electronics Industries Association — Aug 1990
Data Interchange — ATMS — Approved
Provides a standardized cable converter/decoder interface compatible with the baseband television receiver.

EIA/IS-51 **Emission Limitation for AM Broadcast Transmission.**

Electronics Industries Association — Sept. 1988
Communications — ATMS, ATIS — Approved
AM broadcast emission limits.

EIA/IS-52 **Uniform Dialing Procedures and Call Processing Treatment for Use in Cellular Radio Telecommunications.**

Telecommunications Industry Association — Nov. 1989
Communications — ATMS, ATIS — Approved
Recommended dialing plan and processing treatment for use in cellular radiotelephone service.

EIA/IS-60 **EIA Home Automation System (CEBus).**

Electronics Industries Association — October 1992
Vehicle Area Network — Vehicles — Approved
Local area network intended for consumer applications in the home.

EIA/TIA-232-E **Interface Between Data Terminal Equipment and Data Circuit-Terminating**

Equipment Employing Serial Binary Data Interchange.

Telecommunications Industry Association		July 1991
Data Interchange Serial Data Transfer	All	Approved

EIA/TIA-250-C **Electrical Performance Standards for Television Relay Facilities.**

Telecommunications Industry Association		Feb. 1990
Communications	ATMS, ATIS, APTS	Approved

EIA/TIA-455-A **Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components.**

Electronics Industries Association		August 1991
Communications	ATMS	Approved

A series of fiber optic test procedures, EIA-455-1 through EIA-455-190.

EIA/TIA-464-A **Private Branch Exchange (PBX) Switching Equipment for Voiceband Application.**

Telecommunications Industry Association		Feb. 1989
Communications	ATMS	Approved

Voiceband telephone switching equipment.

EIA/TIA-496-A **Interface Between Data Circuit-Terminating Equipment (DCE) and the Public Switched Telephone Network (PSTN).**

Telecommunications Industry Association		Nov. 1989
Data Interchange	ATMS	Approved

Technical requirements for interfacing and connecting a data arrangement to the PSTN for purposes of data transmission.

EIA/TIA-530-A **High Speed 25-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment, Including Alternative 26-Position Connector.**

Telecommunications Industry Association		June 1992
Data Interchange	ATMS	Approved

Applicable to the interconnection of data terminal equipment employing serial binary data interchange with control information exchanged on separate control circuits. Defines signal characteristics, interface mechanical characteristics, and functional

EIA/TIA-547 **Network Channel Terminal Equipment for DS1 Service.**

Telecommunications Industry Association		March 1989
Communications	ATMS	Approved

Performance and technical criteria of interfacing and connecting with the various element of the public telecommunications network.

EIA/TIA-553 **Mobile Station-Land Station Compatibility Specification.**

Telecommunications Industry Association		Sept. 1989
Communications	ATIS, ATMS, CVO, APTS	Approved

A compatibility standard for cellular mobile telecommunications systems.

EIA/TIA-561 **Simple 8-Position Non-Synchronous Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment**

Telecommunications Industry Association Oct. 1909
Data Interchange ATMS Approved
Simple 8-position non-synchronous interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.

EIA/TIA-562 Electrical Characteristics for an Unbalanced Digital Interface.

Telecommunications Industry Association Sept. 1990
Data Interchange ATMS Approved
Electrical characteristics of unbalanced digital interface circuit in interconnection between voice or data equipment.

EIA/TIA-574 9-Position Non-Synchronous Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial

Telecommunications Industry Association Sept. 1990
Data Interchange ATMS Approved
9 position non-synchronous interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.

EIA/TIA-578 Facsimile DCE Control Standard - Service Class I.

Telecommunications Industry Association Nov. 1990
Communications ATMS Approved
Standard for "fax" boards. Protocol for use between a DTE and a facsimile DCE, includes automatic calling and answering. Includes EIA-232-D, CCITT V.24, and SCSI, ANSI X3.131 interface.

EIA/TIA-579 Acoustic-to-Digital and Digital-to-Acoustic Transmission Requirements for ISDN Terminals.

Telecommunications Industry Association Feb. 1994
Communications ATMS Approved
Transmission requirements for ISDN transmission of digital data.

EIA/TIA-594 Private Digital Network Synchronization

Telecommunications Industry Association August 1991
Communications ATMS Approved
Digital network communications synchronization.

EIA/TIA/IS-41.1B Cellular Radiotelecommunications Intersystem Operations: Functional Overview.

Telecommunications Industry Association Dec. 1991
Communications ATMS, ATIS Approved
Cellular telephone, intersystem functional operations.

EIA/TIA/IS-41.2B Cellular Radiotelecommunications Intersystem Operations: Intersystem Handoff.

Telecommunications Industry Association Dec. 1991
Communications ATMS, ATIS Approved
Cellular telephone, intersystem handoff (between systems) operations.

EIA/TIA/IS-41.3B Cellular Radiotelecommunications Intersystem Operations: Automatic Roaming.

Telecommunications Industry Association Dec 1991
Communications ATMS, ATIS Approved
Cellular telephone, automatic roaming operations.

EIA/TIA/IS-41.5B **Cellular Radiotelecommunications Intersystem Operations: Data Communications.**

Telecommunications Industry Association		Dec. 1991
Communications	ATMS, ATIS	Approved

Cellular telephone, data communications operations.

EIA/TIA/IS-54-B **Cellular System Dual-Mode Mobile Station-Base Station Compatibility Standard.**

Telecommunications Industry Association		April 1992
Communications	ATMS, ATIS	Approved

Interim standard for Cellular telephone, base station standardization.

EIA/TIA/IS-55-A **Recommended Minimum Performance Standards for 800MHz Dual-Mode Mobile Stations.**

Telecommunications Industry Association		Sept. 1993
Communications	ATMS	Approved

Details definitions, methods of measurement, and minimum performance requirements for 800MHz Cellular Base Stations.

EIA/TIA/IS-63 **Procedures for Automatic Interworking between Automode Modems and Modems conforming to Recommendations V.32, V.22bis and V.22.**

Telecommunications Industry Association		August 1990
Communications	ATMS	Approved

Procedures for interworking modems conforming to CCITT recommendations V.32, V.22bis and V.22.

EPRI NP-3657 **Human Factors Guidelines for Nuclear Power Plant Control Room Development**

Electrical Power Research Institute		Complete
Human Factors	ATMS	Approved

A framework for systematically applying human factors principles and criteria throughout the development of a nuclear power plant control room.

ETTM **Electronic Toll & Traffic Management (ETTM) User Requirements for Future National Interoperability**

Intelligent Transportation Society - America		Jan 1995
ETTM	AVI, ATMS, ETC, CVO, APTS.	Approved

Electronic tag requirements, for toll collection and traffic management.

FAA/ASE-100 **Computer Human Interface (CHI) Evaluation Checklist**

Volpe Transportation Center		UNK
Human Factors	ATMS	Draft

Computerized tool for evaluation of computer human interface for air traffic control systems.

FHWA-STD-WP-08 **Update of the VRC Standards Requirements Package**

Architecture Development Team		
ETTM	ETTM, CVO, Vehicles	Proposed

Describes the communications messages between the vehicle and roadside. Includes message sequencing, content and data dictionary.

FHWA-STD-WP-09 **Dedicated Short Range Communications Standards Requirements Package**

Architecture Development Team

ETTM	CVO	Proposed

Describes the communications messages for dedicated short range communications devices (Vehicle to Roadside Communications). Includes message sequencing, content and data dictionary.

FHWA-STD-WP-10 Transit Management to Transit Vehicle and Remote Traveler Service Interfaces Standards Requirements Package

Architecture Development Team

Traveler Information	ATIS, APTS, Vehicles	Proposed

Describes the communications messages between transit management and the remote traveler (kiosk) and between transit management and the transit vehicle. Includes message sequencing, content and data dictionary.

FHWA-STD-WP-11 Information Service Provider Wireless Interfaces Standards Requirements Package

Architecture Development Team

Traveler Information	ATIS, APTS, CVO, Vehicles	Proposed

Describes the wireless communications messages / interfaces between the Information Provider and users. Provides message sequences, contents and data dictionary.

FHWA-STD-WP-12 Personal, Transit and HAZMAT MAYDAYS Standards Requirements Package

Architecture Development Team

Mayday	Traveler, vehicles	Proposed

Describes the communications messages between travelers and vehicles with an emergency service provider. Includes message sequencing, content and data dictionary.

FHWA-STD-WP-13 Digital Map Data Exchange and Location Referencing

Architecture Development Team

Digital Maps	All	Proposed

Describes the communications messages required for spatial data information transfer, both digital map data and position information. Includes message sequence, content and data dictionary.

FHWA-STD-WP-14 Traffic Management Subsystem to Other Centers Standards Requirements Package.

Architecture Development Team

Traffic Control	ATMS, ATIS, APTS, CVO, ETTM	Proposed

Describes the communications messages required between a traffic management center and a host of other centers (Traveler information, transit, traffic, CVO, etc.) Includes message sequencing, content and data dictionary.

FHWA-STD-WP-15 Signal Priority for Emergency and Transit Vehicles Standards Requirements Package

Architecture Development Team

Traffic Control	ATMS, APTS, Vehicle, Mayday	Proposed

Describes the communications messages between traffic management and emergency and transit vehicle for signal control. Includes message sequencing, content and data dictionary.

FHWA-STD-WP-16 Information Service Provider Subsystem To Other Centers Standard Requirements Package.

Architecture Development Team
Traveler Information | ATIS, APTS, Vehicles | Proposed

Describes the wireline communications messages / interfaces between the Information Provider and users / data providers. Provides message sequences, contents and data dictionary.

FIPS 1 Federal Information Processing Standard, American National Standard Code for Information Interchange (ASCII).

National Bureau of Standards
Computers | ATMS, ATIS, APTS, ARTS, CVO | Complete Approved

Computer eight bit code for 256 character set of printing and control characters. (See ANSI X3.4)

FIPS 127 Federal Information Processing Standard, Structured Query Language.

National Bureau of Standards
Database Queries | APTS, ATIS, CVO, others? | Complete Approved

Structured Query Language is a standardized set of commands for accessing and updating databases.

FIPS 148 Federal Information Processing Standard, Government Open System Interface Procedures.

National Bureau of Standards
Communications | ATMS, ATIS, APTS, ARTS, CVO | Complete Approved

U.S. Government standard for ISO Open System Interconnection.

FIPS 151-1 Federal Information Processing Standard, POSIX

National Bureau of Standards
Operating System | ATMS, ATIS, APTS, ARTS, CVO | Complete Approved

U.S. Government standard for UNIX operating system.

FIPS 158 Federal Information Processing Standard, X-windows.

National Bureau of Standards
Terminal User Interface | ATIS, ATMS, APTS, CVO. | Complete Approved

U.S. Government standard for MIT X-windows. X-windows is a terminal based graphics user interface.

FIPS 173 Federal Information Processing Standard, Spatial Data Transfer Standard

National Bureau of Standards
Digital Maps | ATIS, ATMS, | Complete Approved

	APTS, CVO, Vehicles	

Standard for transferring data from one geographic information system (GIS) to a second GIS. Defines the requirements for a transfer module.

FIPS 185 **Federal Information Processing Standard # 185, Escrowed Encryption Standard**

National Bureau of Standards		Feb 1994
Security	CIA, BATFA, DEA, FBI, SS ?	Approved

This standard enables law enforcement agencies to conduct "lawfully" authorized electronic surveillance by having access to the encryption key. Mandatory for Federal computer systems, voice, facsimile and computer information transmitted by telephone.

