FLORIDA'S ITS INTEGRATION GUIDEBOOK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

OCTOBER 1, 2002

FLORIDA'S ITS INTEGRATION GUIDEBOOK

http://www11.myflorida.com/IntelligentTransportationSystems

Prepared for

District Seven
Florida Department of Transportation
11201 N. Malcolm McKinley Drive
Tampa, Fl 33612
Planning

Prepared by

Center for Urban Transportation Research
College of Engineering, University of South Florida
4202 E. Fowler Ave., CUT100
Tampa, Fl 33620

October 1, 2002

Acknowledgements

This guidebook has been prepared for Florida Department of Transportation, FDOT, in cooperation with the FDOT-District Seven Office. FDOT Project Manager was Jerry Karp, District Seven Planning Programs Manager. CUTR ITS research team consisted of Mike Pietrzyk, Firoz Kabir, and Nevine Labib Georggi.

Appreciation is expressed to the following individuals for providing valuable comments:

Guidebook Peer Review Group Members
Mr. Eric Hill, Metroplan Orlando
Mr. Liang Hsia, Florida Department of Transportation
Mr. Bob Krzeminski, Florida Department of Transportation
Mr. Carlos Roa, Miami-Dade County Metropolitan Planning Organization
Mr. Chung Tran, Federal Highway Administration
Dr. Charles Wallace, PB Farradyne Inc. (previously with University of Florida)
Ms. Sarah Ward, Pinellas County Metropolitan Planning Organization

Center for Urban Transportation Research Reviewers
Dr. Edward Mierzejewski, Director
Ms. Patricia Ball, Administrative Services
Ms. Patricia Turner, Safety Research

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Intelligent transportation systems (ITS) apply advanced technologies in communications, control, electronics, and computer hardware and software to improve surface transportation system performance. Often, several technologies are combined in a single integrated system, providing synergistic benefits that exceed the benefits of any single technology.

Integrated ITS are generally defined in nine broad infrastructure components: Electronic Toll Collection, Emergency Management, Incident Management, Freeway Management, Arterial Management, Regional Multimodal Traveler Information, Electronic Fare Collection, Highway-Rail Intersections and Transit Management. For ITS to be effective, systems must share information so that state and local jurisdictions can coordinate their responses to traffic conditions. By standardizing common elements of these systems and establishing physical links between traditionally distinct systems, all components can benefit from each other's information. For instance, a system that monitors traffic conditions can transmit its data to a system that controls traffic signals, so that signals can be programmed to optimize traffic flow and give priority to transit and emergency vehicles.

Other benefits include enhanced route planning for travelers (real time information allows travelers to make decisions that reduce trip times and improve safety); improved emergency response and security for transit (integrated information systems improve response times to crime and mechanical emergencies); cost savings, improved productivity, and better customer service for transit (electronic fare cards used on multiple modes saves passenger time and multiple operators sharing dispatching systems save money); and improved incident response provided by the integration of advanced technologies that accelerates incident detection, response, and clearance through shared infrastructure and information.

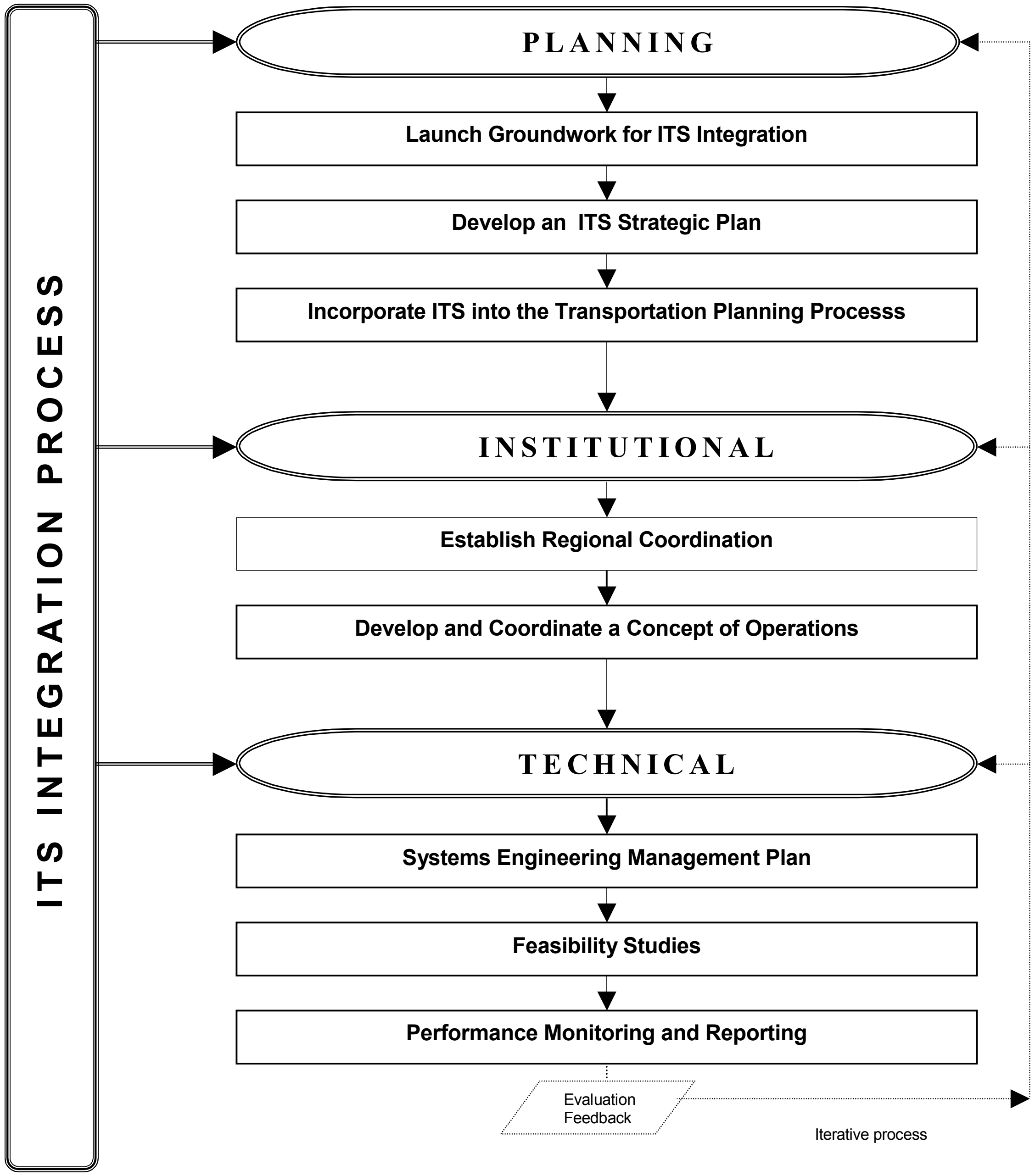
ITS policy makers and professionals must understand and proactively deal with potential interactions, dependencies, and commonalities of the ITS functional areas and user services. The guidebook addresses this very issue to help maximize the benefits of technology and information particularly at a time when limited transportation funding and resources are available. The guidebook serves as an informational tool in defining the ITS integration context technically and institutionally.

The key to a successful interoperable transportation system is to integrate ITS via systems engineering approach into all stages of planning, designing and deployment of transportation projects at the state, regional and local settings. This guidebook recommends an iterative process to achieve overall ITS integration that involves planning, institutional and technical integration processes. The guidebook outlines the suggested process and provides the necessary steps to attain integration in planning and implementing ITS. At the core of the suggested approach is the iterative process of developing, using and maintaining a Regional ITS Architecture, RIA, as part of an ITS strategic plan, considered the focal activity in planning and implementing ITS integration.

Questions concerning ITS integration that policy-makers and planners may ask are answered in the section on planning and institutional integration processes. Answers to potential questions from ITS project designers, operational and technical ITS staff, are offered in separate sections that address technical integration.

Figure ES-1 serves as a guide and roadmap for using the suggested process for achieving ITS integration. A brief description of the figure and the process is provided next.

Figure ES-1: Process for Achieving ITS Integration



Planning Integration

As seen in Figure ES-1, the initial effort in the suggested process is achieving integration in planning using the following three steps:

> **Step I – Launch the Groundwork for ITS Integration.** Two parallel tasks are recommended in this step. The first task, identifying ITS stakeholders and ITS champions, involves identifying coordinating partners/users/stakeholders coalitions, establishing a core group of stakeholders and promoting champions for ITS. The second task is performing outreach and inreach activities to gain participation and support of stakeholder coalitions, ITS staff, and ITS executives by educating and enlisting agency decision-makers and other staff in the ITS development process.

Step II – Develop an ITS Strategic Plan. Building on Step I in expanding stakeholder coalitions, the strategic plan is developed based on input from stakeholders articulating an ITS vision for the region or the state. Next task would involve screening market packages and developing a sequence for market packages implementation. Based on the Market Package Sequence/Plan, the functional capabilities for desired ITS projects would be defined. Once a Market Package Plan has been developed that documents the ITS services that should be deployed in a region, the regional framework in which these services will be deployed should be defined. The National ITS Architecture, NIA, provides a general framework that may be adapted and elaborated into a broad range of regional transportation system designs. A regional architecture is a key product of this process that begins to overlay major technology and interface choices that are appropriate for the region onto the more general NIA. Adopting a regional architecture is the focal step in the planning integration effort.

Step III – Incorporate ITS into the Transportation Planning Process. This step addresses challenges that agencies must successfully overcome in order that ITS integration projects reach design and implementation stages. Considering ITS as part and parcel projects of traditional transportation planning documents need to be a routine practice for all planning and implementing agencies. Discussion on incorporating ITS into the traditional planning process include incorporating an ITS element in the Long-range Transportation Plan, ITS Projects in Transportation Improvement Programs, ITS Tasks in the Unified Planning Work Programs, ITS as a Congestion Management Tool, Role of ITS in Corridor Studies, ITS to Meet Concurrency Management Needs, and ITS for Sustainable Development.

Institutional Integration

Step I – Establish Regional Coordination. Steps to establish regional coordination include designating a lead agency, emphasizing regional leadership, create a committee structure, building on existing methods for regional cooperation, and establishing governance agreements and understandings

Step II – Develop and Coordinate a Concept of Operations. In this step, stakeholders' current and future roles and responsibilities in the implementation and operation of the regional systems are defined in more detail. The concept of operations documents these roles and responsibilities for selected transportation services in specific operational scenarios. It provides an "executive summary" view of the way the region's systems will work together to provide ITS services.

Technical Integration

Step I - Systems Engineering Management Plan, SEMP. Systems engineering is a structured process for arriving at a final design of a system, both at the level of an ITS architecture and the level of project implementation. To demonstrate that the systems approach is consistently being taken, more than assertions may be needed. One-way of demonstrating an ITS program is based on systems approach is to adopt a Systems Engineering Management Plan which describes the methodology and milestones in systems integration, and control system development and testing. SEMP also describes the processes to be used to integrate the software and hardware in the control system, and to integrate communications and field devices.

Step II – Feasibility Studies. Based on SEMP, a feasibility study for a specific ITS integration project can be undertaken to determine the cost/benefit analysis. Measures accomplished through a feasibility study include defining data transfer and control, analyzing system functional requirements, developing an ITS procurement plan, and defining operations and management options.

Step III - Performance Monitoring and Reporting. In this step, it is emphasized that ITS data can be used to evaluate the transportation systems before and after ITS deployments. Highlighted in this step is the federal effort on program assessment/evaluation and an example that shows how a state agency, Florida Department of Transportation, FDOT, adapted national performance measures to fit localized characteristics.

The suggested process for achieving ITS integration is iterative but always relies on use of a RIA, related standards, and the systems approach. The planning, institutional and technical integration tasks overlap.

ITS integration is dependent on various factors including leadership, technology, jurisdiction and financial strength of the implementers. To many smaller county/city transportation agencies, ITS integration may still be considered a luxury available to the larger agencies or jurisdictions with greater financial strength, which could justify the expense of upgrading or retrofitting the existing systems as well as building the new systems requiring integrated infrastructure of communications, computers and electronics. While the larger agencies and the regional (multi-agency) organizations will continue to provide the leadership in ITS integration, the smaller jurisdictions will have to do their part of incremental adjustment to upgrade their transportation systems with strategic, technical and financial backing provided through local, regional, state and national ITS deployment initiatives.

The guidebook provides an integration relationship matrix (Table ES-1) showing several levels of integration, where each level is linked with specific responsibilities and actions to be undertaken by DOT central offices and districts, county/city transportation divisions, toll road authorities, transit agencies, public safety agencies, metropolitan planning organizations, MPOs, regional operating organizations, ROOs, multi-state corridor coalitions and the private sector.

Level One: intra-agency local integration, L1. This level of integration recognizes the basic fact that a transportation agency serves a geographic area at a local level. Examples of such geographic divisions include: a state DOT that is divided into regional districts, a local/regional transit agency that has a jurisdiction to serve, and a county/city traffic department that runs its own signal systems within a geographic boundary.

Level Two: intra-agency central Integration, L2. At L2, ITS integration is meant to establish the central command and control capability of an agency's multiple units, which may include independently administered local operational units or geographically separated independent operational units. Establishing a central command and control of all state DOT transportation management centers is an example of intra-agency central integration.

Level Three: inter-agency regional integration, L3. At L3, integration occurs among multiple agencies that provide ITS services in a region. This will include integration of traffic, transit, police, fire and other services in a region.

Level Four: inter-agency statewide integration, L4. At L4, ITS integration is achieved via integrating multiple regional operations within a state.

Level Five: inter-agency multi-state integration, L5. At L5, ITS integration is achieved via integrating multiple operations located in multiple states in a certain geographic transportation corridor.

Level Six: nationwide integration, L6. The nationwide integration is achieved via incremental levels of integrations at L1, L2, L3, L4 and L5.

ITS implementer roles in each of the above levels are shown in Table ES-1. In order to achieve ITS integration in a structured manner, the implementer roles were identified in three types; lead

(L), participatory (P), and regulatory (R) based on implementer's nature of involvement in each of the six integration levels. The table emphasizes that ITS integration activities are expected to be pursued by key ITS implementers at both intra-agency and inter-agency levels, with an ultimate goal to reach a stage of optimal integration of transportation services across jurisdictions, boundaries and modes.

Table ES-1: Integration Relationship and Leadership Matrix

		Levels of Integration and Implementer Roles					
		Intra-agency Local Integration (Level L1)	**Intra-agency Central Integration (Level L2)**	**Inter-agency Regional Integration (Level L3)**	**Inter-agency Statewide Integration (Level L4)**	**Inter-agency Multi-state Integration (Level L5)**	**Nationwide Integration (Level L6)**
Implementer Roles	State DOT ITS Office	P	L	P	P	P	L/P
	State DOT Districts/Regions	L	P	L/P	L	L	P
	County/City Transportation Division	L	L	L/P	P	P	P
	Toll Facility Authorities	L	L	P	P	P	P
	Transit Agencies	L	L	P	P	P	P
	Public Safety Agencies	L	L	P	P	P	P
	Metropolitan Planning Organizations	P	P	P	P	P	P
	Regional Organizations/Consortiums	P	P	L	L	L/P	P
	Multi-State Corridor Coalitions	P	P	P	P	L	L
	Private Sector	P	P	P	P	P	P
	U.S. DOT	R	R	R	R	R	R/L
	Major ITS Actions at Each Level of Integration	Each agency deploys enabling ITS technologies to primarily serve its users/customers	Each agency establishes central integration of agency's multiple centers	Two or more agencies integrate operations via regional data servers and/or co-location	State level integration of similar and interdependent agencies	Multi-State integration of contiguous corridors and/or State agencies	Nationwide integration via transportation information infrastructure

L – Lead Role
P – Participatory Role
R – Regulatory Role

CHAPTER 1

INTRODUCTION

Intelligent transportation systems (ITS) apply advanced technologies in communications, control, electronics, and computer hardware and software to improve surface transportation system performance. Often, several technologies are combined in one incorporated system, providing synergistic benefits that exceed the benefits of any single technology.

Integrated ITS are generally defined in nine broad infrastructure components: Electronic Toll Collection, Emergency Management, Incident Management, Freeway Management, Arterial Management, Regional Multimodal Traveler Information, Electronic Fare Collection, Highway-Rail Intersections and Transit Management *(1)*. For ITS to be effective, systems must share information so that state and local jurisdictions can coordinate their responses to traffic conditions. By standardizing common elements of these systems and establishing physical links between traditionally distinct systems, all components can benefit from each other's information.

Unless ITS are regarded from the start as an integrated set of capabilities, the full benefits will never be realized. Unfortunately, this characteristic of ITS is sometimes overlooked and generally misunderstood by transportation professionals and policy makers. Developing this guidebook to address this issue maximizes the benefits of technology and information from the limited transportation funding and resources that are available. The expectation is that well-planned integration produces ITS improvements that are much more than the sum of their parts.

Agencies are now discovering the tangible benefits of coordinating with each other to plan, deploy, and operate ITS components in an integrated manner. For example, freeway traffic flow can be improved through a combination of technologies that monitor and communicate freeway conditions and recommend alternative routes (e.g., road sensors, video cameras, and electronic signs). These benefits are magnified when freeway management systems are integrated with traffic signal control, transit management, and rail-highway intersection control systems.

While there is a tremendous amount of information available on ITS integration policies through the United States Department of Transportation's ITS Joint Program Office (ITS JPO) and the Florida Department of Transportation (FDOT) ITS Office, little guidance exists on how to apply the information to regional and local ITS integration decisions. To facilitate the application of ITS integration in Florida, the FDOT District 7 contracted with the Center for Urban Transportation Research (CUTR) to develop an ITS Integration Guidebook to assist ITS practitioners and decision-makers. The guidebook represents a single, concise, and practical resource that contains decision-making materials for ITS integration planning and implementation. This guidebook was prepared in fulfillment of a proposal to explore ITS integration as part of the FDOT Research Program.

1.2 Guidebook Purpose and Audience

The guidebook is expected to provide integration guidelines to a national audience of ITS planners and implementers at all levels of government. Although targeted to a national audience, the guidebook recognizes Florida's experience; serving as a companion resource to the previously issued "Florida's ITS Planning Guidelines, Integration of ITS into the Transportation Planning Process," prepared by CUTR for FDOT Office of State Transportation

Planner, and published June 2000. The guidelines can be accessed at http://www.dot.state.fl.us/planning/systems/sm/its/PDFs/Guidelines_080700.pdf. In the context of ITS integration, key implementers discussed in the guidebook include state DOT (central ITS offices and the districts/regions), transportation departments at county/city public works, toll road authorities, transit agencies, public safety agencies (law enforcement, emergency management services, fire and rescue), MPOs and ROOs, and the private sector. For each implementer the guidebook will address a suggested process for achieving ITS integration that will encompass the following focus areas:

- ITS Strategic Plan
- Regional ITS Architecture
- ITS Integration Projects
- Legacy and Interoperability
- Integrated ITS Deployment Goal
- Integration Tracking and Reporting
- Formation of Regional Organizations/Consortiums

1.3 Guidebook Preparation

The guidebook was sponsored by Florida Department of Transportation, FDOT. Mr. Jerry Karp, Planning Programs Manager for FDOT District 7 served as the project manager. The CUTR ITS research team consisted of Mr. Michael Pietrzyk, Ms. Nevine Labib Georggi, and Mr. Firoz Kabir. Preparation of the guidebook consisted of several tasks. First, several ITS professionals were identified to form a peer review group, representing MPOs and the FDOT, to provide content input and oversee the development of the guidebook. The group included Mr. Eric Hill, Metroplan Orlando, Mr. Liang Hsia, FDOT, Mr. Carlos Roa, Miami-Dade County MPO, Mr. Chung Tran, FHWA, Dr. Charles Wallace, PB Farradyne Inc. (previously with University of Florida), and Ms. Sarah Ward, Pinellas County MPO. The group played an integral part in ensuring consensus and support for the ITS Integration Guidebook.

Second, information and activities needed for ITS integration planning were determined. The research team reviewed national and state legislation, policies, plans, and procedures related to ITS integration and summarized the relevant documents and recommendations for ITS integration. The team conducted a state-of-the-practice literature review by searching the U.S. DOT National Transportation Library, the international database Transportation Research Information Services from the Transportation Research Board, the JPO ITS Resource Guide 2001, and other Internet resources. The research team also reviewed national case studies to document different aspects of ITS integration.

Third, specific steps and activities on how to integrate ITS at the regional, state and local levels were determined.

1.4 Guidebook Organization

Chapter 2 offers the definition of ITS integration and sheds some light on the integration process. The national ITS goals are presented in a table format with corresponding examples of potential objectives that state, regional and local ITS implementers can define based on their specific needs. Improved traffic flow, enhanced route planning for travelers and improved emergency response are examples of the benefits of integration listed in Chapter 2. "Architecture integration" and "deployment integration" are among terms defined under the system integration terminology section in this chapter. Shared infrastructure, shared information and coordinated control are implications of multi-jurisdictional integration as presented in

Chapter 2. A description of how ITS infrastructure components communicate or "talk to each other" is offered in this chapter. Highlighted in this chapter is the federal effort to quantify progress in the deployment and integration of ITS components in 78 large metropolitan areas in the nation. A summary of the functions of ITS components, integration links and integration indicators concludes the chapter.

Chapter 3 provides a summary of the major legislative acts and federal rulings guiding ITS integration particularly the National ITS Architecture and Standards Conformity rule published January 8, 2001. As part of provisions of the Transportation Equity Act for the 21st Century, TEA-21, the ITS Integration Program is highlighted in this chapter. Guidance on selection criteria and eligible activities for funding is also summarized in this chapter. An overview of final rule on National ITS Architecture Conformity and Standards related to integration is also provided with special emphasis on RIA as the backbone for ITS integration.

Chapter 4 is an overview of FDOT efforts in ITS Integration. A brief scan of statewide planning documents is offered, with emphasis on the Florida Planning Guidelines as a complement to this guidebook. Goals, objectives, and potential applications of ITS deployment in Florida as stated in the Statewide ITS Strategic Plan are tabulated in this chapter. Coordinated control, active facilities management, and information processing, sharing and warehousing are discussed as the statewide themes of ITS integration. The national ITS tracking database was used to summarize the state of ITS deployment and integration in six metropolitan areas in Florida: Jacksonville, Miami-Fort Lauderdale, Orlando, Sarasota-Bradenton, Tampa-St. Petersburg-Clearwater and West Palm Beach-Boca Raton-Delray Beach. The chapter concludes by providing an overview of the Florida ITS integration experience. Four case studies are discussed: ITS in Volusia County, South Florida Regional Advanced Traveler Information System, SunGuide Road Rangers Service Patrol and Broward County ITS Operations Facilities.

Chapter 5 provides summaries of five national case studies that represent a broad range of ITS integration efforts in their scope, strategies, and the crosscutting nature of physical deployments among multiple jurisdictions. This chapter emphasizes the lessons learned from each case study. These case studies are: 1) Regional Integration: Central Ohio, 2) Multiple State Integration: New York-New Jersey-Connecticut, 3) Corridor Integration: San Antonio's Medical Center Corridor, 4) Cross-Jurisdictional Traffic Signal Coordination: Phoenix Metropolitan Area, and 5) County Integration: Oakland County, Michigan (FAST-TRAC).

The key to a successful interoperable transportation system is to integrate ITS via systems engineering approach into all stages of planning, designing and deployment of transportation projects at the state, regional and local settings. Chapter 6 recommends an iterative process to achieve ITS integration that involves planning, institutional and technical integration steps. The purpose of this chapter is to outline the suggested process and provide the necessary steps to attain integration in planning and implementing ITS. At the core of the suggested approach is the iterative process of developing, using and maintaining a RIA considered to be the focal activity in planning and implementing ITS integration.

Questions concerning ITS integration that policy-makers and planners may ask are answered in the section on planning and institutional integration processes. Answers to potential questions from ITS project designers, operational and technical ITS staff, are offered in separate sections that address technical integration.

Chapter 7 provides perspective on ITS integration in terms of a relationship integration model showing several levels of integration, where each level is linked with specific responsibilities and actions to be undertaken. The purpose of this chapter, and the model, is to provide organizations with a perspective of how mature they are in performing ITS integration, and to explain how to reach policy judgments as to the relative maturity they might want to achieve.

CHAPTER 2

ITS INTEGRATION

In the early days of ITS deployment (late 1980s-early 1990s), transportation system requirements were identified with little regard to adjacent systems. Transportation “efficiency” implied diffusing traffic crises and improving the capacity of the National Highway System. With advances in technology, isolated ITS projects were deployed to serve relatively limited purposes. System design did not include provisions for integration with other existing systems or with future systems. This oversight created a less-than-optimal environment for the traveler because trip-making was not seamless between modes and jurisdictions, and decision-making for the traveler was not easy due to lack of comprehensive information between systems.

This chapter offers interpretations of ITS definitions and various ITS integration terminologies. ITS integration goals, objectives and benefits are discussed in the context of the national ITS program goals. An overview of ITS components for metropolitan ITS infrastructure initiatives is provided, including the integration linkages among various ITS components.

2.1 Definition of ITS Integration

Synonyms of the word “integrate” are: whole, entity, system, sum and totality *(2).* Integration can be defined as the process through which technologies and services are planned, specified, designed, and assembled into a single and complete system to achieve the intended functionality. That being stated, the definition of *integration* can also take on different characteristics and requirements depending upon the context in which it is discussed. Examples of these differences are described later in this chapter (Sections 2.4 and 2.5).

ITS integration projects improve transportation efficiency; promote safety; enhance transit integration; improve paratransit/demand-responsive transit operations, including operations of health and human service providers; improve traffic flow, including the flow of intermodal freight at ports of entry; reduce emissions of air pollutants. They improve traveler information; promote tourism; enhance alternative transportation modes; or support improved transportation systems operations, management and maintenance.

2.2 Integration Goals and Objectives

A goal is defined as a statement based on meeting acknowledged problems developed from needs assessment. A goal, thus, can never be fully achieved, but progress is expected by directing efforts toward it. A goal should express a fundamental and long-range desire that should not change much in the course of years. An objective is defined as a specific directed course of action aimed at goal attainment, which can be measured and monitored by appropriate indicators. The goals and objectives of ITS integration should be developed based on the overall ITS goals defined in the National ITS Program Plan as well as the ITS strategic planning documents developed by the state DOT, the DOT districts/regions, the local government organizations (e.g., the city/county public works departments, and the metropolitan planning organizations) or other regional operating organizations/consortia. The National ITS Program Plan identified the goals and potential objectives for the National ITS Program as seen in Table 2-1, *(3).*

To local and regional ITS planners and implementers, these national and state ITS goals should serve as basis to help define a set of ITS goals for their own regions. Each of the goals identified in the Table can be associated with potential objectives as ITS implementers plan for ITS in their own jurisdictions. Examples of one or more major objectives that can be associated with each of the national ITS program goals are provided in Table 2-1.

Table 2-1: The National ITS Goals and Examples of Potential Objectives

Goals of National ITS Program	Examples of Potential ITS Objectives
Improve the safety of the nation's surface transportation system	Improving safety by reducing the number of collisions and by reducing the severity of collisions when they occur
Increase the operational efficiency and capacity of the surface transportation system	Improving the operational efficiency of the transportation system by reducing disruptions due to incidents and improving the level of service and convenience provided to travelers
Reduce energy and environmental costs associated with traffic congestion and reducing fuel consumption	Reducing harmful emissions, particularly hydrocarbons and carbon monoxide (CO) by reducing congestion
Enhance present and future productivity	Reducing transportation costs for all users of surface transportation system, including businesses, operating agencies, fleet managers, and individuals. Productivity can be improved by reducing the costs incurred by fleet operators and others, by reducing travel time and by improving transportation systems planning and management
Enhance the personal mobility and the convenience and comfort of the surface transportation system	Providing real-time access to pre-trip and en-route information about routes, fares, and connections on bus and rail, and on automobile routes and traffic conditions. Travelers will benefit from greater predictability about their travel times and experience a reduction in the stresses involved in their travel. Other objectives can be built around improving the security of travel on both public and private vehicles.
Create an environment in which the development and deployment of ITS can flourish	Supporting the establishment of a significant U.S.-based industry for hardware, software, and services that can achieve substantial domestic market penetration and a strong international presence.

Source: The National ITS Program Plan, Volume 1, First Edition, U.S. DOT ITS JPO and ITS America, 1995.

While the National ITS Program goals are expected to provide some guidance to the understanding of the nature of ITS goals in general, ITS implementers at local and regional levels are encouraged to consult the region-specific ITS strategic planning documents, if available, in developing ITS integration goals. As a reference, Florida's ITS planning goals are presented in Chapter 4. It is not necessary to develop a new set of ITS goals for every ITS integration activity. This guidebook recommends that regional ITS integration activity goals complement the national and state level ITS goals.

2.3 Benefits of ITS Integration

Transportation agencies are discovering that if they coordinate with each other to plan, deploy and operate ITS components in an integrated fashion, there are tangible benefits to be gained. Likewise, integrated technologies make it easier for agencies to work together, allowing them to share information and resources so that they can each do their job better and often at a reduced cost. According to the U.S. DOT's, the primary benefits of integration include the following *(4)*:

- *Improved Traffic Flow* from freeway management systems is particularly effective in reducing congestion. Traffic operators can combine a wide range of technologies (road sensors, video cameras, and electronic signs) to monitor and communicate conditions and recommendations for alternative routes. These benefits are further enhanced when freeway management systems are integrated with traffic signal control, transit management, and rail-highway intersection control systems.

- *Enhanced Route Planning for Travelers* is improved from real-time information on traffic, road, and weather conditions to select the best routes, modes, and times for travel. Travelers who choose to use this information will be able to make decisions that will reduce trip time and improve safety. Timely information can also enhance the attractiveness of other modes of travel to the automobile, which can save cost and also further reduce congestion by reducing the number of vehicles on the road.
- *Improved Emergency Response and Security for Transit* can reduce personal safety concerns for transit riders. Integrating information systems can greatly improve response time to crime and mechanical emergencies making transit a more attractive mode of travel for the "choice" rider. Buses can be equipped with video surveillance, covert microphones, and silent alarm systems to more rapidly respond with the appropriate assistance. The location of buses and the nearest supervisory vehicle are automatically displayed to the dispatcher on an electronic map with an integrated AVL system, and dispatchers can give emergency response personnel the exact bus location. Also, calls to the dispatcher can be prioritized with an integrated computer-aided dispatch system.
- *Cost Savings, Improved Productivity and Better Customer Service for Transit* can be provided when advanced technologies are integrated together. For example, electronic fare cards can be used on multiple modes providing even more convenience to passengers, and multiple adjacent small transit operators can integrate their dispatching operations into a single system to provide more timely and efficient service at a small portion of the cost for each operator to provide its own dispatching system.
- *Improved Incident Response* is provided by the integration of advanced technologies accelerating incident detection, response, and clearance through shared information. For example, emergency personnel can detect an incident with closed-circuit cameras or special patrol vehicles, and AVL can be used to locate the nearest available emergency response vehicles. Integrated technologies can also enable the coordination of various response agencies so that only those resources most appropriate for that particular incident are properly notified to respond.

2.3.1 Measures of Effectiveness for ITS Benefits

The U.S. DOT ITS JPO has been collecting information in 78 metropolitan areas on the benefits of ITS on the operations and management of surface transportations systems. The ITS Benefits Database (www.benefitcost.its.dot.gov) maintained by U.S. DOT provides a compendium of reported impacts of ITS. The U.S. DOT JPO has established several goal areas, and several measures of effectiveness to evaluate the benefits of ITS in each goal area. An overview of goal areas and the corresponding measures of effectiveness is provided in Table 2-2.

Table 2-2: Measures of Effectiveness for ITS Benefits

Goal Areas	Corresponding Measures of Effectiveness
Safety	Reduce the crash rate of a facility or system
Mobility	Reduce delay in travel times on a facility or system
Efficiency	Increase throughput, which reflects the maximum number of travelers that can be accommodated by a transportation system
Productivity	Increase cost savings (benefit to cost ratio) as a result of implementing ITS
Energy and Environment	Reduce environmental impacts (by reducing emission levels of CO, NOx and HC) and encourage increasing fuel economy (miles/gallon)
Customer Satisfaction	Increase customer satisfaction to travel (as measured through various customer satisfaction surveys)

Source: ITS Program Assessment/Evaluation. *http://www.its.dot.gov/eval/definition.htm*

Table 2-3 provides a summary of the metropolitan ITS benefits by program area as ITS JPO has been actively collecting information regarding the impact of ITS projects on the operation of the surface transportation network.

This guidebook recommends that the benefits of ITS integration activity be evaluated using the same performance measures used for the National ITS Benefits Database.

