September 1998

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Introduction to the National ITS Architecture and Standards Resource Guide

Introduction to the National ITS Architecture and Standards Resource Guide

The Transportation Equity Act for the 21st Century (TEA-21) encourages the use of the National ITS Architecture and the adoption of ITS standards and protocols. This guide provides field personnel with the guidance and resources necessary for implementing the federal policy.

Background

Intelligent Transportation Systems (ITS) provide a means to increase the safety and efficiency of the existing highway and transit infrastructure. The National ITS Program seeks to implement these technologies to improve the operational capacity of the national transportation system.

To optimize the benefits of ITS systems and technologies, a National ITS Architecture was developed. The National ITS Architecture provides a framework for the deployment of ITS technologies, and calls for the adoption of standards and protocols for communicating information. Simply stated, the National ITS Architecture provides the blueprint, the standards and protocols provide the interlocking mortar, and the programs and projects provide the bricks with which the National ITS infrastructure will be constructed and maintained.

TEA-21 promotes the use of the National ITS Architecture and the development and adoption of ITS standards and protocols. This binder provides the guidance for implementing the federal policy as well as supporting resource and reference materials on ITS architecture and standards.

Organization

This guide includes three major sections: Guidance, Information Resources, and Reference Materials.

- **Guidance:** presents the *Interim Guidance on Conformity with the National ITS Architecture and ITS Standards*. The guidance, which is the core of this binder, is the first section that field staff should read; the other sections are designed to assist in the implementation of this guidance.

- **Information Resources:** provides materials or describes how to obtain materials that field personnel can share with stakeholders and policymakers to introduce the issues and benefits associated with National ITS Architecture and standards. These resources are designed to help field staff communicate to other stakeholders the importance of using the National ITS Architecture and associated standards.

- **Reference Materials:** include additional resources to address questions that may not be addressed in this binder.

Electronic Resources

Electronic Document Library

Many of the selections included in this *Resource Guide* are available in the U.S. DOT ITS Electronic Document Library (EDL). The introduction to each subsection indicates whether that selection was available in the EDL at the time of publication by noting the associated EDL document number. The EDL can be accessed through the U.S. DOT's ITS website at

www.its.dot.gov.

ITS Cooperative Deployment Network

The ITS Cooperative Deployment Network, or ICDN, is a shared Internet resource containing up-to-date news, insight, and resources for transportation professionals and agencies on ITS issues. It is sponsored by the National Associations Working Group for ITS, and can be accessed at

www. nawgits.com.

Section One: Guidance

This section includes two documents which present the policy guidance for ensuring consistency with the National ITS Architecture and standards.

A. **Interim Guidance:** the interim policy for implementing the TEA-21 language requiring conformance with the National ITS Architecture and standards. This subsection includes relevant definitions, responses to frequently asked questions, and a TEA-21 legislative excerpt.

B. **Checklist:** a resource to assist federal field staff in using the interim guidance.

Conformity vs. Consistency

The TEA-21 language addressed by the interim guidance calls for "conformity" with the National ITS Architecture and Standards. U.S. DOT's incremental, phased approach to implementing this provision is better reflected by the use of the term "consistency" with the National ITS Architecture. For the purposes of this Resource Guide, these terms are deemed synonymous.

Introduction to Interim Guidance

Contents

This subsection includes the *Interim Guidance on Conformity with the National ITS Architecture and ITS Standards*, which includes a set of definitions, questions and answers, and the legislative language in TEA-21 requiring conformity with the National ITS Architecture.

Summary

This *Interim Guidance* is provided to assist agencies with meeting Section 5206 (e) of TEA-21, which requires that Intelligent Transportation Systems (ITS) projects carried out using funds made available by the Highway Trust Fund conform to the National ITS Architecture, applicable or provisional standards, and protocols. Included with the *Interim Guidance* is a recommended approach to ensure that ITS projects meet the legislative intent. Through the Interim Guidance and recommended approach, U.S. DOT is promoting sound systems planning and design practices for ITS projects, including the consideration of applicable regional ITS architectures, the National ITS Architecture, and applicable standards.

Uses

This *Interim Guidance* is U.S. DOT's interim policy to be used by U.S. DOT field staff and constituent agencies to implement Section 5206 (e) of TEA-21, which calls for conformity with the National ITS Architecture.

To obtain additional copies, see the U.S. DOT's ITS website at www.its.dot.gov.

For more information on inventorying ITS deployments (as addressed in Section V of the *Interim Guidance*), see *Measuring ITS Deployment and Integration* in the Reference Materials section (3-E).

Memorandum

U.S. Department of Transportation
Federal Highway Administration

Subject: **INFORMATION**: Interim Guidance on Conformity with the National ITS Architecture and Standards

Date: October 2, 1998

From: Federal Highway Administrator
Federal Transit Administrator

Reply to Attn of: HVH-1

To: FHWA Division Administrators
FTA Regional Administrators
FHWA\OMC State Directors

Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21) requires that Intelligent Transportation Systems (ITS) projects using funds from the Highway Trust Fund (including the Mass Transit Account) conform to the National ITS Architecture and standards. To begin the process of implementing this legislative requirement, the U.S. Department of Transportation (DOT) has developed the attached Interim Guidance (which includes sections on definitions, questions and answers, and statutory language).

The Interim Guidance reflects input received from Federal, State, local, and private sector transportation stakeholders in conjunction with national transportation association forums and 10 outreach sessions held across the Nation this spring. The intent of the Interim Guidance is to:

- foster integration,
- encourage the incorporation of ITS into the transportation planning process, and
- focus on near-term ITS projects with the greatest potential for affecting regional integration.

The Interim Guidance is effective immediately, and is expected to be in effect for approximately 1 year. During this period, it is anticipated that a final policy will be developed through formal rulemaking. Therefore, Interim Guidance is the first step of a phased approach for implementing the TEA-21 conformity provision.

To support U.S. DOT field staff with implementation of the Interim Guidance, a Resource Guide has been prepared that includes the Interim Guidance, background material on the National ITS Architecture and Standards, benefits of using the National ITS Architecture, ITS and Commercial Vehicle Operations, and additional supplemental information. The Resource Guide will be distributed to members of your staff. In addition, the Department's ITS website serves as a helpful source of current/recently published information: **www.its.dot.gov.**

Interim Guidance

Consistent with the integration goals supported by the National ITS Architecture, as you begin the process of implementing the Interim Guidance, careful consideration of potential Y2K (Year 2000) computer problems should be a crucial part of your efforts. As you know, intelligent, integrated transportation systems, like most computer-based systems, are susceptible to Y2K computer problems. Additional information on Y2K issues specific to ITS can be found at the following website: **www.fhwa.dot.gov/y2k.**

Implementation of the Interim Guidance is an important step toward regional ITS integration. Your comments and experiences in applying the Interim Guidance will help to shape the final policy. Your efforts in support of implementing this Interim Guidance are appreciated.

Gordon J. Linton

Kenneth R. Wykle

Attachments

Interim Guidance on Conformity with the National ITS Architecture and Standards

I. Introduction

The Transportation Equity Act for the 21st Century (TEA-21) contains a provision requiring Intelligent Transportation System (ITS) projects implemented with funds from the Highway Trust Fund (including the Mass Transit Account) to conform to the national architecture [National ITS Architecture], applicable or provisional standards, and protocols. This document provides Interim Guidance for meeting this section of the law (Section 5206(e)—Conformity with National Architecture). Included with the Interim Guidance is a recommended approach to assist in meeting the legislative intent.

II. Background and Goals

Section 5206 of the legislation aims to accelerate the integrated deployment of ITS in metropolitan and rural areas and in commercial vehicle operations through the use of the National ITS Architecture or locally developed regional architectures. The legislation also aims to facilitate interoperability through the use of standards and protocols. The National ITS Architecture is a tool to help agencies identify and plan for the many functions and information sharing opportunities which may be desired.

The greatest benefit from ITS accrues when ITS projects are planned and designed within a broad regional context that supports the operation and management of the transportation system. Additionally, the development and use of a regional ITS architecture to guide the integration of ITS projects and programs and enable information sharing among stakeholders within an area is good, sound practice. Due to the variety of ITS services and stakeholders, a "region" can be defined as metropolitan, statewide, multi-state, and, for some applications, national.

Implementation of this legislative provision will foster sound ITS systems planning and design practices to achieve the following goals:

- involve and unite a wide range of stakeholders in planning for ITS
- support flexibility in tailoring ITS deployment and operations to local requirements
- achieve integration of ITS systems and components
- enable information sharing among stakeholders
- facilitate future ITS expansion in a cost-effective way
- provide for future interoperability of key ITS services at a national level.

The achievement of these goals will ultimately be manifested in five ways:

1. The consideration of transportation system operations and management will be integrated into the transportation planning process and reflected in regional transportation goals and objectives.
2. ITS strategies that effectively address regional goals and objectives will be considered and prioritized within regional planning efforts to promote efficient system management and operation. The development of a regional ITS architecture will complement this framework.
3. ITS projects will provide for all applicable information sharing opportunities.
4. ITS projects will use open standards and protocols in support of interoperability.
5. The National ITS Architecture will be used as a tool in regional architecture development and project design, as appropriate.

III. Applicability and Exceptions

The processes and practices being promoted in this document are sound practices for any project; however, listed below are the factors that affect whether or not this Interim Guidance applies:

Type of Project

For the purposes of the Interim Guidance, projects are classified into four categories:

(1) projects without ITS,
(2) ITS projects that affect regional integration,
(3) ITS/Commercial Vehicle Operations (CVO) projects, and
(4) other ITS projects

Categories (2), (3), and (4) are all considered to be ITS projects. ITS projects include both stand-alone ITS projects and projects that contain ITS elements. (See Appendix A for definitions). The Interim Guidance applies to all ITS projects, with particular attention to those ITS projects that affect regional integration. In the case of category (3), ITS/CVO projects, the Interim Guidance references other procedures that have been developed to support Commercial Vehicle Information Systems and Networks (CVISN) deployment. The Interim Guidance does not apply to category (1), projects without ITS.

Funding Source

All ITS projects receiving funding in whole or in part from the Highway Trust Fund are subject to the Interim Guidance.

Stage of Development

As of the date of issuance of the Interim Guidance, all ITS projects that are under construction or projects for which final design is complete are exempt from this Interim Guidance.

Legislative Exceptions

TEA-21 allows the Secretary to authorize exceptions to the conformity requirement for projects designed to achieve specific research objectives [as defined in Section 5206 (e) (2) (A)] and for projects to upgrade or expand an ITS in existence as of the date TEA-21 was enacted. Only those projects meeting three specific criteria are eligible for exception as an upgrade or expansion. These criteria [as defined in Section 5206 (e) (2) (B)] are that the project:

(i) (would) not adversely affect the goals or purposes of this subtitle [The ITS Act of 1998];
(ii) is carried out before the end of the useful life of such system; and
(iii) is cost-effective as compared to alternatives that would meet the conformity requirement.

TEA-21 also includes a general exception on funds used for the operation or maintenance of an ITS in existence on the date TEA-21 was enacted. A copy of the TEA-21 ITS Act goals, purposes, and exception language is provided in Appendix C.

Meeting the intent of the TEA-21 conformity language (and this Interim Guidance) does not in any way require replacements or retrofitting of existing systems. Logically planned enhancements take existing (or legacy) systems into account. Because one of the purposes of the ITS Act is to improve regional cooperation and operations planning, ITS projects that affect regional integration would generally not satisfy exception criteria (i) above. If an exception is granted, documentation of the determination and rationale should be kept in the project files.

IV. Interim Guidance

For the period of this Interim Guidance, to ensure conformity with the National ITS Architecture and applicable standards, the following applies:

A. ITS Projects

1. Recipients of funds from the Highway Trust Fund for ITS projects that affect regional integration shall evaluate those projects for institutional and technical integration with transportation systems and services within the region, and consistency with the applicable regional ITS architecture or the National ITS Architecture. Based upon this evaluation of the project(s), Highway Trust Fund recipients shall take the appropriate actions to ensure that development of the project(s): (a) engages a wide range of stakeholders, (b) enables the appropriate electronic information sharing between shareholders, (c) facilitates future ITS expansion, and (d) considers the use of applicable ITS standards.

2. Recipients of funds from the Highway Trust Fund for ITS/CVO projects should follow the ITS/CVO Conformance Assurance Process Description to guide development of the project(s). These procedures are provided in the National ITS Architecture and Standards Resource Guide. Projects having a CVO technology component, but not meeting the definition of an ITS/CVO Project, should be treated as either ITS projects that affect regional integration or other ITS projects for the purposes of this Interim Guidance, and are subject to (IV.A.1) above or (IV.A.3) below.

3. Recipients of funds from the Highway Trust Fund for other ITS projects (not deemed to affect regional integration and not defined as ITS/CVO projects) should consider the same evaluation and actions described in (IV.A.1) above.

B. ITS Considerations in Transportation Planning

Statewide and metropolitan planning activities should include consideration of the efficient management and operation of the transportation system. This should include the regional implementation and integration of ITS services and development of a regional ITS architecture(s), as appropriate. Regional consideration of ITS should address (a) the integration of ITS systems and components, (b) inclusion of a wide range of stakeholders, (c) flexibility in tailoring ITS deployment and operations to local needs, (d) electronic information sharing between stakeholders, and (e) future ITS expansion.

The Interim Guidance is anticipated to be in effect for approximately one year. The Interim Guidance is the first step in a phased approach for implementing the TEA-21 conformity provision. The final implementing policy may contain additional requirements.

V. Recommended Approach

An approach for meeting the Interim Guidance (given in section IV) is suggested below.

A. Immediate Actions

1. Agencies should cooperatively work with FHWA Division (Federal Aid and Office of Motor Carriers) and/or FTA Region staff and other local agencies, including the applicable Metropolitan Planning Organization (MPO) or planning agency, to categorize projects receiving funding through the Highway Trust Fund into four categories: (1) projects without ITS, (2) ITS projects that affect regional integration, (3) ITS/CVO projects, and (4) other ITS projects. These categories will help to determine the projects for which the Interim Guidance applies. As a minimum, this action applies to all projects included in transportation plans, Statewide Transportation Improvement Programs (STIPs), Transportation Improvement Programs (TIPs), Commercial Vehicle Safety Plans (CVSPs), projects in design, and other projects that are under consideration. If an overall categorization is not carried out, then determination should be made on a case by case basis by recipient agencies and federal field staff.

2. In consultation with FHWA Division and/or FTA Region field staff and the applicable MPO or planning agency, agencies should determine if a regional ITS architecture exists within which individual ITS projects and programs should fit (at a metropolitan, statewide, corridor, or multi-state level). The regional ITS architecture should be defined at the subsystem and information (architecture) flow level, showing the type of information exchanges planned between specific agencies.

B. ITS Projects

The suggested approach for meeting the Interim Guidance on ITS Projects is provided below for the different categories of ITS projects. It is suggested that these steps be accomplished early in the planning and/or design process, as there will be greater ease in making modifications in the scoping and early design stages.

For ITS Projects that Affect Regional Integration and Other ITS Projects :

The suggested approach provided below (or an alternative approach that meets the intent of the Interim Guidance) should be applied to ITS projects that affect regional integration. The same approach is also recommended for other ITS projects, to a degree that is appropriate to the local situation, integration needs, and the type of project being implemented. The approach is tailored to accommodate areas both with and without a regional ITS architecture.

1A. For areas with a regional ITS architecture:
Scope the project to be consistent with the regional ITS architecture. If the project is under design, determine if that project fits within (is addressed by) the regional ITS architecture. If the project does not fit within the regional ITS architecture, consider whether the regional ITS architecture needs revision or whether the project scope/design needs modification.

1B. For areas without a regional ITS architecture:
Determine the applicable portions of the National ITS Architecture within which the project generally fits. As closely as possible, define the project using the subsystems and information (architecture) flows from the National ITS Architecture.

2. Early in project design (and periodically throughout the design process), the following considerations should be addressed:

   a. Include all relevant agencies/stakeholders (including agencies responsible for transportation operations and appropriate planning agencies) in the project design process and ensure their continuing participation.
   b. Ensure that all applicable subsystems and information (architecture) flows from the regional ITS architecture [or from the National ITS Architecture, for areas without a regional ITS architecture] have been considered in the project design. If not, consider modifications. It may be helpful to include, in the design documentation, listings or illustrations of the subsystems and information flows that are being provided by the project, and any relevant supporting discussion that indicates why information flows suggested by the regional ITS architecture [or from step 1B, for areas without a regional ITS architecture] may not have been included.
   c. Consider incorporating additional information flows, as appropriate to the situation, in anticipation of future needs.
   d. Ensure that relevant technology and operating agreements are reached between the affected parties.
   e. Ensure that future expansion and information sharing opportunities are kept open through the project design strategy.

3. Identify any applicable standards and protocols that are appropriate for the project. Consider incorporating them into the project design and specifications. Wherever feasible, open systems should be considered in lieu of systems with proprietary interfaces. It may be helpful to clearly identify, in the design documentation and specifications, the standards which are being used in the project.

   Even if a regional ITS architecture exists, the National ITS Architecture can be used as a valuable resource for many of the above steps (e.g., for consideration of additional information flows, item 2c).

<u>For ITS/CVO Projects:</u>

1. Review the ITS/CVO Architecture Utilization Policy and, at a minimum, the following two related documents: the ITS/CVO Conformance Assurance Process Description and the Interoperability Testing Strategy. All three documents are included in the National ITS Architecture and Standards Resource Guide.

2. Follow the recommendations in the ITS/CVO Conformance Assurance Process Description:

   a. Assess commitment to the architecture and operational concepts,
   b. Assess project and work plans, reviews, and top-level design,
   c. Assess detailed design, and
   d. Assess implemented systems through interoperability testing.

   The Conformance Assurance Process Description defines evaluation criteria for ITS/CVO architectural conformity, and establishes a mechanism for fostering conformance in a deployment or implementation. Each ITS/CVO project should have a plan which includes an incremental checkpoint system for assessing architecture conformance. At each checkpoint, documents should be reviewed against architecture criteria and issues and potential interoperability problems identified. If problems are discovered, remedial actions should be developed and implemented to resolve the problems. Progress toward resolution should be tracked, and action assignments/resolutions should be documented to serve as a monitoring and lessons learned tool for future CVO deployments.

3. Use the standards recommended for ITS/CVO to facilitate interoperability.

C. ITS Considerations in Transportation Planning

The activities within the suggested approach given below are intended to encourage sound consideration of the operations and management of the transportation system, including the development of a regional ITS architecture and related efforts to advance ITS in a region.

It should be noted that what constitutes a region is locally determined based on the needs for sharing information and coordinating operational strategies. For a metropolitan region, it is recommended that the size of a region not be smaller than a metropolitan planning area boundary. For ITS/CVO projects, it is recommended that the size of the region not be smaller than a state, with consideration for multi-state, national, and international applications. The size of the region should promote integration of transportation systems by fostering the exchange of information on operating conditions across a number of agencies and jurisdictions. Likewise, the determination of the leadership or "champion" role in carrying out these planning activities is a local decision.

Engage a broad range of stakeholders

An open and inclusive process for engaging a broad range of transportation stakeholders in developing ITS activities is key to achieving integration and information sharing. As appropriate, stakeholders should include but are not limited to the following:
state transportation agencies, transit providers, metropolitan planning organizations, local (city/county) transportation agencies, police departments, fire departments, emergency medical services, toll authorities, traveler information providers, the media, telecommunications providers, other private transportation providers, port authorities, airport authorities, commercial trucking associations, freight railroad associations, motor carrier regulatory or enforcement agencies, non-governmental organizations, and the general public.

Identify needs that can be addressed by ITS

The transportation problems and needs that can potentially be addressed through operations and management strategies should be identified. These needs should be developed in the context of the needs, goals, and objectives already developed as part of the applicable transportation planning process. Participants should discuss opportunities for using ITS applications as part of the overall mix of strategies to meet identified needs and goals.

Describe existing and planned ITS enhancements

A sound understanding of current and committed ITS projects, operational agreements, and information sharing arrangements is needed before future plans for ITS development are discussed. Participants should (1) identify existing ITS components and integration and (2) then develop a list of planned ITS enhancements that will address identified needs and improve the operations and management of the transportation system. The existing situation and planned ITS enhancements should be described in terms of the physical system description and the extent of information sharing. Metropolitan ITS and CVISN Deployment

Tracking Surveys and indicators provide a useful starting point and approach for describing existing and planned ITS enhancements.

Define a regional ITS architecture

Given the existing and planned ITS enhancements, identified needs, and using the National ITS Architecture as a tool, a regional ITS architecture can be developed to serve as a high-level template for ITS project development and design. The regional ITS architecture should include subsystems and information flows relevant to the area. The regional ITS architecture should be periodically revisited and updated to reflect ongoing discussions and improvements. An existing regional ITS architecture should be assessed to ensure that it provides an appropriate level of detail.

Define operating requirements

Implementation of the planned ITS enhancements and information sharing arrangements requires further definition of the operational agreements between the various agencies and jurisdictions. An operating concept should be established that identifies the general roles and responsibilities of the stakeholders in the development and day-to-day operation of the system. This includes establishing requirements or agreements on information sharing and traffic device control responsibilities and authority (e.g., deciding if back-up control capability is desired given a loss of power or failure condition). These decisions will be factored into the regional ITS architecture and will also flow-down through ITS projects as they are phased in. Because many ITS services and strategies involve communication and coordination, this step should not be overlooked.

Coordinate with planned improvements

As agencies begin to determine ITS projects that can be implemented in the near to mid-term time frame, potential opportunities should be explored for leveraging activities with planned capital projects such as facility reconstruction, capacity expansion, or new bus purchases. These projects are likely already contained in Transportation Improvement Programs (TIPs), Statewide Transportation Improvement Programs (STIPs), Commercial Vehicle Safety Plans (CVSPs), applicable transportation plans, or specific agency plans. An example of this coordination would be adding the ITS communications and surveillance infrastructure (or other components) at the same time as a reconstruction project, resulting in overall cost savings and minimized traffic disruption compared to adding the ITS infrastructure after the reconstruction project was completed.

Develop phasing schedule

The phasing of ITS projects and strategies into the regional transportation system and planning process will need to be considered. Phasing considerations include anticipated time frame for implementation, geographic context (both within and between jurisdictions), functional capabilities, and funding considerations. Geographic considerations involve decisions such as the initial and future system coverage area, which jurisdictions in the region will be upgraded first, which transit agencies in the region will participate in the electronic fare media project, etc. Functional considerations include deciding which basic functions of a system should be implemented first and which should be deferred. The phasing considerations and decisions made in the initial stages may be conceptual, with flexibility for changes and further definition during future project development and design.

Develop regional technology agreements

As potential ITS actions are advanced, it may become necessary for stakeholders to reach agreement on some technologies, standards, or deployment choices that have regional significance. This particularly applies to the near-term projects that have been identified. For example, regional choices on technologies or standards may be required for the telecommunications infrastructure, electronic toll tags, signal controllers and interfaces, electronic fare media, and specialized mobile radio systems. For ITS/CVO projects, public and private stakeholders need to reach agreement on hardware, software, operational, and programmatic requirements for interoperability to exist in multi-state and national systems. Standards should be identified to foster interoperability of systems and interchangeability of components. When identifying standards, agencies should consider the current status of ITS standards development activities and determine how and when these can best be incorporated into the designs of projects within the region.

Identify ITS projects for incorporation into transportation planning products

ITS projects utilizing funds from the Highway Trust Fund will be incorporated, as appropriate, into transportation planning and programming products (such as the transportation plan, the STIP, TIP, and the CVSP) and adopted by the metropolitan planning organization or other applicable planning agency. Ultimately, this can be best achieved when the consideration of ITS is consistent with the goals and objectives adopted by regional transportation planning bodies and carried out in the context of the transportation planning process.

VI. Appendices

Appendices include:

- A. Definitions
- B. Questions and Answers
- C. Applicable Legislation

A. Definitions

For the purpose of explaining terms used in this Interim Guidance, the following definitions are provided:

Intelligent transportation systems (ITS).–As defined in TEA-21, the term "intelligent transportation system" means electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

ITS Project - Any project that (in whole or in part) involves the application of ITS.

ITS Project that Affects Regional Integration - An ITS project that can serve as a catalyst in achieving regional ITS integration. Generally, those ITS projects with the potential to support electronic data sharing between transportation stakeholders, projects with substantial software design, projects involving major upgrades of central transportation management functions, and projects involving significant communications would be considered ITS projects that affect regional integration.

ITS/CVO Projects - A subset of ITS projects which: (1) complete any component/service incorporated in the Commercial Vehicle Information Systems and Networks (CVISN) Level 1 deployment, and/or (2) install the International Border Clearance Safety System (IBCSS).

Other ITS Projects - The remaining ITS projects that are not characterized as affecting regional integration or being an ITS/CVO project, as explained above.

CVISN - Commercial Vehicle Information Systems and Networks. A concept that includes the information systems and communications networks that support Commercial Vehicle Operations (CVO). CVISN includes information systems owned and operated by governments, carriers, and other stakeholders.

CVISN Architecture - The ITS/CVO information systems and networks portion of the National ITS Architecture. The CVISN Architecture documentation begins with the National ITS Architecture and adds more detail in some areas (e.g., the operational scenarios and Electronic Data Interchange (EDI) message requirements) to facilitate further development.

Documentation is available on the World-Wide Web at http://jhuapl.edu/program/transport/trans.htm or contact the FHWA ITS/CVO Division Office at phone: 202-366-0950, fax: 202-366-7908.

CVISN Level 1 Deployment - The development and implementation of basic ITS/CVO information system elements in three capability areas (safety information exchange, credentials administration, and electronic screening) in conformance with the CVISN Architecture and Standards.

International Border Clearance Safety System (IBCSS) - An information system to identify impending border movements, access relevant safety and credentials information, and conduct clearance assessments on motor carriers, commercial motor vehicles, and drivers. The IBCSS is a portion of the International Border Clearance System, which provide the communications path between the commercial motor vehicle (CMV) and the border crossing in support of all border stakeholders, and an electronic border clearance assessment process for motor carriers, commercial motor vehicles, and drivers at North American land borders.

National ITS Architecture (also "national architecture") - As defined in TEA-21, the National ITS Architecture is the common framework for ITS interoperability that defines

(A) the functions associated with intelligent transportation system user services;
(B) the physical entities or subsystems within which the functions reside;
(C) the data interfaces and information flows between physical subsystems; and
(D) the communications requirements associated with the information flows.

Documentation is available from the U.S. DOT on the World-Wide Web at http://www.its.dot.gov or http://www.odetics.com/itsarch/ or contact the ITS Joint Program Office at phone: 202-366-9536, fax: 202-366-3302. As of September 20, 1998, Version 2.0 is the official version of the National ITS Architecture.

Regional ITS Architecture - A regional framework for ITS project development and design, which could be specified at a metropolitan, statewide, multi-state, or interurban corridor level. A regional ITS architecture is tailored to address specific local needs and, for the purposes of this Interim Guidance, includes the subsystems, agencies, and information flows relevant to the area. The National ITS Architecture may serve as a tool in the development of a regional ITS architecture.

ITS User Service - A categorization of ITS that represents what the system will do from the perspective of the user. User services formed the basis for the National ITS Architecture development. As of July 1998, the National ITS Architecture consists of 30 user services. Additional user services are planned for incorporation during the next year or two.

Standard - As defined in TEA-21, the term "standard" means a document that is published by an accredited Standards Development Organization, and
(A) contains technical specifications or other precise criteria for intelligent transportation systems that are to be used consistently as rules, guidelines, or definitions of characteristics so as to ensure that materials, products, processes, and services are fit for their purposes; and
(B) may support the national architecture and promote
(i) the widespread use and adoption of intelligent transportation system technology as a component of the surface transportation systems of the United States; and
(ii) interoperability among intelligent transportation system technologies implemented throughout the States.

Provisional Standard - As defined in TEA-21, Section 5206 (c), a provisional standard is a standard that the Secretary may establish if the Secretary finds that the development or balloting of an ITS standard jeopardizes the timely achievement of the objectives identified in Section 5206 (a), after consultation with affected parties, and using, to the extent practicable, the work product of appropriate standards development organizations.

Subsystem - A physical entity within the National ITS Architecture or a regional ITS architecture within which the ITS functions reside. Subsystems are typically associated with one or more transportation agencies or stakeholders. Examples of subsystems from the National ITS Architecture include traffic management, transit management, fleet and freight management, toll administration, emergency management, information service provider, roadway, remote traveler support, and vehicle.

Information (Architecture) Flow - A representation of data that originates at one subsystem (or external system) and ends at another within the National ITS Architecture or a regional ITS architecture, depicting the information exchanges planned between specific agencies. The National ITS Architecture documentation refers to these information flows as physical architecture flows.

B. Questions and Answers

Applicability and Scope

1. **Q**: Which federally funded projects does this Interim Guidance apply to?

   A: Any ITS project receiving whole or partial funding from the Highway Trust Fund (including the Mass Transit Account) is subject to this Interim Guidance. The Highway Trust Fund includes a broad range of transportation projects and programs, including Federal Aid Highway Programs, Federal Transit Administration programs, and safety programs. Examples of subject programs include (but are not limited to):

   - National Highway System Program
   - Congestion Mitigation and Air Quality Improvement Program
   - Surface Transportation Program
   - Urbanized and Non-Urbanized Areas Formula Grants Programs
   - Transit Capital Investment Grants and Loans (Section 5309 funding)
   - Motor Carrier Safety Assistance Program Grants
   - Demonstration projects identified in TEA-21 (including High Priority Projects, and other earmarks under the ITS subtitle)
   - Federal Lands Highways Program
   - Interstate Maintenance Program
   - Highway Bridge Program
   - Job Access and Reverse Commute Program
   - Rural Transportation Accessibility Programs
   - Elderly and Persons with Disabilities Program
   - Federal Aid Highway Safety Programs

2. **Q**: Are any ITS projects excepted from the conformity requirement?

   A: Yes. Section 5206(e) of TEA-21 excepts the following projects:

   1. Authorized projects designed to achieve specific research objectives outlined in the National ITS Program Plan or the Surface Transportation Research and Development Strategic Plan;

   2. The upgrade or expansion of an existing ITS, if the expansion won't adversely

affect the goals of conformity, is carried out before the end of the system's useful life, and is cost-effective as compared to alternatives that would be consistent; and

3. Projects to operate or maintain an existing ITS.

In addition, the Interim Guidance excepts projects already in construction and those that have completed the design phase. Note, however, that ITS projects that affect regional integration likely will not be excepted by Number 2 above, because to do so would adversely affect the goals of conformity.

3. **Q:** Does the Interim Guidance apply to ITS projects that do not receive funding from the Highway Trust Fund?

A: No. The Interim Guidance only applies to ITS projects that receive whole or partial funding from the Highway Trust Fund. However, the Interim Guidance and recommended approach to ITS projects and planning are considered sound practices for regional integration of ITS. Therefore, it is recommended that ITS projects not funded by the Highway Trust Fund also adhere to the Interim Guidance. Examples of projects which would not need to follow the Interim Guidance include projects funded entirely by state or local transportation agencies; projects funded by police, fire, or emergency medical services; and projects which are privately funded.

4. **Q:** Does the Interim Guidance apply to demonstration projects and other earmarks?

A: The Interim Guidance applies to all ITS projects with funding from the Highway Trust Fund, including demonstration projects (also referred to as "High Priority Projects"). The Interim Guidance also applies to CVO projects as indicated in the ITS/CVO Architecture Conformance Assurance Process. In addition, for ITS projects funded under section 5001(a) of TEA-21, refer to the Guidance for Congressionally-Designated ITS Projects (commonly referred to as "earmarked projects").

5. **Q:** How does the Interim Guidance differ from the Guidance for Congressionally-Designated ITS Projects?

A: The applicability differs in that Interim Guidance applies to all ITS projects funded in part or in whole by the Highway Trust Fund, whereas the guidance for congressionally-designated ITS projects (often known as "earmark" projects) applies only to projects being funded with ITS program category funds found under Section 5001(a) of TEA-21. The principles and intent of the Interim Guidance and the ITS earmark guidance are the same. However, since congressionally-designated projects are intended to serve as examples for meeting the conformity requirement, the ITS earmark guidance has slightly more detailed and specific documentation requirements. As an example, for one category of earmarked projects (regional deployments), states are being asked to commit to the development of a regional ITS architecture (and other regional ITS systems planning activities) as part of the partnership agreement. In addition, under the ITS earmark guidance, project designs must include specific documentation of architecture conformity, which will be reviewed by FHWA Division and/or FTA Region offices, as appropriate. This is in contrast to the Interim Guidance, which does not require specific documentation, but encourages agencies to incorporate conformity documentation into normal project and planning documentation.

6. **Q:** Which transit projects does the Interim Guidance apply to?

   A: Any ITS project receiving whole or partial funding from the Highway Trust Fund, including the Mass Transit Account, is subject to the Interim Guidance. This is true for both transit and highway projects.

7. **Q:** Does the Interim Guidance apply to ITS applications that are part of a larger construction project?

   A: Yes. The Interim Guidance applies to all ITS projects that receive Highway Trust Funds, even when the ITS application is part of a larger project. However, having an ITS component in a larger project does not subject the non-ITS portions of your project to the Interim Guidance; but, you can consider the Interim Guidance as a framework to look for sensible ways to enhance connectivity in your region. Looking at it another way, larger projects may provide an opportunity to include ITS elements that may not have originally been scoped, such as laying telecommunication cable during construction.

8. **Q**: Does the Interim Guidance apply to ITS projects outside metropolitan areas or in rural areas?

   A: Yes, the Interim Guidance applies outside metropolitan areas and in rural areas. As stated in the Interim Guidance, ITS projects that affect regional integration must be assessed for integration opportunities. Furthermore, development of a statewide architecture which addresses rural and small urban ITS applications is encouraged. Regardless of whether your area is rural or metropolitan, the National ITS Architecture can be useful in the development of the regional architecture.

9. **Q**: The National ITS Architecture is quite extensive in scope and lays out a multitude of information sharing possibilities. Do I have to plan for all of these interfaces and

information exchanges in order to meet the intent of the Interim Guidance?

A: No. It is unlikely that any one region would implement everything envisioned by the National ITS Architecture. Planning and project development should continue to focus on meeting local and/or regional needs. Some of the functionality and information exchanges in the National ITS Architecture will not apply to your situation (e.g., your region might not have any toll roads and thus the Toll Administration and Toll Collection Subsystems of the National ITS Architecture would not apply). Using the National ITS Architecture may help you identify opportunities you might not have otherwise considered in developing your regional ITS architecture and ITS projects. In all circumstances, however, the regional ITS architecture and individual ITS projects should be tailored to local needs and problems.

10. **Q:** Will National ITS Architecture conformity dictate the characteristics of the design of my ITS system?

A: No. The National ITS Architecture and ITS standards do not specify design; rather, they focus on ensuring interface compatibility and structured information exchange. The National ITS Architecture supports a variety of detailed designs and is flexible enough to support both distributed and centralized systems. The National ITS Architecture does not make technology decisions for you. For example, collection of traffic data can be performed with a variety of technologies, including loop detectors, video imaging, and vehicle probes. Nor are you required to implement interfaces identified in the National ITS Architecture. The Interim Guidance on National ITS Architecture conformity does, however, imply that information sharing opportunities between transportation stakeholders are explored to the extent possible and appropriate for your area.

11. **Q:** Does conformity with the National ITS Architecture ensure interoperability?

A: No. The vision of ITS integration is a seamless, interoperable transportation network. Because the National ITS Architecture does not specify the interfaces or the technologies to be used in transportation systems and services, conformity does not ensure interoperability. Only through interjurisdictional agreements and cooperation can interoperability be assured. The National ITS Architecture does provide a framework for determining the needs or desirability of interoperability, and for making the institutional and technological decisions that are the foundation of an interoperable network. Interoperability is furthered through the adoption and widespread use of ITS standards.

12. **Q:** Will U.S. DOT require interoperability?

A: Where federal funding supports technologies and interfaces considered critical for national interoperability, U.S. DOT expects to require interoperability, but only after the standards have matured to ensure their operational capability. As called for in TEA-21, U.S. DOT is currently developing a list of critical standards appropriate for ensuring interoperability.

13. **Q:** What is the distinction between the use of the terms "conformity" and "consistency?"

A: The TEA-21 language (Section 5206[e]) addressed by the Interim Guidance calls for "conformity" with the National ITS Architecture and Standards. U.S. DOT's incremental, phased approach to implementing this provision is better reflected by the use of the term "consistency" with the National ITS Architecture. For the purposes of the Interim Guidance, these terms are deemed synonymous.

<u>ITS Projects</u>

14. **Q:** What are some examples of "ITS projects that affect regional integration" as defined in this Interim Guidance?

A: Generally, ITS projects that affect regional integration are those that can serve as catalysts in achieving ITS integration for a region. Examples of ITS projects that affect regional integration include the construction or functional expansion of a transportation management center, installation or expansion of the functional capability of a communications system, and the purchase of an AVL-equipped bus fleet. Another example is a multi-agency project which aims to integrate transportation systems (e.g., freeway-arterial system integration, traffic-transit integration).

15. **Q**: What do I do for ITS projects that do not affect regional integration?

A: The Interim Guidance is designed to focus attention on ITS projects that do affect regional integration, but all ITS projects (receiving Highway Trust Funds) should consider the intent and approach in the Interim Guidance as a way to ensure conformity with the National ITS Architecture and permit cost-effective future expansion should the need arise. Examples of ITS projects that do not affect regional integration are the installation of an isolated traffic signal system in a small, rural town; or the purchase of a limited set of replacement buses.

16. **Q**: How does the Interim Guidance apply to projects in the final stage of design?

A: Adherence to the Interim Guidance is not required for projects in the final stage of design as of the date of Interim Guidance issuance. However, it is good practice to review projects for anything that can be done at a reasonable cost to facilitate future integration. Projects in the final stage of design are not specifically excepted by the legislation, so the project's lead agency should work with the FHWA Division or FTA Region office to determine the appropriate course of action. Projects for which design has been completed or that are in construction as of the date this Guidance is issued do not need to revisit the design stage.

17. **Q**: How will existing (legacy) equipment with proprietary interfaces be addressed?

A: The Interim Guidance does not require replacement of legacy systems or equipment having proprietary interfaces. Rather, it is recommended that you plan with existing systems in mind and encourage future investments that would facilitate electronic data-sharing and the use of open interfaces, while minimizing the use of proprietary interfaces. Existing systems such as traffic signals, overhead messages, computer-aided dispatch for ambulances, or automatic vehicle location for buses are an important consideration in developing an ITS project and your regional ITS architecture. As new features and system upgrades are planned, the new designs should provide for open, non-proprietary interfaces identified in the National ITS Architecture and approved ITS standards as appropriate for your area and consistent with your regional ITS architecture.

ITS Considerations within Transportation Planning

18. **Q:** Are ITS projects excepted from the metropolitan or statewide planning processes?

A: No. ITS projects should be developed using the same planning processes as other transportation projects, in accordance with metropolitan and statewide planning procedures specified in TEA-21 (sections 1203, 1204, 3004, and 3005). In addition, ITS may be considered as one strategy for addressing the new systems management and operation planning factor requirement in TEA-21.

19. **Q:** What are the benefits of integrating ITS into the planning process?

A: Statewide and metropolitan planning activities should consider a broad range of actions and investments aimed at improving the management and operation of the transportation system. ITS is a powerful tool for meeting the system operation and management needs of a region. Like any tool, it is most effective when it has broad support and is applied in the proper circumstances. Regional efforts aimed at identifying appropriate ITS strategies and investments should be advanced in the context of the goals and objectives adopted by the planning process. This will ensure that specific ITS deployment options will address regional transportation goals and objectives in the most effective possible manner. In addition, there is considerable overlap between the planning process and ITS systems planning. The integration of ITS and planning will ensure that these processes are carried out together in a consistent and efficient manner.

20. **Q**: Who should be the lead in developing a regional ITS architecture?

A: Identifying a lead agency is a local decision; development of a regional architecture can take place in whatever forum suits the area. You are encouraged to develop ITS activities within your existing planning processes. Making use of existing agency agreements and structures may help you to determine who should be involved and who may be best suited to take the lead role.

21. **Q**: Who should be involved as ITS is considered within the planning process?

A: The range of stakeholder involvement is most appropriately addressed at the local level. A fundamental goal is to involve and unite a wide range of stakeholders to ensure consideration of the broadest range of integration opportunities. It is expected that the number of stakeholders included in any area will grow over time as ITS is incorporated into the regional transportation planning process and the range of ITS activities expands. As a starting point, agencies or other groups within a region that are typically involved in transportation planning or ITS development should be involved. The National ITS Architecture may help you identify stakeholders that are not normally included in the transportation planning process but who may be important to ITS systems planning (e.g., private sector information service providers; police, fire, and other emergency services; and private sector transportation service providers).

22. **Q**: What if certain stakeholders do not want to participate?

A: The intent of gathering a broad range of stakeholders is to ensure that the consideration and development of potential ITS actions and investments stems from a collaborative, inclusive effort. Good faith efforts should be made to include all stakeholders. Notwithstanding this, the process should begin with those agencies/parties willing to participate.

23. **Q:** What is a "region" as it relates to the development of a regional ITS architecture?

A: What constitutes a region is a local determination that should be based on the needs for sharing information and coordinating operational strategies in order to address transportation problems. In this context, a region is not constrained by political boundaries, and could be specified at a metropolitan, statewide, multi-state, or inter-urban corridor level. For a metropolitan region, it is recommended that the size of a region not be smaller than a metropolitan planning area boundary. For ITS/CVO projects, it is recommended that the size of the region not be smaller than a state, with consideration for multi-state, national, and international applications. The size of the region should promote integration of transportation systems by fostering the exchange of information on operating conditions across a number of agencies and jurisdictions.

24. **Q:** What is the relationship between the nine core components of the metropolitan ITS infrastructure and the National ITS Architecture?

A: The nine core components of the metropolitan ITS infrastructure (Freeway Management, Incident Management, Traffic Signal Control, Electronic Toll Collection, Transit Management, Electronic Fare Payment, Highway Rail Intersections, Emergency Management, and Regional Multimodal Traveler Information) represent an initial way of thinking about the potential types of ITS technologies that could be usefully linked in a metropolitan region. The National ITS Architecture provides the framework necessary for more detailed planning about how to structure the communications and information flows between and among the different subsystems that characterize a fully integrated regional ITS system.

25. **Q:** How does the Interim Guidance relate to the deployment and integration tracking of CVISN and metropolitan ITS infrastructure that have been ongoing in recent months in some regions?

A: The definitions of metropolitan ITS infrastructure and the framework used in the deployment tracking questionnaire provide excellent starting points for developing and collecting the information necessary for beginning work on a regional ITS architecture in your area. If a deployment tracking survey has already been filled out, it should be very helpful in documenting the existing level of ITS deployment (including information sharing arrangements), which is fundamental to future planning efforts. Further explanation of the metropolitan and CVISN deployment tracking is included in the Resource Guide.

26. **Q**: Can a regional ITS architecture, developed from an Early Deployment Plan, be used to demonstrate conformity with the National ITS Architecture?

A: Architectures developed under previous early deployment efforts may be considered for potential applicability to the Interim Guidance. Some early deployment studies that do not include architectures, or were not inclusive of a wide range of stakeholders, do not meet the intent and approach of the Interim Guidance. In such cases, additional steps may be necessary, such as identifying/determining information flows between regional architecture subsystems. Conversely, Early Deployment Plans that engaged a broad range of stakeholders and included a regional ITS architecture would likely meet the intent of the Interim Guidance.

Federal Role

27. **Q:** What is the federal oversight role, specific to integrating ITS into the planning process?

    A: The Interim Guidance does not change federal oversight of the transportation planning process. Within existing federal oversight roles and activities, FHWA and FTA staff are encouraged to explore opportunities with their constituents for integrating ITS into the transportation planning process. Such opportunities may become obvious during the development of plan updates to Unified Planning Work Programs, the STIP or TIP, or triennial certifications. These reviews should also consider whether a regional ITS architecture exists, defined at the subsystem and information (architecture) flow level. For commercial vehicle operations, ITS opportunities should be considered during updates of the Commercial Vehicle Safety Plan.

28. **Q:** How will the Interim Guidance affect the STIP/TIP development cycle?

    A: The Interim Guidance is not intended to delay the development cycle (preparation, review, or approval) of a STIP or TIP. However, applying the Interim Guidance to the transportation planning process at the earliest practical convenience will aid in identifying and capitalizing on potential cost-saving and system-enhancing opportunities.

29. **Q:** What constitutes the federal oversight role at the project stage?

    A: The Interim Guidance does not change the federal oversight role at the project stage. For those ITS projects with federal oversight, the appropriate federal office will ensure that the Interim Guidance is followed as part of the regular review process. For those projects with no federal oversight requirement, recipients are responsible for ensuring that the Interim Guidance is followed. Compliance with the Interim Guidance may be a discussion topic in process or triennial reviews.

30. **Q**: Are all ITS projects subject to federal oversight?

A: No. Refer to the appropriate oversight procedure for the project in question. If the state DOT is willing, it is suggested that FHWA and FTA be involved in all ITS projects on the National Highway System during the initial implementation period for the Interim Guidance.

31. **Q**: What kind of help and support can be expected from U.S. DOT?

A: Various support mechanisms are under way or being planned at the present time. A training course on the National ITS Architecture is available now with more offerings planned in the fall of 1998. Technical assistance documents on the use of the National ITS Architecture to facilitate project development and planning for specific application areas will be available shortly. Technical assistance is also available through the U.S. DOT peer-to-peer program. Checklists also will be made available to serve as helpful guidance and reminders. For more information, contact your local FHWA or FTA office, and visit the ITS website: www.its.dot.gov.

ITS Standards

32. **Q**: What is an ITS standard and which standards have been adopted?

A: Standards define how system components inter-connect and interact within an overall framework called an architecture. The National ITS Architecture identified the need for many ITS standards to support interface compatibility. U.S. DOT has yet to adopt ITS standards, and anticipates proceeding cautiously in order to allow emerging standards to reach a point of acceptability by implementing agencies. Initial standards are just now beginning to be completed and approved by Standards Development Organizations. Once approved by the Standards Development Organizations, it will take some time for standards to be validated to the satisfaction of implementing agencies.

33. **Q**: Should an ITS standard be used if it has not yet been approved, or adopted by U.S. DOT?

A: If an agency deems that an ITS standard is not yet sufficiently mature for routine use, it should deploy ITS mindful of the new standard and in anticipation of an eventual transition. Your design process may incorporate draft standards, but recognize that these may change before being finalized. Therefore, work with your vendors to be sure that they commit to bringing their products into compliance with the final standard when it is approved.

Documentation

34. **Q**: What documentation is required for implementation of the Interim Guidance?

A: No new documentation is required, but additional information within existing documentation needs to demonstrate that the intent of the Interim Guidance has been met.

C. Applicable Legislation

SECTION 5203. GOALS AND PURPOSES [of the Intelligent Transportation Systems Act of 1998].

(a) Goals.--The goals of the intelligent transportation system program include–

(1) enhancement of surface transportation efficiency and facilitation of intermodalism and international trade to enable existing facilities to meet a significant portion of future transportation needs, including public access to employment, goods, and services, and to reduce regulatory, financial, and other transaction costs to public agencies and system users;

(2) achievement of national transportation safety goals, including the enhancement of safe operation of motor vehicles and nonmotorized vehicles, with particular emphasis on decreasing the number and severity of collisions;

(3) protection and enhancement of the natural environment and communities affected by surface transportation, with particular emphasis on assisting State and local governments to achieve national environmental goals;

(4) accommodation of the needs of all users of surface transportation systems, including operators of commercial vehicles, passenger vehicles, and motorcycles, and including individuals with disabilities; and

(5) improvement of the Nation's ability to respond to emergencies and natural disasters and enhancement of national defense mobility.

(b) Purposes.--The Secretary shall implement activities under the intelligent system transportation program to, at a minimum–

(1) expedite, in both metropolitan and rural areas, deployment and integration of intelligent transportation systems for consumers of passenger and freight transportation;

(2) ensure that Federal, State, and local transportation officials have adequate knowledge of intelligent transportation systems for full consideration in the transportation planning process;

(3) improve regional cooperation and operations planning for effective intelligent transportation system deployment;

(4) promote the innovative use of private resources;

(5) develop a workforce capable of developing, operating, and maintaining intelligent transportation systems; and

(6) complete deployment of Commercial Vehicle Information Systems and Networks in a majority of States by September 30, 2003.

SECTION 5206. NATIONAL ARCHITECTURE AND STANDARDS.

(a) IN GENERAL-

(1) DEVELOPMENT, IMPLEMENTATION, AND MAINTENANCE-

Consistent with section 12(d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note; 110 Stat. 783), the Secretary shall develop, implement, and maintain a national architecture and supporting standards and protocols to promote the widespread use and evaluation of intelligent transportation system technology as a component of the surface transportation systems of the United States.

(2) INTEROPERABILITY AND EFFICIENCY- To the maximum extent practicable, the national architecture shall promote interoperability among, and efficiency of, intelligent transportation system technologies implemented throughout the United States.

(3) USE OF STANDARDS DEVELOPMENT ORGANIZATIONS- In carrying out this

section, the Secretary may use the services of such standards development organizations as the Secretary determines to be appropriate.

(b) REPORT ON CRITICAL STANDARDS- Not later than June 1, 1999, the Secretary shall submit a report to the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure and the Committee on Science of the House of Representatives identifying which standards are critical to ensuring national interoperability or critical to the development of other standards and specifying the status of the development of each standard identified.

(c) PROVISIONAL STANDARDS-

(1) IN GENERAL- If the Secretary finds that the development or balloting of an intelligent transportation system standard jeopardizes the timely achievement of the objectives identified in subsection (a), the Secretary may establish a provisional standard after consultation with affected parties, and using, to the extent practicable, the work product of appropriate standards development organizations.

(2) CRITICAL STANDARDS- If a standard identified as critical in the report under subsection (b) is not adopted and published by the appropriate standards development organization by January 1, 2001, the Secretary shall establish a provisional standard after consultation with affected parties, and using, to the extent practicable, the work product of appropriate standards development organizations.