FIPS 46 **Federal Information Processing Standard, Data Encryption Standard**

National Bureau of Standards		1977
Security	Electronic Funds Transfer	Approved

Published by NBS for public encryption/security use, available on VLSI chips. Two modes: Key Auto Key (KAK - 64 bit block encryption) and Cipher Text Auto Key (CTAK - 8 bit block encryption). CTAK is much slower, and provides greater protection than KAK.

ICS 1-1990 **General Standards for Industrial Control and Systems.**

National Electrical Manufacturers Association		Complete
Traffic Control	ATMS	Approved

ICS 4-1983 **Terminal Blocks for Industrial Use.**

National Electrical Manufacturers Association		Complete
Traffic Control	ATMS	Approved

ICS 6-1988 **Enclosures for Industrial Control and Systems.**

National Electrical Manufacturers Association		Complete
Traffic Control	ATMS	Approved

Enclosure (electronic cabinet) requirements.

IEEE 1000-1987 **Standard 8-Bit Backplane Interface.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 1014-1987 **Standard for a Versatile Backplane Bus: VME Bus.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 1096-1988 **Standard for a Multiplexed High-Performance Bus Structure.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 1101-1987 **Mechanical Core Specifications for Microcomputers**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 1196-1987 **Simple 32-Bit Backplane Bus: NuBus.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 1228 **Software Safety Plans**

Institute of Electrical and Electronics Engineers		Apr 1994
Human Factors	ATIS, ATMS, APTS, CVO, Vehicles	Approved

Software safety.

IEEE 1296-1987 **High Performance Synchronous 32-Bit Bus: MULTIBUS.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 162-1963 **Definitions of Terms of Electronic Digital Computers.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

Terms and definitions for digital computers.

IEEE 166-1977 **Standard Definitions of Terms of Hybrid Computer Linkage Components.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

Terms and definitions for hybrid (combined digital and analog) computers.

IEEE 172-1983 **Standard Definitions of Navigation Aid Terms.**

Institute of Electrical and Electronics Engineers		Complete
Navigation	ATMS	Approved

Standard terms and definitions for navigation aids.

IEEE 173-1959 **Navigation Aids.**

Institute of Electrical and Electronics Engineers		Complete
Navigation	ATMS	Approved

Direction finder measurements.

IEEE 488.1-1987 **Standard Digital Interface for Programmable Instrumentation**

Institute of Electrical and Electronics Engineers		Complete
Programming	ATMS	Approved

Interface standard for connecting test equipments to computers.

IEEE 488.2-1987 **Standard Codes, Formats, Protocols, and Common Commands for Use with IEEE 488.1 Standard Digital Interface for Programmable Instrumentation.**

Institute of Electrical and Electronics Engineers		Complete
Programming	ATMS	Approved

Formats, protocols, codes and commands for digital computers to control test equipments.

IEEE 696-1983 **Standard 696 Interface Device.**

Institute of Electrical and Electronics Engineers		Complete
Interface	ATMS	Approved

IEEE 754-1985 **IEEE Standard for Binary Floating Point Arithmetic.**

Joint ANSI/IEEE		Complete
Computers	All	Approved

Floating point binary arithmetic.

IEEE 796-1983 **Standard Microcomputer System Bus**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 802.2 **Standard for Local Area Networks: Logical Link Control.**

Institute of Electrical and Electronics Engineers		Complete
Communications	ATIS, ATMS, APTS, CVO.	Approved

Basic standard for ethernet and other local area networks. Also see IEEE 802.(3, 4, 5). Also ISO 880(2, 3, 4, 5).

IEEE 802.3 **CSMA/CD Access Method and Physical Layer Specification.**

Institute of Electrical and Electronics Engineers		Complete
Communications	ATIS, ATMS, APTS, CVO.	Approved

Ethernet - Carrier Sensing Multiple Access/Collision Detecting protocol standard.

IEEE 802.4 **Token - Passing Bus Access Method and Physical Layer Specification.**

Institute of Electrical and Electronics Engineers		Complete
Communications	ATIS, ATMS, APTS, CVO.	Approved

Networking using token passing access protocol.

IEEE 802.5 **Token Ring Access Method and Physical Layer Specification.**

Institute of Electrical and Electronics Engineers		Complete
Communications	ATIS, ATMS, APTS, CVO.	Approved

Networking using token passing access protocol.

IEEE 802.6 **Dual Queue Data Bus - Metropolitan Area Network**

Institute of Electrical and Electronics Engineers		Complete
Communications	ATMS, APTS, ATIS	Approved

Specification for a Metropolitan Area Network.

IEEE 823-89 **Standard methods for specifying voice grade transmissions.**

Institute of Electrical and Electronics Engineers		Complete
Communications	ATMS	Approved

Voice communications requirements.

IEEE 896.1-1987 **Backplane Bus Specification for Multiprocessor Architectures: Futurebus.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 9121 **Software Quality Assurance.**

Institute of Electrical and Electronics Engineers		Complete
Quality Assurance	ATIS, ATMS, APTS, CVO, ARTS.	Approved

Software (computer programs) quality assurance provisions.

IEEE 949 **Trial-Use Standard for Media Independent Information Transfer.**

Institute of Electrical and Electronics Engineers		Unknown
Interface	ATMS	Draft

Draft Standard for media independent interface information transfer.

IEEE 959-1988 **Specifications for an I-O Expansion Bus: SBX Bus.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

IEEE 961-1987 **8-Bit Microcomputer Bus System: STD Bus.**

Institute of Electrical and Electronics Engineers		Complete
Computers	ATMS	Approved

ION STD 101 **GPS Test Standards. Test standards for GPS receivers for land vehicles, marine and hand held applications**

Institute of Navigation		1996
Navigation	Vehicles	Draft

Uniform test methods to provide a basis for purchasers to evaluate and compare offerings of alternative vendors.

ISO 10374:1991 **Freight Containers - Automatic Identification.**

International Standards Organization		Complete
Container, Vehicle Id.	CVO.	Approved

Shipping container identification system.

ISO 11898 **Controller Area Network (CAN)**

International Standards Organization		Complete
Vehicle Area Network	Vehicles, APTS	Approved

ISO version of the Bosch developed Controller Area Network (CAN) in-vehicle area network for automobiles and lorries. Supported by a number of European manufacturers.

ISO 3166 **Country codes.**

International Standards Organization		Complete
Country Codes	ATIS, ATMS, CVO.	Approved

Digital codes for countries, states and provinces.

ISO 3309:1991 **Data Communications - HLDC Procedures - Frame Structure.**

International Standards Organization		1991
Packet Switching	ATMS, ATIS, APTS.	Approved

High level digital data link control - Link protocols.

ISO 3779 **Standard Vehicle Identification Numbering (VIN) System.**

International Standards Organization		Complete
Vehicle Identification	ATMS, CVO, APTS, ETC.	Approved

Numbering system requirements for Vehicle Identification Numbering (VIN).

ISO 4335:1991 **Data Communications - High Level Data Link Control (HLDC) Procedures.**

International Standards Organization		1991
Packet Switching	ATMS, ATIS, APTS.	Approved

HLDC procedures (Link protocols.)

ISO 4909:1987 **Bank Cards - Magnetic Stripe data for track 3.**

International Standards Organization		1987
Banking	APTS, CVO, ATMS, vehicles.	Approved

Magnetic card format for electronic banking data.

ISO 6346:1984 **Freight containers - Coding, identification and marking.**

International Standards Organization		1984
Container, Vehicle Id.	CVO	Approved

Shipping container standard for marking.

ISO 7498:1990 **Information Processing Systems - Open System Interconnect - Basic Reference Model.**

International Standards Organization		1990
Data Communications	ATIS, ATMS, APTS, ARTS, CVO, ETC	Approved

ISO OSI model of seven layer data communications model.

ISO 8072:1984 **Information Processing Systems - Open System Interconnection - Transport Service Definition**

International Standards Organization		1984
Communications	ATIS, APTS, ATMS, CVO	Approved

Defines the transport layer (layer 4) requirements for network service. Class 4, Type C is similar to, and based on MIL-STD 1778 Transport Control Protocol.

ISO 8073:1984 **Information Processing Systems - Open System Interconnection - Connection-Oriented Transport Protocol Specification.**

International Standards Organization		1984
Communications	APTS, ATIS, ATMS, CVO	Approved

Defines the transport layer (layer 4) protocol requirements for network service. Class 4, Type C is similar to, and based on MIL-STD 1778 Transport Control Protocol.

ISO 8208:1990 **Information Technology - Data Communications X.25 Packet Layer Protocol for Data Terminal Equipment.**

International Standards Organization 1990
Packet Switching ATMS, ATIS, APTS. Approved
Network protocol for data communications.

ISO 8571 **Information Processing Systems - Open System Interconnection - File Transfer, Access and Management (FTAM)**

International Standards Organization Aug 1986
Communications Approved
A series of ISO standards dealing with files, storage and transfer.

ISO 8822 **Information Processing Systems - Open System Interconnection - Connection-Oriented Presentation Service Definition**

International Standards Organization May 1986
Communications ATMS, APTS Approved
Defines service for connection (circuit) presentation.

ISO 8823 **Information Processing Systems - Open System Interconnection - Connection-Oriented Presentation Service Protocol Specification**

International Standards Organization May 1986
Communications ATMS, APTS Approved
Protocol requirements for connection-oriented presentation service.

ISO 8824:1990 **Information Processing Systems - Open Systems Interconnection - Specification for Abstract Syntax Notation One (ASN.1).**

International Standards Organization 1990
Data Communications ATIS, ATMS. Approved
Abstract Syntax Notation.

ISO 8825:1990 **Information Processing Systems - Open Systems Interconnection - Specification of Basic and Coding Rules for ASN.1.**

International Standards Organization 1990
Data Communications ATIS, ATMS. Approved
Abstract Syntax Notation.

ISO 9000-1 **Quality Management and Quality Assurance Standards - Part 1: Guidelines for Selection and Use.**

International Standards Organization 1994
Quality Assurance All Approved
Quality assurance management guideline requirements.

ISO 9000.3 **ISO 9000 International Standards for Quality Management**

International Standards Organization 1994
Quality Assurance All Approved
Quality assurance requirements.

ISO 9001-94 **Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Service.**

International Standards Organization 1994
Quality Assurance All Approved
Quality assurance model used in design and development.

ISO 9002-94 **Quality Systems - Model for Quality Assurance in Production, Installation, and Service**

International Standards Organization		1994
Quality Assurance	All	Approved

Quality assurance model used in production.

ISO 9003-94 **Quality Systems - Model for Quality Assurance in Final Inspection and Test.**

International Standards Organization		1994
Quality Assurance	All	Approved

Quality assurance model for first article test.

ISO 9004-1 **Quality Management and Quality Systems Elements - Part 1: Guidelines**

International Standards Organization		1994
Quality Assurance	All	Approved

Guidelines for quality assurance.

ISO 9075:1988 **Structured Query Language.**

International Standards Organization		1988
Database Queries	APTS, ATIS, CVO, others?	Approved

Structured Query Language is a standardized set of commands for accessing and updating databases.