Table 2-3: Summary of Metropolitan Benefits by Program Area

Program Area	Benefit Measure	Summary
Arterial Management Systems	Safety Improvements	Automated enforcement of traffic signals has reduced red-light violations 20-75%.
	Delay Savings	Adaptive signal control has reduced traffic delay 14-44%. Transit signal priority has reduced bus journey times by 7%.
	Throughput	
	Customer Satisfaction	In Michigan, 72% of surveyed drivers felt "better off" after signal control improvements.
	Cost Savings	Transit signal priority on a Toronto Transit Line allowed same level-of-service with less rolling stock.
	Environmental	Improvements to traffic signal control have reduced fuel consumption 2-13%.
	Other	Between 1969 and 1976 traffic signal preemption systems in St. Paul, MN reduced emergency vehicle accidents by 71%.
Freeway Management Systems	Safety Improvements	Ramp Metering has shown a 15-50% reduction in crashes.
	Delay Savings	In Minn-St. Paul, MN ramp metering has reduced freeway travel time 22% for an annual savings of 25,121 vehicle-hours.
	Throughput	Ramp metering has increased throughput 13-16%
	Customer Satisfaction	After the Twin Cities ramp meter shutdown test, 69% of travelers supported modified continued operations.
	Cost Savings	The GA Navigator (integrated system) supported incident delay reductions for an annual savings of $44.6 million.
Transit Management Systems	Safety Improvements	In Denver, AVL systems with silent alarms have supported a 33% reduction in bus passenger assaults.
	Delay Savings	CAD/AVL has improved on-time bus performance 9-23%.
	Throughput	
	Customer Satisfaction	In Denver, installation of CAD/AVL decreased customer complaints by 26%.
	Cost Savings	In San Jose, AVL has reduced paratransit expense from $4.88 to $3.72 per passenger.
	Environmental	
	Other	More efficient bus utilization has resulted in a 4-9% reduction in fleet size.
Incident Management Systems	Safety Improvements	In San Antonio, integrated VMS and incident management systems decreased accidents by 2.8%.
	Delay Savings	Incident management in city and regional areas has saved 0.95-15.6 million vehicle-hours of delay per year
	Throughput	Models of the Maryland CHART system have shown fuel savings of 5.8 million gallons per year.
	Customer Satisfaction	Customers have been very satisfied with service patrols (hundreds of letters).
	Cost Savings	Cost savings have ranged from 1-45 million dollars per year depending on coverage area size.
	Environmental	Models of the Maryland CHART system have shown fuel savings of 5.8 million gallons per year.
	Other	The I-95 TIMS system in PA has decreased highway incidents 40% and cut closure time 55%.
Emergency Management Systems	Safety Improvements	95% of drivers equipped with PushMe Mayday system felt more secure.
	Delay Savings	
	Throughput	
	Customer Satisfaction	
	Cost Savings	In Palm Beach, GPS/AVL systems have reduced police response times by 20%.
	Environmental	
	Other	

Program Area	Benefit Measure	Summary
Electronic Toll Collection	Safety Improvements	Driver uncertainty about congestion contributed to a 48% increase in accidents at E-PASS toll stations in Florida.*
	Delay Savings	The New Jersey Turnpike Authority (NJTA) E-Zpass system has reduced vehicle delay by 85%.
	Throughput	Tappan Zee Bridge: Manual lane 400-450 vehicles/hour (vph), ETC lane 1000 vph.
	Customer Satisfaction	
	Cost Savings	ETC has reportedly reduced roadway maintenance and repair costs by 14%.
	Environmental	NJTA models indicate E-Zpass saves: 1.2 mil gallons of fuel/yr, 0.35 tons of VOC/day, and 0.056 tons NOx/day.
	Other	20% of travelers on two bridges in Lee County, FL adjusted their departure times as a result of value pricing at electronic tolls.
Electronic Fare Payment	Safety Improvements	Europe has enjoyed a 71-87% user acceptance of smart cards for transit/city-coordinated services.
	Delay Savings	The Metro Card System saved New York approximately $70 million per year.
	Throughput	Europe has enjoyed a 71-87% user acceptance of smart cards for transit/city-coordinated services.
	Customer Satisfaction	The Metro Card System saved New York approximately $70 million per year.
	Cost Savings	Europe has enjoyed a 71-87% user acceptance of smart cards for transit/city-coordinated services.
	Environmental	The Metro Card System saved New York approximately $70 million per year.
	Other	Europe has enjoyed a 71-87% user acceptance of smart cards for transit/city-coordinated services.
Highway Rail Intersections	Safety Improvements	In San Antonio, VMS with railroad crossing delay information decreased crashes by 8.7%.
	Delay Savings	
	Throughput	
	Customer Satisfaction	School bus drivers felt in-vehicle warning devices enhanced awareness of crossings.
	Cost Savings	
	Environmental	Automated horn warning systems have reduced adjacent noise impact areas by 97%.
	Other	
Regional Multimodal Traveler Information	Safety Improvements	IDAS models show the ARTIMIS traveler information system has reduced fatalities 3.2% in Cincinnati and Northern Kentucky
	Delay Savings	A model of SW Tokyo shows an 80% decrease in delay if 15% of vehicles shift their departure time by 20 min.
	Throughput	
	Customer Satisfaction	38% of TravTek users found in-vehicle navigation systems useful when traveling in unfamiliar areas.
	Cost Savings	
	Environmental	EPA-model estimates of SmarTraveler impacts in Boston show 1.5% less NOx, and 25% less VOC emissions.
	Other	Models of Seattle show freeway-ATIS are 2x more effective at reducing delay if integrated with arterial ATIS.

* Database also includes negative impacts of ITS

Source: http://www.benefitcost.its.dot.gov/ , December 31, 2001.

2.4 System Integration Terminologies

This section introduces various terminologies currently in use to describe the integration activities for ITS-based projects. The basic activity inherent to each of these integration terminologies is not mutually exclusive. Rather, an ITS integration effort is likely to be a crosscutting effort involving activities discussed under several integration terminologies described below.

Physical Architecture. The physical architecture is the part of the NIA that provides agencies with a physical representation (though not a detailed design) of the important ITS interfaces and major system components. It provides a high-level structure around the processes and data flows defined in the logical architecture (The logical architecture view of the NIA defines what has to be done to support the ITS user services. It defines the processes that perform ITS functions and the information or data flows that are shared between these processes.) The principal elements in the physical architecture are the subsystems and architecture flows that connect these subsystems and terminators into an overall structure. The physical architecture takes the processes identified in the logical architecture and assigns them to subsystems. In addition, the data flows (also from the logical architecture) are grouped together into architecture 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.

Architectural Integration. This type of integration focuses on the physical and functional inter-connectivity among subsystems and consistency of data format and interfaces. Architecture development is the most fundamental step in any ITS integration process. The National ITS Architecture (NIA) Program materials are used as basic guidance documents for developing a framework for architectural integration. The State ITS Architecture (SIA), the regional ITS architecture (RIA), and corridor ITS architectures are examples of key architectural integration efforts that have been undertaken by various jurisdictions in the nation for over a decade and the efforts are likely to continue in the future. Architecture development efforts are fundamental to ensure that ITS are planned and deployed in an integrated manner within an agency and across jurisdictional lines involving multiple agencies in a region. The complexity of this particular issue is addressed in the integration relationship matrix developed in Chapter 7 of this guidebook, making it practical for ITS implementers to define achievable integration plans for their particular agencies.

In the context of understanding architectural integration, it is assumed that the users of this guidebook are familiar with key NIA terms such as user services, market packages, subsystems, functions and interfaces. A glossary of NIA terms can be found at http://itsarch.iteris.com/itsarch/html/glossary/glossary.htm

There are two types of system integration at the architectural level; functional and semantic or data integration *(5).*

> *Functional Integration* defines the purpose of each ITS-based subsystem and the necessary interfaces for data sharing for each subsystem. In most cases, the basis for functional integration is the architectural integration previously described. Details for *functional integration* include:
>
> - Identifying where each user service is to be conducted,
> - Determining from where and how data will be collected and analyzed,
> - Deciding which functions will be shared among user services,
> - Selecting the most effective means of data sharing among user service sites, and
> - Agreeing between agencies about the terms of operating and managing the system.
>
> *Data integration* ensures that the same data means the same thing in different portions of the system, is acceptable to senders and receivers of the data, and that a translation mechanism exists to resolve any data inconsistencies to allow for exchange of

information across subsystems. It can become difficult to integrate subsystems if the same data is defined differently among the subsystems that need to "talk" with each other, or when identical data is named differently in each subsystem. Data inconsistencies can exist when different vendors provide different subsystems, but can be remedied when standards are used for definition and naming of data elements, message sets, processes, files, and documents across all the subsystems. The use of these standardized definitions throughout the architecture facilitates integration of user services and market packages.

Deployment integration. Deployment integration focuses on coordination of technologies (hardware and software) that support the transfer of data among the subsystems, which in most likelihood, have been previously identified in the architectural integration activity described above. At the deployment level, different contractors may formulate system architectures for different agencies or regions differently on different projects. However, with the National ITS Architecture and related standards, systems integration at the regional or local level becomes much more defined and efficient even though multiple contractors/vendors are used for hardware/software deployment. There are four types of deployment integration that allow the contractor to become both an assembler of components as well as a system manager:

Technology integration binds the system together through automatic transfer of data, common database structures, and well-defined communication interfaces. Well-defined communication interfaces increase the potential for inter-operability, and also lower costs associated with system procurement and integration.

Product/Service integration takes into account the synergistic potential in deploying ITS products and services. It is critical for the systems integrator to understand that some products and services offer inherent integration opportunities. For example, ramp metering and incident detection may require traffic detectors that can be used by both systems. Additionally, ramp metering may be able to reduce downstream incidents on the freeway so the net benefits from the combined deployment can be greater than the sum of each individual service.

User integration allows the traveler to experience seamless mobility and not have to be overwhelmed by the technologies or even notice the user interfaces between modes and jurisdictions. This type of integration is supported by but is not defined by the architecture. Standardization also stimulates healthy competition among service vendors.

Inter-jurisdictional integration (often referred to as institutional integration) is arguably the most difficult to accomplish. Lack of coordination between state and local (and between local) jurisdictions is common across the county. A particular challenge to this type of integration is to identify continuously changing players, roles, and responsibilities, who are in charge, and who is to pay for deployment and operations among participating jurisdictions. Each transportation agency generally operates independently because the infrastructure needs are funded locally, and this independence usually results in inefficiencies. One of the best examples of this inefficiency is the lack of coordinated traffic signals along a single corridor that passes through multiple jurisdictions. Only if these institutional barriers are broken down can a common architecture across jurisdictions be established and implemented. The regions that have developed regional/state/corridor ITS architectures have already accomplished a key step at the planning level towards inter-jurisdictional integration. It is expected that the transportation infrastructure developers, service providers and users in the region who have already participated in the development of a regional/state/corridor ITS architecture, as well as the new participants, will continue the dialogue through regional or MPO ITS committee forums to accomplish seamless integration of ITS across jurisdictions.

Emphasis on steps and tips to achieve this type of integration is seen throughout this guidebook. The process to achieve planning integration is presented in Chapter 6, while guidance to implementers' roles and responsibilities at various levels of inter-agency integration is presented in the proposed integration relationship matrix in the final chapter of the guidebook.

2.5 Implications of Multi-Agency Integration

Deploying integrated ITS across jurisdictional borders or achieving integration of ITS among multiple agency operations is inherently more complex and requires a higher level of technical and institutional coordination than deploying isolated ITS projects or systems. There are three progressively more complex phases of integration that have been defined for ITS infrastructure. In increasing order of complexity, they are shared infrastructure, shared information, and coordinated control *(6)*.

2.5.1 Shared Infrastructure

Sharing physical infrastructure refers to the joint use by different agencies of the same equipment. Many times a metropolitan area might construct a regional communication backbone to support interactions between ITS components, and this shared communications link would eliminate the needs and associated costs to build many point-to-point links. Sharing infrastructure requires technical coordination to make certain that transmitting and receiving equipment are compatible and comply with applicable standards, and institutional coordination to make certain that each individual agency's needs are addressed. When two government entities are sharing infrastructure for similar deployments, for example laying communications cables, the possibility of "shared funding" also exists.

In San Antonio, Texas, two agencies are sharing a single fiber-optic communications cable. The Travel Speed Database uses the cable to communicate and maintain a record of transportation network speed information. The Lifelink project equips ambulances with video conferencing capabilities, and uses the same communications cable to allow emergency room staff at nearby hospitals to remotely monitor patients' vital signs and interact with paramedic personnel at the incident site and while the ambulance is in transit.

In Florida, a shared communication link via fiber-optic cable along 2,200 miles of state roadway right-of-way is planned to link eight FDOT regions located throughout the state with each other by year 2006, and this same communications system is available to support communications for other state facilities such as major educational institutions.

2.5.2 Sharing Information

Sharing information refers to the transfer of data between agencies. The types of information that may be transferred can include data and graphic images about traffic conditions, incident information, incident response actions, traffic control actions, etc. For example, emergency management personnel may receive live video surveillance from a traffic management source in order to provide more efficient and effective response to incidents. Sharing real-time information requires overcoming a more complicated set of technical and institutional barriers than associated with just sharing infrastructure. Specific video feeds and other data may have to be called for and received in a timely manner. Reliable information exchange requires advance planning, discussion, and execution among participating agencies.

In Seattle, Washington, a total of 19 jurisdictions share information collected as part of the Smart Trek Metropolitan Model Deployment Initiative, MMDI. This project compiles information from comprehensive data for key traffic corridors being received in real-time from multiple traffic management centers. The information from this electronic database provides a regional traffic management overview, which utilizes stored historical traffic and transit data for joint planning and research purposes.

In southeast Florida, the South Florida Advanced Traveler Information System (ATIS) is providing real-time traveler information throughout a three-county area (Palm Beach, Broward, and Dade) in a public/private partnership with SmartRoute, Inc. Three FDOT regional offices, three MPOs, an Expressway Authority, and several other municipal agencies are sharing in this partnership. The traveler information is primarily provided by gathering existing travel conditions through infrastructure owned by the local and regional transportation operating agencies in the partnership. Through the partnership agreement, SmartRoute has direct access to public agency traffic information that it can verify and may enhance before publishing. The publication of traveler information occurs via any one of several media such as Internet, telephone, and TV.

2.5.3 Coordinated Control

Coordinated control refers to the most complete, comprehensive type of integration. This phase occurs when one transportation agency uses shared information to make control decisions for a broader purpose. Agencies merely sharing information may still alter their individual control strategies based on data received from another agency. On the other hand, agencies participating in coordinated control jointly plan and execute their activities. For example, in anticipation of traffic congestion caused by a special event, the adjacent municipalities may jointly establish traffic signal plans to improve the system wide ability to clear out the congestion. Coordinated control requires overcoming the highest levels of technical and institutional barriers, as well as developing and utilizing compatible communications and computer platforms. An agency would, typically, give up some or all of is control for the good of the common system under coordinated control. Instead of only a local focus, this phase of integration requires that participating operating agencies adopt a regional concept of operations approach while still maintaining interest in traffic activities that are totally local in consequence.

In Phoenix, Arizona, several agencies have integrated ITS technologies to coordinate traffic management control activities. The AZTech Smart Corridor arterial traffic signal control system and the Arizona Department of Transportation's Freeway Management System are integrated to attempt a seamless traffic management system. In addition to day-to-day coordination, joint traffic control and management plans for incidents and special events are also being formalized.

In Tampa, Florida, the Tampa-Hillsborough County Expressway Authority (THCEA) is designing and constructing a nine-mile, elevated, limited access, reversible-lane toll facility between I-75 and downtown Tampa. This future facility is located in the median of THCEA's existing four-lane divided toll road. Due to the regional nature of this facility and the complexity of the daily real-time operating requirements for a reversible facility, the THCEA and the county and city through which the Expressway flows are jointly developing a plan for control and operation of the reversible lane facility during regular commuting, special downtown events, and incidents on parallel roadways.

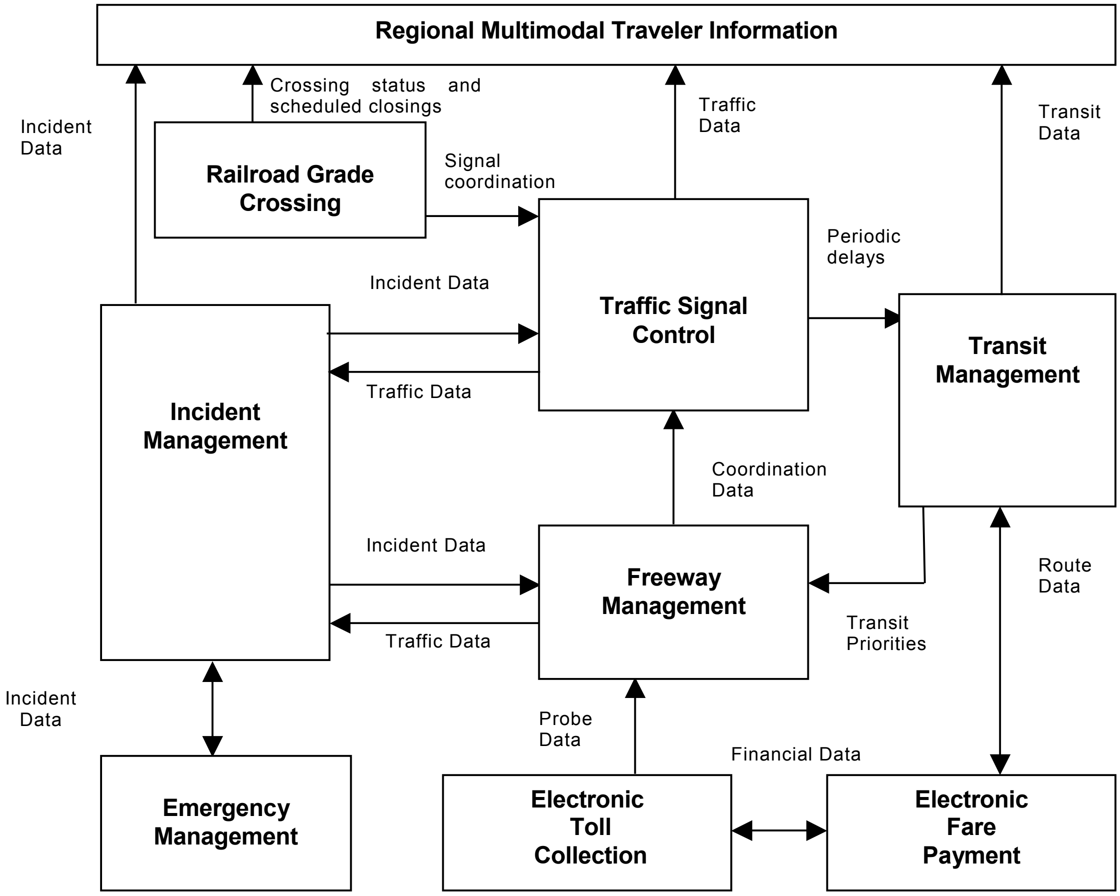
As noted earlier, an integration relationship matrix is developed later in this guidebook (Chapter 7, Table 7-1), where shared infrastructure, shared information and coordinated control are the anticipated outcomes at all levels of inter-agency integration.

2.6 Integrated ITS Infrastructure Components

Integration of components takes place through the transfer of information between components, and the use of transferred data by components. One study lists thirty-two information exchanges possible between ITS components, some between and some within components. Figure 2-1 shows the possible data exchanges among the nine ITS components.

The intra-component exchanges occur within the Traffic Signal Control (TSC), Electronic Toll Collection (ETC), and Electronic Fare Payment (EFP) components. Within a TSC system, for example, data can be exchanged between traffic signals across multiple local jurisdictions within the same metropolitan area; therefore making better arterial signal coordination possible. A common electronic tag can also be used at toll collection points owned and operated by different toll authorities, making integration within an ETC system possible *(7).*

Figure 2-1: Data Flows Between Integrated ITS Infrastructure Components



Source: Building the ITI: Putting the National Architecture into Action, Mitretek Systems, FHWA, April 1996, p. 24, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPT_MIS/BJ01!.PDF

Starting at the left side of Figure 2-1 are two tightly coupled components: Incident Management (IM) and Emergency Management (EM). IM has interfaces with the Regional Multimodal Traveler Information (RMTI) and Traffic Signal Control (TSC) and Freeway Management (FM) components. IM receives traffic data from the TSC/FM components whenever there is an indication of the possible presence of congestion. These data include such information as vehicle counts, queue lengths, and speeds. IM analyzes these data for incidents. If the system detects an incident, the appropriate IM functions are carried out. This includes passing the location of the incident on to the EM component, if appropriate. EM will dispatch the appropriate vehicles to the scene. Details on the incident and the response status are passed back in the reverse direction from EM to IM. In addition, details on the location, time, type, and severity of the incident are passed to RMTI and TSC/FM. Information on predicted incidents, such as planned lane closures, is also passed. For RMTI, incident data are supplemented with information on the impact on traffic. Incident data passed back to TCS/FM enable signal timings to be adjusted to allow green waves for emergency vehicles responding to the incident. Incident data also serve as the basis for generating messages displayed on Dynamic Message Signs (DMS).

Transit data are transferred directly by the Transit Management (TM) shown on the right side of the diagram for use by RMTI. There are two basic types of transit data. The first type does not change rapidly over time. It includes information on transit routes, schedules, and services.

Clearly, such information does not have to be exchanged on a minute-by-minute basis. The second type of transit data is dynamic and includes estimated arrival times at transit stops and destinations, and deviations from published schedules and routes. TM generates data for its own operation and makes it available to the RMTI component for dissemination to the traveling public. It is responsible for packaging the data and disseminating it to the public in a variety of formats. For example, the route number of an approaching transit vehicle can be displayed on electronic signs at roadside transit stops. Interactive kiosks and personal hand-held devices can receive the data for use in trip planning, or an Independent Service Provider can broadcast the information over a wide area. This division of responsibility between TM and RMTI is illustrative of how the architecture assigns functional responsibility and why the various Intelligent Transportation Infrastructure (ITI) components must be integrated to provide maximum benefit. It also illustrates the regional variations allowed while still conforming to the architecture. TSC/FM, shown at the center of the figure, are the hub of the ITI. Both of these components are responsible for the surveillance, monitoring, device control, and management of the road network. Each passes traffic data to the IM and TM components. These data include link travel times, traffic volumes, and speeds currently flowing on the road and highway network. Model predictions for these quantities may also be included. The traffic data are also output to RMTI. There they are disseminated to the public for trip planning and other purposes.

The TSC/FM components monitor the current traffic situation through surveillance equipment and through receipt of incident data. A portion of this information is passed on to TM in the form of predicted delays along various portions of the road network. TM needs these data to manage transit vehicle schedule deviations and generate the necessary corrective actions such as the introduction of extra vehicles or the premature termination of some services. It would be inefficient for TM to duplicate the collection of raw traffic data and generate the delay information. Again, by integrating ITI components, the architecture enables TM to take advantage of the available information in another component.

Information also flows in the reverse direction—from TM to the TCS/FM components. This takes the form of transit priorities. Static priority data is passed from TM to TSC. This establishes the overall transit priority on the roadway. Real-time priority data is also passed. Originating within transit vehicles, these data allow TSC to adjust traffic signals. Priority or even signal preemption is given to transit vehicles in accordance with the overall management philosophy.

Similar static and dynamic priority data are also passed from TM to FM. This allows control signals at freeway ramps to be adjusted in accordance with an overall ramp management philosophy. The TSC/FM components also exchange coordination data with each other as shown inside the larger box. The coordination data flow allows the traffic management strategies on the freeways, the freeway ramps, and the surface street network to act as an integrated system. These data define the actions to be taken by the system when a particular signal timing plan is in effect on the road network, and when a particular sign plan is in effect on the highways. For example, ramp meter timings and traffic signal controls could be coordinated to ensure that queues do not back up into intersections. Or consider a scenario in which traffic is being diverted off a freeway to bypass an incident. Traffic signal timings can be adjusted to handle the increased flow on the arterials. At the same time, DMSs can be updated along the arterials to give directions on how to return to the freeway beyond the incident location.

ETC is responsible for automatic collection of tolls so that motorists do not have to stop to pay them. Although this offers significant benefits as an isolated system, there is further synergism obtained by integrating ETC with other ITI components. In particular, the ETC roadside and vehicle electronics can be used as a source of traffic probe surveillance data for TSC/FM components.

Financial data may be transferred between ETC and EFP components. These data facilitate intermodalism. Advanced payments are made and then converted to either fares or tolls as the travelers' need arises. Without this interface between the ETC and EFP components, travelers would have to maintain separate accounts for tolls, transit fares, and parking. The goal is to be able to use a standard credit card, much as being done in many supermarkets or at gas pumps.

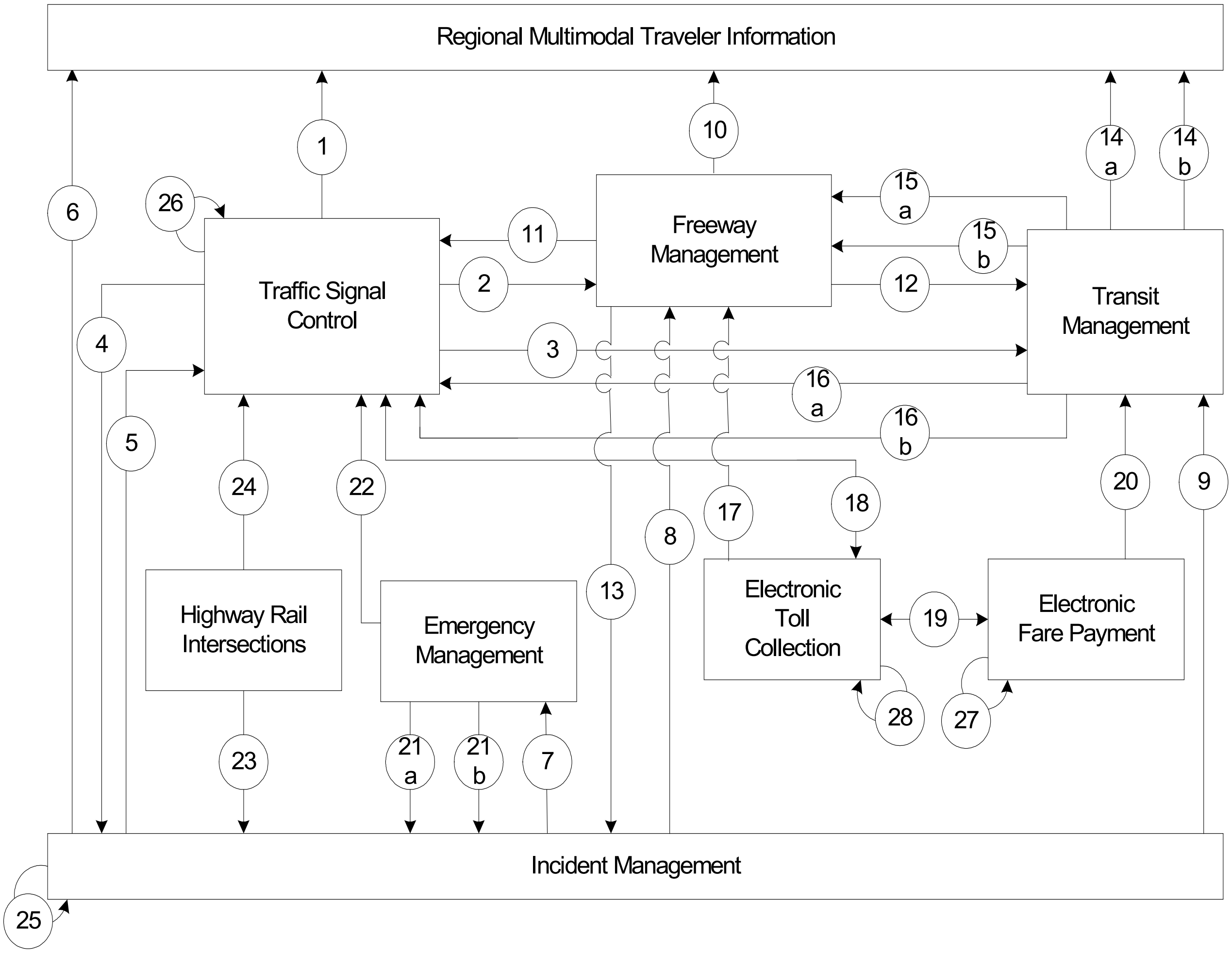
The RMTI component is the most visible one in that it provides information to the public. It receives incident, traffic and transit data from the other ITI components. Multiple jurisdictions and agencies are involved in this process. The data are combined to provide a region-wide, multi-modal information stream for dissemination to the public. A variety of electronic media can be used to get information to travelers and businesses, ranging from radio and TV broadcasts and transit kiosks, to subscriber information via personal devices. While much of ITI is public sector deployment, RMTI presents opportunities for private sector Information Service Providers (ISPs).

2.7 Measuring ITS Deployment and Integration

In January 1996, the U.S. DOT set a goal of deploying integrated ITS infrastructure in 75 (recently raised to 78) of the nation's largest metropolitan areas by 2006 *(8)*. In order to track progress toward fulfillment of this goal, U.S. DOT ITS JPO developed the metropolitan ITS deployment tracking methodology in 1997. This methodology tracks deployment of the nine components that make up the ITS infrastructure: FM; IM; AM; EM; TM; ETC; EFP; HRI; and RMTI. Figure 2-2 depicts the infrastructure components and their linkages. Table 2-4 lists the information flow linkages (interactions) between the ITS infrastructure components.

Information is gathered through a set of surveys periodically distributed to metropolitan area agencies involved with these infrastructure components. The surveys gather information on the extent of deployment of the infrastructure and on the extent of integration between the agencies that operate the infrastructure. Deployment is measured using a set of indicators tied to the major functions of each component. Integration is measured by assessing the extent to which agencies share information and cooperate in operations based on a set of defined links between the infrastructure components.

Figure 2-2: Integration Linkages between ITS Infrastructure Components



Source: Measuring ITS Deployment and Integration, U.S. DOT ITS JPO, January 1999, p. 6, *http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf*

Table 2-4: Shared and Used Information at Integration Linkages between ITS Infrastructure Components

Link	From - To	Information Shared	Information Use
1	TSC to RMTI	Arterial travel times, speeds and conditions	Display to travelers via RMTI media
2	TSC to FM	Arterial travel times, speeds and conditions	Adjust freeway ramp meters, VMS or HAR
3	TSC to TM	Arterial travel times, speeds and conditions	Adjust transit routes and schedules
4	TSC to IM	Arterial travel times, speeds and conditions	Detect incidents and manage incidents response activities
5	IM to TSC	Incident severity, location, and type	Adjust traffic signal timing
6	IM to RMTI	Incident severity, location, and type	Display to travelers via RMTI media
7	IM to EM	Incident severity, location, and type	Incident notification
8	IM to FM	Incident severity, location, and type	Adjust freeway ramp meters, VMS, or HAR
9	IM to TM	Incident severity, location, and type	Adjust transit routes and schedules

Link	From - To	Information Shared	Information Use
10	FM to RMTI	Freeway travel times, speeds, and conditions	Display to travelers via RMTI media
11	FM to TSC	Freeway travel times, speeds, and conditions	Adjust traffic signal timing
12	FM to TM	Freeway travel times, speeds and conditions	Adjust transit routes and schedules
13	FM to IM	Freeway travel times, speeds, and conditions	Detect incidents and manage incident response
14a	TM to RMTI	Routes, schedules, and fares	Display to travelers via RMTI
14b	TM to RMTI	Transit schedule adherence	Display to travelers via RMTI
15a	TM to FM	Transit vehicle ramp preemption	Adjust ramp meters
15b	TM to RM	Transit vehicle probe date	Determine freeway conditions
16a	TM to TSC	Transit vehicle signal priority	Adjust traffic signals
16b	TM to TSC	Transit vehicle probe data	Determine arterial conditions
17	ETC to FM	Vehicle probe data	Adjust freeway ramp meters, VMS, and HAR
18	ETC to TSC	Vehicle probe data	Adjust traffic signal timing and determine arterial conditions
19	ETC to/from EFP	Fare or toll payment credit information	Share fare and toll payment media
20	EFP to TM	Rider origin/destination information	Transit service planning
21a	EM to IM	Incident notification	Incident detection
21b	EM to IM	Incident clearance	Manage incident response
22	EM to TSC	Emergency vehicle signal preemption	Adjust traffic signals
23	HRI to IM	Crossing status	Incident detection
24	HRI to TSC	Crossing status	Adjust signal timing
25	IM (intra)	Incident severity, location, type	Incident detection and response
26	TSC (intra)	Traffic signal timing	Adjust traffic signal timing
27	EFP (intra)	Fare payment credit information	Fare payment
28	ETC (intra)	Toll payment credit information	Toll payment

ITS Components
EFP – Electronic Fare Payment
EM – Emergency Management
ETC – Electronic Toll Collection
FM – Freeway Management
HAR – Highway Advisory Radio
HRI – Highway Rail Intersection
IM – Incident Management
RMTI – Regional Multimodal Traveler Information
TM – Transit Management
TSC – Traffic Signal Control
VMS – Variable Message Sign

Source: Measuring ITS Deployment and Integration, January 1999. ITS Joint Program Office, US DOT, p.7, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf

Table 2-5 summarizes the functions of the nine ITS components, the integration links for each, and the indicators chosen to serve as estimators of the extent of technology deployment supporting critical functions. For each component, one of these indicators has been designated to serve as a summary for the whole component.