(3) PERIOD OF EFFECTIVENESS- A provisional standard established under paragraph (1) or (2) shall be published in the Federal Register and remain in effect until the appropriate standards development organization adopts and publishes a standard.

(d) WAIVER OF REQUIREMENT TO ESTABLISH PROVISIONAL STANDARD-

(1) IN GENERAL- The Secretary may waive the requirement under subsection (c)(2) to establish a provisional standard if the Secretary determines that additional time would be productive or that establishment of a provisional standard would be counterproductive to achieving the timely achievement of the objectives identified in subsection (a).

(2) NOTICE- The Secretary shall publish in the Federal Register a notice describing each standard for which a waiver of the provisional standard requirement has been granted, the reasons for and effects of granting the waiver, and an estimate as to when the standard is expected to be adopted through a process consistent with section 12(d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note; 110 Stat. 783).

(3) WITHDRAWAL OF WAIVER- At any time the Secretary may withdraw a waiver granted under paragraph (1). Upon such withdrawal, the Secretary shall publish in the Federal Register a notice describing each standard for which a waiver has been withdrawn and the reasons for withdrawing the waiver.

(e) CONFORMITY WITH NATIONAL ARCHITECTURE-

(1) IN GENERAL- Except as provided in paragraphs (2) and (3), the Secretary shall ensure that intelligent transportation system projects carried out using funds made available from the Highway Trust Fund, including funds made available under this subtitle to deploy intelligent transportation system technologies, conform to the national architecture, applicable standards or provisional standards, and protocols developed under subsection (a).

(2) SECRETARY'S DISCRETION- The Secretary may authorize exceptions to paragraph (1) for--

(A) projects designed to achieve specific research objectives outlined in the National ITS Program Plan under section 5205 or the Surface Transportation Research and Development Strategic Plan developed under section 508 of title 23, United States Code; or

(B) the upgrade or expansion of an intelligent transportation system in existence on the date of enactment of this subtitle, if the Secretary determines that the upgrade or expansion--

(i) would not adversely affect the goals or purposes of this subtitle;

(ii) is carried out before the end of the useful life of such system; and

(iii) is cost-effective as compared to alternatives that would meet the conformity requirement of paragraph (1).

(3) EXCEPTIONS- Paragraph (1) shall not apply to funds used for operation or maintenance of an intelligent transportation system in existence on the date of enactment of this subtitle.

(f) SPECTRUM- The Federal Communications Commission shall consider, in consultation with the Secretary, spectrum needs for the operation of intelligent transportation systems, including spectrum for the dedicated short-range vehicle-to-wayside wireless standard. Not later than January 1, 2000, the Federal Communications Commission shall have completed a rulemaking considering the allocation of spectrum for intelligent transportation systems.

Introduction to Interim Guidance Checklist

Contents

This subsection includes a Checklist for the *Interim Guidance on Conformity with the National ITS Architecture and ITS Standards*.

Summary

This Checklist accompanies the *Interim Guidance* and is intended to assist agencies with meeting Section 5206 (e) of TEA-21, which requires that Intelligent Transportation System (ITS) projects carried out using funds made available by the Highway Trust Fund (including the Mass Transit Account) conform to the National ITS Architecture, applicable or provisional standards, and protocols. The organization of and terms used in the Checklist are similar to those of the *Interim Guidance* and the suggested procedures. Included in the Checklist are a number of questions that are intended to serve as helpful reminders of important questions to be addressed to ensure that ITS projects meet the legislative intent. The questions are organized along the major categories of (1) project development and (2) planning for ITS.

Uses

This Interim Guidance Checklist is intended to assist U.S. DOT field staff and constituent agencies in beginning to implement the TEA-21 requirement. *The Checklist and the imbedded questions are aimed at improving the planning and design processes for ITS projects and are not intended to serve as a set of criteria for approval or for demonstrating that the conformity requirement has been met.*

Checklist for the Interim Guidance on Conformity with the National ITS Architecture and Standards

The following questions are intended to provide helpful guidance and reminders of key questions and issues that should be addressed during planning and ITS project development activities. *They are aimed at improving the current development process and assist agencies in meeting the intent of the interim guidance.* They are not intended to serve as a set of criteria for approval.

The list of questions has been arranged to address a range of ITS deployment activities since individual agencies and regions may be at different points in the process of developing and implementing ITS. Therefore the checklist has been arranged into the following categories corresponding to the Interim Guidance and recommended approach for ITS projects and ITS considerations in transportation planning: a) Regional transportation planning activities initiated that will ultimately lead to the development of a regional ITS architecture, b) ITS projects that affect regional integration and other ITS projects (for areas with and without a regional ITS architecture), c) ITS/CVO projects.

I. ITS Considerations in Transportation Planning

1. What activities have been initiated to engage regional ITS stakeholders (e.g., an MPO technical subcommittee)?
    a. What non-traditional partners (public and private) need to be brought into the process?
    b. What activities are underway or being planned to engage these partners?
2. What system management and operations needs have been identified through regional planning activities?
    a. How are they identified in the planning process (e.g., plans, programs, MPO work plans, corridor studies, subregional studies, etc.)?
    b. Which ITS strategies or enhancements have been identified to meet those needs?
3. What existing and planned ITS enhancements have been identified or are under consideration in the region?
    a. Has a metropolitan ITS infrastructure or CVISN deployment tracking survey been completed? (If so, it can serve as a useful starting point. For more information see the deployment tracking survey section of the Resource Guide.)
    b. What ITS infrastructure (i.e., traffic signals, freeway management), information

sharing and operational agreements currently exist in the region?

c. What ITS infrastructure (i.e., traffic signals, freeway management), information sharing and operational agreements are planned for the region?

d. Where are the planned ITS enhancements identified ; the transportation plan, Statewide Transportation Improvement Program (STIP), Transportation Improvement Program (TIP), or the Commercial Vehicle Safety Plan (CVSP)?

4. Has a regional ITS architecture been defined?

a. If no, are there plans to define one? If yes, did the process consider b-g below?

b. Are relevant agency systems identified? Does the regional ITS architecture include the key transportation agencies and stakeholders (e.g., state highway, county and city traffic, police, fire and emergency rescue, and transit)?

c. Does the regional ITS architecture define subsystems and information (architecture) flows, showing what information is (or will be) exchanged between subsystems?

d. Are applicable information subsystems and information flows from the National ITS Architecture included in the regional ITS architecture?

e. Is the regional ITS architecture defined using terms from the National ITS Architecture to the subsystem and information flow level?

f. Is there general consensus among the stakeholders for the regional ITS architecture? How has this agreement been (or how will it be) documented (i.e., MOU, or some other formal agreement)?

g. How have current legacy systems and future systems been accounted for in the architecture?

5. Have operating requirements for planned ITS enhancements been identified?

a. Has a concept of operations been developed that identifies the general roles and responsibilities of the stakeholders and day to day operations of the system?

b. What specific requirements or agreements on information sharing and control responsibilities are included in the concept of operations?

6. How will planned ITS enhancements be coordinated with other transportation improvements?

   a. Which planned ITS improvements will stand alone and which will be integrated with other capital improvements projects (e.g., installing communication, and surveillance infrastructure with roadway reconstruction)?

7. Has a deployment phasing schedule been developed?

   a. Does the deployment phasing schedule include anticipated time for implementation, geographic context, and functional capabilities?

   b. Does the deployment phasing schedule include what agencies should be upgraded first?

   c. Does the deployment phasing plan identify what functions of the system should be implemented first, and which should be deferred?

8. Have regional technology agreements been established where needed?

   a. Which regional technology choices have been agreed upon to ensure the potential for future information exchange and compatibility?

   b. Which existing standards have been identified to provide interoperability of systems and interchangeability of components?

II. ITS Project Development

1. Is the project considered to be an ITS project? If yes, under which Interim Guidance ITS project category does it fall?

   a. Is the project considered to be an ITS project that affects regional integration?, If yes, go to *ITS Projects that Affect Regional Integration and other ITS Projects*, or

   b. Is it considered to be an ITS/CVO project? If yes, go to *ITS/CVO Projects*, or

   c. Is it considered to be an "other ITS project"? If yes, go to *ITS Projects that Affect Regional Integration and other ITS Projects*

ITS Projects that Affect Regional Integration and other ITS Projects

Has a regional ITS architecture been developed that this project fits into? If yes, go to A. If no, go to B.

A. **If a regional ITS architecture has been developed**

1. Is the scope of the current project consistent with the regional ITS architecture?

   a. If the project is under design, does the project fit within the regional ITS architecture?

   b. If the project does not fit within the regional ITS architecture, has consideration been given to revising the regional ITS architecture or modifying the project scope and design?

2. Early in project design (and periodically throughout the design process), have the following considerations addressed?

   a. How has the project design process included the participation of all relevant stakeholders?

b. Which subsystems and information (architecture) flows in the regional ITS architecture have been considered in the project design? If the project design is not consistent with the regional ITS architecture, what modifications to the project design or regional ITS architecture will be needed? Does the design documentation list or illustrate subsystems and information flows that are being provided by the project? What is the rationale as to why any relevant information flows suggested by the regional ITS architecture may not have been included in the project design?

c. Has consideration been given to incorporating additional information flows, as appropriate to the situation, in anticipation of future needs? If so, which information flows?

d. What technology and operating agreements have been reached between the affected parties?

e. How has the potential for future expansion and information sharing opportunities been kept open through the project design strategy?

3. Which standards and protocols, as appropriate for the project, have been identified?

a. Have they been incorporated into the project design and specifications?

b. Are the standards that are being used in the project clearly identified in the project design documentation and specifications?

B. **If a regional ITS architecture has not yet been developed**

1. Which portions of the National ITS Architecture are applicable to the project? Has the project been defined using the subsystems and information (architecture) flows provided in the National ITS Architecture as appropriate?

2. Early in project design (and periodically throughout the design process), have the following considerations be addressed?

a. How has the project design process included the participation of all relevant stakeholders?

b. Which subsystems and information (architecture) flows from the National ITS Architecture have been considered in the project design? Are any other subsystems or information flows from the National ITS Architecture applicable? If so, will modifications to the project be considered? Does the design documentation list or illustrate subsystems and information flows that are being provided by the project? What is the rationale as to why any relevant information flows suggested from step B(1) may not have been included in the project design?

c. Has consideration been given to incorporating additional information flows, as appropriate to the situation, in anticipation of future needs? If so, which information flows?

d. What technology and operating agreements have been reached between the affected parties?

e. How has the potential for future expansion and information sharing opportunities been kept open through the project design strategy?

3. Which standards and protocols, as appropriate for the project, have been identified?

a. Have they been incorporated into the project design and specifications?

b. Are the standards that are being used in the project clearly identified in the project design documentation and specifications?

ITS/CVO Projects

1. Has the ITS/CVO Architecture Utilization Policy been reviewed? Have the ITS/CVO Conformance Assurance Process Description and the Interoperability Testing Strategy been reviewed?

2. Have the recommendations in the ITS/CVO Conformance Assurance Process been followed?

a. Assess commitment to the architecture and operational concepts.

b. Assess project and work plans, reviews, and top level design.

c. Assess detailed design.

d. Assess implemented systems through interoperability testing.

3. Have the recommendations in the ITS/CVO Conformance Assurance Process been followed? Have standards recommended for ITS/CVO been used?

Section Two: Information Resources

This section includes seven subsections of resources that field personnel can use to introduce stakeholders and policymakers to the issues and benefits associated with the National ITS Architecture and standards.

A. **Introduction to the National ITS Architecture:** provides an introduction to the purpose and scope of the National ITS Architecture.

B. **Introduction to Standards for ITS:** introduces the importance of national standards and protocols for ITS.

C. **Benefits of Integrated Technologies and the National ITS Architecture:** describes the five major benefits associated with ITS integration through the National ITS Architecture. The discussion of each benefit is illustrated with examples of ITS projects in various states of deployment.

D. **Using the National ITS Architecture: Brief Case Studies:** includes six short case studies (vignettes) of successful ITS integration.

E. **ITS and Commercial Vehicle Operations (CVO):** includes a series of documents that address architecture conformance issues for CVO projects.

F. **Developing ITS Using the National ITS Architecture: An Executive Edition for Senior Transportation Managers:** describes the importance of National ITS Architecture conformance to transportation agency managers.

G. **Understanding and Applying the National ITS Architecture:** provides additional technical resources for understanding the National ITS Architecture.

Introduction to the National ITS Architecture

Contents

This subsection includes an updated version of the document *An Introduction to the National Intelligent Transportation Systems (ITS) Architecture* that was published by the Joint Program Office and widely disseminated at ITS America (May 1998) as well as at the National ITS Architecture Consistency Outreach Meetings (February-May 1998).

Summary

This document provides an introduction to the basic concepts of the National ITS Architecture. Adopted in 1996, the National ITS Architecture provides a technical and institutional framework to guide the coordinated deployment of ITS by public agencies and private organizations alike. It defines the functions performed by ITS components and the various ways in which components can be interconnected. Although the architecture is national in scope, it benefits state and local agencies by helping them to save time and money in achieving maximum benefits through the implementation of integrated ITS.

Uses

This document is designed to introduce transportation stakeholders to the basic ideas of the National ITS Architecture. It provides answers to frequently asked questions, and a reference section for further information. This document could be shared by transportation professionals with other stakeholders in their area.

An Introduction to the National Intelligent Transportation Systems (ITS) Architecture

Intelligent Transportation Systems (ITS) collect, store, process, and distribute information relating to the movement of people and goods. Examples include systems for traffic management, public transportation management, emergency management, traveler information, advanced vehicle control and safety, commercial vehicle operations, electronic payment, and railroad grade crossing safety.

Currently, ITS technologies and services are being deployed as independent projects by individual agencies. This results in a "patchwork" of systems, making it difficult for agencies to exchange information and realize the full potential of ITS. By working together to coordinate and integrate ITS, agencies can improve safety, mobility, and public transit services; alleviate traffic congestion; and enhance economic productivity without sacrificing environmental quality. Integrating ITS across organizations, jurisdictions, and modes is the key to cost-effective ITS deployment.

The National ITS Architecture: A Framework for Integration

To realize the full potential of ITS, a unified framework for integration, called a "systems architecture," is needed to guide the coordinated deployment of ITS by public agencies and private organizations alike. The National ITS Architecture is a framework that defines the functions performed by ITS components and the various ways in which components can be interconnected. The specific technologies and institutional arrangements used in any particular deployment are left to the discretion of the individual agencies and organizations involved. The National ITS Architecture allows agencies to design projects and deployment approaches for meeting near-term needs while keeping their options open for eventual system expansion and integration.

The National ITS Architecture does not represent a particular design or ITS construct. Rather, it provides a starting point from which stakeholders can work together to make the vision of a unified ITS for their region a reality. Although the architecture is national in scope, it benefits state and local agencies by helping them to save time and money in achieving maximum benefits through the implementation of integrated ITS.

This document provides answers to frequently asked questions about the National ITS Architecture, and identifies sources of additional information.

What Is The Purpose Of The National ITS Architecture?

ITS involves diverse electronic systems and applications. Tying these pieces together is difficult and makes integrated ITS deployment more challenging. The National ITS Architecture organizes a "system of subsystems" and makes it easier to manage ITS deployment. The National ITS Architecture also suggests phased implementation scenarios that allow for cost-effective, incremental deployment in step with each area's needs and available funding.

Why Was A National ITS Architecture Developed?

The National ITS Architecture was developed to provide a unified framework and building blocks that agencies can use to create an integrated ITS strategy that meets the needs of a particular state or region. Recognizing that the design of integrated ITS requires a comprehensive systems approach, the Intelligent Transportation Society of America (ITS America), recommended that the USDOT sponsor the development of a national architecture. The Congress determined that individual state and local agency development of a comprehensive systems approach to the design of integrated ITS would be so resource-intensive that it would pose an unacceptable burden. Thus, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 called for the Secretary of Transportation "to promote compatibility among intelligent (transportation) technologies implemented throughout the states."

How Was the National ITS Architecture Developed?

The National ITS Architecture Development Program, undertaken by the USDOT in partnership with ITS America, involved teams drawn from private industry, the public sector, and academia over a three-year period. Four preliminary architecture concepts were developed and evaluated by a broad range of technical experts and ITS stakeholders. The best features from these four concepts were combined by the Architecture Team to produce the National ITS Architecture, which was completed in 1996. Subsequent modifications will be made to respond to new user services, deployment experiences, and standards activities.

What Is Included In the National ITS Architecture?

The National ITS Architecture is a tool for planning and achieving integrated ITS deployment. It defines functions to be performed by ITS systems and information that flows among ITS systems. It does not specify who is responsible for these flows and functions or which design details and technologies are to be used. The Architecture defines interactions among the physical components of the transportation system (including, travelers, vehicles, control centers, and roadside devices). It also defines the information infrastructure that connects the physical transportation components (i.e., the types of information and communication system capabilities needed, how data should be shared and used, and where standards are needed to facilitate information sharing). In addition to the technical details of how transportation components are integrated and share information, the National ITS Architecture also documents a set of analyses (cost, benefit, risk, and communications) which can be of value in planning for regional ITS deployments.

How Is the National ITS Architecture Useful?

The National ITS Architecture helps public agencies identify potential ITS applications and deployment opportunities for addressing local needs, in the context of institutional constraints. The National ITS Architecture is a set of options that can be considered when making ITS choices or decisions. It provides information on other systems that might be integrated or connected to a regional ITS framework. The National ITS Architecture provides a set of tools that help describe the interfaces to be considered. In some cases, the architecture tools provide insight into potential synergies between systems. The National ITS architecture is also a source of information for creating and enhancing institutional relationships within a region. It identifies institutional linkages and emphasizes potential information exchange and activity coordination that can improve efficiency and performance.

What Are the Benefits of Using the National ITS Architecture?

State DOT personnel and system engineers who have used the National ITS Architecture have found that the National ITS Architecture:

- Reduces the time and resources required to tailor a regional architecture to local circumstances.
- Helps identify agencies and jurisdictions that should participate in the creation of the regional architecture, and helps these organizations communicate complex ideas by providing a common language.
- Enables up-front planning for the development of an entire system, allowing for phased implementation while reducing the possibility of future costly retrofits.
- Reduces the possibility of costly "gaps" in system definition and integration requirements.
- Provides a framework for integrating legacy systems with each other and with new, open systems.
- Provides a basis for moving forward with individual projects while a regional architecture is under development.
- Identifies where standards should be used to make possible the development of open interfaces supported by multiple vendors.

Where Have These Benefits Been Proven In Practice?

Several areas of the country already have realized benefits from using the National ITS Architecture.

- The Southern California Corridor estimates a one-third reduction in regional architecture development time by drawing upon the National ITS Architecture as a resource.
- In Washington's Puget Sound Region, use of the National ITS Architecture reduced by half the time that otherwise would have been necessary for system engineers to map projects to the user service requirements. Mapping to the National ITS Architecture in this region also helped to identify gaps in local services, such as in the areas of public transit safety, commercial vehicle operations, and electronic payment services, as well as to identify duplications in service. National ITS Architecture data flows also helped to guide decisions in this region on which legacy systems are candidates for integration, and which should be "grandfathered" or replaced through future projects because integration would be too difficult.
- The Colorado Department of Transportation (CDOT) cut six months from the time needed to create a detailed system architecture for the Denver metropolitan area by basing their work on the foundation provided by the National ITS Architecture. The CDOT also used the National ITS Architecture to designate "placeholders" for services to be developed or implemented at a later date.
- In Michigan, the institutional model included in the National ITS Architecture helped to foster multi-jurisdictional cooperation and achieve consensus in discussions among the Michigan Department of Transportation, the Oakland County Road Commission, and public safety units within the Detroit metropolitan region.

How Will the USDOT Promote Conformance With the National ITS Architecture?

The Transportation Equity Act for the 21st Century (TEA-21) requires that highway and transit ITS projects and plans receiving funding from the Federal

Highway Trust Fund conform to the National ITS Architecture and related standards. In response to this legislative requirement and to assist agencies which are implementing ITS projects and planning for ITS, the USDOT will issue Interim Guidance on Conformity with the National ITS Architecture and ITS Standards. Through this Interim Guidance, the USDOT seeks to foster the involvement of a wide range of stakeholders, support flexibility in using ITS to meet local needs, achieve integration of ITS systems and components, enable information sharing among stakeholders, and support future expansion. USDOT intends to encourage the integration of ITS applications into existing transportation planning processes by promoting their consideration as part of the suite of strategies that can improve the operation and management of the transportation system.

What Are ITS Standards and Protocols?

ITS standards specify the data exchanged between ITS components and the communications protocols used to exchange the data. The National ITS Architecture identified the key interfaces for standardization. The standards are under development by numerous national Standards Development Organizations (SDO's).

What Is the Relationship Between the National ITS Architecture and Standards?

The National ITS Architecture identifies the information that is to be exchanged among various ITS functions (or "subsystems") without specifying how this exchange is to occur; thus, it is descriptive, rather than prescriptive. It does, however, identify where standards are needed to specify how ITS components are to be interconnected, and to provide uniform data definitions.

Why Are ITS Standards Important?

ITS standards are essential to achieving the vision of a seamless, intermodal, national intelligent transportation system. Standards help guarantee the accurate flow of data across multiple systems. Standards enable ITS technologies to communicate, provide guidance to manufacturers, and reassure purchasers that their systems will be compatible with those deployed elsewhere. The use of national ITS standards will let ITS devices continue to function as travelers move by highway or transit, within metropolitan regions and across borders. Such compatibility is key to promoting a vibrant and effective ITS market.

FOR MORE INFORMATION:

Contact:

U.S. Department of Transportation
Joint Program Office for Intelligent Transportation Systems

400 Seventh Street, S.W. (HVH-1)
Washington, DC 20590
202.366.9536 voice
202.366.3302 fax

http://www.its.dot.gov

ITS America

400 Virginia Avenue, S.W.
Suite 800
Washington, DC 20024-2730
202.484.4847 voice
202.484.3483 fax

http://www.itsa.org/home.nsf

Web Sites:

USDOT ITS Joint Program Office outlines DOT activities and provides links to additional sites. Periodic updates on the National ITS Architecture program and other ITS activities will be posted routinely on this web site.

http://www.its.dot.gov/architecture

Information on ITS standards also is available through the Joint Program Office at

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

ITS America (see above reference for web site) provides information on the National ITS Architecture, as well as a complete set of the National ITS Architecture documents available for downloading.

The ITS Cooperative Deployment Network (ICDN) web site provides updated information on ITS studies, publications and deployment. The site is maintained by the National Associations Working Group for ITS (NAWG), a cooperative effort of organizations spearheading ITS deployment in the U.S.

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

Publications:

The following guidance documents are available upon request from the ITS Joint Program Office (contact information provided above):

"The National Architecture for ITS: Framework for Integrated Transportation into the 21st Century," brochure.

"Developing Intelligent Transportation Systems Using the National ITS Architecture: An Executive Edition for Senior Transportation Managers."

"Developing Traffic Signal Control Systems Using the National ITS Architecture."

"Developing Traveler Information Systems Using the National ITS Architecture."

"Developing Freeway and Incident Management Systems Using the National ITS Architecture."

"ITS Deployment Guidance for Transit Systems, Executive Edition."

"ITS Deployment Guidance for Transit Systems, Technical Edition."

Complete original documentation of the National ITS Architecture is available on CD-ROM from the USDOT ITS Joint Program Office. A new edition is due in September 1998.

Technical Assistance:

The ITS Peer-to-Peer Network offers technical assistance through a vast network of experienced public and private sector transportation professionals. Limited free access to network resources is made available to public agencies under USDOT sponsorship.

Contact: Brian Biddle
(888) 700-PEER (7337)
dotpeer@erol.com

Training:

USDOT is committed to providing guidance and training on the implementation of ITS through its Professional Capacity Building (PCB) Program. The following courses about the National ITS Architecture are currently available:

"Using the National ITS Architecture for Deployment" (FHWA course #13613 and #13614). The objective of this course is to demonstrate how transportation professionals can apply the National ITS Architecture tools and methodologies developed for the USDOT. The three-day course (#13613) is an interactive class intended for public and private sector professionals who develop ITS solutions. The two day course (#13614) is geared toward public sector professionals involved in planning or deploying ITS.

The following courses are under development (titles are tentative):

"Introduction to the National ITS Architecture and Consistency Policy." (FHWA Course 13612) The objective of this one-day course--for transportation management staff involved in ITS planning, decision-making, and implementation--is to convey the concepts and benefits of applying the National ITS Architecture. The seminar also presents USDOT Interim Guidance on Conformity with the National ITS Architecture and Standards. The course can be tailored to meet audience needs. Expected availability: Fall 1998.

"ITS Standards Training and Training Modules." These modules will present information on specific ITS Standards and are targeted for project engineers, but can be tailored for senior managers as well. Expected availability: Winter 1998/Spring 1999.

The PCB course catalog is available on-line at:

http://www.fhwa.dot.gov/hst/pcb/itscord1.htm

Introduction to Standards for ITS

Contents

This subsection includes *An Introduction to Standards for Intelligent Transportation Systems (ITS)*, which was published by the Joint Program Office and widely disseminated at the ITS-America Annual Meeting (May 1998), as well as at the National ITS Architecture Consistency Outreach Meetings (February-May 1998). The original text was updated for this publication.

Summary

The National ITS Architecture established a framework for ITS deployment. In order to fulfill the goals of nationwide interoperability and compatibility envisioned by this blueprint, a set of standards and protocols is being developed. The U.S. Department of Transportation is sponsoring the accelerated development of these standards by independent standards development organizations.

Uses

This subsection is most useful for understanding the importance and process of developing ITS standards. It can be used to introduce transportation stakeholders to the standards development process.

An Introduction to Standards for Intelligent Transportation Systems (ITS)

Surface transportation agencies expect that the systems they deploy will be able to exchange pertinent data with those deployed by others. They also have reason to expect that ITS infrastructure can be upgraded and expanded over time so as to build upon past investments, rather than make them obsolete. Similarly, the American public expects that ITS equipment purchased for use in their homes and vehicles, as well as that purchased for transit systems, will function consistently and reliably anywhere in the country that ITS services are offered. National ITS standards and protocols are essential for achieving the interoperability and compatibility necessary to meet such expectations. (In general, the term "standards" will cover both standards and protocols.)

Leading members of the transportation community from all levels of government, private industry, and academia have worked for the past several years to develop a unified framework for ITS deployment. This framework is robust enough to enable interoperability and compatibility, yet flexible enough to accommodate a variety of needs and preferences. Their efforts have resulted in the creation of a consensus National ITS Architecture -- a master blueprint that defines basic ITS components and identifies those that must interface and interact with one another to deliver any ITS services to various users, including public agencies.

The National ITS Architecture identifies the need for standards but it does not propose specific solutions. To address this need, the U.S. DOT has sponsored the accelerated development of ITS standards by existing standards development organizations. Over the next several years, the U.S. DOT plans to adopt national ITS standards based on the results of these development efforts. Use of these adopted standards will be encouraged in various ways, including making the award of federal highway and transit funds for ITS deployment contingent upon consistency with the National ITS Architecture and critical ITS standards. Congressional intent regarding consistency with national ITS standards is reflected in statutory provisions governing Federal funding under the Transportation Equity Act for the 21st Century (TEA-21).

This document provides answers to frequently asked questions about ITS standards. Sources of additional information also are identified.

What are standards?

Standards and protocols, grouped together as "standards," define how system components interconnect and interact within an overall framework known as an architecture. Standards specify how various technologies, products, and components must perform when used in combination or interchanged. Standards enable telephone systems in various countries to transmit and receive voice signals, for example. Protocols, which define how data are to be exchanged, cover addressing, security, priority, and other data handling information.

Standards are "open" if published for use on a non-discriminatory, competitively neutral basis, thereby enabling open competition among interchangeable products. This prevents agencies from being limited to using a particular vendor for ITS upgrades and enhancements. Open television standards, for example, allow TV sets with different capabilities made by many different manufacturers over the last 50 years to use common broadcast signals.

Are national ITS standards necessary?

Yes. Adherence to ITS standards will enable travelers to use the same ITS device as they travel by car or transit between cities or across borders. Such compatibility and interoperability among agencies, jurisdictions, and states is key to promoting the an effective ITS market.

What are "critical" ITS standards, and how are these determined?

Congress has directed the U.S. DOT to identify standards that are "critical" to ensuring national ITS interoperability or critical to the development of other standards. In the event that standards organizations are unable to issue appropriate standards by January 1, 2001, the Secretary of Transportation is to adopt provisional standards. A report identifying "critical" ITS standards is to be submitted to the Congress by the U.S. DOT before June 1, 1999. The Department intends to consider views offered by various stakeholders as it determines which standards are designated "critical."

What is the status of ITS standards?

The National ITS Architecture identified the need for approximately 100 standards, of which more than 50 are of immediate priority and have been targeted for accelerated development. Over half of these high-priority standards will be voted on by standards organizations in 1998. For each standard, the U.S. DOT intends to determine the extent to which testing or operational experience is needed prior to adoption for routine use on federally funded projects. Several standards already are available for use in advanced traffic management, commercial vehicle operation, and advanced public transportation systems.

Who pays for the transition to new ITS standards?

Because ITS standards will be phased-in as part of major system upgrades or replacements, little or no additional cost is associated with the transition. Federal highway and transit funds can be used for transition purposes at normal matching rates.

In addition to enabling interoperability, what are other advantages of standards?

ITS standards ensure the safety of the traveling public. They also facilitate more widespread ITS deployment, thereby creating a national market conducive to the efficiencies of mass production. This allows agencies to deploy and upgrade components over time with products and services from multiple vendors, which results in lower cost and higher quality.

Are ITS standards and fundamental to interoperability?

Yes. However, additional efforts may be required. For example, if traffic control centers are to share traffic condition information with transit operators, detailed design specifications and institutional arrangements must be developed.

Is the use of ITS standards required on federally funded ITS deployments?

Section 5206 of the Transportation Efficiency Act for the 21st Century (TEA-21) requires that ITS projects funded out of the Highway Trust Fund (including the Mass Transit Account) adhere to national standards and protocols. This provision is similar to requirements regarding the use of AASHTO design guides or APTA Standard Bus Procurement Guidelines on traditional highway and transit improvement projects that use federal funds.

How can consistency be demonstrated?

At a minimum, federal funds recipients will be expected to agree that they will adhere to standards in the context of a regional operations and deployment strategy. Adherence to standards will be included as part of the procurement packages used in the regular procurement process.

How can I ensure the consistency of ITS products and services with standards?

One way to ensure consistency is to include a requirement in requests for proposals. With suitable proposal evaluation factors, consistency can be the basis for awarding a design contract or a contract for development and deployment. Requirements for independent testing of ITS interoperability prior to final payment can be incorporated into the surety release.

Is a rulemaking anticipated?

DOT may use the rulemaking process to formally adopt certain ITS standards for use on federally funded projects; however, the general policy intent is to motivate, rather than mandate, the use of standards. If and when a proposed rule requiring the use of a particular ITS standard or protocol in federally funded projects is to be promulgated, notice will be given in the Federal Register.

Should I wait for ITS standards to be made final and adopted before I proceed with deployment?

No. It is important to begin identifying the standards that are pertinent to the elements of the National ITS Architecture that will be implemented in your region or state. Once deployment objectives have been established through cooperative interagency planning, the transition time needed to convert existing systems to fit ITS standards can be addressed by the local agency.

Will ITS standards work with existing technology?

During the transition period, many agencies will need to operate with a mixture of new and old standards. Careful deployment can avoid many problems by isolating the new from the old, but there will be times when the use of "dual mode" technologies may be necessary.

What if ITS standards don't fit my needs?

This is unlikely. ITS standards were developed based on input from experienced highway and transit system operators throughout the country. Nonetheless, mechanisms exist for amending published ITS standards, influencing those under development, and proposing new ones. A process will be established for obtaining waivers to avoid situations where incurring the costs to comply with standards would not add value, be cost-effective, or make common sense.

Will system performance be degraded if I use open systems?

ITS standards should provide system performance that is comparable to existing systems, but will be less costly to install, operate, maintain, and upgrade over time.

For More Information

Key Contacts:

Mike Schagrin, Standards Program Manager
Bill Jones, Technical Director
U.S. DOT ITS Joint Program Office
400 Seventh Street, S.W.
Washington, DC 20590

Roy Courtney, Senior Standards Engineer
Ray Starsman, Director of Systems Integration
ITS America, Suite 800
400 Virginia Avenue, S.W.
Washington, DC 20590

Web Sites:

DOT ITS Joint Program Office outlines DOT activities and provides links to additional sites
http://www.its.dot.gov/standards

ITS America provides a list of ITS standards, an electronic version of "Standards Quarterly," and standards and protocol news
http://www.itsa.org/standards

Publications:

"Standards Quarterly," available from ITS America.

Technical assistance:

The ITS Peer-to-Peer Network offers technical assistance through a vast network of experienced public and private sector transportation professionals. Limited free access to network resources is made available to public agencies under U.S. DOT sponsorship.

Contact: Brian Biddle
(888) 700-PEER (7337)
dotpeer@erols.com

Training:

U.S. DOT Professional Capacity Program (PCB) courses address ITS standards in the context of various applications. Available courses covering ITS standards can be found in the PCB course catalog that is available on-line at:

http://www.fhwa.dot.gov/hst/pcb/itscord1.htm

Standards Development Organizations:

These organizations are preparing guidelines and recommended practices to accompany ITS standards under development. Most offer opportunities for participating in ITS standard and protocol development efforts.

◊ American Association of State Highway and Transit Officials
Contact: Dave Hensing (202) 624-5812
  - NTCIP (12 Protocols)

◊ American Society of Testing and Materials
Contact: Dan Smith (610) 832-9727
  - Dedicated Short-Range Communication (DSRC) Physical and Data Links

◊ Institute of Electrical and Electronics Engineers
Contact: Jerry Walker (732) 562-3823
  - ITS Data Dictionary and Message Set Template, DSRC Message Set and Incident Management Message Set

◊ Institute of Transportation Engineers
Contact: Mark Norman (202) 544-8050 X126
  - Advanced Traffic Controller (2070)
  - Advanced Traffic Management System Data Dictionary
  - Traffic Management Center Message Sets for External Communications
  - Transit Communications Interface Profiles (TCIP)

◊ Society of Automotive Engineers
Contact: Arlan Stehney (412) 727-7157
  - Advanced Traveler Information System Data Dictionary and Message Set
  - High-Speed FM Subcarrier Messages
  - ITS Data Bus
  - Location Referencing
  - Mayday Reporting
  - Navigation and Route Guidance System Man-Machine Interface
  - Safety and Human Factors

Introduction to Benefits of Integrated Technologies and the National ITS Architecture

Contents

This material summarizes the benefits being realized from using the National ITS Architecture to create regional architectures and to integrate information systems. Benefits described cover highway and transit modes in urban and rural areas, as well as services such as incident response and traveler information.

Summary

The National ITS Architecture is a versatile tool that can help each state, region, or metropolitan area meet its unique needs. The benefits available from using the National ITS Architecture and integrating ITS systems include improved traffic flow; enhanced route planning for travelers; improved incident response on roadways and transit; and cost savings, productivity enhancements, and better customer service for transit.

Use of the National ITS Architecture also helps states save time and money because regional and statewide architectures do not have to be developed from scratch. In addition, using the National ITS Architecture helps ensure that state and regional ITS architectures will be able to incorporate key elements needed for future expansion. This means that systems can evolve over time and in accordance with local priorities and available resources. As states and regions expand their use of the National ITS Architecture, the power of integrated ITS systems will be magnified.

Uses

These descriptions can be used to demonstrate the benefits of using the National ITS Architecture to both public and private stakeholders. Potential stakeholders include: elected officials; management and staff of the state DOT and other state departments, such as public safety; the private sector, including industry associations; academic institutions; the media; and the general public.

Note: For further information on each topic, sources are listed in the endnotes and referenced in parentheses after each entry.

Benefits of Integrated Technologies and the National ITS Architecture

For years, public agencies have recognized the ability of computer and communications technology -- or Intelligent Transportation Systems (ITS) -- to make transportation system facilities operate more efficiently. Now agencies are discovering that if they coordinate with each other to deploy and operate such technologies as an integrated system, the payoffs are even greater. Integrated technologies, in turn, make it easier for organizations to work together, allowing them to share information and resources, so that each can do its job better and, often, at a lower cost.

Integrated technologies translate to more lives saved through the coordinated action of traffic engineers (in detecting when and where traffic incidents occur) and police, fire, and rescue forces. Immediately after detecting an incident, an appropriate emergency response can be launched, based on shared information. Shared data also lets transit operators improve the "on-time" performance of buses, because they are using the same roadway congestion and traffic incident information as the roadway traffic managers. From the public's viewpoint, integrated technologies show the complete travel picture – such as the location of roadway congestion <u>and</u> public transit options – so travelers can make informed decisions about where, when, and how they can make their trip most quickly and easily. Here are two recent examples of how metropolitan areas in different parts of the country are applying integrated technology concepts.

> *By integrating traffic technologies,* ***Houston*** *has been able to remain one of the few metropolitan areas with both increasing growth and decreasing traffic congestion. The Greater Houston Transportation and Emergency Management Center, known as Transtar, makes the most of the region's existing roads and bridges by combining technologies to monitor and control transit and traffic systems. Transtar's success is based on the cooperative efforts of city, county, regional, and state transportation and transit agencies, which use the systems to share information and keep traffic moving. In addition, by locating the local Offices of Emergency Management at Transtar, Houston saves resources because common equipment can be used for many purposes. Even more important, life and property are better protected because the Transtar agencies share vital information such as weather conditions, road closures, and evacuation plans.*

> *The* ***Atlanta metropolitan region*** *linked eight agencies' operations to prepare for the 1996 Olympics. In cooperation with nearly two dozen private companies, these agencies formed the Atlanta Regional Traffic Management Center (TMC). The TMC was able to respond to the Games' special transportation needs by using integrated technologies for traffic surveillance and control. In addition, the TMC provided the over 2 million visitors with real-time transit and traffic information, available through cell phones, local cable television, the Internet, and 130 kiosks. As a result of this coordinated effort in what is normally one of the more congested American cities, the Olympic athletes, dignitaries, media, and spectators enjoyed light traffic and accessible transit during the Games.*

Designing such integrated technology systems requires some advance thinking and a comprehensive systems approach to your region's travel needs. For this, you need a master plan, or "system architecture." Based on input from state and local transportation agencies across the country, a National ITS Architecture was prepared to provide a unified framework. The National ITS Architecture includes generic building blocks that agencies can use to develop a technology integration strategy for transportation in a region or an entire state. The resulting "regional architecture" identifies jurisdictions and agencies that need to be involved to achieve the desired level of technology integration. A regional architecture also provides the context so that agencies which are ready to deploy technologies now, can do so confident that what they implement will work with what is deployed by others later. Using the National ITS Architecture saves time and money in the long run because a regional architecture does not have to be developed from scratch and can build upon a comprehensive framework that ensures key elements needed for future expansions are not inadvertently overlooked.

This packet provides examples of the benefits of both integrating technologies and of using the National ITS Architecture. These examples have been gathered from reports and personal contacts with state departments of transportation and transit agencies. The benefits of integration are grouped according to the following categories: Improved Traffic Flow; Enhanced Route Planning for Travelers; Improved Incident Response on Roadways; Improved Emergency Response and Security for Transit Vehicles; and Cost Savings, Improved Productivity, and Better Customer Service for Transit. Information gathered for this packet, however, shows that using the National ITS Architecture can magnify the power of integrated technologies. Moreover, the potential for saving both cost and time is much greater when an architecture is used to integrate systems.

Benefits From Integrated Technologies

Improved Traffic Flow

Freeway management systems are particularly effective in relieving congestion and the associated stop/start movement of traffic, keeping travelers and traffic moving. With such management systems, traffic operators can combine a range of technologies such as road sensors, video cameras, and electronic signs to monitor traffic conditions and communicate information on route alternatives to drivers. These benefits are greatly leveraged when the freeway management system is integrated with other transportation systems, such as traffic signal control, transit management systems, and railroad grade crossings. Such integrated systems can respond immediately to changing conditions and keep traffic moving. Following are examples of areas integrating technologies and the benefits they are realizing.

Phoenix, Arizona. In Phoenix, the transit agency is providing better information to riders on bus arrival times, and traffic managers know how smoothly traffic is moving on main roads, even where no sensors are installed. These capabilities are possible because the transit management system has been linked to the City's traffic management system so they share information on the location of transit buses, which are equipped with automatic vehicle location devices. Bus drivers need only push a button when a major vehicular accident occurs that will affect their service. That information feeds directly to the traffic management center and to the police, so that incidents are immediately reported and a response can quickly begin. A quicker response can clear the roadway more rapidly, providing needed emergency assistance and allowing travelers to be on their way. (31)
Systems: Freeway Management, Transit Management, Incident Response

Puget Sound Region, Washington. Traffic moves more smoothly region-wide in the Seattle metropolitan area now that transportation operation centers for freeways and main roads share video images, providing each center with a regional view of congestion and incidents. Traffic managers in the cities of the South Puget Sound can view the traffic entering their jurisdictions, adjust traffic signals before congestion reaches critical levels, and decrease travel time so commuters get home faster and goods and services are delivered on schedule. (3, 28)
Systems: Freeway Management, Traffic Signal Control

Houston, Texas. Travelers along Houston's extensive freeway network depend on the region's Computerized Freeway Management System to keep traffic moving. This system combines technologies such as roadway sensors, video cameras, electronic message signs, and highway advisory radio to monitor and control traffic. One use of these integrated technologies is to encourage

travelers to use transit or rideshare services that take advantage of Houston's high-occupancy vehicle (HOV) freeway lanes. During rush hour, the five HOV lanes move the same volume of passengers as 19 main freeway lanes. This system helps reduce the number of vehicles on the road, in turn reducing traffic congestion during the busiest times of the day. (36, 37)
Systems: Freeway Management, Regional Multimodal Travel Information

San Antonio, Texas. Drivers on San Antonio's freeways are alerted to potential delays at railroad grade crossings that are located near freeway exits. Electronic signs notify drivers of the anticipated delay. Drivers save time by choosing alternate routes, and avoid sitting for long periods of time at railroad grade crossings as they wait for trains to pass. (3, 4)
Systems: Freeway Management, Railroad Grade Crossings

San Antonio, Texas. Drivers on San Antonio's main roads are starting to experience smoother and less congested traffic during incidents that divert vehicles from freeways to surface streets. The Texas Department of Transportation (TxDOT) is developing the capability to share freeway incident information and associated traffic data with the City of San Antonio, which controls the traffic signals on surface streets. The City, previously able to modify traffic signal timing and change electronic message signs on surface streets that are near freeways, is now receiving improved information about freeway conditions. This will provide better information to travelers and help clear the way for emergency vehicles. (32)
Systems: Freeway Management, Traffic Signal Control

Minneapolis-Saint Paul, Minnesota. In the Minneapolis-Saint Paul metropolitan area, traffic will move more smoothly region-wide once the traffic management centers operated by cities, counties, and the state are connected to share traffic signal, volume, and incident data. Traffic operators will know in advance if congestion at their jurisdictional boundaries is getting worse. They will be able to adjust their traffic signals before the congestion turns into gridlock, helping to keep traffic moving within their own borders and from one jurisdiction to the next; whereas before the technologies were integrated, traffic operators could only view travel activity within their individual jurisdictions. (27)
Systems: Freeway Management, Traffic Signal Control

Long Island, New York. Automatic vehicle detection devices, once installed, will help prevent trains at the New Hyde Park passenger station in Long Island from hitting vehicles that become trapped between railroad grade crossing gates. Vehicles sometimes get caught on the tracks, between the closed gates, because of traffic back-ups that occur at a nearby traffic light. Traffic signals at the intersection are now timed to minimize the back-ups, and electronic signs will inform drivers of the length of time the gates will remain closed. Integrating these technologies increases safety and keeps traffic moving. (8)
Systems: Traffic Signal Control, Railroad Grade Crossing

Enhanced Route Planning for Travelers

Integrating transportation technologies makes it easier for travelers to plan their trips in advance. All travelers, from commuters to commercial truck operators to tourists, will benefit from real-time information on traffic, road, and weather conditions to select routes that best accommodate their personal schedules and business demands. Integrated technologies can provide specific information on an expansive range of transportation options, from bicycle routes to high-speed rail. Travelers will be able to make decisions that will reduce their trip time and improve their safety. Timely information can also highlight the attractiveness of transit, which not only can save time for individual travelers, but can also further reduce congestion by reducing the number of vehicles on the road. Examples follow of areas where integrated technologies are being put in place to benefit travelers.

<u>Atlanta, Georgia.</u> Spectators, the media, dignitaries, and the athletes themselves benefited from integrated technologies as over 2 million visitors moved between the geographically scattered events and attractions of the 1996 Olympic Games. Tying together the many locations was the Atlanta Regional Transportation Management Center (TMC). The TMC used sensors, video cameras, fiber optic lines, and buses equipped with automatic vehicle location devices to gather data on regional transportation conditions. Transit options and traffic information were then available to the public via cell phone, cable television, and 130 kiosks, so travelers had clear information on how to move from one event to the next. Contrary to early predictions, the area experienced lighter-than-usual traffic conditions during much of the Games. The TMC is now expanding its success by opening satellite centers in surrounding counties to broaden the region's information-sharing opportunities. (14,38)
Systems: Regional Multimodal Travel Information, Freeway Management, Transit Management

<u>San Francisco, California.</u> Through a single telephone number, travelers in the San Francisco Bay Area can receive real-time information on traffic incidents and congestion, route and schedule information for transit trip planning, and help arranging carpools. Much of this information is provided through integrated technologies. Real-time information on traffic congestion, speed, and incidents is also available over the Internet. More than 50,000 people request information each month and surveys indicate a high level of customer satisfaction. (12, 13)
Systems: Regional Multimodal Travel Information, Freeway Management

<u>Puget Sound Region, Washington.</u> Drivers in the Puget Sound Region have easy access to better information to make informed travel choices that accommodate today's busy lifestyles. They can use the Internet to view real-time freeway conditions, road closure information, construction projects, and

travel times for alternate routes. In the future, travelers and businesses will get real-time information on freeway and arterial conditions, bus and ferry transit options, and airport vehicular traffic, all available through pagers, the Internet, airport display terminals, and at transit stations. Integrated technologies will make information about travel alternatives easily available to travelers. (3, 28)
Systems: Regional Multimodal Travel Information, Freeway Management, Transit Management, Incident Management

Minneapolis-Saint Paul, Minnesota. Better information will soon be available to travelers in the Minneapolis-Saint Paul metropolitan area. Travelers will access real-time roadway and transit conditions using the Internet or telephone. The Minnesota Department of Transportation's (MnDOT's) freeway management system and maintenance department, the state patrol, metro transit, and a city parking management group will all share information electronically. Collected data will be sent to a private traveler information center to be made available to the public. Travelers will save time by planning their trips in advance, and choosing the best possible route and means of travel. Commuters will get to work and home faster, and commercial vehicles will deliver their products and services more reliably. (27)
Systems: Freeway Management, Transit Management, Regional Multimodal Travel Information, Incident Management

San Antonio, Texas. Travelers in San Antonio will be able to avoid traffic back-ups and have better information for choices on when and how to travel. Strategically located kiosks will have information on traffic, bus schedules, and airport parking, all in real-time. Public transit riders will know if their buses will be late, and people traveling to the airport will know the availability of parking spaces in airport parking lots. Citizens will be able to adjust their schedules and routes so they are not wasting time waiting or caught unexpectedly in traffic. (3, 32)
System: Freeway Management, Transit Management, Regional Multimodal Traveler Information

Improved Incident Response on Roadways

Incidents refer to any obstruction of traffic, ranging from victims trapped by a mudslide across a roadway to the congestion created by a major sporting event. Advanced technologies can save lives and keep traffic moving safely by accelerating the detection, response, and clearance of incidents and by improving traffic management through traveler information. These benefits reduce congestion, minimize backups, and enable traffic to return to normal more quickly.

For example, with integrated technologies, emergency personnel can detect a roadway accident almost as soon as it happens with closed-circuit cameras or specialty patrol vehicles. Automated vehicle location devices can be used to locate the closest available emergency response vehicles. Integrated technologies also enable the cooperation of various emergency response personnel, such as ambulances and highway patrol, so that only those resources most appropriate for any particular accident are sent to the scene. Some areas are already experiencing the benefits of integrated technologies.