ISO 9595 **Information Technology - Open System Interconnect- Common Management Information Service Definition**

International Standards Organization		1991
Communications	ATIS, APTS, ATMS, CVO, Vehicles	Approved

Defines the common management information protocol (CMIP, analogous to TCP) and service.

ISO 9596 **Information Technology - Open System Interconnect - Common Management Information Protocol (CMIP) Specification**

International Standards Organization		1991
Communications	APTS, ATIS, ATMS, CVO, Vehicles	Approved

CMIP is similar to TCP. CMIP provides a connection-oriented data-transfer service between users in order to overcome damage, loss, duplication and misordering of packets during transmission through multiple networks. May replace TCP about 2001.

ISO 9735 **Electronic data interchange for administration, commerce and transportation (EDIFACT).**

International Standards Organization		Complete
Data Interchange	ATIS, ATMS, APTS, CVO, ETC	Approved

Application of EDIFACT syntax.

ISO 9945-1 **Portable Operating System Interface (Posix).**

International Standards Organization		Complete.

Operating System	ATIS, ATMS, APTS, CVO.	Approved

UNIX operating system for multiple, different hardware.

ITA #2 **International Telecommunications Alphabet #2, weather alphabet.**

Consultative Committee for International Telegraph and Telephone		Complete
Weather Data	ATMS, ATIS.	Approved

Telecommunications alphabet used to transmit weather symbols and data on a world wide basis.

ITE ST-017 **Equipment and Material Standards of the Institute of Transportation Engineers.**

Institute of Transportation Engineers		Complete
Traffic Control	ATMS	Approved

Covers pre-timed and actuated controllers, cabinets and detectors.

J1213 **Glossary of vehicle networks for multiplexing and data communications.**

Society of Automotive Engineers		Complete
Vehicle Area Network	Vehicles	Approved

J1455 **Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design of Heavy Duty Trucks and Busses**

Society of Automotive Engineers		Complete
Vehicle Area Network	APTS, CVO, Vehicles	Approved

Design Goals for climatic, mechanical, chemical, electrical and dynamic conditions found on, and generated by, heavy duty trucks and buses.

J1587 **Joint SAE/TMC R. P. for Electronic Data Interchange Between Microcomputer Systems in Heavy Duty Vehicle Applications.**

Society of Automotive Engineers		Complete
Vehicle Data Interface	CVO.	Approved

Recommended practice defining on-board vehicle information interchange messages and formats. Developed for heavy vehicles.

J1663 **Truth-In-Labeling Standard for Navigation Map Databases**

Society of Automotive Engineers		AUG 1995
Digital Maps	ATIS, APTS, ATMS, vehicles	Approved

Truth-in-labeling standard for navigation digital map databases. Provides criteria for labeling contents of map database.

J1699 **J1850 verification test procedures**

Society of Automotive Engineers		Complete
Vehicle Area Network	Vehicles	Approved

J1708 **Truck and Bus Practice. Serial Data Communications between Microcomputer Systems in Heavy Duty Vehicle Applications.**

Society of Automotive Engineers		Complete
Vehicle Area Network	APTS, CVO	Approved

Serial Data Communications Between Microcomputer Systems in Heavy Duty Vehicle Applications. Details the hardware interface and outlines the communications protocol.

J1746 **Recommended Practice for Traveler Information Service Message List.**

Society of Automotive Engineers		Sep 1995
Communications	ATMS, APTS, ATIS, CVO, Vehicles	Draft

Overall message list for all communications within an Intelligent Transportation System (ITS).

J1757 **R. P. for In Vehicle Sensor Interface for IVHS Applications.**

Society of Automotive Engineers		UNK
Sensors	ATIS, APTS, CVO, Vehicles	Proposed

Recommended Practice for interface requirements for vehicle sensors, including gyroscopes, compasses, odometer, etc. to an in-vehicle navigation computer.

J1760 **DRAFT Information Report (IR) - Compendium of Emerging IVHS Technologies**

Society of Automotive Engineers		UNK
Architecture	All	Draft

An introduction to existing IVHS/ITS equipments and components currently under development or being marketed. Includes descriptions of ITS systems such as route guidance.

J1761 **Information Report on ITS Terms and Definitions.**

Society of Automotive Engineers		Dec 1995
Architecture	All	Draft

A dictionary of terminology in the field of Intelligent Transportation Systems (ITS). Focused on the vehicle and interfaces to the vehicle.

J1762 **DRAFT Recommended Practice, DRAFT Standard for System Architecture Documentation.**

Society of Automotive Engineers		Dec 1995
Architecture	All	Draft

A "How to" on documenting system architecture.

J1763 **Information Report - A Conceptual IVHS Architecture: an ATIS Perspective.**

Society of Automotive Engineers		JUL 1995
Architecture	ATIS, APTS	Approved

An overview conceptual framework for ITS Architecture and Protocols. Emphasis on communications.

J1850 **Class B Communication Network Interface.**

Society of Automotive Engineers		Complete
Vehicle Area Network		Approved

Vehicle local area network. Each automobile manufacturer builds different versions.

J1922 **Powertrain Control Interface for Electronic Controls; Used in Medium and Heavy Duty Diesel on Highway Vehicle Applications.**

Society of Automotive Engineers		Complete
Vehicle Data Interface	CVO.	Approved

Vehicle information interchange.

J2178/1 **Class B Data Communications Network Messages**

Society of Automotive Engineers		Complete
Vehicle Area Network	Vehicles	Approved

Describes actual messages transmitted over a J1850 vehicles area network.

J2256 **Recommended Practice for In Vehicle Navigation Systems Communications Device Message Set.**

Society of Automotive Engineers		Dec 1995
Navigation	ATIS, APTS, CVO, Vehicles	Draft

Recommended practice defining a message set for navigation. The navigation message set is to be a proper subset of the ITIIS message set.

Jxxxx **DRAFT Standard for On-board Land Vehicle Positioning Device Interface.**

Society of Automotive Engineers		Sep 1995
Sensors	ATIS, APTS, CVO, Vehicles	Draft

Interface requirements, messages, and protocols for position device (e.g., GPS receiver) to an in-vehicle navigation computer.

Jxxxx **DRAFT On-Board Land Vehicle MAYDAY Message Protocol**

Society of Automotive Engineers		1996
Emergency Services	Vehicles, APTS, CVO	Draft

This standard describes the message protocol between an on board mayday detection system and the external response center (E911 center).

MIL-STD 1472D **Human Engineering Design Criteria for Military Systems, Equipment and Facilities**

United States Department of Defense		
Human Factors	ATMS, APTS, ATIS, Vehicles	Approved

Human engineering design criteria, principles and practices to integrate the human into the system; and achieve effectiveness and safety of operations and maintenance

MIL-STD 1777 **Internet Protocol (IP)**

United States Department of Defense		Aug 1977
Communications	ATIS, ATMS, APTS, CVO	Approved

Internet protocol supports the interconnection of networks, using an internal datagram service to determine the shortest time distance to the end connection..

MIL-STD 1778 **Transport Control Protocol (TCP)**

United States Department of Defense		Oct 1983
Communications	ATMS, ATIS, APTS, CVO.	Approved

Transport control protocol provides a connection-oriented data-transfer service between users in order to overcome damage, loss, duplication and misordering of packets during transmission through multiple networks. May be replaced by ISO 8072 and 8073.

MIL-STD 1780 **File Transport Protocol**

United States Department of Defense | | May 1984
Communications | ATIS, ATMS, APTS, CVO | Approved

File transport protocol is the "upper-layer protocols" that commands the transport control protocol issuing 'service requests' and receiving 'service responses'.

MIL-STD 1781 Simple Mail Transfer Protocol

United States Department of Defense | | May 1984
Communications | ATIS, ATMS, APTS, CVO | Approved

an "upper layer protocol" for mail transfer through a network based on transfer control protocol (TCP) and internet protocol (IP).

MIL-STD 1782 TELNET Protocol

United States Department of Defense | | May 1984
Communications | ATMS, ATIS, APTS, CVO | Approved

TELNET is a virtual circuit switching system (CCITT X.75) similar to Internet.

Model 170 Traffic Signal Control Equipment Specification.

CALTRANS | | Complete
Traffic Control | ATMS | Approved

Hardware specifications for Model 170 controller unit and associated program modules, flasher units, switch packs, sensors, modems, cabinets and support assemblies.

MPEG 3

Motion Pictures Expert Group | | Unknown
Television | ATMS, APTS | Draft

A video data coding and compression standard being formed to allow high definition video television and stereo audio to be transmitted over existing 5 MHz bandwidth channels. May reduce standard TV to approx. 64 kHz for transmission over ISDN circuits.

NAD 27 North American Datum - 1927.

United States Geodetic Service | | Complete
Navigation | ATMS, ATIS, APTS, CVO, Vehicles. | Approved

Geodetic datum for the North American Continent per 1927. Most US maps are based on NAD 27 geodetic constants.

NAD 83 North American Datum - 1983.

United States Geodetic Service | | Complete
Navigation | ATMS, ATIS, APTS, CVO, Vehicles. | Approved

Geodetic datum for the North American Continent per 1983. Some US maps are based on NAD 83 geodetic constants.

NEMA 0183 Asynchronous serial data (?)

National Electrical Manufacturers Association | | Complete
Traffic Control | ATMS | Approved

NEMA 250-1988 **Enclosures for Electronic Equipment.**

National Electrical Manufacturers Association — Complete
Traffic Control — ATMS — Approved
Enclosure (electronic cabinet) requirements.

NMEA 0183 **Standard for interfacing marine electronics devices (?)**

National Marine Electronics Association — Complete
Navigation — Vehicles — Approved
Widely used standard for interfacing GPS Receivers to navigational equipments

NP 1.1 **Glossary of Standard Terminologies for Reference Models, and Taxonomy in the Transport Information & Control Systems (TICS)**

International Standards Organization — 1997
Architecture — All — Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, proposed effort.

NP 1.2 **Glossary of Standard Terminologies for the Transport Information and Control Sector**

International Standards Organization — 1997
Architecture — All — Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, proposed effort.

NP 1.3 **Reference Model Architecture for the TICS Sector**

International Standards Organization — 1997
Architecture — All — Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, proposed effort.

NP 1.4 **Reference Model Architecture(s) for the TICS Sector**

International Standards Organization — 1997
Architecture — All — Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, effort.

NP 1.5 **Standard AVI/AEI Generic System Specification.**

International Standards Organization — 1997
Architecture — All — Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, effort.

NP 1.6 **Numbering Schemes for Generic AVI/AEI.**

International Standards Organization — 19967
Architecture — All — Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, effort.

NP 1.7 **Data Modeling for Transport Information and Control System (TICS) Sector.**

International Standards Organization — 1997

Architecture All Proposed
ISO Technical Committee TC204, Traffic Information and Control Systems, WG1 Architecture, effort.

NP 10.1 Traveler and Traffic Information (TTI) Conceptual Model Architecture and Terminology.

International Standards Organization 1997
Communications ATIS, ATMS Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 10.2 Traffic Message Coding for Traffic and Traveler Information.

International Standards Organization 1997
Communications ATIS, APTS, ATMS, CVO Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 10.3 Centrally-Determined Route Guidance

International Standards Organization
Navigation ATMS, ATIS, Vehicles Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 10.4 Locally-Determined Route Guidance

International Standards Organization
Navigation ATIS, Vehicles Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 10.5 Medium-Range Pre-Information

International Standards Organization
Communications ATIS, APTS Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 10.6 Stationary Dissemination Systems for Traffic and Traveler Information.