The significance of deployment indicators in quantifying deployment are emphasized in Chapter 4 where measuring ITS deployment and integration in Florida is presented. In Chapter 7, a recommendation to standardize the tracking process using the national tracking database questionnaires is discussed.

Table 2-5: Summary of Functions of ITS Components, Integration Links and Deployment Indicators

ITS Components	Functions	Integration Links (Relationship to other components)	Indicators
Electronic Fare Payment	▪ Capability to pay public transit fares on fixed-route bus and light-rail transit vehicles using EFP media. ▪ Capability to pay public transit fares at heavy-rail transit stations using EFP media.	▪ One integration link is with TM when ridership details collected as part of EFP are used in transit planning (i.e., origin-destination patterns of transit riders are used to manage routes and schedules better). ▪ Integration link with operators of different public transit services share common electronic fare payment media.	▪ Percentage of fixed-route bus and light-rail transit vehicles that accept electronic payment of fares ▪ Percentage of heavy-rail transit stations that accept electronic payment of fares
Incident Management	▪ Capability to detect incidents on the freeway and arterial roadway system (i.e., incident detection). ▪ Capability to verify incidents on the freeway and arterial roadway system (i.e., incident verification). ▪ Capability to respond to incidents on the freeway and arterial roadway system (i.e., incident response).	▪ IM monitors real-time arterial travel times, speeds, and conditions using data provided by TSC to detect arterial incidents and manage response, ▪ Incident location, severity and type are displayed by RMTI media, ▪ Incident location, type and severity is used to notify EM for response, ▪ Monitors freeway travel time, speed and condition data collected by FM to detect incidents and monitor response.	▪ Percentage of miles covered by incident detection algorithms ▪ Percentage of miles covered by free cellular calls to a dedicated number, ▪ Percentage of miles covered by on-call towing services or publicly-sponsored service patrols (like the "Road Rangers" that patrol I-95 and other freeways in Florida), ▪ Percentage of miles covered by surveillance cameras, ▪ Existence of a formal incident management plan or team (as exists in an increasing number of metropolitan areas throughout the nation).
Emergency Management	▪ Capability to operate public sector emergency vehicles under CAD. ▪ Capability to provide public sector emergency vehicles with in-vehicle route guidance capability.	▪ EM vehicles being equipped with traffic signal priority capability ▪ EM provides incident clearance activity status to IM for the purpose of managing incident response, ▪ EM notifies IM of location, severity and type of incident for the purpose of acknowledging incidents on arterials and freeways	▪ Percentage of emergency vehicles under computer-aided dispatch, ▪ Percentage of emergency vehicles that have in-vehicle navigation systems
Regional Multimodal Traveler Information	▪ Collect current, comprehensive, and accurate roadway and transit performance data for the metropolitan area. ▪ Provide traveler information to the public via a range of communication techniques (broadcast radio, FM subcarrier, the Internet, cable TV) for presentation on a range of devices (home/office computers, television, pagers, personal digital assistants, kiosks, radio) ▪ Provide multimodal information to the traveler to support mode decision-making.	▪ RMTI media displaying arterial travel times, speed and condition data from TSC ▪ RMTI media displaying incident location, severity and type information from IM ▪ RMTI media displaying freeway travel time, speed and condition information from FM ▪ RMTI media displaying transit routes, fixed schedule and schedule adherence status, and fare information from TM	▪ Percentage of total possible media types used to display information to travelers ▪ Percentage of total possible media types used to display information of two or more travel modes to travelers ▪ Percentage of freeway miles surveillance data provided from FM
Electronic Toll Collection	▪ Automatically collect toll revenue through the application of in-vehicle, roadside, and communication technologies to process toll payment transactions (i.e., electronically collect tolls).	▪ Vehicles equipped with ETC tags are monitored by FM for purposes of determining freeway travel times and speeds ▪ Vehicles equipped with ETC tags are monitored by TSC for purposes of determining arterial travel times and speeds ▪ Transit operators accept ETC tags for EFP ▪ ETC agencies share a compatible toll tag to facilitate seamless toll transactions.	▪ Percentage of toll collection lanes with electronic toll collection capability ▪ Percentage of toll collection plazas with electronic toll collection capability.

ITS Components	Functions	Integration Links (Relationship to other components)	Indicators
Transit Management	▪ Capability to monitor the location of transit vehicles to support schedule management and emergency response (i.e., Automatic Vehicle Location [AVL]). ▪ Capability to monitor maintenance status of the transit vehicle fleet (i.e., vehicle maintenance monitoring). ▪ Capability to provide demand responsive flexible routing and scheduling of transit vehicles (i.e., paratransit management). ▪ Capability to provide real-time, accurate transit information to travelers (i.e., information display).	▪ Adjustment of routes and schedules in response to arterial travel times, speeds and conditions provided by TSC ▪ Adjustment of routes and schedules in response to incident location, severity and type provided by IM ▪ Adjustment of routes and schedules in response to freeway travel times, speeds and conditions provided by FM ▪ Freeway ramp meters are adjusted in response to transit vehicle pre-emption notification ▪ Traffic signals are adjusted in response to transit vehicle pre-emption notification ▪ Transit vehicles equipped with automatic vehicle location technology are monitored as probe vehicles by TSC for determining arterial speeds and travel times (excluding dwell times at stops).	▪ Percentage of fixed-route transit vehicles equipped with AVL (global positioning based AVL preferred over sign-post beacons) ▪ Percentage of fixed-route transit vehicles equipped with electronic monitoring of vehicle operating and maintenance conditions ▪ Percentage of paratransit vehicles under computer-aided dispatching ▪ Percentage of bus stops with electronic display of information ▪ Number of public locations where real-time transit information is displayed.
Freeway Management	▪ Capability to monitor traffic conditions on the freeway system in real-time (i.e., traffic surveillance). ▪ Capability to implement appropriate traffic control and management strategies (such as ramp metering and lane control) in response to recurring or non-recurring flow impediments (i.e., traffic control). ▪ Capability to provide critical information to travelers through infrastructure-based dissemination methods such as VMS, HAR, or In-Vehicle Signing (IVS) (i.e., information display).	▪ Monitoring arterial travel times, speeds and conditions using data provided from TSC to adjust ramp metering, lane use control, and HAR in response to changing conditions on parallel arterials ▪ Monitoring incident location, severity and type from IM to adjust ramp metering, lane use control, or HAR.	▪ Percentage of freeway centerline miles covered by permanent dynamic message sign systems ▪ Percentage of freeway centerline miles covered by HAR ▪ Percentage of freeway centerline miles covered by in-vehicle information displays ▪ Percentage of freeway centerline miles controlled by lane use control systems ▪ Percentage of freeway centerline miles controlled by ramp metering ▪ Percentage of freeway centerline miles under electronic surveillance.
Highway-Rail Intersection	▪ Coordinate rail movements with the traffic control signal systems ▪ Provide travelers with advanced warning of crossing closures ▪ Improve and automate warnings at highway-rail intersections	▪ IM is automatically notified of crossing blockages by HRI for better management of incident response ▪ Interconnection of HRI and TSC to automatically adjust signal timing during train crossings.	▪ Percentage of highway-rail intersections under electronic surveillance.
Arterial Management	▪ Capability to monitor traffic flow conditions on arterials in real-time (i.e., traffic surveillance). ▪ Capability to implement traffic signal timing patterns that are responsive to traffic flow conditions (i.e., traffic control). ▪ Capability to provide critical information to travelers through infrastructure-based dissemination methods such as VMS, HAR, or IVS (i.e., information display).	Integration links not previously mentioned under other components include: ▪ Agencies operating traffic signals along common corridors sharing information, possibly control to maintain progression	▪ Percentage of agencies and municipalities in charge of traffic signal operation across the region that have cooperative agreements in place to share information for coordinated control ▪ Percentage of arterial system miles that have electronic monitoring (multi-point/segment flow detection is preferred, along with surveillance capabilities for public parking lot occupancies) ▪ Percentage of traffic signals under closed loop or centralized control (adaptive signal control is preferred over static timing plans based on historical data).

CHAPTER 3

CONSISTENCY WITH NATIONAL ITS POLICIES

This chapter provides an overview of the major legislative acts and federal rulings that impact ITS integration. The two current major acts and/or rulings that address ITS integration projects are:

- Transportation Equity Act for the 21st Century (TEA-21), Title V Subtitle C--Intelligent Transportation Systems *(9).* Section 5208 addresses the ITS Integration Program, Section 5209 addresses Commercial Vehicle ITS Infrastructure Deployment.
- The final FHWA rule (23 CFR 940) of January 8, 2001 promotes deployment of integrated ITS in accordance with regional ITS architectures and ITS standards. The provisions in the rule help to speed ITS deployments by requiring development of regional ITS architectures no later than April 7, 2005 *(10).* The rule was effective April 8, 2001. On the same date, the FTA adopted a policy of attaining consistency of projects with the regional ITS architectures and ITS standards, and thereby had similar intent to the FHWA rule, differing mainly in regard to recognizing a different type of grant administration than with highway grants *(11).* Rule 23 CFR 940, and a companion FTA policy, on National ITS Architecture Consistency and Standards, deal with architecture conformity issues.

The above policies are designed to inform and guide ITS practitioners, state and local agencies on many transportation-related-issues from both planning and implementation perspectives. The following sections will discuss the above policies as they relate to ITS integration in particular. The objective of this discussion is to provide the reader with description, interpretation, and observation with regard to national ITS rules and policies.

3.1 TEA-21 ITS Integration Program

TEA-21 enacted by Congress in 1997, created a two-part ITS deployment program. One part was the ITS Integration Program (Section 5208 of TEA-21) established to increase integration and interoperability of ITS systems in metropolitan and rural areas. Interoperability refers to individual subsystems' ability to communicate with each other and work as a single system. The other part is the Commercial Vehicle ITS Deployment, which is not discussed in this guidebook. The ITS Integration Program in TEA-21 provides federal funding for the integration of multi-modal ITS components in a variety of settings, including large regional areas (for example, statewide, multi-state, or multi-city), metropolitan areas, non-metropolitan areas, and rural areas. According to the program description, ITS integration projects should improve transportation efficiency, promote safety; enhance transit integration; improve paratransit/demand responsive transit operations, including operations of health and human service providers; improve traffic flow, including the flow of intermodal freight at ports of entry; reduce emissions of air pollutants; improve traveler information; promote tourism; enhance alternative transportation modes; or support improved transportation systems operations, management and maintenance.

3.1.1 ITS Integration Program Funding Criteria

The program requires local matching funds that at least equals the federal ITS funds being provided (i.e., 50% federal and 50% local). Projects qualifying for funding under this program must meet the criteria summarized in Table 3-1. Although the "50% local" may include other federal aid, the 50% strictly local funds must provide a 20% match for all federal funds. By specifying these funding requirements, local partnerships are encouraged to show evidence of strong local support.

Table 3-1: Summary of ITS Integration Program Criteria

Contribute to national deployment goals and objectives
Demonstrate a strong commitment to stakeholder cooperation and partnering
Encourage, maximize, and leverage private sector involvement and financial commitment
Demonstrate inclusion in statewide or metropolitan transportation planning processes
Ensure long-term operation and maintenance without continued reliance on federal ITS funds
Demonstrate conformity to national architecture and standards
Demonstrate that personnel have the necessary technical skills and training for effective operations
Mitigate adverse impacts on bicycle and pedestrian safety
For rural areas, address economic development goals

Source: Participation in the ITS Deployment Program, as authorized in TEA-21, May 7, 1999, http://www.its.dot.gov/tea21/solfy00.htm

Additional details on the ITS Integration Program Criteria, as stated in Section 5208 of TEA-21, are provided below. The projects selected for ITS integration program funding shall:

1) Contribute to national deployment goals and objectives outlined in the National ITS Program Plan (briefly discussed in Chapter 1; also a synopsis of the Plan can be found at http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_PR/2YT01!.PDF.)
2) Demonstrate a strong commitment to cooperation among agencies, jurisdictions, and the private sector, as evidenced by signed memoranda of understanding that clearly define the responsibilities and relations of all parties to a partnership arrangement, including institutional relationships and financial agreements needed to support integrated deployment;
3) Encourage private sector involvement and financial commitment, to the maximum extent practicable, through innovative financial arrangements, especially public-private partnerships, including arrangements that generate revenue to offset public investment costs;
4) Demonstrate commitment to a comprehensive plan of fully integrated intelligent transportation system deployment in accordance with the national ITS architecture and standards and protocols;
5) Be part of approved plans and programs developed under applicable Statewide and metropolitan transportation planning processes and applicable State air quality implementation plans, as appropriate, at the time at which federal ITS funds are sought;
6) Minimize the relative percentage and amount of federal ITS funding to total project costs;
7) Ensure continued, long-term operations and maintenance without continued reliance on Federal ITS funding as evidenced by documented evidence of fiscal capacity and commitment from anticipated public and/or private sources;

8) Demonstrate technical capacity for effective operations and maintenance or commitment to acquiring necessary skills;
9) Mitigate any adverse impacts on bicycle and pedestrian transportation and safety; and
10) In the case of a rural area, meet other safety, mobility, geographic and regional diversity, or economic development criteria.

3.1.2 Guidelines for Funding Eligibility

TEA-21 funding incentives for ITS integration is set at $75 million, nationally, for fiscal year (FY) 1999, $83 million for FY 2000, $83 million for FY 2001, $85 million for FY 2002, and $85 million for FY 2003. About 90 percent of this funding is available for ITS integration activities in metropolitan areas and 10 percent for rural ITS integration.

FHWA has provided eligibility guidelines for TEA-21 ITS integration program funding. The funding may be used to support *(12):*

- System design and integration of existing ITS systems: examples include traffic signal control, freeway management, incident management, transit management, electronic fare payment, highway-rail intersection control, emergency services management, traveler information services, paratransit and demand-responsive transit, and electronic toll collection.
- Creation of a regional multi-modal transportation information system that would support public sector transportation management needs.
- Creation of a data repository of real-time, multi-modal traveler information for dissemination to the traveling public, businesses and commercial vehicle operators through a variety of delivery mechanisms, and possibly as a value-added service by the private sector.
- Creation of a process to use ITS systems to automatically capture or archive operational transportation data for later use in planning, evaluation, performance monitoring, or other similar purposes.
- Deployment of system components that support integration of systems outside of metropolitan areas; and/or development of a regional or project ITS architecture to support integrated ITS deployment.
- Training directly related to the proposed integration project, ITS architecture, and ITS standards. In general, the use of ITS integration component funds for the development of training materials for use outside of the integration project is not acceptable
- In metropolitan areas, only the integration activities - but not infrastructure deployment activities - are eligible for funding with the ITS congressionally designated funds and the 20% matching share.

Note: For projects outside of metropolitan areas (for statewide applications or in rural areas), funding may be used for integration purposes as well as for limited deployment of ITS infrastructure components to support integration.) Table 3-2 provides a summary of the additional information on eligible integration activities *(13).*

Table 3-2: Summary of Additional Information on Eligible Integration Activities

Communications Equipment	▪ Installing communications equipment could be part of an integration activity or an infrastructure deployment activity. Eligibility for funding as an integration activity is determined by the use of the communication system to allow for the sharing of information either (1) to integrate different types of systems or (2) to integrate individual systems across jurisdictional or agency boundaries. ▪ Installation of conduit is eligible if it is part of a communication system that meets criteria 1 or 2 above. Installation of conduit in preparation for later use is eligible if it will be part of a communications system that meets these criteria and the project commits to deploy the cable through the conduit within a reasonable time frame. ▪ A communications "backbone" must also meet criteria 1 or 2 above. The backbone must be accessible for the connection of multiple systems or multiple Traffic Operation Centers.
Transportation Operations Centers	▪ For defining eligible integration activities associated with Transportation Operation Centers (or Traffic Management Centers (TMC)), the TOC is considered to have two parts. The first part is the physical structure or building; the second part comprises the communications and computer equipment used during the operation of the TOC. The first part is not eligible for funding by the ITS Congressionally Designated funds and the 20% matching share; the second part is eligible. Both parts are eligible as 30% Match.
Hardware and Software Interfaces	▪ Hardware and software needed for the exchange of information or data among Systems are eligible for funding with the ITS Congressionally Designated funds and are eligible for 20% Match. For example, costs related to the deployment of interfaces or translators among systems or infrastructure elements are eligible when they result in the integration of the systems.
Laptop Computers	▪ Laptop computers are eligible for funding with the ITS Congressionally Designated project funds and the 20% matching share only if they are used in the integration of systems, that is if the laptops are used primarily to share information across systems or control integrated systems.
Research and Planning Activities	▪ Research activities or planning and design activities that directly support a) the deployment or expansion of integration activities or b) the completion of a regional architecture are eligible when accompanied by a commitment in the Project Description that, within a reasonable amount of time, the research, planning, or design activities will lead to integration activities, that is to an actual deployment of integrated systems. Two examples of such eligible activities are: the development of a prototype integrated system planned for regional or statewide deployment; and the design and development of specification for a TOC or communication system that supports integration. ▪ For rural projects, in addition to integration activities and deployment of integrated systems, the research activities or planning and design activities are eligible when accompanied by a commitment in the Project Description that, within a reasonable amount of time, the research, planning and design activities will lead to the deployment of ITS infrastructure elements.

Source: Guidelines for participation in the FY02 ITS Integration Component of the ITS Deployment Program Appendix D: Additional Information on Eligible Integration Activities.
http://www.ops.fhwa.dot.gov/Travel/Deployment_Task_Force/EarAppD.htm

A helpful source that provides information on the Federal ITS Integration Program guidance, project description template and checklist is the FHWA's ITS Integration Program web page http://www.ops.fhwa.dot.gov/Travel/Deployment_Task_Force/its_integration_program.htm

The financial incentive for ITS integration provided to all ITS implementers through the TEA-21 programmed funds is a prime example of how the U.S. DOT can play a vital role in all levels of ITS integration (presented later in Chapter 7). Major federal funding for ITS improvements, however, is essentially the mainstream highway funds provided in each federal authorization bill. Without regard to incentives provided in the ITS Integration Program, ITS projects are still expected to be integrated into a RIA.

3.2 FHWA Rule and FTA Policy on Architecture Conformity

On January 8, 2001, former Secretary of Transportation, Rodney E. Slater, announced the publication of two important and related documents, a FHWA regulation and a FTA policy, that will lead to accelerated deployment of integrated ITS. According to Secretary Slater . . .

> *The rule and policy contain provisions that would help to speed ITS deployment locally by requiring the development of Regional ITS Architectures. Regional ITS Architectures help guide the integration of ITS components. During a regional architecture's development, agencies that own and operate transportation systems cooperatively consider current and future needs to ensure that today's processes and projects are compatible with one another and with future ITS projects. The rule and the policy also require development of Regional ITS Architectures that conform with the National ITS Architecture, to which subsequent ITS projects must adhere.*

The FHWA rule and FTA policy were provided to ensure that ITS projects carried out using Highway Trust Fund conform to the NIA and applicable standards. The target of the Rule and Policy emphasizes the achievement of integration. In order to achieve ITS integration, the FHWA Final Rule 940 requires that a region that is implementing ITS projects must have a RIA by April 7, 2005. Regions without ITS must have a RIA established within four years of their first ITS project advancing to final design. A RIA fundamentally establishes the ongoing process for planning ITS integration within the region, and as stated previously, the NIA is to be used as a resource in developing appropriate regional architectures.

For those regions currently without a RIA, the Rule provides that ITS deployments using federal funds be consistent with the NIA.

Development of the RIA is to be consistent with the transportation planning process for Statewide and Metropolitan Transportation Planning. Architecture development, to be based on regional selections of market packages from the NIA, would logically be based on a concept of operations predetermined by local, regional, and often, state governments, via an "outreach" process. The concept of operations is explained later in this chapter.

Finally, at the project development level (which could be local, regional, or even national), the FHWA rule and the FTA policy require that all ITS projects be based on a systems engineering analysis, commensurate with the project scope. Systems engineering analysis is reviewed later in this chapter and also emphasized in Chapter 6 as a step in the suggested process to achieve integration.

3.2.1 The National ITS Architecture and Standards

A set of 19 NIA documents provides a comprehensive description of the architecture, its goals, objectives, definition, evaluation, and deployment *(14).* For the benefit and use of ITS transportation practitioners, systems engineers, system developers, consultants, technology experts, etc., the architecture documents fall into five categories: Executive Summary, Architecture Definition, Evaluation, Implementation Strategy and Standards. These documents can be accessed at http://www.its.dot.gov/arch/access.htm

The Executive Summary of the NIA documents published by the U.S. DOT, December 1999, provides the most complete definition of the architecture *(15):*

> *The NIA provides a common structure for the design of intelligent transportation systems. It is not a system design nor is it a design concept. What it does is define the framework around which multiple design approaches can be developed, each one specifically tailored to meet the individual needs of the user, while maintaining the benefits of a common architecture . . .*

The architecture defines:

1) The functions (e.g., gather traffic information or request a route) that must be performed to implement a given user service.
2) The physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle).
3) The interfaces/information flows between the physical subsystems.
4) The communication requirements for the information flows (e.g., wireline or wireless).

In addition, it identifies and specifies the requirements for the standards needed to support national and regional interoperability, as well as product standards needed to support economy of scale considerations in deployment.

The expectation of U.S. DOT is that any local ITS project would be an implementation of the NIA. A review of the requirements of the NIA and Standards final rule will be offered in this chapter in order that any local or major ITS project can be consistent with national policies.

ITS Standards and Operability Tests

Standards define how various technologies, products, and components within a system framework interconnect and interact. They are mainly communication protocols describing standardized data sets and message formats to achieve interoperability. ITS standards are industry-consensus standards that define how system components shall operate within the NIA. They specify how different technologies, products, and components interconnect and interoperate among the different systems so that information can be shared automatically. Standardizing each of the critical links between ITS components helps ensure that agencies can communicate and share data consistently and reliably. Standardization also help ensure that systems and equipment are interoperable, which is a big step toward establishing an ITS integrated environment.

The U.S. DOT ITS Standards Program is working toward the widespread use of standards to encourage the interoperability of ITS systems. Through cooperative agreements with five standards development organizations (SDOs), the Standards Program is accelerating development of about 100 non-proprietary, industry-based, consensus ITS standards, and is encouraging public-sector participation in the development process. Beyond developing the standards, the program is moving into standards deployment support.

Formal adoption of a standard is achieved by industry acceptance, as part of the function of the SDOs but formal acceptance of standards requires that the DOT will go through the rulemaking process. The DOT has developed a set of criteria to determine when a standard could be considered for formal acceptance. These criteria include, at a minimum, the following elements:

1) The standard has been approved by SDOs
2) The standard has been successfully tested in real world applications as appropriate
3) The standard has received some degree of acceptance by the community served by the standard
4) Products exist to implement the standard
5) There is adequate documentation to support the use of the standard
6) There is training available in the use of the standard where applicable

Testing is an important step toward interoperable ITS systems because it provides information to potential users on the reliability, interoperability, functionality, and performance of systems based upon the standards. A comprehensive program has begun to test ITS standards that are emerging from the standards development process. The primary purpose of the ITS standards testing program is to investigate the operation, correctness and completeness of the standards, and to "prove" the standards in realistic settings. As an important measure to encourage acceptance and use of ITS standards, testing provides timely and meaningful information on standards readiness to the ITS community. The testing program leverages ongoing and planned ITS field deployments.

A summary of ITS standards is available at http://www.its-standards.net/Documents/LIST2.pdf. The relationship of standards to the NIA is available at http://itsarch.iteris.com/itsarch/html/standard/standard_b.htm

3.2.2 Regional ITS Architecture

The final requirements of Rule 940 for a regional architecture are seen in Table 3-3. A RIA encompasses a region that is anything less than national, with a minimum being that of the MPO boundaries, and may include multi-state areas, states, and any area in which there are to be coordinated transportation and public safety operations. Since the availability of the NIA documents (published first in 1996 and periodically updated thereafter), various regions in the U.S. have developed RIAs based on those documents. Various types of ITS architectures developed over the years include multi-state ITS architecture, state-level ITS architecture, metropolitan ITS architecture, and city/county ITS architecture. An example of multi-state regional ITS architecture is the I-95 Corridor Coalition ITS Architecture developed for the I-95 corridor spanning from Maine to Virginia. The Florida's ITS Architecture developed by the FDOT is an example ITS integration initiative at the state-level. The Tampa Bay Area Regional ITS Architecture encompasses an area bounded by the FDOT District 7 expanded to include other agencies, counties and cities to achieve the communications needed to operate highways within the region.

Table 3-3: Rule 940 Minimum Requirements of a RIA

A description of the region
The identification of the participating agencies and other stakeholders
An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders
Any agreements (existing or new) required for operations
System functional requirements
Interface requirements and information exchanges with planned and existing systems and subsystems
Identification of ITS standards supporting regional and national interoperability
The sequence of projects required for implementation

Source: FHWA, U.S. DOT, 23 CFR Parts 655 and 940, Intelligent Transportation System Architecture and Standards, Final Rule, January 8, 2000 (10).

As defined in the FHWA rule and FTA policy, a RIA is a local selection from the NIA resulting from public outreach. It provides a regional framework to be a basis for institutional agreements and for technical integration of ITS projects. According to the Rule, the RIA may also include market packages not in the NIA that meet locally perceived needs. Since such market packages have no counterparts in the NIA, their inclusion in the RIA indicates that work will be needed to develop mainly the functional requirements and information flows so that the market packages can be designed and made useful. Additional work at the national level would be needed if they are to be finally included in the NIA or need development of additional standards.

These requirements are elaborated in the following sections, with any pertinent guidance that might be useful.

Description of the region. A *region* is defined by local participants and is based on the needs for information sharing and coordination. It can be a metropolitan area, a state, a multi-State area, or a corridor. A *region* is further defined as a geographical area based on local needs for sharing information and coordinating operational strategies for transportation facilities. In metropolitan areas, a region should be an area no smaller than the boundaries of a metropolitan planning area, but may be larger. In fact, within the definition, a *region* can be anything less than the entire nation. That means the *region* may be multi-state as it is in the Cincinnati/Covington area, it may be statewide as it is in Florida, it may be a corridor as it is with the Gary/Chicago/Milwaukee corridor, or it may be a sub-state area as it is in San Francisco.

Identification of the participating agencies and other stakeholders. Stakeholders within a region are simultaneously identified with the definition of the region. There needs to be a convening agency, however, one that takes the lead in identifying participants and other stakeholders. Within the defined region, an ITS committee would be chartered likely within the structure of the MPO as suggested by the Florida ITS Planning Guidelines, to bring the participating agencies and stakeholders to the table.

Concept of operations. A concept of operations identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the RIA. It also describes, at a high level, how the system will be coordinated, operated, maintained, and managed. A concept of operations would include:

- Goals, objectives, and the general themes and strategies of operations, without necessarily showing how the system or products would be implemented (examples of themes are "coordinated operations, active facility management, and information sharing and processing")
- Roles and responsibilities of participating agencies and private partners in the operation and implementation of planned and future ITS, that would include the results of decisions on operations and maintenance policies and procedures, staffing, and funding decisions

Required agreements. Any interagency or public/private agreements (existing or new) required for operations including, at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture. This step is rather challenging but vital to institutional integration. It is up to agencies to decide the degree of formality to which contracts and agreements are drafted. Agreements should fully address both administrative and operational responsibilities. The operational concept defines roles and responsibilities of each agency involved. It is up to stakeholders to decide if memoranda of understanding, MOUs, contracts, partnering agreements, policy statements or interagency agreements best define roles and responsibilities. Since public-private partnerships are encouraged, other important issues such as intellectual property rights and technology transfer should be fully and appropriately addressed.

In a 1999 FHWA report on successful approaches to deploying metropolitan ITS *(16),* it was concluded that written policies achieve greater efficiency, cooperation, consistency, and legal protection that may prove more beneficial than costly. However, evidence may also be found that successful agreements can be accomplished informally, "on a handshake," thereby providing a more flexible operating environment.

Typical topics included in interagency agreements are:

- sharing of fiber-optics and other communications equipment,

- use of agreed upon technology,
- transition to standard technologies, and
- interagency operations

A four-page sample of intergovernmental agreement between the State of Arizona and Paradise Valley is provided in Appendix A*.*

System functional requirements. An ITS physical architecture is defined to have four possible subsystems: vehicle, roadside, centers, and travelers. Each subsystem includes market packages that are made up of one or more equipment packages. Table 3-4 is a listing of market package requirements by technology area. It identifies functional groups of technologies and relates them to the market packages. Each column in the table represents a general technology area applied through one or more market packages to support ITS user services. The technology requirements for each market package are presented in the body of the table using the following icons:

The "■" denotes a basic relationship between the market package and the technology area. This assignment indicates that the technology area is fundamental to the core services provided by the market package.

The "□" denote a secondary relationship between the market package and the technology area. This assignment indicates that the technology would enhance the market package through provision of optional features or by playing a supplementary role in supporting core services. Use of this technology area is desirable but not necessarily required for market package implementation.