<u>Detroit, Michigan.</u> Michigan State Police dispatchers are located at the State traffic management center where they can be immediately notified of incidents and can quickly begin responding. Immediate dispatching of appropriate emergency response teams to the incident scene potentially saves more lives by reducing the response time so that victims can be treated more quickly. "With the Michigan State Police sharing the MITS [Michigan Intelligent Transportation Systems] Center, our ability to respond quickly to freeway incidents has improved tremendously," notes Dr. Kunwar Rajendra, Michigan Department of Transportation Engineer for Transportation Systems. (33)
Systems: Freeway Management, Incident Management

<u>Denver, Colorado.</u> Roadway incidents in Denver are cleared faster, thereby improving safety and reducing traffic back-ups. Enhanced video coverage enables police to dispatch the right kind of assistance to the scene as quickly as possible. Patrol cars arrive more promptly to aid victims and clear the roadway. The Colorado Department of Transportation (CDOT), the local transit operator, the police, and the city and county transportation departments share video images and other available information. If the police need to view an area that is not covered by their cameras, they can share cameras operated by the transit operator, TV stations, or CDOT in the police dispatch center. Integrated technologies provide them with more information to better do their jobs. (26)
Systems: Freeway Management, Transit Management, Incident Management

<u>San Antonio, Texas.</u> Since 1995, injury-related accidents have decreased by 15 percent along 26 miles of highway in San Antonio due to an ambitious, integrated traffic and incident management system. Transportation management center operators can identify incidents and dispatch the appropriate help within two minutes, since the 911 dispatcher is co-located with the traffic management center. Traffic operators can then tell the public, through traveler information technology, to expect delays. Reduced response time and better information can help save lives and reduce time spent waiting in traffic. (1)

Ambulances equipped with two-way video teleconferencing are now augmenting this system's effectiveness. Trauma center physicians can "see" inside the ambulance to determine the types of injuries involved in an incident, and can route patients to the most appropriate facility. This is the first time traffic management system capabilities have been used in this capacity and represents a major advance in the ability to allocate resources, improve medical attention,

and save lives. It can also save money – as much as $15,000 per incident, according to one source. (4, 39)
Systems: Freeway Management, Incident Response, Emergency Response

Arrowhead Region, Minnesota. Integrated technologies are improving safety for transit riders in the highly rural, 18,000 square mile region of Arrowhead, Minnesota. By fitting transit buses with automatic vehicle locators (AVL) and cellular phones, operators at the state patrol dispatch center can track and communicate with these vehicles at all times. Equipping transit buses with AVL has reduced rescue time for stranded transit buses from about two hours to half an hour. The technology is also installed on state patrol cars, snowplows, and maintenance vehicles, which, like the transit buses, were often out of communication range as they traveled. Integrating technologies will allow vehicles to report incidents as well as information on road conditions to the dispatch center, which then can dispatch emergency response or take other appropriate action. This is especially important during the severe winter weather conditions that the area experiences. (14, 15)
Systems: Emergency Management, Freeway Management, Transit Management

Chicago, Illinois. In Chicago, an electronic map of the City at the 911 headquarters determines the exact location of a distress call. This information, combined with automatic vehicle location devices on emergency vehicles, allows a central system to identify the rescue vehicles closest to the incident within three seconds. Calls are automatically routed to fire and police (14). This integration can reduce response time and improve resource allocation.
System: Emergency Management Services

Milwaukee, Wisconsin. Integrated technologies in Milwaukee help rescuers save lives by improving response time. Milwaukee's fire department vehicles and ambulances are given right-of-way at intersections along certain routes. At signalized intersections along these routes, optical detectors "read" signals emitted from the approaching emergency vehicles and electronically request the traffic signal controller to provide a green light for the emergency vehicle. If doing this would disrupt the flow of traffic too much, the system can substitute an extended "green" signal. Public safety is also enhanced because conflicts are eliminated between emergency vehicles and cross-street traffic. (14)
Systems: Traffic Signal Control, Emergency Management Services

Southern California. In Southern California, plans to integrate arterial and freeway information systems will allow traffic operators to respond to incidents and ease traffic flow on a regional level. The California Department of Transportation (Caltrans) and the City of Los Angeles each operate traffic management centers (TMCs) through which they share a series of preplanned responses to incidents. Messages displayed on electronic signs, traffic signal timing, and freeway on-ramp metering rates are automatically changed to reduce

congestion resulting from an incident. In addition, the TMCs share functions so that if an accident occurs when one Center is closed, the other is able to activate the preplanned responses covering both jurisdictions. Integrated technologies allow the centers to share rather than duplicate resources. In the future, more jurisdictions' transportation centers will be integrated to share video images, traffic volume and speed data, and to adjust systems quickly to respond to incidents at the regional level. (29)
Systems: Freeway Management, Traffic Signal Control

Improved Emergency Response and Security for Transit Vehicles

Personal safety concerns can deter travelers from riding public transit. Integrating information systems greatly improves response to crime and medical emergencies on public transit, making travel by this mode a more attractive option. Buses can be equipped with devices that allow the operator to communicate with the dispatcher via coded messages, voice communications, and silent emergency alarms. The buses can also be equipped with covert microphones so the dispatcher can listen to the nature of the problem without the perpetrator knowing, and respond with the appropriate assistance. Now, a bus operator need only activate a silent emergency alarm to receive assistance. The locations of the bus and the nearest supervisory vehicle are automatically displayed to the dispatcher on an electronic map. Dispatchers can give response personnel the exact location of the bus. Calls going to the dispatcher can be ranked in order of priority, allowing for response to high priority calls first. Some examples follow of areas using integrated technologies to improve safety for transit riders.

<u>Kansas City, Missouri.</u> Response time to crime on Kansas City transit was reduced from between 4-10 minutes to one minute by integrating transit and emergency management systems. Automatic vehicle locating (AVL) devices were installed on the transit buses, allowing dispatchers to pinpoint bus locations and provide that information to the police for a fast response. (14)
Systems: Transit Management, Incident Management

<u>Denver, Colorado.</u> Integrating transit management and emergency response systems in Denver has improved public safety by reducing average police response time to crime on buses by more than 80 percent, down from more than ten minutes to under two minutes (1). In one case, a bus operator used a silent alarm and covert microphone to notify the dispatcher that a man was assaulting passengers in the back of the bus. The dispatcher notified the police, providing the exact location of the bus. The police arrived in just four minutes and caught the perpetrator. The police and transit dispatchers have also found another use for this integrated technology. The police provide descriptions for suspects and lost or missing people to dispatchers, who then send a message to bus operators. If the person is spotted on a bus, the operator has only to press a

silent alarm or use a covert microphone or encoded message to notify the dispatcher. The dispatcher automatically knows where the bus is located and sends the police. (20)
Systems: Transit Management, Incident Management

Cost Savings, Improved Productivity, and Better Customer Service for Transit

Individually, advanced technologies can save costs, improve productivity, and provide better customer service for transit. When integrated together, they can provide better service to customers and help the transit system operate more efficiently. For instance, electronic fare cards can be used on multiple transit modes, providing even more convenience to riders. Small transit operators that use integrated technologies to share dispatching operations are able to provide better, more timely service to riders at a fraction of what it would cost for each operator to provide its own dispatching service. Following are examples of some areas already experiencing these benefits.

Sweetwater County, Wyoming. Five years after the installation of a computer-aided dispatch system, the operating costs of Sweetwater County's on-call bus system have decreased by 50 percent and ridership has increased by 5 times. Integrated technologies are allowing the transit center to provide dispatching service to approximately 20 agencies in this rural region, including a child development center and several senior citizens' centers. These facilities could not afford dispatch centers on their own. The on-call service is used by 28 percent of the general public and helps meet the travel needs of welfare recipients who find new jobs. (24, 25)
Systems: Transit Management

Chicago, Illinois. In Chicago, electronic fare cards cover bus service for two separate transit agencies, as well as rail service. This allows riders the convenience of traveling on several modes using a single payment and decreases boarding times. It also allows the transit agencies to save money on transfers and avoid theft. (30)
Systems: Transit Management Systems, Electronic Fare Payment

Portland, Oregon. In Portland, fewer buses are needed to serve routes where traffic signals have been equipped with technology that gives buses priority to cross intersections. Extending the green light by just a few seconds helps the buses stay right on schedule. The transit agency therefore provides a better service using fewer buses, saves the capital costs of buying new ones, and makes transit a more attractive travel option. (1)
Systems: Transit Management, Traffic Signal Control

Phoenix, Arizona. A program to reduce fraud and misuse is being instituted in 1998 for the 12,000 students in the Phoenix school district who are eligible for state transportation assistance. Under the new program, student ID cards are encoded electronically for use as bus passes. These cards enable the transit agency to track student transit use accurately and bill the school district accordingly. Using the cards also allows faster passenger boarding, since the youth fare is automatically charged for students under sixteen years old, eliminating the need for them to show additional identification for proof of age. Transit buses are thus better able to meet their schedules. (23)
Systems: Transit Management, Electronic Fare Payment

Lake Tahoe, Nevada. Integrated technologies will be used at Lake Tahoe to coordinate the movements of nearly 50 vans and minibuses, operated by the various public and private transit services that carry visitors around the lake. Passengers will request service by using touchscreen kiosks in retail shopping areas, casinos, and hotel lobbies. In response to these requests, the computerized system will dispatch a roving fleet vehicle and notify passengers when they will be picked up. Lake Tahoe's population swells from 30,000 permanent weekday residents to 200,000 on the weekend. By making the buses a more dependable option, this technology will relieve the traffic snarls created when the area's visitors arrive. (12)
Systems: Transit Management, Regional Multimodal Travel Information

Benefits Realized from Using the National ITS Architecture

Designing integrated technologies requires a comprehensive systems approach. For this, you need a master plan, or "system architecture." Developing a system architecture is a resource-intensive undertaking that would be difficult for many agencies to complete on their own. Based on input from state and local transportation agencies across the country, a National ITS Architecture was prepared to provide a unified framework and generic building blocks that agencies can adapt to create a strategy for integrating transportation technology in a region or an entire state. Following are the benefits described in conversations with public agency personnel and system engineers who have used the National ITS Architecture.

Saves Time and Resources

Using the National ITS Architecture saves resources by providing a basic framework from which agencies can develop a detailed systems architecture tailored to their region. Creating a systems architecture from scratch is a complex task that few organizations have the time and resources to complete. Some examples follow of the savings being realized by areas using the National ITS Architecture.

Denver, Colorado. The Colorado Department of Transportation (CDOT) cut six months from the time needed to create a detailed system architecture for the Denver metropolitan area by basing their work on the National ITS Architecture. This freed up staff time and public resources to devote to other issues. (26)

Detroit, Michigan. Building on the basic framework of the National ITS Architecture, the Michigan Department of Transportation (MDOT) was able to control costs for its planned improvement of traffic management and traveler information systems. These systems will cover 180 miles of freeway in the metropolitan Detroit area, and are being deployed at a lower cost (per mile) compared to similar systems. (33)

Puget Sound Region, Washington. By using the framework provided in the National ITS Architecture, systems engineers needed only half the time it otherwise would have taken to match existing and planned projects to the user services described in the National ITS Architecture. (28)

Southern California. The California Department of Transportation (Caltrans) cut by 30 percent the development time needed to create a regional architecture for the Southern California region, starting with the basic framework provided by the National ITS Architecture. Because of this time saving, Caltrans was able to develop their regional transportation technology strategy using fewer resources. (29)

Virginia. Virginia Department of Transportation (VDOT) staff recognized that without the foundation provided by the National ITS Architecture, a statewide system architecture would have been too expensive to develop on their own. Using the National ITS Architecture allowed VDOT to save enough time and money to develop a systems architecture for the entire state. (34)

Coordinates All Stakeholders and Provides a Common Language

Developing a regional plan and architecture for integrated technologies requires the cooperation of many organizations. Typically, transit agencies, state DOTs, local transportation agencies, the state patrol, and private information service providers need to work together. The National ITS Architecture includes an institutional model that helps identify agency needs and capabilities, ensuring that no organizations will be overlooked. The National ITS Architecture also provides uniform system descriptions and data definitions that make it easier for different agencies and jurisdictions to communicate their expectations and commitments to one another. Following are some examples of institutional cooperation based on the National ITS Architecture.

Detroit, Michigan. Applying the National ITS Architecture fostered multi-jurisdictional cooperation among the Michigan Department of Transportation (MDOT), the Oakland County Road Commission, and public safety units in the Detroit metropolitan region. The National ITS Architecture provided a common language for discussing complex systems and reaching consensus. Brent Bair, managing director of the Oakland County Road Commission, notes: "jurisdictional boundaries between MDOT and the Oakland County Road Commission no longer keep us from looking at the whole road network. Technology has given us the means to cooperate for the good of our mutual customers, travelers in Southeast Michigan." (33)

Minneapolis-St. Paul, Minnesota. The Minnesota Department of Transportation worked with stakeholders from city and county transportation agencies, transit agencies, and law enforcement units in adapting the National ITS Architecture to meet regional needs throughout the state. Using National ITS Architecture terminology and data definitions allowed these stakeholders to communicate with each other, making it easy to undertake the integrated technology projects that grew out of the cooperative decision-making process. (27)

Phoenix, Arizona. Applying the National ITS Architecture in Phoenix helped foster a creative mindset, encouraging users to think of relationships beyond those already defined. When agencies began making plans to have fire departments notify traffic management centers when a fire gets worse so that traffic can be diverted from the vicinity, they didn't stop there. They thought that this notification should be given to the water department as well so that pressure could be increased on the water lines, ensuring that the fire department and other consumers in the area have sufficient water. The National ITS Architecture was instrumental in getting agencies to focus on the relationships that exist between traffic agencies and police and fire departments, so users began asking themselves what other types of information fire and police might need to do their jobs better. (31)

Seattle, Washington. The common language provided by the National ITS Architecture helped public agencies communicate better with each other and with the private companies involved with enhancing and implementing the regional systems architecture. The National ITS Architecture's common language helped vendors work with the public sector to identify regional needs. By matching their product offerings to services outlined in the National ITS Architecture, vendors could better explain their products and services to a public agency. This allowed public and private sector representatives to understand each other better as they discussed complex technical issues. (28)

Virginia. The Virginia Department of Transportation (VDOT) used the institutional framework outlined in the National ITS Architecture to help identify all agencies and jurisdictions that should be included in the technology integration process. Working through this process provided the impetus to set up meetings with stakeholders, such as law enforcement officials, to discuss data needs and integration opportunities. Agencies and local jurisdictions were able to communicate with one another when discussing the complex subject of technology integration because they spoke the common language provided in the National ITS Architecture. Finally, coordinating with stakeholders and listening to their feedback helped VDOT staff to develop their own vision and to consider how they should be organized internally to best meet their public service mission and address the needs of their local stakeholders. (34)

Helps Plan for the Entire System Up-front and Reduce the Possibility of Future Changes

Using the National ITS Architecture facilitates planning for an entire system up-front, while eliminating the possibility of "gaps" in system definition and integration. This allows systems to be implemented in stages, while reducing the possibility of future costly changes to hardware or software that can be common as systems are upgraded over time. Examples follow of areas using the National ITS Architecture to realize this benefit.

Denver, Colorado. The Colorado Department of Transportation used the blueprint provided in the National ITS Architecture to identify current and future opportunities for integrating technologies with other agencies. The regional architecture that has been created provides the basis for this integration and allows the designation of "placeholders" for future services, such as systems related to commercial vehicle applications, which will not be developed until a later date. Planning the entire system up front will reduce the need for costly planning and retrofits later. (26)

Puget Sound Region, Washington. Comparing their own services against those described in the National ITS Architecture helped to identify gaps in local services, such as in the areas of public transit safety, commercial vehicle operations, and electronic payment services. This step also helped to identify duplications in service. This provided a reasoned foundation from which to more accurately identify future needs, and to more effectively allocate scarce public resources. (28)

Southern California. The California Department of Transportation (Caltrans) and local transportation agencies are integrating their information systems and will avoid future costly hardware and software changes that are often required as information systems evolve. The framework embedded in the National ITS Architecture allowed Caltrans to plan for the entire system up-front. Caltrans selected the services needed immediately and in the future from the National ITS Architecture to create a systems architecture for the region. The framework provided by the National ITS Architecture ensured that no systems were overlooked and that no "gaps" existed among the connections between traffic management, transit management, and information service providers. (29)

Virginia. According to Virginia Department of Transportation (VDOT) staff, using the National ITS Architecture has likely reduced changes to technology integration that would be needed in the future. The National ITS Architecture identified gaps in system planning. Knowing where the gaps are, VDOT can create current systems that are flexible enough to be expanded later. This will help to avoid costly hardware and software changes in the future. (34)

Helps Projects Move Forward Before the Regional Architecture is Complete

The National ITS Architecture provides guidance for moving forward with individual projects before a unique regional architecture is defined and ready for use. Many future requirements are unknown, but the National ITS Architecture helps planners and engineers think ahead, so they can begin planning for future systems while they hammer out the details of their intended regional architecture. This will help save resources by creating systems that can be expanded rather than replaced as local communities grow and their needs change and as new services become available.

Virginia. Matching their systems to those identified in the National ITS Architecture allowed Virginia Department of Transportation (VDOT) staff to see the relationship between various integrated technologies and particular statewide transportation goals. This allowed staff to determine that although there may be several steps toward reaching that goal, some can be initiated before the statewide architecture is finalized. VDOT was then able to start providing services with confidence that what they do now will not be obsolete later. (34)

Helps Integrate Existing Technologies with Each Other and With New Systems

The National ITS Architecture provides a framework to integrate existing, or "legacy," systems with each other and with newer, more interoperable systems. Older existing systems were often not designed to be linked together, so it can be difficult to connect old and new systems. This makes overall system planning more complex. Following are descriptions of some areas that have used the National ITS Architecture to save resources by extending the life of their legacy systems while expanding service with new systems.

<u>Denver, Colorado.</u> The National ITS Architecture provided the Colorado Department of Transportation with a framework to design new, open systems and to integrate legacy systems with new ones. Without the National ITS Architecture, integrating these legacy systems with each other and with newer, open systems would have been more difficult and time consuming. (26)

<u>Puget Sound Region, Washington.</u> The Washington Department of Transportation is using the framework provided in the National ITS Architecture to decide how to best integrate existing, or "legacy" systems with new systems. The National ITS Architecture helped guide decisions on which legacy systems are candidates for integration, and which would be too difficult to integrate, and should be replaced through future projects. (28)

<u>Southern California.</u> Systems that are being developed using the National ITS Architecture are able to share data and have the same control interfaces. Because of the shared designs, regional traffic management centers will be able to talk to county and local traffic management centers or to transit centers. Local centers will also be able to talk with each other, resulting in seamless communication between existing traffic operation centers throughout the regional network. (29)

Identifies Standards

The National ITS Architecture identifies standard interfaces to be used to connect basic technologies. These common design elements are known as "standards." Standards will make possible the use of off-the-shelf equipment from multiple vendors, which is cheaper than using proprietary systems from single vendors.

Albany, New York. Systems designed using the National ITS Architecture and standards are more compatible with each other. Therefore, by requiring that contractors building advanced technology systems use the National ITS Architecture, Albany's Capital District Transit Authority (CDTA) avoided having to select a single vendor to ensure that multiple systems would be interoperable. This positioned them to take advantage of price competition among multiple vendors. (35)

Denver, Colorado. Because the National ITS Architecture supports multiple vendors, the Colorado Department of Transportation will be able to take advantage of price competition when choosing among vendors for the development of specific systems. (26)

Summary of Benefits Realized by Using the National ITS Architecture

Based on the experiences of areas already using the National ITS Architecture, the benefits of using the National ITS Architecture to create a systems architecture for a particular region are listed below. The National ITS Architecture:

- Saves time and resources by providing a model from which to develop a regional architecture.
- Helps identify all agencies and jurisdictions that should be included in creating the regional architecture. Helps agencies communicate complex ideas by providing a common language and definitions.
- Enables planning of an entire system up-front while maintaining a long-term perspective. This allows the system to be implemented in stages, while reducing the possibility of future costly retrofits. Using the National ITS Architecture eliminates the possibility of "gaps" in system definition and integration.
- Provides a framework for integrating existing ("legacy") systems with each other and with new, open systems.
- Provides guidance for moving forward with individual projects even before a regional architecture is defined and ready for use.
- Identifies where standards should be used. Standards will make possible the use of off-the-shelf equipment from multiple vendors, which is cheaper than using proprietary systems from a single vendor.

Glossary of Systems

Traffic Signal Control – Signaling systems that react to changing traffic conditions are an important component in improving transportation system efficiency and smoothing traffic flow. Traffic signal systems can accommodate changing traffic conditions using real-time input from police incident reports and video cameras. Local jurisdictions typically control the traffic signals on their arterial roadways from traffic operation centers.

Transit Management – Transit management systems provide better service and improve safety. Technologies include hardware and software on buses that facilitate automatic passenger counting, advanced voice and data communications, or emergency response. Automatic Vehicle Location (AVL) systems provide reliable bus position information to the dispatcher for tracking schedule adherence.

Freeway Management – These systems are used for monitoring freeway conditions. They include sensors such as video cameras and inductive loop detectors to provide traffic count and speed (flow) data. Input from maintenance crews, the police, and drivers with cellular phones are also used to gather information. State departments of transportation manage freeways from Freeway Management Centers (or from multiple centers when responsibility for the freeway system is shared by more than one jurisdiction).

Electronic Toll Collection – Electronic toll collection reduces delays at toll plazas and operating costs of toll agencies. These systems include hardware and software for roadside and in-vehicle use. The system may include debit, credit, and stored value toll tag capability.

Regional Multimodal Travel Information – These systems are used to provide timely travel information to drivers and transit riders, so they can make informed transportation choices. Information ranges from transit schedules to real-time congestion and transit traffic. Traveler information may by provided directly to the public or to Information Service Providers (ISPs) who will supplement it with additional information and services and market the enhanced product.

Electronic Fare Payment – Electronic fare payment systems are used to collect transit fares, parking lot fees, etc. The systems include hardware and software for roadside, in-vehicle, and in-station use. Travelers will no longer need to carry exact fare amounts. These systems can include debit, credit, and stored value cards.

Railroad Grade Crossings – Railroad Grade Crossings pose safety challenges since trains which travel at high speeds can take up to a mile to stop.

Automated systems are becoming available which will allow the deployment of safety systems that adequately warn drivers of crossing hazards.

Emergency Management Services – Efficient management and use of emergency equipment are important contributors to a safe transportation system. By equipping emergency vehicles with automatic vehicle location devices, these vehicles can be more efficiently managed by allowing dispatchers to know the locations of various pieces of equipment. Other technologies are regional digital maps to track vehicles. The materials in this packet use the Federal Government definition of emergency management services as described here. However, some regions define emergency management services as the responses in place for infrequent, large-scale emergencies, such as natural disasters. These areas classify regular, daily response to emergencies as incident management.

Incident Management – Rapid and effective response to incidents is an essential factor in saving lives and reducing travel delays. Incident Management Systems identify and facilitate the responses for incidents that occur on freeways and major arterial roads. The objectives are to rapidly respond to incidents with the proper personnel and equipment, to aid victims, and to facilitate the rapid clearance of the incident from the roadway.

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Introduction to Using the National ITS Architecture: Brief Case Studies

Contents

This subsection presents six descriptions of how the National ITS Architecture is being successfully used to develop systems for metropolitan and statewide areas. These brief case studies (vignettes) are based primarily on information from interviews conducted with the public and private sector transportation officials who developed the projects and plans for their areas. The states and metropolitan areas for which vignettes are provided are Colorado (Denver), Michigan (Detroit), Minnesota (Twin Cities), Washington (Seattle), Southern California, and Virginia.

Summary

The National ITS Architecture has been useful to state and local transportation agencies in a variety of ways, illustrated here for six areas. Each region undertook a deliberate process to assess their current ITS projects and their transportation needs, and to use the National ITS Architecture to help identify opportunities for systems integration.

For example, in Seattle, the National ITS Architecture was used to identify gaps in local services, such as in public transit safety, commercial vehicle operations, and electronic payment. This provided a foundation from which to more accurately identify future needs and to compete effectively for scarce public resources. Using the National ITS Architecture as a framework, Virginia has developed a statewide architecture, and plans to create regional architectures representing different parts of the state. By using these architectures, the state will avoid costly hardware and software changes in the future as it expands its ITS capabilities. In many cases, the National ITS Architecture helped improve communication between transportation agencies and their stakeholders; a common vocabulary enabled them to address complex issues that crossed traditional jurisdictional boundaries.

Uses

These case studies of architecture application summarize the experiences that some areas have already had in applying the National ITS Architecture to their transportation systems and services. The vignettes can be used to indicate the potential benefits that the National ITS Architecture may bring to a variety of situations. The studies can also familiarize stakeholders and technical staff with ways to incorporate the National ITS Architecture into existing processes for transportation planning and projects.

USING THE NATIONAL ITS ARCHITECTURE: BRIEF CASE STUDIES

These brief case studies illustrate the processes used in, and benefits realized from, integrating technologies using the framework provided by the National ITS Architecture. The studies have been gathered from reports and personal contacts with implementing agencies. Six regions were examined: Colorado (Denver), Michigan (Detroit), Minnesota (Twin Cities), Washington (Seattle), Southern California, and Virginia.

Applying the National ITS Architecture: Improving Emergency Response in Denver, Colorado

The Colorado Department of Transportation (CDOT), the local transit operator, the police, and the City and County transportation departments improved emergency response and traffic movement in the Denver metropolitan area by linking their information systems. The partners are connected to CDOT's traffic management center (TMC), where they have access to all video images and other available information, improving each agency's operations. If the police need to view an area that is not covered by their cameras, they can share cameras operated by the transit operator, TV stations, or CDOT – all without leaving the police dispatch center. This enhanced video coverage enables police patrol cars and other emergency vehicles to be dispatched to an accident scene more promptly to aid victims and clear the roadway. It is cost-effective because it reduces the dispatch of unnecessary assistance, and helps to get the right kind of help to an accident scene as quickly as possible. Traffic back-ups resulting from an accident or special event are reduced as vehicles are diverted to other routes as necessary, and drivers have information to make more informed decisions regarding how and when to travel.

The essential core of CDOT's integrated information system is their system architecture – the "blueprint" for how agencies communicate and exchange information. The architecture is a key factor in the effective design of complex information systems, which can be very time consuming to engineer. By using the National ITS Architecture as a foundation, CDOT cut six months from the time needed to create their architecture, thereby significantly reducing the development cost. With the assistance of a consultant, Lockheed Martin, CDOT selected the technologies and services they needed, both immediately and in the future, from the National ITS Architecture to create an architecture that would meet the unique requirements of the Denver region.

In addition, because they planned for their entire system at once and represented it through their architecture, the different agency partners will avoid the need for costly software and hardware changes that often are required as information systems evolve. Thus, all of the agencies can make cost-effective decisions about equipment purchases now and will continue to realize savings in the future.

The National ITS Architecture also helped identify possible current and future opportunities for expanding technology integration through linkages to other agencies. CDOT's architecture provides the basis for expansion and allows the designation of "placeholders" for future services, such as systems related to commercial vehicle applications, which will not be developed until a later date. Because the National ITS Architecture supports multiple vendors, CDOT will be able to take advantage of price competition when choosing among vendors for the development of specific systems.

CDOT also is saving time and money by using the regional systems architecture to guide integration of existing, or "legacy," systems, which will continue to operate in the Denver region, with new systems both now and in the future. These older systems were not designed to communicate with other systems; thus connecting old and new systems makes planning more complex. The Denver regional systems architecture provides a framework that incorporates legacy systems into the overall plans, while supporting the movement toward future open systems.

By using the blueprint in the National ITS Architecture to integrate information technologies, transportation operators and emergency response organizations in the Denver area can do their jobs more efficiently and effectively. They will send medical assistance faster to accident scenes, make regional travel safer, help traffic move faster, and aid drivers in making better decisions about their travel choices. Local communities will benefit in time saved, lower travel costs, and safer trips.

(Source: Personal interviews with Systems Chief of Lockheed Martin, ITS)

Applying the National ITS Architecture: Linking Public Safety Systems in Detroit, Michigan

The Michigan Department of Transportation (MDOT) is improving transportation and emergency response on 180 miles of freeway in the Detroit metropolitan area by linking the information systems of services that until now have operated independently. Already, as a result of these improvements, State police are able to respond more quickly to freeway incidents, saving lives and improving roadway safety. At the Michigan Intelligent Transportation System (MITS) Center, traffic operators use the newly integrated system to monitor current freeway conditions, active incidents, and construction work zones. The new system also alerts traffic operators to potential incidents, helps public safety officers verify whether the incident really occurred, and notifies appropriate agencies. When an incident is verified, the new system identifies and facilitates control of changeable electronic message signs, freeway on-ramp meters, and highway advisory radio so that operators can advise drivers in a timely manner.

Michigan State Police dispatchers are co-located at the MITS Center to facilitate immediate incident response. This coordinated arrangement provides for fast dispatching of appropriate response units and emergency services to the incident scene, potentially saving lives by reducing the response time so that victims can be treated more quickly. "With the Michigan State Police sharing the MITS Center, our ability to respond quickly to freeway incidents has improved tremendously," notes Dr. Kunwar Rajendra, MDOT Engineer for Transportation Systems. Faster response to incidents reduces traffic back-ups and clears congestion more quickly, thus returning traffic to normal.

Integrating information systems will also provide travelers with easy access to information. They will be able to receive up-to-the-minute traffic conditions by telephone and over the Internet to make better choices about when, where, and how to travel. People and goods will move more freely throughout the region, as traffic movement is improved and congestion is reduced. Reducing the amount of time spent stuck in traffic has a positive effect on the economy, as well as on quality of life.

MDOT is working with Odetics ITS to make these improvements possible by linking together traffic management, emergency response, and traveler information systems, to provide better information to travelers and transportation organizations. The integration of information technologies is a complex, resource-intensive task that is made easier by having a blueprint, or architecture, to guide how institutions will exchange information with one another. MDOT used the blueprint provided in the National ITS Architecture to improve and integrate the freeway information systems and to provide better traffic information to travelers. This is one reason that MDOT plans to deploy a fully functional system for an estimated $33 million – lower, on a cost per mile basis, than any comparable system built to date.

Equally important, applying the National ITS Architecture fostered multi-jurisdictional cooperation among MDOT, the Oakland County Road Commission, and local public safety units within the Detroit metropolitan region. It provided a common language for discussing the complex systems and reaching consensus. Brent Bair, managing director of the Oakland County Road Commission, notes: "jurisdictional boundaries between MDOT and the Oakland County Road Commission no longer keep us from looking at the whole road network. Technology has given us the means to cooperate for the good of our mutual customers, travelers in Southeast Michigan. ITS has become a bridge to overcome operational impediments to safer and more convenient travel for everyone."

(Source: "Cutting the Cost Per Mile," Michigan DOT and Odetics ITS, Traffic Technology International; Personal interviews with Odetics ITS staff.)

Applying the National ITS Architecture: Minneapolis-St. Paul, Minnesota's Strategy for Sharing Information

The Minnesota Department of Transportation (MnDOT) is using the National ITS Architecture to integrate the information systems of key organizations in the Minneapolis-St. Paul region. This allows MnDOT to provide traffic and transit information to the traveling public and to keep traffic moving smoothly region-wide. Cities, county, and state traffic signal operation centers will continue to operate their own traffic management centers, but will soon be connected, so they can share traffic signal, volume, and incident data. Traffic operators will know in advance if congestion at their jurisdictional boundaries is getting worse. They will be able to adjust their traffic signals before the congestion turns into gridlock, helping traffic to move smoothly within their own borders and from one jurisdiction to the next. Before the systems were integrated, using the framework of the National ITS Architecture, traffic operators could view travel activity only within their individual jurisdictions.

Information systems will also be connected for MnDOT's freeway management system and maintenance department, the state patrol, metro transit, and a city parking management group, so that they will be able to share traffic data and coordinate their operations. The shared data will include information covering roadway and transit conditions, and will be sent to a private traveler information center to be made available to the public, in real-time, on the Internet and by telephone. Drivers throughout the region will be able to choose how and when to travel, commuters will get to work and home faster, and commercial vehicles will deliver their products and services more reliably. Timely information can also highlight the attractiveness of transit and save time for individual travelers. More transit trips means less congestion because fewer vehicles are on the road, so freight and other critical traffic can move more quickly.

Designing and integrating information systems is a complex task that is made easier by using a framework, or architecture, to assess available and required data and how it will be shared among organizations. MnDOT staff saved time by using the National ITS Architecture as a starting point rather than developing an architecture from scratch. Using the blueprint in the National ITS Architecture, MnDOT created a statewide architecture that was then applied within the Minneapolis-St. Paul metropolitan area. The National ITS Architecture helped them conceptualize and plan for the entire system up-front. The resulting statewide architecture identified the jurisdictions involved, defined the technologies to be implemented, and provided a master blueprint to ensure that the various pieces will work together.

Stakeholders from transit agencies and the county, as well as law enforcement personnel, were involved in adapting the statewide architecture to the Minneapolis-St. Paul region. The system descriptions drawn from the National ITS Architecture allowed stakeholders to know precisely what to expect, making it easier to deploy the projects that grew out of this cooperative decision-making process. The National ITS Architecture will also help facilitate future cooperation among stakeholders.

The blueprint provided by the National ITS Architecture also pointed out ways for project planners and engineers to take advantage of system integration opportunities. Consistent with the National ITS Architecture, each traffic jurisdiction will continue to operate independently, while electronically transmitting data to and from the others. Thus they will have the benefits of better and more complete data -- obtaining a regional perspective for traffic patterns -- but will be able to avoid any single point of vulnerability that could result in system-wide failure. Sharing data with other jurisdictions helps prevent traffic congestion and ultimately keeps people and goods moving to support the city and region's economies and meets their constituents' busy schedules.

(Source: Personal interviews with MnDOT staff, Metro Division)

Applying the National ITS Architecture: Meeting Increased Travel Demand in Seattle, Washington

The Washington State DOT (WSDOT) is linking the transportation and traveler information systems of key public agencies in the Puget Sound Region to meet the increasing demands placed on the transportation infrastructure by travelers, tourists, and businesses as the population grows and economic activity increases. For example, traffic operation centers for freeways and arterial roadways now share video images, providing each center with a regional view of congestion and incidents. Traffic managers in the cities of the South Puget Sound can view the traffic entering their jurisdictions, adjust traffic signals before congestion turns into gridlock, and decrease travel time so commuters get home faster and goods and services are delivered on schedule. The efficient movement of goods is particularly important in this area because of the critical role played by the Seattle and Tacoma ports in Pacific Rim commerce.

WSDOT has realized the benefits of information systems in this region since the 1960's; however, most systems have previously operated somewhat independently of one another. Now, transportation information systems are being integrated to maximize their benefits, increase their usefulness, and provide more complete information to operators and travelers. Travelers and businesses will get information on current freeway and arterial conditions, bus and ferry transit options, and airport vehicular traffic information. All this will be available through pagers, the Internet, airport display terminals, and at transit stations. With better information, travelers can decide when and how to travel, and can reduce the time lost to congestion. Businesses can rely on receiving their just-in-time deliveries as scheduled. Tourists will be able to make bus and ferry connections with ease and confidence. Transit riders will know before leaving their homes whether their bus is going to be on time, making transit a more attractive transportation option.

Planning for the integration of technologies is made easier by using a blueprint, or architecture. Creating an architecture from scratch is a complex, resource-intensive undertaking. In the Puget Sound region, local officials used the framework provided by the National ITS Architecture to create a systems architecture tailored to the region's unique needs. Matching the existing infrastructure with the transportation services identified in the National ITS Architecture reduced by half the time it would have taken to create a regional architecture from scratch. The National ITS Architecture helped identify gaps in local services, such as in the areas of public transit safety, commercial vehicle operations, and electronic fare and toll payment services, as well as to identify duplications in service. This analysis provided a reasoned foundation from which to more accurately identify future needs, and to compete effectively for scarce public resources.

In addition, the common language provided by the National ITS Architecture helped public agencies communicate better with each other and with the private companies involved with enhancing and implementing the regional architecture. Public and private sectors came to understand each other better as they discussed complex technical issues. The National ITS Architecture's common language helped vendors work with the public sector to identify regional needs. By comparing their products to the National ITS Architecture, vendors could better explain their products and services to public agencies.

Finally, WSDOT is using the framework provided in the National ITS Architecture to decide how best to integrate existing, or "legacy," systems with new systems. The National ITS Architecture is helping to guide decisions on which legacy systems are candidates for integration, and which will be difficult to integrate and should be replaced through future projects.

(Source: Technology Based Transportation Solutions, Model Deployment Initiative, FHWA; Personal interviews with Battelle Pacific NW Division staff)

Applying the National ITS Architecture: Creating a Systems Architecture for the Southern California Region

The California Department of Transportation (Caltrans) is integrating the information systems of key organizations to improve transportation services and traveler information on 550 miles of freeway that cross multiple jurisdictions and travel modes. Once integrated, each jurisdiction's information systems can be adjusted according to the shared data to respond quickly to incidents at the regional level and even across extensive freeway networks. Some integration has already occurred. Caltrans and the City of Los Angeles each operate Traffic Management Centers (TMCs) through which they share a series of preplanned responses to incidents. A recommended response will be applied only after being approved by operators at both TMCs. Once approved, the messages on changeable electronic message signs, traffic signal timing, and freeway on-ramp metering rates are automatically adjusted to reduce congestion resulting from the incident. In addition, the TMCs share functions and responsibilities, so that if an accident occurs when the City of Los Angeles' TMC is closed, Caltrans can activate the preplanned responses and can operate some of the local streets in the City of Los Angeles.

Different jurisdictions' transportation centers will also share video images, and traffic volume and speed data, providing each center with a regional perspective of traffic. This will help to keep traffic moving throughout the region. California Smart Traveler provides schedule information for many public transit systems over the Internet, as well as information about Interstate, U.S., and State Route highway conditions. Citizens and the trucking industry will have better information on road conditions and so will be able to make better decisions about when and how to travel.

Caltrans has been operating advanced technologies for 30 years, increasingly as partially integrated ITS. Now, the technology exists to integrate the traffic and transit management systems more completely with the information service providers. Integrating these information systems can add enormous value to the many billions of dollars of public investment in the present (and future) transportation infrastructure. To plan for the integration of these complex technologies, it was necessary to develop a framework, or architecture, to identify the information systems, the linkages between them, and how they would work with one another. Building an architecture from scratch is complex and resource-intensive. Caltrans cut 30 percent off of the development time needed to create a regional architecture for the Southern California region by using the framework provided by the National ITS Architecture.

Applying the National ITS Architecture not only helped Caltrans save resources while developing a regional architecture, but will help to save resources in the future. Caltrans and the other stakeholders will avoid costly changes to hardware and software that are often required as information systems evolve.

The National ITS Architecture helped the stakeholders select the services they needed immediately and those they would need in the future to create the regional architecture. This allowed them to plan for the entire system up-front, ensuring that no systems were overlooked, and that no "gaps" existed among the connections between traffic management, transit management, and information service providers.

Equally important, the systems that are developed using the National ITS Architecture share the same data and control interfaces. The National ITS Architecture identified the data they would need and a framework for how systems could be linked with each other to share the data. This means that regional traffic management centers will be able to talk to local traffic centers or to transit centers, resulting in seamless communication between traffic operation centers throughout the regional network.

(Source: National Intelligent Transportation Systems Program, 1996 Report to Congress; Personal interview with staff from the New Technology and Research Program, Caltrans)

Applying the National ITS Architecture: Virginia's Statewide Strategy

The Virginia Department of Transportation (VDOT) has embarked on a far-reaching program to improve transportation services by integrating transportation information systems statewide. By creating an integrated network of information systems to collect and share information on the conditions of Virginia's highways and byways, VDOT will help traffic move more safely and smoothly. Throughout the state, VDOT has already installed synchronized traffic signal systems in more than fifteen urban areas, covering thousands of intersections, and they have installed freeway management systems in the Northern Virginia and Hampton Roads areas. These systems eventually will be integrated regionally with other systems, magnifying their benefits by providing statewide communication and coordination of transportation information.

Better information will allow travelers to make the best decisions regarding routing, choice of travel mode, and the timing of a trip, all of which should help reduce their total travel time. Law enforcement, emergency medical, and maintenance personnel will be able to respond to and clear incidents more quickly. Freight shippers will be able to save time and money by avoiding costly delays due to traffic tie-ups and can more easily meet their delivery schedules.

The first steps in successfully integrating information systems are to define existing and planned services, identify available and required data, and recognize which organizations are critical to the smooth exchange of information. This is made easier by using a blueprint, or architecture, but creating a systems architecture from scratch that covers an entire state's needs is resource-intensive and complex. Accordingly, VDOT staff chose to use the National ITS Architecture because a statewide architecture would have been too expensive to create on their own.

Basing the statewide architecture on the National ITS Architecture not only saved development costs, but will also save costs in the future. The National ITS Architecture identifies gaps across all areas of development, from system identification, design, and integration, to agency and jurisdictional coordination. Identifying gaps in the information system early on helps to avoid costly hardware and software changes in the future.

The framework provided by the National ITS Architecture also helped VDOT break down institutional hurdles to systems integration. The process of using the National ITS Architecture showed where institutional gaps existed and provided the impetus for meetings with stakeholders, such as law enforcement officials, to discuss data needs and integration opportunities. VDOT has been able to coordinate with other agencies and regional and local jurisdictions, leaving no one out. The common language provided in the National ITS Architecture helped the agencies and jurisdictions communicate their expectations with one another when discussing the complex subject of systems integration.

VDOT used the blueprint in the National ITS Architecture as a guide, modifying it to fit their needs. For example, VDOT defined some technology services differently than the National ITS Architecture, and then grouped the services into categories according to the agency responsible for deployment and operations. Presently, the statewide framework focuses on traffic control, incident management, and emergency management. From the statewide framework, VDOT will develop regional frameworks. These will address local system needs, such as transit, that are not included in the statewide framework.

Finally, developing a statewide architecture from the National ITS Architecture helped VDOT staff develop a vision and focus for their integrated technology efforts. It guided organizational changes and helped set resource requirements that will enable them to realize that vision.

(Source: Personal interview with VDOT staff)

GLOSSARY OF SYSTEMS

Traffic Signal Control – Signaling systems that react to changing traffic conditions are an important component in improving transportation system efficiency and smoothing traffic flow. Traffic signal systems can accommodate changing traffic conditions using real-time input from police incident reports and video cameras. Local jurisdictions typically control the traffic signals on their arterial roadways from traffic operation centers.

Transit Management – Transit management systems provide better service and improve safety. Technologies include hardware and software on buses that facilitate automatic passenger counting, advanced voice and data communications, or emergency response. Automatic Vehicle Location (AVL) systems provide reliable bus position information to the dispatcher for tracking schedule adherence.

Freeway Management – These systems are used for monitoring freeway conditions. They include sensors such as video cameras and inductive loop detectors to provide traffic count and speed (flow) data. Input from maintenance crews, the police, and drivers with cellular phones are also used to gather information. State departments of transportation manage freeways from Freeway Management Centers (or from multiple centers when responsibility for the freeway system is shared by more than one jurisdiction).

Electronic Toll Collection – Electronic toll collection reduces delays at toll plazas and operating costs of toll agencies. These systems include hardware and software for roadside and in-vehicle use. The system may include debit, credit, and stored value toll tag capability.

Regional Multimodal Travel Information – These systems are used to provide timely travel information to drivers and transit riders, so they can make informed transportation choices. Information ranges from transit schedules to real-time congestion and transit traffic. Traveler information may by provided directly to the public or to Information Service Providers (ISPs) who will supplement it with additional information and services and market the enhanced product.

Electronic Fare Payment – Electronic fare payment systems are used to collect transit fares, parking lot fees, etc. The systems include hardware and software for roadside, in-vehicle, and in-station use. Travelers will no longer need to carry exact fare amounts. These systems can include debit, credit, and stored value cards.

Railroad Grade Crossings – Railroad Grade Crossings pose safety challenges since trains which travel at high speeds can take up to a mile to stop.

Automated systems are becoming available which will allow the deployment of safety systems that adequately warn drivers of crossing hazards.

Emergency Management Services – Efficient management and use of emergency equipment are important contributors to a safe transportation system. By equipping emergency vehicles with automatic vehicle location devices, these vehicles can be more efficiently managed by allowing dispatchers to know the locations of various pieces of equipment. Other technologies are regional digital maps to track vehicles. The materials in this packet use the Federal Government definition of emergency management services as described here. However, some regions define emergency management services as the responses in place for infrequent, large-scale emergencies, such as natural disasters. These areas classify regular, daily response to emergencies as incident management.

Incident Management – Rapid and effective response to incidents is an essential factor in saving lives and reducing travel delays. Incident Management Systems identify and facilitate the responses for incidents that occur on freeways and major arterial roads. The objectives are to rapidly respond to incidents with the proper personnel and equipment, to aid victims, and to facilitate the rapid clearance of the incident from the roadway.

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Introduction to ITS and Commercial Vehicle Operations (CVO)

Contents

This subsection includes four documents designed to provide further information on achieving conformance with the National ITS Architecture in CVO applications.

1. *Intelligent Transportation Systems / Commercial Vehicle Operations (ITS/CVO): Architecture Utilization Policy* provides guidance on how to assure that technology and system deployments are consistent with the National ITS Architecture.

2. *ITS/CVO Architecture Utilization Policy Implementation Tool* provides a description of the conformance assurance process.

3. *ITS/CVO Architecture Conformance Guidance Documentation* provides a summary of the documents that address architecture conformance issues for CVO.

4. Glossary defines terminology relevant to ITS/CVO architecture conformance.

Summary

There are two major initiatives to provide an architecture specific to CVO. The Commercial Vehicle Information Systems and Networks (CVISN) architecture addresses local, regional, and national CVO systems, while the International Border Clearance (IBC) architecture pertains to commercial vehicle operations across U.S. borders. While both systems are part of the National ITS Architecture, the IBC architecture incorporates additional allowances for the multitude of stakeholders involved in international trade.

Due to the far-flung nature of commercial vehicle movements, having a systematic process in place for evaluating system design, development, and implementation is an important factor in fostering interoperability across users, systems, and jurisdictions. These documents provide guidance for using the ITS/CVO Architecture and identify several tools and documents for assuring conformance.

Uses

These documents provide an overview of ITS/CVO architecture guidance tools and documentation. They are a guide for federal field staff in the implementation of ITS projects for commercial vehicle operations.

Intelligent Transportation Systems/ Commercial Vehicle Operations (ITS/CVO)

Architecture Utilization Policy

ITS/CVO Architecture Utilization

1. Introduction

The Intelligent Transportation Systems (ITS) Program has developed a National ITS Architecture, which was defined and baselined in 1996. ITS has been interpreted to be a "system of systems," and its architecture serves as the master blueprint for ITS to assist in achieving Secretary Slater's vision of "building a transportation system that is international in reach, intermodal in form, intelligent in character, and inclusive in nature." The National ITS Architecture is comprised of several "subsystems" that are components of the overall ITS. Commercial Vehicle Operations (CVO) comprises four of these subsystems, and a more detailed architecture consistent with, and derived from, the National ITS Architecture exists to support it. The ITS/CVO Architecture was developed to provide a technical framework for the development of systems for implementing various ITS/CVO user services. The architecture has already achieved many of its original objectives in that it has been the basis for the progress in the ITS/CVO Program to date. However, there is now a need to provide guidance for exactly how the ITS/CVO Architecture will be used and maintained in the future to assure that technology and system deployments are consistent with the National ITS Architecture.

This paper provides the policy and guidance for ITS/CVO Architecture Utilization.

Topics include:
1. Introduction
2. The need for an ITS/CVO Architecture Policy
3. Policy for ITS/CVO Architecture Utilization
4. What is the ITS/CVO Architecture?
5. Uses of the ITS/CVO Architecture
6. Tools for implementing the Policy

2. The Need for an ITS/CVO Architecture Policy

A formal policy for architecture utilization is required for several reasons:

- To support the legislative mandate of the U.S. Congress
- As a basis for program & budget planning
- To establish a plan for stable ITS/CVO expansion across the nation
- To lay out a process to help foster interoperability through consistent architectures
- To ensure the architecture is maintained
- To ensure information about the architecture and how to use it is easily accessible to all potential users

The U.S. Congress has mandated that the implementation of ITS using funds authorized by the reauthorization of ISTEA, the Transportation Equity Act for the 21st Century (TEA-21) must be in conformance with the National ITS Architecture and Standards.

The Federal Government, state governments, motor carriers, and technology suppliers are developing plans for the next 1-5 years for deployment of ITS/CVO systems. They need a stable basis for planning which this policy helps in part to provide. For example, if states and vendors know that their systems will be required to pass Federally specified interoperability tests, or that they need to comply with standards, they can and will plan to invest resources to make their systems consistent with the architecture and with standards. On the other hand, if the architecture is not maintained, and a clear set of interoperability criteria are not defined, neither states nor vendors will want to invest in being consistent with the architecture.

A primary goal of the architecture is to achieve geographic and functional interoperability of ITS/CVO systems. The architecture can help with this, but only if it is supported by a test program that allows technology providers and customers to test for specific interoperability characteristics in accordance with national standards and guidelines.

Factors which influence the architecture are constantly changing. The needs of motor carriers evolve in response to changes in the marketplace caused by factors such as global competition. New technologies emerge and old ones become obsolete. Public policy and legislation changes. If the architecture is to remain current and useful, a policy is required to define how it is to be used and maintained.

3. Policy for ITS/CVO Architecture Utilization

<u>FHWA will use and encourage others to use the ITS/CVO Architecture for:</u>

- Government and private industry planning
- Standards development
- Deployment and testing of interoperable systems
- Structuring operational practice agreements
- Market development of ITS/CVO products and services

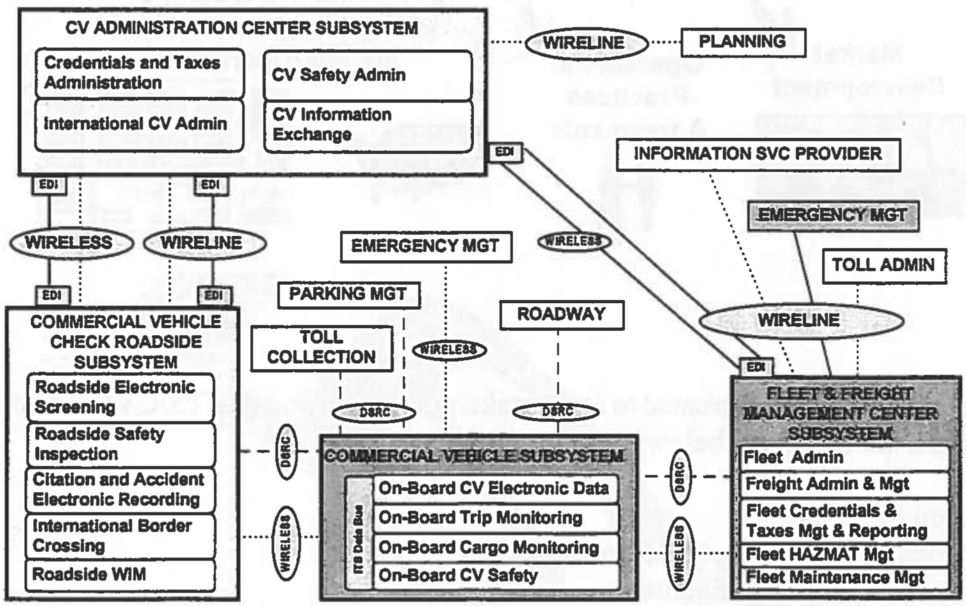
<u>FHWA will provide funding to support:</u>

- Architecture maintenance and updates based on lessons learned and incorporation of new technologies and capabilities
- Continued evolution of standards specified in the architecture
- Approved projects that are consistent with the architecture
- Development and maintenance of selected interoperability tests
- Development of operational practice agreements to foster institutional interoperability

Subject to the direction of the U.S. Congress, FHWA will provide funding throughout the period of the next highway reauthorization bill, which would extend through 2003. At the end of this period, the architecture utilization program will be evaluated to see if it should be continued, turned over to one or more private organizations, or discontinued.