International Standards Organization
Communications ATIS Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 10.7 User Services Integration for Traffic and Traveler Message List

International Standards Organization UNK
Traveler Information ATMS, ATIS, APTS Proposed
ISO TC 204 Working Group 10 Traveler Information Systems effort.

NP 11.1 A Study of Standards Requirements for the On-Vehicle Interface between an External Information Communication Device and a Navigation Computer.

International Standards Organization UNK
Navigation Vehicles Proposed
ISO TC 204 Working Group 11 Route Guidance effort.

NP 2.1 Levels of Safety & Environmental Criticality

International Standards Organization		1997
Quality Assurance	All	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG2 Quality and Reliability Requirements, proposed effort.

NP 3.1.1 Geographic Data File

International Standards Organization		1997
Digital Maps	All	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG3 TICS Database Technology, effort.

NP 3.2.1 Physical Storage for TICS Database Technology

International Standards Organization		1997
Digital Maps	All	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG3 TICS Database Technology, effort.

NP 5.1 Interface Specification for Clearing Between Operations

International Standards Organization		1997
ETTM	CVO, ATMS, APTS	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG5, Fee & Toll Collection (FTC), effort.

NP 5.2 Integration of Payment Systems through an Enabled End-to-end Chain of information.

International Standards Organization		1996
ETTM	ATIS, APTS, ATMS, CVO	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG5, Toll & Fee Collection (FTC), effort.

NP 5.3 Automatic Fee Collection Application Interface Definition for Dedicated short Range Vehicle Beacon Communications.

International Standards Organization		1996
Electronic Toll Collection	ATIS, APTS, ATMS, CVO	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG5, Fee & Toll Collection (FTC), effort.

NP 5.4 Test Procedures for Automated Fee Collection User Equipment and Automatic Fee Collection Fixed Equipment

International Standards Organization		1996
Electronic Toll Collection	ATIS, ATMS, APTS, CVO	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG5, Fee & Toll Collection (FTC), effort.

NP 5.5 Automatic Fee Collection Requirements for Dedicated Short Range Vehicle-Beacon Communications.

International Standards Organization		1996
Electronic Toll Collection	ATIS, APTS,	Proposed

ATMS, CVO

ISO Technical Committee TC204, Traffic Information and Control Systems, WG5, Fee & Toll Collection (FTC), effort.

NP 5.6 **Automatic Fee Collection Requirements for IC-cards.**

International Standards Organization		1996
Electronic Toll Collection	ATIS, APTS, ATMS, CVO	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG5, Fee & Toll Collection (FTC), effort.

NP 9.3 **Data Interfaces Between Centers for Transport Information and Control Systems.**

International Standards Organization		1997
Traffic Control	ATMS, ATIS	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG9, Integrated Transport Information Management and Control, effort.

NTCIP **National Traffic Control / ITS Communications Protocol (NTCIP).**

National Electrical Manufacturers Association		Unknown
Traffic Control	ATMS.	Draft

Traffic control interface and protocols to sensors, control devices (signals) and traffic management applications.

NTSC

National Television System Committee		Complete.
Television	ATIS, ATMS, APTS, CVO.	Approved

U.S. Standard for color television broadcast.

P1404 **Microwave Communications Systems: Guidelines for Design, Procurement, Installation & Maintenance**

Institute of Electrical and Electronics Engineers		1996
Communications	ATIS,ATMS, APTS	Draft

A guide to microwave communications systems procurement for the non-communications manager.

P1436 **Standard for Ground Based Transportation Collision Avoidance Radar**

Institute of Electrical and Electronics Engineers		UNK
Vehicle	Vehicle	Proposed

Standard for vehicle radar applications, power, and safety considerations.

P1449 **Practices and Procedures, Engineering Considerations for Lightning Protection: Device Placement, Grounding, Bonding and System Geometry**

Institute of Electrical and Electronics Engineers		1996
Architecture	Infrastructure	Draft

Lighting protection measures and devices for infrastructure devices and structures.

P1454 **Recommended Practice for the Selection and Installation of Fiber Optic Cable in ITS Urban, Suburban and Rural Environments**

Institute of Electrical and Electronics Engineers		UNK
Communications	ATIS, ATMS,	Proposed

APTS

Management guidelines for determining requirements for, and procurement and installation of optical fiber systems.

P1455 Standard for Message Sets for Vehicle/Roadside Communications

Institute of Electrical and Electronics Engineers		UNK
Communications	ATMS, ETC, Vehicles	Proposed

Message set for vehicle to roadside beacon communications. Includes toll and traffic management.

PWI 13.2 TICS Bibliography for Human Factors and Safety.

International Standards Organization		1996
Human Factors	All	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG13, Human Factors and Man-Machine-Interface (MMI), proposed effort.

PWI 13.3 Taxonomy of Driver-Vehicle Transactions Associated with Advanced Navigation and Route Guidance Systems.

International Standards Organization		1996
Human Factors	All	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG13, Human Factors and Man-Machine-Interface (MMI), proposed effort.

PWI 13.4 Operational Standards for Driver-Vehicle Control and Warning Systems (DVCWS).

International Standards Organization		1996
Human Factors	All	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG13, Human Factors and Man-Machine-Interface (MMI), proposed effort.

PWI 13.5 Framework for the integration of Driver Information and Control Systems.

International Standards Organization		1997
Human Factors	Vehicles	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG13, Human Factors and Man-Machine-Interface (MMI), proposed effort.

PWI 14.3 Forward Obstacle Warning Systems

International Standards Organization		1997
Vehicle	Vehicles	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG14, Vehicle Control Systems, proposed effort.

PWI 14.4 Short Range Warning Systems for Low Speed Maneuvering.

International Standards Organization		1997
Vehicle	Vehicles	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG14, Vehicle Control Systems, proposed effort.

PWI 14.5 Side Obstacle Warning Systems

International Standards Organization		1997
Vehicle	Vehicles	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG14, Vehicle Control Systems, proposed effort.

PWI 14.6 **Roadside Traffic Impediment Warning System**

International Standards Organization		1997
Vehicle	Vehicles	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG14, Vehicle Control Systems, proposed effort.

PWI 14.7 **Blind Curve & Section Warning Systems.**

International Standards Organization		1997
Vehicle	Vehicles	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG14, Vehicle Control Systems, proposed effort.

PWI 15.1 **Protocol for Leaky Cable Communications.**

International Standards Organization		1996
Communications	ATIS, APTS, ATMS, CVO	Proposed

ISO Technical Committee TC204, Traffic Information and Control Systems, WG15, Dedicated Short Range Communications for TICS Applications, proposed effort.

RBDS **United States Radio Broadcast Data System (RBDS) Standard - FM subcarrier data transmission.**

National Radio Systems Committee [NRSC] (EIA and NAB)		Jan 1995
Communications	ATIS, APTS, others	Draft

Proposed FM subcarrier signaling for wide area data transfer to vehicles.

SC-104 **RTCM Recommended Standard for Differential NAVSTAR GPS Service.**

Radio Technical Commission for Maritime Service		Jan 1994
Navigation	Vehicles	Approved

Data formats and protocol for differential correction signals for GPS. Decreases GPS positioning error from approx 100 m Spherical Error Probable (SEP) (with selective availability) or 16 m SEP (nominal GPS specified accuracy) to 1 - 10 m SEP.

SCC32-11 **Guidelines for Application of Information Security Concepts in Systems**

Institute of Electrical and Electronics Engineers		UNK
Security	All	Proposed

Information security application to ITS.

SCC32-2 **Definitions and Terms**

Institute of Electrical and Electronics Engineers		UNK
Architecture	All	Proposed

Electrical, Electronics and Communications Terms and Definitions for ITS applications.

SCC32-5 **Practices and Installation Procedures for Surge Protection Devices**

Institute of Electrical and Electronics Engineers		UNK
Architecture	Infrastructure	Proposed

Lighting protection devices, installation and maintenance.

SCC32-6 **Extension of Personal Communications Systems Applications to Public Transportation**

Institute of Electrical and Electronics Engineers — UNK
Communications — ATIS, Vehicles — Proposed
Requirements and guidelines for use of personal communications devices in/on public transit vehicles

SCC32-7 **Guidelines for Procurement/Installation of SONET**

Institute of Electrical and Electronics Engineers — UNK
Communications — ATIS, ATMS, APTS — Proposed
Management guidelines to developing requirements for and development of Synchronous Optical NETworks.

SCC32-9 **Integrated Communications Systems for Vehicle to Infrastructure Communications**

Institute of Electrical and Electronics Engineers — UNK
Vehicle — Vehicle — Proposed

Series 68 **SPC Series 68 Controller Specification.**

New York State DOT — Unknown
Traffic Control — ATMS — Draft

TIA/EIA-334-B **Signal Quality at Interface between Data Terminal Equipment and Synchronous Data Circuit-Terminating Equipment for Serial Data Transmission**

Telecommunications Industry Association — May 1994
Communications — ATMS — Approved
Provides a basis of agreement on the signal quality at the DTE/DCE interface in synchronous serial data transmissions systems where timing leads are exchanged across the interface.

TIA/EIA-422-B **Electrical Characteristics of Balanced Voltage Digital Interface Circuits**

Telecommunications Industry Association — May 1994
Data Interchange — All — Approved
Standard for parallel data transfer.

TIA/EIA-603 **Land Mobile FM or PM Communications Equipment Measurement and Performance Standards.**

Telecommunications Industry Association — Feb. 1993
Communications — ATMS — Approved
Performance standards for radio equipment used in Private Dispatch Land Mobile Services, for transmission of voice or data using analog or digital techniques with a maximum frequency of 1 GHz.

TIA/EIA/IS-124 **Cellular Radio Telecommunications Intersystem Non-Signalling Data Communications**

Telecommunications Industry Association — Nov. 1993
Communications — ATIS, ATMS, APTS, CVO, Vehicles — Draft
Interim standard describes procedures to provide non-signalling data communications.

TIA/EIA/IS-95 **Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband**

Spread Spectrum Cellular System.

Telecommunications Industry Association		July 1993
Communications	ATIS, ATMS, APTS, CVO	Draft

Code Division Multiple Access (CDMA). A cellular telecommunications scheme in which multiple users may simultaneously share a frequency as each is using a different code for their information transfer.

Title 21 **AVI Compatibility Specification**

California State Code of Regulations		Complete
Automated Vehicle Location	ATMS, APTS, ETC	Law

Specification for Automated Vehicle Location transponder requirements.

TS-1 **Traffic Control Systems**

National Electrical Manufacturers Association		Complete
Traffic Control	ATMS	Approved

Traffic Control Systems - for solid state actuated traffic signal controllers, detector amplifiers, conflict monitors, backpanels, cabinets, and load switches.

TS-2 **Traffic Control Systems**

National Electrical Manufacturers Association		Complete
Traffic Control	ATMS	Approved

Traffic Control Systems - for solid state actuated traffic signal controllers (Types 1 and 2), detector amplifiers, conflict monitors, backpanels, cabinets, and load switches.

TSB-19 **Optical Fiber Digital Transmissions Systems: Considerations of Users and Suppliers.**

Electronics Industries Association		March 1986
Communications	ATMS	Approved

Engineering, operational and maintenance guidance to users and suppliers of optical fiber digital transmission systems for telecommunications applications.