Table 3-4: Market Packages Requirements by Technology Area

		Technology Area																							
		Sensor									Location Determination	Communication					Algorithms	Information Management	Payment	User			Control		
	Market Packages	Traffic	Vehicle Status	Environment	Vehicle Monitoring	Driver Monitoring	Cargo Monitoring	Obstacle Ranging	Lane Tracking	Security		Cell-based	Vehicle Roadside	Vehicle-vehicle	Broadcast	Fixed				Driver	Traveler	Operator	Signals	Signs	Vehicle
ATMS	Network Surveillance	■		□												■	□	■				■			
	Probe Surveillance				■						■	■	□			□	■	■				■			
	Surface Street Control	■														■						■	■		
	Freeway Control	■														■						■	■	□	
	HOV Lane Management	■									■	■				■	□					■	□	■	
	Traffic Information Dissemination														■	■	□	■				■		□	
	Regional Traffic Control	■			■											■	■	■				■	■	■	
	Incident Mgmt System	■			■						■	■				■	■	■				■	□	□	
	Traffic Forecast and Demand Mgmt.	■			■											□	■	■				■			
	Parking Facilities Management	■											■									■			
	Electronic Toll Collection	■	■									□	■		□	■	■	■	■	■		■	□	□	
	Emissions Monitoring and Mgmt.		■	■	□											■	■	■		□		■		□	
	Virtual TMC and Smart Probes Data				■						■	■	□			□	■	■				■			
	Standard Railroad Grade Crossing	■														■		□					■		
	Advanced Railroad Grade Crossing	■	□			□		□								■	■	□					■		

		Technology Area																							
		Sensor										Communication								User			Control		
	Market Packages	Traffic	Vehicle Status	Environment	Vehicle Monitoring	Driver Monitoring	Cargo Monitoring	Obstacle Ranging	Lane Tracking	Security	Location Determination	Cell-based	Vehicle Roadside	Vehicle-vehicle	Broadcast	Fixed	Algorithms	Information Management	Payment	Driver	Traveler	Operator	Signals	Signs	Vehicle
	Railroad Operation Coordination				■						■	■	□			■	■	■				■			
	Reversible Lane Management															■						■		■	
	Regional Parking Management				■								■			■						■			
	Speed Monitoring	■		■									■			■								■	
	Drawbridge Management	■		■									■			■						■	■	■	
APTS	Transit Vehicle Tracking				□	□					■	■	□			□		■			□	■			
	Transit Fixed-Route Operations											□	□			□		■		□	□	■			
	Demand Response Operations											■				□	□	■		■	□	■			
	Transit Passenger and Fare Mgmt									□	□	□				□		■	■		■	■			
	Transit Security									■	□	□				□		□		■	■	■			
	Transit Maintenance				■	□					□	□				□		■		■		■			
	Multi-modal Coordination										■	■	■			■	□	■		■		■			
	Transit Traveler Information										■				□	■		■				■			
ATIS	Broadcast Traveler Information	■		□											■	■	■	□		■	■	■			
	Interactive Traveler Information	■		□							□	■				■	■	□		■	■	■			
	Autonomous Route Guidance										■						■	□		■	■				
	Dynamic Route Guidance	■		□							■	□			■	■	■	□		■	■				
	ISP-Based Route Guidance	■		□							■	■				■	■	■	□	■	■	■			
	Integrated Transportation Mgmt/RG	■		□							■	■				■	■	■	□	■	■	■			
	Yellow Pages and Reservation										□	■				■	■	□		■	■	■			
	Dynamic Ridesharing									□		■				■				■	■	■			
	In Vehicle Signing		□	□	□	□	□				■	□	■			□	□	□		■		□			
AVSS	Vehicle Safety Monitoring				■							□					□			■					
	Driver Safety Monitoring				■	■						□					■			■					
	Longitudinal Safety Warning				■	□		■									■			■					
	Lateral Safety Warning				■	□		■	■								■			■					
	Intersection Safety Warning		■	□	■	□		■	■			□	■	□		■	■	□		■			□	□	
	Pre-crash Restraint Deployment				■	□		■									■								□
	Driver Visibility Improvement					□		■												■					
	Advanced Vehicle Longitudinal Ctrl				■	□		■									■			■					■
	Advanced Vehicle Lateral Control				■	□		■	■								■			■					■
	Intersection Collision Avoidance		■	□	■	■		■	■			□	■	□		■	■	□		■			□	□	■
	Automated Highway System	□	■	□	■	■		■	■	□	■	■	■	■		■	■	■	□	■		■	□	□	■
CVO	Fleet Administration				■						■	■	□			□	□	■		■		■			
	Freight Administration						■				■	■	□			■	□	■		■		■			
	Electronic Clearance												■			■		■		■		■	□	□	
	CV Administrative Processes											□				■		■							
	International Border Clearance												■			■		■		■		■	□	□	
	Weigh-in Motion		■										□				□					■	□	□	

	Market Packages	Technology Area																							
		Sensor									Location Determination	Communication					Algorithms	Information Management	Payment	User			Control		
		Traffic	Vehicle Status	Environment	Vehicle Monitoring	Driver Monitoring	Cargo Monitoring	Obstacle Ranging	Lane Tracking	Security		Cell-based	Vehicle Roadside	Vehicle-vehicle	Broadcast	Fixed				Driver	Traveler	Operator	Signals	Signs	Vehicle
	Roadside CVO Safety		■		□		□						■			■	□					■	□	□	
	On-board CVO Safety				■	■	■					□	□				□			■					
	CVO Fleet Maintenance				■						■	■				□	□	■		■		■			
	Hazmat Management						■				■	■	□			■	□	■		■		■			
EM	Emergency Response									■	□	□				■	□	■				■			
	Emergency Routing			□	□						■	■	□			□	□	■		■		■			
	Mayday Support		□								■	■				■		□		■	■	■			
	Roadway Service Patrols										■	■						□		■		■			
ADUS	ITS Data Mart	□		□						□	□					■	□	■				■			
	ITS Data Warehouse	□		□						□	□					■	□	■				■			
	ITS Virtual Data Warehouse									□	□					■	□	■				■			
MCO	Maintenance and Construction Vehicle Tracking				■						■		■	□	■	□									
	Maintenance and Construction vehicle Maintenance		■									■						■				■			
	Road Weather Data Collection			■									■		□	■	□								
	Weather Information Processing and Distribution														□	■	□							■	
	Roadway Automated Treatment												□			■									
	Winter Maintenance	■	■	■							■	■	■	□	■							■			
	Roadway Maintenance and Construction	■	■	■							■	■			■							■			
	Work Zone Management	■										■	■			□								■	
	Work Zone Safety Monitoring	■									■	■	■		■	□	□						■	■	
	Maintenance and Construction Activity Coordination											■			■	■	□	■				■			

Source: National ITS Architecture Documents: Market Packages; Lockheed Martin Federal Systems and Odetics Intelligent, U.S. DOT, April, 2002 p. 167 - 168, *http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/95j01!.pdf*

The columns in Table 3-4 are highlighted for technology areas that require further development. The rows in the table are highlighted where a market package requires at least one of these critical technology areas. Table 3-4 is useful in performing comprehensive analysis of functional requirements by using the following steps:

- Identify the subsystems that are relevant to each market package;
- Identify the technology areas that are relevant to subsystems within each market package; and
- Specify system requirements by subsystem and technology area for each market package.

Interface requirements and information exchanges with planned and existing systems and subsystems. By definition, a physical architecture collects related functions into subsystems and defines the communication interfaces between the market packages within each subsystem. There will be a need for a Communications Concept Document to augment the RIA that provides analysis of the communication requirements of the architecture, including discussion of options for implementation of communications links. The NIA Communications document at http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/45m01!.pdf presents a comprehensive, cohesive treatment of communications within the NIA. This comprises two broad, major thrusts: 1.) communication architecture definition (also referred to as the definition of the "communication layer" of the ITS architecture); and 2.) analysis of communication systems performance to meet the connectivity and data loading requirements of the ITS architecture. The objective of this analytical thrust is to demonstrate the feasibility of the architectural decisions made in the definition of the communication layer and to present the key supporting tradeoffs. This feasibility is from the standpoint that communication technologies exist and will evolve to continue to meet the architecture's demands in a predictable, cost effective manner. The communication analysis thrust includes:

- A comprehensive analysis of the data loading requirements of the architecture for different scenarios and time frames.
- A balanced assessment of a wide array of wireless and wireline communication techniques and systems applicable to the ITS architecture.
- An in-depth, quantitative performance evaluation of specific example system implementations.
- A compilation of the supporting technical and economic telecommunication analyses.

Identification of ITS standards supporting regional and national interoperability. When developing a RIA, selection of the ITS standards associated with the NIA, is recommended and encouraged. ITS project designs which are consistent with the RIA automatically have available the ITS standards for the project. In addition, multiple ITS projects with procurement packages based on the same ITS standards can be expected to be interoperable - - a key ingredient for integrated ITS.

The sequence of projects required for implementation. An implementation plan should be developed identifying the sequence of ITS improvements that should be implemented within a reasonable timeframe. The usual practice has been to identify specific projects for deployment in the short term (0 through 5 years), mid term (6 through 10 years) and long term (11 – 20 years). When eventually included in the MPOs Long-Range Transportation Plan and its Transportation Improvement Program, the identified ITS improvements must be made financially feasible. Each short-term project should be defined with sufficient detail so that the implementer is adequately clear about the required technologies; the planning level estimates for capital costs as well as operations and maintenance costs. The mid-term and long-term projects should be presented at least with conceptual detail of the types, technologies and, if possible, an approximate range of costs. Although the mid-term and long-term projects may also be presented with the same level of details as the short term projects, if so desired, the implementer is cautioned not to be fixated on the level of details (e.g. specific technologies, costs, etc.) as the rapid changes in technologies and the competition in the market place will require that projects be revisited for their appropriateness and cost implications at the time of deployment.

The sequence of projects should be derived from the RIA and should be the result of a dependency analysis. Local and regional priorities may also be applied to provide a logical implementation plan for regional ITS Projects.

3.2.3 Project Consistency

According to the final rule of NIA conformity, an *ITS project* may be defined as any project that in whole or in part funds the acquisition of services, technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the NIA.

A *Major ITS Project* is defined as any ITS project that implements part of a regional ITS initiative that is multi-jurisdictional, multi-modal, or otherwise affects regional ITS integration. An example of a major ITS project in Florida is the I-4 corridor ITS deployment.

Consistency is to be seen as a determination of whether ITS designed via the systems approach to assuring conformity with RIA or the NIA. A *systems approach* includes the following, as a minimum:

- A description of the scope of the ITS project
- An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the ITS Project
- Functional requirements of the ITS project
- Interface requirements and information exchanges between the ITS project and other planned and existing systems and subsystems
- Identification of applicable ITS standards.

Project Implementation: The final design of ITS projects, funded with highway trust funds, are to accommodate the interface requirements and information exchanges specified in the RIA. If the final designs are inconsistent with the RIA, then the RIA may be updated in accordance with the process identified by regional stakeholders, via an ITS Committee.

Project Authorization: For ITS projects using federal funds, architecture consistency will have been demonstrated prior to authorization of federal highway trust funds for construction. U.S. Code 23 Section 940.13(a) provides that funds may be withheld from these projects should there be no compliance. Further, U.S. Code 23 Section 940.13(b) provides that compliance with this part will be monitored under federal-aid oversight procedures as provided under U. S. Code 23 sections 106 and 133. It should be noted that a project level architecture is only required if a RIA is not in place prior to the project entering the design phase.

3.2.4 Systems Engineering Analysis

Systems engineering is a structured process for arriving at a final design of a system, both at the level of an ITS architecture and the level of project implementation. Rule 23 CFR 940 requires that each of these developments utilize a systems engineering approach. The final design is selected from a number of alternatives that would accomplish the same objectives and considers the total life-cycle of the project including not only the technical merits of potential solutions but also the costs and relative value of alternatives. According to the rule, Systems Engineering Analysis for a project is to be performed on a scale adequate with the scope of the project.

To demonstrate that the systems engineering approach is consistently being taken, more than assertions may be needed. One-way of demonstrating an ITS program is based on systems engineering is to adopt a Systems Engineering Management Plan (SEMP). An approach to a SEMP would show the following at a minimum:

- Use of public outreach and involvement in developing a RIA and then including the resulting improvements in formally adopted MPO plans,
- Developing a RIA, with associated standards, in conformance with the NIA,
- Identification of the portions of the RIA being implemented (or if a RIA does not exist, the applicable portions of the NIA),
- Limitations of time, money, or safety that preclude greater project consistency with the RIA,
- Identification of participating agencies roles and responsibilities,
- Functional requirements definitions,
- Analysis of alternative system configurations and technology options that meet functional requirements,
- Procurement options,
- Identification of applicable ITS standards and testing procedures, and
- Procedures and resources necessary for operations and management of the system.

SEMP is further emphasized in this guidebook as part of the suggested process towards achieving ITS integration, (Section 6.3.1)

In all the discussions presented in this section, the underlying theme being stressed is that a RIA is a required step toward ITS integration in a region. The development of a RIA has been identified as a focus area for the ITS implementers discussed later in the concluding chapter of this guidebook (Chapter 7).

CHAPTER 4

FDOT ITS INTEGRATION INITIATIVES OVERVIEW

Chapter 4 is an overview of FDOT efforts in ITS Integration. A brief scan of statewide planning documents is offered, with emphasis on the Florida ITS Planning Guidelines as a companion this guidebook. Goals, objectives, and potential applications of ITS deployment in Florida as stated in the Statewide ITS Strategic Plan are tabulated in this chapter. Coordinated control, active facilities management, and information processing, sharing and warehousing are discussed as the statewide concept of ITS integration. The national ITS tracking database was used to summarize the state of ITS deployment and integration in six metropolitan areas in Florida: Jacksonville, Miami-Fort Lauderdale, Orlando, Sarasota-Bradenton, Tampa-St. Petersburg-Clearwater and West Palm Beach-Boca Raton-Delray Beach. The chapter concludes by providing an overview of the Florida ITS integration experience. Four case studies are discussed: ITS in Volusia County, South Florida Regional Advanced Traveler Information System, SunGuide Road Rangers Service Patrol and Broward County ITS Operations Facilities.

4.1 ITS Planning in Florida

In December 1999, FDOT adopted a Statewide ITS Strategic Plan, with a group of informative issue papers that set in motion several events. One result was to adopt a statewide ITS architecture on February 9, 2001. A second result was to establish a statewide ITS organization consisting of an ITS Office and ITS engineers in each of eight district offices. A third result was to establish a ten-year program for deploying ITS on state expressways, mainly including interstates, funded with almost $500 million. A fourth result was the development of Rule 940 Statewide Implementation Strategy to provide technical guidance, assistance, education and training to the MPOs as they integrate ITS into their long-range transportation planning process.

4.1.1 Florida Statewide ITS Architecture

Development of the Statewide ITS Architecture (SIA) was accomplished utilizing *Turbo Architecture*, with special adaptations for accessing stored information and to permit assembling eight district architectures elements and five principal corridor elements into the one statewide architecture based on the NIA. The development process included extensive interviewing with stakeholders throughout the state to establish current ITS inventories and plans for future ITS expansions. The Florida SIA is a unique regional architecture in that it brings together regional and corridor elements by focusing on statewide elements, functional requirements and information flows of the interfaces between elements.

The process included systematically identifying the existing and future inventory of stakeholder elements at the subsystem level (as defined in the NIA) based on existing regional and corridor deployments, existing ITS architectural documentation, and articulation of stakeholder needs in the workshops conducted regionally. Next, generic services through NIA market packages were identified, and where stakeholders indicated a need, those market packages were customized for specific applications (existing or future). This customization identifies information exchange at the architecture flow level as specified in the NIA. All these information exchange requirements at each subsystem level entity in the region were defined and reviewed with the stakeholders.

The SIA is also unique in that it introduces three market packages not contained in the NIA. In Florida, there are perceived needs for market packages that would enhance pedestrian mobility and make it safer, one that would facilitate large-scale evacuations, and one that would make construction work zones safer. The latest version 4.0 of the NIA includes two of these.

The Florida Statewide Architecture and Standards can be accessed at http://www.jeng.com/florida/Default.htm

An encouraging fact is that the FDOT ITS Office has already taken major steps for statewide deployment and integration of ITS in accordance with the SIA. In Chapter 7, the statewide inter-agency ITS integration has been identified as an advanced level of integration where a State DOT provides a lead role.

4.1.2 FDOT ITS Office

To support the coordinated deployment of ITS on a statewide basis, FDOT established an ITS Office. The mission of the FDOT ITS Office is to coordinate and promote the deployment of ITS and incident management activities conducted. FDOT ITS Office information is included on their main website at http://www11.myflorida.com/IntelligentTransportationSystems/default.htm. The specific functions and activities of that office are summarized in Table 4-1.

Table 4-1: Functions and Activities of FDOT ITS office

Policy, Program Development, Budgeting	▪ Develop and maintain ITS policies and procedures ▪ Coordinate ITS input in Program Resource Plan, Legislative Budget Requests and Work Program Development ▪ Provide guidance on determining ITS staffing and resource needs ▪ Develop or respond to Federal State Statutory and regulatory changes affecting the ITS program ▪ Set priorities for and coordinate the Statewide ITS Research Program ▪ Determine ITS grant sources and coordinate grant applications
ITS Architecture and Standards	▪ Coordinate regional and statewide architecture development to ensure consistence with the National ITS Architecture ▪ Ensure statewide consistence in incident management and implementation ▪ Coordinate the development of an Operations and Management Manual and any other needed supporting manuals, handbooks or guidelines. ▪ Coordinate the development of data management/warehousing standards consistent with national requirements and Department databases ▪ Ensure ITS applications standard consistency ▪ Provide support and guidance on migration of "legacy systems" to national and statewide ITS standards
Intergovernmental and Public/Private Stakeholder Input and Coordination	▪ Determine the needs and coordinate and support the development of a statewide ITS training, education and public awareness program ▪ Ensure coordination of ITS activities with public transportation organization including transit agencies, rail agencies and companies, and airline and airport authorities. ▪ Promote, coordinate and support private sector "stakeholder" involvement activities ▪ Coordinate state-level partners in service delivery (police, fire, medical) ▪ Develop and maintain the ITS element of the Department's web page integrating general ▪ ITS information and real-time traveler information from the Transportation Management Centers ▪ Coordinate statewide communication with federal officials
Commercial Vehicles and Toll Operations	▪ Coordinate the development of a safety based pre-clearance CVO element for Florida ▪ Coordinate CVO activities with other states, organization and the FHWA ▪ Coordinate the development of a seamless electronic toll collection systems for all toll facilities in Florida

Source: Florida's Statewide ITS Strategic Plan, Final Report, FDOT, 1999, p.20

The FDOT ITS Office has retained an ITS General Consultant (GC) to support its activities. One task for the GC is to provide and maintain a Florida ITS website, http://www.floridaits.com which is a forum for the dissemination of ITS-related materials of statewide significance and information about projects being undertaken by the ITS GC. The official Florida DOT ITS website has the Statewide, District ITS Architectures, and Florida Rule 940 Strategy. Another website will soon exist for traveler information that will permit selection of traffic images, conditions, and perhaps events, throughout the state.

4.1.3 The Florida ITS Program Plan

The ITS Office, and each of the Florida eight district offices have cooperatively developed ITS Program Plans for Florida's five principal corridors which include Interstate 95, Interstate 75, Interstate 4, Interstate 10 and Florida's Enterprise, (Turnpike).

The ITS Corridor Plans define the needs, alternatives and recommended implementation of ITS projects along each of the corridors and, as appropriate, for the associated diversion or bypass routes. The results of these ITS Program Plans was combined into a statewide ITS Program Plan for the deployment of a coordinated, integrated, and interoperable system. This ITS Program Plan identifies the anticipated ITS needs, funding and recommended sequence of projects from 2002 to 2010 for programming on a statewide basis along the five key corridors.

4.1.4 Statewide Planning Documents

FDOT realized the importance of having a vision that incorporates ITS into the Department's authored 2020 Florida Transportation Plan. The Plan includes statement of Florida's vision, mission, and policy for transportation. As such, it includes in outline the contents of the Statewide ITS Strategic Plan as well as endorses maintaining consistency of ITS projects with the State and National ITS Architecture and Standards.

Integrating ITS into state and metropolitan planning is critical to the successful deployment of ITS programs. An important goal is "mainstreaming" ITS into the planning and decision-making process so that ITS deployments may occur integrated with other improvements to achieve local, regional, and state transportation system visions *(17).*

The FDOT has published several documents to aid planning and implementing agencies, both locally and nationally, in planning of ITS. Examples of these state-level planning documents are:

- Florida's Intelligent Transportation Systems Strategic Plan, Final Report; adopted December, 1999.
- Florida's ITS Planning Guidelines: Integrating ITS into the Transportation Planning Process, June, 2000.
- FDOT Statewide ITS Architecture and Standards, February 9, 2001.
- Rule 940 Statewide Implementation Strategy For the Integration of ITS into the Florida Planning Process, June 2002.
- Florida's Guidebook for ITS Integration, October 2002.

As recognized in U.S. Code 23 CFR 940, ITS projects, like other transportation projects, are to be incorporated in the planning process, the design process, and the project production schedule. The *Florida Transportation Plan*, as well as *Florida's Statewide ITS Strategic Plan* and the MPOs' *Long Range Transportation Plans*, meet the planning need. ITS incorporation in these plans accomplishes the following purposes:

- To guide the Department, MPOs, and local governments in the planning, programming, and implementation of integrated multi-modal ITS elements at the statewide, regional or local level.
- To provide a Business Plan to guide project development, finance, scheduling, and procurement.
- To establish a Department organization to efficiently deploy, manage, and operate ITS.

- To provide a statewide vision of how ITS can help maximize the safety and efficiency of the Florida Transportation System and how it can contribute to the economic health and growth of the state in a world economy.
- To provide sufficient direction to allow for individual professional judgment and consistency in the planning for and deployment of ITS at the regional level.

The essential purpose of *Florida's ITS Planning Guidelines: Integrating ITS into the Transportation Planning Process* is to provide guidance to local and state planners explaining why, when, and how to program ITS project deployments, and what ITS applications are to be considered via the systems engineering approach *(18).* The Guidelines are a further effort to refine previous work providing direction to integrate ITS into all aspect of Florida's transportation planning and growth management processes. Detailed discussion on the use of the Guidelines is provided in appropriate sections of this guidebook.

Third, the purposes of the *FDOT Statewide ITS Architecture and Standards* are summarized as follows *(19):*

- achieving interoperability between ITS deployments and RTMCs at minimum cost;
- documenting the current and future information sharing relationships, between system operators, with public safety agencies, and others participating in the system; and
- guiding the implementation of the external interfaces of identified architecture elements (e.g. specific centers, field equipment, vehicles and traveler equipment).

Fourth, Rule 940 Statewide Implementation Strategy for the integration of ITS into the Florida planning process. The purpose of this Statewide Implementation Strategy is to recommend an approach for the implementation of Federal Rule 940 in Florida and to develop guidelines for integration of ITS into the planning process and the Long-Range Transportation Plan (LRTP). This strategy should:

- Define an ITS architecture, its region and stakeholders
- Identify a method for validating and adopting the statewide and regional architectures and standards
- Develop a change process to update and maintain the regional architectures and standards
- Define agency roles and responsibilities in the development and maintenance of architectures and standards
- Identify options for Metropolitan Planning Organization (MPO) input
- Establish an MPO outreach program to explain the architecture process and components, the use of standards, and Statewide Implementation Strategy in non-technical terms
- Identify state, district and MPO ITS representatives responsible for ITS architecture and planning processes
- Illustrate a relationship to existing implementation processes, plans and documents

Last, this guidebook supports *Florida's ITS Planning Guidelines* by providing elaboration of methodology in the forms of suggested steps when integrating ITS, and some decision-making steps which may be used to achieve, or to evaluate, development of integrated ITS. While the *ITS Planning Guidelines* provides the basics of incorporating ITS applications into the transportation planning process, this guidebook assists planning and implementing agencies to adopt and follow systematic approaches in activities that include concept planning, project definition, project selection, and integrated deployment.

Much of the effort to recognize ITS, described above, is augmented by the training activities and publication of general guidance documents. There is coordination, for instance between the Department, ITS Florida, and the FHWA Florida Division to produce and regularly conduct training for ITS professionals. The ITS Florida Professional Capacity Building Program presents ITS training and seminars which are offered free or at a discount to members. Florida ITS Chapter will offer an ITS training calendar to include all ITS training opportunities provided by the Florida DOT, NHI, ITS America, and ITE at http://www.itsflorida.org/html/its_training.html.

4.1.5 Goal and Objectives of ITS in Florida

The main goal of integrating ITS in Florida is to maximize the benefits of ITS applications locally, regionally and statewide. FDOT outlined a goal-oriented ITS program that contributed to the ITS Strategic Plan goals in parallel to the goals of the *2020 Florida Transportation Plan (FTP*). The goals of the *Statewide ITS Strategic Plan* are shown in Table 4-2, with emphasis on relevant ITS applications.

ITS applications shown in Table 4-2 fit into the nine ITS integration components described in Chapter 1. The integration links between the nine ITS components are established through institutional agreements as directed within the RIA. A good example of ITS integration on a state level is the use of SunPass, the FDOT's ETC System that is used for toll collection in all state operated toll facilities across the state. Because of improved integration, ITS services benefit from better availability and sharing of traveler information.

Table 4-2: FDOT Goals, Objectives and Selected Applications of ITS Program

ITS Objectives	ITS Applications
Goal 1: Safe transportation for residents, visitors and commerce	
Minimize response time for incidents and accidents	Incident management programs
Reduce commercial vehicle safety violations	Commercial vehicle operations safety programs
Reduce weather related traffic incidents	Road-weather information systems
Minimize grade crossing accidents	Highway-rail interface safety systems
Improve emergency management communications	Coordination of communication frequencies; real-time traveler information systems for evacuation and major route closings, re-routings or restrictions
Improve security for highway and transit users	Surveillance cameras, call boxes, and emergency services support
Improve the security, safety and convenience of pedestrians and bicyclists	Improved interfaces at pedestrian crossings, signalized intersections, kiosks, surveillance systems
Goal 2: Protection of the public's investment in transportation	
Reduced vehicular delay from incidents	Incident response programs
Improved peak period flow and throughput	Traffic control systems and operations
Reduce cost of commercial vehicle fleet operations	CVO and intermodal systems
Assist in providing safe and efficient maintenance of traffic during project construction	Work zone monitoring systems, real-time traveler information systems
Goal 3: A statewide interconnected transportation system that enhances Florida's economic competitiveness	
Reduce cost and delay of intermodal connections	Commercial vehicle operations and information systems
Minimize shipping and delivery delays to improve freight operations	Real-time system management programs
Improved predictability of travel and delivery times	Incident management systems
Improve efficiency of fleet operations	CVO information systems
Improve tourist access and convenience	Special traveler information systems
Increased employment	New ITS industry in Florida

ITS Objectives	ITS Applications
Goal 4: Travel choices to ensure mobility, sustain the quality of the environment, PRESERVE community values and reduce energy consumption	
Improve mobility and choices for highway and transit users	Traveler information systems for conditions and modal/route options
Improve tourist access	Specialized traveler information systems
Reduce need to travel	Communications infrastructure to support telecommuting, teleconferencing, teleshopping, etc.
Reduce energy use and environmental degradation	ITS systems management to reduce vehicle trips, and vehicle miles of travel
Improve service for special traveler needs	Smart cards, computer-aided dispatch and automated vehicle location system to enable true demand-responsive transit systems
Improved multi modal travel	Smart cards, traveler information and transit management systems to reduce transit travel times
Reduced energy use and delay associated with major incidents	ITS systems management and route diversion
Improve efficiency of toll operations	Electronic toll collection systems
Enhance and support ride sharing opportunities	High occupancy vehicle/high occupancy toll systems

Source: FDOT ITS Strategic Plan, 1999.

4.2 Statewide ITS Themes

Based on these goals and objectives, Florida adopted the following themes that summarize the desired outcomes of the ITS deployments along the five principal corridors: I-4, I-75, I-95, I-10 and Florida's Turnpike. They are working policies to describe the desired outcomes in non-technical terms that stakeholders can understand. They also are the basis of a statewide concept of operations for ITS when combined with the allocation of interagency roles and responsibilities *(20).*

4.2.1 Coordinated Operations

- Facilitate, support, and enhance the coordination and implementation of interagency efforts in response to the needs of inter-city travel and major incidents, or special events of regional significance along major travel corridors, and the security of the transportation infrastructure.
- Promote coordination and cooperation among all organizations involved in incident management including state, county, and local transportation departments, toll road authorities, law enforcement agencies, emergency service providers, and other operating agencies within the corridor.
- Foster and facilitate continued development and implementation of regional incident management initiatives and educate the public and responders to the benefits of incident management.
- Encourage technology and resource sharing, coordinating the development of training programs to support member agencies' incident management programs and activities.
- Demonstrate and evaluate the application of innovative procedures and technologies to enhance incident management activities.
- Provide regional solutions for serving intercity travel by promoting the through movement of vehicles.
- Provide procedures and coordination for evacuations and other emergency situations to make the best use of system resources.
- Promote coordination among agencies in the notification and implementation of the maintenance and construction.

4.2.2 Active Facilities Management

- Support traffic management across all facilities in a coordinated manner.
- Support incident management for detection of, response to, and clearance of accidents and other major incidents, such as freeway service patrols, Mayday/E-9-1-1 support; development of incident response scenarios and traffic diversion plans, incident response centers or command posts, and traffic surveillance technologies.
- Provide transit management, including bus, commuter rail, and park-and-ride facilities, as well as other transit-related activities and manage SULs, such as high-occupancy toll or other value pricing, reversible lane control for high-occupancy vehicle (HOV) facilities, and transit or emergency vehicle signal preemption systems.
- Improve the ability to monitor, schedule, and dispatch maintenance, construction, special services, or other public/community transportation fleets.
- Manage traffic flow and safety during evacuations related to hurricanes, fires, and other emergencies.
- Serve commercial vehicle operations (CVO), such as the electronic screening systems that verify compliance of motor carriers with size, weight, safety, credentials regulations, and emergency response systems.
- Promote the use of electronic toll collection (ETC) and electronic payment systems (EPS) to improve traffic flow efficiencies, parking operations, transit operations, and reduce infrastructure requirements.
- Implement procedures and systems that cost-effectively manage construction work zone activities.
- Manage lane closure prediction and scheduling.
- Collect/maintain data on work zone locations and delay and alternate routing for mainline and standard diversion or evacuation routes.
- Automate speed enforcement and variable speed limits in work zones.
- Manage reverse lane traffic flow facilities.
- Provide on-highway assistance via service patrols.
- Manage traffic through construction work zones.
- Take security oriented measures in the event of state or national crises.
- Support advanced traveler information systems (ATIS).
- Provide evacuation guidance that includes basic information to assist potential evacuees in determining whether evacuation is necessary. Once the decision is made to evacuate, the services will also assist evacuees determine destination, routes to shelters and other lodging options. This function will also provide guidance for returning to evacuated areas, information regarding clean up, and other pertinent information to be distributed from federal, state, and local agencies.
- Provide evacuation travel information that will benefit evacuees in planning their evacuation trip once the decision to evacuate has been made. This function will also allow travelers to change course during the trip based on route and destination conditions.
- Provide evacuation traffic management to assist evacuation coordination personnel to manage evacuation operations on the transportation network.
- Provide evacuation planning to support the evacuation process by providing information, current and historical, to emergency management planning personnel.
- Promote evacuation resource sharing to allow information and resource sharing between agencies involved in the evacuation including transportation, emergency management, law enforcement and other emergency service agencies.
- Improve the coordination of construction activity and other roadway activities with maintenance
- Provide infrastructure security against terrorist attacks.

4.2.3 Information Processing, Sharing, and Warehousing

- Coordinate data collection, information processing, management, and distribution.
- Coordinate data collection programs and sensor installation/operation.
- Inform and exchange data through coordinated operations.
- Centralize information processing, management and storage.
- Open access to information delivery and use.
- Coordinate information report development.
- Coordinate transportation management strategy development.

Utilizing public/private partnerships for these functions may raise questions about intellectual property rights. The Florida Public Records statute requires that access be given to records in public custodianship, including ITS data, to anyone requesting such information, with only very limited exceptions. The Public Records statute sets up a legal question when a public agency would share data from one ISP to another. The question, one that is being debated at separate locations nationwide, is whether the ISP maintains rights over the data shared with the public agency.

4.3 The Florida Experience

The Florida experience is incomplete. Yet, it already includes some generally applicable lessons. A review of the material presented earlier shows it began in earnest with a strategic plan. That plan led the way for setting Department policies for ITS, for establishing an ITS Office, for developing a statewide ITS architecture, and for substantial funding of a program being defined.

In fact, some have observed that the ITS process caused the Department to shift focus from building and preserving transportation facilities, still important themes, to one of managing and operating transportation facilities. The shift is likely to continue as congestion increases, right-of-way acquisition costs increase, and the need for safety and efficiency can no longer be completely met via building and preserving. Examples of Florida efforts in integration to follow in subsequent sections.

4.3.1 ITS in Volusia County

Underway since June 2001 with anticipated completion in Summer 2002, this project will allow FDOT District 5, the City of Daytona Beach Traffic Department, Volusia County Traffic Engineering, VOTRAN (the county's public transit agency), and other county operating agency stakeholders to share existing and future traffic video and traffic data in real-time in order to improve special event traffic management and incident detection/response capabilities. This project includes: (1) the development of an ITS architecture for Volusia County, Concept of Operations, and Communications Master Plan, (2) the provision of video integration for FDOT, Volusia County TMC, Daytona Beach TMC, and VOTRAN, and (3) the development of data/video interfaces to a new public access Internet website. "Before" and "after" performances measures related to event management and incident management that have been established by the project stakeholders, and these will be documented in the project's Local Evaluation Report. This will be the first project in Florida to assess the quantitative (and qualitative) benefits of shared video and data in regards to event/incident management.

4.3.2 South Florida Regional Advanced Traveler Information System

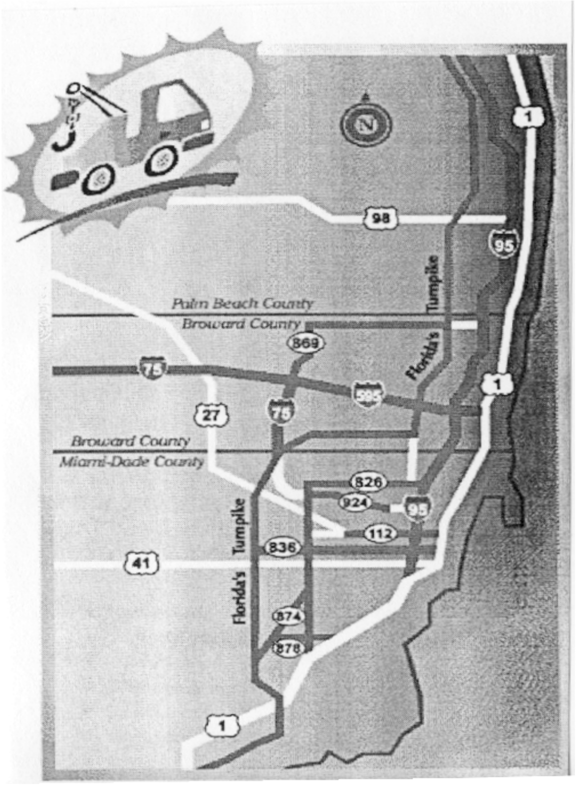
Under a 5-year partnership agreement that expires in November 2005, SmartRoute Systems, Inc. has established a traveler information center (known as "SmarTraveler") that officially opened on May 3, 2001 serving the tri-county area that includes Miami-Dade, Broward, and Palm Beach counties. Public sector partners, each annually committing funding toward center operations under the terms of partnership agreement, include three FDOT Districts and the Miami-Dade Expressway Authority. In addition, the four public transit agencies in the tri-county area have formally agreed to dedicate the necessary funding for provision and upkeep of their respective transit trip-making databases for integration into the traveler information/trip planning services provided by the SmartRoute Systems Center. The SmarTraveler center is establishing a real-time data and video exchange network with all of the local operating agencies whereby travelers can receive up-to-the-minute traffic and transit information via interactive voice response telephone system, exclusive internet website, email alerts, fax alerts, dynamic message signs, and highway advisory radio. Information comes into the SmarTraveler center directly or indirectly from various sources such as Florida Highway Patrol radio, helicopter reports, other travelers calling in on cell phones, closed circuit video cameras, the FDOT Road Rangers, and roadway sensors. This project is the first public-private partnership in Florida to provide traveler information.