4. What is the ITS/CVO Architecture?

The ITS/CVO architecture is a framework which serves as guidance for stakeholders in the CVO community to develop information systems, standards, interfaces, and subsystems to support identified user services. These user services are based upon stakeholder needs and requirements, and are an outgrowth of analyzing "operational scenarios" within the commercial motor vehicle environment. A top-level picture of this architecture is shown in the figure below.



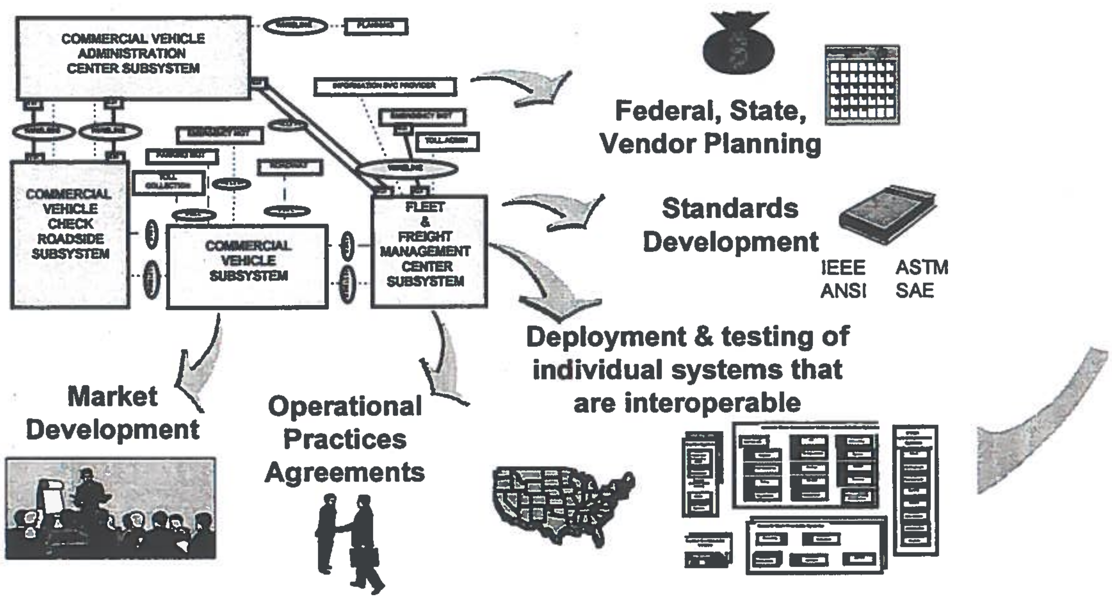
The ITS/CVO architecture is a concept. It is defined by a set of documentation that describes requirements, standards, operational concepts, notional designs, implementation guidance, and other supporting technical and management information. The architecture defines:

- The functions associated with ITS/CVO user services,
- The physical entities or subsystems within which such functions reside,
- The data interfaces and information flows between physical subsystems, and
- The communications requirements associated with information flows

5. Uses of the ITS/CVO Architecture

The architecture has multiple uses as shown in the figure below.

How can the architecture be used?



Specific documents have been created to assist stakeholders in using the ITS/CVO Architecture, several of which are identified below:

- Introduction to CVISN
- CVISN Operational Concept Document
- CVISN Architecture Specification
- CVISN DSRC Interface Requirements and CVISN EDI Interface Requirements
- CVISN Operational and Architectural Compatibility Handbook (COACH)
- EDI Standards & Implementation Guides (Transaction Sets 284, 285, 286)
- DSRC Standards
- CVISN System Design Description
- Product requirements and design specifications
- Prototype or recommended practices
- Guides to CVISN applications
- International Border Clearance Concept of Operations
- International Border Clearance System Architecture
- International Border Clearance Business Processes

The architecture provides a framework for **planning**. It allows Federal and state governments to define programs in terms of shared goals, concepts and nomenclature. It allows vendors to develop products and services independently and know that these will fit into a larger scheme. As architectural elements are proven, federal guidance, policies & practices are re-worked, and state plans and policies, regulations, and enforcement programs are updated.

It identifies where **standard interfaces** are required. Based on those requirements, the Federal government supports the development of standards through standards development organizations such as ANSI, ASTM and IEEE.

The architecture allows customers to specify the technical characteristics of procured systems necessary for interoperability. It provides detailed specifications to allow them to **implement and test** that interoperability characteristics have been achieved.

It provides a framework for states to develop **operational practice agreements** that lead to administrative process uniformity and system interoperability. For example, the architecture provides a technical framework that allows states to identify specific requirements for common practices to achieve interoperability in the area of electronic screening. Existing organizations (such as ITS America, AASHTO, ITE, NEMA, and AAMVA) will usually provide forums for consensus-building on practices.

The architecture supports **market development** by providing a framework for states and motor carriers to identify common needs, thereby creating a market large enough to support investment by system integration contractors, product vendors, and service providers. It allows the Federal government to encourage market growth by funding operational tests, prototype or pilot efforts to implement systems in accordance with architectural standards and guidelines in areas where a clear need has been identified.

6. Tools for Implementing the Policy

Other than the documents referred to above, FHWA intends to provide several additional tools to assist in implementing this policy:

- Briefing packages
- Training, workshops and conferences
- Technical and management documents
- Interface standards
- Conformance Assurance Process
- Standard interoperability tests
- Architecture & Standards Maintenance Process

Details of these tools will be developed and documented separately. Key documents include:

- Conformance Assurance Process (CAP) Description
- Interoperability Testing Strategy
- Architecture & Standards Maintenance Process Description

ITS/CVO Architecture Utilization Policy Implementation Tool

June 30, 1998

Conformance Assurance Process Description

How to foster CVO deployment conformance with the National ITS Architecture

Infrastructure vs. Information

The ITS arena is changing the way we do business, and in many areas is breaking new ground in public-private partnerships, as well as internal and external stakeholder relationships. Traditionally, Federal-Aid and OMC have had distinct responsibilities, and personnel from the agencies have interacted only slightly. Similar institutional arrangements exist at the State levels.

With the acceleration of ITS deployments, a shift is occurring in the way governmental entities carry out their duties. ITS is providing the impetus for the evolution of the Department's transportation program into the next Century. The times of traditional infrastructure development are being slowly phased out, as we are moving more towards an approach of improving existing systems rather than building new ones. With this evolution has come the need for information exchange. In this paradigm shift, information needs are driving infrastructure upgrades and development. Additionally, with this movement has come the need to define the information networks in a structured way, as well as to define the uses and users of the information. The National ITS Architecture was created to fulfill this need.

Multiple entities vie for access to the information collected in transportation operations. The implementation of ITS is dynamic in nature, rather than traditional infrastructure development and maintenance, which is generally static.

What does this all mean? In OMC's case, it will mean that in certain instances we will have to coordinate more with Federal-Aid and, potentially, with other modal personnel. In many cases, there are overlaps in the need for information, as shown in the National ITS Architecture, and these needs will have to be worked in concert with infrastructure development and modification. For example, say a State wants to put in a new weigh station, or for that matter, make modifications to an existing facility, and they want to use Federal-Aid funds to do it. It should not be OMC's position to dictate how those infrastructure changes will be made. Rather, we should ensure that the ITS/CVO user services, operational concepts, and information exchanges are supported and fulfilled as identified in the architecture. If we are in a position and possess the knowledge to make recommendations on how these infrastructure changes can be made, it would be wise to do so; however, the States should be allowed to make their own decisions on infrastructure support.

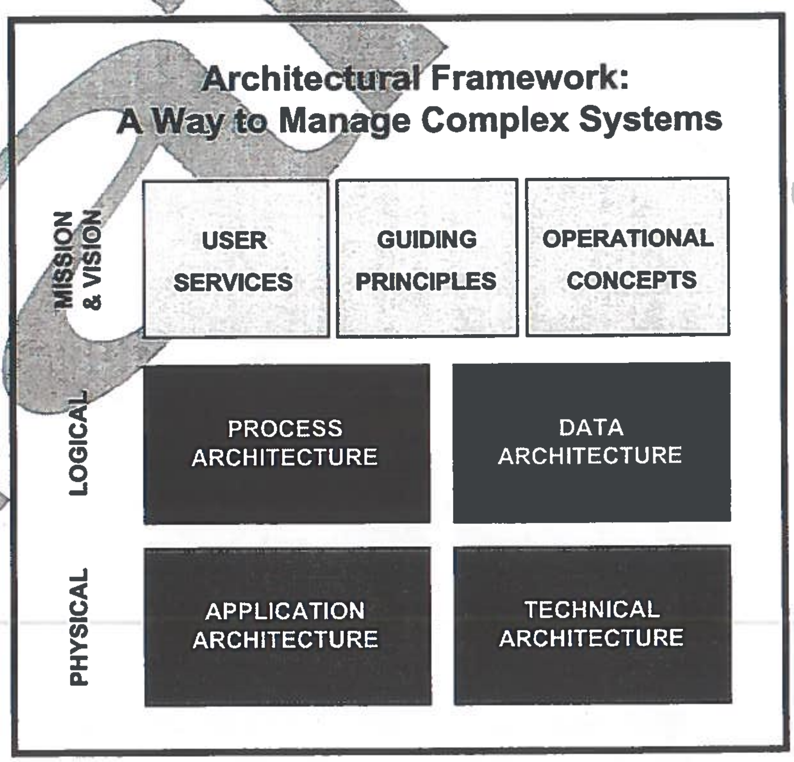
Supporting this concept, work is underway to provide such guidance on the roadside infrastructure deployments needed to support the range of ITS user services identified in the architecture. We would expect that similar efforts to coordinate and address stakeholder needs will be done on the Federal-Aid side as well. For example, Emergency Response Vehicles need to collect and distribute a variety of information to an assortment of stakeholders. This information will be required to service the needs of both OMC and Federal-Aid, as well as others. It is in cases like these where collaborative efforts must be undertaken to ensure that everyone's needs are addressed.

What is "architecture"?

There are many technological advancements occurring in the commercial motor vehicle industry and within OMC. A few examples of such technology initiatives include GPS, smart cards, weigh-in-motion, transponders, performance based brake testing devices, as well as Commercial Vehicle Information Systems and Networks (CVISN), ASPEN, and Safety Fitness and Electronic Records (SAFER), just to name a few. In addition, the International Border Crossing (IBC) program has made great strides recently in promoting seamless and safe movements across the US, Canada, and Mexico. A few such examples are the TRIBEX and MONY initiatives.

There are many factors driving the development and deployment of such technologies, most of which involve safety and/or efficiency. With the implementation of the Intermodal Surface Transportation Efficiency Act (ISTEA) back in 1991, the ITS program was created. Within the ITS piece of this legislation, US DOT established the environment and the infrastructure to foster transportation technology research, development, and deployment. These technologies, as well as the information they contain and disseminate, are pieces of a larger puzzle - the National ITS Architecture.

Architecture is a framework which lays out a blueprint for construction. Prior to breaking ground on the construction of a new house, a contractor must develop architectural plans and specifications, and get approvals from appropriate agencies. In the OMC "city of the future," CVISN will be our "information house." The architecture of the CVISN house is a critical component of the way OMC will conduct business into the next century. Equally as important is the plan and specification approval phase, which will be the focus of this document.



The CVISN creates a way for existing and new systems to exchange information electronically through the use of standards and commercially available communications systems. The CVISN will provide a fully integrated collection of commercial vehicle information systems operated by the states, the FHWA, carriers, and other stakeholders.

It defines a common framework upon which information systems can be developed, modified, or refined to allow for interoperability between systems and jurisdictions. The architecture development phase has been completed for CVISN, and a draft has been completed for the IBC Program. This guidance is one of the implementation tools to assist in approving the "houses" for construction.

What is "architecture conformance"?

Architectural conformance means how closely a deployment or implementation is in agreement with a CVISN or IBC architecture. As time passes, technology advances, and standards are developed, architectures will evolve to accommodate these advancements. To this end, a conformance process should be dynamic and flexible enough to embrace the evolution of the architecture and help guide deployment efforts, while still ensuring for interoperability among systems and jurisdictions. Critical to this evolution will be the emerging EDI (Electronic Data Interchange) and DSRC (Dedicated Short-Range Communications) standards, as well as common data definitions, particularly identifiers for carrier, vehicle, and driver. In addition to being consistent with the National ITS Architecture, it is also necessary that initiatives affecting ITS/CVO remain current with the the more specific CVISN and IBC architectures. States and other ITS/CVO implementers begin to effect consistency with the National ITS Architecture by establishing top-level designs that fit within the ITS/CVO architectural framework.

Why and how will OMC determine what needs to be in "conformance" with an architecture?

In order for the North American transportation system to function in a safe, efficient, and effective manner into the next century, in many cases it is of critical importance that all modal administrations within the US, as well as Mexico and Canada, are "singing off the same sheet of music". In terms of the information infrastructure, the National ITS architecture represents this sheet of music. It is the public sector's responsibility to ensure that all the "musicians" not only have the right sheet music, but that the proper instruments, talent, and conductor are in place so the sounds are appropriately emanated.

Additionally, the legislative language contained in the Department's reauthorization of ISTEA, "The Transportation Equity Act for the 21st Century" (TEA-21), has spawned the concept of "architecture conformance", by containing provisions which link Federal Highway Trust Fund monies used for ITS Projects to being in conformance with the National ITS Architecture and Standards. Thus, it is necessary to establish a policy for uniform and informed decisions to be made with regards to this subject. The ITS/CVO Architecture Utilization Policy establishes the framework in which these decisions will be made. Since the ITS/CVO Program affects all aspects of the Office of Motor Carrier's program responsibilities, it is imperative that OMC activities affecting the ITS/CVO Program are coordinated within FHWA, our State partners, and with other stakeholders. Additionally, Federal-Aid planning and project level activities need to be more closely coordinated with OMC in the event that CVO initiatives are employed through Federal-Aid funding mechanisms.

CVO Deployments and CVISN

CVISN is the backbone of the ITS/CVO Program, in that it defines the framework and the rules with which all CVO stakeholders, at all levels, can operate within. In this vein, it is of paramount importance that CVO initiatives conducted within and apart from CVISN are carried out in accordance with the National ITS Architecture. For example, a state may want to update their credentials administration system to implement electronic credentialing, but may not want to/be able to implement the other aspects of CVISN Level 1 deployment such as safety information exchange or electronic screening. The state should still conform to the part of the CVISN architecture that applies to credentials administration. As another example, the brake testing program is a CVO initiative that is not normally considered to be part of the CVISN. However, for the brake tests to be used effectively in roadside safety inspections, the test results must be reported. This means that software and hardware requirements must be imposed on the brake testing machines in order to interface with parts of CVISN-conforming inspection reporting systems. In this light, we should always be conscious of the information exchange needs and requirements to conform to the CVISN or IBC architecture, since the success and advancement of OMC's Programs depends on it.

I. Introduction

The National ITS Architecture is an organized approach to implementing, in a consistent manner across the US, the various ITS user services envisioned for the next 20 years or more. It is a framework that lays out the boundaries, players, and strategies for the process of information management. This framework provides guidance in developing standards and making deployment decisions that result in safety, efficiency, economies of scale, and national interoperability. The development of the National ITS Architecture was a three year effort and was the first step toward achieving the vision Congress put forth for ITS in 1991, a vision of a seamless, multimodal, national intelligent transportation system that would have a consistent personality across this country. Additionally, in key areas the architecture lays out the framework for implementing ITS/CVO throughout all of North America, to foster commercial motor vehicle safety and efficiency across US borders into Mexico and Canada.

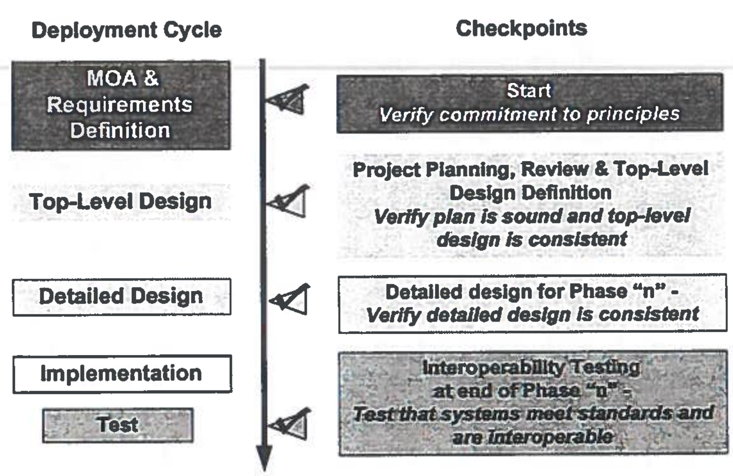
This Conformance Assurance Process defines evaluation criteria for ITS/CVO architectural conformity, and establishes a mechanism for fostering conformance in a deployment or implementation. Each ITS/CVO project using Federal Highway Trust Funds should have a plan which will consist of an incremental checkpoint system for assessing architecture conformance. At each checkpoint, documents should be submitted to a Conformance Assessment Team (COAT) to review design development and to identify issues and potential interoperability problems. During the procedure at each checkpoint, the assessment teams will document and identify any conformance barriers or problems. If discovered, remedial actions will be developed and implemented to resolve the problems. Progress toward resolution should be tracked, and action assignments/resolutions should be documented to serve as a monitoring and lessons learned tool for future CVO deployments.

Summary

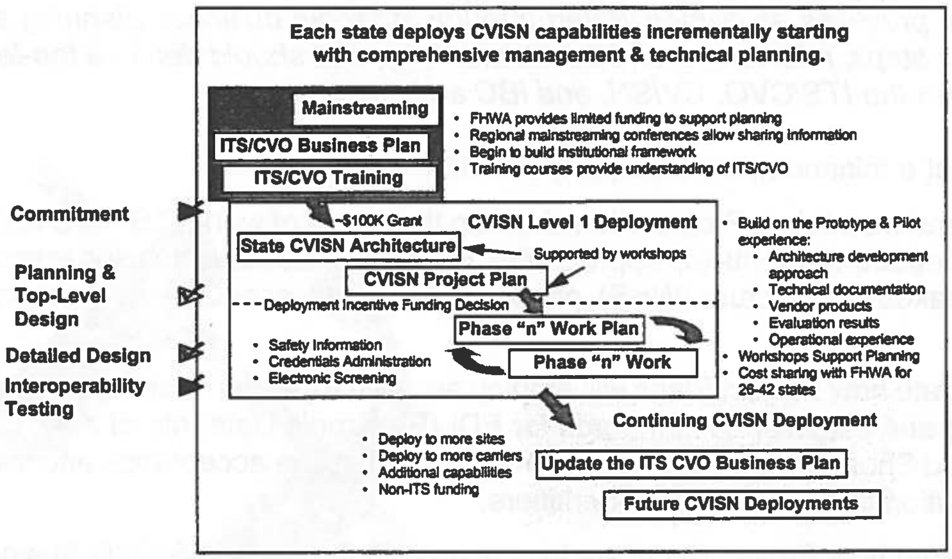
To foster Commercial Vehicle Operations (CVO) architectural conformance, projects should be evaluated by the COAT at various checkpoints in the deployment cycle to include:

- Assessment of *commitment* to the architecture and operational concepts
- Assessment of project and work *plans, reviews, and top-level design*
- Assessment of *detailed design*
- Assessment of *implemented systems* through interoperability testing

The Conformance Assurance Process checkpoints ITS/CVO deployment throughout the lifecycle



The Conformance Assurance Process dovetails with the existing deployment process



The *criteria* for evaluating architectural conformance are outlined in Section II, followed by a detailed description of the *process* for evaluating conformance in Section III.

II. Conformance Criteria

Evaluation of conformity with the National ITS architecture, CVISN (Commercial Vehicle Information Systems and Networks) and IBC (International Border Crossing) architectures involves the criteria outlined below in paragraphs 2.1 through 2.4.

2.1 Commitment

For any ITS/CVO project using federal funds, the lead party and stakeholders within the state/consortium should commit, in a Memorandum of Agreement, an ITS Partnership Agreement, and/or a Commercial Vehicle Safety Plan (CVSP) to the project and the ITS/CVO objectives as well as to being in conformance with the National ITS architecture, CVISN and IBC architectures (as applicable), and standards development/implementation.

This means at a minimum, the lead party should:

- Agree to work together within their region/state/consortium, and with Regional Champions to accomplish ITS/CVO objectives,
- Agree with CVO guiding principles, ITS/CVO capability area and system requirements,
- Agree to work with other stakeholders to develop and refine standards and recommended practices for Standards Development Organizations (SDOs), and
- Agree to successfully complete an interoperability testing program.

2.2 Planning, Top-Level Design & Review

For any ITS/CVO project using federal funds, the lead party should follow best project management practices as demonstrated through strategic business planning and review (that includes steps, milestones, and bench marking), and should define a top-level design consistent with the ITS/CVO, CVISN, and IBC architectures.

This means at a minimum, the lead party should:

- Provide and maintain a Project Plan showing the scope of work, ITS/CVO and CVISN & IBC architecture elements (as appropriate), team organization, roles and responsibilities, Work Breakdown Structure (WBS), phases, milestones, schedule and resources for the project,
- Demonstrate how Project Plans will employ an open top-level design which implements emerging and established standards for EDI (Electronic Data Interchange) and DSRC (Dedicated Short-Range Communications), as well as the acceptance and transmission of information through common identifiers,
- Demonstrate how Project Plans are in concert with the State ITS/CVO Business Plans,
- Ensure jurisdictions utilize clearinghouses and adhere to base state agreements,
- Prepare and use phase-oriented work plans (e.g. implement ITS/CVO in a phased approach),
- Report status in program reviews with the Conformance Assessment Team (at least once per quarter),
- Conduct design reviews with the assessment team (at least once per quarter), and
- Involve peers in program & design reviews.

2.3 Detailed Design

For any ITS/CVO project using federal funds, the proposed ITS/CVO detailed design should be consistent with appropriate National ITS Architecture/CVISN/IBC design features and standards.

This means at a minimum, the lead party should:

- Allocate CVISN system requirements to information systems within the region/state/consortium,
- Exchange safety and credentials information with other jurisdictions via core infrastructure systems, using carrier, vehicle, and driver snapshots to support the exchange,
- Adopt recommended EDI standards for state-public interaction, state/national-private interaction, and state-national system interaction,
- Adopt recommended DSRC standards for vehicle-to-roadside communications,
- Adopt standard data definitions, including standard identifiers, to facilitate information exchange,

- Follow guidelines in Operational Concept Documents and recommended best practices for CVO capabilities such as safety information exchange, credentials administration, and electronic screening, and
- Adopt standards for sensors and controls that interface with the public (for example, adopt standard text for variable message signs).

2.4 Interoperability Testing

For any ITS/CVO project using federal funds, the deployment should be verified through interoperability testing.

This means at a minimum, the lead party should

- Use architecture-certified vendor products where applicable,
- Develop the design incrementally, with some end-to-end capability emerging from each phase of implementation,
- Submit deployments to interoperability testing* to verify architectural compatibility,
- Maintain records of interoperability test reports, and
- Provide results to FHWA upon request.

* *Initial testing capabilities and supporting documentation for assuring conformance with the CVISN architecture will be developed by Johns Hopkins University/Applied Physics Laboratory (JHU/APL). The Federal Government will be responsible for covering the costs of establishing the testing capability and supporting documentation for CVISN Level 1 Deployment interoperability testing; however, costs associated with the application of interoperability tests to CVISN Level 1 deployments will be the responsibility of the entity implementing such deployment.*

III. Conformance Assurance

To evaluate for CVO architectural conformance, ITS/CVO projects should be evaluated by the Consistency Assessment Team (COAT) at various checkpoints in the deployment cycle to include:

- Assessment of *commitment* to the CVISN or IBC architecture and operational concepts
- Assessment of project and work *plans, reviews, and top-level design*
- Assessment of *detailed design*
- Assessment of *implemented systems* through interoperability testing

As highlighted in the introduction each project should follow this process, and it is recommended that implementation be organized and conducted with several pieces of information which, at a minimum should detail the following:

- The project description, Statement of Work, budget, and schedule,

- The project stakeholders,
- The Conformance Assessment Team (COAT) members and their responsibilities,
- A journal to record activities, and
- As they are received, checkpoint documents provided to the assessment team (e.g. memoranda of agreement, business plans, project plans, operational concept documents, system design descriptions, architecture specifications, data dictionaries, etc.).

To assist each team, the references, checklists and guidance documents listed in Appendix A will be provided. Because of the complexities that will be encountered during these assessments, the team concept is critical. It is anticipated that teams will be comprised of various Commercial Motor Vehicle community representatives (OMC, Federal, State, Motor Carrier Industry, Associations, others) possessing a variety of skills. The participation of stakeholders is encouraged as appropriate. Non-federal participants will contribute as non-voting members of the team. This Conformance Assurance Process details objectives and goals, as well as the steps to be taken to accomplish those goals. These "steps" are the assurance checkpoints denoted in Section III (Conformance Assurance) of this document. At each checkpoint, progress should be evaluated in terms of the criteria identified in Section II (Conformance Criteria).

Table 1 summarizes the assurance checkpoints, measurement tools, and measures at each checkpoint. The *checkpoints and criteria* identify when each conformity criterion listed in Section II should be checked. The *measurement tools* include documents that should be used to evaluate conformity at each checkpoint. The CVISN Operational and Architectural Compatibility Handbook (COACH) documents are recommended as a relatively concise set of checklists to assist at various checkpoints. More concise checklists may also be developed. The *conformance measures* summarize the assessment process at each checkpoint.

Table 1 - Checkpoint Summary

Checkpoint & Criteria	Measurement Tools	Conformance Measures
1. ***Checkpoint:*** Start ***Criteria:*** Commitment	Memorandum of Agreement (MOA), an ITS Partnership Agreement, and/or a Commercial Vehicle Safety Plan (CVSP); COACH Part 1, chapters 2 & 4;	Agency commitment to guiding principles and institutional framework; Stakeholder buy-in
2. ***Checkpoint:*** Project Plan and Top-Level Design Completion ***Criteria:*** Planning & Review	Project Plan; COACH Part 1, chapters 3, 5, 6, 7; COACH Part 2; Operational Concept documentation; Top-level design documentation *NOTE: If COACH Part 2 guidance is followed, the Project Plan itself may contain top-level operational concept & architecture documentation*	Commitment to capability area requirements and system requirements; Commitment to project management process; Reflection of those commitments in project planning and top-level design documentation; Definition of scope of work, architecture, team organization, work breakdown, phases, milestones, & schedules
3. ***Checkpoint:*** Detailed design (Phase) Completion ***Criteria:*** Design	Detailed design documentation; COACH Part 3; COACH Part 4; Recommended Practices	Use of specified open standards (EDI, DSRC, identifiers); Flow-down of COACH technical requirements/commitments to design elements; Compatibility with recommended practices; Adoption of standards for sensors and controls
4. ***Checkpoint:*** Implementation & Integration (Phase) Completion ***Criteria:*** Implementation	Test documentation; Test reports; User's documentation; COACH Part 5	Interoperability tests passed; Incremental capability achieved

Each checkpoint may be revisited several times by the COAT throughout the project lifecycle as phases of development and deployment are completed. The following paragraphs outline some of the activities that will occur at each assurance checkpoint. At all checkpoints, self-evaluation should be the first step.

The roles and responsibilities of stakeholders involved in the process of assuring consistency are described below:

Lead party
The entity allocated funds or responsible for project management will be accountable for meeting project goals and objectives.

Conformance Assessment Team (COAT)
Team membership is suggested to include a select group of individuals with program management, enforcement, industry, and information system disciplines. It is expected that the minimum representation should consist of the project manager, project system architect, OMC field representative, Regional Champion, neighboring Model Deployment State representative, and a CVISN/IBC expert. Critical to the success of the team will be the designation of a Team Leader. Other representation may be necessary depending on the nature of the project. It is expected that this team will be limited in number, and will have enforcement/compliance decision making authority on projects affecting their jurisdiction (As discussed previously, non-federal participants will contribute as non-voting members). On projects having regional or national implications, appropriate OMC and FHWA staff shall be selected as voting members on the team [as well as other stakeholders (as appropriate)]. Enforcement may take on a variety of forms, and may include withdrawal of funds, transfer of funds and/or project management responsibilities to another lead party, and others.

Interoperability Testers
Membership is to include an entity with systems engineering/integration capabilities. It is expected that FHWA will support the initial (CVISN Level 1) interoperability test capability through sponsoring construction and maintenance of reusable test plans.

A Conformance Assessment Team (COAT) supports the Conformance Assurance Process for each project

3.1 Checkpoint 1
START

At the start of an ITS/CVO project using Highway Trust funds, prior to the release of funds or authorization to begin work, the following **should** be executed:

- A Memorandum of Agreement (MOA), an ITS Partnership Agreement, and/or a CVSP among all CVO stakeholders affected by the project, as appropriate (e.g. state trucking associations, other industry associations, state agencies, etc.). The lead party shall be responsible for executing the MOA, and depending on the nature of the project, could be different entities. For State specific systems, the MOA would typically be among State agencies involved in Commercial Motor Vehicle administration and enforcement, with stakeholders assuming an advisory role. For other projects (e.g. an academic institution developing a database), the roles of the stakeholders may take on a different form. In all cases, the agreement must include a commitment to the CVO Guiding Principles, Institutional Framework, and conformance with the National ITS Architecture, CVISN and IBC Architectures as appropriate.

Conformance measurement should include verifying the existence of and content in the MOAs, ITS Partnership Agreements, and/or CVSPs. The COACH Part 1, chapters 2 and 4 may be used as a checklist for assessment at this stage. If appropriate approvals are not received, the project should not commence.

3.2 Checkpoint 2
PROJECT PLAN AND TOP-LEVEL DESIGN COMPLETION

The second stage of conformance assurance will involve a high-level assessment of the project plan and top-level design conceptual development. Project definition and commitments to capability area and system requirements are necessary at this stage. The Project Plan should define the project. Either the project plan or separate documentation should clarify commitments to the CVO capability areas (e.g., safety information exchange, credentials administration, electronic screening, etc.) being implemented and related system requirements. The documentation in this phase shall support that which was presented during Checkpoint 1. To support evaluation at this checkpoint, the following shall be provided to the COAT:

- Project Plan - Answers basic questions on what the project is; how the work is broken down; what organizations and individuals are supporting the work; how the work is organized into phases; when major milestones are scheduled; what resources are required and allocated; what management and technical processes will be used; what products will be delivered. Lists open issues.

- Operational Concept documentation - Answers basic questions on what existing operational processes will be modified or what new ones will be added; what user interactions will be changed. Focuses on "what" and not "how." May be framed as a series of functional thread diagrams and included in the Project Plan.

- Top-level design documentation - Defines the top-level design in terms of processes, data, system elements, and interfaces; provides a technical basis for determining interface requirements; supports the identification and development of standards; provides system element descriptions to show how interoperability is achieved. A key result of this document is determining interface requirements among CVO systems and those which interface with CVO systems. From this, standards can be identified and either utilized, or developed if necessary. The design could be presented in a variety of documents, and may be framed as diagrams and tables and included in the Project Plan.

Conformance measurement should include verifying the existence of and content in the Project Plan, operational concept, and architecture documentation. The COACH Part 2 may be used as a checklist for project planning and review evaluation. The COACH Part 1, chapters 3, 5, 6, and 7 may be used as checklists for operational concept and top-level design assessment.

3.3 Checkpoint 3
DESIGN COMPLETION

This checkpoint will involve a detailed look at the project's detailed design of system elements in each of the phases defined in the Project Plan. Critical to this stage is the use of open standards to facilitate interoperability, such as EDI, DSRC, and common identifiers. Standardized interfaces will be utilized, and in areas where standards have yet to be established, project system designs must support their development. Additionally, in standard-lacking areas, recommended practices are other documented processes that should be used as guidance.

Standards should be adopted for sensor and control interfaces with public entities (e.g., messages used on variable message signs). The documentation at this point shall support that which was presented during Checkpoints 1 and 2. At this stage, the COAT may simply choose to review the results of the self-evaluation. Evaluation at this stage includes review of:

- System or system element documentation - Depicts the detailed requirements and design of system elements; provides a technical framework for all stakeholders to develop and establish interoperability; identifies the detailed interface requirements between system elements; defines the structure of individual elements and how they all fit together; describes user-system element interaction.

- Data Dictionary* - Low level definition of data entities, data flows, data structures, and data elements, as well as the attributes for each. This definition provides for the necessary detailed requirements to support information exchange within the IBC, CVISN, and National Architectures.

* *This portion of the conformance assurance process should be approached with caution. In many cases the amount of time and effort needed to evaluate to this level of detail will be impractical.*

Conformance measurement should include verifying the existence of and content in the design documentation. The COACH Parts 3 and 4 may be used as a checklist for detailed design assessment.

3.4 Checkpoint 4
INTEROPERABILITY TESTING COMPLETE

As part of the conformance assessment at the end of each phase of project development, interoperability testing should be required to demonstrate successful system implementation. The testing development and execution shall support that which was presented during Checkpoints 1, 2 and 3.

Interoperability testing may take a variety of forms, depending on the scope of the project. The COAT shall ensure that testing results indicate that components and the system as a whole support the CVO Guiding Principles and User Services. The "ITS/CVO Architecture Conformance: Interoperability Testing Strategy" has been developed to assist in this phase.

Conformance measurement should include verifying the successful execution of interoperability tests and other tests (such as vendor certification tests) that demonstrate that the phase's objectives for incremental capability were achieved. The COACH Part 5 may be used as a checklist for interoperability testing. Standardized tests for CVISN Level 1 conformance will be executed by the project.

3.5 General Conformance Assurance Guidance

In some instances, self-certification of architecture conformance may be authorized in lieu of formal assessment team review of source documentation. However, at any time, the COAT should retain the authority to audit the project for architectural conformity. If architectural aberrations are discovered during either self-evaluation or assessment team review, the problem should be recorded and action(s) assigned for resolution. The assessment team should monitor the status of all reported problems, and assist in implementing expeditious solutions. If, after repeated efforts problems continue to persist, it may be necessary to transfer funds and/or responsibility, and potentially even terminate the project.

To aid assessment teams in their conformance endeavors, the ITS/CVO Division is developing workshop modules to instruct the COAT members on the conformance assurance process. These workshops will go beyond traditional instructional training courses in that they will be hands on and will help assessment teams develop their conformance approach and implementation strategy. Additionally, ITS Architecture training courses are now available through FHWA's Professional Capacity Building Program. The workshop development work has been and will continue to be done with input from all stakeholders, including OMC field staff.

We expect that ITS/CVO Project funding will be released incrementally, with funding allocations being predicated on successful conformance assessments at each of the checkpoints.

Questions regarding ITS/CVO architecture conformance can be directed to Jeff Loftus, OMC - ITS/CVO Division; phone: (202) 366-4516, e-mail: jeffrey.loftus@fhwa.dot.gov.

Appendix A

This documentation will be provided to the architecture Conformance Assessment Teams:

Purpose	Document
Documentation available	CVISN Tool Kit List, Internet Web Sites, etc.
Sample MOA	Existing MOAs from CVISN Pilot States
Checkpoint evaluation	Sample checklists
How to accomplish procurement	FHWA Guidance documents
Top-Level Generic Design Physical Dataflows	CVISN System Design Description
Summary of Top-level Design: Operational Compatibility Checklist Top-level Design Compatibility Checklist Institutional Framework Compatibility Checklist	COACH, Part 1
How to Manage a Technical Project: Program Management Checklist	COACH Part 2
How To Allocate Requirements to Particular Systems/Products: Guidelines for Requirements Allocation to systems in the generic design	COACH Part 3
How To Design Particular Systems: Detailed Design and Operational Recommendations	Recommended Best Practices; Operational Concept Documents
Open Interface Standards	DSRC Standards (ASTM/IEEE/SAE), EDI ANSI ASC X12; Implementation Guides
Reference document pointing to current Standards: Interface Specification	COACH Part 4
How to Verify Conformance through Testing: Interoperability Test Criteria	COACH Part 5
Checking Conformance: Interoperability Test Descriptions & Data	Interoperability Tests

Intelligent Transportation Systems/ Commercial Vehicle Operations (ITS/CVO) Architecture Conformance Guidance Documentation

June 30, 1998

1. Introduction

Guidance for being in conformance with the ITS/CVO architecture is provided in these documents:

- ITS/CVO (Intelligent Transportation System/Commercial Vehicle Operations) Architecture Utilization Policy
- ITS/CVO Architecture Utilization Policy: *Conformance Assurance Process Description*
- CVISN (Commercial Vehicle Information Systems and Networks) Operational and Architecture Compatibility Handbook (COACH)
- Applicable Standards
- ITS/CVO Architecture Utilization Policy: *Interoperability Testing Strategy*
- ITS/CVO Interoperability Test Suite Package
- Other historical CVISN documents
- IBC (International Border Clearance) documents

The following summarizes the purpose, audience, and availability of each document.

2. ITS/CVO Architecture Utilization Policy

Commercial Vehicle Operations are addressed by a group of user services in the National ITS Program Plan. The National ITS Architecture is composed of several "subsystems" that are components of the overall ITS. CVO comprises four of those subsystems, and a more detailed architecture consistent with and derived from the National ITS Architecture exists to support it. The ITS/CVO architecture was developed to provide a technical framework for the development of systems for implementing various ITS/CVO user services. The architecture has already achieved many of its original objectives, in that it has been the basis for the progress in the ITS/CVO Program to date. However, there is now a need to provide guidance for exactly how the ITS/CVO Architecture will be used and maintained in the future to assure that technology and system deployments are consistent with the National ITS Architecture. The ITS/CVO Architecture Utilization Policy document provides guidance for using the ITS/CVO architecture, and identifies several tools and documents for assuring conformance. FHWA, state, regional, and private industry planners use the policy to understand how FHWA is using the architecture, and what FHWA will provide funding to support. The draft policy is available on the WWW at: jhuapl.edu/program/transport/trans.htm.

3. ITS/CVO Architecture Utilization Policy: *Conformance Assurance Process Description*

The Conformance Assurance Process (CAP) defines a mechanism for fostering architecture conformance in a deployment or implementation. The CAP Description defines the process, stakeholders involved and their roles, measurement criteria, and conformance evaluation checkpoints. ITS/CVO project leaders use the CAP throughout an ITS/CVO project lifecycle. The CAP points to the COACH and Interoperability Test documents as the detailed checklists and procedures associated with assuring architectural conformance. The draft CAP Description is available on the WWW at: jhuapl.edu/program/transport/trans.htm.

4. CVISN Operational and Architecture Compatibility Handbook (COACH)

CVISN is the collection of the information systems and communications networks that support commercial vehicle operations. The CVISN architecture is consistent with and derived from the National ITS Architecture. To aid in the deployment of ITS/CVO products and services, the CVISN architecture is more detailed than the National ITS Architecture. The COACH provides a comprehensive checklist of what is required to be compatible with CVISN operational concepts, architecture and standardized interfaces. It is intended for use by state agencies with a motor carrier regulatory function, by motor carriers, and by standards-compliant product vendors. It is also intended to provide a quick reference for developers of CVISN Core Infrastructure systems. The COACH is divided into five parts: Part 1 - Operational Concept and Top-Level Design Checklists; Part 2 - Project Management Checklists; Part 3 - Detailed System Checklists; Part 4 - Interface Specification; Part 5 - Interoperability Test Criteria.

COACH Part 1, Operational Concept and Top-Level Design Checklists

The Part 1 checklists are used to indicate which items the project agrees with. Project leaders complete the checklists at the start of a CVISN-related project to indicate the level of commitment for each item.

The COACH, Part 1 includes these checklists:

- Guiding Principles: high level strategic guidelines
- ITS/CVO Capabilities Checklists: conformance requirements for processes
- Organizational Framework Checklists: conformance requirements for the policies and coordinating activities for states and carriers
- CVISN Top-level Design Checklists: top-level conformance requirements for state. core infrastructure, and carrier system designs.

This part of the COACH is available on the WWW at: jhuapl.edu/program/transport/trans.htm.

COACH, Part 2, Project Management Checklists

The Part 2 checklists are used to indicate which project management methods the project has adopted. The project manager completes the checklists during the project planning stage.

The COACH, Part 2 includes these checklists:

- Project Management
- Project Planning
- Work Planning

This part of the COACH is available on the WWW at: jhuapl.edu/program/transport/trans.htm.

COACH, Part 3, Detailed System Checklists

The COACH, Part 3 maps the Top-Level Design conformance requirements from Part 1 to systems in the generic CVISN design. This part of the COACH will be published in CY 1998.

COACH, Part 4, Interface Specification

The COACH, Part 4 defines where standardized interfaces apply, and refers to standards and product interface documents that either exist or are under development. This part of the COACH will be published in CY 1998.

COACH, Part 5, Interoperability Test Requirements

Project managers and architects complete these checklists as part of planning system acceptance tests.

The COACH, Part 5 includes these checklists:

- Terminology: definitions of terms used in this document
- Pairwise Interface Interoperability Criteria: top-level interoperability test criteria requirements organized around interfaces between pairs of products for electronic credentialing, electronic screening, and safety information exchange.
- End-To-End Interface Interoperability Criteria: sample test criteria for verifying end-to-end functional capability of the CVISN systems as a whole. The Part 5 checklists indicate the minimum test criteria the delivered systems should pass in order to be interoperable and consistent with CVISN Level 1 Deployment interface definitions.

An incomplete draft of this part of the COACH will be available in July 1998 on the WWW at: jhuapl.edu/program/transport/trans.htm.

5. Applicable Standards

Standards Development Organizations are involved in producing ITS standards applicable to CVO. The standards cover two types of interfaces: vehicle-to-roadside communications via Dedicated Short Range Communications (DSRC), and computer-to-computer Electronic Data Interchange (EDI).

- ASTM Subcommittee E l 7.5 l is responsible for the Data Link Layer: Medium Access and Logical Link Control. and the Physical Link Layer standards.
- IEEE Standards Coordinating Committee on Intelligent Transportation Systems (SCC 32) is responsible for P1455. Message Sets for DSRC for ETTM and CVO
- ANSI ASC X.12 Subcommittees are responsible for various EDI transaction sets (TS), including three new standards for CVO (TS 284 Commercial Vehicle Safety Reports, TS 285 Commercial Vehicle Safety and Credentials Information Exchange and TS 286 Commercial Vehicle Credentials) A list of applicable standards will be provided in the COACH Part 4, Interface Specifications. Implementers should use the standards for public-private interactions in order to be interoperable. The DSRC standards are expected to go to ballot in the summer of 1998. ANSI ASC X.12 EDI TS 285 and 286 are approved standards, and TS 284 is in the voting process as of June 1998. Implementation Guides for the EDI standards are available on the WWW at: jhuapl.edu/program/transport/trans.htm.

6. ITS/CVO Architecture Conformance: Interoperability Testing Strategy

The Interoperabiliby Testing Strategy establishes the approach for demonstrating, through testing, that deployed CVISN systems are interoperable. Interoperabilitv testing will verify that interfaces between selected pairs of products/systems meet the applicable standards (pairwise interface testing) and will verify dataflow and data usage among several selected products/systems (end-to-end interface testing). The strategy is used to formulate testing plans. The Interoperability Testing Strategy is available on the WWW at: jhuapl.edu/program/transport/trans.htm.

7. ITS/CVO Interoperability Test Suite Package

The Interoperability Test Suite Package complements the COACH Part 5, Interoperability Test Criteria. The package is organized into four parts:

Part 1- Test Specifications
Part 2 - Test Cases & Procedures
Part 3 - Test Tool Description
Part 4 - Test Data

The combination of the COACH Part 5 and the Interoperability Test Suite Package is intended to provide a complete set of information about what should be tested, how to accomplish the tests, and the data and common tools for completing the tests. Test planners and testers use the package as they plan and execute system acceptance tests. An incomplete draft package for the first set of interoperability tests is being published in parallel with the first draft of the COACH Part 5 so that readers can provide feedback. An incomplete draft of the Interoperabilitv Test Suite Package will be available in July 1998 on the WWW at: jhuapl.edu/program/transport/trans.htm.

8. Other historical CVISN documents

Several other documents provide additional background information about CVISN. Those new to CVISN may find them helpful. but, except as noted, *the reader is cautioned that these documents are not being maintained*. The documents include:

- Introduction to CVISN - an overview of the CVISN program
- CVISN Operational Concept Document - comparable to the National ITS Architecture's Concept of Operations. this document describes operational scenarios that are envisioned under CVISN implementations
- CVISN Architecture Specification - this document starts with the equipment packages from the National ITS Architecture's Physical Architecture, and decomposes those packages into functions, processes, and supporting internal and external interfaces. This document provided the impetus for detailed requirements for EDI and DSRC interfaces.
- CVISN DSRC Interface Requirements and CVISN EDI Interface Requirements - these documents drove the development of the DSRC and EDI standards.
- CVISN System Design Description - a description of the CVISN systems. including a generic state system design. carrier system design. and descriptions of the CVISN Core Infrastructure systems. This document will be maintained. but has not been updated since March 1997. All are available on the WWW at: jhuapl.edu/program/transport/trans.htm.

9. International Border Clearance documents

The International Border Clearance (IBC) Program documentation is structured to depict the relationship of the IBC System Architecture within the overall hierarchy and flow of program documentation that collectively defines the IBC Program. The IBC System Architecture flows directly from the IBC Concept of Operations and IBC Business Processes documents. The *IBC Concept of Operations* document describes the future IBC operations of the various border stakeholders and their logical relationships, and creates a common reference for border modernization initiatives. The *IBC Business Processes* document identifies the processes and interfaces that comprise the IBC concept of operations.

The IBC System Architecture describes the architecture for an IBC system that supports electronic international border clearance of commercial vehicles, drivers, and cargoes at North American land borders. The architecture integrates IBC operations concepts and business processes into a unified framework. This framework is described from two perspectives; a logical architecture and a physical architecture. The logical architecture describes the processes, interfaces, and data flows of the IBC system, and the physical architecture defines the subsystems that perform the functions in support of IBC processes.

The IBC system architecture addresses both transportation and non-transportation stakeholders. The IBC system provides the communications path between the commercial motor vehicle (CMV) and the border crossing in support of all border stakeholders, but only performs electronic clearance for transportation stakeholders. It is intended that this architectural approach be adaptable to all transportation modes, whether by highway, rail, sea, or air.

9. Summary

As additional materials are developed, they will be posted on the WWW. Hard copies of documents and are available. Please forward comments and questions to: Jeff Loftus, OMC - ITS/CVO Division; phone: (202) 366-4516, e-mail: jeffrey.loftus@fhwa.dot.gov.

Glossary

Architecture conformance = The degree to which design and implementation match the architecture. For ITS/CVO projects, the keys to architecture conformance are using common identifiers, open EDI standards, and open DSRC standards. Conformance is demonstrated during the acceptance phase by executing pre-defined interoperability tests,

Architecture Utilization Policy = FHWA's policy on how the ITS/CVO architecture will be used, and what FHWA kinds of activities intends to support, within funding constraints.

CAP = Conformance Assurance Process. A process for fostering conformance with the National, CVISN, and IBC architectures. Based on a series of checkpoints, the process includes evaluation criteria applied throughout the project lifecycle.

COAT = **CO**nformance **A**ssessment **T**eam. A group of project members and experts who are responsible for implementing the Conformance Assurance Process.

CVISN = Commercial Vehicle Information Systems and Networks. A collection of information systems and communication networks that provide support to commercial vehicle operations. CVISN includes information systems owned and operated by governments, motor carriers, and other stakeholders.

CVO Component Project = One that involves the application of electronics, communications, and/or information processing technologies, used singly or in combination, to one or more commercial vehicle transportation problems for the purpose of improving the efficiency and/or safety of a surface transportation system. More specifically, it is a project that either as a whole or in portions, provides or enables ITS/CVO user services.

IBC Architecture = The structure and unifying design characteristics of an International Border Clearance Architecture will permit electronic clearance of commercial motor vehicles at North American land border crossings. This architecture addresses both transportation and non-transportation stakeholders in the IBC community.

ITS/CVO Architecture/CVISN Architecture = The ITS/CVO information systems and networks portion of the National ITS Architecture. The ITS/CVO Architecture (or CVISN Architecture) documentation begins with the National ITS Architecture and adds more detail in some areas (e.g., the operational scenarios and Electronic Data Interchange (EDI) message requirements) to facilitate further development.

ITS/CVO Project = For the purposes of ITS/CVO architecture conformance assurance, these are projects for which a State receives ITS Deployment Incentive funds to:

- complete CVISN Level 1 Deployment, and/or
- conduct a Field Operational Test of the IBCSS (International Border Clearance Safety System) concept.

National ITS Architecture = The common framework for interoperability adopted by the Secretary, and which defines the functions associated with ITS user services, the physical entities or subsystems within which such functions reside, the data interfaces and information flows between physical subsystems, and the communications requirements associated with information flows. The ITS/CVO elements are a subset of the National ITS Architecture.

Introduction to Developing ITS Using the National ITS Architecture: An Executive Edition for Senior Transportation Managers

Contents

This section provides a copy of *Developing Intelligent Transportation Systems Using the National ITS Architecture: An Executive Edition for Senior Transportation Managers,* U.S. DOT, February 1998.

Summary

This document has been included to provide managers of transportation agencies with a high-level understanding of the National ITS Architecture. This paper emphasizes the benefits of integrating and coordinating the ITS planning, development, and deployment efforts of the various transportation agencies in a region. This section will also provide transportation agencies with references on where they may find assistance with the National ITS Architecture.

Uses

This document will be useful for U.S. DOT field staff to share with transportation managers within their jurisdiction to introduce them to the National ITS Architecture. Aspects of this section may prove helpful in explaining the importance of integration and a regional architecture approach to other stakeholders and policy makers.