Type 179 **Type 179 Traffic Control Hardware Specifications.**

New York State DOT		Complete
Traffic Control	ATMS	Approved

UCRL-15673 **Human Factors Design Guidelines for Maintainability of DOE Nuclear Facilities**

Lawrence Livermore National Laboratory		Complete
Human Factors	ATMS, APTS	Approved

Guidelines concerned with design features of DOE nuclear facility repair and maintenance activities

UMTRI-93-21 **Suggested Human Factors Design Guidelines for Driver Information Systems**

University of Michigan Transportation Research Institute		1995
Human Factors	Vehicles	Draft

Guidelines for IVHS-related driver information systems. Describes how to make such systems safe and easy to use. Includes manual controls, spoken input, etc.

V.24 **Functions and electrical characteristics of circuits at the interface between**

data terminal equipment and data communications equipment.

Consultative Committee for International Telegraph and Telephone		Complete
Communications	ATIS, ATMS	Approved

Terminal to communications system interface standards.

V.28 **Electrical characteristics for interface circuits.**

Consultative Committee for International Telegraph and Telephone		Complete
Communications	ATMS, ATIS, APTS	Approved

Characteristics of electrical circuits used between terminal and communications devices.

V.35 **Transmission of 48 kilobits/second data using 60 to 108 kiloHertz group bank circuits.**

Consultative Committee for International Telegraph and Telephone		Complete
Communications	ATMS, APTS, ATIS	Approved

Transmission of 48 kilobits per second digital data over telephone group circuits with bandwidths of 60 to 108 kiloHertz.

VDV 04.05.2 **Technical Requirements for Location Beacon Systems**

Verbund Deutscher Verkehrsunternehmen		Complete
Automated Vehicle Location	APTS, AVL	Approved

Defines protocols and data formats for communications between infrared and microwave wayside beacons and transit vehicles. Defines formats for location, change in voice radio channel and traffic signal preemption. (German Association of Public Transport

VDV 04.05.5 **Radio Data Interface**

Verbund Deutscher Verkehrsunternehmen		Complete
Automated Vehicle Location	APTS, AVL, Vehicles	Approved

Defines Protocols and data formats to be used in interface between the central computer and radio system in transit Automatic Vehicle Location/Control (fleet management) system. (German Association of Public Transport Operators)

VDV 300 **Integrated On-Board Information systems (IBIS)**

Verbund Deutscher Verkehrsunternehmen		Complete
Automated Vehicle Location	APTS, AVL, Vehicles	Approved

Defines physical characteristics of on-board transit computers, peripherals, interconnecting wiring and connectors, protocols and message structures for busses and light rail. (German Association of Public Transport Operators)

VDV 420 **Technical Requirements for Automatic Vehicle Location/Control Systems - Radio Data Transmission.**

Verbund Deutscher Verkehrsunternehmen		Complete
Communications	APTS, ATMS	Approved

Protocols and message structure for public transit fleet management. Communications between vehicle to/from transit control center. (German Association of Public Transport Operators)

WD 1-1983 **General Requirements for Wiring Devices.**

National Electrical Manufacturers Association		Complete
Equipment Design	ATMS	Approved

WD 6-1983 **Wiring Devices - Dimensional Requirements.**

National Electrical Manufacturers Association		Complete
Equipment Design	ATMS	Approved

WGS 84 **World Geodetic System - 1984.**

United States Department of Defense		Complete
Navigation	ATMS, ATIS, APTS, CVO, Vehicles.	Approved

Geodetic constants and datum used with the Global Positioning System (GPS). Constants for transformation to other datums are included.

X-11 **X-Windows, Version 11.**

Massachusetts Institute of Technology		Complete.
Terminal User Interface	APTS, CVO, others?	Approved

Standard for MIT X-windows. X-windows is a terminal based graphics user interface.

X.21 **General-purpose interface between data terminal equipment and data circuit-terminating equipment for start-stop transmission services on public networks.**

Consultative Committee for International Telegraph and Telephone		Complete
Communications	ATIS, ATMS, APTS, CVO, Vehicles	Approved

Defines the physical characteristics and control procedures for a synchronous digital transmission between the user machine and network. Provides end-to-end digital transmission.

X.25 **Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Terminals Operating in the Packet Mode on Public Data Networks.**

Consultative Committee for International Telegraph and Telephone		1984
Communications	ATMS, APTS, ATIS	Approved

Interface protocol standard specifying physical control (layer 1), link control (layer 2) and network control (layer 3) for packet format data transfer connection to a network.

X.400 **Message Handling Systems: System Model-Service Elements**

Consultative Committee for International Telegraph and Telephone		1984
Communications	ATIS, ATMS, APTS, CVO	Approved

"Upper Level Protocols" for Message and Mail transfer on networks.

Appendix 2 - Priority Deployments for Architecture Flows

Table A2.1 Deployment Priorities for Each Architecture Data Flow*

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Basic Vehicle	Parking Management	vehicle characteristics	P	NA			X				
Basic Vehicle	Roadway Subsystem	vehicle characteristics	P	NA							X
Basic Vehicle	Toll Collection	vehicle characteristics	P	NA			X				
Basic Vehicle	Vehicle	vehicle measures	W	product	I	R			X		
Commercial Vehicle	Commercial Vehicle Check	CVO weight and presence	P	NA				X		X	
Commercial Vehicle	Commercial Vehicle Subsystem	vehicle measures	W	product	I	R		X		X	
Commercial Vehicle Administration	Commercial Vehicle Check	credentials information	W,U1t	regional	04			X		X	
Commercial Vehicle Administration	Commercial Vehicle Check	CVO database update	W	regional	04			X		X	
Commercial Vehicle Administration	Commercial Vehicle Check	international border crossing data	W	regional	04					X	
Commercial Vehicle Administration	Commercial Vehicle Check	safety information	W,U1t	regional	04			X		X	
Commercial Vehicle Administration	CVO Information Requestor	credentials and safety information response	W	national	04			X			
Commercial Vehicle Administration	DMV	license request	W	national	04	P		X			
Commercial Vehicle Administration	Enforcement Agency	request for information on violators	W	national	04	P		X			
Commercial Vehicle Administration	Enforcement Agency	violation notification	W	regional	04	P		X			
Commercial Vehicle Administration	Financial Institution	payment request	W	national	04	F		X			
Commercial Vehicle Administration	Fleet and Freight Management	activity reports	W	national	04			X			
Commercial Vehicle Administration	Fleet and Freight Management	compliance review report	W	national	04			X			

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Commercial Vehicle Administration	Fleet and Freight Management	electronic credentials	W,U1t	national	04			X			
Commercial Vehicle Administration	Government Administrators	tax-credentials-fees request	W	national	04			X			
Commercial Vehicle Administration	Other CVAS	credentials and safety information request	W	national	04			X			
Commercial Vehicle Administration	Other CVAS	CVAS information exchange	W	national	04			X		X	
Commercial Vehicle Administration	Planning Subsystem	operational data	W	regional	04				X		
Commercial Vehicle Check	Commercial Vehicle Administration	citation and accident data	W	regional	04	P		X			
Commercial Vehicle Check	Commercial Vehicle Administration	credentials information request	W	regional	04			X			
Commercial Vehicle Check	Commercial Vehicle Administration	international border crossing data update	W	regional	04					X	
Commercial Vehicle Check	Commercial Vehicle Administration	roadside log update	W	regional	04			X		X	
Commercial Vehicle Check	Commercial Vehicle Administration	safety information request	W	regional	04			X		X	
Commercial Vehicle Check	Commercial Vehicle Driver	CVO Pull in message	H	regional	H			X		X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	border clearance event record	U2	national	01	T				X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	border clearance request	U2	national	01	T				X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	clearance event record	U2	national	01	T		X		X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	lock tag data request	U2	national	01	T				X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	on-board safety request	U2	national	01	T				X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	pass/pull-in	U2	national	01	T,R		X		X	
Commercial Vehicle Check	Commercial Vehicle Subsystem	safety inspection record	U2	national	01	T				X	

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Commercial Vehicle Check	Commercial Vehicle Subsystem	screening request	U2	national	01	T		X		X	
Commercial Vehicle Check	CVO Inspector	CVO inspector information	H	product	H					X	
Commercial Vehicle Driver	Commercial Vehicle Subsystem	CVO driver initialization	H	product	H			X			
Commercial Vehicle Manager	Fleet and Freight Management	fleet manager inquiry	H	product	H			X			
Commercial Vehicle Subsystem	Commercial Vehicle	lock tag data request	W	product						X	
Commercial Vehicle Subsystem	Commercial Vehicle Check	border clearance data	U2	national	01	T				X	
Commercial Vehicle Subsystem	Commercial Vehicle Check	lock tag data	U2	national	01	T				X	
Commercial Vehicle Subsystem	Commercial Vehicle Check	on board safety data	U2	national	01	T				X	
Commercial Vehicle Subsystem	Commercial Vehicle Check	screening data	U2	national	01	T,R		X		X	
Commercial Vehicle Subsystem	Commercial Vehicle Driver	alerts, messages	H	product	H			X			
Commercial Vehicle Subsystem	Commercial Vehicle Driver	CVO Pull in message	H	product	H			X		X	
Commercial Vehicle Subsystem	Commercial Vehicle Driver	log information	H	product	H			X			
Commercial Vehicle Subsystem	Fleet and Freight Management	driver and vehicle information	U1t	none	P			X			
Commercial Vehicle Subsystem	Fleet and Freight Management	on board vehicle data	U1t,U2	none	P					X	
Commercial Vehicle Subsystem	Vehicle	processed cargo data	W	product	I					X	
Construction and Maintenance	Traffic Management	work zone status	H	product	H		X				
CVO Information Requestor	Commercial Vehicle Administration	credentials and safety information request	W	national	04			X			
CVO Inspector	Commercial Vehicle Check	CVC override mode	H	product	H	T		X		X	

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
CVO Inspector	Commercial Vehicle Check	CVO inspector input	H	product	H			X			
DMV	Commercial Vehicle Administration	registration	W	national	04	P		X			
DMV	Parking Management	vehicle characteristics	W	national			X				
DMV	Toll Administration	registration	W	national		P	X				
DMV	Traffic Management	registration	W	national	06	P	X				
Driver	Vehicle	driver inputs	H	product	H				X		
Driver	Vehicle	request for service	H	product	H		X				
E911 or ETS	Emergency Management	incident information	W	regional	09		X				
Emergency Management	E911 or ETS	emergency status	W	regional	09		X				
Emergency Management	Emergency System Operator	emergency dispatch status	H	product	H		X				
Emergency Management	Emergency Vehicle Subsystem	assigned route	U1t	regional		E	X				
Emergency Management	Emergency Vehicle Subsystem	emergency dispatch requests	U1t	regional		E	X				
Emergency Management	Emergency Vehicle Subsystem	Hazmat information	U1t	regional		E		X			
Emergency Management	Fleet and Freight Management	Hazmat information request	W	national	09	E		X			
Emergency Management	Information Service Provider	emergency vehicle route request	W	regional	09	E	X				
Emergency Management	Information Service Provider	incident information	W	regional	09		X				
Emergency Management	Map Update Provider	map update request	W	national	02		X				
Emergency Management	Other EM	emergency coordination	W	regional	09	E	X		X		
Emergency Management	Personal Information Access	emergency acknowledge	W,U1t	national	05				X		
Emergency Management	Planning Subsystem	operational data	W	regional	09				X		