4.3.3 SunGuide Road Rangers Service Patrol

A Florida-based example of "corridor integration" is the SunGuide Road Rangers project. The service patrols were originally developed in the 1980s to assist disabled vehicles in construction zones. Currently, the SunGuide Road Rangers service patrol is a coordinated, multi-corridor, motorist assistance program that has been expanded to cover the limited-access facilities in seven of the eight FDOT districts. In south Florida, for instance, it began as a joint-funded effort between the FDOT and the Miami-Dade Expressway Authority in 1996. This service has now expanded northward into Broward and Palm Beach counties, as highlighted by the darkened roadways in Figure 4-1.

Road Rangers operations cover I-95, I-595, I-75, State Road 836 (Dolphin), State Road 826 (Palmetto) State Road 112 (Airport), State Road 874 (Don Shula), State Road 878 (Snapper Creek), State Road 924 (Gratigny), and Florida's Turnpike. The Road Rangers also remove roadway debris and assist the Florida Highway Patrol during incidents. On the Florida Turnpike, the Road Rangers operate during peak periods, 365 days a year; 24 hours, 7 days a week in Miami-Dade and Palm Beach counties; and 6 a.m. - 7 p.m. weekdays only in Broward County. More than 7,500 people are assisted every month. All of the contracted, specialized tow trucks are (or will eventually be) AVL-equipped vehicle. Also 20 % to 25% of the tow trucks will be required to be equipped with DMS equipment. Planning is now underway to provide seamless control and dispatching from a single (existing or future TMC) location, integrating service over the three FDOT jurisdictional areas.

Figure 4-1: Road Rangers Service Area Map in Broward and Palm Beach Counties



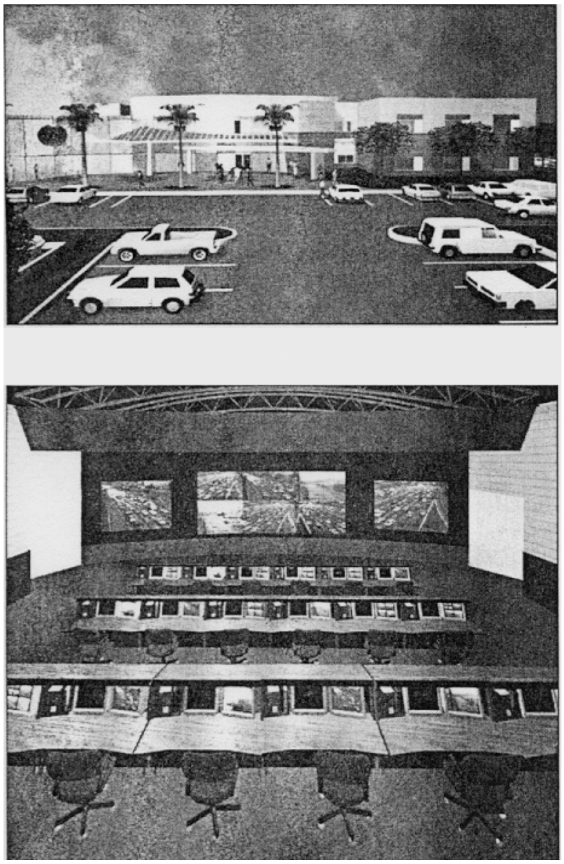
Source: *http://www.sunguide.org/patrolarea.htm*

4.3.4 Broward County ITS Operations Facility

A Florida-based example of "county integration" is the Broward County ITS Operations Facility project. This project, to build a new operation and command center, represents a public-public partnership between the FDOT and Broward County, which includes 30 municipalities such as Ft. Lauderdale and Hollywood. The new $7.3 million operations center (20,500 square feet) will provide communications and operations control for FDOT ITS systems in the area, while the second floor of the center will serve as a $3.3 million replacement facility (16,900 square feet) for Broward County Traffic Engineering Division's 40-year old control center. Figure 4-2 is a rendering of the facility exterior and ITS Operations Center.

The Broward ITS Operations Facility will be one of several regional transportation centers within the tri-county region of Dade (Miami), Broward (Ft Lauderdale), and Palm Beach counties that are to provide ITS integration and sharing of travel information in the statewide SunGuide Advanced Traveler Information System. The joint use center will be owned and generally maintained by Broward County, while FDOT will have unrestricted, permanent access and use of the first floor ITS control center. Broward County will serve as the building manager, and the FDOT will pay for its proportional share of utilities, maintenance and other facility-related costs. A joint participation agreement for operations and maintenance of the overall building was established between FDOT and Broward County. Prior to acceptance and transfer of the facility to the county following successful completion of the construction contract, the FDOT and county will agree on standard operating guidelines for all personnel in the ITS Operations Center.

Figure 4-2: Broward County ITS Operations Facility



Source: ITE Journal, August 2000, p.37.

The master plan development process for the Broward County ITS Operations Facility provided several lessons. While the initial focus was on combining the county's signal system with the state's freeway system, provisions were made to accommodate the Florida Highway Patrol; traveler information services providers, transit agencies, and university (research and development) partners. It is recommended that metropolitan areas planning a similar traffic management center prepare an ITS strategic plan/system architecture prior to the TMC master plan phase to provide a rational structure for integrating the TMC into the region. It is also recommended that memorandums of understanding and interagency agreements be prepared in parallel with the conceptual design process, particularly to define early cost-sharing needs to assure smooth implementation. Finally, TMC users must strike a balance between providing ample space for existing needs and realistic additional space for growth, particularly for communication requirements and additional co-located operations partners.

4.4 Tracking the Deployment of Integrated Metropolitan ITS Infrastructure in Florida

Chapter 2 outlined the effort the U.S. DOT being undertaken to measure and track ITS deployment and integration in 78 large metropolitan areas nationwide. Figures 2-1 and 2-2 and the accompanying Table 1-2, detailed the shared and used information at integration linkages between ITS infrastructure components nationwide. Because this chapter of the guidebook describes Florida's efforts towards ITS integration, this section will utilize information from the national tracking database to report on Florida's ITS deployment and integration based on the year 2000 results. The national database can be accessed at http://itsdeployment2.ed.ornl.gov/its2000/default.asp. The Florida portion of the database can be accessed at http://itsdeployment2.ed.ornl.gov/its2000/MetroListingResults.asp?State=FL. Deployment indicators have been developed for two broad areas of interest: (1) the individual components, including their basic functions and characteristics and (2) integration of components, including how these components work together to provide coordinated regional service.

As mentioned earlier, these indicators are expressed as percentages of the possible deployment opportunity and not necessarily what should be deployed. Requirements for deployment and integration between each component will vary based on local conditions and cannot be assigned without extensive coordination with individual metropolitan areas. This assessment approach associated with each component and its indicators, used survey questionnaires for data gathering. The indicators are judged to be the single best representative of a component and are being used as summary indicators for each component. Because indicators are expressed as a percentage, and deployment goals have yet to be established, these indicators should not be read as a comparison of what is deployed versus eventual deployment goals. Instead, they only reflect what is deployed compared to full market saturation (i.e., opportunity for deployment). Each component indicator was selected to reflect a critical function of the individual components.

A comprehensive set of locally defined deployment goals is not currently available. Therefore, it was necessary to develop a methodology to determine the level of deployment for an area based on a "top-down" approach. A set of deployment threshold values were identified and applied across all metropolitan areas in order to categorize each metropolitan area into one of three levels of deployment: High, Medium, or Low. These threshold values were established in a way that allowed demarcation of meaningful progress toward an achievable, 10-year goal, while still maintaining some requirement for "stretching" to reach the goal. The emphasis of the national tracking database is on deployment and integration of ITS components, the local emphasis might consider tracking operational aspects in addition to deployment goals.

Table 4-3 highlights the deployment indicators and surrogates used for each component.

4.4.1 ITS Deployment Tracking in Florida

In addition to FHWA efforts, the Florida ITS Office is currently tracking ITS devices types and locations for all existing, programmed and planned ITS projects along the five-principal FIHS corridors. The database is available at http://www.floridaits.com/TWO3-Final_Deliverable/Device%20Database.pdf

ITS deployment tracking in the six metropolitan areas in Florida is documented in Table 4-4. The table provides a quick look into the year 2000 survey of these metropolitan areas and the target year 2006 goal. A discussion of some sample figures is provided below to better understand the meaning behind the figures.

For example, in the case of FM, three basic functions are defined: surveillance, traffic control, and information display. The three indicators developed to reflect these functions are: percentage of freeway centerline miles under electronic surveillance (surveillance function), percentage of freeway entrance ramps managed by ramp meters (traffic control function), and percentage of freeway centerline miles covered by permanent VMS, HAR, or in-vehicle signing (information display function).

Table 4-3: Deployment Indicators for ITS Infrastructure Components

ITS Components	Deployment Indicators
Electronic Fare Payment	▪ Percentage of fixed-route bus and light-rail transit vehicles that accept electronic payment of fares ▪ Percentage of heavy-rail transit stations that accept electronic payment of fares
Incident Management	▪ Percentage of miles covered by incident detection algorithms ▪ Percentage of miles covered by free cellular calls to a dedicated number, ▪ Percentage of miles covered by on-call towing services or publicly-sponsored service patrols (like the "Road Rangers" that patrol I-95 and other freeways in Florida), ▪ Percentage of miles covered by surveillance cameras, ▪ Existence of a formal incident management plan or team (as exists in an increasing number of metropolitan areas throughout the nation).
Emergency Management	▪ Percentage of emergency vehicles under computer-aided dispatch, ▪ Percentage of emergency vehicles that have in-vehicle navigation systems
Regional Multi-modal Traveler Information	▪ Percentage of total possible media types used to display information to travelers ▪ Percentage of total possible media types used to display information of two or more travel modes to travelers ▪ Percentage of freeway miles surveillance data provided from Freeway Management.
Electronic Toll Collection	▪ Percentage of toll collection lanes with electronic toll collection capability ▪ Percentage of toll collection plazas with electronic toll collection capability.
Transit Management	▪ Percentage of fixed-route transit vehicles equipped with AVL (global positioning based AVL preferred over sign-post beacons) ▪ Percentage of fixed-route transit vehicles equipped with electronic monitoring of vehicle operating and maintenance conditions ▪ Percentage of paratransit vehicles under computer-aided dispatching ▪ Percentage of bus stops with electronic display of information ▪ Number of public locations where real-time transit information is displayed.
Freeway Management	▪ Percentage of freeway centerline miles covered by permanent dynamic message sign systems ▪ Percentage of freeway centerline miles covered by HAR ▪ Percentage of freeway centerline miles covered by in-vehicle information displays ▪ Percentage of freeway centerline miles controlled by lane use control systems ▪ Percentage of freeway centerline miles controlled by ramp metering ▪ Percentage of freeway centerline miles under electronic surveillance.
Highway-Rail Intersection	▪ Percentage of highway-rail intersections under electronic surveillance.
Arterial Management	▪ Percentage of agencies and municipalities in charge of traffic signal operation across the region that have cooperative agreements in place to share information for coordinated control ▪ Percentage of arterial system miles that have electronic monitoring (multi-point/segment flow detection is preferred, along with surveillance capabilities for public parking lot occupancies) ▪ Percentage of traffic signals under closed loop or centralized control (adaptive signal control is preferred over static timing plans based on historical data).

Source: Measuring ITS Deployment and Integration, January 1999, ITS Joint Program Office, US DOT, p. 6.
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf

Table 4-4: Tracking Deployment in Florida

ITS Component Indicator*	**Florida Metropolitan Area Current Year -Target Year**											
	Jacksonville		**Miami, Fort Lauderdale**		**Orlando**		**Sarasota, Bradenton**		**Tampa, St. Petersburg, Clearwater**		**West Palm Beach, Boca Raton, Delray**	
	2000	2005	2000	2005	2000	2005	2000	2005	2000	2005	2000	2005
Arterial Management Signalized Intersections under centralized or closed loop control	27%	33%	79%	95%	67%	76%	65%	65%	67%	82%	64%	73%
Electronic Fare Payment Fixed route buses that accept EFP	N/R	N/R	N/R	N/R	100%	100%	0%	100%	97%	100%	0%	0%
Electronic Toll Collection Toll collection lanes with ETC	0%	0%	80%	80%	95%	95%	81%	100%	0%	0%	0%	0%
Emergency Management Emergency management vehicle under CAD	75%	87%	57%	61%	26%	56%	N/R	N/R	80%	100%	90%	100%
Freeway Management Freeway miles under electronic surveillance	0%	11%	0%	29%	32%	100%	N/R	N/R	0%	35%	0%	25%
Highway Rail Intersection HRI under Electronic surveillance	N/R	N/R	17%	68%	10%	21%	N/R	N/R	9%	6%	0%	33%
Incident Management Freeway miles covered by service patrol	55%	81%	96%	76%	19%	31%	N/R	N/R	5%	35%	52%	52%
Arterial miles covered by service patrol	0%	0%	N/R	N/R	0%	0%	N/R	N/R	0%	0%	0%	0%
Regional Multimodal Traveler Information Freeway conditions disseminated to travelers	0%	0%	0%	0%	32%	32%	0%	N/R	0%	0%	0%	0%
Transit Management Fixed Route Vehicles with AVL	N/R	N/R	100%	100%	1%	100%	0%	100%	57%	97%	0%	0%

*N/R – no response.

**Indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity.

***Deployment opportunity reflects potential totals that do not necessarily reflect actual need.

Source: Tracking Deployment 2000 Survey Results: Metropolitan Areas within the State of Florida
http://itsdeployment2.ed.ornl.gov/its2000/MetroListingResults.asp?State=FL

Example: Calculating Component Indicators for FM

Consider a metropolitan area with 100 miles of freeway and 25 freeway entrance ramps. The area has no ramp meters, 10 freeway miles for which traffic data are collected electronically, and 5 freeway miles, which are covered by highway advisory radio.

The component indicator for electronic surveillance is calculated as (10/100) or 10%.

The component indicator for ramp meter control is calculated as (0/25) or 0%.

The component indicator for HAR coverage is calculated as (5/100) or 5%.

The summary indicator for the metropolitan area is calculated as (10%+0%+5%)/3 = 5%.

As indicated in Table 4-3, the ITS deployment activities in the major metropolitan areas in Florida are still in the preliminary stages, and is responding favorably to its ten-year deployment program funded with $500 million.

4.4.2 Measuring ITS Infrastructure Integration in Florida

The individual ITS components routinely collect information that is used for purposes internal to that component. For example, the AM component monitors arterial conditions to revise signal timing and to convey roadway conditions to travelers through such technologies as DMSs and HARs.

Other ITS components can make use of this information too in formulating their control strategies. For example, TM may alter routes and schedules based on real-time information on arterial traffic conditions, and FM may alter ramp metering or diversion recommendations based on the same information. As with the component indicators, definitions for inter- and intra-component integration were developed for each component, and indicators, derived from these definitions, were produced for each component. Each integration indicator has been assigned a coded *link* number and an origin/destination path from one ITS infrastructure component to another. For example, the number "10" identifies the integration of information from the Freeway Management component to the RMTI component. The coded *links* permit tracking the survey results in accordance with the survey model shown in Figure 2-2

Table 4-5 summarizes the complete set of integration indicators developed for metropolitan areas in Florida and the evaluation of year 2000 survey results.

Table 4-5: Measuring Integration in Florida

Link	ITS Integration Indicator Link*	Florida Metropolitan Area Year 2000 Results					
	From – To	Jacksonville	Miami, Fort Lauderdale	Orlando	Sarasota, Bradenton	Tampa, St. Petersburg, Clearwater	West Palm Beach, Boca Raton, Delray
1	TSC to RMTI	0%	50%	25%	0%	28%	50%
2	TSC to FM	25%	50%	0%	0%	14%	50%
3	TSC to TM	0%	0%	0%	0%	14%	0%
4	TSC to IM	25%	50%	0%	0%	14%	50%
5	IM to TSC	0%	66%	100%	0%	0%	100%
6	IM to RMTI	0%	0%	0%	0%	0%	0%
7	IM to EM	0%	0%	100%	0%	0%	0%
8	IM to FM	100%	0%	100%	0%	0%	0%
9	IM to TM	0%	0%	0%	0%	0%	0%
10	FM to RMTI	0%	0%	100%	0%	0%	0%
11	FM to TSC	0%	33%	100%	0%	0%	100%
12	FM to TM	0%	0%	0%	0%	0%	0%
13	FM to IM	0%	0%	100%	0%	0%	0%
14a	TM to RMTI	100%	40%	100%	100%	100%	0%
14b	TM to RMTI	100%	0%	100%	100%	33%	0%
15a	TM to FM	0%	0%	0%	0%	0%	0%
15b	TM to RM	100%	20%	0%	0%	0%	0%
16a	TM to TSC	0%	0%	0%	0%	0%	0%
16b	TM to TSC	100%	20%	0%	0%	0%	0%
17	ETC to FM	0%	0%	0%	0%	0%	0%
18	ETC to TSC	0%	0%	0%	0%	0%	0%
19	ETC to EFP	0%	0%	100%	0%	0%	0%
20	EFP to TM	100%	40%	0%	0%	33%	0%
21a	EM to IM	0%	0%	100%	0%	0%	0%
21b	EM to IM	0%	0%	100%	0%	0%	0%
22	EM to TSC	0%	8%	40%	28%	18%	0%
23	HRI to IM	0%	0%	0%	0%	0%	0%
24	HRI to TSC	50%	100%	75%	100%	100%	100%
25	IM (intra)	88%	16%	80%	57%	45%	71%
26	TSC (intra)	75%	0%	0%	0%	42%	0%
27	EFP (intra)	100%	20%	100%	0%	33%	0%
28	ETC (intra)	N/R	0%	100%	N/R	N/R	N/R
29	TM to IM	0%	20%	100%	0%	0%	0%
30	FM (intra)	100%	0%	100%	0%	0%	0%

ITS Components
EFP – Electronic Fare Payment
EM – Emergency Management
ETC – Electronic Toll Collection
FM – Freeway Management
HAR – Highway Advisory Radio

HRI – Highway Rail Intersection
IM – Incident Management
RMTI – Regional Multimodal Traveler Information
TM – Transit Management
TSC – Traffic Signal Control
VMS – Variable Message Sign

*N/R – no response
**Indicators are single surrogates that do not necessarily reflect the full breadth of ITS deployment activity.

Source: Tracking Deployment 2000 Survey Results: Metropolitan Areas Within the State of Florida, http://itsdeployment2.ed.ornl.gov/its2000/MetroListingResults.asp?State=FL

As with the component deployment indicators, definitions for inter- and intra-component integration were developed for each component, and indicators derived from these definitions were produced for each component. Each integration indicator has been assigned a number and an origin/destination path from one ITS infrastructure component to another. For example, the number "10" identifies the integration of information from the FM component to the RMTA component.

Example: Calculating Integration between AM and RMTI

Consider a metropolitan area with three AM agencies. One out of three provides information to the public using a RMTI Media (e.g., internet, kiosk, pager, etc...).

The integration indicator is 1/3 or 33%.

As evident in the above example from the national integration tracking database, the criteria of arriving at a percentage for integration has been defined in simplistic fashion which usually does not represent the exchange of detail data or flows. Therefore, Table 4-5 should be read with caution. It merely represents that some level of information is being exchanged between multiple ITS components of Florida's metropolitan areas and more progress is to be achieved in future.

CHAPTER 5

CASE STUDIES IN ITS INTEGRATION

The U.S. DOT has documented several case studies engaging local and regional efforts of ITS integration in various parts of the nation. These case studies represent a broad range of ITS integration efforts in their scope, strategies, and the crosscutting nature of physical deployments among multiple jurisdictions. The case studies highlighted in this Guidebook are:

- Regional Integration: Central Ohio
- Multiple State Integration: New York-New Jersey-Connecticut
- Corridor Integration: San Antonio's Medical Center Corridor
- Cross-Jurisdictional Traffic Signal Coordination: Phoenix Metropolitan Area
- County Integration: Oakland County, Michigan (FAST-TRAC)

This chapter provides a summary of these five case studies and emphasizes the lessons learned from each one. Each case study includes a discussion of the following:

- Summary of Case Study
- Approach to Integration
- Implementation Strategy
- Conformity to National ITS Architecture
- Lessons Learned

The chapter concludes by providing a summary of lessons learned from the case studies presented.

5.1 Regional Integration: Central Ohio (Mid-Ohio Regional Planning Commission)

5.1.1 Summary of Case Study

As ITS systems were being deployed throughout central Ohio, the Mid-Ohio Regional Planning Commission, MORPC, in 1998, saw a growing need to provide a mechanism through which all transportation stakeholders could understand what was being planned, and have a forum to discuss and examine how these systems could (or should) interact with each other. It was MORPC's primary goal in the development of an ITS Integration Strategy for Central Ohio to make this a regional process, which required involving many stakeholders who had never been previously involved with ITS efforts. The purpose of this Integration Strategy is three-fold *(21)*:

1. guide to enable local government to plan future projects that are integrated with projects of other neighboring jurisdictions,
2. vehicle for interagency and inter-jurisdictional communications, and
3. means for local agencies to convey the benefits of ITS to policymakers, and help foster support for ITS deployment.

The Integration Strategy expanded the scope of ITS consensus building to include input from traffic, transit, and safety representatives; develop a list of ITS needs not currently addressed; and most importantly, develop "functional flow diagrams" (central Ohio's customized equivalent of the NIA's market packages). These functional flow diagrams helped stakeholders identify opportunities for project integration and information sharing. It seems evident that the MORPC intended this ITS Integration Strategy to serve as their first step toward conformity with the NIA.

5.1.2 Approach to Integration

The Integration Strategy effort began with MORPC reforming the existing ITS stakeholders group, the Transportation Management Committee (TMC). Expanding the TMC from the traditional "traffic community," the new 25-agency TMC now included representation from local area police, fire, emergency management, chambers of commerce, airport authorities, and AAA. The TMC's responsibility was focused on education and information sharing. The subcommittees of the TMC inventoried current and planned ITS programs within each subject area, then identified potential interactions (functional flow diagrams). The MORPC also worked closely with other key ITS program representatives across the nation to better understand what had failed and what had been successful in integration efforts. Scanning tours for several TMC subcommittees to mature ITS deployment sites were also arranged in co-sponsorship with FHWA.

5.1.3 Implementation Strategy

Key elements of the MORPC implementation strategy are:

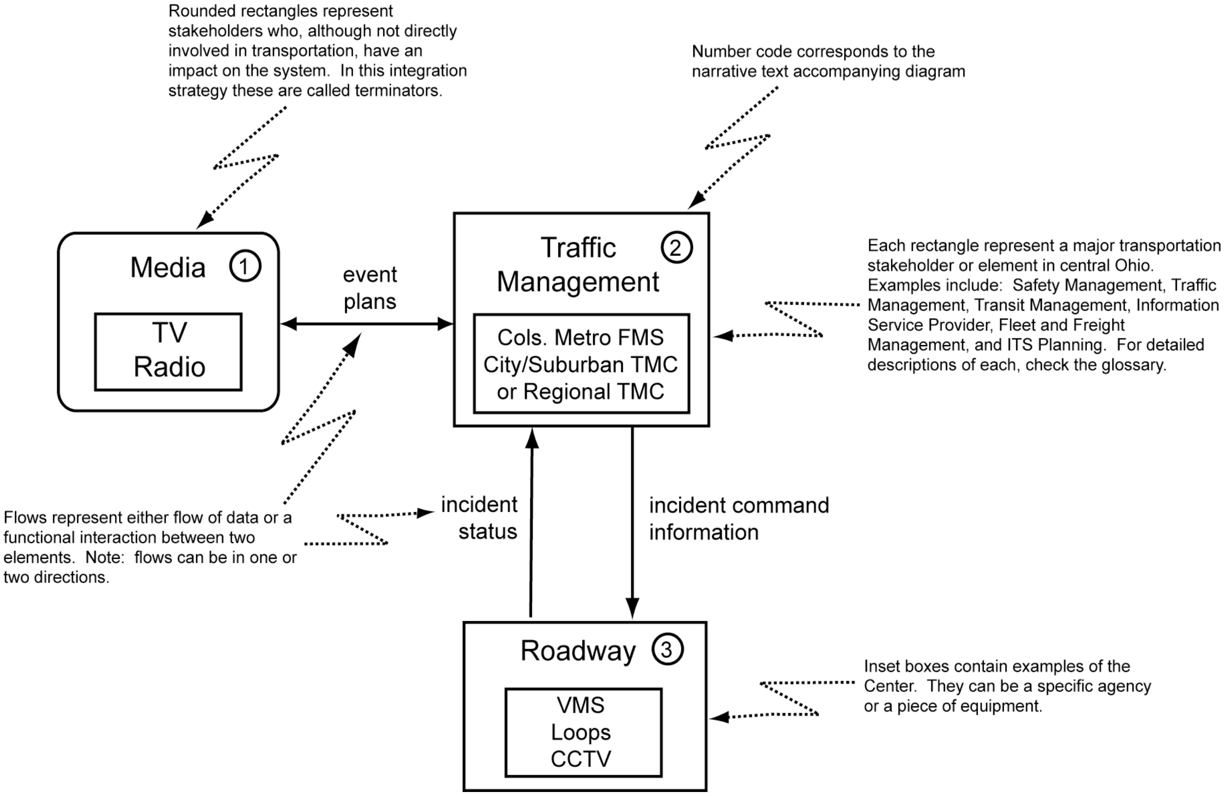
- Establishing the ITS implementation process by reaching out to multiple jurisdictions, agencies and other interests (e.g. chamber of commerce).
- Forming a new 25-member TMC that included members from the traffic community (e.g. city, county, state transportation department officials) as well as non-traditional traffic community such as police, fire, airport authorities and AAA. Subcommittees were also created to address specific issues and/or to pursue specific actions such as inventorying the existing and planned ITS and identifying interactions.
- Preparing a regional mobility needs report documenting growth in population and congestion, and potential mitigating measures using ITS
- Identifying and quantifying the anticipated benefits from ITS deployment (accident reduction, reduction in incident response times, reduced delay, reduced travel times, and improved air quality) based on actual impacts of existing and planned ITS projects in central Ohio, and other deployments in the nation
- Developing a consensus based ITS project implementation plan to address the ITS needs in the short term (5-year), and far term (5+ years). Included are such crosscutting projects as a centralized regional transportation management center, a regional marketing effort for ITS awareness, rail crossing and tunnel surveillance, regional ITS system evaluation, and cross jurisdictional signal coordination.

Finally, all regional stakeholders are committed to continuously working together to identify sources of funding for ITS projects in the region.

5.1.4 Conformity to National ITS Architecture

The TMC's first task was to tailor the NIA diagram to reflect central Ohio current and future ITS implementation. Once this was completed, the details of interaction were identified and developed by the TMC subcommittees in the functional flow diagrams (pieces that are required to implement a particular transportation service, and are customized to reflect real world problems and needs). Since it was MORPC's goal to make the Integration Strategy for central Ohio as understandable as possible, much of the NIA jargon was replaced with easier to understand terms. Figure 5-1 is an example from MORPC work of how to read a functional flow diagram. All boxes in the functional flow diagrams reflecting the Integration Strategy are numbered and correspond to numbered paragraphs found in the text below them that further explain interaction and informational flows.

Figure 5-1: Sample Portion of Functional Flow Diagram



Source: ITS Integration Strategy for Central Ohio, Figure 25, p. 43.
http://209.57.154.225/trans/its/ITS%20Integration%20Strategy%20for%20Central%20Ohio.PDF

The MORPC continues to develop requirements for conformity and they are considering surveying new integration partners using the functional flow diagrams that already developed. That would include diagrams for traveler information, freeway control, regional transportation management, surface street control, transit passenger and fare management, transit route operations, transit maintenance, transit security, multimodal coordination, emergency vehicle routing, special event management, incident management, emergency response, motorist assistance, public sector fleet administration, and ITS planning. The diagrams provide new partner with immediate visibility as to what their integrated contribution might be.

Legacy ITS-related systems, or systems already in design, are being excluded from conformity requirements. Architecture consistency will be expected, as legacy systems are upgraded and new ITS projects are planned and implemented. Rule 940, as discussed in Chapter 2, provides additional information on the architecture conformity requirements for existing and future projects.

5.1.5 Lessons Learned

Based on the MORPC's development of this formal ITS Integration Strategy for Central Ohio, utilizing public outreach, a regional integration strategy for ITS deployment was explicitly unveiled. It was the logical next step for a public agency to take after having led several major ITS studies for the region. An expanded, regional, consensus building process for ITS was needed, and the collective effort of the Integration Strategy report provided a vehicle to accomplish this goal (particularly as a proactive effort prior to issuance of the FHWA Final Rule). Most importantly, this Integration Strategy is being incorporated into the overall MORPC planning process and update for the region's Transportation Plan.

This case study serves as proof that planning organizations/councils can take the leadership role in making ITS integration activities part of their transportation planning process to promote intra-agency and inter-jurisdictional communications.

5.2 Multiple State Integration: New York-New Jersey-Connecticut (TRANSCOM)

5.2.1 Summary of Case Study

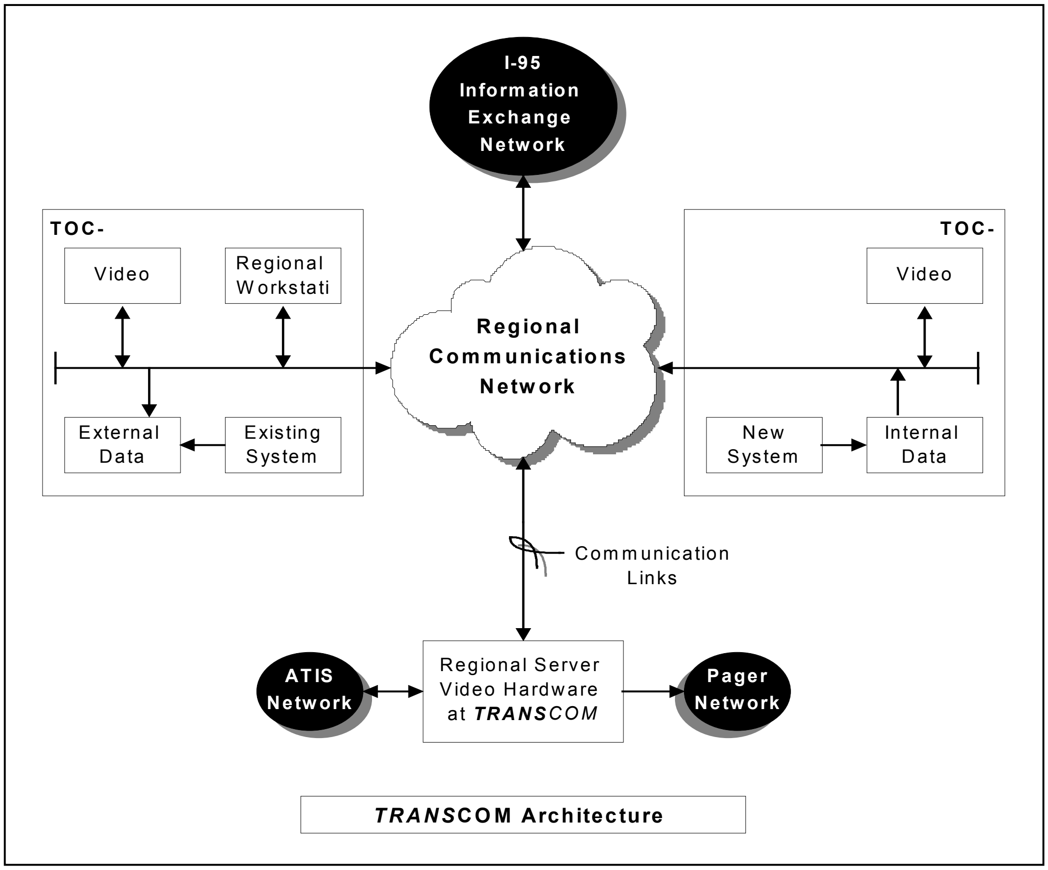
The New York-New Jersey-Connecticut region covers 29 counties and over 21 million residents. In order to address the need for improved transportation operations, 16 operating agencies in the region formed the Transportation Operations Coordinating Committee, TRANSCOM, and developed a proactive incident management and construction coordination scheduling system in 1986 *(22)*.