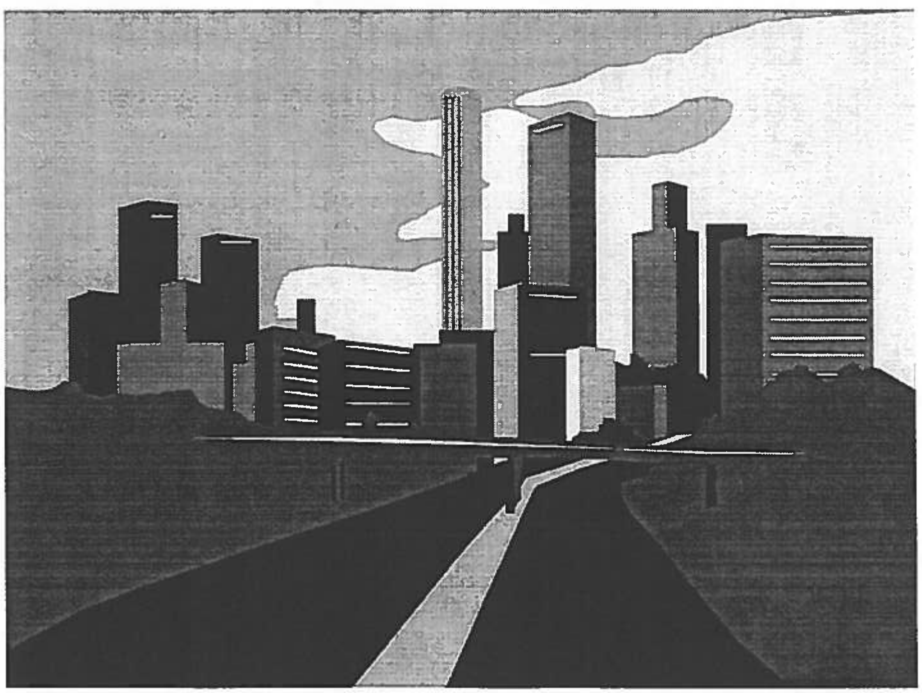
To obtain additional copies, see the U.S. DOT's ITS website at www.its.dot.gov. This selection is available in the Electronic Document Library as document #3014.

U.S. Department
of Transportation

Developing Intelligent Transportation Systems

Using the National ITS Architecture

An Executive Edition for Senior Transportation Managers



U.S. Department of Transportation
Intelligent Transportation Systems Joint Program Office

February 1998

Prepared for the Federal Highway Administration
by Mitretek Systems, Inc.

WHICH HAT DO YOU WEAR?

Are you a manager in a transportation agency? If so, please KEEP READING! This information is for YOU! It will fill you in on the use of regional ITS architectures as a way to achieve the benefits of integrating and coordinating ITS efforts of the various transportation agencies in your area...and if your agency needs help in using the National ITS Architecture to deploy ITS, we'll tell you how and where to get it.

Are you called upon to manage transportation assets with limited transportation funds in the face of overwhelming growth of transportation demands? If you are a policy maker or someone who oversees the planning, design, or implementation of transportation management programs, then this brochure is meant for you. If you are a transportation planner or engineer, this brochure will help you implement integrated intelligent transportation, but you'll probably want to see the Technical Editions which go along with this. And if you wear one of these hats...

YOU KNOW THE PROBLEM!

Traffic congestion – It affects both the quality of life and the economy. In the past 10 years, the amount of travel on the Interstate Highway System has grown by 30 percent, and the demand for travel is expected to increase by another 50 percent over the next 20 years. For transportation system users, this means more lost time. In 1995, Americans spent more than 2 billion hours in traffic jams—that's 83 million days or more than 22,800 years. The annual cost of congestion to the Nation in lost productivity is over $100 billion, exclusive of the cost of wasted fuel and environmental damage. According to the Federal Highway Administration, in 1995, over 1/3 of all urban freeway miles, and 55% of all urban freeway travel, experienced congested conditions during peak periods.

"...the construction of more roadways and roadway lanes is no longer feasible or credible in many areas as the primary solution to traffic congestion."

For many years, state highway departments and localities responded to traffic congestion problems by building more roadways and roadway lanes. In the 1980s, transportation planners began facing greater public concerns about land use, highway safety, environmental sensitivity, and transportation efficiency. In addition, government budgets were shrinking. Construction of additional lanes to handle increasing traffic loads became more expensive due to higher land values and roadway construction costs. As a result, the construction of more roadways and roadway lanes was no longer feasible or credible in many areas as the primary solution to traffic congestion.

You probably knew all that.

BUT DID YOU KNOW...?

A group of technologies, known collectively as Intelligent Transportation Systems, or ITS, is being developed and deployed globally to improve transportation system efficiency.

ITS uses a number of technologies, including information processing, communications, and control. By coordinating and integrating these technologies with our transportation system, we can improve safety, reduce congestion, improve mobility, improve economic productivity, and save public investment dollars without negatively affecting the environment.

ITS applies innovative techniques and advanced technologies to make transportation systems safer, more efficient, and more customer service-oriented.

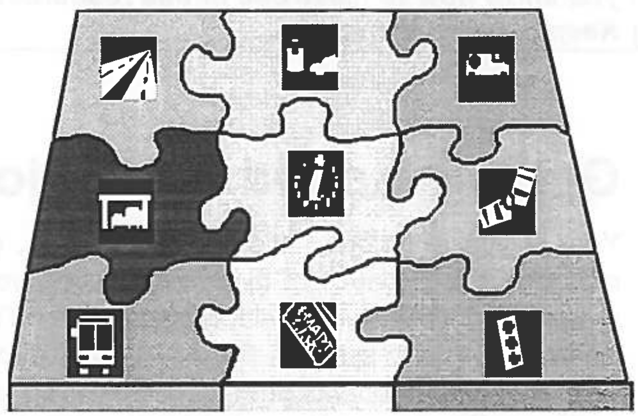
ITS offers an alternative to traditional measures for addressing transportation problems and needs. It applies advanced technologies to transportation systems to make them safer, more efficient and more customer service–oriented. The technology includes systems for communicating transportation options, conditions, and schedule information to transportation consumers; smarter vehicles and smarter roads; flexible traffic control; and enhanced fleet management systems. Creative ideas include new ways to disseminate information to travelers, public/private partnerships, linking various public partners to provide real-time information, innovative financing and techniques, and leveraging of non-transportation investments.

While the advent of ITS has been heralded as a new way of doing business, the underlying concepts are not new.

What is new? The concept of integrating the transportation systems within a region.

U.S. DOT has identified nine ITS infrastructure components that can be integrated to become a platform for managing travel in metropolitan areas and support a variety of other services on the technology horizon:

ITS Infrastructure



- ♦ Traffic Signal Control Systems
- ♦ Freeway Management Systems
- ♦ Transit Management System
- ♦ Regional Multi-modal Traveler Information System
- ♦ Emergency Management System
- ♦ Electronic Fare Payment System
- ♦ Electronic Toll Collection System
- ♦ Incident Management Program
- ♦ Railroad Grade Crossing Warning System
- ◊ And over time there will be others

The Key to the solution is Integration

Implementing these systems or services is not that tricky. You've been doing many of these for years. The difficulty arises in integrating these systems, so that information from one is passed to another, rather than using multiple sensors or systems to accomplish the same task. This integration allows individual components of ITS to work together and will pay great dividends to your transportation customers and resultant cost savings to agencies. According to studies published in *ITI Benefits: Expected and Experienced,* the benefits provided by an integrated transportation system include increased safety (e.g., fewer accidents), decreased travel time, decreased delay, decreased fuel consumption, reduced emissions.

But beyond these "technical" benefits, institutional benefits are also to be expected with the integration of transportation systems. Does your agency obtain and use information that originates from other agencies in your area? Do you provide information to others? Does your agency coordinate with others on traffic control on a regular basis or for incident management? Better, more complete information allows the job of managing transportation to be done better. Every agency has a piece of the picture – by sharing this information through integrated systems, everyone sees the same, whole picture. The exchange of information between agencies requires the keepers of the information or stakeholders to be involved from the initial planning of these systems to address transportation operations and management issues. The integration of systems across institutional and modal boundaries fosters team-building while allowing all participants to make good use of scarce resources and save money – now and into the future.

You may have heard about the National ITS Architecture... which was developed for US DOT as the framework for implementing modern transportation operations systems. Systems design based on the Architecture will change the way you do business. But do you know how to make use of this resource?
Keep reading to find out....

Getting started...A Regional Architecture

Your region is unique. It's different in size, geography, demographics, and institutional arrangements. Because of these differences, you'll want to craft your transportation operations system to fit your own problems and needs. These specific needs really come to the forefront when dealing with systems that are already in place. A regional architecture maps out how the various ITS components are ultimately tied together and integrated -- both physically as well as institutionally. Gathering a wide range of stakeholders and developing a regional architecture which responds to local transportation needs and problems can serve as a guiding framework for coordinated development of ITS within a region. This gathering of stakeholders will evoke the discussion of operations roles and responsibilities, phasing considerations for planned ITS enhancements, and regional agreements on technology or standards. This approach also allows systems to be built and installed incrementally, to accommodate the real world of incremental funding. To ensure that everything "plays together" the way it should, it is imperative for your region to have an ITS architecture tailored to your specific needs.

OK, so you want to deploy Intelligent Transportation Systems which will help alleviate the problems you and your customers face. But you also want these deployments to be sound investments; investments that are wise expenses now, and will continue to pay dividends into the future. Your transportation engineers and planners are implementing ITS to solve problems today and taking advantage of the gains made possible by the "information age" and integration of technologies. Just as they followed "good engineering principles" with earlier transportation investments, they are following a systems engineering approach. The system engineering process, a structured approach to system design, is really the way to attack the design effort. This design is tailored toward the unique features of your region. On a larger scale, your regional architecture is a road map of the information flows between the various systems (and institutions) that are essential to you (e.g., you might want to establish a connection between the Traffic Management Center and the regional transit operations center so that information on operating conditions may be exchanged). But all of this design and architecture effort could take a lot of time and money.

How can you help your staff through the systems engineering - regional architecture process? You don't need to reinvent the wheel! The integration of many different ITS functions is more easily accomplished by using the National ITS Architecture. It is available as a resource and is ready to be used. The National ITS Architecture is a highly developed functional analysis of ITS elements integrated together. It does not dictate the design of your system, but rather helps you to align your requirements for the deployment you envision. Detailed technical information on the National ITS

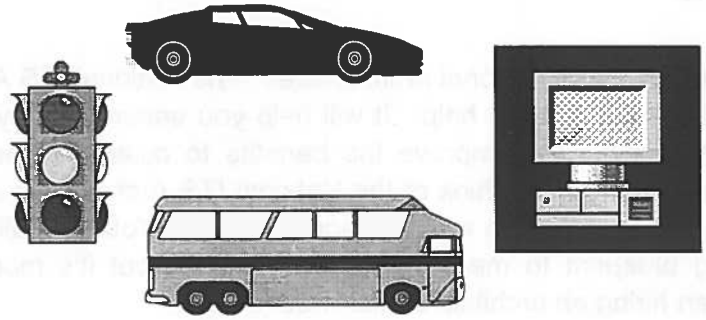
Architecture can be found in the series of supplemental publications on *Developing Systems Using the National ITS Architecture Technical Edition.* These Technical Editions are written for:

Freeway Management

Traveler Information

Traffic Signal Control

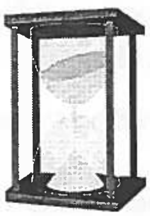
Transit



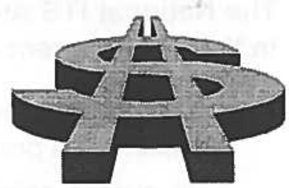
Each Technical Edition is written for system project management personnel and staff. They provide guidance and recommended practices for developing and deploying systems using the National ITS Architecture as a tool. They also include helpful hints and lessons learned from transportation agencies that have already deployed ITS systems. The Technical Editions also describe how to conduct regional ITS planning activities (as part of the planning process) to guide the overall deployment of systems.

A Regional ITS Architecture...Just why should you bother?

A lot of time and effort went into developing the National ITS Architecture...for a very good reason. To make the process of designing and implementing these systems easier for you. YOU CAN SAVE STAFF HOURS AND ENGINEERING DESIGN COSTS.



Your Regional ITS Architecture guides transportation agencies in interconnecting and coordinating individual ITS applications, such as traveler information systems, traffic signal control systems, freeway management systems, and transit systems. Individually, these applications provide their own benefits. When integrated together, the whole is greater than the sum of its parts.



The National ITS Architecture...The right tool for the job

How do you build your regional architecture? The National ITS Architecture is a tool that will help. It will help you ensure that systems are integrated and improve the benefits to customers and transportation agencies. Think of the National ITS Architecture as a template that is similar to a model home design. You can tailor the existing blueprint to meet your unique needs, but it's much cheaper than hiring an architect to start from scratch.

National ITS Architecture Benefits

The National ITS Architecture provides a common structure for the design of intelligent transportation systems. It defines the framework around which many different design approaches can be developed, each one specifically tailored to meet specific regional needs, while maintaining the benefits of a common architecture within current (legacy) and planned systems. Your Regional ITS Architecture defines the functions (e.g., traffic signal control, freeway management, or incident management) that must be performed by components or subsystems, where these functions reside (e.g., roadside, traffic management center, or in-vehicle), the interfaces and information flows between subsystems, and the communications requirements for the information flows (e.g., wireline or wireless).

There are specific benefits to be gained in the transportation community through informed application of the National ITS Architecture methodology, knowledge base, and tools. The major benefits of the National ITS Architecture are discussed below.

The National ITS Architecture can provide *short term benefits* -- saving time and money in the development of a project from its inception through its implementation, since it:

- Correlates needs and problems to services that must be performed, thus providing traceability for a project to overall transportation needs.
- Illustrates efficiencies that can be gained by eliminating redundant implementations of similar functions.
- Provides a view into the future to identify services and functionality that may not have been initially considered, currently needed, or even feasible. This provides a checklist of future capabilities that could be planned for now in anticipation of future needs (e.g., you may want to plan for an information service provider to distribute traffic and other information to subscribers in the future).
- Provides an extensive list of the transportation agencies (by matching the functions they perform with the corresponding subsystem names in the National ITS Architecture) that an agency should consider talking to during initial planning of an implementation (i.e., the stakeholders).
- Defines the kind of information one should consider sharing among these agencies. The agency can use this information as a checklist in planning the project and in discussions

with other stakeholders to show how they can participate through sharing of the information.

- Serves as a good starting point or template (which can be tailored) for developing the architecture that will drive the design for a specific project. Starting with the National ITS Architecture, one can merely delete the functions and information flows that do not apply and then incorporate modifications or additions to address specific local requirements and considerations.
- Provides a departure point for developing functional requirements and system specifications to be included in a procurement package.
- Identifies the interfaces (some of which may have standards work under way) and data exchanges that must be included (e.g., a number of potential data exchanges are identified between the Traffic Management and Roadway subsystems).
- Helps reduce the need for costly changes late in the design and implementation process.
- Provides ballpark estimates of costs for a wide range of ITS-related equipment and services that can be used for initial project costing.
- Provides a check on the product being provided by a design contractor (if the contractor is asked to demonstrate the use of the National ITS Architecture and its relationship to the design being offered).

Using the National ITS Architecture and ITS standards will also provide *broad longer term benefits*. These will benefit the nation and your region as well:

- *Interoperability*: The National ITS Architecture has identified where standards are needed for system interoperability (interfaces and products). Because the National ITS Architecture is serving as the common foundation for ongoing ITS standards development work, factoring it into your current system enhancements will facilitate the transition to a standard interface definition in the future. Using standard interfaces will provide for national and regional interoperability and interchangeability of systems and devices used in ITS travel management.
- *Increased competition*: By requiring use of open (non-proprietary) standards, multiple vendors that can meet the standards will be able to respond to RFPs. Support and upgrades can also be obtained from multiple potential sources, avoiding the problems of being locked in to one source by increasing competition.
- *Future expandability*: By designing within a common framework and using open standards, you will create an environment that integrates legacy systems with new ITS applications and allows more functionality to be added when desired or as needed.
- *Lower costs*: Long-term costs of deployment will go down by the economies of scale for off-the-shelf ITS equipment and products and competition through multiple vendors.
- *Increased transportation system integration*: The open nature and structure of the National ITS Architecture and use of standards-compliant components will make integration of complex traffic management components and other regional system components easier. Improved integration of systems operated by different agencies will permit effec-

tive information sharing and more effective use of resources. Seamless traveler services across agency lines will become a reality.

The National ITS Architecture...You've got help!

The National ITS Architecture guides regions in developing integrated and compatible Intelligent Transportation Systems that provide even more benefits to customers and transportation agencies. The National ITS Architecture offers a great deal of guidance on the development and implementation of ITS -- providing agencies with specific suggestions on how to optimize their transportation management systems by integrating key functions, eliminating redundancy, and sharing information with other local agencies and systems -- and wraps it all up in a comprehensive package.

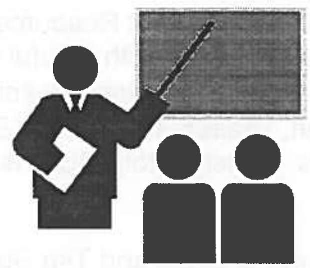
The National ITS Architecture is available in several formats (paper , the Web, and CD-ROM) and is ready to be put to work -- today!

How do you Find Out More About ITS and the National ITS Architecture? We've made it easy for you...

A lot of time and effort has already gone into making the Architecture easy to use. This brochure is the lead-in to *Developing Intelligent Transportation Systems Using the National ITS Architecture Technical Editions.* These documents detail the process for implementing Freeway Management, Traffic Signal Control, Traveler Information, and Transit Systems. The Technical Editions are written for managers of transportation systems and their staff. They provide guidance and recommended practices for developing and deploying intelligent transportation systems using the National ITS Architecture. These resources also include project application scenarios, helpful hints and lessons learned from transportation agencies that have deployed ITS systems. These documents, as well as other good sources of information related to the National Architecture are listed below:

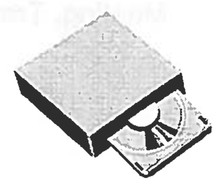
For more information on the availability of these resources, contact your local FHWA Division or FTA Region Office, or use the additional contact information provided.

National ITS Architecture Training



- *Using the National ITS Architecture for Deployment* Training Course -- This 3 day course given by the Architecture Team gives the student the mechanics for implementing regional systems using the Architecture.
- A 1 day course is also being developed by the Architecture Team.

Technical Resources



- National ITS Architecture documents, databases, and other useful navigational tools on a single CD-ROM at no charge.
- *Developing Intelligent Transportation Systems Using the National ITS Architecture - Technical Editions:* These are the accompanying volumes to this document intended for those involved in the planning, development, deployment and operation of particular systems.
  - o *Developing Freeway Management Systems Using the National ITS -- Technical Edition.*
  - o *Developing Traveler Information Systems Using the National ITS Architecture -- Technical Edition.*
  - o *Developing Traffic Signal Control Systems Using the National ITS Architecture -- Technical Edition.*
  - o *Developing Transit Systems Using the National ITS -- Technical Edition.*
- The National ITS Architecture documents on the World-Wide Web at:
  - http://www.its.dot.gov
  - http://www.itsa.org/public/archdocs/national.html
  - http://www.odetics.com/itsarch/
- ITS Joint Program Office, (HVH-1), Federal Highway Administration, U.S. Department of Transportation, 400 Seventh Street SW, Washington, DC 20590; phone: 202-366-9536, fax: 202-366-3302
  - *The National Architecture for ITS: A Framework for Integrated Transportation into the 21st Century*
  - *Building the ITI: Putting the National ITS Architecture into Action*
- ITS America, 400 Virginia Avenue SW, Suite 800, Washington, DC 20024; phone: 202-484-4847
  - Copies of the National ITS Architecture documents are available for a fee. Specific National ITS Architecture volumes are available from the ITS America bookstore at 202-484-4584 or 800-374-8472.

Further Information on ITS

- MITRE Corporation, The. 1996. *Intelligent Transportation Infrastructure Benefits: Expected and Experienced.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration. FHWA-JPO-96-008.
- *Benefits Assessment of Advanced Public Transportation Systems,* Volpe National Transportation Systems Center, Research and Special Programs Administration, U.S. Department of Transportation, Cambridge, MA
- Department of Transportation. 1992. *Intermodal Surface Transportation Efficiency Act of*

1991, A Summary. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. FHWA-PL-92-008.

- ITS Procurement Resource Guide, ITS JPO, FHWA-JPO-97-0025. Contains several articles or reports with helpful information on ITS procurement issues.
- Telecommunications Resource Guide. A JPO compilation of studies on shared resources.
- Kraft, Walter H. 1995. *ITE Operations and Maintenance Conference - Summary of Findings*. Washington, DC: Institute of Transportation Engineers.

- Ginger Daniels and Tim Starr, Texas Transportation Institute, *Guidelines for Funding Operations and Maintenance of ITS/ATMS.* January 1996. Presented at the 76th Annual Meeting, Transportation Research Board, Washington DC

Acknowledgements

This work was funded by the U.S. Department of Transportation ITS Joint Program Office. There have been contributions to this document by people from several organizations. In particular, the editor and prime authors would like to express their sincere appreciation to the contributing authors from TransCore and PB Farradyne. In addition, the review efforts of FHWA ITS Joint Program Office, FHWA Office of Traffic Operations and ITS Applications, and the various individuals representing state and local transportation agencies are greatly appreciated.

Introduction to Understanding and Applying the National ITS Architecture

Contents

This subsection includes the following two items:

1. *Key Concepts of the National ITS Architecture* provides a semi-technical, high level overview of the National ITS Architecture.
2. *Applying the National ITS Architecture to Planning and Project Development Activities* discusses how to use the National ITS Architecture as a tool in the development of a regional ITS architecture and in ITS project development.

(Both are excerpts from *Developing Traffic Signal Control Systems Using the National ITS Architecture, February 1998, FHWA-JPO-98-026.)*

Summary

Key Concepts explains the essential terminology and describes the key concepts of the National ITS Architecture. These concepts are presented to ensure that the reader understands the fundamental principles and the structure of the National ITS Architecture.

Applying the National ITS Architecture identifies how to apply the principles and information sources of the National ITS Architecture to the planning, development, and implementation of ITS. The National ITS Architecture helps identify the ITS services and linkages to address the unique needs and goals of each region.

Uses

An understanding of these key concepts will give those individuals involved in planning, development, and deployment of ITS on a local or regional level the context needed to properly apply the National ITS Architecture to their own situation. These documents provide readers with examples of how the National ITS Architecture may be applied, or adapted for use in their own region.

To obtain additional copies, see the U.S. DOT's ITS website at www.its.dot.gov. These selections are both available in the Electonic Document Library in document #3015.

1. Key Concepts of the National ITS Architecture

The National ITS Architecture is available as a resource for any region and will continue to be maintained by the U.S. DOT independently of any specific system design or region in the nation. It represents the work and collective thinking of a broad cross-section of the ITS community (systems engineers, transportation practitioners, technology specialists, system developers, consultants, etc.) over several years. As such, the National ITS Architecture contains material that will assist agencies at each step of project development and in thinking about how an individual project, such as a traffic signal control project, fits into a larger regional transportation management context.

Because of the extensive geographic and functional scope of the National ITS Architecture and the requirements which drove its development, it is structured somewhat differently and uses different terminology than is typically used today in the transportation community. It was developed to support ITS implementations over a 20-year time period in urban, interurban, and rural environments across the country. Accordingly, general names were given to the physical transportation system components and locations in order to accommodate a variety of local design choices and changes in technology or institutional arrangements over time. This allows the general structure of the National ITS Architecture to remain stable while still allowing flexibility and tailoring at the local implementation level. This difference in language can be easily overcome with a better understanding of how the National ITS Architecture is organized and how it relates to familiar systems of today.

As background, this section explains the essential terminology and concepts needed to understand, navigate, and use the National ITS Architecture and then provides a summary of the key documents produced under the National ITS Architecture development effort which will be referred to in the next section. The following concepts and terms are explained in this section:

- User Services and User Service Requirements
- Logical Architecture
- Physical Architecture
- Equipment Packages
- Market Packages

1.1 User Services and User Service Requirements

User services represent what the system will do from the perspective of the user. A user might be the public or a system operator.

Table 1 presents the 30 user services which formed the basis for the National ITS Architecture development effort, grouped into seven bundles for convenience. These user services were jointly defined by a collaborative process involving USDOT and ITS America with significant stakeholder input. Clearly, a different set could have been defined. The important point is that the concept of user services allows the process of system or project definition to begin by thinking about what high level services will be provided to address identified problems and needs. New or updated user services may be added to the National ITS Architecture over time.

Table 1. User Services for the National ITS Architecture

User Service Bundle	User Service
Travel and Transportation Management	En-Route Driver Information Route Guidance Traveler Services Information Traffic Control Incident Management Emissions Testing and Mitigation Highway-Rail Intersection
Travel Demand Management	Pre-Trip Travel Information Ride Matching and Reservation Demand Management and Operations
Public Transportation Operations	Public Transportation Management En-Route Transit Information Personalized Public Transit Public Travel Security
Electronic Payment Services	Electronic Payment Services
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance Automated Roadside Safety Inspection On-Board Safety Monitoring Commercial Vehicle Administrative Processes Hazardous Material Incident Response Commercial Fleet Management
Emergency Management	Emergency Notification and Personal Security Emergency Vehicle Management
Advanced Vehicle Control and Safety Systems	Longitudinal Collision Avoidance Lateral Collision Avoidance Intersection Collision Avoidance Vision Enhancement for Crash Avoidance Safety Readiness Pre-Crash Restraint Deployment Automated Highway Systems

A number of functions are required to accomplish each user service. To reflect this, each of the user services was broken down into successively more detailed functional statements, called *user service requirements*, which formed the fundamental requirements for the National ITS Architecture development effort. For example, the traffic control user service is actually defined by over 40 "functions" (the hierarchy of functional requirements makes it difficult to provide an exact number). In the Traceability Matrix of the National ITS Architecture documentation, the user service requirements can be reviewed. Many of these user service requirements can be implemented today, although some of them may be more representative of future capabilities and should be deferred for now. These requirements can be used as a departure point for the development of project functional requirements and system specifications.

Table 2 provides an illustration of user service requirements using an excerpt from the traffic control user service.

Table 2. Example of User Service Requirements: Excerpt from Traffic Control

1.6.0 (ITS) shall provide a Traffic Control capability. Traffic Control provides the capability to efficiently manage the movement of traffic on streets and highways. Four functions are provided which are (1) Traffic Flow Optimization, (2) Traffic Surveillance, (3)Control Function, and (4) Provide Information. This will also include control of network signal systems with eventual integration of freeway control.
1.6.1 Traffic Control shall include a Flow Optimize function to provide the capability to optimize traffic flow. **1.6.1.1** The Flow Optimize function shall employ control strategies that seek to maximize traffic-movement efficiency. **1.6.1.2** The Flow Optimize function shall include a Wide Area optimization capability, to include several jurisdictions. **1.6.1.2.1** Wide area optimization shall integrate the control of network signal systems with the control of freeways. **1.6.1.2.2** Wide area optimization shall include features that provide preferential treatment for transit vehicles.
1.6.2 Traffic Control shall include a Traffic Surveillance function.

1.2 Logical Architecture

A logical architecture is best described as a tool that assists in organizing complex entities and relationships. It focuses on the functional processes and information flows of a system. Developing a logical architecture helps identify the system functions and information flows, and guides development of functional requirements for new systems and improvements. A logical architecture should be independent of institutions and technology, i.e., it should not define where or by whom functions are performed in the system, nor should it identify how functions are to be implemented.

The logical architecture of the National ITS Architecture defined a set of functions (or processes) and information flows (or data flows) that respond to the user service requirements discussed above. Processes and data flows are grouped to form particular transportation management functions (e.g., manage traffic) and are represented graphically by data flow diagrams (DFDs), or bubble charts, which decompose into several levels of detail. In these diagrams, processes are represented as bubbles and data flows as arrows. Figures 1 and 2 depict simplified data flow diagrams from the National ITS Architecture documents. Note that each bubble in the logical architecture is a process that describes some logical function to be performed.

For example, as shown in Figure 1, at the highest level of the National ITS Architecture, the manage traffic process (which includes traffic signal control functions) interacts with seven other processes.

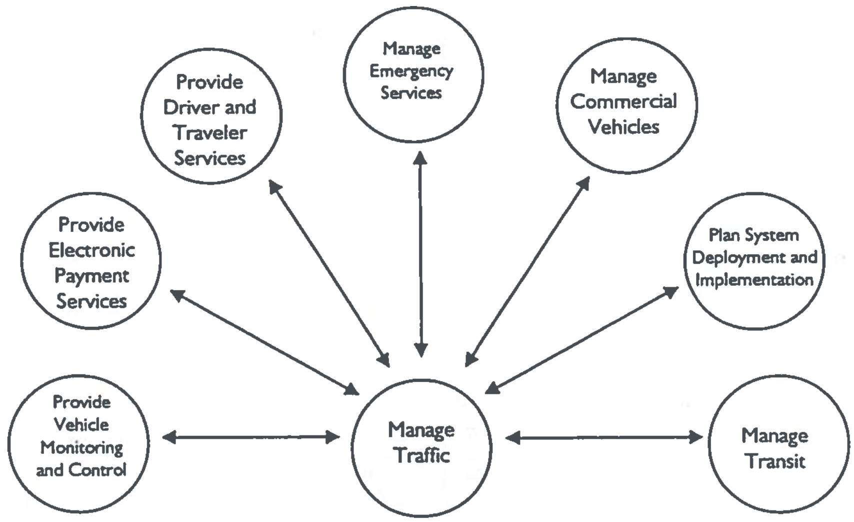


Figure 1. The Eight Major Processes within the Logical Architecture

Figure 2 illustrates how the manage traffic process is then further broken down into five sub-processes; how one of those processes, Provide Traffic Surveillance, is broken down into seven sub-processes; and so on. Each of these processes are then broken down even further so that a complete functional view of a system emerges. At the lowest level of detail in the functional hierarchy are the *process specifications* (referred to as *P-specs* in the documentation). Table 3 shows an example of a process specification (Process Traffic Data) within the functional decomposition. These process specifications can be thought of as the elemental functions to be performed in order to satisfy the user service requirements (i.e., they are not broken out any further). The information exchanges between processes and between P-specs are called the (logical) *data flows*. Example overview descriptions of process specifications relevant to traffic signal control systems are given below:

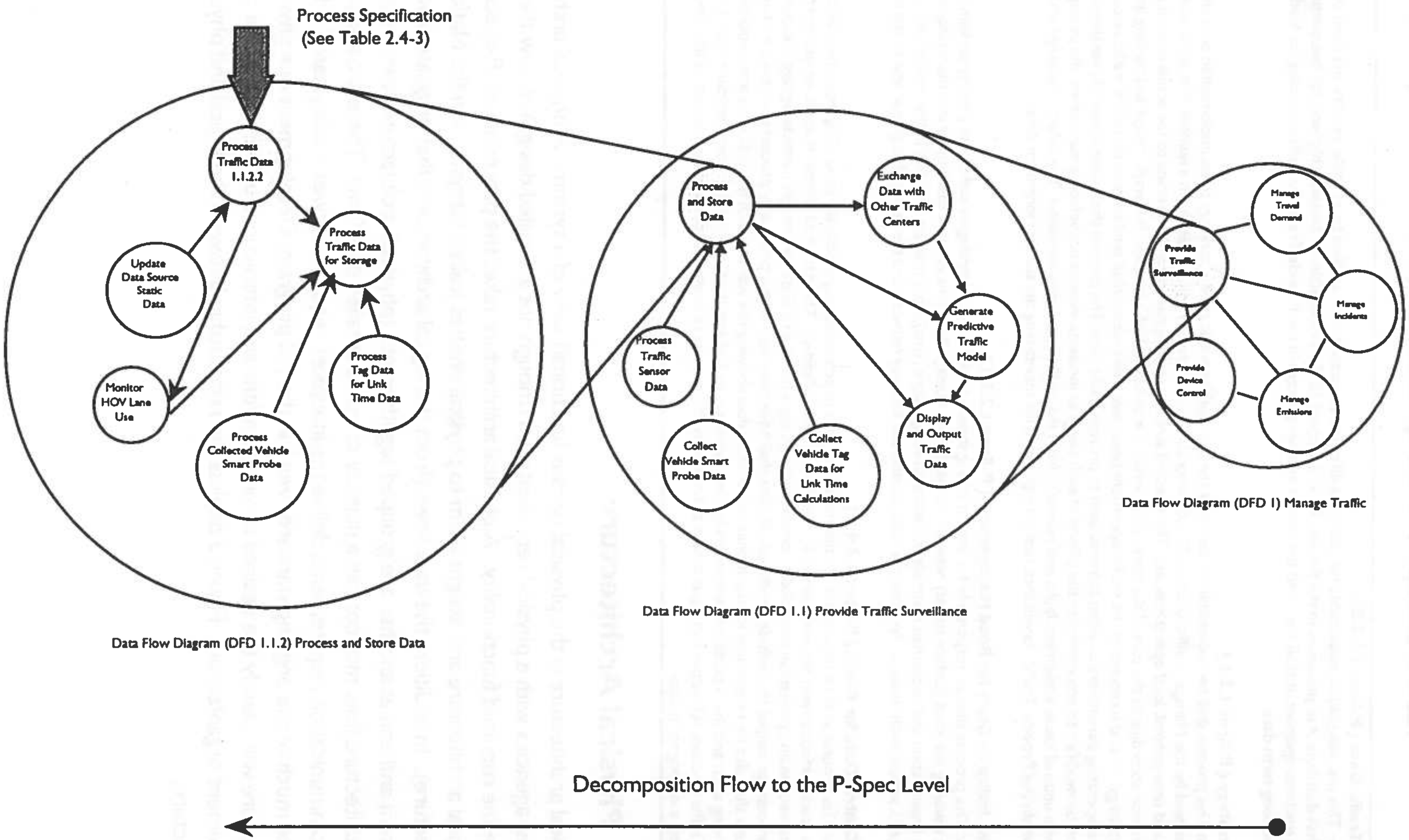


Figure 2. Example of Logical Architecture Functional Decomposition

Table 3. Example Process Specifications (Overview Descriptions)

Process Traffic Data (P-Spec 1.1.2.2)
Overview: This process shall be responsible for collecting all of the processed data supplied from traffic sensors and from sensors at HRIs. The process shall distribute it to processes in the Provide Device Control facility responsible for freeway, highway rail intersections, parking lot, ramp and road management. It shall also send the data to another process in the Provide Traffic Surveillance facility for loading into the stores of current and long term data.

Select Strategy (P-Spec 1.2.1)
Overview: This process shall be responsible for selecting the appropriate traffic control strategy to be implemented over the road and freeway network served by the Manage Traffic function. The strategy shall be selected by the process from a number that are available, e.g. adaptive control, fixed time control, local operations, etc. The selected strategy shall be passed by the process to the actual control processes for implementation according to the part of the network to which it is to be applied, i.e. roads, freeways, ramps and parking lots. When part of the selected strategy, or at the request of the traffic operations personnel, the process shall send commands to the traffic sensor data process to change the operating parameters of video cameras used to provide traffic data. The process shall make it possible for the current strategy selection to be modified to accommodate the effects of such things as incidents, emergency vehicle green waves, the passage of commercial vehicles with unusual loads, equipment faults and overrides from the traffic operations personnel. The selected strategy shall be sent to the process within the Provide Traffic Surveillance facility responsible for maintaining the store of long term data.

Determine Indicator State for Road Management (P-Spec 1.2.2.2)
Overview: This process shall be responsible for implementing selected traffic control strategies and transit priority on some or all of the indicators covering the road (surface street) network served by the Manage Traffic function. It shall implement the strategies only using the indicators (intersection and pedestrian controllers, variable message signs (vms), etc.) that are specified in the implementation request and shall coordinate its actions with those of the processes that control the freeway network and the ramps that give access to the freeway network.

Output Control Data for Roads (P-Spec 1.2.4.1)
Overview: This process shall be responsible for the transfer of data to processes responsible for controlling equipment located at the roadside within the road (surface street) network served by the Manage Traffic function. This data shall contain outputs for use by roadside indicators, such as intersection and pedestrian controllers, variable message signs (vms), etc. Data for use by in-vehicle signage equipment shall be sent to another process for output to roadside processes. All data shall have been sent to this process by processes within the Manage Traffic function. This process shall also be responsible for the monitoring of input data showing the way in which the indicators are responding to the data that they are being sent, and the reporting of any errors in their responses as faults to the Collect and Process Indicator Fault Data facility within the Manage Traffic function. All output and input data shall be sent by the process to another process in the Manage Traffic function to be loaded into the store of long term data.

1.3 Physical Architecture

A physical architecture is the physical (versus functional) view of a system. A physical architecture provides agencies with a physical representation (though not a detailed design) of how the system should provide the required functionality. A physical architecture takes the processes (or P-specs) identified in the logical architecture and assigns them to physical entities (called *subsystems* in the National ITS Architecture). In addition, the data flows (from the logical architecture) that originate from one subsystem and end at another are grouped together into (physical) *architecture flows*. In other words, one architecture flow may contain a number of more detailed data flows. These architecture flows and their communication requirements define the *interfaces* required between subsystems, which form the basis for much of the ongoing standards work in the ITS program. Development of a physical architecture will identify the desired communications and interactions between different transportation management organizations. Figure 3 depicts the relationship between the logical and physical architecture.

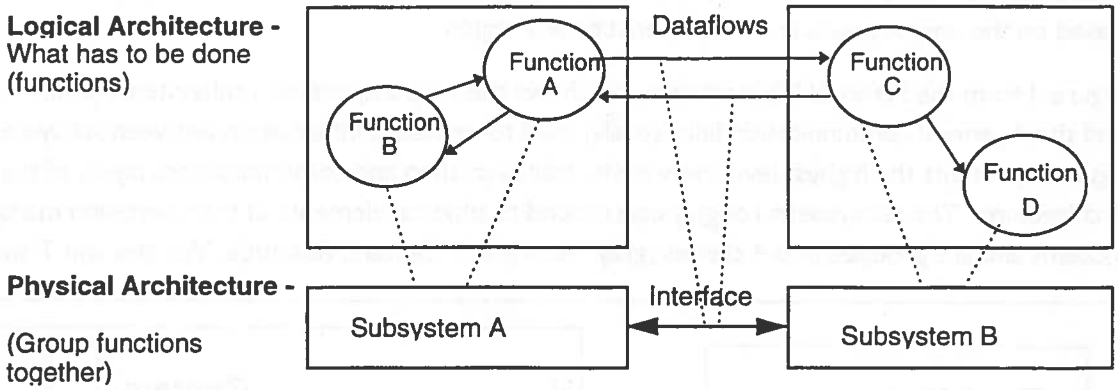


Figure 3. Representative Logical and Physical Architecture

In the National ITS Architecture, the physical architecture is described by two layers: the transportation layer and the communications layer. Each of these is briefly described below.

<u>Transportation Layer</u>

The transportation layer of the physical architecture shows the relationships among the transportation-management-related elements. It is composed of subsystems for travelers, vehicles, transportation management centers, and field devices, as well as external system interfaces at the boundaries (called *terminators* in the documentation). It may include:

- Field devices for traffic surveillance and motorist information dissemination
- Traffic signal and ramp metering controllers
- Transportation management centers
- Emergency management centers

<u>Communications Layer</u>

The communications layer of the physical architecture shows the flow of information and data transfer for the transportation layer components. This layer depicts all of the communications necessary to transfer information and data among transportation entities, traveler information and emergency service providers, and other service providers such as towing and recovery. The communications layer clearly identifies system interface points where national standards and communications protocols can be used.

<u>Institutional Implications</u>

While an institutional layer is not actually part of the physical architecture, the physical architecture cannot be fully defined in a region without some decisions being made regarding the jurisdictional structure and working relationships that will provide a framework for ITS planning and implementation. These institutional decisions should lead to depiction of who should communicate with whom, and what information should be communicated in the transportation and communications layers, and will vary based on the unique needs and characteristics of a region.

Figure 4 from the National ITS Architecture, shows the 19 transportation subsystems (white rectangles) and the 4 general communication links (ovals) used to exchange information between subsystems. This figure represents the highest level view of the transportation and communications layers of the physical architecture. The subsystems roughly correspond to physical elements of transportation management systems and are grouped into 4 classes (gray rectangles): Centers, Roadside, Vehicles and Travelers.

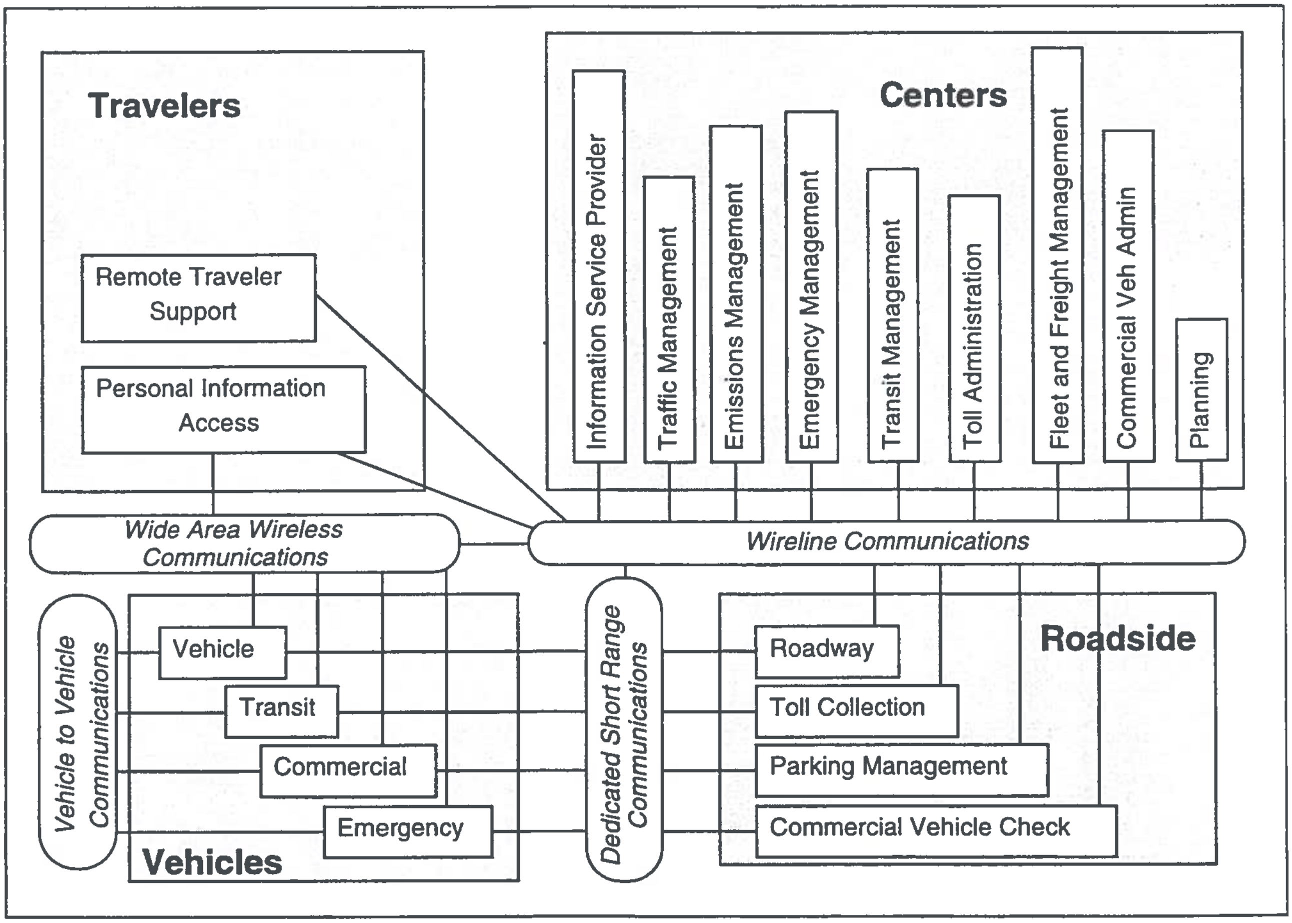


Figure 4. National ITS Architecture Subsystems and Communications

Basic traffic signal control systems are represented by functions within 2 of the 19 subsystems: the Traffic Management subsystem and the Roadway subsystem. This is illustrated in figure 5, which depicts traffic signal control related elements as an overlay to the diagram just presented.

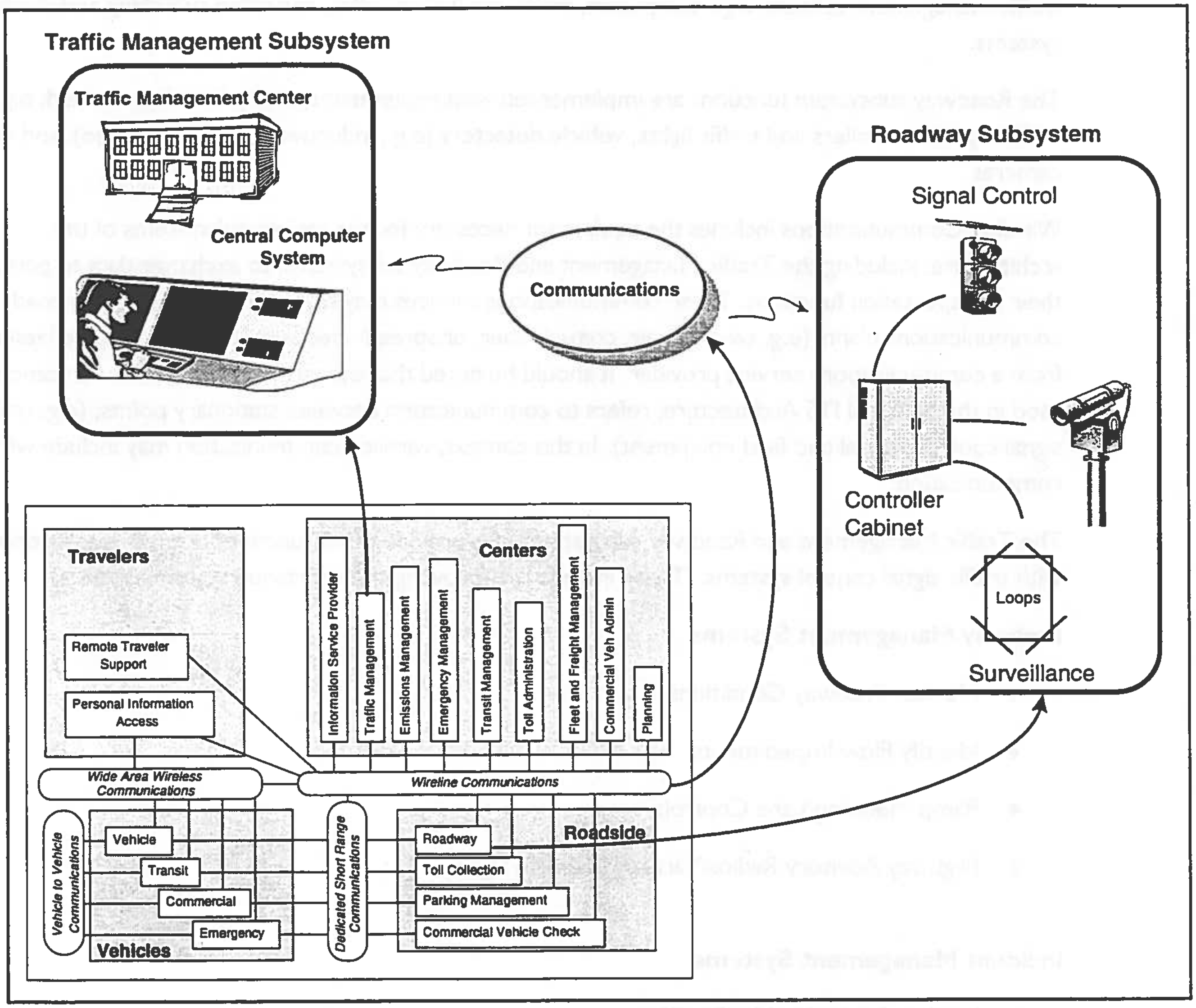


Figure 5. Basic Traffic Signal Control System Architecture Depiction

These two subsystems, together with the necessary communications to exchange control and surveillance information, provide the following capabilities typically associated with traffic signal control systems:

- Area-wide signal coordination
- Arterial network traffic conditions
- A range of adaptive control strategies
- Integration with freeway management, incident and emergency management, transit management, etc.

The Traffic Management subsystem functions are implemented with central equipment typically found in traffic management centers; e.g., computers, traffic control consoles, and video switching and display systems.

The Roadway subsystem functions are implemented with equipment typically found in the field; e.g. traffic signal controllers and traffic lights, vehicle detectors (e.g., inductive loop, radar, video), and video cameras.

Wireline Communications includes the equipment necessary for the various subsystems of the architecture, including the Traffic Management and Roadway subsystems, to exchange data to perform their transportation functions. These communications services may be provided by agency-owned communications plants (e.g. twisted pair, coaxial, fiber, or spread-spectrum radio), or may be leased from a communications service provider. It should be noted that the term "wireline communication" as used in the National ITS Architecture, refers to communication between stationary points, (e.g. traffic signal control central and field equipment). In this context, wireline communication may include wireless communication.

The Traffic Management and Roadway subsystems also provide other functions not typically associated with traffic signal control systems. These include the following transportation system functions:

Freeway Management Systems

- Monitor Freeway Conditions
- Identify Flow Impediments
- Ramp Metering/Lane Controls
- Highway Advisory Radios/Variable Message Signs

Incident Management Systems

- Incident Detection/Verification
- Incident Response/Clearance

Railroad Grade Crossing Systems

- Improve and automate Highway-Railroad Intersection warnings and Traffic Signal Control
- Provide advanced warning of closures
- Coordinate traffic signal control with rail movements

An important concept to understand from the physical architecture is that of support for combining subsystems together (or functionality from multiple subsystems) in an actual implementation. This is particularly important for the "center" subsystems, which should not be immediately thought of as separate buildings. In simplest terms, the center subsystems are not "brick and mortar". Each subsystem is a cohesive set of functional definitions with required interfaces to other subsystems; subsystems are functionally defined, not physically defined. A regional implementation may include a single physical center that collocates and integrates the capabilities from several of the center subsystems. For instance, a single Transportation Management Center may include Traffic Management Subsystem, Transit Management Subsystem, Emergency Management Subsystem, and Information Service Provider subsystem capabilities. Conversely, a single subsystem may be replicated in many different physical centers in a complex metropolitan area system. For instance, the traffic management subsystem may be implemented in a traffic management center for freeway control in addition to several distinct city traffic management centers that cooperatively control the arterials. Figure 6 provides an indication of the range of ways that center subsystems may be implemented in physical centers.