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Emergency Management	Remote Traveler Support	emergency acknowledge	W,U1t	national	05				X		
Emergency Management	Traffic Management	emergency vehicle greenwave request	W	regional	08,09	E	X				
Emergency Management	Traffic Management	incident information	W	regional	09		X	X			
Emergency Management	Traffic Management	incident response status	W	regional	09		X				
Emergency Management	Transit Management	transit emergency coordination data	W	regional	09,05		X				
Emergency Management	Vehicle	emergency acknowledge	U1t	national	05				X		
Emergency System Operator	Emergency Management	emergency dispatch request	H	product	H		X				
Emergency Vehicle Driver	Emergency Vehicle Subsystem	EV driver inputs	H	product	H	E	X				
Emergency Vehicle Subsystem	Emergency Management	emergency vehicle driver inputs	U1t	regional		E	X				
Emergency Vehicle Subsystem	Emergency Management	emergency vehicle driver status update	U1t	regional		E	X				
Emergency Vehicle Subsystem	Emergency Management	emergency vehicle tracking data	U1t	regional		E	X				
Emergency Vehicle Subsystem	Emergency Vehicle Driver	emergency dispatch order	H	product	H	E	X				
Emergency Vehicle Subsystem	Roadway Subsystem	emergency vehicle preemption request	U2	regional	08,01	T,E	X				
Emissions Management	Map Update Provider	map update request	W	national	02						X
Emissions Management	Planning Subsystem	operational data	W	regional					X		
Emissions Management	Roadway Subsystem	vehicle pollution criteria	W	product	07						X
Emissions Management	Traffic Management	widearea statistical pollution information	W	product	07						X
Emissions Management	Traffic Operations Personnel	pollution data display	H	product	H						X

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Enforcement Agency	Commercial Vehicle Administration	information on violators	W	regional	04	P		X			
Environment	Emissions Management	pollution data	P	NA							X
Environment	Roadway Subsystem	pollution data	P	NA							X
Event Promoters	Traffic Management	event plans	W	regional	06						X
Financial Institution	Commercial Vehicle Administration	transaction status	W	national	04	F		X			
Financial Institution	Information Service Provider	transaction status	W	national	E	F					X
Financial Institution	Parking Management	transaction status	W	national	E	F	X				
Financial Institution	Toll Administration	transaction status	W	national	E	F	X				
Financial Institution	Transit Management	transaction status	W	national	E	F	X				
Fleet and Freight Management	Commercial Vehicle Administration	credential application	W	national	04			X			
Fleet and Freight Management	Commercial Vehicle Administration	information request	W	national	04			X			
Fleet and Freight Management	Commercial Vehicle Administration	tax filing, audit data	w	national	04	P				X	
Fleet and Freight Management	Commercial Vehicle Manager	fleet status	H	product	H			X			
Fleet and Freight Management	Commercial Vehicle Subsystem	fleet to driver update	U1t	none	P			X			
Fleet and Freight Management	Emergency Management	Hazmat information	W	national	09,05			X			
Fleet and Freight Management	Information Service Provider	route request	W	none	10	P		X			
Fleet and Freight Management	Intermodal Freight Depot	intermod CVO coord	W	national	04					X	
Fleet and Freight Management	Intermodal Freight Shipper	intermod CVO coord	W	regional	04					X	
Fleet and Freight Management	Payment Instrument	request for payment	S	national				X			
Government Administrators	Commercial Vehicle Administration	regulations	W	national	04			X			

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Information Service Provider	Emergency Management	emergency vehicle route	W	regional	09		X				
Information Service Provider	Emergency Management	incident information request	W	regional	09		X				
Information Service Provider	Financial Institution	payment request	W	national	E						X
Information Service Provider	Fleet and Freight Management	route plan	W	none	10	P		X			
Information Service Provider	Intermodal Transportation Service Provider	intermodal information	W	regional	10		X				
Information Service Provider	ISP Operator	ISP route planning parameters	H	product	H						X
Information Service Provider	Map Update Provider	map update request	W	national	02						X
Information Service Provider	Media	incident information	W	product	10		X				
Information Service Provider	Media	traffic information	W	product	10		X				
Information Service Provider	Media Operator	incident information	W	product	10		X				
Information Service Provider	Media Operator	traffic information	W	product	10		X				
Information Service Provider	Other ISP	ISP coord	W	national	10						X
Information Service Provider	Parking Management	parking lot data request	W	regional	10	P					X
Information Service Provider	Parking Management	parking reservations request	W	regional	10	P					X
Information Service Provider	Personal Information Access	broadcast information	W,U1b	national	03		X				X
Information Service Provider	Personal Information Access	traveler information	W,U1t	national	03	P	X				X
Information Service Provider	Personal Information Access	trip plan	W,U1t	national	03	P	X				X

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Information Service Provider	Planning Subsystem	road network use	W	regional	10				X		
Information Service Provider	Remote Traveler Support	broadcast information	W,U1b	product	10		X				
Information Service Provider	Remote Traveler Support	traveler information	W,U1t	product	10	P	X				X
Information Service Provider	Remote Traveler Support	trip plan	W	product	10	P	X				X
Information Service Provider	Toll Administration	toll data request	W	regional	10		X				
Information Service Provider	Traffic Management	incident notification	W	regional	06		X				
Information Service Provider	Traffic Management	logged route plan	W	regional	06	P					X
Information Service Provider	Traffic Management	request for traffic information	W	regional	06		X				X
Information Service Provider	Traffic Management	road network use	W	regional	06		X				
Information Service Provider	Transit Management	demand responsive transit request	W	regional	10	P					X
Information Service Provider	Transit Management	selected routes	W	regional	10	P					X
Information Service Provider	Transit Management	transit information request	W	regional	10		X				X
Information Service Provider	Vehicle	broadcast information	U1b	national	03		X				X
Information Service Provider	Vehicle	traveler information	U1t,U1b	national	03	P	X				X
Information Service Provider	Vehicle	trip plan	U1t	national	03	P					X
Information Service Provider	Yellow Pages Service Providers	provider registration confirm	W	national	10	P					X
Information Service Provider	Yellow Pages Service Providers	travel service request	W	national	10	P					X
Intermodal Freight Depot	Fleet and Freight Management	intermod CVO coord	W	national	04					X	

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Intermodal Freight Shipper	Fleet and Freight Management	intermod CVO coord	W	regional	04					X	
Intermodal Transportation Service Provider	Information Service Provider	intermodal information	W	regional	10		X				
Intermodal Transportation Service Provider	Transit Management	intermodal information	W	regional			X				
ISP Operator	Information Service Provider	route planning parameters	H	product	H						X
Location Data Source	Personal Information Access	position fix	L	product	02				X		X
Location Data Source	Vehicle	position fix	L	product	02		X		X		X
Map Update Provider	Emergency Management	map updates	W	national	02		X				
Map Update Provider	Emissions Management	map updates	W	national	02						X
Map Update Provider	Information Service Provider	map updates	W	national	02						X
Map Update Provider	Personal Information Access	map updates	W,U1t	national	02				X		X
Map Update Provider	Planning Subsystem	map updates	W	national	02				X		
Map Update Provider	Remote Traveler Support	map updates	W	national	02						X
Map Update Provider	Traffic Management	map updates	W	national	02		X				
Map Update Provider	Transit Management	map updates	W	national	02		X				
Map Update Provider	Vehicle	map updates	U1t	national	02		X		X		X
Media	Information Service Provider	external reports	W	product	10		X				
Media Operator	Information Service Provider	incident notification	W	product	10		X				
Multimodal Crossings	Roadway Subsystem	request for right of way	W	national		R					X
Multimodal Crossings	Roadway Subsystem	right of way preemption request	W	national		R	X				

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Other CVAS	Commercial Vehicle Administration	credentials and safety information response	W	national	04			X			
Other CVAS	Commercial Vehicle Administration	CVAS information exchange	W	national	04			X		X	
Other EM	Emergency Management	emergency coordination	W	regional	09	E	X		X		
Other ISP	Information Service Provider	ISP coord	W	national	10						X
Other TM	Traffic Management	TMC coord.	W	regional	06		X				X
Other TRM	Transit Management	TRMS coord	W	regional			X				
Other Vehicle	Vehicle	vehicle to vehicle coordination	U3	national	A	T,R					X
Parking Management	DMV	license request	W	national			X				
Parking Management	Driver	transaction status	H	product	H		X				
Parking Management	Enforcement Agency	violation notification	W	regional			X				
Parking Management	Financial Institution	payment request	W	national	E		X				
Parking Management	Information Service Provider	parking availability	W	regional	10						X
Parking Management	Information Service Provider	parking lot reservation confirmation	W	regional	10						X
Parking Management	Parking Operator	parking status	W	product							X
Parking Management	Parking Service Provider	parking availability	W	product							X
Parking Management	Planning Subsystem	operational data	W	regional					X		
Parking Management	Traffic Management	demand management price change response	W	regional	06						X
Parking Management	Traffic Management	parking availability	W	regional	06						X
Parking Management	Transit Management	transit parking coordination	W	regional			X				
Parking Management	Vehicle	request tag data	U2	national	01	T,R	X				
Parking Management	Vehicle	tag update	U2	national	01	T,R	X				
Parking Operator	Parking Management	parking instructions	H	product	H		X				
Parking Service Provider	Parking Management	request for performance data	W	product							X

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Payment Instrument	Fleet and Freight Management	payment	S	national				X			
Payment Instrument	Personal Information Access	payment	S	national							X
Payment Instrument	Remote Traveler Support	Payment	S	national		F	X				
Payment Instrument	Transit Vehicle Subsystem	payment	S	national		F	X				
Payment Instrument	Vehicle	payment	S	national		F	X				
Pedestrians	Roadway Subsystem	crossing call	H	national	H		X				
Personal Information Access	Emergency Management	emergency notification	U1t	national	05	E			X		
Personal Information Access	Information Service Provider	traveler information request	W,U1t	national	03	P	X				
Personal Information Access	Information Service Provider	trip confirmation	W,U1t	national	03	P					X
Personal Information Access	Information Service Provider	trip request	W,U1t	national	03	P	X				X
Personal Information Access	Information Service Provider	yellow pages request	W,U1t	national	03	P					X
Personal Information Access	Map Update Provider	map update request	W,U1t	national	02				X		
Personal Information Access	Payment Instrument	request for payment	S	national							X
Personal Information Access	Transit Management	demand responsive transit request	U1t	national							X
Personal Information Access	Traveler	traveler interface updates	H	product	H	P			X		
Planning Subsystem	Map Update Provider	map update request	W	national	02				X		
Planning Subsystem	Traffic Management	planning data	W	regional	06				X		
Planning Subsystem	Transportation Planners	planning data	W	regional					X		
Potential Obstacles	Vehicle	physical presence	P	NA							X
Remote Traveler Support	Emergency Management	emergency notification	W,U1t	national	05	E			X		