While this early consortium provided significant regional benefits, its capabilities were limited because it originally relied on a manual transfer of data (telephone reports) between the agencies. The early manual system is being phased out as automated communication systems are being deployed. The early "manual architecture" did provide, however, the institutional and technical precedents to facilitate the development of further regional ITS integration (e.g., E-Z electronic toll collection system in 1990, and the I-95 Corridor Coalition in 1992). The five toll authorities operating within the E-ZPass system are all TRANSCOM member agencies, so a working relationship between these agencies had already been established. Additionally, TRANSCOM serves as the communications center for the I-95 Corridor Coalition.

5.2.2 Approach to Integration

A complex geography, along with complicated jurisdictional structures affects the regional transportation system in this tri-state region. There are also a number of operating agencies that maintain overlapping responsibility for managing the region's transportation network. Improving operational efficiency by better management of the existing system is now the main focus of ITS for the region's three state departments of transportation, numerous transit agencies, transportation authorities, and local transportation agencies. In addition to the regional ITS architecture effort, four ITS Early Deployment Plans (EDP) were completed in the for region. These EDPs represent ITS deployment for specific parts of the region, but they are planned and integrated with the RIA as the "blueprint." Figure 5-2 illustrates the first cut of the proposed RIA.

Figure 5-2: TRANSCOM Regional ITS Architecture



Source: Regional ITS Architecture Development, New York-New Jersey-Connecticut Region, Building a Framework for Regional ITS Integration, ITS JPO, September 1999, p.7, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/7fv01!.pdf

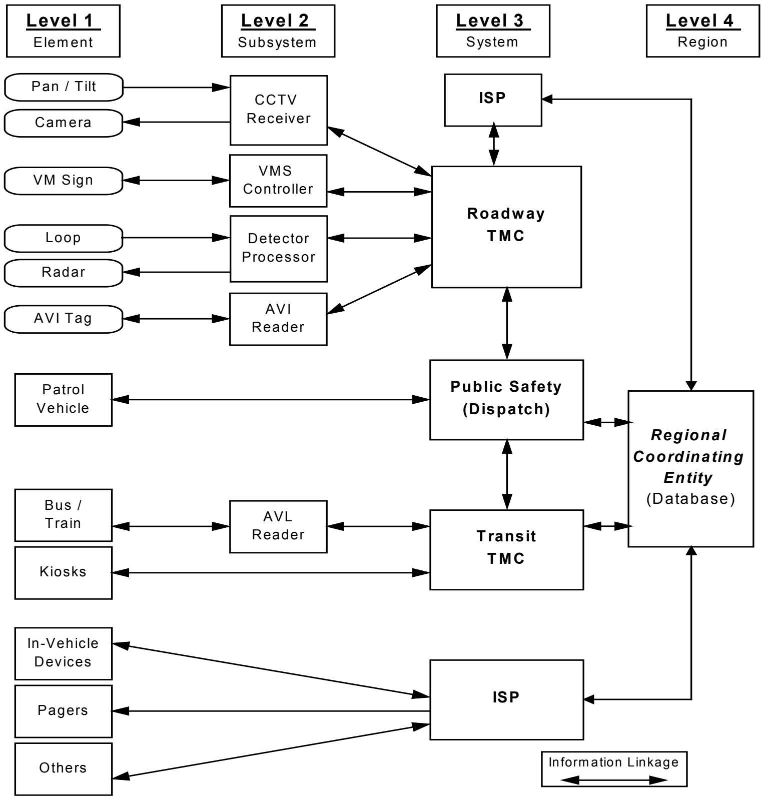
The four EDPs previously mentioned each created (or are creating) a sub-regional architecture to work within an RIA shown in Figure 5-2. As the TRANSCOM Regional Architecture encompasses a very large metropolitan area, the concept of having a sub-regional architecture for the New York City area simply represents the need for a higher level of coordination within the city agencies. For example, The New York City EDP included a sub-regional plan for joint control by New York State DOT and New York City DOT of the road network within New York City at a single, co-located operating center.

5.2.3 Implementation Strategy

In 1993, TRANSCOM began to plan a strategy to develop an automated RIA. An RFP was issued to develop the enhanced (automated) RIA, under the oversight of TRANSCOM's Technology and Operations Committee (members of this oversight committee are senior staff of the TRANSCOM member agencies). The automated architecture would be used to improve the collection and dissemination of information.

Figure 5-3 provides an illustration of proposed data flows between the different levels of the regional architecture.

Figure 5-3: Example of Data Flow for Automated TRANSCOM Architecture



Source: Regional ITS Architecture Development, New York-New Jersey-Connecticut Region, Building a Framework for Regional ITS Integration, ITS JPO, September 1999, p.10,
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/7fv01!.pdf

5.2.4 Conformity to National ITS Architecture

The process to develop a new RIA began with a review of the "manual architecture" previously mentioned at a time that preceded the publication of the NIA. The RIA was subsequently developed as a pragmatic response to the needs of operating agencies in the region. TRANSCOM staff and partners were aware of and directly involved in the development of the NIA. Also, training and other tools that were created as part of the NIA development process were effectively utilized by agencies in the region. TRANSCOM maintains responsibility for updating the regional ITS architecture as needs and priorities change.

5.2.5 Lessons Learned

While each participating agency was primarily motivated by their own operational needs and concerns, bringing these organizations together early on in the process, and establishing new relationships cultivated a greater interest in regional transportation issues and regional ITS solutions. However, participants often had difficulty translating the need for ITS integration to their organizations. In many agencies, both senior management and operation staff found the concept of an ITS architecture difficult to explain. Therefore, the lesson learned is that it is critical to cultivate understanding and interest in ITS at all levels of the participating agencies early in ITS development. Operations staff needs to understand how coordination of systems and information flows can improve their operational responsibilities, and planning staff needs to understand their role in ITS planning and the roles and the responsibilities of operations staff.

Creating new lines of communication was seen as something that extended beyond just ITS. It became widely recognized that ITS must be part of a regional mobility strategy and not viewed separately. Unlike most other transportation projects that are done in isolation of the overall transportation system, ITS projects are now being viewed as a means to improve the management and operation of the overall regional transportation network.

TRANSCOM epitomizes a leadership role in a large metropolitan area integration effort where multi-state agencies are expected to work together to achieve inter-agency/multi-state integration (Level 5, Table 7-1). It also exemplifies how sub-regions would function within more broadly defined regions.

5.3 Corridor Integration: San Antonio's Medical Center Corridor

5.3.1 Summary of Case Study

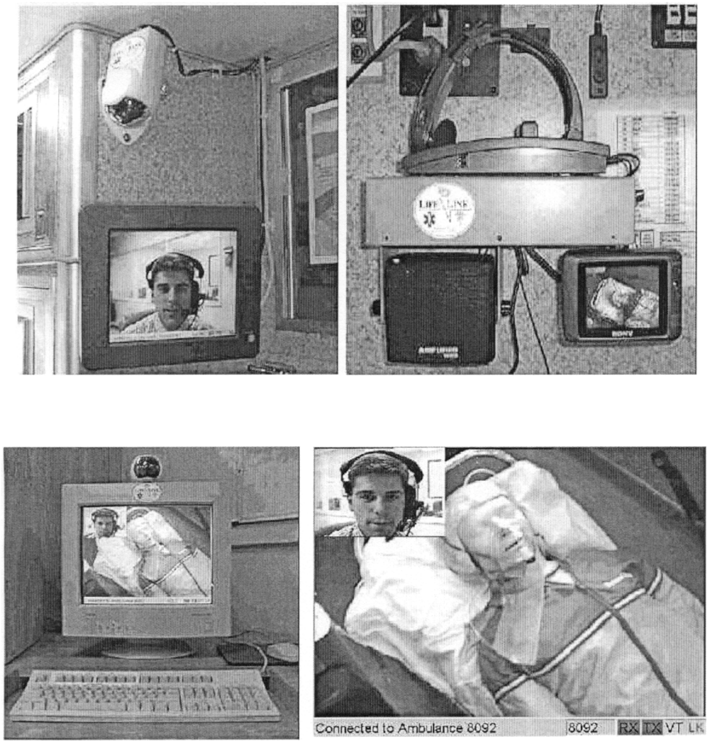
As one of the four sites participating in the Metropolitan Model Deployment Initiative (MMDI) effort, San Antonio is committed to integrating the region's highly successful freeway management system with a newly developed arterial management system in the city's 5.4-mile, Medical Center (north end) Corridor to improve incident response and management. Jointly developed, deployed, and operated by the Texas DOT, the City of San Antonio, and the region's emergency service providers, the Medical Center Corridor (MCC) project is one of several projects under the MMDI. The MCC is designed to identify, respond, and manage incidents within the corridor in a coordinated, seamless fashion.

The LifeLink deployment, solely devoted to improving emergency services, may be the "crowning jewel" of the San Antonio MMDI-MCC. This innovative project allows video and voice teleconferencing capabilities between University Hospital and ten ambulances by facilitating communication between the attending emergency medical technician (at the scene and in the ambulance enroute) and the physician in the hospital's emergency room. Basically, the LifeLink system uses the freeway system's fiber-optic network and roadside radio-frequency beacons for data transmission *(23).* Graphic images of this integrated communication system are shown below in Figure 5-4. Predicted benefits resulting in continued usage of the LifeLink system include reduced emergency treatment costs, reduced delay and secondary crashes, reduced litigation and claims, and improved patient survivability and recovery. This urban application of mobile emergency tele-medicine is also expected to be extended to rural locations using satellite communication.

5.3.2 Approach to Integration

Incidents are first detected and confirmed through the freeway system's video and loop detector stations (spaced at 1.6 km or less intervals). This information is then relayed in real-time to the TransGuide freeway operations center. At that point, incident response plans are developed and actions are undertaken. These actions may include dispatch of emergency service equipment as directed by co-located emergency service providers, or dispatch of Texas DOT service patrols. Incident information is also provided back to the travelers in the corridor. On the freeway, this information is displayed through overhead lane control signs (indicating which lanes are blocked), and by variable message signs. On the arterial, the information is displayed through a series of dynamic message signs located along the major approaches to the freeway system. These dynamic message signs provide only a single message—whether there is a freeway incident or not.

Figure 5-4: LifeLink Communication Displays



Source: San Antonio MMDI Evaluation Report, May 2000, p. 68,
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/9xv01!.pdf

The incident information is also shared with the City of San Antonio's traffic management center, which is co-located in the TransGuide facility. The sharing has the synergistic effect of facilitating efficient operations of A number of predetermined incident-response arterial signal plans can then be activated to provide greater capacity parallel to the interstates to support responding vehicles *(24).*

5.3.3 Implementation Strategy

Freeway installation benefited from a strategic decision to conduct much of the deployment at the same time major freeway reconstruction was occurring. Arterial operations and maintenance costs also benefited by co-locating the operations center within the existing TransGuide operations center. Initial cooperation from the City of San Antonio was gained by offering this unique opportunity to co-locate their operations center and take full advantage of centralized staffing for response and maintenance operations. Also, a peer-to-peer permissive operating philosophy was adopted whereby incident response signal plans continued to be *locally* developed and implemented by the City of San Antonio under a *regional* context of freeway-arterial management.

5.3.4 Conformity to National ITS Architecture

Building upon the highly successful TransGuide freeway operations system that first began in the 1960's, the San Antonio MMDI developed and integrated nine individual projects, designed to address five different functional goals for the region. Table 5-1 identifies the nine projects associated with the five goal areas selected from the National ITS Architecture as being most appropriate for the San Antonio metropolitan area.

Table 5-1: San Antonio MMDI Functional Goals and Associated Projects

Functional Goal	Projects
Improved Traveler Information	In-Vehicle Navigation, Web Site, Kiosks
Improved Traffic Management	Freeway Management System Expansion, Medical Center Corridor
Improved Highway-Rail Traveler Information	Advanced Warning to Avoid Railroad Delays (AWARD)
Improved Emergency Services	LifeLink
Improved Travel Speed and Roadway Condition Database	Travel Date Server, Vehicle (AVI) Probes

Source: San Antonio MMDI Evaluation Report, May 2000, p. 15,
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/9xv01!.pdf

5.3.5 Lessons Learned

LifeLink has been successful as a "proof-of-concept" and is an example of how cost savings can be achieved through integration and shared infrastructure. Considering the complexity of the project, many believe the project was readily achieved n terms of the technologies needed, but might not have been feasible without extensive interagency integration. However, the full benefits have not yet been realized for two principle reasons. First, the hospital community has been unable or unwilling to offer full support primarily because of resource and staffing shortages (a problem common to many hospitals). Second, budget cuts ultimately forced the elimination of LifeLink's telemetry-transmitting capability to continuously monitor the patient's vital signs (believed by tele-medicine experts to represent up to 90 percent of the ultimate benefits for such a project).

5.4 Cross-Jurisdictional Traffic Signal Coordination: Phoenix Metropolitan Area

5.4.1 Summary of Case Study

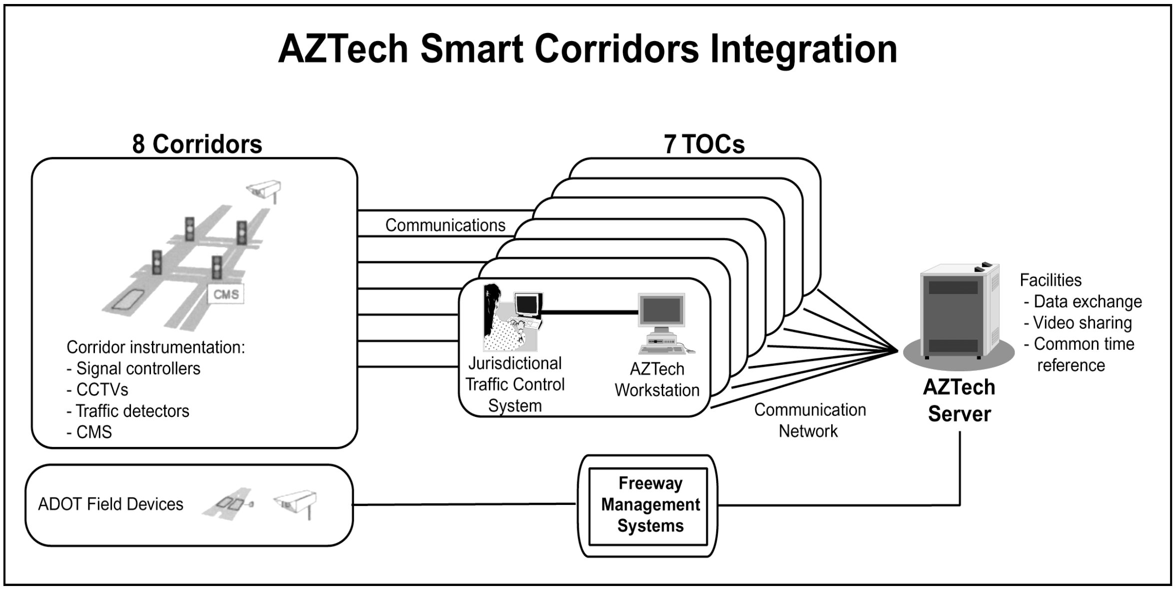
The overall AZTech MMDI represents a seven-year effort to develop and integrate 15 ITS projects for the 2.5 million residents of the Phoenix metropolitan area *(25).* 19 public sector partners and 13 private sector participants, with Arizona DOT responsible for project administration and Maricopa County handling project management duties, formed AZTech. Three of the 15 MMDI projects were included under the area of Advanced Traffic Management Systems, and one of these three projects was involved with cross-jurisdictional signal coordination along a 6-mile, major north/south arterial that connects the cities of Scottsdale and Tempe. There are 21 traffic signals within 2 jurisdictions along this arterial segment. Arizona State University (in Tempe) is also served by this arterial.

Prior to the signal coordination project, the jurisdictional separation was a boundary for signal coordination, delaying motorists with unnecessary stops between cities. This coordination boundary was relocated to allow signal coordination through the city (Tempe). The AZTech Technical Oversight Committee established interagency coordination standards, synchronizing traffic signals along corridors between adjacent jurisdictions.

5.4.2 Approach to Integration

In order to facilitate data exchange and achieve full technical integration, the eight Smart Corridors were linked to the AZTech server. Implementing a regional communications infrastructure, as shown in Figure 5-5, (new or upgraded traffic signal controllers, surveillance equipment, and detection devices) maintained the necessary information flows between operating jurisdictions. Also, traffic signal controllers, surveillance equipment, and detection devices were installed or upgraded to collect information. Workstations were installed at the Traffic Operations Centers (TOCs) in each jurisdiction to allow sharing of the traffic information, which in turn provided each jurisdiction with the opportunity to update signal-timing plans to reflect real-time changes traffic patterns.

Figure 5-5: AZTech Integration



Source: Cross-Jurisdictional Signal Coordination in Phoenix & Seattle - Removing Barriers to Seamless Arterial Travel, ITS JPO, 2000, p. 6. http://www.itsdocs.fhwa.dot.gov/jpodocs/edlbrow/@701!.pdf

Workstations for each jurisdictional were also installed at the AZTech Traffic Operations Centers to allow for sharing of real-time changes in traffic patterns that triggered signal timing plan updates.

Another key factor in integration was the development of a regional traffic control and management plan. This plan included a variety of signal timing plans for arterials passing through multiple jurisdictions, and procedures for coordinating regional traffic management activities between jurisdictions.

5.4.3 Implementation Strategy

As mentioned previously, traffic signals along the Scottsdale-Rural Road corridor were originally operated at different background cycle lengths, which negated the progression of vehicle movement. Several signals along the corridor were retimed to a common background cycle length with appropriate offsets (average travel time in progression between traffic signals). Also, through the pre-established partnership agreements and regional operating policies, capital costs and annual costs were shared among jurisdictions. For example, each of the eight regions involved with cross-jurisdictional signal coordination was responsible for 12.5 percent of the annual operating costs of the AZTech Traffic Operations Center. Finally, to control and manage the ever increasing ITS project workload, several dedicated positions were created or re-defined at the key organizations. ADOT created the position of statewide ITS Coordinator, Maricopa County DOT split its ITS unit to create a section for countywide ITS activities and a section for the AZTech MMDI, and the Maricopa Association of Governments added a staff person to coordinate the MPO's ITS Committee with the participating municipalities *(26)*.

5.4.4 Conformity to National ITS Architecture

The overall AZTech MMDI was designed to produce an arterial and freeway network that was safer and more efficient for the traveling public. The architecture selected to accomplish this objective consists of five major, integrated components as shown in Table 5-2.

Table 5-2: AZTech Major Integrated Components

ITS Component	Objectives
AZTech Server	Fuses information from various sources (transit AVL, Smart Corridor arterials, and freeway management system) to provide multi-modal traveler information through privatized services
Smart Corridors	Large-scale arterial signal coordination and detection system, with traffic data being shared by all jurisdictions. Video monitoring was deployed on arterials and images were being sent to the AZTech server.
Transit AVL	AZTech server provided real-time bus status on 94 buses along several fixed routes in Phoenix and Mesa to generate schedule adherence.
Incident Management	A mobile, computerized crash investigation system was provided to reduce incident clearance time and complete accident reports automatically.
ATIS	A commercial traffic information service company (Metro Traffic Networks) is providing information for dissemination via the ATIS server (provided by Etak) across cable TV, in-vehicle navigation devices, hand-held computers, personalized messaging, Internet, and information kiosks.

5.4.5 Lessons Learned

One of the strongest outcomes of integration was the strengthening of institutional ties among the participating public agencies in the region. Sharing of costs among projects and agencies made individual projects more affordable for participating agencies. The sharing of traffic camera images created the need for agencies to establish new policies for how video images would be used and shared, but also helped bolster support for ITS technologies among the general public due to the overwhelming popularity of these images on the *Trailmaster* web site for AZTech.

AZTech MMDI participants were able to create three innovative techniques for timely procurements: sole-source contracting, on-call contracting, and joint (inter-jurisdictional) procurements.

For the Scottsdale/Rural Road smart corridor project, one jurisdiction simply adopted the signal-timing plan of its bordering jurisdiction. While benefits were achieved on a localized basis, it was recommended that other signal-retiming plans be applied and evaluated to maximize regional benefits.

This case study demonstrates several levels of integration emphasizing lead and participatory roles and responsibilities of the different agencies involved. The range of ITS implementers includes the State DOT, several city governments, the county government, transit service providers, public safety service agencies, the MPO, the U.S. DOT, and the private sector. These roles will be further defined in the Integration Relationship Matrix in Table 7-1.

5.5 County Integration: Oakland County, Michigan (FAST-TRAC)

5.5.1 Summary of Case Study

Oakland County is located in southeast Michigan, about 15 miles north of Detroit, and is part of the greater Detroit metropolitan area. It is Michigan's most populated county, and for the last decade it is where two-thirds of all the new office development in the Detroit metro area has occurred. Oakland County's FAST-TRAC (Faster and Safer Travel through Traffic Routing and Advanced Controls) program represents one of the nations' earliest attempts, and a working model, for implementation and integration of ITS. With over $70 million of committed funding, it was the largest operational test of ITS in the world *(27).*

Beginning deployment in August 1991, the FAST-TRAC program involved the integration of advanced traffic management and traveler information through centralized collection, processing, and dissemination of traffic data *(28).* The original concept included the deployment of three subsystems; the Ali-Scout system developed by Siemens for route guidance, the Sydney Coordinated Adaptive Traffic System (SCATS) for signal control and management, and the AUTOSCOPE™ video vehicle detection system in the City of Troy, Michigan. The Transportation Information Management System (TIMS) is the tool that facilitates the collection, processing, and dissemination of information.

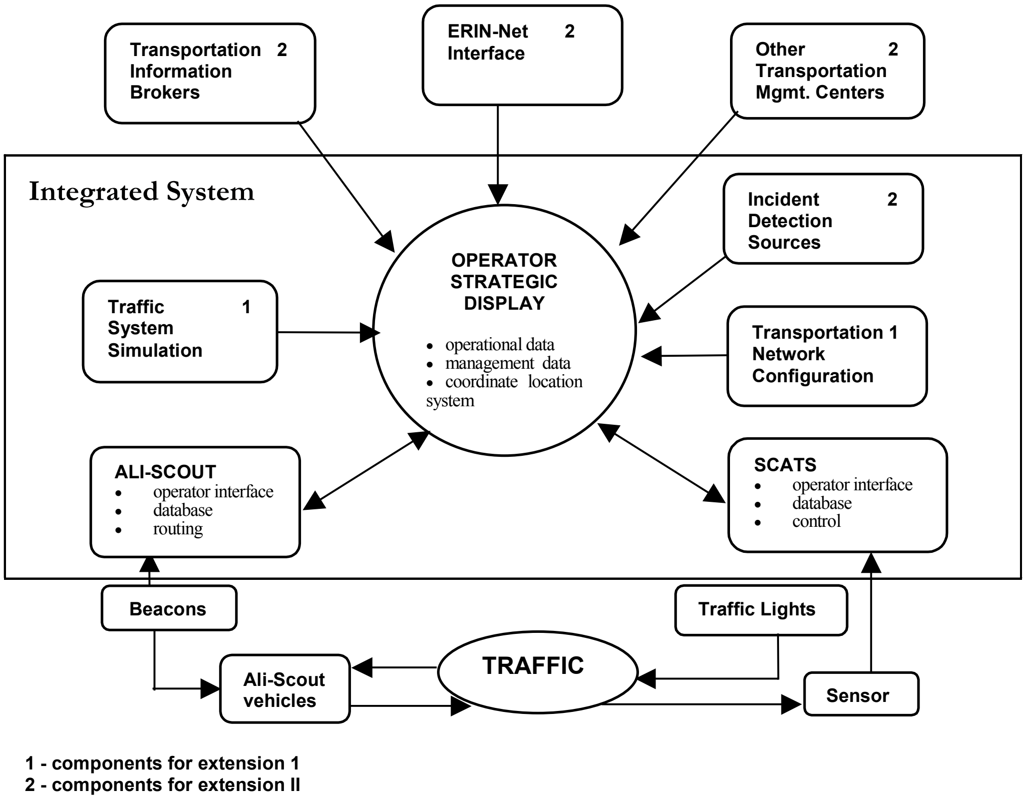
The Road Commission of Oakland County (RCOC) working with the Michigan DOT's traffic operations center, the Suburban Mobility Authority for Regional Transportation (SMART), and other local government agencies established data exchange relationships. There are 61 local units of government in Oakland County. In February 1998, the project partners decided to eliminate the Ali-Scout component (because it was found that integration with SCATS was not technically feasible) from the test. By the completion of the project in August 1998, the number of controlled intersections expanded to 350, including about 20 closed circuit television cameras to perform automated traffic surveillance.

5.5.2 Approach to Integration

The FAST-TRAC integration planning process represents a prime example of learning by doing. The system integration approach was a concerted effort in which the RCOC, a local public agency, collaborated with consultants, systems vendors, and other public authorities. RCOC administered a federal grant locally--a responsibility typically assumed by a state transportation agency. However, a willingness to experiment and the flexibility of public officials and project partners in adjusting to technical advancements, and an ability to respond to shifts in political agendas proved to be major assets of FAST-TRAC.

The initial stage of FAST-TRAC was motivated by local traffic management needs and political earmarking strategies. In this first stage, the interaction and agreements between project partners was very informal. However, the project quickly stretched the local resources and technical expertise. As deployment progressed, FAST-TRAC formally established a Systems Integration Committee in 1992, which included Siemens, FHWA, Michigan DOT, Rockwell International (now known as Odetics ITS), AWA Traffic Systems of America, Inc., and the University of Michigan. The committee met regularly and focused on issues primarily regarding data and subsystem integration. FAST-TRAC moved away from just integrating traffic management and traveler information toward the integration of multiple ITS systems (e.g., freeway operation, computer-aided dispatching for transit, and law enforcement activities), and the ERINet subsystem (Emergency Response Information Network). Figure 5-6 illustrates the original concept for FAST-TRAC systems integration.

Figure 5-6: 1994 FAST-TRAC Integration Concepts



Source: System Integration Case Study, FAST-TRAC, University of Michigan, February 12, 1999, p.9, *http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/7JR01!.PDF*

5.5.3 Implementation Strategy

A key factor in the success of FAST-TRAC was the establishment of a Systems Integration Committee, and the decision to contract directly for systems integration work. Rockwell/Odetics served as the systems integrator. Separate contracts between the Road Commission and the individual ITS system vendors were also established. At least one representative from each of the ITS systems was requested to attend monthly project meetings. Specific, task-oriented working groups (e.g., traffic operations center functions, communications, World Cup Soccer, and traffic management/traveler information integration) were established as needs arose. Through these committees, the partners developed specifications for systems design, and after adoption of these specifications, the implementation documents could be developed and issued.

5.5.4 Conformity to National ITS Architecture

At the start of this project, no appropriate national standards for ITS data transfer were available as guidelines. As a result, the ROCC and its partners had to establish the required communication interfaces between specific system components without the benefit of adopted ITS standards. The need of the project partners to access proprietary information to complete the design of customized communication interfaces also caused significant delays in the project. Today, emerging data exchanges standards help avoid the delays experienced by FAST-TRAC.

5.5.5 Lessons Learned

Institutional integration is the key to successful system integration in a multi-organization project such as FAST-TRAC. One of the most important case study findings for this project was that it was relatively easy to integrate systems, but difficult to integrate companies. Institutional, jurisdictional and legal challenges far outweighed the technical complexities in integrating an advanced traffic management system with an advanced traveler information system. Furthermore, it was found that this integration has the potential to offer benefits beyond those offered by an individual system (e.g., 19% increase in average speeds on major arterials in the peak direction during peak periods, and total intersection delay decreased at most intersections despite the addition of left-turn phases at most intersections). Finally, the RCOC found that video image processing, although not proven at the time of installation, can be a viable traffic detection technology because more than one lane can be monitored and no roadway surface impacts would result during construction compared to more conventional inductive loop detectors.

5.6 What Have We Learned from the Selected Case Studies?

A logical step for a public agency that is leading a major developmental task, one often assisted by regional ITS studies, is to develop a concept of operations. This is also a means to solidify and formalize regional consensus building for ITS projects. However, it is often difficult to appreciate and understand the need for integration. Operational staffs need to understand coordination of systems and how improved information flows can improve operational capabilities. The planning staffs that become involved in ITS planning also need to realize where the planning ends and the operational responsibilities begin.

Technical integration is a challenge that is usually more easily met than integration of institutional processes. When agencies work together, costs are reduced, and sometimes projects are enabled that would not have been feasible otherwise. Institutional ties are strengthened and sustained through integration. ITS integration generally bolsters the support for ITS among the general public as well. New operating policies and sources of funding may need to be established, but innovative techniques for more efficient procurement and deployment may also be an end result of integration. Project benefits usually increase just, simply, by sharing ITS information with a broader based user group.

Institutional integration is the key for ITS success. Case studies point to the fact that it is relatively easy to technically integrate systems, but more difficult to bring companies and agencies together to operate efficiently. Institutional, jurisdictional, and legal challenges usually far outweigh the technical complexities of integrating ITS projects.

The national case studies discussed in this chapter also manifest that ITS integration can occur in different regional settings as well as under different leadership structures. It is evident from the case studies that there is usually a major agency or a consortium contributing as the leader of integration while the smaller (or the less contributing) agencies play an important role by being a participant in the integration process. The regional boundary for integration activities can vary significantly as well. In the example of Oakland County, Michigan (Section 5.5), the integration activities occur within the Country boundary, with the County government being the leader of its own integration. In case of TRANSCOM (discussed in Section 5.2), the integration initiatives span a large geographic area with the involvement major transportation agencies in three states -- New York, New Jersey, and Connecticut -- thus contributing to multi-state integration. The regional consortium, TRANSCOM, consisting of sixteen major transportation agencies in the New York City metro area, provides the leadership.

In summary, the identification of region and the leadership to drive integration in that region prove to be key factors in achieving ITS integration in a systematic manner.

CHAPTER 6

PROCESS FOR ACHIEVING ITS INTEGRATION

The key to a successful interoperable transportation system is to integrate ITS via systems engineering approach into all stages of planning, designing and deployment of transportation projects at the state, regional and local settings. This guidebook recommends an iterative process to achieve overall ITS integration that involves planning, institutional and technical integration processes. This chapter outlines the suggested process and provides the necessary steps to attain integration in planning and implementing ITS. At the core of the suggested approach is the iterative process of developing, using and maintaining a RIA as part of an ITS Strategic Plan, considered the focal activity in planning and implementing ITS integration.

Questions concerning ITS integration that policy-makers and planners may ask are answered in the section on planning and institutional integration layers. Answers to potential questions from ITS project designers, operational and technical ITS staff, are offered in separate sections that address technical layer.

Figure 6-1 shows the organization of this chapter, and serves as a guide and roadmap for using the suggested process for achieving ITS integration. A brief description of Figure 6-1 and the process is provided next.