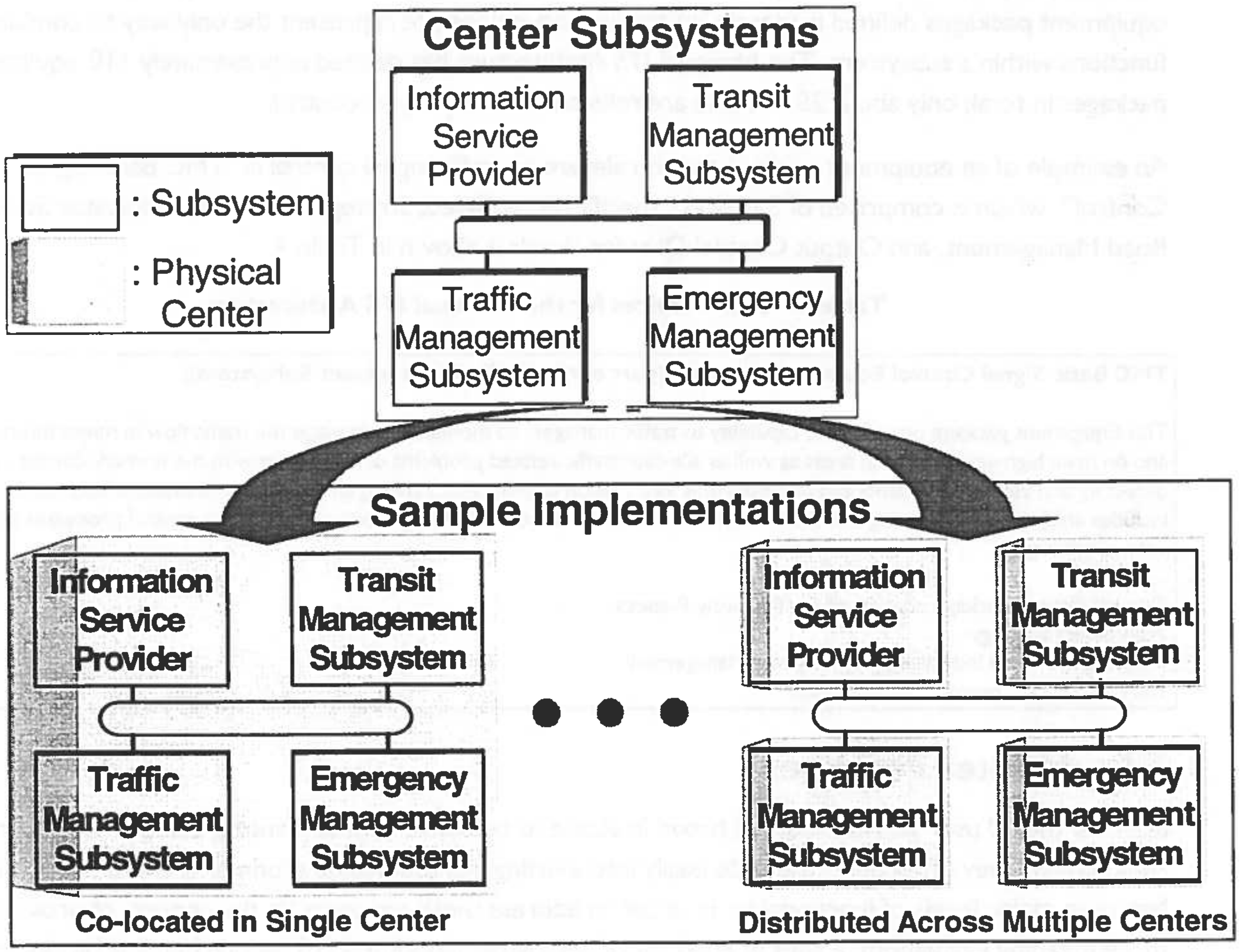


Figure 6. Center Subsystems May Be Implemented In Various Regional Configurations (Source: National ITS Architecture Implementation Strategy)

1.4 Equipment Packages

The logical and physical architectures contain all of the essential architecture elements needed to provide the user services (and their more detailed requirements). Although the formal definition of the National ITS Architecture stops there, other categorizations of the architecture elements were made for the purposes of evaluation and to better understand the deployment implications.

The term "*equipment package*" was used in the National ITS Architecture development effort to group like functions (P-specs) of a particular subsystem together into an "implementable" package of hardware and software capabilities. The grouping of functions also took into account the user services and the need to accommodate various levels of functionality within them. The equipment packages are associated closely with market packages (which will be discussed next) and were used as a basis for estimating deployment costs (as part of the evaluation that was performed). The specific set of equipment packages defined is merely illustrative and is does not represent the only way to combine the functions within a subsystem. The National ITS Architecture has defined approximately 110 equipment packages in total; only about 25 of these are relevant to traffic signal control.

An example of an equipment package that is relevant to traffic signal control is "TMC Basic Signal Control", which is comprised of 3 process specifications: Select Strategy, Determine Indicator State for Road Management, and Output Control Data for Roads is shown in Table 4.

Table 4. User Services for the National ITS Architecture

TMC Basic Signal Control Equipment Package (part of the Traffic Management Subsystem):
This Equipment package provides the capability to traffic managers to monitor and manage the traffic flow in major intersections and on main highways for urban areas as well as alleviate traffic related problems of rural areas with the primary concern of detecting and verifying incidents and providing this information to emergency management service providers. This capability includes analyzing and reducing the collected data from traffic surveillance equipment as feedback to control processes and for control strategies.
This equipment package consists of the following P-specs: 1.2.1 Select Strategy 1.2.2.2 Determine Indicator State for Road Management 1.2.4.1 Output Control Data for Roads

1.5 Market Packages

Some of the 30 user services are too broad in scope to be convenient in planning actual deployments. Additionally, they often don't translate easily into existing institutional environments and don't distinguish between major levels of functionality. In order to address these concerns (in the context of providing a more meaning evaluation), a finer grained set of deployment-oriented ITS service building blocks were defined from the original user services. These are called "*market packages*" in the documentation.

Market packages are defined by sets of equipment packages required to work together (typically across different subsystems) to deliver a given transportation service and the major architecture flows between them and other important external systems. *In other words, they identify the pieces of the National ITS Architecture required to implement a service.* As such, they are directly grounded in the definition of the Architecture. Most market packages are made up of equipment packages in two or more subsystems.

Market packages are designed to address specific transportation problems and needs and can be related back to the 30 user services and their more detailed requirements.

For example, the functionality of the broad user service named "traffic control" was broken up into several market packages to allow for explicit consideration of:

- basic functions (such as surveillance, which is represented by the "network surveillance" and "probe surveillance" market packages),
- institutional settings (by separating control functions typically performed by different agencies into the "surface street control" and "freeway control" market packages), and
- functional levels of service (by including a "regional traffic control" market package that provides for coordination of control strategies across jurisdictions).

In addition, a "multi-modal coordination" market package was defined that is comprised of functionality for transit and emergency vehicle priority treatment at traffic signals.

Figure 7 provides an example of a market package related to traffic signal control and Figure 8 explains the basic elements of the market package diagrams.

Surface Street Control (ATMS3)
This market package provides the communication links and the signal control equipment for local surface street control and/or arterial traffic management control. An example would be arterial signalization control. This market package is considered an intra-jurisdictional package since coordination between adjacent cities is required to coordinate signal control along arterials. This package is consistent with typical urban traffic signal control systems.

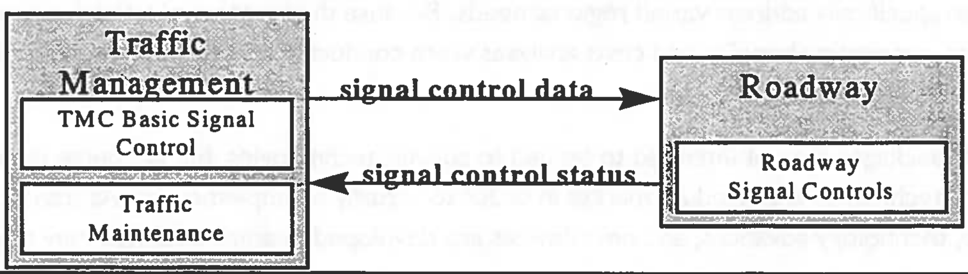


Figure 7. Surface Street Control Market Package (Adapted From Appendix A of the Implementation Strategy)

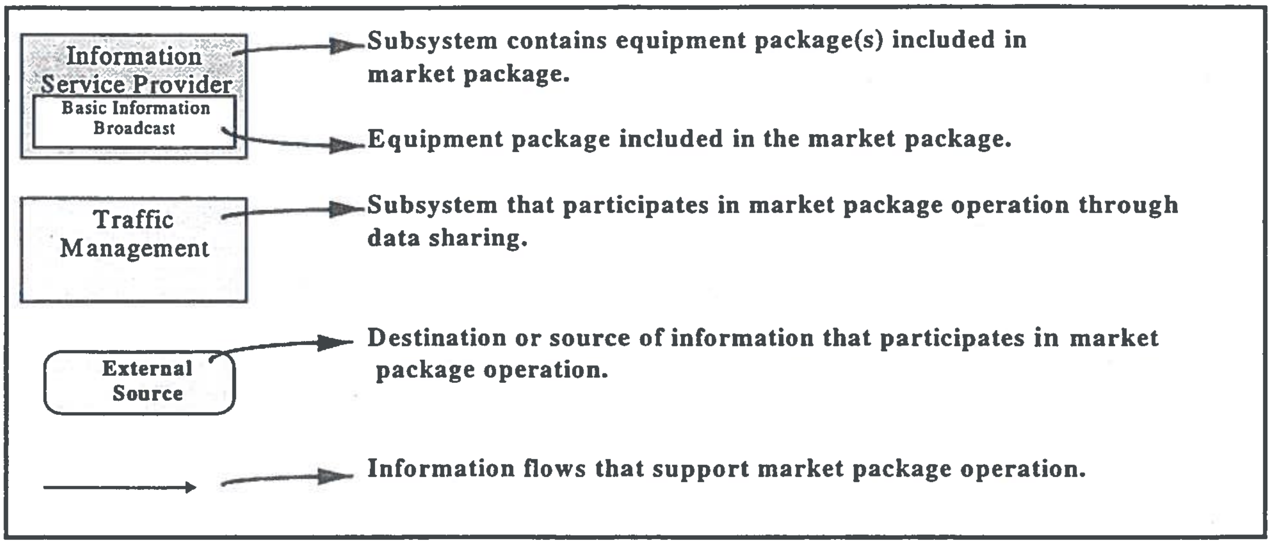


Figure 8. Market Package Elements
(Adapted From Appendix A of the Implementation Strategy)

The National ITS Architecture development effort identified a total of 56 market packages that reflect the current definition of ITS and the evolving technology market. Table 5 contains a complete listing of these, grouped according to their respective major application areas. As with equipment packages, the specific set of market packages defined is merely illustrative and does not represent the only way to combine the functions and equipment in order to provide ITS services. The market packages most closely related to traffic signal control are highlighted in the table.

A given market package may provide only part of the functionality of a user service (supporting multiple service levels), but often serves as a building block by allowing more advanced packages to use its components. Market packages also allow early deployments to be separated form higher risk services and can specifically address varied regional needs. Because they were evaluated during the development process, supporting benefits and costs analyses were conducted for the market packages which can also be accessed as a resource.

Market packages are not intended to be tied to specific technologies, but of course depend on the current technology and product market in order to actually be implemented. As transportation needs evolve, technology advances, and new devices are developed, market packages may change and new market packages may be defined.

In short, market packages provide another method for entering into the National ITS Architecture information and can be used as an alternative starting point for defining project functional requirements and system specifications. The important point to remember is that they provide a set of manageable, service-oriented views which allow the user to jump right into the physical architecture definition.

Table 5. ITS Market Packages

Traffic Management	Advanced Vehicles
Network Surveillance	Vehicle Safety Monitoring
Probe Surveillance	Driver Safety Monitoring
Surface Street Control	Longitudinal Safety Warning
Freeway Control	Lateral Safety Warning
HOV and Reversible Lane Management	Intersection Safety Warning
Traffic Information Dissemination	Pre-Crash Restraint Deployment
Regional Traffic Control	Driver Visibility Improvement
Incident Management System	Advanced Vehicle Longitudinal Control
Traffic Network Performance Evaluation	Advanced Vehicle Lateral Control
Dynamic Toll/Parking Fee Management	Intersection Collision Avoidance
Emissions and Environmental Hazards Sensing	Automated Highway System
Virtual TMC and Smart Probe Data	
Standard Railroad Grade Crossing	**Commercial Vehicles**
Advanced Railroad Grade Crossing	Fleet Administration
Railroad Operations Coordination	Freight Administration
	Electronic Clearance
Transit Management	Commercial Vehicle Administrative Processes
Transit Vehicle Tracking	International Border Electronic Clearance
Transit Fixed-Route Operations	Weigh-In-Motion
Demand Response Transit Operations	Roadside CVO Safety
Transit Passenger and Fare Management	On-board CVO Safety
Transit Security	CVO Fleet Maintenance
Transit Maintenance	HAZMAT Management
Multi-modal Coordination	
	Emergency Management
Traveler Information	Emergency Response
Broadcast Traveler Information	Emergency Routing
Interactive Traveler Information	MAYDAY Support
Autonomous Route Guidance	
Dynamic Route Guidance	**ITS Planning**
Information Service Provider (ISP) Based Route Guidance	ITS Planning
Integrated Transportation Management/Route Guidance	
Yellow Pages and Reservation	
Dynamic Ridesharing	
In-Vehicle Signing	

1.6 National ITS Architecture Documents

In summary, the National ITS Architecture provides a common structure for the design of ITS; it defines the functions that must be performed by components or subsystems, where these functions reside (e.g., roadside, traffic management center, or in-vehicle), the interfaces and information flows between subsystems, and the communications requirements for the information flows (e.g., wireline or wireless) in order to address the underlying user service requirements. Since the National ITS Architecture is also the foundation for much of the ongoing ITS standards work, consideration of the interface and information exchange requirements established by the Architecture today will likely facilitate or ease the transition to incorporating standards-compliant interfaces in the future (when approved standards are available).

The following are brief descriptions of the documents produced under the National ITS Architecture Development Program that are referred to in subsequent sections. Paper copies of these can be obtained and used as reference documents. Another way to access them is via CD-ROM or on the Internet. The CD-ROM and the Internet sites will be more useful than hard copies when trying to access information rapidly. On the Internet, logical links (called "hyperlinks") between different parts of the architecture facilitate use of information for the type of exercises described later in this section. The CD-ROM also contains the underlying relational databases which define the Architecture (developed with Microsoft Access™), which can be useful for performing tailored searches or other advanced analyses. *It is important to remember that the key concepts and elements of the National ITS Architecture as presented in sections 1.2.2 -1.2.5 are interrelated and traceable in a variety of ways (forwards and backwards)*.

Although the documentation at first can appear to be extensive, even overwhelming, keep in mind that only a portion of the information will apply to the specific needs of an agency at any point in time. Using the electronic tools with search capabilities and the linked HTML version of the National ITS Architecture, finding the relevant information becomes even more manageable.

US DOT plans to update and maintain the National ITS Architecture over time to reflect changing needs and correct any deficiencies that may be found through the experience of users. Accordingly, critical portions of these documents, particularly those containing the Architecture definition, will be updated over time (e.g., an update is planned for late 1998). *Therefore, while this document provides specific information and examples from the National ITS Architecture (January 1997 version) for illustration purposes, the reader should always consult and defer to the latest version of the National ITS Architecture.*

It is important to keep in mind that several of the documents that were produced were done so for the purposes of evaluation; these documents can be used as additional resources (e.g., the Cost Analysis) but are peripheral to the fundamental definition. A first time interested reader should find the Executive Summary, Vision, and Implementation Strategy to be the most accessible starting points for looking into the documentation.

<u>Vision</u>

The vision is the starting point for developing an architecture and is the component that drives everything else. The vision statement provides a description of the likely transportation system in the next 5, 10, and 20 years based on the National ITS Architecture. In the vision, the ITS User Services that the transportation system is to provide are identified in groups.

Mission

The Mission addresses the goals and objectives of a national intelligent transportation system. In the Mission, user service requirements are defined, and benefits that the system is expected to provide are identified. The mission definition ties the National ITS Architecture to the National ITS Program Plan developed jointly by US DOT and ITS America.

Logical Architecture

The Logical Architecture document contains three volumes: *Description* (Volume 1), *Process Specifications* (Volume 2), and *Data Dictionary* (Volume 3). These documents present a functional view of the ITS user services, contain diagrams that show processes and data flows among them, and define data elements, respectively.

Physical Architecture

The Physical Architecture document contains architecture flow diagrams that show data passing among physical subsystems, and presents characteristics and constraints on the data flows.

Traceability

The Traceability document shows how the National ITS Architecture satisfies the user service requirements. It contains tables that provide traceability of ITS user service requirements to National ITS Architecture elements, and traceability between logical architecture elements and physical architecture elements.

Theory Of Operations

This document provides a detailed narrative of how the architecture supports the ITS user services, described in the Mission Definition. It is a technical document, intended for engineers, operators, and others involved in detailed systems design.

Communications

The Communications document presents an analysis of the communications aspects of the National ITS Architecture. It presents a technology assessment that covers several potential communications technology alternatives. The alternatives are compared against ITS requirements. This document proposes quantitative data loading requirements for a hypothetical system design, and contains an extensive set of appendices that deal with a specific communications study.

Cost Analysis

The Cost Analysis provides typical unit costs for market packages and equipment packages. Methodologies are delineated.

Performance and Benefits Study

The Performance and Benefits Study documents the results of evaluations of several hypothetical ITS deployment scenarios. It also presents a discussion of the overall benefits of developing the National ITS Architecture.

Standards Requirements

The Standards Requirements document contains detailed information on requirements for 12 high-priority standards packages. Standards interface packages that apply directly to traffic signal control include:

- Traffic Management Center for Other Centers
- Traffic Management Center to Roadside Devices
- Digital map data exchange and location referencing
- Highway-Rail Intersections
- Signal priority for emergency and transit vehicles

Implementation Strategy

The Implementation Strategy document presents a process for implementing ITS services in a phased approach. The process is part of an overall strategy that includes recommendations for future research and development, operational tests, standards activities, and training.

The Implementation Strategy translates the National ITS Architecture to implementation through market packages. It identifies the market packages that provide certain ITS services and recommends a phased deployment of those market packages to provide the most needed and most feasible user services initially, and less needed/feasible user services at a later date. The Implementation Strategy considers several items and issues regarding deployment, such as legacy systems, politics, funding, market package synergy, technology requirements, and standards requirements.

2. Applying the National ITS Architecture to Planning and Project Development Activities

2.1 Development of a Regional ITS Architecture

2.1.1 Overview

A regional architecture is a framework that provides a logical and organized approach to regional ITS implementation and operation. This section will describe an example process for developing a regional architecture that uses the principles and information sources of the National ITS Architecture.

2.1.2 Development of a Regional Architecture

Regional ITS architecture development should build from the results of concept planning. The architecture should meld existing systems and services with new systems, services and improvements identified during concept planning. The regional architecture should:

- Identify the different transportation management systems in a region and how they will interact
- Allow multiple agencies, service providers, and users to communicate
- Show the responsibilities of the different organizations and service providers involved in the system
- Identify communications and data flows among participants
- Support development of open systems (i.e., systems with interfaces that use standard or known communications protocols)
- Incorporate the use of existing and planned systems
- Enable synergy among the different systems
- Allow for accommodation of new technologies in the future
- Minimize ambiguity of system design
- Provide structure for future planning and growth
- Facilitate future system compatibility and interoperability

The architecture should identify all-important physical transportation subsystems (by stakeholder/agency) and external system interfaces and should show information flows between them. A functional description of each of the subsystems should also be developed. The architecture representation(s) should reflect both the existing and the proposed future ITS situation.

Using the logical and physical architecture concepts discussed in the National ITS Architecture documents will assist agencies in the process of developing a regional architecture. Figure 1 shows how the top level physical architecture diagram from the National ITS Architecture can be used as the starting point for a depiction of a regional physical architecture.

The process of implementation planning will require that more detail on the interface requirements for each of the participating agencies be specified. Figure 2 shows an example of how the overall interface requirements vary among the four traffic management systems in a hypothetical region called Anytown. The architecture flows that are allocated are associated with the Network Surveillance, Regional Traffic Control, and Traffic Information Dissemination Market Packages. As can be seen, no two agencies have precisely the same set of allocated architecture flow requirements since each agency has individual needs and resources for ITS applications. Figure 2 illustrates the level of detail that is included in a subsystem and architecture (information) flow diagram. Developing this level of detail will enable each participating agency to view how they fit into the overall transportation management picture in the region.

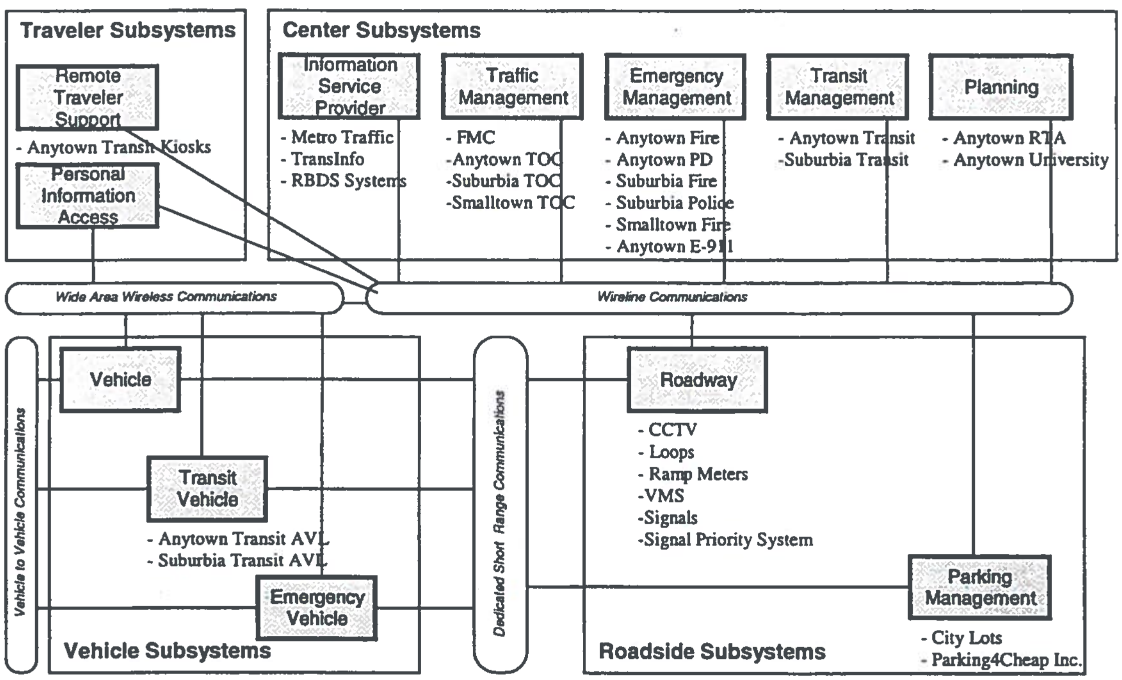


Figure 1. Example Regional Architecture (Top Level Interconnect View)

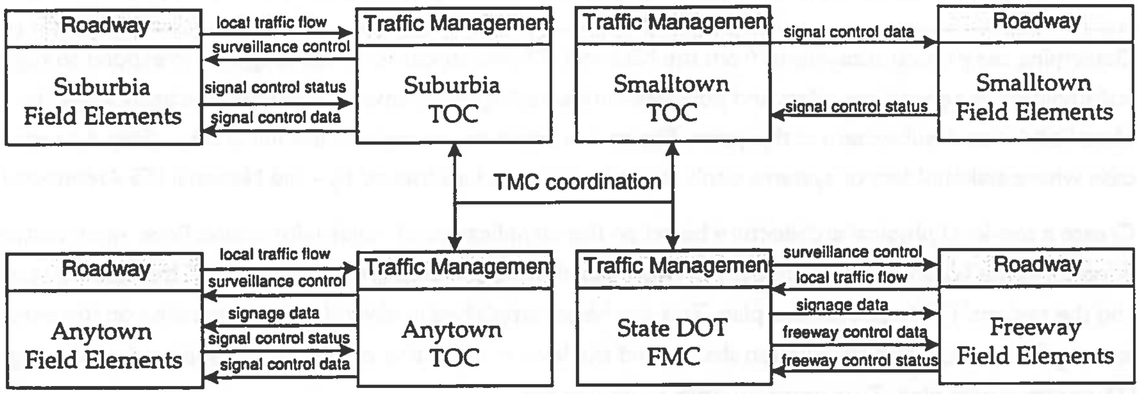


Figure 2. Architecture Flow Diagram (Excerpt): Regional Traffic Control Architecture Flows (Subsystem and Architecture Flow Level of Detail)

Instead of developing the regional ITS architecture in one single development process it may evolve from a phased approach. Each phase of development would build on the previous phase. Logical steps for developing the regional ITS architecture in this fashion correspond to the time phasing of ITS within a region (proceeding in order from step 1 to 3)

1. Existing (on the ground) ITS deployments
2. Committed or programmed ITS (near term projects)
3. Future ITS plans

Using the National ITS Architecture to Guide Regional Architecture Development (Example Method)

There are several ways to define the regional architecture at the appropriate level of detail by using the National ITS Architecture information as a starting point. One potential method is illustrated below:

1. Determine the general subsystems from the National ITS Architecture, which roughly correspond to regional stakeholders or service providers and populate with actual agency names. More than one agency may be identified for each subsystem at this point. Figure 1 provides an example of this initial step. (Step 4 handles the case where stakeholders or systems don't map to - or are not addressed by - the National ITS Architecture)
2. Create a top-level physical architecture based on the identification of major information flows (architecture flows from the National ITS Architecture) between stakeholders that are consistent with the existing systems and the regional ITS improvement plan. This can be accomplished in several ways, depending on the extent of existing ITS services and information sharing and the level of detail and organizational approach of the regional ITS improvement plan. Two potential ways to do this are:
   (a) Look at the relevant interfaces contained in the physical architecture to determine and document the architecture flows which roughly correspond to the regional ITS improvement plan. Combine these into a single representation.
   (b) Determine which market packages most closely represent the existing ITS situation and the regional ITS improvement plan. Use the market package diagrams to identify and document the most relevant subsystems, architecture flows, and important external interfaces. Combine and consolidate these diagrams into a single view.
3. Reevaluate the physical architecture carried over from the previous step. Delete or modify the portions of the National ITS Architecture (information flows, subsystems, or external interfaces, or functions) which upon further review don't apply to the region or are not consistent with the regional ITS improvement plan.
4. Incorporate any auxiliary specific local requirements or issues (information flows, subsystems, external interfaces, or functions) which are not addressed by the National ITS Architecture that exist or are a part of the regional ITS improvement plan.
5. Add detail or create diagrams that show the interactions and information exchanges of specific agencies within the region, in accordance with the operations requirements or concept of operations (roles and responsibilities) decided upon.
6. Document the major functions carried out in each subsystem.

2.2 Use of the National ITS Architecture Tools in ITS Project Development

2.2.1 Overview

This section presents the details of how the National ITS Architecture can be applied to ITS project development activities. The section shows how to apply the National ITS Architecture concepts and databases to the various steps in the general project development process.

2.2.2 Using the National ITS Architecture to Develop ITS Projects

This section describes the specific ways that the National ITS Architecture can be used in each of the general steps of the project development process making use of the key concepts of the National ITS Architecture. This process addresses (1) needs or problem identification, (2) solution identification, (3) solution planning and design, and (4) funding, procurement, and implementation. It should be noted that the processes illustrated in this section are only some of the potential uses of the National ITS Architecture in the development of individual projects. Agencies may choose to apply the principles of the National ITS Architecture differently to meet their individual needs.

National ITS Architecture Application Guidance

The National ITS Architecture tools are intended to augment and support existing ITS project development processes, and should be applied with engineering judgment in that context. The National Architecture is not a process in and of itself. It contributes information and analysis to existing processes (e.g., systems engineering). By providing a source for critical information early in the development process, the National ITS Architecture can lower project risks and costs while also improving the potential that the resulting deployment will have long term utility and support regional ITS integration over time.

The National ITS Architecture tools are most applicable in the early stages of project development. They fully support the rapid definition of a starting point for project definition, with local requirements then driving the tailoring of that project for specific applications. Of course, the tools do not contain all the information necessary to fully design and implement ITS projects. While helpful information is sometimes available within the documentation (for example, in the evaluation documents), specification of issues such as performance requirements, design options, technology choices, existing system interfaces and constraints, detailed implementation and operational decisions, and which standards to use needs to be carried out at the local level. Awareness of how far into the project development process the National ITS Architecture tools apply is important to being able to make the best use of them.

The National ITS Architecture can be used to provide project developers with additional options to consider for information exchanges and functionality that may not have initially been conceived at the outset of the project. As such, its utility is likely to be greater for larger projects with a variety of possible interfaces. Using the National ITS Architecture should not be viewed as an all-or-nothing requirement;

rather, the material can be used as is, tailored, or dropped, as appropriate for the situation. This will be discussed further in this section.

There are several ways to apply the National ITS Architecture; the most accessible of these methods will be presented in this section.

Entry Points into the National ITS Architecture

The definition of the National ITS Architecture can be found in the logical and physical architectures. These architecture definitions exist in several formats, including paper documents, Microsoft Access™ relational databases, and a HyperText Mark-up Language (HTML) model, which provides access through a linked model. The databases and the linked HTML model are available on CD-ROM and the World Wide Web. The logical and physical architecture definitions represent a breadth and depth of information that can seem overwhelming to access and apply. However, there are tools to view the architecture definition that make the extraction of information more efficient. These maps and tables provide access or "entry points" to the details of the architecture in an organized fashion. Figure 3 shows the top-level of information shown for the linked HTML model, which provides easy access to most of these entry points. Some of the key entry points and their relevance to project development are discussed below.

National ITS Architecture Browsing Site
(January 1997 Edition)

This presentation of the National Intelligent Transportation Systems (ITS) Architecture Definition provides a hypertext view of the logical architecture, physical architecture, and implementation-oriented components of the architecture definition. This hypertext view provides access to all process specifications, data flows, subsystems, equipment packages, and terminators that make up the architecture definition. Your entry to the architecture may be through a number of different paths.

The National ITS Architecture was developed to support intelligent transportation systems extending to the year 2012. The Federal Highway Administration defined the scope of the Architecture by the definition of 30 User Services. Toward fulfilling the User Service requirements, the architecture Vision provides a general forecast of the ways in which transportation improvements will be made over the next 20 years.

The architecture framework that supports this vision is made up of many Physical Architecture entities consisting of subsystems and terminators. By selecting a physical entity (either a subsystem or a terminator), you can browse through the process specifications that define each subsystem's functionality or the data flows that connect the subsystems.

Near term plans and planned deployments include the Intelligent Transportation Infrastructure and CVISN. The architecture structure for these near term deployments is provided in Market Packages.

Another entry which is suitable for locally searching for data flows with particular text is a complete file of Logical Architecture Data Flows (Note - this file is very big (200k bytes)) or Physical Architecture Architecture Flows.

Yet another entry through the logical architecture is through the Pspec (Process specification) names.

Finally, a set of standards requirement packages has been created which bundle the dataflows into sets of interest to standards organizations. The launch point for these packages is Standards Requirements packages (Cross references are provided for flows, which reside in more than one package).

The entire set of architecture documents are available on the ITS America Web Site.

Figure 3. National ITS Architecture Hypertext View
(Source: http://www.odetics.com/itsarch, June 1998)

> Note to the reader: As the National ITS Architecture is updated and maintained over time, changes may be made to facilitate access to key information and allow greater flexibility for the user. Thus, some of the specifics shown in Figure 3 and the mechanics discussed in subsequent text boxes for accessing the entry points may become dated.

- *User Services* are what drove the definition of the National ITS Architecture. They represent high-level descriptions of the services to be provided by ITS, from the perspective of the user. The National ITS Program Plan provides detailed descriptions of the user services. User services can be related to general needs and higher-level goals and objectives. Traceability exists to map user services to the underlying architecture definition.

- *User Service Requirements* are the "shall" statements that define the user services in detail and serve as the fundamental requirements of the National ITS Architecture. By selecting those user service requirements that apply to the definition of a specific system, traces can be made to the physical and logical architectures. The user service requirements are listed in Appendix A of the Traceability document on paper or CD-ROM, and are available in the hyperlinked HTML model.

> In the HTML model, click on "hypertext view" from the side bar, then "User Services" (see Figure 3) in order to see a list of the current User Services. User Services are then grouped according to their functional area (e.g., Travel and Traffic Management, Public transportation Management, etc.). By selecting and clicking on a User Service you are then able to view a definition of the User Service and a functional description of the Use Service, or shall statements, as well as the process specification (p-specs) that compose the user service. By clicking on the given p-spec you are able to view a definition of the p-spec, as well as the architecture flows that compose the p-spec.

- *Logical Architecture* describes "what" the National ITS Architecture must do to satisfy the User Services by defining required functions and dataflows. These functions and dataflows define the lower level details of the architecture. This tool is useful when defining the functions required to satisfy a service, requirement, or need. It leverages the extensive analysis already performed in the development of the National ITS Architecture. It provides process specifications that can be tailored to fit local requirements. The logical architecture is available on paper, CDROM, and the hyperlinked HTML model.

> In the HTML model, click on "hypertext view" from the side bar, then "Process Specifications" (see Figure 3) in order to see a list of the p-specs, which are organized numerically according to their definition in the data flow diagram hierarchy. Or, you can click on "Data Flows" in order to see the alphabetized list of logical data flows and get more information on them.

- *Physical Architecture Elements* are the subsystems and architecture flows that result from a partitioning of the logical architecture. These subsystems and architecture flows define a higher level of the architecture and can be aligned with high-level system functions such as "traffic management" or "information service provider". In this manner, a mapping at the physical architecture subsystem level can be developed that provides the links to the underlying logical architecture. The physical architecture is available on paper, CDROM, and the linked HTML model.

> In the HTML model, click on "hypertext view" from the side bar, then "Physical Architecture" (see Figure 3) in order to see a list of the subsystems and terminators, which are given alphabetically. Clicking on one of the subsystems gives lots of information about the subsystem, including a description, list of equipment packages it contains, corresponding process specifications, and an architecture flow diagram. Some of these can be further explored via additional links. You can also click on Physical Architecture Data Flows, as shown on Figure 3.

- *Market Packages* represent slices of the architecture that address specific services such as surface street control. These physical architecture subsets can be selected and aggregated to form a high-level architecture at the subsystem level. The market packages can be traced further to equipment packages and logical architecture functions. The market package definitions are available in the Implementation Strategy on paper and the CD-ROM, and also in the hyperlinked HTML model.

> In the HTML model, click on "hypertext view" from the side bar, then "Market Packages" (see Figure 1) in order to see a list of the market packages. Clicking on one of the market packages produces a wealth of information on relevant subsystems, equipment packages, architecture flows, related market packages, and evaluation information.

By using the CD-ROM with appropriate viewing software that can read ".pdf" files (such as the Adobe Acrobat® Reader), searches can be carried out on words of interest that might apply to a specific project or functional area. In addition, textual information can be copied (using the "select text" feature of the software) and pasted into a word processing application for further modification. Graphics information can also be downloaded (using "select graphics"), although it may not be as easy to modify these electronic tables or figures. Text and graphics information can always be printed and the information manually entered as inputs to other software programs.

2.2.2.1 Identification of Needs or Problems

Most transportation needs and problems are identified through the planning process as part of the ongoing process of improving transportation systems at the local level. As such, the National ITS Architecture is unlikely to contribute much information to this initial step. However, it can assist agencies in identifying ITS goals and objectives that are specific to their needs. Both current and future needs should be identified.

The National ITS Architecture documentation includes a Vision Statement, which describes ITS capabilities now and into the future in magazine article style. The Vision can also serve to foster general ideas about the types of local needs and problems that ITS can be used to address.

The National ITS Architecture also includes data collection subsystems, such as the planning subsystem, to highlight the value of using ITS to collect long-term performance data on the transportation system. Collecting and using this type of information can enhance and augment the process of identifying needs and problems in the future.

Useful National ITS Architecture Documents: Mission Definition, Vision Statement

2.2.2.2 Identification of Solutions

There are at least two major ways that the National ITS Architecture can be applied to the identification of alternative solutions to the given needs and problems, leading to the ultimate selection of a preferred solution. During this step, traditional solutions to the problem or combinations of traditional and ITS strategies may also be explored.

2.2.2.2.1 User Services

User services and associated user service requirements were fundamental to the National ITS Architecture development effort. These user services were designed to address surface transportation needs. Agencies may wish to review the list of user services in their search for potential solutions to the given needs and problems.

Under this approach for this step, agencies should select those user services and user service requirements that are most relevant toward meeting the current and future needs previously identified. Those user services and user service requirements that remain in the preferred solution can be carried further into the next step of project development.

2.2.2.2.2 Market Packages

Reviewing and selecting market packages is another convenient approach that can be taken for performing this step. Market packages were defined in the National ITS Architecture development effort to serve as deployment-oriented ITS service "building blocks". In general, the market packages offer a finer grained set of options than do user services, offering more alternatives to choose from in this step of the process. In addition, evaluation information (such as costs and benefits related material) is more readily available for the market packages than for user services, which can provide added support to project planning. Market packages identified in the National ITS Architecture that support traffic signal control functions include:

For additional help in connecting needs and problems with market packages, the Implementation Strategy document contains a table that provides this kind of information. For illustration, the excerpt of this table, shown as Table 1, shows the market packages that best address the problems of traffic congestion and air pollution.

In addition, the Performance and Benefits Study contains tables that relate the ITS system goals to individual market packages and the likely benefits of each market packages. Agencies can use these as an aid in determining which market packages best address local needs.

Useful National ITS Architecture Documents: Traceability Matrix, Implementation Strategy, Performance and Benefits Study

Table 1. Connecting Problems, Solutions, and the National Architecture
(Excerpt from Table 4.2-1 of the Implementation Strategy)

Problem	Solution	Conventional Approach	Advanced Systems Approach	Supporting Market Packages
Traffic Congestion	Increase roadway capacity (vehicular throughput)	• New roads • New lanes	• Advanced traffic control • Incident Management • Electronic Toll Collection • Corridor Management • Advanced vehicle systems (Reduce headway)	• Surface Street Control • Freeway Control • Incident Management System • Dynamic toll/parking fee management • Regional Traffic Control • Railroad Operations Coordination • Advanced vehicle longitudinal control • Automated highway system
	Increase passenger throughput	• HOV Lanes • Car Pooling • Fixed route transit	• Real-time ride matching • Integrate Transit and Feeder Services • Flexible route transit • New personalized public transit	• Dynamic Ridesharing • Multi-modal coordination • Demand Response Transit Operations
	Reduce demand	• Flex Time Programs	• Telecommuting • Other telesubstitutions • Transportation Pricing	• Dynamic toll/parking fee management
Air Pollution	Increase transportation system efficiency, reduce travel and fuel consumption	• More efficient conventional vehicles • Vehicle emissions inspections • Promotion of alternatives to single occupant vehicle travel • Increased capacity to reduce vehicle delay • Regulations	• Remote sensing of emissions • Advanced traffic management to smooth flows • Multi-modal pre-trip info • Telecommuting • Other telesubstitutions • Transportation Pricing • Alternative fuel vehicles	• Emissions and environmental hazards sensing • Surface Street Control • Freeway Control • Regional Traffic Control • Interactive Traveler Information • Dynamic Toll/Parking Fee Management

2.2.2.3 Planning and Design of the Solution

Project planning and design, particularly in the early phases, is likely the most important step for applying the National ITS Architecture information. There are a variety of ways to apply the National ITS Architecture in this step; the most important of these are discussed below. By using the various entry points other methods for facilitating the design process can be explored. The overall goal is for agencies to harness the analysis work already performed and to have the opportunity to consider additional functions, interfaces, and information sharing possibilities beyond the initial project scope, which can be planned for now in anticipation of future needs.

The planning and design activities that are discussed in this section include:

- Determine Functional Requirements
- Identify Information Exchange Requirements
- Identify Standards

2.2.2.3.1 Determine Functional Requirements

The National ITS Architecture can be used as an input to defining project or system functional requirements. This involves a more detailed look at the user service requirements or market packages carried through from the previous step. Potential approaches include:

- *User service requirements* - The user service requirements associated with the proposed solution can be evaluated for their applicability to the project. For example, they can be used to augment the functional specification that may be put out in an RFP for detailed design and procurement. Using the Traceability Matrix, the process specifications that are associated with the relevant (selected) user service requirements can also be analyzed. For those process specifications that are maintained in the system design, the data is available to relate those functions to the rest of the logical and physical architecture.
- *Market packages* - The high-level architecture defined using the market packages can be further refined by examining the logical architecture elements that support these subsystems and architecture flows. The linked model can provide the maps to the underlying functions and data flows of the logical architecture. The process specifications associated with the market packages can be tailored to satisfy more closely the local needs or requirements that the solution must address. As originally defined, the market packages may identify more subsystems, equipment packages, or terminators than are required to satisfy the identified needs. While this presents a chance to drop unneeded features, it should also be viewed as an opportunity to consider additional capabilities that may satisfy other needs at marginal cost. During the process of designing the project, expansion capability may also be identified that can be planned for in future solutions.
- *Physical Architecture Subsystems* - Even if the user service or market package approach isn't followed initially, agencies should be able to determine the relevant subsystems associated with a given project. Given a list of these subsystems, the physical architecture entry point can be used to determine the associated equipment packages, process specifications, and information flows. The underlying process specifications can be evaluated for their applicability and potential contribution to the functional needs of the given project (or future ones). This entry point is particularly useful for projects with a substantial amount of central equipment and software costs, such as a TMC upgrade.

For each alternative presented above, the National ITS Architecture material can be used as is, dropped, modified, or added to as appropriate to the situation. In most cases, additional performance requirements and other types of decisions will need to be included in the specification of a system before it can be procured (even if the detailed design work is to be put out for bid). It is important to recognize that the National ITS Architecture does not address reliability, availability, or maintainability. These and other operational and maintenance needs must be added to any requirement definition or system specification.

Unique local needs that are not covered as part of the 30 user services will also require the addition of subsystems or functions that are outside the National ITS Architecture. These types of elements may represent legacy system functions or portions of legacy systems. The addition of functionality, subsystems, and external interfaces (terminators) that are not part of the National ITS Architecture is part of the process of tailoring the solution architecture to satisfy the identified needs.

2.2.2.3.2 Identify Information Exchange Requirements

The physical architecture identifies the physical subsystems and data flows among subsystems that will support the communications requirements of a given project. It is important to identify physical data flows because they are the actual representation of communication ties among agencies and subsystems. Figure 4 illustrates a simplified physical architecture data flow diagram for traffic management.

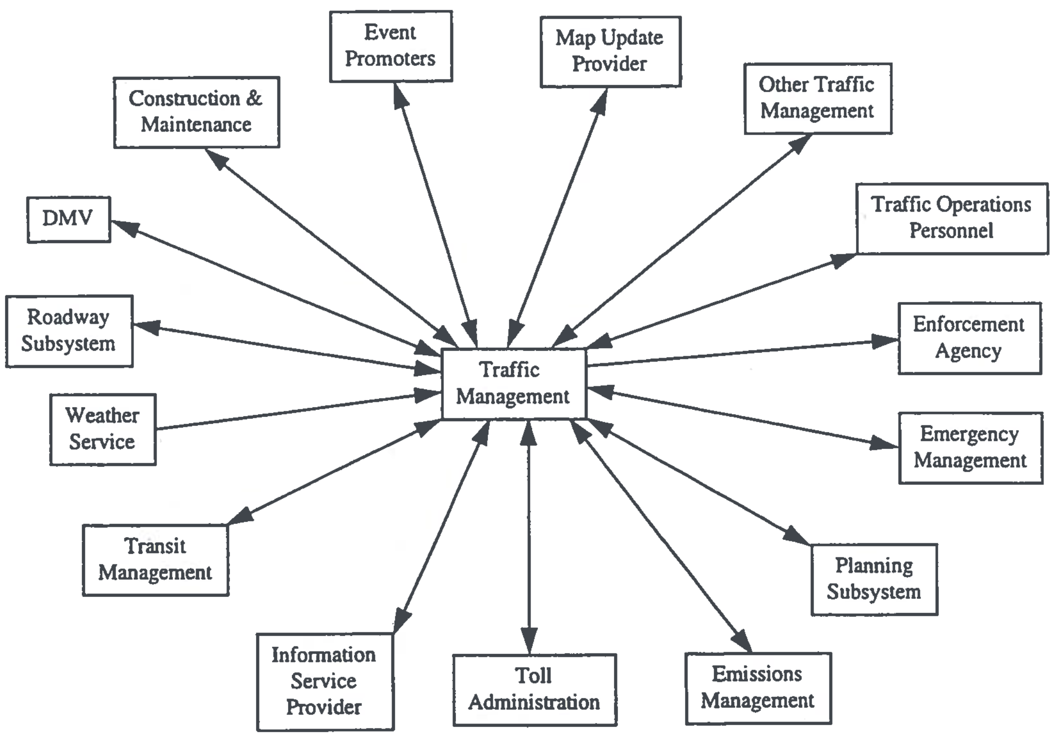


Figure 4. Example Physical Data Flows for Traffic Management (Data Flow Names Not Provided)

In the process of specifying the information exchange requirements for the project, the underlying logical data flows associated with the identified physical information flows should be evaluated for their inclusion in the definition of communication messages. In cases where data flows are not currently available (but might be in the future), accommodation of extra message fields in the software development for the project should be considered. This will likely be done more economically if it is carried out now instead of having to modify the software later to handle the increased and changed needs for communications.

The Theory of Operations document can be used to obtain a better understanding of how the physical architecture elements work together to provide ITS services. For example, it provides diagrams and descriptions indicating the intended sequencing of messages for particular user services. These diagrams illustrate the sharing of information between subsystems, which is relevant in determining the working relationships needed between different agencies for a given project. This type of information can be invaluable in developing a concept of operations for a project.

During the process of analyzing the possible information requirements contained in the National ITS Architecture, information exchanges beyond what was originally planned may become desirable additions to the project. This could entail establishing working relationships and agreements with agencies that were not originally part of the project planning effort, which could lead to an expansion of the project steering team. The information exchanges identified in the National ITS Architecture can stimulate the discussion of operational roles and responsibilities and are therefore critical to establishing the operations requirements for the project.

2.2.2.3.3 Identify Standards

The rapid pace of progress in technology will introduce many new systems and devices into transportation systems. As transportation systems incorporate advanced technology, there will be a need for standards to promote multi-vendor interoperability and ease of integration. With standards, it is simpler to share data and communicate between transportation systems, particularly between agencies within the same region. Without standards, it is more difficult to integrate transportation systems with each other, and consequently there is a danger of isolating systems and limiting their potential effectiveness in solving a region's transportation needs and problems.

One of the major reasons for developing the National ITS Architecture was to identify where standard system interfaces were needed. Because the National ITS Architecture is serving as the common foundation for the ongoing ITS standards development work, factoring it into your current system enhancements will facilitate the transition to a standard interface definition in the future. The Standards Requirements document contains detailed information on the requirements for 12 high-priority standards packages.

Agencies can take advantage of these standards as they emerge by specifying their use in procurement packages. Among the pertinent national ITS standards development activities in process are the suite of standards being developed under the National Transportation Communications ITS Protocol (NTCIP) effort, and Dedicated Short Range Communications (DSRC) standards.

Agencies should also keep in mind that a variety of existing communications and information-based standards, which may have been created for other reasons, are applicable to ITS projects and are being used in systems today.

2.2.2.3.4 Market Package Aggregation and Modification Illustration

This subsection illustrates the use of market packages as a way to create a high-level physical architecture that can be further tailored to address local requirements. For an existing ITS project, or one already under design, this methodology can also be used to help determine the applicable portions of the National ITS Architecture.

As market packages are selected to address the given problems and needs, they may be aggregated by connecting or overlapping duplicate subsystems. The subsystems are connected by architecture flows that define subsystem interfaces. The aggregation of market packages will result in a high-level physical architecture that has been extracted from the National ITS Architecture and will represent a starting point for refinement and tailoring to unique local needs or requirements. For example, the Surface Street Control and Incident Management System market packages might be found to be the most applicable solutions to the identified problem.

The aggregation of these two market packages would result in the architecture illustrated in Figure 5. This diagram shows the aggregation of the equipment packages (shown as white boxes inside the gray subsystems) and physical architecture flows (shown as arrows) of both market packages. Compared to the original Surface Street Control market package diagram, the traffic management subsystem has accumulated more functionality in the aggregated market package since the equipment packages from the individual market packages for that subsystem have been aggregated as well. In addition, more architecture flows have been identified between the traffic management and roadway subsystems resulting in an expanded interface definition.