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Remote Traveler Support	Information Service Provider	traveler information request	W	product	10	P	X				
Remote Traveler Support	Information Service Provider	traveler selection	W	product	10	P	X				
Remote Traveler Support	Information Service Provider	trip request	W	product	10	P	X				X
Remote Traveler Support	Information Service Provider	yellow pages request	W	product	10	P					X
Remote Traveler Support	Map Update Provider	map update request	W	national	02						X
Remote Traveler Support	Payment Instrument	request for payment	S	national		F	X				
Remote Traveler Support	Transit Management	emergency notification	W	product	05,11	E	X				
Remote Traveler Support	Transit Management	transit request	W	product	11	P	X				
Remote Traveler Support	Transit Management	traveler information request	W	product	11	P	X				
Remote Traveler Support	Transit User	traveler information	H	product	H		X				
Remote Traveler Support	Traveler	traveler interface updates	H	product	H	P	X				
Roadway	Vehicle	roadway conditions	P	NA							X
Roadway Environment	Roadway Subsystem	weather conditions	P	NA							X
Roadway Environment	Vehicle	weather conditions	P	NA							X
Roadway Subsystem	Driver	traffic information	H	national	H		X				
Roadway Subsystem	Emissions Management	pollution data	W	product	07						X
Roadway Subsystem	Multimodal Crossings	grant right of way and/or stop traffic	W	national		R	X				
Roadway Subsystem	Pedestrians	crossing permission	H	national	H		X				
Roadway Subsystem	Traffic Management	AHS status	W	product	07						X
Roadway Subsystem	Traffic Management	fault reports	W	product	07		X				
Roadway Subsystem	Traffic Management	freeway control status	w	product	07		X				

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Roadway Subsystem	Traffic Management	HOV data	W	product	07		X				
Roadway Subsystem	Traffic Management	incident data	W	product	07		X				
Roadway Subsystem	Traffic Management	local traffic flow	W	product	07		X				X
Roadway Subsystem	Traffic Management	request for right of way	W	product	08		X				X
Roadway Subsystem	Traffic Management	signal control status	W	product	07		X				
Roadway Subsystem	Traffic Management	signal priority request	W	product	08,07	R	X				
Roadway Subsystem	Traffic Management	vehicle probe data	W	product	07		X				X
Roadway Subsystem	Vehicle	AHS control data	U2	national	01	T,R					X
Roadway Subsystem	Vehicle	intersection status	U2	national	01	T,R					X
Roadway Subsystem	Vehicle	request tag data	U2	national	01	T	X				
Roadway Subsystem	Vehicle	vehicle signage data	U2	national	01	T					X
Secure Area Environment	Transit Management	physical activities	P	product		P	X				
Toll Administration	DMV	license request	W	national			X				
Toll Administration	Enforcement Agency	violation notification	W	regional			X				
Toll Administration	Financial Institution	payment request	W	national	E		X				
Toll Administration	Information Service Provider	probe data	W	regional	06		X				
Toll Administration	Information Service Provider	toll data	W	regional	10		X				
Toll Administration	Planning Subsystem	operational data	W	regional					X		
Toll Administration	Toll Collection	toll instructions	W	regional			X				
Toll Administration	Toll Operator	toll transaction reports	H	product	H		X				
Toll Administration	Toll Service Provider	toll revenues and summary reports	W	product			X				
Toll Administration	Traffic Management	demand management price change response	W	regional	06						X
Toll Administration	Traffic Management	probe data	W	regional	06		X				
Toll Collection	Driver	transaction status	H	national	H		X				
Toll Collection	Toll Administration	toll transactions	W	regional			X				
Toll Collection	Vehicle	request tag data	U2	national	01	T,R	X				
Toll Collection	Vehicle	tag update	U2	national	01	T,R	X				
Toll Operator	Toll Administration	toll operator requests	H	product	H		X				

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Toll Service Provider	Toll Administration	toll fees	H	product	H		X				
Traffic	Roadway Subsystem	vehicle count	P	NA			X				
Traffic Management	Construction and Maintenance	work schedule	H	product	H		X				
Traffic Management	DMV	license request	W	national	06		X				
Traffic Management	Emergency Management	incident information request	W	regional	09	E	X				
Traffic Management	Emergency Management	incident notification	W	regional	09	E	X	X			
Traffic Management	Emissions Management	pollution state data request	W	product	07						X
Traffic Management	Enforcement Agency	violation notification	W	regional	06		X				
Traffic Management	Event Promoters	event confirmation	W	regional	06		X				
Traffic Management	Information Service Provider	traffic information	W	regional	06		X				X
Traffic Management	Map Update Provider	map update request	W	national	02		X				
Traffic Management	Other TM	TMC coord.	W	regional	06		X				X
Traffic Management	Parking Management	demand management price change request	W	regional	06		X				X
Traffic Management	Parking Management	parking instructions	W	regional	06						X
Traffic Management	Planning Subsystem	operational data	W	regional	06				X		
Traffic Management	Roadway Subsystem	AHS control information	W	product	07						X
Traffic Management	Roadway Subsystem	freeway control data	W	product	07	T,S	X				
Traffic Management	Roadway Subsystem	signage data	W	product	07	S	X				X
Traffic Management	Roadway Subsystem	signal control data	W	product	07	T,S	X				X
Traffic Management	Toll Administration	demand management price change request	W	regional	06		X				X
Traffic Management	Traffic Operations Personnel	traffic operations data	H	product	H		X				
Traffic Management	Transit Management	demand management price change request	W	regional	06						X
Traffic Management	Transit Management	signal priority status	W	regional	06		X				
Traffic Management	Transit Management	traffic information	W	regional	06		X				

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Traffic Operations Personnel	Emissions Management	pollution data parameters	H	product	H						X
Traffic Operations Personnel	Traffic Management	traffic control	H	product	H		X				
Transit Driver	Transit Vehicle Subsystem	transit driver inputs	H	product	H		X				
Transit Fleet Manager	Transit Management	schedule Guidelines	H	product	H		X				
Transit Maintenance Personnel	Transit Management	maint Status	H	product	H		X				
Transit Management	Emergency Management	security alarms	W	regional	05,09	E	X				
Transit Management	Enforcement Agency	violation notification	W	regional			X				
Transit Management	Financial Institution	payment request	W	national	E		X				
Transit Management	Information Service Provider	demand responsive transit plan	W	regional	10	P					X
Transit Management	Information Service Provider	transit and fare schedules	W	regional	10		X				X
Transit Management	Information Service Provider	transit request confirmation	W	regional	10	P	X				
Transit Management	Intermodal Transportation Service Provider	intermodal information	W	regional			X				
Transit Management	Map Update Provider	map update request	W	national	02		X				
Transit Management	Other TRM	TRMS coord	W	regional			X				
Transit Management	Parking Management	parking lot transit response	W	regional			X				
Transit Management	Personal Information Access	demand responsive transit route	W,U1t	national							X
Transit Management	Planning Subsystem	operational data	W	regional					X		
Transit Management	Remote Traveler Support	emergency acknowledge	W	product	05,11		X				
Transit Management	Remote Traveler Support	transit and fare schedules	W	product	11		X				
Transit Management	Remote Traveler Support	traveler information	W	product	11	P	X				

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Transit Management	Secure Area Environment	camera control	W	product			X				
Transit Management	Secure Area Environment	emergency acknowledge	W	product			X				
Transit Management	Traffic Management	demand management price change response	W	regional	06						X
Transit Management	Traffic Management	request for transit signal priority	W	regional	08,06		X				
Transit Management	Traffic Management	transit system data	W	regional	06		X				
Transit Management	Transit Driver	route assignment	H	product	H		X				
Transit Management	Transit Fleet Manager	actual schedule and fare info	H	product	H		X				
Transit Management	Transit Maintenance Personnel	work schedule	H	product	H		X				
Transit Management	Transit System Operators	transit operator display	H	product	H		X				
Transit Management	Transit Vehicle Subsystem	bad tag list	U1t	product	11		X				
Transit Management	Transit Vehicle Subsystem	driver instructions	U1t	product	11		X				
Transit Management	Transit Vehicle Subsystem	emergency acknowledge	U1t	product	05,11		X				
Transit Management	Transit Vehicle Subsystem	request for vehicle measures	U1t,U2	product	11		X				
Transit Management	Transit Vehicle Subsystem	schedules, fare info request	U1t	product	11		X				
Transit Management	Transit Vehicle Subsystem	traveler information	U1t	product	11	P	X				
Transit System Operators	Transit Management	transit operator fare schedules	H	product	H		X				
Transit User	Remote Traveler Support	traveler information request	H	product	H		X				
Transit User	Transit Vehicle Subsystem	emergency notification	H	product	H		X				
Transit User	Transit Vehicle Subsystem	transit user inputs	H	product	H		X				

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Transit Vehicle	Transit Vehicle Subsystem	vehicle measures	W	product	I	R	X				
Transit Vehicle Subsystem	Payment Instrument	request for payment	S	national		F	X				
Transit Vehicle Subsystem	Roadway Subsystem	local signal priority request	U2	regional	01,08	T	X				
Transit Vehicle Subsystem	Transit Driver	transit driver display	H	product	H		X				
Transit Vehicle Subsystem	Transit Management	emergency notification	U1t	product	11,05	E	X				
Transit Vehicle Subsystem	Transit Management	fare and payment status	U1t,U2	product	11	F,T	X				
Transit Vehicle Subsystem	Transit Management	request for bad tag list	U1t,U2	product	11	F,T	X				
Transit Vehicle Subsystem	Transit Management	transit vehicle conditions	U1t,U2	product	11		X				
Transit Vehicle Subsystem	Transit Management	transit vehicle passenger and use data	U1t,U2	product	11		X				
Transit Vehicle Subsystem	Transit Management	traveler information request	U1t	product	11	P	X				
Transit Vehicle Subsystem	Transit Management	vehicle probe data	U1t	product	11		X				
Transit Vehicle Subsystem	Transit User	transit user fare status	H	product	H		X				
Transit Vehicle Subsystem	Transit User	transit user outputs	H	product	H		X				
Transit Vehicle Subsystem	Vehicle	traveler advisory request	W	product			X				
Transportation Planners	Planning Subsystem	planning data	W	regional					X		
Traveler	Personal Information Access	traveler information request	H	product	H		X				
Traveler	Remote Traveler Support	traveler information request	H	product	H		X				
Vehicle	Basic Vehicle	vehicle control	W	product	I	R					X

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Vehicle	Commercial Vehicle Subsystem	cargo data request	W	product	I					X	
Vehicle	Driver	driver updates	H	product	H				X		
Vehicle	Driver	transaction status	H	product	H		X				
Vehicle	Emergency Management	emergency notification	U1t	national	05	E		X	X		
Vehicle	Emergency Vehicle Subsystem	vehicle location	W	product			X				
Vehicle	Information Service Provider	traveler information request	U1t	national	03	P	X				
Vehicle	Information Service Provider	trip confirmation	U1t	national	03	P					X
Vehicle	Information Service Provider	trip request	U1t	national	03	P					X
Vehicle	Information Service Provider	vehicle probe data	U1t	national	03	P	X				
Vehicle	Information Service Provider	yellow pages request	U1t	national	03	P					X
Vehicle	Map Update Provider	map update request	U1t	national	02				X		
Vehicle	Other Vehicle	vehicle to vehicle coordination	U3	national	A	T,R					X
Vehicle	Parking Management	tag data	U2	national	01	T,P	X				
Vehicle	Payment Instrument	request for payment	S	national		F	X				
Vehicle	Roadway Subsystem	AHS vehicle data	U2	national	01	T,R					X
Vehicle	Roadway Subsystem	vehicle probe data	U2	national	01	T,P	X				X
Vehicle	Toll Collection	tag data	U2	national	01	T,P	X				
Vehicle	Transit Vehicle Subsystem	vehicle location	W	product	I		X				
Vehicle Characteristics	Parking Management	vehicle image	P	NA		P	X				
Vehicle Characteristics	Toll Collection	vehicle image	P	NA		P	X				
Weather Service	Information Service Provider	weather information	W	regional	10		X				
Weather Service	Traffic Management	weather information	W	regional	06						X