Planning Integration

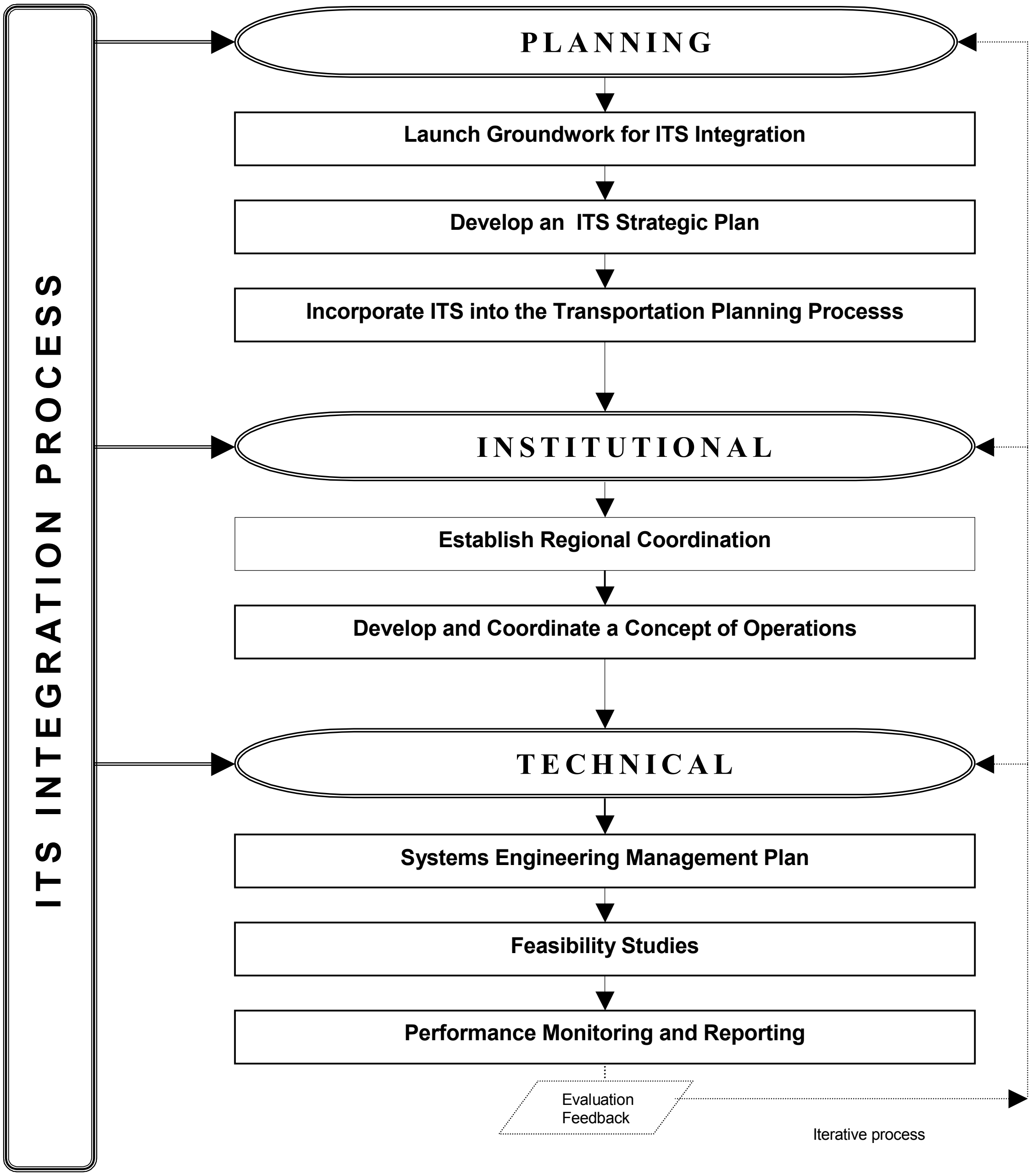
As seen in Figure 6-1, the initial effort in the suggested process is achieving integration in planning using the following three steps:

Step I – Launch the Groundwork for ITS Integration. Two parallel tasks are recommended in this step. The first task, identifying ITS stakeholders and ITS champions, involves identifying coordinating partners/users/stakeholders coalitions, establishing a core group of stakeholders and promoting champions for ITS. The second task is performing outreach and inreach activities to gain participation and support of stakeholder coalitions, ITS staff, and ITS executives by educating and enlisting agency decision-makers and other staff in the ITS development process.

Step II – Develop an ITS Strategic Plan. Building on Step I in expanding stakeholder coalitions, the strategic plan is developed based on input from stakeholders articulating an ITS vision for the region or the state. Next task would involve screening market packages and developing a sequence for market package implementation. Based on the market package sequence/plan, the functional capabilities for desired ITS projects would be defined. Once a Market Package Plan has been developed that documents the ITS services that should be deployed in a region, the regional framework in which these services will be deployed should be defined. The NIA provides a general framework that may be adapted and elaborated into a broad range of regional transportation system designs. A regional architecture is a key product of this process that begins to overlay major technology and interface choices that are appropriate for the region onto the more general NIA. Adopting a regional architecture is the focal step in the planning integration effort.

Step III – Incorporate ITS into the Transportation Planning Process. This step addresses challenges that agencies must successfully overcome in order that ITS integration projects reach design and implementation stages. Considering ITS as part and parcel projects of traditional transportation planning documents need to be a routine

Figure 6-1: Process for Achieving ITS Integration



practice for all planning and implementing agencies. Discussion on incorporating ITS into the traditional planning process may include incorporating an ITS element in the Long-range Transportation Plan, ITS Projects in Transportation Improvement Programs, ITS Tasks in the Unified Planning Work Programs, ITS as a Congestion Management Tool, Role of ITS in Corridor Studies, ITS to Meet Concurrency Management Needs, and ITS for Sustainable Development.

Institutional Integration

Step I – Establish Regional Coordination. Steps to establish regional coordination include designating a lead agency, emphasizing regional leadership, create a committee structure, building on existing methods for regional cooperation, and establishing governance agreements and understandings

Step II – Develop and Coordinate a Concept of Operations. In this step, stakeholders' current and future roles and responsibilities in the implementation and operation of the regional systems are defined in more detail. The concept of operations documents these roles and responsibilities for selected transportation services in specific operational scenarios. It provides an "executive summary" view of the way the region's systems will work together to provide ITS services.

Technical Integration

Step I - Systems Engineering Management Plan, SEMP. Systems engineering is a structured process for arriving at a final design of a system, both at the level of an ITS architecture and the level of project implementation. To demonstrate that the systems approach is consistently being taken, more than assertions may be needed. One-way of demonstrating an ITS program is based on systems approach is to adopt a Systems Engineering Management Plan which describes the methodology and milestones in systems integration, and control system development and testing. SEMP also describes the processes to be used to integrate the software and hardware in the control system, and to integrate communications and field devices.

Step II – Feasibility Studies. Based on SEMP, a feasibility study for a specific ITS integration project can be undertaken to determine the cost/benefit analysis. Measures accomplished through a feasibility study include defining data transfer and control, analyzing system functional requirements, developing an ITS procurement plan, and defining operations and management options.

Step III - Performance Monitoring and Reporting. In this step, it is emphasized that ITS data can be used to evaluate the transportation systems before and after ITS deployments. Highlighted in this step is the federal effort on program assessment/evaluation and an example that shows how a state agency, Florida Department of Transportation, FDOT, adapted national performance measures to fit localized characteristics.

The suggested process for achieving ITS integration is iterative but always relies on use of a RIA, related standards, and the systems approach. The planning, institutional and technical integration tasks overlap. Detailed steps to achieve ITS integration at the planning, institutional and technical activities are offered in subsequent sections.

6.1 Planning Integration

Transportation planning is an ongoing, iterative process. It's goal is making quality, informed decisions pertaining to the investment of public funds for regional transportation systems and services. As seen in Figure 6-1, planning-level integration involves three consecutive steps, the first of which involves laying the foundation for the integration process. The core of groundwork activities to lay this foundation is the RIA, a powerful tool for planning the regional integration of a transportation system. Developing the RIA is created with the use of the planning information already developed by an agency. The RIA will be the cornerstone of planning for effective inter-agency coordination during deployment and operation of technology-based projects.

6.1.1 Launch the Groundwork for ITS Integration

The efforts highlighted here are recommended as on-going activities to lay the foundation for launching fully-integrated ITS projects.

Identify ITS Stakeholders and ITS Champions

Identification of participating agencies and stakeholders is one of the required components of a regional ITS architecture as identified in FHWA Rule 940 Section 9(d)2 and FTA Policy Section 5(d)2.

> **Identify Coordinating Partners/Users/Stakeholders Coalitions.** Coalition of involved organizations remains a key requirement after RIA adoption. It should be viewed and fostered as a continual process. The national architecture provides a technical framework that assists with regional integration of systems. Precisely if, when, and how this integration will occur within a particular region can only be determined by engaging each of the involved parties. The list of stakeholders identified in Table 6-1 includes the range of stakeholders that have participated in regional ITS architecture development efforts around the country. The table makes a good checklist of possible stakeholders that may be involved in RIA development.
>
> Not all stakeholders are members of organizations, but it is mainly the cooperating agency planners and implementers, and the ITS consultants and vendors who are the stakeholders that regularly contribute to ITS development. The range of these organizations includes transportation, public safety, emergency management, telecommunications services, information service providers, and commercial movers of goods.
>
> Broadening stakeholder involvement is important because the value of the information disseminated through the systems (connected by way of the RIA) is progressively enhanced as it is used more. Of course, the determination of what the region is, the cooperation and coordination needed to operate efficiently within the region, and the RIA greatly determine which stakeholders are motivated to participate.
>
> **Core Stakeholders Group**. The core of main participants includes the state and local planners and traffic operations staffs, transit operators, the state highway patrol and the county sheriffs, and the consultants who plan projects, perform design, operate the transportation management centers, and supervise installation and testing of ITS field devices. They should be a diverse group with representation from major transportation agencies/organizations, planning and system operators. Core stakeholders should be people that plan, own or operate ITS systems in their region. They may include representatives from an MPO, traffic operations department of a DOT, state planners, local traffic engineers, transit operators, and emergency management organizations. The more these participating organizations cooperate, communicate, share ideas and information, and solve problems together, the greater success there is for ITS integration.
>
> **ITS Champions**. "Champions" are a crucial ingredient in the successful development of a regional ITS architecture. They are civic leaders, lobbyists, and advocates that bridge institutional gaps, educate and inform others, promote the ITS program in the region, promote good planning, seek funding, and help obtain additional resources. They are often regional personages such as a county commissioner, a congressman, an MPO director, or a nationally recognized expert who is a local resident. The ITS Champions typically become expert, themselves, on ITS topics but are just as often supported by a dedicated staff that provide background and factual information. Having and developing ITS Champions is an important contribution to achieving ITS program objectives.

In conclusion, identifying stakeholders and engaging them in the process early on will provide necessary momentum to vital institutional integration. Noteworthy here, is that the marketing strength of ITS integration is the plethora of data generated from ITS technologies and applications. Although more stakeholders can be identified on continuing basis, the main ones discussed in this section serve as the core group. Other stakeholders include academia, private sector, freight and commercial vehicle management groups, and other groups that can utilize ITS-derived data. Appendix B lists different stakeholders' groups and how they use ITS-derived data.

Table 6-1: Candidate Stakeholder List

Transportation Agencies	▪ State Departments of Transportation (DOT) ▪ Local Agencies (City & County) ○ Department of Transportation ○ Department of Public Works ▪ Federal Highway Administration (FHWA) ▪ State Motor Carrier Agencies ▪ Toll/Turnpike Authorities ▪ Bridge/Tunnel Authorities ▪ Port Authorities ▪ Department of Airport or Airport Authority
Transit Agencies/Other Transit Providers	▪ Local Transit (City/County/Regional) ▪ Federal Transit Administration ▪ Paratransit Providers (e.g., Private Providers, Health/Human Services Agencies) ▪ Rail Services (e.g., AMTRAK) ▪ Intercity Transportation Services (e.g., Greyhound)
Planning Organizations	▪ Metropolitan Planning Organizations (MPOs) ▪ Council of Governments (COGs) ▪ Regional Transportation Planning Agency (RTPA)
Public Safety Agencies	▪ Law Enforcement ○ State Police and/or Highway Patrol ○ County Sheriff Department ○ City/Local Police Departments ▪ Fire Departments ○ County/City/Local ▪ Emergency Medical Services ▪ Hazardous Materials (HazMat) Teams ▪ 911 Services
Other Agency Departments	▪ Information Technology (IT) ▪ Planning ▪ Telecommunications ▪ Legal/Contracts
Activity Centers	▪ Event Centers (e.g. sports, concerts, festivals, ski resorts, casinos, etc.) ▪ National Park & US Forest Services ▪ Major Employers ▪ Airport Operators
Fleet Operators	▪ Commercial Vehicle Operators (CVO ○ Long-Haul Trucking Firms ○ Local Delivery Services ▪ Courier Fleets (e.g., US Postal Services, Federal Express, UPS, etc.) ▪ Taxi Companies
Travelers	▪ Commuters, residents, bicyclists/pedestrians ▪ Tourists/Visitors ▪ Transit Riders, others
Private Sector	▪ Traffic Reporting Services ▪ Local TV & Radio Stations ▪ Travel Demand Management Industry ▪ Telecommunications Industry ▪ Automotive Industry ▪ Private Towing/Recovery Business ▪ Mining, Timber or Local Industry Interest
Other Agencies	▪ Tourism Boards/Visitors Associations ▪ School Districts ▪ Local Business Leagues/Associations ▪ Local Chambers of Commerce ▪ National Weather Services (NWS) ▪ Air & Water Quality Coalitions ▪ Bureau of Land Management (BLM) ▪ Academia Interests, local Universities ▪ National and Statewide ITS Associations (e.g. ITS America, ITE ITS members, etc.) ▪ Military

Source: Regional ITS Architecture Guidance: Developing Using and Maintaining the ITS in your Region, U.S. DOT, October 2001, p.29, *http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//13598.pdf*

Perform Outreach/Inreach Activities

"Outreach" is a communication activity that centers on customers and stakeholders external to the implementing agencies. Its purpose is to gain their participation and support. Limiting technical terminology and jargon, and emphasizing regional integration, are important aspects of "outreach."

"Inreach", is a communication process that focuses on the staff and executives at the participating planning and implementing agencies. Its purpose is also to obtain participation and support mainly by educating and enlisting agency decision-makers and other staff in the ITS development process.

Recommended Outreach/Inreach Techniques *(29)*

Target Materials. Educational materials and information should be tailored for specific audiences, depending mainly on the purpose of the meeting, or workshop. Perceiving the sophistication of the audience in ITS knowledge and awareness, and predetermining training objectives are important activities in tailoring educational materials needed. Agency public/community affairs staffs can play a crucial role in this, as was the case in Arizona where ADOT's public affairs office played a leading role in apparently successful statewide ITS architecture outreach activities across the state.

Undertake Cross-Agency and Cross-Jurisdictional Outreach. Cross-agency and cross-jurisdictional sharing of information is necessary to develop, deploy, and maintain integrated ITS. Building consensus is an essential and practical way to get the job done. Building consensuses is a process that include a set of building blocks:

- Build consensus in the region for the decision to develop a RIA by emphasizing the benefits, rather than the rule/policy requirements.
- Schedule ongoing meetings and/or provide a consistent mechanism for communication to/from agencies responsible for the overall transportation program.
- Address issues as they arise by using the consensus building process to make decisions about projects, ITS regional goals, etc.
- Facilitate a broad review of the draft inventory and incorporate comments. Stakeholders can check with other departments in their agencies to verify the inventory for their agency is complete and accurate.
- Build consensus on needs and services for the region. Focus discussions on those services that require group buy-in. Issues will surface during operational concept development. Identify and document key issues that cannot be resolved.
- Review connections and ensure stakeholders agree with the identified interfaces for their ITS systems. Change connections and iterate until stakeholders are satisfied with the interconnections.

Similar to traditional planning, project sequencing is a consensus building process and should not be viewed as a ranking of projects. Stakeholders should begin with existing planning documents and focus on short, medium and long term planning decisions. Agreements take a long time to execute, therefore, build consensus early with simple agreements like MOUs while final agreements are being developed.

In Arizona, for example, broad stakeholder participation ensured that weather and traffic data would be shared among ADOT district offices and other interested parties, such as the Department of Public Safety, the regional railroads, and area weather forecasting stations.

Demonstrate Benefits. Successful deployments can be the best way to convince decision-makers of the benefits of participating in ITS development process. The "E-ZPass" (automated toll collection) program in the NY-NJ-CT Region gave solid evidence to decision-makers and the public throughout the region of the advantages of both ITS and interagency coordination. According to the February 15, 2002 article in "Inside ITS" E-ZPass ETC installation is successful from the viewpoint of service to customers and reduction in congestion at plazas. However, some of E-ZPass higher than estimated costs are due to its popularity. It has increased the operational costs of the customer service center and the violation-processing center. Sufficient improvements in the overall collections of administrative fees will meet expectations in a timeframe extended than was originally projected *(30).*

Keep Partners Informed. Regular information sharing with a broad range of individuals and organizations is important. Those actively involved in the process must keep those less involved informed. Newsletters, frequently used as an effective tool in accomplishing this goal, are made more convenient as electronic formats become the common practice.

6.1.2 Develop an ITS Strategic Plan

Building on the groundwork for ITS integration (Section 6.1.1) and expanding stakeholder coalitions, the strategic plan is developed based on input from stakeholders articulating an ITS vision for the region or the state. Steps to develop an ITS strategic plan that identifies not merely concepts but implementable ITS projects is presented in Table 6-2, *(18)*. The strategic plan for a region guides ITS projects from their inception to inclusion in TIPs or STIPs. The outcome of the strategic planning process includes a sequence of market packages, often referred to as Market Package Plan, and a RIA.

Notes on Developing a RIA

A regional architecture can be prepared by using *Turbo Architecture*, an interactive software tool for developing regional and project architectures. The primary functions of the software are to help develop ITS architectures from the NIA, as follows *(31):*

- Record and depict the result of stakeholders' meetings and workshops
- Develop and diagram a RIA, with defined links to the NIA and national standards
- Create an architecture for a single ITS project when no regional architecture exists
- Create a project architecture from an existing regional architecture
- Add a defined project architecture to an existing regional architecture

Benefits of *Turbo Architecture* software include leveraging NIA for structured local planning, maximizing ITS integration opportunities, facilitating efficient expansion of ITS and saving time and money in development of ITS architectures. Some practitioners, however, state disadvantages of using the current version of *Turbo Architecture*. The software tends to reduce the RIA to an unnecessary level of detail and tends to be ineffective in achieving interregional interfaces. In addition, although Rule 940 permits market packages not in the NIA, *Turbo* software has not developed a means by which a new market package may be included in the RIA.

Table 6-2: Process for Developing an ITS Strategic Plan

Define Problems & Document Goals.	Based on the needs assessment, this activity links the ITS effort directly to established, agreed-upon regional transportation goals. It also defines the problems that ITS should address and provides the existing ITS inventory base upon which the ITS regional framework will be built.
Develop Vision	This step defines the long-term vision for the future regional transportation system. The Vision is developed as a short, approachable product that can be used to focus the attention of the initial coalition. It provides a platform for establishing ITS goals and objectives and serves as an important benchmark for the remainder of the project. All other activities in the planning process should be predicated on the fact that they help to achieve the vision. Moreover, a well-crafted vision serves as a significant aid in attracting additional members of the coalition. By demonstrating how ITS is envisioned to work within the regional transportation system, stakeholders will clearly be able to see how their activities may be affected by ITS.
Perform Technology Review	When identifying ITS market packages/equipment packages for deployment, there is a need to know what technologies, do they meet standards, what they can do, how much they cost and when they might be available. While an overall assessment of technology needs may be conducted for both short-term and long-term, the detail technology review should be conducted only for short-term (0 to 5 years) projects. As the technologies are changing rapidly, the new innovations and cost-effectiveness will require re-evaluation of technology needs beyond the early 3 to 5 years period.
Develop Sequence of Market Packages	This step considers the spectrum of transportation improvements available to the regional planner, including alternatives to the identified market packages and expanded treatment of the implementation options and associated costs, benefits, and risks. The range of available solutions evaluated determines those services most appropriate for implementation in the region. Market packages also have a direct linkage to the underlying architecture that is helpful in subsequent steps. The next task is to document the market packages that should be implemented over both short and long terms. Sequencing based on local priorities, deployment dependency guidance, and tailoring of national deployment strategy guidelines. These plans can be integrated with the mainstream planning documents (e.g., the Regional Transportation Plan) as issues are resolved and potential funding sources are found.
Identify Desired Functional Capabilities	Desired functional capabilities should be explicitly defined based on local characteristics. Better insight into appropriate functional capabilities will also be gained through subsequent evaluation of the implemented project and on-going evaluation of similar projects in other areas. The desired functional capabilities should be defined based on a set of performance criteria. Use of the architecture products and subsequent standards can streamline this process since it should enable standardized building blocks for many of the basic ITS components. Definition of standard, higher-level components will ease the job of system specification by effectively reducing the level of granularity to which the systems analyst must go.
Regional ITS Architecture	<u>Adopt or Develop a RIA</u>. Communications choices, technology choices, and allocation of information management and control processing capabilities within the regional transportation system are developed to define a regional architecture. The process of regional architecture definition involves three steps: ▪ Map existing systems to NIA framework: The existing system inventory and local institutional framework are mapped to the physical architecture framework. ▪ Assess existing system national compatibility: standards requirements are identified for each interface and compatibility with these requirements, and any identified standards are determined. Architectural integration focuses on the functional inter-connectivity among subsystems and consistency of data format and interfaces. Determine costs/benefits of achieving compatibility: Normally systems will evolve towards compatibility as equipment is upgraded or replaced. The cost of retrofitting existing systems to be architecture compatible, whether in the context of a system upgrade or a stand-alone project, is determined and weighed against estimated costs of incompatibility. Where cost-effective, compatibility attainment is planned. The architecture development is the most fundamental step in any ITS integration process. At this level, engineers define the system, subsystems, functions, and interfaces required to deliver the selected ITS user services. ▪ Develop the corresponding logical and organizational architecture diagrams. It is possible that several options will need to be developed that reflects different ways of organizing the market packages. Organizational responsibility can be associated with either the logical or physical architecture diagrams, if desired. Work through variations of the architecture diagrams in a consensus building process until the right combination of market package interrelationships and agency responsibilities is derived. Decisions regarding the agencies, with which certain functions will reside, can be reached through consensus. In most cases, ITS will primarily involve enhancement of existing agency functions, not a reconstruction of core functions. However, substantial losses in efficiency or increases in expense can sometimes be incurred if decisions on consolidation or change of agency functions are not a consideration. It is here that the consensus-building skills of the steering committee leader will be particularly important. <u>Maintenance</u>. As ITS projects are implemented, new ITS priorities and strategies are likely to emerge. As the scope of ITS expands and evolves to incorporate new ideas, the RIA will need to be updated. It is recommended that the responsibility for long-term maintenance of a RIA be firmly identified with consensus from planning agencies involved. The organization instituted for the development process is usually viewed as the most suitable structure for maintaining the RIA. Adopting a long-term ITS architecture maintenance plan, that specifically addresses this issue, is recommended. A maintenance plan guides controlled updates to the RIA baseline so that it continues to accurately reflect the region's existing ITS capabilities and future plans. <u>Consistency of ITS Deployment with the RIA</u>. The real success of the RIA effort hinges on effective use of the architecture once it is developed. The RIA is an important tool for use in transportation planning and project implementation. It can identify opportunities for making ITS investments in a more cost-effective fashion. Once a RIA is created, it can by used by stakeholders in planning their ITS projects to support regional goals. It can be used to maximize appropriate integration of projects identified by the planning process.
Project Sequencing	At this step, the general strategies, defined regional architecture, and identified market packages refined and translated into a sequenced set of specific projects

6.1.3 Incorporate ITS into the Transportation Planning Process

The next step in achieving ITS integration is incorporating ITS integration plans into the transportation planning process. Outlined in the Florida issue paper, "Integration of ITS into the MPO Transportation Planning Process, June 1999," an important role for MPOs to play in transportation planning, including the planning of ITS improvements and operations. The issue paper presents the following guidelines:

- Consideration of ITS should be included at all stages of the multi-modal transportation planning process.
- Institutional and inter-jurisdictional cooperation and coordination in the planning, deployment, operation and management of ITS must be established.
- ITS must be planned on a regional, integrated and interoperable basis in conformance with the NIA and standards.
- Stakeholders must recognize the unique challenges of ITS and identify the barriers these challenges create.
- ITS should be introduced into the planning process as a combination top-down and bottom-up approach.
- Transportation professionals should recognize opportunities for including ITS as an integrated element alongside "traditional" infrastructure improvements.
- Advocates for ITS should promote ITS within the planning environment.
- Potential ITS projects should be evaluated to determine the proper roles for the public sector, private sector, or public/private partnerships.
- Resource centers should be identified and developed to encourage the dissemination of ITS information.

For the MPOs and for other area wide and statewide planning agencies, the RIA will provide information for updating both the LRTP and the TIP. It will also provide information for use in other planning studies and activities, including the Mobility Management Plan, Corridor and Sub-Area Studies, performance-monitoring activities, Transit Development Plans, and other locally defined studies or plans. For statewide planning agencies, it will provide information for updating the Statewide TIP, and other statewide or multi-region plans and studies.

Florida's ITS Planning Guidelines, Integration of ITS into the Transportation Planning Process, June 2000, provides advice to integrate ITS into most aspects of the transportation planning and growth management process. The *Guidelines* also address the following challenges for resolution by transportation planners:

> **ITS Element in the Long Range Transportation Plan, LRTP.** A LRTP contains forecasts of transportation demand, transportation needs and cost feasible improvements over a twenty-year planning period. ITS can have a vital role in both the financially constrained transportation plan and in the long range plan vision. For example, ITS enhancements to conventional transportation improvements can be developed to reduce the project's life-cycle costs as well as maximize the use of existing facilities and services. ITS features can be considered as separate projects or in conjunction with capacity projects. The ITS element in LRTP should identify how ITS investments will meet statewide or metropolitan goals and objectives, the existing and future ITS systems, including their functions and electronic information sharing expectations. Regional ITS architecture and any regional ITS initiatives (a program of related projects) that are multi-jurisdictional and/or multi-modal, ITS projects that affect regional integration of ITS systems, and projects which directly support national interoperability. The LRTP should also identify goals and objectives from the ITS strategic plan and TEA-21 which can be

quantified for project evaluation and mainstreaming with typical capacity projects in the development of a cost-feasible plan.

ITS Projects in Transportation Improvement Programs, TIPs. TIPs balances priorities and production schedules with available transportation funding for five years. A TIP advances projects from the LRTP by essentially allocating funding resources to specific project development and construction activities. The TIP project development process defines the priorities of the local area for the implementation of ITS. Projects for the LRTP/TIP should be derived and phased in accordance with the sequence of projects developed from the regional architecture.

ITS Tasks in MPO Unified Planning Work Program, UPWPs. UPWP describes all transportation planning activities to be undertaken within the region, along with appropriate budget information. It also includes descriptions and budgets related to special planning or technical studies undertaken by the MPO as part of the transportation planning process. As it relates to ITS planning, the UPWP should also contain all the MPO's ITS planning activities, including the identification of studies to develop alternative funding strategies for ITS deployment.

ITS as a Congestion Management System, CMS, Tool. Federal laws require that those urbanized areas with greater than 200,000 population prepare congestion management systems. Florida statutes extend this requirement to all MPOs *(32)*. CMS are specifically designed to monitor current congestion levels, forecast future congestion levels, and develop planned programs to ameliorate anticipated travel deficiencies. CMSs can also be viewed as a tool to change travel behavior and help existing transportation facilities operate more efficiently by providing transportation system performance information in such a fashion as to maximize all mobility options for people and goods.

In Florida, the state's Mobility Management Process (MMP) is synonymous with the CMS process. In the perspective of CMS, ITS technologies are used to improve system performance information in two ways. For example, static information over various points in time is used to determine mobility needs, priorities or measure resulting benefits of previous investments in mobility improvements. Also, real-time information is used for the detection and management of recurring and non-recurring congestion.

Role of ITS in Corridor Studies. A typical corridor study involves addressing problems with a coordinated package of transportation strategies. When defining the mobility issues associated with the corridor, elements that lend themselves to ITS applications should be emphasized. For example addressing capacity improvements that pertain to incident or emergency management needs, non-recurrent delays due to weather, peak-hour traffic management or any other elements that have the potential of ITS implementation.

In general, the corridor study process defines and evaluates high cost and high-impact transportation alternatives from cost/benefit, environmental and community perspectives. Incorporating a mixture of ITS user services that are applicable in each multimodal transportation improvement alternative, evaluated by the study, broadens the spectrum of short- and long-term choices available to decisions-makers.

ITS user services may not be the sole solution to the capacity problem of a transportation corridor or sub-area. However, utilizing the appropriate mixture of ITS user services can increase the efficiency and enhance the safety of the system. In some cases the decision to utilize ITS applications along a section of the corridor instead of widening the highway can prove to be a more efficient option.

ITS for Sustainable Development. ITS technologies used in a sustainable community context include; signal prioritization for buses and light rail vehicles, variable message signing at park and ride lots to give motorists the alternative to use transit, environmental forecasting for traffic control, congestion pricing with electronic tolling, pre-trip information systems, automatic vehicle location systems, and other systems. Many communities already are using these applications to contribute to a vision for clear thoroughfares, few wasted trips, safe travel, more options and healthy neighborhoods. The ultimate benefit of ITS in sustainable development is realized when ITS technologies are combined with transportation policies and strategies.

In Phoenix, Arizona, the Bus Card Plus program is helping businesses meet annual goals for reducing auto trips by solitary drivers. These "smart" transit passes enable employers to track employee use of public transit and document trip-reduction efforts. The passes also reward frequent users of public transit with lower fares. Other ITS applications in Phoenix have streamlined ridesharing programs, helping 1,500 companies to reduce single-passenger automobile travel by 3.3 million miles per week.

6.2 Institutional Integration

The institutional layer of the integration process provides the basis for understanding that the implementers will be and the roles these implementers could take in implementing architecture-based ITS systems. Steps to achieve institutional coordination on the regional level through building coalitions that define and buy into a concept of operation are provided in the next activities.

6.2.1 Establish Regional Coordination

A particular project can utilize the already established partnerships between the different entities participating in regional coordination using the following steps *(29):*

Designate a Lead Agency. Progress is more likely if one (or more) agency agrees to lead activities, or even takes the lead until agreement is reached. Within the coordinating committee environment, different approaches reflect regional realities. For example, the chief working level committee for the Gary-Chicago-Milwaukee (GCM) Corridor is chaired by one of the three state DOT ITS program managers, by annual rotation. The example is a logical outcome that results from consideration of such factors as 1) what is the region, 2) who are the major cooperating partners within the region, and, for this large a region, 3) which one of the agencies has sufficient scope in its charter to handle its own sub-region.

Emphasize Regional Leadership. The emergence of regional leaders is a common occurrence as the integration of ITS in a region matures. To characterize "leaders," most importantly, they will have an abiding interest in operating highways and transit in an efficient and safe manner via ITS, and will display sufficient motivation in seeing development move forward. They usually will have responsibility for, and be a competent organization in, planning, deploying, and operating the complex systems that comprise ITS. Finally, the leaders will have a capacity to bring together disparate opinions of participating agencies on developmental or operational issues. This characterization of regional leaders also makes evident that they may be any one of the several "core" participating agencies in a region.

Regional participants form the regional consortiums charter themselves, name other potential participants, and choose the leaders. This process has the effect, essentially, of defining the region. In addition, as discussed previously, regions can be of any size at or above a metropolitan area and typically center on major urban areas or important corridors, or even entire states. When the region is large, containing significant sub-regions, then the sub-region leadership influences the emergence of regional leadership.

Sub-regions may have all the characteristics of a region, and actually function in a relatively independent fashion. The New York-New Jersey-Connecticut consortium, TRANSCOM, includes several sub-regions, which center on major urbanized areas, each with its own lead agency. As a result, the consortium that manages the entire region is less useful for intra-urban travel, where sub-regional partners and conditions are key to successfully operating highways and transit. The main function of the consortium then pertains to interurban travel under urgent or emergency conditions. The large consortiums are also useful if they can merge administrative and planning activities for the region, work on common technical problems, provide training, or seek economies of scale for procurements.

The designation of leadership roles for ITS actually results in designating leadership hierarchies that are more articulated for larger, more complex, regions. One of those designations, a further example of relatively independent sub-regions within a very large region, occurs when a state defines itself as a region. In Florida, where this is the case, the state DOT established an ITS Office to lead a large consortium whose immediate purpose is to manage ITS operation of the state's freeways. Within this consortium, independent field offices of the state DOT manage actual operations in each of eight sub-regions. Prior planning by the ITS Office provides for coordinated operations between the sub-regions, as well as coordinated operations within the sub-region, especially for major incidents and for emergency evacuations. The ITS Office also contributes by solving common technical problems, setting deployment priorities, conducting a training and research program, and providing assistance to the sub-regional staffs. It also develops and provides a statewide ITS architecture with regional elements for each sub-region. In contrast, the state DOT field offices provide the sub-regional leadership, and are in charge of performing ITS planning, deployments and daily operations in each sub-region.

Regional leadership issues can be complicated, especially as regions emerge. Addressing these issues vigorously is a regional priority if ITS integration is to be achieved.

Build on Existing Methods for Regional Cooperation. Regional operations and activities, including the development and management of a RIA, is a cooperative effort that needs, but need not assume, existing regional cooperation. Organizations usually exist that regularly work to develop regional solutions to regional problems. That structure, should it exist, is adaptable for ITS planning activities, including the development and management of RIA. Examples of these existing organizations throughout the United States include:

- Southern California region builds on the work already established by two key metropolitan planning organizations (MPOs) in the region;
- NY-NJ-CT builds on the sub-regional operations described above;
- The GCM Corridor capitalized on existing sub-regional relationships, especially among the tri-state DOTs and the included MPOs; and
- Houston has adapted and expanded from the innovative, interagency coordination of TranStar.
- AZTech built on the cooperation, communication and coordination of 30 public and private entities that were accustomed to functioning independently. AZTech benefited from these partners working together as a team toward a common goal.