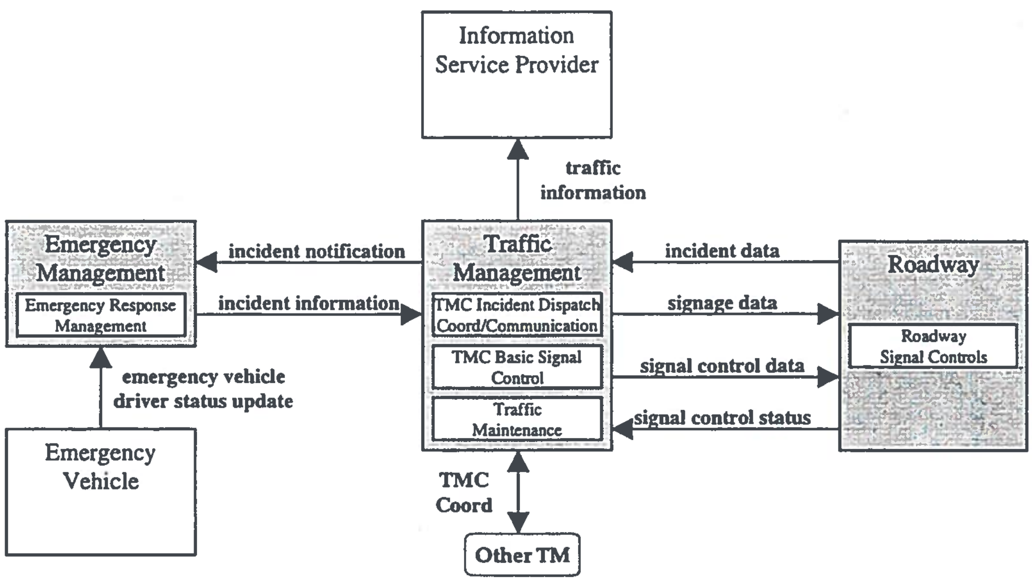


Figure 5. Aggregation of Surface Street Control and Incident Management System

The solution architecture should be analyzed to determine if it properly addresses the identified needs. The solution architecture may have more subsystems than are required or it may be missing subsystems or terminators required to satisfy the needs. If there are extraneous subsystems or architecture flows, they can be dropped from the architecture. For instance, if there was only one TMC in the area and no coordination was deemed necessary in the future, the TMC Coordination architecture flow and the 'Other TM' terminator would be dropped.

If a requirement is not satisfied by the architecture, subsystems and/or architecture flows should be added. The physical architecture should be reviewed for additional subsystems or terminators and their associated architecture flows to satisfy any missing elements in the solution architecture. For example, if there were an additional requirement that a transit management property be given direct traffic information on incidents, a subsystem would be added to include a Transit Management subsystem and a 'traffic information' architecture flow from the Traffic Management Subsystem to exchange the information. Figure 6 illustrates this modification to the architecture.

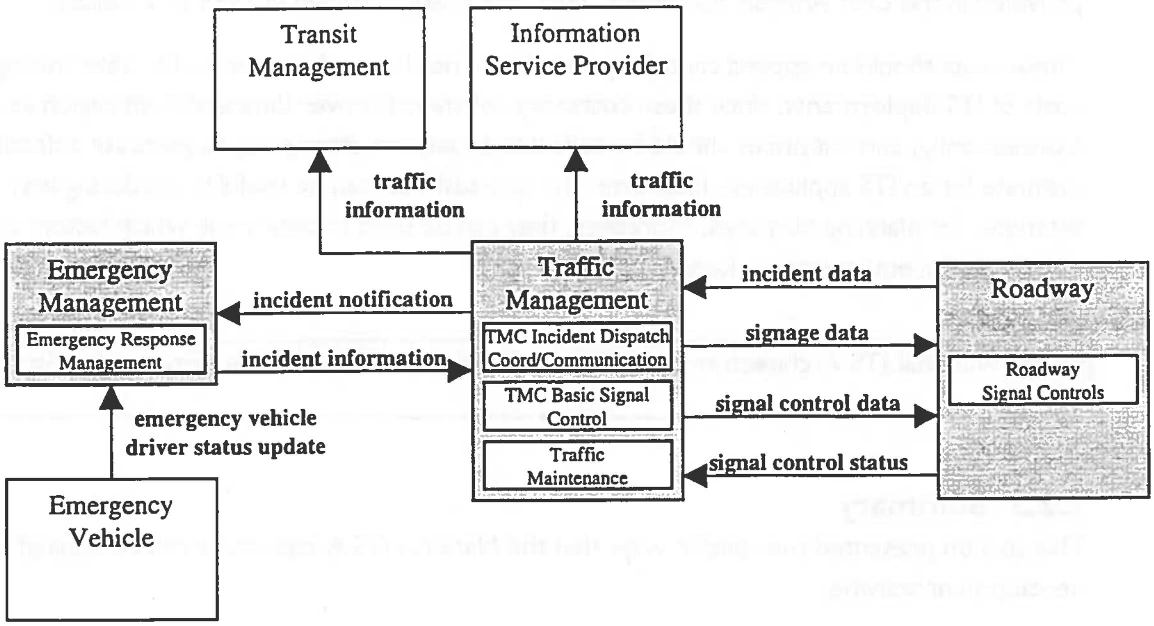


Figure 6. Modification of Aggregated Market Package Architecture

The high-level architecture defined using the market packages and physical architecture subsystems can be further refined by examining the logical architecture elements that support these subsystems and architecture flows. The process specifications can be tailored to satisfy more closely the local needs or requirements that the solution must address. The solution architecture will be refined to a point where it satisfies the identified needs in sufficient detail that design specifications can be generated as inputs to the final design of the solution.

Useful National ITS Architecture Documents: Logical Architecture, Physical Architecture, Traceability, Theory of Operations, Communications Document, Standards Requirements Document

2.2.2.4 Funding, Procurement, and Implementation

The National ITS Architecture material is most useful in earlier steps of the system or project development process. Nevertheless, it can also provide valuable information during this final step, particularly in the area of cost estimation. The evaluation documents and the Implementation Strategy can also be used as a general resource during this final phase of project development.

Cost Estimates

As a tool to assist in the estimation of costs for planning purposes, a series of spreadsheets that contain approximate non-recurring (initial capital investments) and recurring (operation and maintenance) costs of equipment packages was developed as part of the National ITS Architecture effort. These are provided in the Cost Analysis document. These costs are provided in 1995 U.S. dollars.

These costs should be applied cautiously and should not be used as a recipe for determining the actual costs of ITS deployments, since these costs vary substantially over time and from region to region. Consequently, current prices should be collected by anyone attempting to generate a detailed cost estimate for an ITS application. However, the spreadsheets can be useful in producing first order cost estimates for planning purposes. Moreover, they can be used to determine which factors affect the cost of a particular equipment package.

Useful National ITS Architecture Documents: Physical Architecture, Implementation Strategy, and Cost Analysis

2.2.3 Summary

This section presented the specific ways that the National ITS Architecture can be applied to ITS project development activities.

Some of the key themes of this section include:

- The key concepts and elements of the National ITS Architecture are interrelated and traceable in a variety of ways.
- The National ITS Architecture tools are intended to augment and support existing ITS project development processes, and should be applied with engineering judgment in that context.
- There are many ways to apply the National ITS Architecture to the project development process.
- The National ITS Architecture tools are most applicable in the early stages of project development.
- The National ITS Architecture can be used to provide project developers with additional options to consider for information exchanges and functionality that may not have initially been conceived at the outset of the project.
- Using the National ITS Architecture should not be viewed as an all-or-nothing requirement; rather, the material can be used as is, tailored, dropped, or added to as appropriate for the situation.
- The National ITS Architecture is available in several formats, including paper documents, Microsoft Access™ relational databases, and a linked HTML model, which provides access through a linked model.
- Several entry points or methods are also available which make accessing the applicable information more convenient.

A summary of how the National ITS Architecture can be used to support project development activities and the most relevant resource material is provided below:

Identification of Needs or Problems

√ The National ITS Architecture can assist agencies in identifying ITS goals and objectives that are specific to their needs.

√ The Vision Statement can also serve to foster general ideas about the types of local needs and problem that ITS can be used to address.

Useful National ITS Architecture Documents: Mission Definition, Vision Statement

Identification of Solutions

√ Agencies can use two major approaches for identifying possible solutions that are supported by the National ITS Architecture.

- User Services
- Market Packages

√ Evaluation and Implementation Strategy documents have supporting information that can be referenced.

Useful National ITS Architecture Documents: Traceability Matrix, Implementation Strategy, Performance and Benefits Study

Planning and Design of the Solution

√ The National ITS Architecture can be used as an input to defining project or system functional requirements. Potential approaches include:

- *User service requirements* - The user service requirements associated with the proposed solution can be evaluated for their applicability to the project.
- *Market packages* - The high-level architecture defined using the market packages can be further refined by examining the logical architecture elements that support these subsystems and architecture flows.
- *Physical Architecture Subsystems* - Agencies can determine the relevant subsystems associated with a given project and use this as an entry point to accessing the underlying architecture definition.

- √ The physical architecture can be used to support the definition of the information exchange requirements for a given project.
- √ The Standards Requirements document contains detailed information on the requirements for 12 high-priority standards packages, which can be helpful towards the identification of standards for a given project.

Useful National ITS Architecture Documents: Logical Architecture, Physical Architecture, Traceability, Theory of Operations, Communications Document, Standards Requirements Document

Funding, Procurement, and Implementation

- √ The Cost Analysis can be used to help estimate planning-level costs for the project. These costs should be applied cautiously and should not be used as a recipe for determining the actual costs of ITS deployments.
- √ The evaluation documents and the Implementation Strategy can also be used as a general resource during this final phase of project development.

Useful National ITS Architecture Documents: Physical Architecture, Implementation Strategy, and Cost Analysis

Section Three: Reference Materials

This section provides additional resources for field staff to address questions and concerns about ITS related issues.

A. **TEA-21 ITS Architecture and Standards Provisions:** a copy of the portions of the legislation which promote the development and adoption of a National ITS Architecture with standards and protocols.

B. **Supplemental Resources:** a subsection designed to help field personnel increase their knowledge of ITS architecture issues. It includes a reference guide and a curriculum of PCB course offerings.

C. **Guidance for Congressionally-designated ITS Projects:** outlines guidance to congressionally-designated ITS project recipients on the specific requirements that will need to be met in order to receive project funding.

D. **Measuring Metropolitan ITS Deployment and Integration:** provides tools to better understand and track ITS deployments in metropolitan areas.

E. **Glossary of ITS Terms:** defines important ITS terminology.

Please Note: The ITS Electronic Document Library (EDL), which serves as an electronic repository of documents on ITS topics, provides an excellent source of additional resources. The EDL can be reached through the U.S. DOT's ITS website at www.its.dot.gov or directly at www.its.fhwa.dot.gov/cyberdocs/welcome.htm.

Introduction to TEA-21 ITS Architecture and Standards Provisions

Contents

This section includes the portions of the legislation which promote the development and adoption of a National ITS Architecture with standards and protocols. These include:

1. Sections 5202 and 5206 of the Transportation Equity Act for the 21st Century (TEA-21) which contain most of the statutory provisions regarding National ITS Architecture and Standards.

2. Relevant TEA-21 conference report (H. Rept. 105-550) language is included to provide insight into the congressional intent of TEA-21.

3. Excerpts from TEA-21 Metropolitan (Section 1203) and Statewide (Section 1204) Planning provisions regarding planning for integrated operations and management of transportation systems.

Summary

Section 5202 affirms congressional recognition of the value of ITS as a cost-effective solution to surface transportation problems. Citing the success of ITS investments authorized by ISTEA, Section 5202 calls for further investment in National ITS Architecture and Standards development to expedite the incorporation of ITS into our national transportation network.

Section 5206 calls for the development, implementation, and maintenance of a National ITS Architecture and supporting standards to promote the widespread use of efficient, interoperable ITS technologies. The existing National ITS Architecture reflects a consensus among public and private stakeholders as to a basic framework that is flexible enough to allow technological innovations while maintaining system interoperability.

The TEA-21 statutory provisions reinforce and extend the congressional intent that ITS projects be deployed in ways that facilitate interconnection and information sharing to take advantage of cost saving opportunities. Similar provisions have been included in the National Highway System Designation Act and past U.S. DOT appropriations bills. However, unlike past provisions that addressed deployment using only ITS program funds, Section 5206 covers ITS deployments regardless of whether they are categorical ITS program funds or other highway and transit program funding categories. Finally, Section 5206 establishes timeframes for identifying "critical" ITS standards and ensuring their implementation.

Uses

These documents are useful primary source references to legal terms and congressional intent relative to National ITS Architecture and Standards requirements. Sections 5201-5213 of TEA-21 may be cited as the basis for Federal policy and program actions.

This information can also be found on the U.S. DOT's ITS website at www.its.dot.gov.

Transportation Equity Act for the 21st Century (TEA 21)
(ITS Architecture and Standards Provisions)

SEC. 5202. FINDINGS.

Congress finds that—

(1) investments authorized by the Intermodal Surface Transportation Efficiency Act of 1991 (105 Stat. 1914 et seq.) have demonstrated that intelligent transportation systems can mitigate surface transportation problems in a cost-effective manner; and

(2) continued investment in architecture and standards development, research, and systems integration is needed to accelerate the rate at which intelligent transportation systems are incorporated into the national surface transportation network, thereby improving transportation safety and efficiency and reducing costs and negative impacts on communities and the environment.

SEC. 5206. NATIONAL ARCHITECTURE AND STANDARDS.

(a) In General.--

(1) Development, implementation, and maintenance.—Consistent with section 12(d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note; 110 Stat. 783), the Secretary shall develop, implement, and maintain a national architecture and supporting standards and protocols to promote the widespread use and evaluation of intelligent transportation system technology as a component of the surface transportation systems of the United States.

(2) Interoperability and efficiency.--To the maximum extent practicable, the national architecture shall promote interoperability among, and efficiency of, intelligent transportation system technologies implemented throughout the United States.

(3) Use of standards development organizations.--In carrying out this section, the Secretary may use the services of such standards development organizations as the Secretary determines to be appropriate.

(b) Report on Critical Standards.--Not later than June 1, 1999, the Secretary shall submit a report to the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure and the Committee on Science of the House of Representatives identifying which standards are critical to ensuring national interoperability or critical to the development of other standards and specifying the status of the development of each standard identified.

(c) Provisional Standards.--

(1) In general.--If the Secretary finds that the development or balloting of an intelligent transportation system standard jeopardizes the timely achievement of the objectives identified in subsection (a), the Secretary may establish a provisional standard

after consultation with affected parties, and using, to the extent practicable, the work product of appropriate standards development organizations.

(2) Critical standards.--If a standard identified as critical in the report under subsection (b) is not adopted and published by the appropriate standards development organization by January 1, 2001, the Secretary shall establish a provisional standard after consultation with affected parties, and using, to the extent practicable, the work product of appropriate standards development organizations.

(3) Period of effectiveness.--A provisional standard established under paragraph (1) or (2) shall be published in the Federal Register and remain in effect until the appropriate standards development organization adopts and publishes a standard.

(d) Waiver of Requirement To Establish Provisional Standard.--

(1) In general.--The Secretary may waive the requirement under subsection (c)(2) to establish a provisional standard if the Secretary determines that additional time would be productive or that establishment of a provisional standard would be counterproductive to achieving the timely achievement of the objectives identified in subsection (a).

(2) Notice.--The Secretary shall publish in the Federal Register a notice describing each standard for which a waiver of the provisional standard requirement has been granted, the reasons for and effects of granting the waiver, and an estimate as to when the standard is expected to be adopted through a process consistent with section 12(d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note; 110 Stat. 783).

(3) Withdrawal of waiver.--At any time the Secretary may withdraw a waiver granted under paragraph (1). Upon such withdrawal, the Secretary shall publish in the Federal Register a notice describing each standard for which a waiver has been withdrawn and the reasons for withdrawing the waiver.

(e) Conformity With National Architecture.--

(1) In general.--Except as provided in paragraphs (2) and (3), the Secretary shall ensure that intelligent transportation system projects carried out using funds made available from the Highway Trust Fund, including funds made available under this subtitle to deploy intelligent transportation system technologies, conform to the national architecture, applicable standards or provisional standards, and protocols developed under subsection (a).

(2) Secretary's discretion.--The Secretary may authorize exceptions to paragraph (1) for--

(A) projects designed to achieve specific research objectives outlined in the National ITS Program Plan under section 5205 or the Surface Transportation Research and Development Strategic Plan developed under section 508 of title 23, United States Code; or

(B) the upgrade or expansion of an intelligent transportation system in existence on the date of enactment of this subtitle, if the Secretary determines that the upgrade or expansion--

(i) would not adversely affect the goals or purposes of this subtitle;

(ii) is carried out before the end of the useful life of such system; and

(iii) is cost-effective as compared to alternatives that would meet the conformity requirement of paragraph (1).

(3) Exceptions.--Paragraph (1) shall not apply to funds used for operation or maintenance of an intelligent transportation system in existence on the date of enactment of this subtitle.

(f) Spectrum.--The Federal Communications Commission shall consider, in consultation with the Secretary, spectrum needs for the operation of intelligent transportation systems, including spectrum for the dedicated short-range vehicle-to-wayside wireless standard. Not later than January 1, 2000, the Federal Communications Commission shall have completed a rulemaking considering the allocation of spectrum for intelligent transportation systems.

Excerpts from TEA 21 Conference Report Regarding NATIONAL ITS ARCHITECTURE AND STANDARDS

May 22, 1998 CONGRESSIONAL RECORD – HOUSE

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National Architecture and Standards

Senate amendment

Section 529, 23 U.S.C., as proposed, requires the Secretary to develop, implement, and maintain a national architecture to guide nationwide deployment of intelligent transportation systems and to set standards and protocols to promote the widespread use of these technologies and to ensure interoperability. The Secretary is authorized to use standards-setting organizations in carrying out section. The section requires the Secretary to identify critical standards needed to ensure interoperability on a nationwide basis. If one of these critical standards is not adopted by January 1, 2001, the Secretary is required to establish a provisional standard, but a provisional standard would only remain in effect until the appropriate standards-setting organization adopted and published a standard concerning the same subject matter. In addition, the Secretary may waive this requirement as long as a report on the reasons for the waiver and impacts of a delay in setting a particular standard is submitted to Congress. For each standard subject to a waiver, the Secretary is required to submit a progress report to Congress every six months. This section also prohibits the use of funds made available from the Highway Trust Fund on intelligent transportation system technology if the technology does not comply with each relevant provisional and completed standard, but exception is made for intelligent transportation systems deployments already in place. Finally, this section directs the Secretary of Commerce and the Federal Communications Commission to allocate spectrum for the near-term establishment of a dedicated short-range vehicle-to-wayside wireless standard and any other spectrum critically needed for the intelligent transportation systems program.

House bill

Subsection 653(b) requires the Secretary to develop, implement, and maintain of a national architecture to guide nationwide deployment of intelligent transportation systems and to set standards and protocols to promote the widespread use of these technologies and to ensure interoperability. The Secretary is authorized to use standards-setting organizations in carrying out this subsection. This subsection directs the Secretary of Transportation, in consultation with the Secretary of Commerce, the Secretary of Defense, and the Federal Communications Commission, to take all necessary steps to secure spectrum for the near-term establishment of a dedicated short-range vehicle to wayside wireless standard.

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***Conference** substitute*

The Conference adopts the Senate provision with modifications. In establishing the national architecture along with the standards and protocols, the Secretary is to comply with section 12(d) of the National Technology Transfer and Advancement Act of 1995 (15 U.S.C. 272 note; 11 Stat. 783). This provision requires all Federal agencies and departments to use technical standards that are developed or adopted by voluntary consensus standards bodies, unless to do so would be inconsistent with applicable law or otherwise impractical. It is clarified that the report identifying critical standards and their stage of development is to be submitted to the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure and the Committee on Science of the House of Representatives. The Secretary is authorized to establish provisional standards if such action is necessary to ensure progress in achieving the purposes identified in this section for establishing a national architecture and standards and the Secretary is required to adopt a provisional standard if a standard identified as critical is not set by January 1, 2001. But, the Secretary may waive this requirement upon finding that additional time would be productively used or establishment of a provisional standard would be counter-productive. Provisional standards are to be published and will remain in effect until applicable standards to replace them are set by the appropriate standards development organization. Waivers of the provisional standard requirement and withdrawals of such waivers are also to be published. The requirement that intelligent transportation systems projects funded from the Highway Trust Fund must conform to the national architecture and applicable standards is retained. The exceptions for operations and maintenance of intelligent transportation systems projects already in existence is retained as is the exception, at the discretion of the Secretary, for the upgrade or expansion of such projects. Another exception for projects designed to achieve specific research objectives, at the discretion of the Secretary, is added. The Federal Communications Commission is directed to consider, in consultation with the Secretary of Transportation, the spectrum needs of intelligent transportation systems and is required to complete a rulemaking considering the allocation of spectrum for intelligent transportation systems by January 1, 2000.

Transportation Equity Act for the 21st Century (TEA 21)

(Selected Metropolitan and Statewide Planning Provisions)

SEC. 1203. METROPOLITAN PLANNING.

(a) General Requirements.--Section 134(a) of title 23, United States Code, is amended to read as follows:

``(a) General Requirements.--

``(1) Findings.--**It is in the national interest to encourage and promote the safe and efficient management, operation, and development of surface transportation systems** that will serve the mobility needs of people and freight and foster economic growth and development within and through urbanized areas, while minimizing transportation-related fuel consumption and air pollution.

``(2) Development of plans and programs.--To accomplish the objective stated in paragraph (1), metropolitan planning organizations designated under subsection (b), in cooperation with the State and public transit operators, shall develop transportation plans and programs for urbanized areas of the State.

``(3) Contents.--The **plans and programs for each metropolitan area shall provide for the development and integrated management and operation of transportation systems** and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system for the metropolitan area and as an integral part of an intermodal transportation system for the State and the United States.

``(4) Process of development.--The process for developing the plans and programs shall provide for consideration of all modes of transportation and shall be continuing, cooperative, and comprehensive to the degree appropriate, based on the complexity of the transportation problems to be addressed.''.

{Intervening text omitted}

(f) Scope of Planning Process.--Section 134(f) of such title is amended to read as follows:

``(f) Scope of Planning Process.--

``(1) In general.--**The metropolitan transportation planning process for a metropolitan area under this section shall provide for consideration of projects and strategies that will--**

``(A) support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;

``(B) increase the safety and security of the transportation system for motorized and nonmotorized users;

``(C) increase the accessibility and mobility options available to people and for freight;

``(D) protect and enhance the environment, promote energy conservation, and improve quality of life;

``(E) enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;

``(F) promote efficient system management and operation; and

``(G) emphasize the preservation of the existing transportation system.

SEC. 1204. STATEWIDE PLANNING.

(a) General Requirements.--Section 135(a) of title 23,United States Code, is amended to read as follows:

``(a) General Requirements.--

``(1) Findings.--**It is in the national interest to encourage and promote the safe and efficient management, operation, and development of surface transportation systems** that will serve the mobility needs of people and freight and foster economic growth and development within and through urbanized areas, while minimizing transportation-related fuel consumption and air pollution.

``(2) Development of plans and programs.--Subject to section 134 of this title and sections 5303 through 5305 of title 49, each State shall develop transportation plans and programs for all areas of the State.

``(3) Contents.--**The plans and programs for each State shall provide for the development and integrated management and operation of transportation systems** and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system for the State and an integral part of an intermodal transportation system for the United States.

``(4) Process of development.--The process for developing the plans and programs shall provide for consideration of all modes of transportation and shall be continuing, cooperative, and comprehensive to the degree appropriate, based on the complexity of the transportation problems to be addressed.''.

{Intervening text omitted}

(c) Scope of Planning Process.--Section 135(c) of such title is amended to read as follows:

``(c) Scope of Planning Process.--

``(1) In general.--**Each State shall carry out a transportation planning process that provides for consideration of projects and strategies that will--**

``(A) support the economic vitality of the United States, the States, and metropolitan areas, especially by enabling global competitiveness, productivity, and efficiency;

``(B) increase the safety and security of the transportation system for motorized and nonmotorized users;

``(C) increase the accessibility and mobility options available to people and for freight;

``(D) protect and enhance the environment, promote energy conservation, and improve quality of life;

``(E) enhance the integration and connectivity of the transportation system, across and between modes throughout the State, for people and freight;

``(F) promote efficient system management and operation; and

``(G) emphasize the preservation of the existing transportation system.

Introduction to Supplemental Resources

Contents

This subsection includes two documents which identify readily accessible places to find additional information on ITS, the National ITS Architecture, and ITS Standards.

1. *How Do I Find Out More?* is a reference guide to additional information on a wide array of National ITS Architecture and standards topics. It is an updated version of an excerpt from the document *Developing Traffic Signal Control Systems Using the National ITS Architecture.*

2. *The ITS Professional Capacity Building Program (PCB): National ITS Architecture and Standards Curriculum* is a list of technical and non-technical course offerings for managers, planners, and engineers.

Summary

How Do I Find Out More includes references to government agencies, organizations, various publications, and the National ITS Architecture deliverables. These references may prove useful to those involved in the planning, development, and deployment of ITS on a local or regional level.

The PCB curriculum provides a listing of the wide range of courses available to help transportation planning and project implementation professionals apply the National ITS Architecture and ITS standards. Several courses are designed for general and non-technical audiences; others are more technical.

Uses

This subsection is designed to provide field personnel with the tools to pursue additional information on issues related to ITS.

To obtain additional copies, see the U.S. DOT's ITS website at www.its.dot.gov. "How Do I Find Out More," can be found in the Electronic Document Library in document #3015.

How Do I Find Out More

Information on Intelligent Transportation Systems (ITS), the National ITS Architecture, and ITS Standards may be found at the locations described below.

1. What Agencies and Organizations Can I Contact with My Questions?

First verbal contacts should be to your local Federal Highway Administration Division Office or Federal Transit Administration Region Office. This should include queries relative to areas such as program, technical, and policy. Your local office will work with you to schedule courses, seminars, and possibly workshops on ITS topics.

ITS Joint Program Office
Federal Highway Administration, U.S. Department of Transportation, 400 Seventh Street SW, Washington, DC 20590

Phone: (202) 366-9536; FAX: (202) 366-3302
World Wide Web: http://www.its.dot.gov

This U.S. DOT ITS web page also provides links to numerous other sources of ITS-related information. With the wealth of information of all types on ITS available via the Internet, it is becoming important that the key staff involved in any ITS activity have access to the Internet.

Office of Traffic Management and Intelligent Transportation Systems Applications
Federal Highway Administration, U.S. Department of Transportation, 400 Seventh Street SW, Washington, DC 20590

World Wide Web: http://www.fhwa.dot.gov/hst/its.htm

Turner Fairbanks Highway Research Center
Federal Highway Administration, U.S. Department of Transportation, 6300 Georgetown Pike, McLean, VA 22101

World Wide Web: http://www.tfhrc.gov

Office of Mobility Innovation, Advanced Public Transportation Systems Division
Federal Transit Administration, U.S. Department of Transportation, 400 Seventh Street SW, Washington, DC 20590

Phone: (202) 366-4991

ITS America
400 Virginia Avenue SW, Suite 800, Washington, DC 20024

Phone: (202) 484-4847
World Wide Web: http://www.itsa.org

2. How Can I Find Out More About the National ITS Architecture?

Again, first verbal contact should be with your FHWA Division or FTA Region Office. Information on the National ITS Architecture is available through the following sources:

National ITS Architecture Team
The National ITS Architecture documentation and the linked HTML model are available on the World Wide Web at http://www.odetics.com/itsarch/

ITS Joint Program Office, Federal Highway Administration, U.S. DOT
Documents that may be obtained from the Joint Program Office include:

- *The National ITS Architecture for ITS: A Framework for Integrated Transportation into the 21st Century*
- *Building the ITI: Putting the National ITS Architecture into Action*
- *Transit Guidelines for Putting the architecture to work for public transportation system managers, including how to integrate fleet management systems and traveler information systems with each other and with the rest of ITS.*
- *Freeway Management Systems*
- *Traffic Signal Control Systems*
- *Incident and Emergency Management*
- *Traveler Information Systems*

Some of these documents are available on the World Wide Web at http://www.its.dot.gov.

This site also provides a variety of general information, including an overview of ITS, a large glossary, and reports on additional ITS related subjects.

Contact your FHWA Division or FTA Region Office to inquire about training:

A two or three day training course, *Using the National ITS Architecture for Deployment Training Course,* is available from the Federal Highway Administration; this course has been prepared by the National ITS Architecture team and provides information about the National Architecture and how to use it, with practical interaction between students and the Architecture products on CD-ROM. Additional courses will become available. The courses will be offered at many locations throughout the country. Visit the Professional Capacity Building Program website at http://www.fhwa.dot.gov/hst/pcb/itscord1.htm for information on additional courses.

Exploring The National ITS Architecture On Your Own:

- Read the Executive Summary first. Then read the Implementation Strategy – start with chapter 4.

- Use the CD-ROM in concert with a "File Find" utility. Some "File Find" utilities will search the written material in a document for specific words. This will allow you to search the entire National ITS Architecture for specific information.

- Use the Market Packages as guides to the rest of the material in the National ITS Architecture or use them as a starting point. You can think of them as high-level ITS system designs that can be implemented as a project or sub-project.

ITS America
Hard copy versions of the National ITS Architecture documentation may also be purchased from the ITS America Bookstore. Specific National ITS Architecture volumes are available.

Phone: (202) 484-4584 or (800) 374-8472
World Wide Web: http://www.itsa.org/archdocs.nsf

The National ITS Architecture is also available on CD-ROM and includes an easy to use browser and search facility.

3. How Can I Find Out More About Standards?

Again, first verbal contact should be with your FHWA Division or FTA Region Office. Detailed information on ITS Standards is available at the locations listed below:

National Transportation Communications ITS Protocol (NTCIP)
Contact the NTCIP Coordinator at the **National Electrical Manufacturers Organization (NEMA)**

Phone: (703) 841-3231; Fax: (703) 841-3331
World Wide Web: http://www.ntcip.org

Copies of papers regarding the NTCIP standards currently available from NEMA include:

- *National Transportation Communications For ITS Protocol (NTCIP) Guide (Draft)*, December 1, 1996.

- *Center-to-Center Communications Requirements and Issues (White Paper)*, December 16, 1996

- *NTCIP White Paper, Center-To-Center Communications*, November 27, 1996

Copies of NTCIP standards may be purchased from NEMA. The NTCIP standards currently available include:

- NTCIP Overview (NEMA TS3.1) - This publication provides an overview of the concepts and protocols for the NTCIP series of standards, which can be used to implement a working NTCIP-based transportation control system. This standard encompasses roadside device control, data collection, data routing, and file transfer services using various communication system topologies.

- Simple Transportation Management Protocol (NEMA TS3.2) - The Simple Transportation Management Framework (STMF) describes the framework used for managing and communicating information between management stations and transportation devices. It covers integrated management of transportation networks, networking devices and transportation specific equipment attached to NTCIP-based networks.

- NTCIP Class B Profile (NEMA TS3.3) - This communications protocol standard can be used for interconnecting transportation and traffic control equipment over low bandwidth channels. This standard establishes a common method of interconnecting ITS field equipment such as traffic controllers and dynamic message signs (DMS), defines the protocol and procedures for establishing communications between those components, and references common data sets to be used by all such equipment.

- Global Object Definitions (NEMA TS3.4) - The messaging between transportation management and field devices is accomplished by using the NTCIP Application Layer services to convey requests to access or modify values stored in a given device; these parameters and their values are referred to as objects. The purpose of this standard is to identify and provide those object definitions that may be supported by multiple device types (e.g., actuated signal controllers and variable message signs).

- Actuated Controller Unit Object Definitions (NEMA TS3.5, ASC) - This standard defines objects that are specific to actuated signal controller units.

- Object Definitions for Dynamic Message Signs (NEMA TS3.6, DMS) - This standard contains object definitions to support the functionality of dynamic message sets used for transportation applications.

There are a total of sixteen of the NTCIP standards, ten more than listed above. For more information about NTCIP standards, please refer to Appendix A.

Transit Communications Interface Profiles (TCIP)
Further information can be obtained from the following source:

World Wide Web: http://www.tcip.org

ITS America

Contact ITS America for listing of all the ITS standards and status information on standards development.

ITS America, 400 Virginia Avenue SW, Suite 800, Washington, DC 20024

Phone: (202) 484-4847
World Wide Web: http://www.itsa.org/standards.html

Other Standards

The American Association of State Highway and Transportation Officials (AASHTO)
Suite 249, 444 North Capitol Street, NW, Washington, DC 20001
Focus: State-level Agency Participation and Roadside Infrastructure.

World Wide Web: http://www.aashto.org

The American Society for Testing & Materials (ASTM)
Focus: Dedicated Short Range Communications (DSRC) systems.

World Wide Web: http://www.astm.org

The Institute of Electrical and Electronics Engineers (IEEE)
Focus: Electronics and Communications Message Sets.

World Wide Web: http://standards.ieee.org/index.html

The Institute of Transportation Engineers (ITE)
525 School St., SW Suite 410, Washington, DC 20024-2797
Focus: Traffic Management and Transportation Planning systems.

Phone: (202) 554-8050
World Wide Web: http://www.ite.org/standards/index.html

The Society of Automotive Engineers (SAE)
Focus: In-vehicle and Traveler Information.

World Wide Web: http://www.sae.org/PRODSERV/stds/stdsinfo/standard.htm

4. What Publications Are Available to Me?

Most federal reports may be obtained through either of the following sources:

National Technical Information Service (NTIS), Technology Administration, U.S. Department of Commerce, Springfield, VA 22161,

Phone: (703) 605-6000; FAX: (703) 321-8547
World Wide Web: http://www.fedworld.gov/ntis/ntishome.html

Electronic Document Library (EDL), accessible on the internet at http://www.its.dot.gov.

Some of the publications that are available on the topics of ITS, The National ITS Architecture and ITS Standards include:

Assessment of ITS Benefits — Early Results, MP 95W0000192, 1995, Roberts, Donald L., and Dwight E. Shank. The MITRE Corporation, McLean, VA.

Building the ITI: Putting the National ITS Architecture into Action, 1997, Mitretek Systems, prepared for the U.S. Department of Transportation, Federal Highway Administration.

Communications Handbook for Traffic Control Systems, April 1993, U.S. Department of Transportation, Federal Highway Administration, Washington D.C.

Department of Transportation's Intelligent Transportation Systems (ITS) Projects, January 1997, Washington, D.C.: U.S. Department of Transportation, Intelligent Transportation Systems Joint Program Office.

Developing Freeway and Incident Management Systems Using the National ITS Architecture. This document is intended for those involved in the planning, development, deployment, and operation of freeway and incident management systems.

Developing Traveler Information Systems Using the National ITS Architecture. This document is intended for those involved in the planning, development, deployment, and operation of Traveler Information Systems.

FHWA Federal-Aid ITS Procurement Regulations and Contracting Options, 1997, Booz-Allen & Hamilton, prepared for U.S. Department of Transportation, Federal Highway Administration.

Final Report on Telecommunications Shared Resources: Legal and Institutional Issues, 1997, Apogee Research, prepared for U.S. Department of Transportation, Federal Highway Administration.

Guidelines for Funding Operations and Maintenance of ITS/ATMS, January 1996. Ginger Daniels and Tim Starr, Texas Transportation Institute. Presented at the 76th Annual Meeting, Transportation Research Board, Washington D.C.

Innovative Contracting Practices for ITS, April 1997, L. S. Gallegos & Associates, prepared for U.S. Department of Transportation, Federal Highway Administration.

Innovative Contracting Procedures for ITS, 1996, Nossaman, Guthner, Knox & Elliott; Ernesto V. Fuentes & Associates; L.S. Gallegos & Associates; Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.

Integrating ITS Within the Planning Process: An Interim Handbook, 1997, TransCore, prepared for U.S. Department of Transportation, Federal Highway Administration.

Intelligent Transportation Infrastructure Benefits: Expected and Experienced, FHWA-JPO-96-008, 1996, MITRE Corporation, The. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.

Intelligent Transportation Systems Assessment of ITS Deployment, Review of Metropolitan Areas: Discussion of Crosscutting Issues, FHWA-JPO-96-0035, 1996, Blasio, Allan J., David W. Jackson, Anne C. Tallon, Anne C. McEwan, John P. O'Donnell, Cambridge, Massachusetts: U.S. Department of Transportation, Volpe National Transportation Systems Center.

Intermodal Surface Transportation Efficiency Act of 1991, A Summary, FHWA-PL-92-008, 1992, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C.

ITE Operations and Maintenance Conference - Summary of Findings, 1995, Kraft, Walter H., Institute of Transportation Engineers. Washington, D.C., PP-047.

ITS Benefits: Continuing Successes and Operational Test Results, 1997, Mitretek Systems, prepared for the U.S. Department of Transportation, Federal Highway Administration.

ITS Deployment Guidance for Transit Systems: Technical Edition. This document is intended for those involved in the planning, development, deployment, and operation of transit management systems.

ITS Software Acquisition Guidance, 1998, Mitretek Systems, prepared for U.S. Department of Transportation, Federal Highway Administration.

Joint Operations In Operating and Maintaining Advanced Traffic Management Centers, 1996, Douglas W. Wersig, White Paper prepared for the National Conference on Operating and Maintaining Advanced Traffic Management Centers, Minneapolis, MN.

Key Findings From The Intelligent Transportation System (ITS) Program: What Have We Learned?, FHWA-JPO-96-0036, 1996, Mitretek Systems, Washington, D.C., U.S. Department of Transportation, Federal Highway Administration.

Manual of Traffic Signal Design, 1982, Institute of Transportation Engineers, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Manual on Uniform Traffic Control Devices for Streets an Highways, 1988, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C.

Overcoming Non-Technical Barriers: Lessons Learned From ITS Operational Tests, FHWA-JPO-96-0010, 1996, DeBlasio, Allan J,. Cambridge, Massachusetts: U.S. Department of Transportation, John A. Volpe National Transportation Systems Center.

Telecommunications Resource Guide, ITS JPO, U.S. Department of Transportation, Federal Highway Administration

- Tab A, ***Telecommunications in Transportation, A Summary of Key Issues***, FHWA-JPO-97-0019, February 1997.
- Tab B, ***A Case For Telecommunications Analysis***, FHWA-JPO-97-0015, January 1997, Prepared by CSC and the Maryland Department of Transportation.

The National Architecture for ITS: A Framework for Integrated Transportation into the 21st Century, 1997, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C.

Traffic Control Systems Handbook, FHWA-SA-95-032, February 1996, Dunn Engineering Associates, U.S. Department of Transportation, Federal Highway Administration.

Traffic Control Systems, Standards Publication No. TS2, 1992, National Electrical Manufacturers Association, Washington, D.C., 1992.

Transportation Planning and ITS: Putting the Pieces Together, 1998, Sarah J. Siwek & Associates Transportation and Environmental Consultants, prepared for the U.S. Department of Transportation, Federal Highway Administration.

Using the National ITS Architecture for Deployment, Training Course, U.S. Department of Transportation, Federal Highway Administration -- This 3 day course given by the Architecture Team (Lockheed Martin and Odetics) gives the student the mechanics for implementing regional systems using the architecture.

Developing Intelligent Transportation Systems Using the National ITS Architecture An Executive Edition for Senior Transportation Managers, 1998, U.S. Department of Transportation, Washington, DC.

Developing Traffic Signal Control Systems Using the National ITS Architecture, February 1998, FHWA-JPO-98-026.

5. What National ITS Architecture Documents Are Available to Assist Me?

Provided below is a brief overview of all documents that are part of the National ITS Architecture that are available to assist you.

Vision Statement - Written in "magazine style," the Vision Statement sketches a number of possible scenarios of ITS development over the next 20 years. It describes how travelers and system operators may be able to use and benefit from ITS technologies in their day-to-day activities. While the Vision Statement is not a technical document, it does describe the potential impact of ITS technologies on the management of the nation's transportation system.

Mission Definition - The first of the technical documents, the Mission Definition covers a broad range of ITS-related issues. It contains the overall mission of ITS deployment, as well as the operational concept, which deals with specific ITS goals and objectives; ITS user groups and other stakeholders; ITS user services; and potential sources for funding, operations and maintenance. The document also defines operational requirements at the system level, user requirements, performance requirements, and program requirements.

These concepts are important aspects of the National Architecture throughout the deployment process, since they provide the overall direction for the ITS program. Constant evaluation of a region's ITS deployment against the national goals and objectives will ensure that regional ITS deployment is compatible with the philosophy of the National Architecture. The Mission Definition document is important for those that are involved with the initial concepts definition of an ITS system for a particular region.

Logical Architecture - The Logical Architecture document contains three volumes: *Description* (Volume 1), *Process Specifications* (Volume 2), and *Data Dictionary* (Volume 3). These documents present a functional view of the ITS user services, contain diagrams that show processes and data flows among them, and define data elements, respectively.

Physical Architecture - The Physical Architecture document describes the transportation and communications layers resulting from the partitioning of the processes within the logical architecture, presents architecture flow diagrams that show data passing among physical subsystems, and provides characteristics and constraints on the data flows.

Theory Of Operations - This document provides a detailed narrative of the manner in which the architecture supports the ITS user services, described in the Mission Definition. It is a technical document, intended for engineers, operators, and others involved detailed systems design.

Traceability Document - The Traceability Document is a technical document that is used in conjunction with and throughout the development of the Logical and Physical Architectures. It lists all the User Service Requirements (USR), which constitute the highest-level functional specifications for ITS, as provided by the U.S. Department of Transportation. In several tables, these USRs are mapped to the various logical and physical components of an ITS system. The document should be used primarily by those involved in detailed design.

Implementation Strategy - The Implementation Strategy document ties the elements of the National Architecture together, and is intended to assist ITS implementors at all levels with cost-effective, efficient ITS deployment.

Standards Development Plan - This document discusses the issues that are involved in the development of system interface standards. It is primarily intended for Standards Development Organizations and system designers, and will be important at the integration step in the Systems Engineering Process.

Standards Requirements - This is a set of 12 Standards Requirements Packages that presents detailed data flow and interface information pertaining to the priority standards packages that need to be developed to implement the architecture. It, too, is primarily intended for Standards

Development Organizations and system designers, and will be important at the integration step in the Systems Engineering Process.

Evaluatory Design - The Evaluatory Design document is intended to evaluate the National Architecture's performance, benefits, and costs for three conceptual scenarios at various points in time. The scenarios consist of "typical" deployment environments: urban, inter-urban, and rural. The entire document will assist you in developing an evaluation methodology for the architecture that you have developed for your particular region.

Communications Document - This document provides a thorough analysis of the communications requirements of the National Architecture, and ITS in general, and includes a discussion of options for implementing various communications links. With the latest version of the National Architecture, an addendum to this document was published, detailing requirements for the Highway-Rail Intersections User Service. It is an important document for those involved in detailed design and integration during the Systems Engineering Process.

Risk Analysis - This document presents an analysis of potential critical risks that may delay or prevent the deployment of ITS technologies, and recommends mitigation plans which will eliminate of reduce these risks to the deployment process. It is intended for implementors that are involved with the details of ITS deployment in their region, throughout the development of the Regional Architecture.

Cost Analysis - The Cost Analysis document has two purposes. First, it develops a high-level cost estimate of the expenditures that are associated with implementing ITS components. Second, it is a costing tool for implementers, by providing unit prices and systems costs of ITS subsystems. There is significant correlation between the Cost Analysis and the Evaluatory Design documents; the Cost Analysis is based largely on the assumptions made for the three deployment scenarios (urban, inter-urban, and rural). The latest version of the National Architecture documents contains an addendum to the Cost Analysis, accounting for the Highway-Rail Intersection User Service. This is an important document for those involved in planning and design, and could be useful to those responsible for project management in the Systems Engineering Process, including funding and procurement.

Performance and Benefits Study - This document assesses the technical performance of the National Architecture on a number of system-level and operational-level criteria. It could be helpful in supporting the case for ITS deployment, as it provides a measure of the degree to which ITS can help achieve some regional transportation goals.

Evaluation Results - This document contains a concise summary of the various evaluations that were performed in five other National Architecture documents: Evaluatory Design, Communications Analysis, Cost Analysis, Performance and Benefits, and Risk Analysis.

Executive Summary - Provides an overview of the most important aspects of the National Architecture, most notably the Logical and Physical Architectures.

ITS Professional Capacity Building Program

National ITS Architecture and Standards Curriculum

September 1998

The ITS Professional Capacity Building (PCB) Program offers a wide range of courses to help transportation planning and project implementation professionals apply the National ITS Architecture and ITS standards in practice. Several courses are designed for general and non-technical audiences; others are more technical. Non-technical courses provide basic information suited to managers, whereas technical courses address the needs of planners and engineers involved in project details.

Course	**Duration**	**Prerequisites**	**Availability**
ITS Awareness (General)	1 Day	None	As Requested
ITS in Transit (General)	1 Day	None	As Requested
Introduction to ITS/CVO (Non-technical)	1 ½ Days	None	As Requested
ITS and Transit Management (Non-technical)	2 Days	*ITS Awareness, ITS in Transit*, or familiarity with ITS terms and advanced public transit concepts.	As Requested
ITS/CVO Technical Project Management for Non-Technical Managers (Non-technical)	2 Days	*Introduction to ITS/CVO*, or familiarity with ITS/CVO terms and concepts.	As Requested
Deploying Integrated ITS Workshop (Non-technical)	2 ½-3 Days	*ITS Awareness*, or familiarity with ITS terms and concepts.	As Requested
Introduction to the National ITS Architecture and Consistency Policy	½-1Day	*ITS Awareness* or familiarity with ITS terms and concepts.	Fall 1998
Understanding ITS/CVO Technology Applications (Technical)	2 Days	*Introduction to ITS/CVO* and *ITS/CVO Technical Project Management for Non-Technical Managers*	January 1999

CVISN Deployment Workshops	3 Workshop Suite 3 Days per Workshop	*Introduction to ITS/CVO, ITS/CVO Technical Project Management for Non-Technical Managers,* and *Understanding ITS/CVO Technology Applications*	June 1999
Using the National ITS Architecture for Deployment (Technical)	2-2 ½ Days	*ITS Awareness* or familiarity with ITS terms and concepts. Offered for public sector (2½-Days) and private sector (3 Days)	As Requested
ITS Standards Modules to be incorporated in courses above	N/A	N/A	Winter 1998/ Spring 1999

To schedule a course, contact Sylvia Harris, U.S. DOT Volpe National Transportation Systems Center, (617) 494-2552 / FAX (617) 494-2664, E-mail: harriss@volpe62.dot.gov

For more information, visit the course catalog website at http://www.its.dot.gov/pcb/98catalg.htm and Master Schedule at http://www.its.dot.gov/pcb/schedule.htm or contact: Thomas Humphrey, PCB Program Coordinator, U.S. DOT ITS Joint Program Office (202) 366-2211, Fax: (202) 366-3302, E-mail: tom.humphrey@fhwa.dot.gov

Introduction to Guidance for Congressionally-Designated ITS Projects

Contents

This section includes guidance on the requirements for project consistency with the National ITS Architecture, specifically for congressionally-designated ITS projects, also referred to as earmark projects. Also included is a compilation of questions and answers that further clarify the guidance.

Summary

The congressionally-designated ITS projects present an opportunity to ensure ITS systems are deployed in a manner that fosters integration across modes and jurisdictional boundaries. This opportunity will be seized by making sure these projects support regional, multimodal system development. Through this guidance, the DOT will ensure these projects are carried out in a manner based on sound regional planning, and designed and implemented with technical and institutional integration in mind, and in accordance with the National ITS Architecture.

In meeting the requirements of this guidance, ITS projects receiving federal program category funds will be consistent with the National ITS Architecture, contribute to standards development, and promote regional and national interoperability. Meeting this goal will necessitate participation by a broad range of stakeholders, sharing information across transportation systems, and establishing operational agreements.

Uses

These materials can be used by state and local agencies, and by FHWA and FTA field staff, to understand the requirements that recipients will need to meet in order to receive project funding. This guidance is for all congressionally-designated ITS projects included in the 1998 Appropriations legislation and any projects resulting from subsequent legislation in the future.

United States Department of Transportation
Intelligent Transportation Systems

Guidance for Congressionally-designated ITS Projects
May 12, 1998

I. Introduction

The purpose of the this document is to provide guidance to Congressionally-designated ITS project recipients, as well as to Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) field staff, on the specific requirements that recipients will need to meet in order to receive project funding. This guidance is for all Congressionally-designated ITS projects included in the 1998 Appropriations legislation and any projects resulting from subsequent legislation in the future.

The purpose of these requirements is to ensure that Congressionally-designated ITS projects meet the Congressional directives contained in the fiscal year 1997 Appropriations Conference Report:

> "The director of the (Department of Transportation Intelligent Transportation System] joint program office shall ensure that the operations of each of the ITS projects...is consistent with the national systems architecture... These projects shall contribute to the implementation of the standards development work and shall promote interoperability of ITS systems among the States."

Because successful implementation of ITS depends on bridging the technical and institutional gaps between numerous transportation agencies and across jurisdictional boundaries, Congress has clearly affirmed the goal of developing integrated intelligent transportation systems that are consistent with the National ITS Architecture and corresponding standards.

Historically, Congressionally-designated ITS projects were geared toward operational testing. However, the projects contained in the 1998 Appropriations legislation are primarily oriented toward ITS deployment. As such, the thrust of this Guidance is aimed at ensuring Federal ITS funds are used to create technically and institutionally interoperable transportation systems. Furthermore, it is DOT's intent to encourage partnerships with the private sector whenever possible and that Federal funds not be used for activities where the private sector has a market ability to provide products and services.

II. Approach to ITS Project Deployments

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) demonstrated how ITS can make the most of existing infrastructure and further the intermodal goals set forth by the tenets of ISTEA. Where the National ITS Program under ISTEA was primarily a research and testing program, under reauthorization it will be much more focused on the deployment of integrated systems.

Some of the lessons learned during the ISTEA era helped form the basic shape of the reauthorization ITS Program. For example, there is a strong need to have well informed leaders and decision makers who are aware of the operational benefits that ITS offers and who can translate such awareness into transportation investment decisions. There is also a clear need for ITS planning and stakeholder buy-in at the regional level - that is, planning for ITS within the context of larger transportation plans and programs. There is a need for up-front commitment to long-term operations and maintenance of ITS components and their integration. This points to programming future financial resources through traditional or innovative financing mechanisms concurrent with project approvals. Finally, there is a need for a highly trained workforce in order for ITS to become a reality.

The DOT intends that all ITS funding will provide a greater multimodal emphasis in ITS by supporting technical integration and jurisdictional coordination of multimodal ITS infrastructure components that are self-sustaining and meet local needs. Ultimately, the deployment of ITS will help continue the fundamental shift in how the nation approaches mobility - to managing and operating the entire transportation system, with an efficient, multimodal, single-system view of regional mobility and an eye toward getting the most of out of every infrastructure dollar spent.

III. Role of Congressionally-designated projects

The Congressionally-designated ITS projects present an opportunity to ensure ITS systems are deployed in a manner that fosters integration across modes and jurisdictional boundaries. This opportunity must be seized by making sure these projects support regional, multimodal system development and do not create barriers to integration that will take years and significant resources to overcome.