		Architecture	Inter-	Interoper-	Stndrd	Spc'l	Early			Advanced	
Source	Destination	Flow	connects	ability	Pkg	Cnstrt	ITI	CVISN	Other	CVISN	Other
Yellow Pages Service Providers	Information Service Provider	provider registration	W	national	10						X
Yellow Pages Service Providers	Information Service Provider	travel service info	W	national	10						X

*** Interconnect Types as defined in Table A2.2 (Communications Document Chapter 3)**
Interoperability Types in Table A2.3 (Standards Development Plan Chapter 1)
Standards Packages in Table A2.4 (Standards Requirements Document)
Special Constraints in Table A2.5 (Physical Architecture Chapter 2.23)

Table A2.2 Interconnect Types

Interconnect	Interconnect Name	Interconnect Description
H	Human Interface	Can be either a user interface to the system, an operator interface, or a driver.
L	Position Location	Interface between position location equipment and the source for indicating position location. This could be either information from a terrestrial source, GPS, FM subcarrier, Dead Reckoning etc
P	Physical Interface	This is an interface which senses some physical characteristic or causes some action that is not represented using standard communications technology (e.g. observing an obstacle)
S	Payment Instrument	This interface is between the card which is carried by the traveler and which contains the account number of stored value and the an object which accepts this information. The non-card interface could be a reader at a kiosk or in a vehicle. In the latter case, the reader in the vehicle forwards the information to the infrastructure.
U1t	Wide Area Wireless	Wide area 2-way communication capable of communication between a mobile traveler or vehicle and the infrastructure from any location.
U1b	Wide Area Broadcast	Wide area broadcast information in which the mobile traveler or vehicle can receive information from any location.
U2	Vehicle-to-Roadside	Short range vehicle to roadside (e.g. beacon). The interface contains information regarding which mobile entity is communicating.
U3	Vehicle-to-Vehicle	Primarily AHS type communications yet to be defined
W	Wireline	Wireline system interconnect which includes fixed to fixed communication capabilities. May include wide area wireless capabilities for transportable devices such as CMS, and may include short hop wireless connections to wireline subsystems from distributed assets such as signal and sensors. Includes normal telephone and public and private fiber-optic links.

Table A2.3 Interoperability Types

Interoperability	Description
National	Interfaces to the mobile subsystems (Vehicle Subsystems, Personal Information Access Subsystems) in the architecture support national interoperability since the same mobile subsystem should be able to roam the nation and use the local infrastructure to support ITS services. National interoperability is specified for all interfaces to mobile subsystems except where both the mobile subsystem and interfacing infrastructure are owned and operated by the same user. Examples of these include the Information Service Provider to Personal Information Access Subsystem, Toll Collection Subsystem to Vehicle Subsystem, and the Commercial Vehicle Subsystem to Commercial Vehicle Check Subsystem.
Regional	Interfaces connecting subsystems that may be operated by different agencies (interfaces that can span jurisdictional and/or regional boundaries) can be standardized to facilitate the sharing of information between agencies. National standards mitigate issues that may arise as boundaries change and new requirements for information sharing develop over time. Regional interoperability is specified where the underlying coordination issues are regional, rather than national, in scope. For instance, there is no real requirement for a Traffic Management Subsystem in California to be able to communicate and coordinate with a Traffic Management Subsystem in New York. Two different regional dialects for Traffic Management Subsystem communications could be implemented in the two geographically isolated subsystems, without significant impact to national interoperability goals. Examples of these include the Traffic Management Subsystem to Transit Management Subsystem, Traffic Management Subsystem to Information Service Provider, and Traffic Management Subsystem to Traffic Management Subsystem.
Product	Interfaces between subsystems that are operated and maintained by a single stakeholder (e.g. company or agency) do not require standardization to achieve national interoperability. The data formats and communications mechanisms that are used for these interfaces are largely transparent to the remainder of the architecture. In some cases, national standards are still very beneficial (and hence still attainable through the consensus standard process) since they may consolidate a market to achieve economy of scale efficiencies (e.g. Traffic Management Subsystem to Roadway Subsystem). Such standards may also support an optional level of interoperability by enabling various cooperative control options to be implemented based on regional preference.
None	In other cases, the sheer range of application-specific interfaces precludes efficient national standardization and no standard is suggested. For instance, a national standard is not recommended for the interface between the Fleet Management and Commercial Vehicle subsystems since the nature of the interface is so dependent on fleet type. From the National Architecture perspective, standardization for these interfaces is not suggested. Examples include the Fleet Management Subsystem to Commercial Vehicle Subsystem.

Table A2.4 Standards Packages

Number	Requirement Package Name
01	Dedicate Short Range Communications (DSRC)
02	Digital Map Data Exchange and Location Referencing
03	Information Service Provider Wireless Interfaces
04	Inter-Center Data Exchange for Commercial Vehicle Operations
05	Personal and HAZMAT Maydays
06	Traffic Management Subsystems to Other Centers (Except EM)
07	Traffic Management Subsystems to Roadway Devices and Emissions Sensing/Management
08	Signal Priority for Transit and Emergency Vehicles
09	Emergency Management to Other Centers
10	Information Service Provider to Other Centers (except EM and TMS)
11	Transit Management to Transit Vehicle
A	AHS Standards
E	Existing Standards
I	Internal and probably proprietary
P	Proprietary Standards
H	Human Interfaces

Table A2.5 Special Constraints

Constraint Abbreviation	Constraint Name	Description
R	Reliability	Failure of the communication medium may result in severe accident. This communication channel may require redundant paths or extra attention paid to potential failure modes. For wireline cases, this may indicate alternate phone or other connections are required. For wireless cases (for AHS applications), special attention will be paid to the transmitters, receivers, and potential interference for these connections
F	Financial Security	Data contains financial information and must be protected accordingly. This data is specifically called out between the user's card and the infrastructure and between the infrastructure and financial institutions. Protections currently exist for the latter. Financial data transmitted over the air must be recognized as private data with an additional reliability requirement. Financial data may exist between other subsystems as part of normal messaging. It is assumed that such data will be treated with the same constraints as the interfaces specifically identified
P	Personal Privacy	Data contains personal information. Traveler requests and traveler location are private and should be protected. Subsystems aggregate these data and forward specific data with the traveler's permission.
E	Emergency Priority	Communication channel requires priority in emergencies. These data channels require that they be operational even when there is an emergency which might place other loads on the interface. A private communication channel or frequency may be required to satisfy the requirement.
T	Performance (Timing)	Timing is critical. Timing for most ITS communication services is based on the response to a request for data. Because of this, common communication media designed to handle voice data will likely support these requirements. The beacon interface has special requirements of identifying the vehicle as well as exchanging information before the vehicle gets out of range. This is more of a problem with vehicles traveling at speed. The architecture constrains such time critical access to data such that the data is available at the beacon site. This obviates the need for explicit specification of other timing information to support data transfer over a short range beacon.

Appendix 3 - Standards Needs Based on Standards Workshop

These needs areas are based on input from standards organizations at a workshop in the Summary 1995. Each needs area is mapped into one of the architecture standards requirements packages.

Table A3.1 Standards Needs as Related to Standards Requirements Packages

No.	Description of Need	G	01	02	03	04	05	06	07	08	09	10	11	H	I
03	Umbrella Standard for ITS Data Dictionaries	X													
08	Message Set Template	X													
42	ASN.1 application to ITS Message definition recommended practice	X													
44	Survey of Communications Technologies, Practices, and Standards Relevant to ITS	X													
06	Commercial Vehicle Operations Data Dictionary		X												
10	Message Set for Electronic Toll Collection		X												
18	Message set for Automatic Vehicle Identification		X												
26	Message set for Parking Management		X												
33	Dedicated Short Range Communications Protocol		X												
01	Location Reference Specification			X											
02	Spatial Data Interchange			X											
05	Traveler Information Data Dictionary			X											
09	ITS Map Datum			X											
19	Message Set for Automatic Vehicle Location			X											
38	Enhanced Map Database Truth in Labeling Standard			X											
43	Independent testing Institute for validation of map database vendor representations under SAE J1663			X											
05	Traveler Information Data Dictionary				X										
11	Message Set for Vehicle Navigation (1) Outbound Traffic Broadcast				X										
12	Message Set for Vehicle Navigation (2) Interactive Route Guidance				X										
19	Message Set for Automatic Vehicle Location				X										
35	High Speed Data Subcarrier Protocol				X										
36	Radio Broadcast Data System Protocol				X										

No.	Description of Need	G	01	02	03	04	05	06	07	08	09	10	11	H	I
06	Commercial Vehicle Operations Data Dictionary					X									
21	Message set for Hazard Material Management					X									
27	Message set for Commercial Vehicle Safety and Credentials Information Exchange					X									
28	Message set for COmmercial Vehicle Credentials					X									
29	Message set for Commercial Vehicle Complance Review Reporting					X									
31	Message set for Accident Reporting					X									
32	Message set for Commercial Vehicle International Border Crossing					X									
07	Public Transit Data Dictionary						X								
13	Message set for Mayday Alert						X								
21	Message set for Hazard Material Management						X								
04	Traffic Management Data Dictionary							X							
16	Message set for TMC Intercommication							X							
17	Message set for External TMC Communication							X							
26	Message set for Parking Management							X							
04	Traffic Management Data Dictionary								X						
11	Message Set for Vehicle Navigation (1) Outbound Traffic Broadcast								X						
15	Message set for Controlling Field Equipment (NTCIP)								X						
34	National Transportation Communications ITS Protocol								X						
37	Traffic Control 2070 (NTCIP)								X						
04	Traffic Management Data Dictionary									X					
07	Public Transit Data Dictionary									X					
14	Message set for Priority Traffic Signal Priority									X					
19	Message Set for Automatic Vehicle Location									X					
17	Message set for External TMC Communication										X				
20	Message set for Incident Management										X				
24	Message set for Public Transit Emergency Services										X				
05	Traveler Information Data Dictionary											X			
25	Message set for Public Transit Information Services											X			
26	Message set for Parking Management											X			
07	Public Transit Data Dictionary												X		
19	Message Set for Automatic Vehicle Location												X		
22	Message set for Public transit Electron Fare Collection												X		

No.	Description of Need	G	01	02	03	04	05	06	07	08	09	10	11	H	I
23	Message set for Public Transit Operations Management												X		
25	Message set for Public Transit Information Services												X		
40	Vehicle Navigation/route guidance operation and design guidelines													X	
39	In-vehicle databus interface														X
41	Intelligent cruise control operational characteristics														X

Table A3.2 Standards Packages

Number	Requirement Package Name
01	Dedicate Short Range Communications (DSRC)
02	Digital Map Data Exchange and Location Referencing
03	Information Service Provider Wireless Interfaces
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05	Personal and HAZMAT Maydays
06	Traffic Management Subsystems to Other Centers (Except EM)
07	Traffic Management Subsystems to Roadway Devices and Emissions Sensing/Management
08	Signal Priority for Transit and Emergency Vehicles
09	Emergency Management to Other Centers
10	Information Service Provider to Other Centers (except EM and TMS)
11	Transit Management to Transit Vehicle
G	General Area spanning many features of the architecture
I	Internal and probably proprietary
H	Human Interfaces