Through this Guidance, the DOT plans to ensure these projects are carried out in a manner based on sound regional planning, and designed and implemented with technical integration in mind, and in accordance with the National ITS Architecture. In order to ensure that the requirements for each Congressionally-designated ITS project are appropriate and consistent with the size and scope of the project, the DOT has developed the following program framework under which the various projects fall.

A. Deployment Projects

Deployment projects are primarily focused on the implementation of intelligent transportation systems by the Federal, state and local governments and agencies. These projects are categorized in three ways:

1. Technology Deployment Projects

These projects are usually narrow in scope and involve a single ITS hardware application such as variable message signs, and impact only a single jurisdiction. They do not necessarily facilitate integration on a large scale, but they still serve as an important system deployment function and must be consistent with the National ITS Architecture. These projects have the following general attributes:

- They involve hardware procurement and installation;
- They involve aspects of the National ITS Architecture;
- They may involve ITS standards; and
- They facilitate operations and management of the transportation system.

2. Regional Deployment Projects

These are projects affecting the larger regional transportation system and which jurisdictional or modal boundaries. They may be metropolitan-wide, statewide, multi-state in nature. They generally possess the following attributes:

- They have potential regional or statewide impacts;
- They involve or should involve intermodal, interagency and interjurisdictional cooperation;
- They focus or have potential to focus on integrating existing ITS infrastructure components;
- They have potential for data integration or sharing;
- They involve multiple technology deployments;
- They involve aspects of the National ITS Architecture;
- They may involve use of ITS standards; and
- They facilitate operations and management of the transportation system;

3. Commercial Vehicle Information Systems and Networks (CVISN) and International Border Clearance (IBC) Program Projects

These projects fall under the Commercial Vehicle Information Systems and Networks activity. Since CVISN and Border Crossings are a nationwide and international activity requiring interoperability between state and international projects, and require fairly uniform system design across the nation, this category covers only those projects that are primarily focused on some aspect of CVISN and Border Crossings and not simply projects that happen to involve commercial vehicles generally. Any non-CVISN type commercial vehicle projects would be categorized as technology deployment or regional deployment project types. CVISN projects possess the following general attributes:

- They involve motor carrier safety assurance programs potentially including automated roadside safety screening and inspections, safety information systems, and on-board safety monitoring; or
- They involve credentials administration including electronic application, purchase and issuance of credentials, and automated fuel tax reporting and filing; or
- They involve electronic screening of motor carriers to verify size, weight, safety and credentials at fixed weigh stations, mobile sites or international border crossings.

IBC projects possess the following general attributes:

- They involve the electronic clearance of motor carriers for transportation registration and safety purposes, as well as for Customs and Immigration Services requirements at international border crossings.

B. Deployment Support

These projects would not directly deploy ITS technologies, but would support deployment through the conduct of research, the development of new ITS products, or the education of the current or future generation ITS workforce. They may be directed to private sector firms, non-profit organizations, or colleges, universities or other institutes of higher learning. These projects should support the ITS program goals and contribute to the interoperability of ITS. They can serve as a catalyst for achieving technical integration and institutional coordination by delivering research products and services that enable future integration.

1. University Projects

These projects are generally university-based and are considered complementary to the ITS Research Centers of Excellence program. As such, the project requirements will be geared toward complementing the Research Centers of Excellence in a productive manner. These projects can be identified by the following characteristic:

- Funding is directed to colleges, universities or other institutes of higher learning for transportation research activities.

2. Other Research Projects

These are primarily research and development projects directed at the development of specific products. These projects will be geared toward complementing or enhancing ongoing initiatives within the particular area of research. These projects can be characterized by the following characteristic:

- Funding is directed to non-profit organizations or other private sector type firms for specific transportation research and development activities.

IV. Requirements

This section outlines the specific requirements that ITS project recipients will have to meet and document. It discusses general requirements for every project, as well as the additional requirements for each specific project type.

A. Deployment Projects

General Requirements

The following are general requirements applicable to all deployment projects and must be addressed prior to receiving initial project funding approval:

- A Project Agreement must be developed that:
  - Clearly defines the goals and objectives of the project;
  - Provides a Workplan, schedule and realistic budget, including the identification of the minimum 20 percent non-Federal match requirement, for approval by the FHWA Division and/or OMC Regional, or FTA Regional Offices;
  - Requires a short final report documenting lessons learned and how well the project met the defined goals and objectives for submittal to FHWA Division and FTA Regional offices, as well as the ITS Joint Program Office; and
  - Requires all written deliverables be submitted in appropriate electronic format to the ITS Electronic Document Library maintained by the ITS JPO.

- The project must be contained, or in process for inclusion, in the TIP for projects served by MPOs, or STIP for projects not served by MPOs, or in the Commercial Vehicle State Plan (CVSP);

- Project workplans must be reviewed by the National ITS Program Evaluation Coordinator for determination of unique or nationally significant aspects of the project which might warrant evaluation. while it is anticipated that few projects will warrant a national evaluation, those projects deemed to be nationally significant will be required to conduct a formal evaluation under the direction of the ITS Program Evaluation Coordinator. Any required evaluations are to be conducted using project funds; and

- ITS Deployment Tracking Surveys must be completed, if not done so already, in applicable metropolitan areas.

1. Technical Project Development

Once the minimum general requirements defined above have been addressed, funding will be made available from the recipient's account to assist them in meeting the following, more specific technical requirements for final project approval. These requirements are also applicable to all deployment projects:

a. Project Managers shall attend, at project expense, if they have not previously done so, a training course on National ITS Architecture consistency or CVISN design workshop, as appropriate;

b. Detailed project designs must provide architecture consistency documentation by:
   - Providing a "mapping"[1] of the project design and terminology to the applicable regional ITS architecture or to the National ITS Architecture, if a regional ITS architecture is not in existence;
   - Identifying and providing for potential interfaces, including transit and other modal considerations, and providing sound rationale for omitted architecture flows;
   - Showing use of approved ITS standards, where applicable; and

c. Project designs must be approved by the FHWA Division office and/or FTA Regional office.

<u>2. Regional Deployment Projects</u>

In addition to the General and Technical Project Development requirements outlined for all deployment projects, those projects which have regional impacts will also need to meet the following. In general, it is DOT's intent that Technical Project Development funding be tied to and follow the completion of regional ITS planning. Where regional ITS planning has not been completed, funding for project implementation will not be approved until a commitment to regional ITS planning has been demonstrated. Development of regional ITS planning may be carried out in parallel to technical project development, provided that project workplans and actions demonstrate a concerted effort is underway, as determined by the FUWA Division and FTA Regional offices, or OMC State Regional office, as appropriate.

a. Project recipients shall use project funds to host an on-site National ITS Architecture training course for delivery to technical staff from all key stakeholder groups, if not previously done so;

b. Regional ITS planning must be conducted. This planning shall:
   - Identify local needs which can be addressed through ITS applications;
   - Include broad stakeholder participation;
   - Include transit and other modal considerations;
   - Develop descriptions of existing and planned ITS enhancements (physical inventory, sharing of info);
   - Define a regional architecture (subsystems and architecture flow level);
   - Ultimately incorporate ITS in the applicable transportation plan; and

c. The existence of or commitment to regional ITS planning must be certified by the FHWA Division office and FTA Regional office, or OMC State Regional office, as appropriate.

3. Commercial Vehicle Information Systems and Networks (CVISN) and International Border Clearance (IBC) Program Projects

CVISN and IBC projects also affect the larger statewide transportation system. They will also need to meet the General and Technical Project Development requirements outlined above, as well as the following CVISN-specific requirements.

a. Project recipients shall use project funds to host an on-site CVISN training course for delivery to all key stakeholder groups, if not previously done so;

b. A CVISN plan must be developed or in existence that provides for:
- An organizational framework for cooperative systems development among state agencies and motor carriers;
- A memorandum of understanding between the agencies of state government and the motor carrier association;
- A state CVISN system design that conforms to the CVISN Architecture and can evolve to include new technologies and capabilities;
- A structure that includes the 3 main components of CVISN; Safety Information Exchange, Credentials Administration and Electronic Screening;
- A border crossing system design that conforms to the border crossing architecture and can evolve to include new technologies and capabilities, where applicable; and

c. Final project approval must be obtained from the FHWA State OMC Director and the CVISN or IBC Program Manager, as appropriate.

B. Deployment Support

1 University Projects

a. A Project Agreement must be developed that:
- Clearly defines research products and/or training targets;
- Provides a workplan, schedule and realistic budget, including the identification of the 20 percent non-Federal match requirement;
- Clearly defines how the project advances either national ITS research goals and/or supports ITS deployment, including ties to the National ITS Architecture, standards and the ITS Program's overall theme of integration.
- Commits partners to deliver all products to the ITS Electronic Document Library maintained by the ITS JPO in accordance with policies requiring executive summaries, proper electronic format, etc. (These products may include items such as quarterly newsletters, articles, copies of papers and reports, etc.),
- Documents how the project will contribute to the National ITS Professional Capacity Building Program. This contribution can take several forms including, for example:

- Development of case studies;
- Development and delivery of training modules;
- Development and delivery of training courses;
- Delivery of existing training courses;
- Development of an ITS curriculum and incorporation of it into the university curriculum;

b. Project recipients will be expected to participate in designated RCB- and/or Professional Capacity Building Program-facilitated activities at project expense; and

c. Workplans shall be developed in coordination with and approved by a designated USDOT program manager.

<u>2 Other Support Projects</u>

a. A Project Agreement must be developed that:
- Clearly defines project goals, objectives and deliverables;
- Provides a workplan, schedule and realistic budget, including identification of the 20 percent match requirement;
- Clearly defines how the project advances either national ITS research goals and/or supports ITS deployment, including ties to the National ITS Architecture, standards and the ITS Program's overall theme of integration;
- Commits partners to deliver all products to the ITS Electronic Document Library maintained by the ITS JPO in accordance with policies requiring executive summaries, proper electronic format, etc.

b. Provision must be made in the workplan and the research activity for an open architecture, and specific provisions for technology transfer to other private and/or non-profit entities for implementation or further research; and

c. Workplans shall be developed in coordination with and approved by a designated USDOT Program Manager.

Questions and Answers for FY98 ITS Earmarks

Q: What is the intent of the requirement for project consistency with the National ITS Architecture?

A: The underlying purpose of architecture consistency is to promote and foster participation among a broad range of stakeholders for sharing information across transportation systems, and establishing other operational agreements, in a manner to facilitate regional and national transportation system compatibility and interoperability.

Specific goals are to:

- involve and unite a wide range of stakeholders in planning ITS
- support flexibility in tailoring ITS to local requirements
- achieve integration of ITS systems and components
- enable information sharing among stakeholders
- facilitate future expansion
- provide for future interoperability of key ITS services at the national level

Q: The National ITS Architecture is quite extensive in scope and lays out a multitude of information sharing possibilities. Do I have to plan for all of these interfaces and information exchanges in order to be consistent with the National ITS Architecture?

A: No. Planning and project development must continue to be focused on meeting local needs. Some of the functionality and information exchanges in the National ITS Architecture will not apply to your situation (e.g., your region might not have any toll roads and thus the Toll Administration and Toll Collection Subsystems of the National ITS Architecture would not apply). Use of the National ITS Architecture may help you envision possibilities you may not have otherwise considered in the development of your regional ITS architecture and your ITS projects. In all circumstances, however, the regional ITS architecture and individual ITS projects should be tailored to local needs and problems. It is unlikely that any one region would implement everything envisioned by the National ITS Architecture.

Q: Will the National ITS Architecture consistency requirement dictate the characteristics of the design of my ITS system?

A: The focus of the National ITS Architecture and ITS standards is to avoid dictating design, and to focus on ensuring interface compatibility and information exchange. The National ITS Architecture supports a variety of detailed designs and is flexible enough to support both distributed and centralized systems. The National ITS Architecture does not make technology decisions for you. Being consistent with the National ITS Architecture does, however, imply that information sharing opportunities between transportation stakeholders are explored to the extent possible and appropriate for your area.

Q: How will existing (legacy) equipment with proprietary interfaces be addressed?

A: The objective is not to "require" replacement of existing (legacy) systems or equipment having proprietary interfaces, but to plan with existing systems in mind and to encourage future investments that would facilitate electronic sharing of data and the use of open interfaces. Existing systems such as traffic signal, overhead messages, computer-aided dispatch for ambulance or automatic vehicle location for buses are a very important consideration that must be addressed in the development of the ITS project and the regional ITS architecture. As you plan new features and system upgrades, the new designs should provide for the interfaces identified in the National ITS Architecture and approved ITS standards as appropriate for your area and consistent with your regional ITS architecture.

Q: Can I use different terminology from the National ITS Architecture and still be "consistent"?

A: You may use whatever terminology you wish; however, we are asking for consistency documentation that provides a mapping or translation of your unique terminology to the National ITS Architecture terminology (at the subsystem and architecture flow level of detail). We expect that it will be simpler over time to use terminology from the National ITS Architecture as appropriate to your region.

Q: What kind of help/support can I expect from the U.S. DOT?

A: Various support mechanisms are under way or being planned at the current time. A training course on the National ITS Architecture is available now with more offerings planned in the fall of 1998. Technical assistance documents on the use of the National ITS Architecture to facilitate project development and planning for specific application areas are available or will be released in the next 3 months. Technical assistance is also available through the U.S. DOT peer-to-peer program. It is also anticipated that checklists will be made available to serve as helpful guidance and reminders. For more information, contact your local FHWA or FTA office.

Q: Who should be involved in developing the regional ITS architecture?

A: The range of stakeholder involvement is most appropriately addressed at the local level. A fundamental goal is to involve and unite a wide range of stakeholders. It is expected that the number of involved stakeholders in a regional ITS planning process in any area will grow over time. As a starting point, agencies within a region that are typically involved in transportation planning should be involved – but this list should be broadened over time. The National ITS Architecture may help you to identify stakeholders that are not normally included in the transportation planning process but who may be important to ITS planning (e.g., private sector information service providers; police, fire, and other emergency services; and other private sector transportation service providers).

Q: Our area has completed or is still engaged in an Early Deployment Planning project. Can the regional ITS architecture developed from that study be used to meet the consistency requirement for the earmarked projects?

A: Architectures developed under previous Early Deployment efforts should be examined against the requirements and guidance set forth for the earmark projects. It is likely, especially for earlier initiatives, that architectures developed in Early Deployment studies do not meet the intent and requirements established for the earmarks. In such cases, additional activity may be required or desired.

Q: What if the earmark recipient is reluctant to commit to regional ITS planning or the development of a regional ITS architecture?

A: You might want to point out that eventually all regions that want to spend federal funds on traffic signals, freeway management systems, transit tracking systems and similar ITS technology will be asked to show consistency with (preferably) a regional architecture or the national architecture.

Q: What if all the stakeholders don't want to participate

A: The intent of developing a regional architecture is not to allow one agency to hold the others hostage. Good faith efforts should be made to include all stakeholders. FHWA or FTA might offer to act as a convener of some of the first meetings to explain the long range intent and encourage all to participate. When all else fails, however, start with the agencies who are willing.

Q: Is MPO required to do the planning?

A: Interestingly, most of the ITS planning to date has been done outside the MPO. The development of the regional architecture can take place in whatever forum suits the area. It does need to be incorporated into the applicable plans approved by the MPO.

Q: I'm not sure that I have the technical skill to review project consistency documentation.

A: There are probably very few people in the agency who can expertly perform such a review. A few common sense questions that you can easily derive from the various architecture guidance documents will, in all likelihood cover the intent of consistency. Has the project designer provided for communication and information exchange with other logical agencies? How? Do the other agencies agree? Have applicable national standards such as NTCIP been specified?

You should take the architecture training course that is now available and the architecture consistency course that will soon be available. Beyond that, sit down and read the various guidance documents. They are written in English and will give you a good sense of the process and intent that we are looking for.

This will be the first of many projects. You and your partners will become more skilled until the question of "consistency" will become irrelevant.

Misjudgements will happen. We expect that. The review is intended to try to be helpful to the partner, not to be a rigid hurdle that needs to be met. The important thing is that with each project we take a few more steps toward achieving an interoperable "systems" approach.

Introduction to Measuring ITS Deployment and Integration

Content

This subsection contains a synopsis of a larger document entitled *Measuring ITS Deployment and Integration*. The full document provides a useful detailed methodology for transportation planners to inventory the deployment and measure the level of integration of ITS technologies in a region.

Summary

Over the past year, the ITS Joint Program Office sponsored a major data collection effort to track ITS deployment in the nation's largest metropolitan areas. As part of this effort, a consistent and simple method was developed to assess both the level of deployment of individual ITS elements and the level of integration between these elements. This method is based on the metropolitan ITS infrastructure.

The metropolitan ITS infrastructure is a blueprint defined by the U.S. DOT for the early deployment of ITS technologies in large cities. This infrastructure is made up of nine components used to group similarly functioning ITS elements. These components are Freeway Management, Incident Management, Traffic Signal Control, Transit Management, Electronic Toll Collection, Electronic Fare Payment, Highway Rail Intersections, Emergency Management Services, and Regional Multimodal Traveler Information.

To track the deployment and integration of ITS technologies, the methodology uses performance indicators, based on the functions and interactions of each of these nine infrastructure components. Since this metropolitan infrastructure is closely related to the National ITS Architecture, the development of this metropolitan deployment tracking methodology can serve as a starting point for more detailed ITS planning based on the National ITS Architecture. Although the methodology was originally designed for planning and monitoring in metropolitan areas, it can be used in non-metropolitan areas as well.

Uses

This subsection provides a useful methodology for assessing and tracking ITS deployment and integration. An understanding of this method is helpful for transportation professionals charged with implementing the *Interim Guidance* for the National ITS Architecture.

To obtain additional copies, see the U.S. DOT's ITS website at www.its.dot.gov. This document can be found in the Electronic Document Library as document #4372.

For additional information on inventorying ITS deployment, see the Interim Guidance section (1-A).

Measuring ITS Deployment and Integration: A Synopsis

The nationwide deployment of an integrated, Intelligent Transportation Systems (ITS) infrastructure is a major goal of the recently enacted Transportation Equity Act for the 21st Century (TEA-21). Over the next decade, transportation planning and implementing agencies throughout the nation will be working toward this goal through a variety of federal, state, and local initiatives. An essential first step in this planning and implementation process for each region is to inventory its existing ITS infrastructure elements. The document summarized in this subsection details a methodology developed over the past year by the ITS Joint Program Office to evaluate and inventory ITS in urban areas. An understanding of the methodology should be helpful to planners charged with implementing the *Interim Guidance* for the National ITS Architecture.

Over the past year, the ITS Joint Program Office sponsored a major data collection effort to track ITS deployment in the nation's largest metropolitan areas. As part of this effort, a consistent and simple method was developed to assess both the level of deployment of individual ITS elements and the level of integration between these elements. This method is based on the metropolitan ITS infrastructure.

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This subsection of the *National ITS Architecture and Standards Resource Guide* provides an introduction to this method for tracking the deployment and integration of ITS. The full methodology is presented in the ITS Joint Program Office 1998 document, *Measuring ITS Deployment and Integration*, available electronically at www.its.dot.gov. The information included in this binder subsection will summarize the three parts of this larger document and emphasize their relevance to deployments based on the National ITS Architecture.

Section I – "Integrating the Metropolitan ITS Infrastructure"

This section briefly describes the concept, phases, and means of measuring ITS integration and maps the relation of the metropolitan ITS infrastructure to the National ITS Architecture. This mapping shows how the methodology derived from the metropolitan ITS infrastructure may also be applied in the context of the National ITS Architecture for planning integrated regional ITS.

The concept of ITS integration is that technologies that work as a team with other systems are more powerful and versatile than individual ITS systems working alone. However, deploying integrated ITS technologies is more complex and requires more coordination between different organizations than deploying systems in isolation. Therefore, the integration of ITS infrastructure components is likely to be a multiphase process, with each step involving progressively greater levels of technical and institutional coordination.

These progressive phases of integration are *shared infrastructure*, which is probably the simplest, *shared information*, and *coordinated control*, which requires substantial sharing between agencies. Sharing infrastructure refers to the joint use of equipment between transportation agencies. For example, a common electronic fare payment medium may be used by highway, transit, and port authorities. Shared information refers to the transfer of data between different agencies, say between transit and police. For example, incident management personnel may use information gleaned from traffic management video equipment to respond more quickly and efficiently to an accident. Coordinated control refers to the most complete type of integration when a transportation agency uses shared information to make control decisions from a broader perspective than an individual agency. For example, neighboring communities might jointly set traffic signal timing so that the two systems can provide a synchronized response to changing traffic conditions.

Performance indicators have been developed to measure the level of ITS integration within a metropolitan area. These indicators are currently used to evaluate the level of shared information and coordinated control within metropolitan areas. Figure 1 shows the information flows between metropolitan ITS infrastructure components that are measured to indicate how well systems are integrated.

Although categorized differently, the National ITS Architecture subsystems include all of the same functions that are defined in the components of the metropolitan ITS infrastructure as charted in Table 1. This close connection between the metropolitan ITS infrastructure and the National ITS Architecture enables the deployment and integration tracking methods developed for metropolitan areas to be used for planning in the context of the National ITS Architecture as well.

Figure 1. Integration between Components

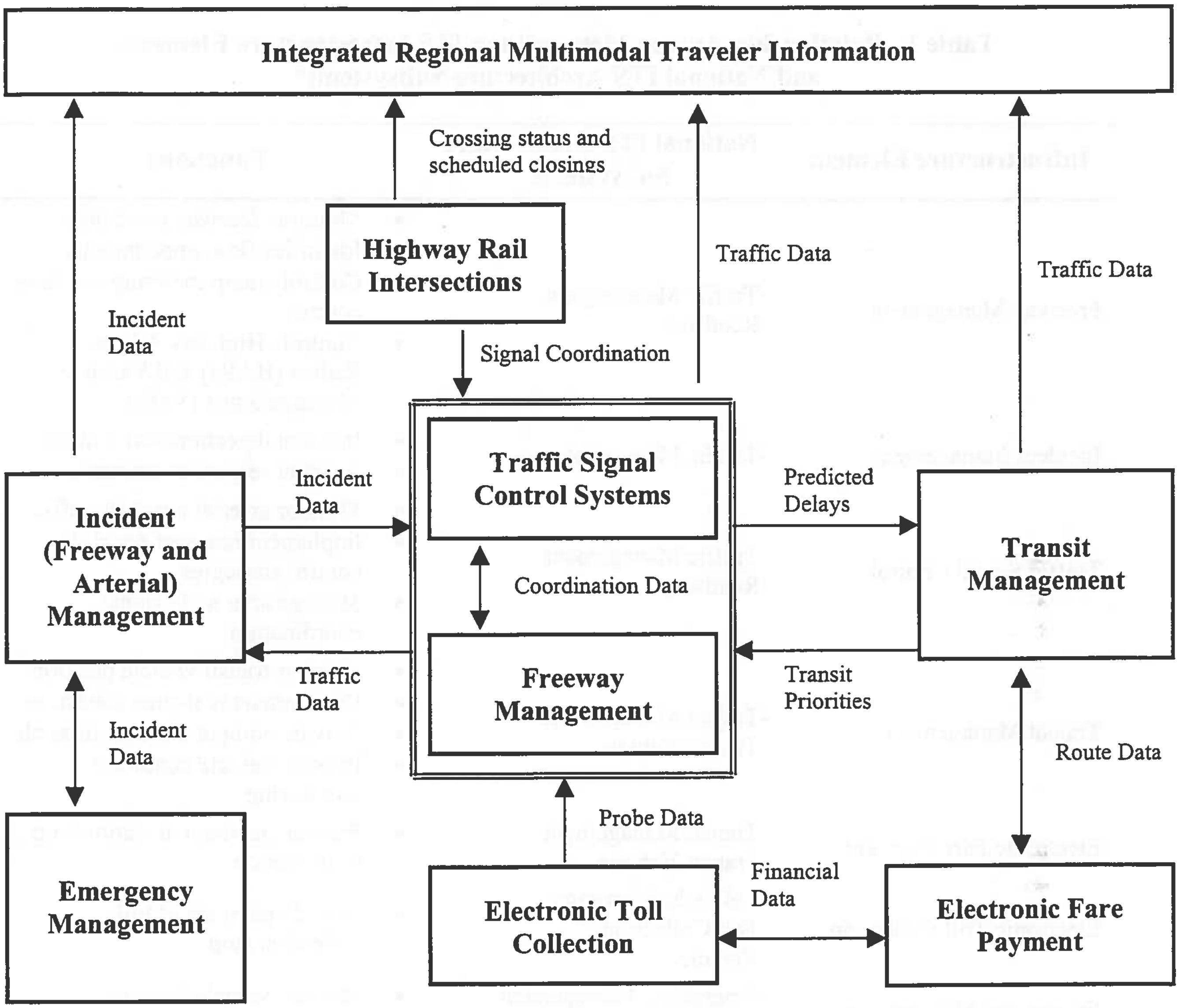

Table 1. Relationship Among Metropolitan ITS Infrastructure Elements and National ITS Architecture Subsystems*

Infrastructure Element	National ITS Architecture Subsystems	Functions
Freeway Management	-Traffic Management -Roadway	• Monitors freeway conditions • Identifies flow impediments • Controls ramp metering and lane control • Controls Highway Advisory Radios (HARs) and Variable Message Signs (VMS)
Incident Management	-Traffic Management	• Incident detection/verification • Incident response/clearance
Traffic Signal Control	-Traffic Management -Roadway	• Monitor arterial network traffic • Implement range of adaptive control strategies • Manage area wide signal coordination
Transit Management	-Transit Management -Transit Vehicle	• Monitor transit vehicle position • Disseminate real-time schedules • Provide computer aided dispatch • Provide vehicle condition monitoring
Electronic Fare Payment	-Transit Management -Transit Vehicle	• Provide payment at station/stop or in-vehicle
Electronic Toll Collection	-Toll Administration -Toll Collection -Vehicle	• Provide payment at toll collection stop
Emergency Management	-Emergency Management -Emergency Vehicle	• Monitor vehicle location • Provide fleet mgt support
Highway Rail Intersection	-Roadway	• Provide remote monitoring of highway rail intersections
Regional Multimodal Traveler Information	-Information Service Provider -Personal Information Access -Remote Traveler Support	• Provide information distribution

*For example, the functions of the Freeway Management infrastructure element are compatible with those provided by the Traffic Management Subsystem and Roadway Subsystem defined in the National ITS Architecture.

Section II - "Describing the Metropolitan ITS Infrastructure"

This section of the document provides a detailed explanation of the deployment and integration tracking indicators, of how they were developed, and how they should be used for each of the nine metropolitan ITS infrastructure components. Sufficient detail is provided so that transportation officials can use the indicators to inventory ITS deployment and integration in their region. A summary of the way the indicators were developed is given below, so that readers of this guide can understand the general contours of this process.

Deployment and integration of the elements of the metropolitan ITS infrastructure in a region are tracked through the use of indicators. For deployment tracking the major purposes or functions of each element are defined. Once these functions are defined, indicators or measures are developed to evaluate how successfully the component performs them. For example, in the case of the freeway management component, three basic functions are defined: surveillance, traffic control, and information display. The three indicators developed to reflect these functions are respectively the percentage of freeway centerline miles that are under electronic surveillance, the percentage managed by ramp meters, and the percentage covered by permanent Variable Message Signs, Highway Advisory Radio, or In-Vehicle Signing. These percentages are tallied and their average is assigned as the overall rating for deployment.

Integration tracking indicators measure how much data is transferred from an information-collecting element to an information-receiving element and how effectively that data is used by the receiving element. For example, calculating the integration of the Freeway Management and Traffic Signal Control components requires that two different types of percentages be considered. The first percentage refers to the amount of collected data that is transferred. For example, if ten miles of highway are under electronic surveillance and data for five of those miles is transferred, then the flow indicator would be assigned a value of fifty percent. The second percentage refers to the amount of the transferred data that is used by the recipient element. For example, if all of the data for those five miles is used, then the control indicator would be valued at one hundred percent.

These indicators do not necessarily reflect the full breadth of metropolitan ITS deployment and integration activity. They were selected to provide simple and intuitive measures of deployment that can be counted and tracked over time.

Section III - "Deployment Tracking Questionnaires"

This section contains the deployment tracking questionnaires that are currently being used to gather data for local metropolitan deployment tracking. These questionnaires provide the information to transportation officials to properly measure ITS deployment and integration in their regions. Such measurement can form the body of an inventory of a region's existing ITS technologies. Creating such an inventory is a crucial early step in developing a regional ITS architecture. Please check the website (www.its.dot.gov) to see the full range of questions.

The following checklist, while not as detailed as the questionnaires, does supply a useful series of questions for transportation officials and planning agencies who would like to get a head start on inventorying their existing ITS.

Are You Integrating the Elements of Your Metropolitan Intelligent Transportation Systems (ITS) Infrastructure?

Joseph I. Peters, Ph.D.
Intelligent Transportation Systems Joint Program Office
Washington, D.C.

Richard Margiotta and Andrew Dixson
Science Applications International Corporation
Oak Ridge, TN

Do you think you have all of the elements of an ITS infrastructure in your metropolitan area? It is important to remember that just having the elements is only part of the ITS answer. Integration across the elements is even more important. Take this quiz to see how your metro area rates in integrating the elements. If you have all of the elements to start with and you can answer "Yes" to each of the following questions, the odds are that you have a fully integrated ITS infrastructure.[1]

1. Are you using real-time information about arterial traffic flow:
   a. To inform travelers?
   b. To affect freeway management strategies?
   c. To select transit vehicle routes and schedules?
   d. To detect incidents?
   e. To allocate signal priority to transit and emergency vehicles?

2. Are you using real-time incident information (e.g., location, severity, and type):
   a. To inform travelers?
   b. To affect arterial management strategies?
   c. To affect freeway management strategies?
   d. To control transit vehicle routes and schedules?
   e. To alert emergency response teams and to adjust the type of emergency response?

3. Are you using real-time information about freeway traffic flow:
   a. To inform travelers?
   b. To affect arterial management strategies?
   c. To select transit vehicle routes and schedules?
   d. To detect incidents?
   e. To allocate signal and lane priority to transit and emergency vehicles?

4. Are you using real-time information about transit routes and schedules:

[1]The purpose of this quiz is to provide a few good indicators that are robust enough to give you a top level assessment of how well your ITS infrastructure is integrated. It is not intended to be exhaustive.

a. To inform travelers?
b. To affect freeway management strategies (e.g., ramp meter priorities)?
c. To affect arterial management strategies (e.g., signal priorities)?
d. To provide probe information on arterial or freeway flows?

5. When you inform travelers about the status of travel conditions:
   a. Do you integrate information from multiple sources (e.g., arterial, freeway, incident, transit, and parking surveillance)?
   b. Do you integrate information about multiple modes of transportation (e.g., transit, highways, light and heavy rail, ferries, airports)?
   c. Do you enable shared access to integrated data bases?

6. Are you using electronic toll tags:
   a. To provide probe information on arterial or freeway flows?

7. Are you using smart electronic fare media:
   a. To pay for both fares and tolls (and possibly other things)?
   b. To do origin/destination studies of transit riders in order to manage routes and schedules better?

8. Are you using emergency vehicles:
   a. To communicate to arterial system managers when incidents are clear?
   b. To detect and report ancillary incidents?
   c. To enable signal priority?

9. Are you using real-time information about railroad grade crossings:
   a. To control nearby traffic signals to prevent track incursions?
   b. To detect and report incidents (e.g., presence of trains or vehicles) at crossings?

If your answers were, "Yes" to all of the above, congratulations![2] You are truly using the power of integration to get all that you can while managing your surface transportation system and continuing to build your ITS infrastructure to expand its coverage throughout your metro area.

If by now you are realizing that you may not have all of the key components of the ITS infrastructure needed to manage your metropolitan surface transportation system effectively, the following quiz is designed to help you make your own assessment of your situation. The quiz asks questions according to each of the ITS infrastructure elements that may be useful in your metropolitan areas.

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[2] Remember: Your area may not need to have all of the ITS elements deployed to be effective. For example, if your area does not have toll facilities, then obviously, you should not worry about electronic toll collection and how it integrates with other pertinent elements. The key is to deploy and integrate those elements that are right for your area.

Do You Have the Key Metropolitan Components of the ITS Infrastructure?

Before you can integrate elements of the ITS infrastructure, you need to have some building blocks to work with. There are nine metropolitan elements of the ITS infrastructure:

- **Traffic Signal Control**
- **Incident Management**
- **Freeway Management**
- **Transit Management**
- **Regional Multimodal Traveler Information**
- **Electronic Toll Collection**
- **Electronic Fare Payment**
- **Emergency Management**
- **Railroad Grade Crossings.**

Although the electronic toll collection element of the infrastructure may not be necessary for your regional area, some degree of deployment of most of the remaining elements will provide benefits. Your transportation planning process should consider these elements as alternatives to other proposed solutions for handling congestion-related problems. The following sections include questions that will help you become aware of the degree to which these elements are present in your metro area.

Traffic Signal Control

Surveillance:

- Does my metro area have electronic surveillance for monitoring arterial traffic flow?

  Score extra if detectors yield link/segment flow information instead of single point detection (e.g., via probe vehicles or multi-point link/segment flow detectors).

  Score extra if surveillance includes key, public parking lot occupancy information.

Control

- Does my metro area use centralized or closed loop control of signals?

  Score extra if my metro area uses dynamic signal timing response based on advanced software instead of static timing plans based on historical data.

Institutional Coordination

- Do the agencies and municipalities in charge of signal systems in key areas across the region have cooperative agreements in place to share information for coordinated control?

  Score extra if agreements enable shared control.

Geographical Coverage

- Is there sufficient geographical coverage to accomplish all of the functions listed above?

Incident Management

Ask these questions separately for your metro area's freeway and arterial systems:

Detection

- Does my metro area use incident detection algorithms or free cellular phone calls?

Surveillance

- Does my metro area use surveillance cameras?

Response

- Does my metro area use on-call, publicly-sponsored service patrols or towing services?

Institutional Coordination

- Does my metro area have a formal incident management plan or team?

Geographical Coverage

- Is there sufficient geographical coverage to accomplish all of the functions listed above?

Freeway Management

Surveillance

- Does my metro area have electronic surveillance for monitoring freeway traffic flow?
  - Score extra if detectors are spaced to give below 1 mile resolution in key areas.
  - Score extra if my metro area uses probe vehicles as sources of flow information.

Control

- Does my metro area have freeway lane control or entrance ramps managed by ramp meters?
  - Score extra if centrally controlled or traffic responsive.

Display

Does my metro area use Variable Message Signs or Highway Advisory Radio to convey real-time conditions to drivers?

Geographical Coverage

- Is there sufficient geographical coverage to accomplish all of the functions listed above?

Transit Management

Surveillance

- Does my metro area use automatic vehicle location systems in its transit fleets?
  - Score extra if Global Positioning System units are used instead of sign-post beacons

Maintenance

- Are transit vehicles using electronic monitoring of vehicle component operations and maintenance status?

Control

- Do paratransit vehicles employ electronic dispatch techniques?

Display

- Are real-time transit schedules, routes, and vehicle locations displayed at transfer points?

Geographical Coverage

- Is there sufficient geographical coverage to accomplish all of the functions listed above?

Regional Multimodal Traveler Information Systems

This element of the ITS infrastructure is particularly characterized by the presence of integration of information from multiple information sources and across multiple modes of travel. The presence of data bases that synthesize this information is an attractive feature of this component. Such data bases can be compiled through public or private investments, with private information service providers providing value added information features for sale to consumers at large.

Media

- Are the following media used to convey regional multimodal traveler information:
  - Electronic mail or other direct personal computer links?
  - Interactive television?
  - Kiosks?
  - Dedicated cable television?
  - In-vehicle navigation devices?
  - Telephone systems?
  - Pagers, personal digital assistants, or other personal information devices?
  - Web sites on the Internet?

Multimodal-Multisource Information

- How many of the media listed above integrate information from multiple modes into a graphical user interface?
- How many of the media integrate information from arterial, freeways, transit management, and incident management data sources?

Geographical Coverage

- Is there sufficient geographical coverage to accomplish all of the functions listed above?

Electronic Toll Collection

Control

- If you have toll facilities, do you have a sufficient number of lanes with ETC capability?

Institutional Coordination

- If you have multiple toll facilities, do they share a common electronic toll tag?

Electronic Fare Payment

- Do you use magnetic stripe cards for fare payment?

  Score extra if you can use a bank credit or debit card to pay for the magnetic stripe card.

  Score extra if you can simply swipe the bank credit or debit card for access.
- Do you use a smart card?

Score extra if you can use a bank credit or debit card to pay for the smart card.

- Do all of the transit operators in your metro area use common fare media?

Emergency Management Systems

- Are your metro area's public emergency vehicles under computer aided dispatch?
- Do your emergency vehicles have in-vehicle navigation systems?

Railroad Grade Crossings

- Do your railroad grade crossings have electronic surveillance?

If you have gotten to this point, and you realize that your metro area falls short in deployment of basic ITS infrastructure components, let alone the integration among them, it's probably a good idea to ask yourself some basic questions about how well ITS alternatives are being considered in the transportation planning process.

Integration of ITS into the Transportation Planning Process

- Does your planning process consider planning for ITS as a separate exercise or integrate ITS into the TIP and STIP?
- Do you have an organizational framework that helps to ensure that most of the pertinent questions above can be answered "Yes" after your ITS infrastructure is deployed?
- Do you have a regional framework to ensure integration of pertinent ITS elements?
- Does your Congestion Management System employ any of the ITS infrastructure to accomplish its goals?
- After you have finished deploying you regional ITS infrastructure, will out of town travelers find it compatible with their home town systems (i.e., Are procedures in place to ensure your infrastructure is compatible with specifications for the National ITS Architecture?)?
- Did your metro area use the ITS National Architecture as source material from which to tailor your own regional architecture?

The above questions, about planning for ITS deployments and deploying ITS infrastructure components and the integration among them, need to be answered in order to track progress toward achieving the US DOT's goal of deploying the ITS infrastructure nationwide by the year, 2006. This is a goal that can not be achieved by the US DOT alone. It is hoped that the States and Metropolitan Areas across the US will join in the initiative to use ITS as an alternative to solving congestion problems. To track progress in deploying the ITS infrastructure in our nation's metropolitan areas, the US DOT will be asking 75 of the nation's largest metro areas many of the same questions included in this paper and reporting this progress annually on the US DOT web site.

Acknowledgments

The authors would like to acknowledge the contributions of Barry Zimmer and many of the ITS staff members from FHWA: Office of Traffic Management and ITS Applications, the ITS Joint Program Office, Office of Research, Office of Technology Assessment, Office of Environment and Planning, and ITS focal points from FHWA Regions and Divisions across the US; ITS staff members from FTA: Off ice of Advanced Public Transportation Systems, and FTA regions across the US; and, ITS staff members from the Volpe National Transportation Systems Center. Steve Gordon, from Oak Ridge National Laboratory, provided management leadership to the contract team as well as insightful comments throughout the development of this paper. The strengths of this paper are largely reflected by comments from these contributors.

Introduction to the Glossary of ITS Terms

Contents

This section includes a glossary of important ITS terms.

Summary

The development of a National ITS Architecture and Standards for intelligent transportation systems also resulted in an accompanying nomenclature. Many of the terms used in this process and in this guide have already been introduced. Nonetheless, in an effort to both maintain consistency with other ITS publications as well as provide a resource for people new to National ITS Architecture and Standards issues, this section defines these relevant terms and acronyms.

Uses

This section is useful primarily as a reference to specific ITS terms, acronyms, and abbreviations used in this resource guide and in other discussions about ITS.

AASHTO American Association of State Highway and Transportation Officials.

ACN Automated Collision Notification system.

AHS Automated Highway System. The AHS is a highly advanced system that will redefine the current vehicle-highway relationship by shifting many tasks from the vehicle operator to the roadway itself. The first demonstration of the AHS concept was in San Diego in August 1997.

APTS Advanced Public Transportation Systems. Collection of technologies to increase efficiency of public transportation systems and offer users greater access to information on system operation.

Architecture An overarching framework that allows individuals ITS services and technologies to work together, share information, and yield synergistic benefits. The national ITS architecture was released as a final document in June 1996.

ARTS Advanced Rural Transportation Systems. ITS technologies aimed at addressing the specific needs of rural communities, particularly the issues of mobility and road safety.

ATIS Advanced Traveler Information Systems. ATIS technologies provide travelers and transportation professionals with the information they need to make decisions, from daily individual travel decisions to larger scale decisions that affect the entire system, such as those concerning incident management.

ATMS Advanced Traffic Management Systems. ATMS technologies apply surveillance and control strategies to improve traffic flow on highways and streets.

AVI Automatic Vehicle Identification. A system which combines an on-board tag or transponder with roadside receiver for the automated identification of vehicles. Used for electronic toll collection, stolen vehicle recovery, using vehicles as traffic probes, etc.

AVL Automatic Vehicle Location system. Computerized system which tracks the current location of fleet vehicles, to assist dispatching, etc.

AVCSS Advanced Vehicle Collision and Safety Systems. These systems employ mostly in-vehicle technologies to help drivers avoid collisions, monitor driver performance, and automatically signal for emergency aid immediately upon collision.

CVISN Commercial Vehicle Information Systems and Networks. A collection

	of information systems and communication networks that provide support to commercial vehicle operations. CVISN includes information systems owned and operated by governments, motor carriers, and other stakeholders.
CVO	Commercial Vehicle Operations. ITS program to apply advanced technologies to commercial vehicle operations, including commercial vehicle electronic clearance; automated roadside safety inspection; electronic purchase of credentials; automated mileage and fuel reporting and auditing; safety status monitoring; communication between drivers, dispatchers and intermodal transportation providers; and immediate notification of incidents and descriptions of hazardous materials involved.
DASCAR	Data Acquisition System for Crash Avoidance Research. A portable on-board vehicle data gathering system that can monitor and record vehicle performance and the driver's physical reactions.
DGPS	Differential Global Positioning System. A technique that can be applied by civilian GPS users to improve GPS accuracy to 1-10 meters.
DOT	Department of Transportation. When used alone, indicated U.S. Department of Transportation. In conjunction with a place name, indicates State, city, or county transportation agency (e.g., Illinois DOT, Los Angeles DOT).
DSRC	Dedicated Short-Range Communications. Wireless, short-range digital communications. Uses electronic readers, tags, and software.
EDI	Electronic Data Interchange.
EDP	Early Deployment Plans.
EMS	Emergency Management Services. Services designed to optimize the response time to incidents.
Enabling Research	Applied research that advances existing technologies to enable them to support ITS applications. This research has refined technology for eventual field testing, developed evaluation methods to determine potential benefits and cost effectiveness, developed human factors guidelines, and established performance specifications and criteria.
ENTERPRISE	Evaluating New Technologies for Roads Program Initiative in Safety and Efficiency. North American ITS cooperative initiative to facilitate the rapid development and deployment of ITS technologies. A

consortium of public and private organizations with compatible ITS goals which will identify and exploit opportunities for cooperative ventures. Participants include Arizona DOT, Arizona State University, Castle Rock Consultants, Colorado DOT, FHWA, Ford, Iowa DOT, Lockheed, Marconi Electronic Devices, Minnesota DOT, New York DOT, Nissan, Ontario Ministry of Transportation, and Transport Canada.

FCC Federal Communications Commission.

FHWA Federal Highway Administration.

FMS Freeway Management Systems. Network systems that allows transportation managers the capability to monitor highway and environmental conditions on the freeway system, identify recurring and non-recurring flow impediments, implement appropriate control and management strategies, and provide collection and dissemination of critical real-time information to travelers.

FOT Federal Operational Test.

FRA Federal Railroad Administration.

FTA Federal Transit Administration.

GCM Gary-Chicago-Milwaukee corridor. One of the ITS Priority Corridor projects as defined by ISTEA to receive funding for applying ITS to assist in reducing extreme or severe ozone. The initial GCM priority is real-time data acquisition and sharing of information across the corridor that is useful to both multi-modal system operators and travelers.

GIS Geographic Information System. Computerized data management system designed to capture, store, retrieve, analyze, and report on geographic/demographic information.

GPS Global Positioning System. A method of determining the position of vehicles using communications with a satellite. Government owned system of 24 Earth-orbiting satellites that transmit data to ground-based receivers. Provides extremely accurate latitude/longitude ground position.

HRI Highway-Rail Intersection. User service that integrates ITS technology into already existing HRI warning systems to enhance their safety effectiveness and operational efficiency. At railroad grade crossings, HRI technologies located both in-vehicle and along the roadside ensure that train movements are coordinated with traffic signals and that drivers are alerted to approaching trains.

Human Factors Research done to understand the impact of automated technology on human decision making and driving behavior. For instance, studies are being done to investigate whether the use of cellular phones while driving distracts drivers to the extent that more accidents occur with their use.

ICC Intelligent Cruise Control. A crash avoidance technology that automatically adjusts vehicle cruise speed to maintain safe following distances.

IMS Incident Management Systems. Monitoring and surveillance system that identifies incidents in real-time so that they can quickly be removed.

Intelligent Transportation Infrastructure Core infrastructure that combines conventional and advanced technologies to integrate essential ITS services so that they are interoperable and intermodal.

Intermodalism Seamless integration of multiple travel modes.

Interoperability The ability to integrate the operation of diverse networks and systems. The vision of the intelligent transportation infrastructure is a seamless interoperable network from coast-to-coast that allows drivers and information to flow through the system without barriers.

In-vehicle navigation Technology that allows drivers to access route guidance information while en-route. Includes location referencing technology, in-vehicle display units, map information, and audio/text delivery technology.

ISTEA Intermodal Surface Transportation Efficiency Act of 1991. Federal law providing primary federal funding for highway and other surface transportation programs in the United States through 1997. ISTEA contains the Intelligent Vehicle-Highway System Act. Directs the establishment of a National ITS program that is to include: a strategic plan for ITS in the United States, implementation and evaluation of ITS technologies, development of standards protocols, an information clearinghouse, the use of advisory committees (one of which is ITS America), and funding for ITS research, development, and testing in such efforts as the corridors program.

ITS Intelligent Transportation System(s). The application of advanced technologies to improve the efficiency and safety of transportation systems.

ITS America — Intelligent Transportation Society of America. A nonprofit, public/private scientific and educational corporation that works to advance a national program for safer, more economical, more energy efficient, and environmentally sound highway travel in the United States. Federal advisory committee used by U.S. Department of Transportation.

IVHS — Intelligent Vehicle-Highway Systems. Now known as intelligent transportation systems

JPO — Joint Program Office for ITS.

Kiosk — An information center for traffic or travel data located in shopping malls, parking decks, hotels, airports, businesses, transit terminals, etc. usually with interactive computer capability.

LAN — Local Area Network. A method of connecting several computers together using either high or low bandwidth communication media.

Location referencing — Technology that more precisely identifies locations of vehicles, locations, and travelers. Used with GPS, AVL technologies. Supports user services such as Mayday, EMS, CVO, ATMS, ATIS, and AVCSS.

Mainstreaming — The act of brining ITS technology into everyday use by travelers and transportation professionals.

Mayday — An ITS program designed to link travelers in trouble with transportation officials in real-time. Uses location referencing technologies and communications systems.

MDI — Model Deployment Initiative. A program designed to develop model sites demonstrating intelligent transportation infrastructure and successful jurisdictional and organizational working relationships. The program is also designed to demonstrate the benefits of integrated transportation management systems that feature strong regional, multimodal traveler information services.

MPO — Metropolitan Planning Organization. Regional agencies representing local governments. MPOs have planning and programming authority under ISTEA.

NAHSC — National Automated Highway Systems Consortium.

NHS — National Highway Systems. A Federal program which funds transportation projects.

NHTSA	National Highway Traffic Safety Administration.
NTCIP	National Transportation Communications for ITS Protocol. Required for traffic management operations. Allows for wireline communications between traffic management centers and field equipment.
Operation Timesaver	Federal initiative aimed at reducing congestion by building an intelligent transportation infrastructure in 75 of the Nation's largest metropolitan areas within 10 years. The goal is to reduce travel times by 15 percent be the year 2005.
PCB	Professional Capacity Building program.
Priority Corridor	One of the first "deployment" programs established by ISTEA. Originally designed to showcase technology and hardware, it has created communication channels and organization frameworks among the numerous agencies that must coordinate to successfully implement ITS.
Protocol	"Envelopes" used to package data for interoperable flow of ITS information. Protocols can include information on addressing, security, priority and other handling information.
Public-Private Partnerships	Agreements with private sector companies to participate in the deployment of ITS through commitment of time, services, products, or capital investment. These partnerships are the foundation of the ITS strategic plan's financial strategy for ITS deployment. The plan assumes that private sector companies will contribute up to 20 percent of testing and deployment costs.
R&D	Research and Development.
RF	Radio Frequency.
RFP	Request for Proposals.
RSPA	Research and Special Programs Administration.
RT-TRACS	Real-Time Traffic-Adaptive Control System. Next-generation traffic and transit management system. An advanced dynamic control strategy that uses state-of-the-art traffic signal control based on real-time demand.

SAVME	System for Assessing the Vehicle Motion Environment. A roadside measurement system to quantify the movement of vehicles in real traffic.
SDO	Standards Development Organization.
Standard	Specifications that are established to address the need for various technologies, products, and components from different vendors to work together.
TMC	Traffic management center.
TMDD	Traffic Management Data Dictionary. A source of standardized information that defines how data is exchanged and how it flows between ITS devices and systems. The TMDD standardizes message sets for national interoperability.
TRB	Transportation Research Board. Part of the National Academy of Science, National Research Council. Serves to stimulate, correlate, and make known the findings of transportation research.
TSCS	Traffic Signal Control Systems. Advanced systems that adjust the amount of green time for each street and coordinate operation between each signal to maximize traffic flow and minimize delay based on real-time changes in demand.
UDOT	Utah Department of Transportation.
User Services	Services available to users (drivers) of an ITS equipped roadway, as set forth by ITS America. The 30 services are arranged in 7 categories as follows: 1) Travel and Transportation Management 2) Travel Demand Management 3) Public Transportation Operations 4) Electronic Payment 5) Commercial Vehicle Operations 6) Emergency Management 7) Advanced Vehicle Control and Safety Systems
WAN	Wide Area Network.
WWW	World Wide Web.