Establish Governance Agreements and Understandings. A Memorandum of Understanding, letter of agreement, or other formal mechanism is usually required when participation includes contributing and sharing resources. They most often make commitments that the jurisdictional councils and commissions would need to approve. Typically they start with informal understandings, become written and formally approved for at least the financial arrangements, but, as a choice matter, may never include technical arrangements that are best handled with "just a handshake."

Create a Committee Structure. ITS Committees serve vital roles in any region by project management. They typically address deployment or operating issues, manage the architecture, and make consistency determinations. The RIA development effort in Southern California and the GCM Corridor, for instance, used committees to bring stakeholders from a wide variety of organizations together, often focusing within affinity groups (such as commercial vehicles, transit, etc.). Possible committee structures include:

- *Working Committee - Plan Management.* This committee could be a continuation of the committee that oversaw development of the ITS strategic deployment plan. It would be responsible for management of the strategic plan to ensure that deployment projects are in conformance with its concepts and architecture. In addition, this committee would update the plan, as necessary, as new technologies and concepts became available.
- *ITS Management Team.* This team would be responsible for overseeing the day-to-day deployment activities of the various phases and elements defined in the strategic plan. The major roles of this team would be to develop deployment strategies and priorities, identify opportunities for deployment as part of other transportation infrastructure improvements, identify alternative funding sources, and promote the concept of ITS to the public. This team would consist of key agencies involved in funding ITS and would be chaired, preferably, by a "champion" of ITS.

Be Prepared for the Impact of External Events. Outside events, political or technical, can influence the development process and cause change. Political change, for instance, may affect the level or nature of participation by agencies and organizations. The structure and organization of governmental agencies in a region requires frequent adaptation of ITS developmental processes that suit the region. The following guidelines should be considered as means to best insulate ITS from extraordinary change while maintaining viability to respond to technical change *(33)*:

1) A joint written agreement for ITS should be adopted, conforming to the mission of participating agencies, to document for the ITS organization such matters as goals and objectives, roles and responsibilities of participating agencies, finance for deployment and operations, and the legacy migration and deployment schedules.
2) Consideration should be given to forming an operating group funded by the "core" agencies, but managed by a directorate of independent staff.
3) Consideration should also be given to staffing by contract, in major part, for the operations center, its maintenance, and the maintenance of field devices.
4) Seek long-term citizen support and general public acceptance, via a continuing "outreach" that emphasizes benefits and accomplishments.
5) Continual efforts should be made to secure funding for innovative ITS technologies to keep the operations and the operating center viable. In addition, periodic technology reviews, as well as standards development reviews, should be conducted to keep TMCs staff informed on the progress of technical change.

Another useful tip is to utilize a long-term regional finance plan, at least for ten years, which funds operations and management, regularly planned capital improvements to keep up with technological change and contingency for unknowns.

6.2.2 Develop and Coordinate a Concept of Operations

A practical outcome of focusing on ITS integration during regional planning activities is the development of a concept of operations defining the operational and implementation roles and responsibilities for the partners involved in the region. Essentially, the two major components of a concept of operations are: the concept itself, which are working policies in the form of regional ITS themes and strategies; and a management plan containing the agreed upon roles and responsibilities of cooperating agencies.

The essential source of a concept of operations is the participating planning and implementing agencies within the region. These agencies would need to adopt the resultant policies, the process of development, and policy recommendations that occur in planning. MPOs, as well as county or regional planning agencies, would take a lead coordination role to assure that appropriate interagency discussions and negotiations are taking place.

Once determined, the concept of operations becomes a basis for the myriad decisions to follow. In determining how ITS investments will contribute to metropolitan goals and objectives, the concept of operations is a reference point for selecting ITS market packages for a RIA, for determining the details of ITS deployments, and for selection of ITS equipments and software. This is especially important when detailing what is needed for existing and future ITS systems, including their functions and electronic information for multi-jurisdictional and/or multi-modal, ITS projects, that affect regional integration of ITS systems, and projects that support national interoperability.

The net result of having a well understood, and adopted, concept of operations is to achieve integration in planning activities leading to overall ITS integration. As an adjunct to the concept of operations, a Business Plan is to be adopted to address important administrative issues such as procurement processes, software acquisition to support operations, center administration; and finance plan showing the funding to support operations and management as well as to support capital acquisitions.

6.3 Technical Integration

Technical integration consists of achieving compatible communications, data transfer and data control. It relies upon reaching agreement as to corridor technologies, communications concept and the use of ITS standards for design, procurement, and testing. The previous integration activities described in the planning and institutional stages of the process are pre-implementation steps to the design and actual deployment of an ITS Projects. The activities described as technical integration bring ITS deployment closer to accomplishment through a systems approach and feasibility studies.

6.3.1 Systems Engineering Management Plan

Systems engineering is a structured process and methodology for arriving at final design of a system, both at the level of an ITS architecture and the level of project implementation.

A systems engineering approach requires the project team to consider all phases of a system's life-cycle from the moment of the system's conception to its installation. This means taking into consideration the stages of planning, design, procurement, deployment, operations, maintenance, expansion, and retirement of the system or subsystems. This approach also requires the team to:

- Identify alternatives at each step of building the system.
- Evaluate each alternative based on costs, political and technical considerations, and customer needs.
- Consider what risks exist throughout the process and plan for their management.

To demonstrate that the systems approach is consistently being taken, more than assertions may be needed. One-way of demonstrating an ITS program is based on a systems approach is to do so via an adopted Systems Engineering Management Plan (SEMP), which describes the methodology and milestones in systems integration, and control system development and testing. A SEMP also describes the processes to be used to integrate the software and hardware in the control system, and to integrate communications and field devices. It also identifies what systems will be integrated, and when and who is responsible for integration and testing. Both pre-existing and new systems would be described by the SEMP.

The FDOT's plan for implementing the requirements for systems engineering in Rule 940 is described in an issue paper prepared by PBS&J, the GC for the Florida ITS Office, published February 19, 2002, "*Proposed Systems Engineering Approach for ITS Deployments along Florida's Limited-Access Corridors*".

6.3.2 Feasibility Studies

Agencies may consider undertaking a feasibility study prior to implementing specific projects for ITS integration. It may be noted that although RIAs are developed as a framework for ITS integration, and reflect functional requirements, the RIAs do not usually define specific ITS projects for implementing ITS integration. To advance the RIA's planning framework to the implementation level, a feasibility study can be performed to define a sequence of ITS integration projects to implement various portions of the RIA. If a RIA does not exist, then an integration project identified in a feasibility study will implement a portion of the NIA. It is also crucial that the integration projects identified in a feasibility study be defined based on using systems engineering analysis. Feasibility studies define data transfer and control, analyze system functional requirements, define ITS procurement plans and define operations and management options.

Define Data Transfer and Control

Data transfer is the physical exchange of data from one system to another, where the recipient system can use the data to structure its response to changing travel conditions more efficiently. Data sharing can occur among computer systems, operators, designers, and the public. Control is the processing and use of the data that have been transferred *(34).*

Many operational functions rely on data about the transportation system. Traveler information is based on real-time data about travel conditions. Incident response can be improved through accurate information about the nature and location of incidents. Signal-system improvements depend on understanding traffic-flow patterns, and asset management is rooted in utilizing information about equipment and resources. Many technical tools are now available to aid in the collection and management of information. Communications tools enable rapid distribution of data among partners. However, harnessing the benefits of these tools depends on establishing processes for exchanging information and for acting on available data in a coordinated manner.

Houston TranStar is a good example of integrated technical systems. All partners' ITS components are connected to a central computer system within TranStar's jointly operated facility, enabling each partner to access all data collected and to control each other's traffic video cameras. Partners can coordinate activities on the spot by being co-located. The organization also has standard operating procedures and rules for system components. These procedures go beyond standards for operation of technical components. The organization also maintains a freeway and incident management Plan and Procedures. These living documents are updated by outcomes of debriefings that are held after major events and incidents *(35).*

Steps towards attaining technical integration include:

- The Identification of the data that need to be transferred.
- The establishment of methods for transferring data between systems.
- The use of the data by the receiving systems.

Both data transfer and control can be measured by varying levels of sophistication in the systems constructed to handle them. For example, lane closures on a freeway due to either planned (construction) or unplanned (incidents) events may cause traffic to divert to alternate arterial routes. This diversion may be directed by the provision of traveler information or may naturally occur as travelers avoid standing queues on the freeway. In an integrated system, traffic data on the freeway are transferred from the freeway-management system to the traffic-signal control system. If these systems are embodied in a comprehensive Traffic Management Center, the transfer is automatic. In systems where they are physically separate, communications techniques must be used, sometimes with operator intervention. Regardless of the method to communicate, the transfer must be made as close as possible to real-time, to be useful. After the data are transferred, a decision of how to use the data must be made (the control function). This can range from implementing pre-determined signal-timing plans based on the severity of freeway conditions (e.g., low speeds over varying distances) to dynamically determining what the appropriate response should be through predictive models.

Analyze System Functional Requirements

Functional requirements define how the system on which the project is based will be expected to function. A step-by step process to analyze functional requirements includes:

1) Develop a high-level description of the required functionality for each system in the inventory. Determine the level of functional requirements specification that is appropriate for the region.
2) Identify the systems that require functional requirements definition. Systems that are on the boundary of ITS (e.g., financial institutions) do not have to be functionally defined since they are not bound by (or even aware of) the regional ITS architecture.
3) Build on the ITS service choices and operational concept to define functional requirements, focusing on those with regional, or interface, implications.
4) Use the NIA (Subsystems, market packages, equipment packages, process specifications) if desired to support the functional requirements development.
5) Using the information gathered in the previous steps, document the functions required to support the services the stakeholders decided to provide for the

region. Document system functional requirements for each ITS system in the inventory.

6) Stakeholders should participate in functional requirements development so that the functions are accurately defined and the stakeholders support the requirements that will be levied on ITS systems.

Information exchanges can be identified in future steps if more detailed functional requirements are to be defined.

Develop ITS Procurement Plan

The predominant procurement practice for ITS projects in Florida, to date, has been the engineer/contractor method, but with experience gained, it is changing. More recently, there have been ITS projects procured by first hiring a Systems Manager, using the Intent To Negotiate (ITN) method to work out public/private partnerships, and using design-build contract variations that may include a provision for management and operations. Florida's ITS Strategic Plan earlier identified six basic steps to be considered in procuring ITS systems, software, or consultant services. These six steps are:

1) Build a team (can include end users, purchasing officials, legal expertise, information management experts, etc.).
2) Plan the project (need for project, define goals and objectives, define roles and responsibilities of team members, standards, risk management, system operation requirements, system acceptance strategy, maintenance responsibilities, impact with "legacy systems", project schedule, etc.).
3) Develop requirements (this includes functional and performance requirements the system MUST meet).
4) Make the "build or buy" decision ("off-the shelf" versus "customized" – understand the tradeoffs).
5) Decide on a procurement method and contracting vehicle.
6) Seek standardization in purchase specifications.
7) Understand, and reflect in the contract language, intellectual property rights, any public records statutes, procurement statutes, and the terms and conditions governing procurements (active involvement of legal experts is critical at this point to protect the public sector and ensure response from the private sector).

The cost of ITS deployment can be reduced if ITS procurement can be coordinated as part of the major reconstruction activities of transportation facilities. While various approaches are used in ITS procurement, research shows that the System Manager/System Integrator (SMSI) approach should be given full consideration. Under the SMSI approach, a consultant is engaged in developing the software and hardware specifications for ITS project(s), and to produce Plans, Procurement Specifications and Estimates, PS&E, for the project. Using the PS&E developed by the SMSI, a contract for furnishing and installing hardware is let, using traditional contracting procedures. However, the SMSI is responsible for the final design, the development of software and for integrating it with the hardware as it is installed, for supervision of the installation of ITS devices, for a testing program, and for providing documentation and training to operating staff in the use of the integrated system. A summary of advantages of SMSI is provided below:

- The process includes competitive bidding for ITS infrastructure construction and for installation of ITS equipment,

- SMSI responsibility and accountability for assuring the system works reliability,
- Access to those developing the system software, and agency control over system development, are greatly facilitated
- The SMSI gives the flexibility to incorporate the latest technologies into the system, as well as to provide integration with other ITS systems. It is important to avoid the low-bid syndrome, where the software is designed to do the absolute minimum required to meet the specifications rather than take advantage of the latest thinking and processes in a rapidly evolving technological market.
- SMSI provides Guarantees about long term performance

ITS procurement is not considered complete until the system integration tests are conducted with respect to requirements identified in the specifications and the system is finally accepted by the operating agency. Some key lessons and best practices on system integration and testing are noted *(36):*

- Integration of existing/working technologies is hard enough without introducing new and untried technologies.
- Systems can be built incrementally; however, any necessary communications equipment needs to be in place for integration with prior and future increments.
- Integration needs to be done in a controlled environment (e.g. design or factory acceptance tests) to isolate problems and system bugs. Interfaces with some devices may have to be emulated for early integration efforts.
- Do integration in steps— add one component at a time. Do not wait until the end of the project to integrate all of the system components, since it would be extremely difficult to isolate problems. Integration and testing can easily take 30–40% of the time and resources of a project.
- Take the time to thoroughly debug and test a few units in the field prior to deploying a large number in the field. Require contractors to successfully conduct acceptance tests on each major deliverable, witnessed by the agency's representatives prior to acceptance by the agency.
- When changes are made in some area of a design, keep in mind that there may be desirable and undesirable consequences of the change that may ripple through the design, and testing must ensure that the device, unit, or subsystem still functions properly after the change.
- Perform operational and maintenance training early. Use those trained staff in hands-on roles for operational and maintenance testing, particularly final development test in the factory and final acceptance test at the first field site. This must be written into the contract since contractors will otherwise not allow non-contractor staff to touch their equipment.

While state procurement regulations may vary from one state to another, a valuable resource on procurement regulations and options is a document titled "*FHWA Federal-aid ITS Procurement Regulations and Contracting Options*," Booz-Allen & Hamilton, 1998, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/2c501!.htm. Some of the approaches discussed in this document include the conventional PS&E/Contract Bid Approach, Systems Manager Approach, and Design/Build Approach. While the benefits of the Systems Manager Approach for ITS is presented above, the project team members should weigh the pros and cons of each while contracting for any particular project.

When ITS improvements are made part of major construction, another procurement strategy is to be considered. The procurement specification, and the procurement itself would wait until late in the major construction, perhaps three to four years after starting to take maximum advantage of technological advances.

Define Operations and Management Options

Staffing Needs. The appropriate operations and management, O&M, staffing is an important consideration if the full potential of ITS is to be achieved. The amount of staffing needed is at first, just a guess based on an agreed Concept of Operations, and the accepted roles and responsibilities of participating agencies and contractors, on the size and complexities of the system, and on experience with similar tasks. An interagency agreement will eventually be needed to document the resultant shared facilities, shared finance, and shared staffing.

A decision is also needed to determine the extent to which staffing will be accomplished with public agency personnel or with contract personnel. A second such decision is needed to determine the extent to which staffing will be accomplished by the lead transportation agency or by a partner agency. The variables in the decision are usually 1) operational flexibility to be gained with contract positions, 2) relative cost, 3) type of service/function, and 4) availability of public agency positions. At the ARTIMIS center in Cincinnati, operational staffing is almost totally by contract. In contrast, staffing at the Minnesota Guidestar center in Minneapolis is largely by MnDOT personnel. Moreover, the services needed from an Information Service Provider (ISP) are proving more and more valuable. Here, the ISP profits from the availability of publicly generated data and camera images to which they could have access without charge. They performed public service and, yet, may be able to commercialize the data and images in their possession.

Annual O&M Costs. The annual O&M costs associated with ITS are significant and must be anticipated in agency budgets. The federal government now recognizes the need to provide O&M funding for ITS investments, but with one important change in policy. Federal funds remain unavailable to pay for ITS maintenance, but, according to new policy, may be used to pay for ITS operations and management activities. These costs of ITS O&M include the cost of managing and staffing center operations, the cost of software update, the cost of rendering ITS services, and the cost of ITS equipment or software replacements.

In any case, the cost of ITS O&M is to be a regularly anticipated recurring cost in public agency budgets, and to be considered as part of life cycle costing when considering the cost of deployments.

6.3.3 Performance Monitoring and Reporting

In this step, it is emphasized that ITS data can be used to evaluate the transportation systems before and after ITS deployments. Highlighted in this step is the federal effort on program assessment/evaluation and an example of how an agency, (FDOT), adapts national performance measures to fit localized characteristics.

An often underemphasized and sometimes totally overlooked ITS deployment activity is system performance monitoring, measures, and reporting. The information gathered has a myriad of uses include evaluation of transportation systems operations, making program decisions, and providing data for education and public outreach. In recent years, performance monitoring, evaluation, and reporting, is used to determine if integrated operation is being achieved and, with it, is bringing greater operational efficiencies. The same performance data becomes useful to evaluate the overall efficiencies of ITS operations. In particular, ITS data can be used to evaluate the transportation systems before and after ITS deployments have been made.

Program Assessment/Evaluation

Periodic evaluations are critical to ensuring progress toward integrated operation of ITS and achieving ITS goals. As previously discussed in Section 2.3.1 of this guidebook, measures of effectiveness for ITS benefits, ITS performance measures were identified by the JPO and used to assess the estimated benefits of ITS (Table 2-2 summarizes the national ITS performance measures). Performance monitoring and periodic evaluations are also critical to an understanding of the value, effectiveness, and impacts of the National ITS Program activities, and allow for the program's continual improvement. The National ITS Program has undertaken assessment activities to satisfy these needs, and to use the spirit behind the Government Performance and Results Act (GPRA) to help ensure that the program is effective in meeting DOT's transportation goals. In keeping with GPRA, tracking of both program outputs and outcomes is emphasized. Program outputs track the progress of a program (e.g., the number of toll plazas equipped with electronic toll collection capability). Program outcomes track the benefits of a program from the perspective of the end-user (e.g., reduction in delay waiting to pay tolls). Another activity is outreach, where evaluation results are communicated to select target audiences in ways that are meaningful to them. In addition, under ITS Evaluation sponsorship, in-depth studies are conducted concerning modeling and simulation of the impact of ITS deployments, estimating the costs and benefits of ITS technologies, determining user acceptance of ITS products and services, and investigating institutional and policy issues related to ITS. The Program Assessment/Evaluation Guidance can be accessed at http://www.its.dot.gov/eval/index.htm

The National ITS Program has highlighted five major goal areas, each with preferred measures of effectiveness in the *ITS Evaluation Resource Guide*, FHWA JPO, February 2000, Appendix A, http://www.its.dot.gov/eval/ResourceGuide/EvalGuidelines_ResourceGuide.htm#Appendix_A. This guidebook recommends utilizing the same MOEs as summarized in Table 6-3:

Table 6-3: Key Measures of Effectiveness Associated with National ITS Program Goal Areas

ITS Program Goal Areas	Key Measures of Effectiveness
Safety	▪ Reduction in overall crash rate ▪ Reduction in the rate of crashes resulting in fatalities ▪ Reduction in the rate of crashes resulting in injuries ▪ Improvement in surrogate measures (e.g., reduction in speeds during inclement weather, reduction in red light running, etc.)
Mobility	▪ VMT/lane-mile ▪ Reduction in travel time delay ▪ Reduction in travel time variability ▪ Increase in customer satisfaction (e.g., product awareness, expectations of product benefits, product use, change behavior, realization of benefits, and assessment of value) ▪ Improvement in surrogate measures (e.g., improvement working relationships between agencies responsible providing mobility, improved agency operations, etc.)
Efficiency	▪ Increase in throughput or effective capacity of existing (e.g., VMT/lane-mile) ▪ Extent of addressing local area needs (e.g., deployment priority)
Productivity	▪ Cost savings (before vs. after ITS installation, or compared traditional transportation improvement) ▪ Extent of cost sharing with non-public funds ▪ Energy and Environment ▪ Reduction in emissions ▪ Reduction in fuel consumption
Energy and Environment	▪ Reduction in emissions ▪ Reduction in fuel consumption

Source: http://www.its.dot.gov/eval/ResourceGuide/EvalGuidelines_ResourceGuide.htm#Appendix_A

6.4 A Practical Summary for Expediting ITS Integration

Groundwork:

- Strategic plan
- Stakeholders
- ITS committee
- Concept of operations
- Regional architecture
- Definition of the region
- SEMP

Parallel Planning Work

- Identify priority ITS corridors/sequences of projects
- Agree upon technologies to be deployed
- Work out multi-jurisdictional/multi-discipline agreements
- Include in MPO long-range plans and transportation improvement plans

CHAPTER 7

INTEGRATION GUIDELINES FOR ITS IMPLEMENTERS

There will always be multiple approaches to integration. ITS implementers will have to adopt a suitable approach to integration that serves the implementing agency well and helps the agency's integration with regional operations. This chapter is intended to provide some guidelines in that direction. It presents integration guidelines for decisions to be made by ITS implementers at state, regional and local levels. An *Integration Relationship and Leadership Matrix (IRM)* has been developed streamlining the potential roles of the ITS implementers at various levels of integration. ITS integration activities are expected to be pursued by key ITS implementers at both the intra-agency and inter-agency levels, with an ultimate goal to reach a stage of optimal integration of transportation services across jurisdictions, boundaries, and modes.

7.1 Integration Relationship and Leadership Matrix

ITS integration is dependent on various factors including leadership, technology, jurisdiction and financial strength of the implementers. Table 7-1 shows an integration relationship matrix to streamline the activities at several levels of integration, where each level is linked to specific responsibilities and actions to be undertaken by the implementers. The relationship model for integration includes the following levels:

- Level One: intra-agency local integration, L1
- Level Two: intra-agency central Integration, L2
- Level Three: inter-agency regional integration, L3
- Level Four: inter-agency statewide integration, L4
- Level Five: inter-agency multi-state integration, L5
- Level Six: nationwide integration, L6

Key implementers of integrated ITS considered in Table 7-1 are:

- State DOT ITS offices
- DOT districts/regions
- County/city public works - transportation division
- Toll authorities
- Transit agencies
- Public safety agencies (police, EMS, fire/rescue)
- Metropolitan Planning Organizations (MPOs)
- Regional Operating Organizations (ROO)
- Multi-state corridor coalitions
- Private sector
- U.S. DOT

Table 7-1: Integration Relationship and Leadership Matrix (IRM)

		Levels of Integration and Implementer Roles					
		Intra-agency Local Integration (Level L1)	**Intra-agency Central Integration (Level L2)**	**Inter-agency Regional Integration (Level L3)**	**Inter-agency Statewide Integration (Level L4)**	**Inter-agency Multi-state Integration (Level L5)**	**Nationwide Integration (Level L6)**
Implementer Roles	State DOT ITS Office	P	L	P	P	P	L/P
	State DOT Districts/Regions	L	P	L/P	L	L	P
	County/City Transportation Division	L	L	L/P	P	P	P
	Toll Facility Authorities	L	L	P	P	P	P
	Transit Agencies	L	L	P	P	P	P
	Public Safety Agencies	L	L	P	P	P	P
	Metropolitan Planning Organizations	P	P	P	P	P	P
	Regional Organizations/Consortiums	P	P	L	L	L/P	P
	Multi-State Corridor Coalitions	P	P	P	P	L	L
	Private Sector	P	P	P	P	P	P
	U.S. DOT	R	R	R	R	R	R/L
	Major ITS Actions at Each Level of Integration	Each agency deploys enabling ITS technologies to primarily serve its users/customers	Each agency establishes central integration of agency's multiple centers	Two or more agencies integrate operations via regional data servers and/or co-location	State level integration of similar and interdependent agencies	Multi-State integration of contiguous corridors and/or State agencies	Nationwide integration via transportation information infrastructure

L – Lead Role
P – Participatory Role
R – Regulatory Role

The list represents major public agencies that are responsible for operating surface transportation facilities or services. In addition, it includes key transportation policy-making organizations for ITS integration at the national and metropolitan levels. The Integration Relationship and Leadership Matrix (Table 7-1) recognizes important realities in ITS integration that:

- ITS technologies are to be implemented by the individual transportation facility owners and service operators.
- Regional planning and operating organizations/consortiums can be coordinators and facilitators of regional and multi-region/multi-state ITS integration. These organizations participate in ITS integration by providing a forum for regional discussions, conflict resolution, decision-making, funds allocation, tracking technological advance, and procuring training.
- A State DOT ITS Office and the U.S. DOT are also identified as implementers that influence ITS integration through state and national policies, regulations, ITS programs, appropriations and funding decisions.

As shown in the Integration Relationship and Leadership Matrix (Table 7-1), an implementer may be classified according to three types:

- <u>Lead Role (L)</u> - An implementer can serve as the leader at a certain level of integration. At the intra-agency levels (L1 and L2), most transportation facility owners will lead the integration of ITS services within the agency itself. As an example, a county transportation division will lead all ITS integration activities for the agency-owned transportation operations; so may a district DOT field office, a toll authority, and other facility operators. At the inter-agency levels of integration (L3, L4 and L5), the lead role is likely to be assumed by an implementer serving a larger jurisdiction, or an implementer who can possibly muster greater influence in building coalitions for regional, state and national ITS integration priorities. Therefore, the State DOT, the regional operating organizations, and multi-state corridor coalitions are the likely candidates to lead the regional inter-agency integration initiatives. Emergence of one or more "ITS Champions" within each agency is crucial in L1 and L2; so is true for "Regional Leadership" (i.e., a lead agency and its ITS champion) for integration in L3, L4 and L5. Desired characteristics of "ITS Champion" and "Regional Leadership" were previously discussed in Chapter 6.
- <u>Participatory Role (P)</u> – An ITS stakeholder may not lead the integration efforts, but foster integration in a participatory role. As an example, a city transportation division may not lead a regional inter-agency ITS integration effort, but its participation in the regional integration initiatives is important. Similarly, a MPO can foster regional ITS integration in a participatory role to help build regional stakeholder coalitions/committees.
- <u>Regulatory Role (R)</u> – The U.S. DOT helps achieve ITS integration via regulatory policy making on various integration issues including funding allocations and federal rules.

A leadership role in ITS integration may still be considered a luxury available to the larger agencies or jurisdictions with greater financial strength. While the larger agencies and the regional (multi-agency) organizations will continue to provide the leadership in interagency ITS integration (L3 through L6), all small and large agencies will have to do their part of incremental integration work (L1 and L2) by upgrading their transportation systems with strategic, technical and financial backing provided through local, regional, state and national ITS deployment initiatives.

Use of the integration levels, the implementer roles, and the level of integration development are presented in details in the subsequent sections of this chapter.

7.2 Levels of Integration and Implementer Roles

Broadly, ITS integrations are of two types: intra-agency integration and inter-agency integration. Intra-agency integration is aimed at achieving efficient command and control of transportation operations within an agency. Inter-agency integration is aimed at efficient exchange of information and effective communications between two or more agencies.

As shown in Table 7-1, this guidebook suggests that intra-agency and inter-agency integrations can be viewed at six levels, each of which contributes to achieve integration at a certain geographic jurisdiction, all progressively leading to nationwide integration of ITS services.

These integration levels are described below.

Level One: Intra-agency Local Integration, L1

This level of integration recognizes the basic fact that a transportation agency serves a geographic area at a local level. Examples of such geographic divisions include: a state DOT that is decentralized into several regions, a local/regional transit agency that has a jurisdiction to serve, and a county/city traffic department that operates its own signal systems within a geographic boundary.

At L1, each agency may deploy ITS technologies to serve its core operational needs and strives to establish a command and control structure of its operations within the geographic area it serves. Integration at L1 serves as an incremental step towards L2 integration. At L1, Table 7-1 shows that the lead implementers in their jurisdictions are expected to be:

- State DOT districts/regions
- County/city transportation divisions
- Toll road authorities
- Transit agencies
- Public safety agencies

Level Two: Intra-agency Central Integration, L2

At L2, ITS integration is meant to establish the central command and control capability of an agency's multiple units, which may include independently administered local operational units or geographically separated independent operational units. Establishing a central command and control of all state DOT transportation management centers is an example of intra-agency central integration (L2). Table 7-1 shows that, at L2, the lead implementers within their jurisdictions are expected to be:

- State DOT districts/regions
- County/city transportation divisions
- Toll road authorities

- Transit agencies
- Public safety agencies

Level Three: Inter-agency Regional Integration, L3

At L3, integration occurs among multiple agencies that provide ITS services in a region. This will include integration of traffic, transit, police, fire and other services. Table 7-1 shows that, at L3, the lead implementers within their jurisdictions are expected to be:

- State DOT districts/regions
- Regional/metropolitan operating organizations/consortiums
- County/city transportation divisions

Level Four: Inter-agency Statewide Integration, L4

At L4, ITS integration is achieved via integrating multiple regional operations within a state. Table 7-1 shows that, at L4, the lead implementers at this level are expected to be:

- State DOT districts/regions
- Regional/metropolitan organizations/consortiums

Level Five: Inter-agency Multi-state Integration, L5

At L5, ITS integration is achieved via integrating multiple operations located in multiple states in a certain geographic transportation corridor. Table 7-1 shows that, at L5, the lead implementers are expected to be:

- State DOT districts/regions
- Regional/metropolitan operating organizations/consortiums
- Multi-state corridor coalitions

Level Six: Nationwide Integration, L6

The nationwide integration is achieved via incremental levels of integrations at L1, L2, L3, L4 and L5. Although most integration activities leading to L6 will be progressively undertaken by the local, regional and state agencies, the U.S. DOT's leadership role will continue to be vital in formulating national policies and rules conducive to nationwide integration of ITS. Such national activities may include influencing ITS funding decisions at the federal level (as in TEA-21), as well as preparation of national program plans (e.g., National ITS Program Plan: A Ten-Year Vision, January 2002, U.S. DOT) and national guidance documents (e.g., NIA documents and Rule 940). At L6, the lead implementers are expected to be:

- State DOT ITS offices
- Multi-state corridor coalitions
- U.S. DOT

7.3 Membership in Integration Levels

For a considerable period, until ITS integration matures at individual agencies and within regions, most ITS implementers will remain in a transitory state in three levels of integration; L1, L2, and L3. Deployments may be expected to occur at all three levels. The significant implication of this transitory state is that while an implementer strives to integrate in the intra-agency levels (L1 and L2), the same implementer would have to undertake necessary actions to be part of L3, or else the implementer would risk being left out of L3. Therefore, the leadership in every implementing agency has to plan for L1, L2 and L3 simultaneously. The planning and implementation at L1 and L2 are essential and can be undertaken through the internal leadership within the agency. However, at L3 an agency's leadership must be actively involved in regional ITS initiatives (e.g., RIA) and be prepared to make agreements (and/or concessions) with other regional implementers in sharing infrastructure, information, and control – all for common regional good as well as for not being forced out of regional integration.

The membership of implementers in integration levels L1 and L2 is inherent in any agency's efforts in planning and implementing ITS. At L3, a smaller agency that operates in one urban area can be a member of L3 at the sub-regional level, while a larger agency with an operational area spanning multiple urban areas can be a member at both sub-regional and regional levels. Usually, at L3 integration, the membership of an agency will be guided by the agencies identification in the regional ITS architecture framework and the use of ITS standards to promote interoperability. Transitioning from L3 to higher levels of integration may be transparent while the regional consortiums and the state and national agencies provide the leadership role to promote integration at the higher levels (L4 though L6).

An example of how the transition in integration levels (L1 through L6) can occur is manifested by the progressive implementation and integration of electronic toll collection systems by the E-ZPass Regional Consortium in the Northeastern United States *(37).* The E-ZPass Regional Consortium includes five agencies and offers E-ZPass, an interoperable electronic toll collection technology, for use on the Port Authority of New York and New Jersey bridges and tunnels, Delaware Turnpike (I-95), Atlantic City Expressway, the New Jersey Turnpike, and the Garden State Parkway. The Consortium member agencies are also a part of the larger Interagency Group, IAG, an association of sixteen northern toll agencies spanning seven states (Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Virginia) that have committed to offering a fully interoperable electronic toll collection system for motorists using the toll roads, bridges and tunnels in the region.

Each toll authority in the above example has implemented E-ZPass electronic toll collection at its own facility (equivalent to intra-agency integration, levels L1 and L2). It happened over the course of several years conforming to the interoperability principles established by IAG. Five agencies formed the E-ZPass regional consortium for processing electronic toll collection (equivalent to inter-agency integration level L3), while 16 agencies in seven states are members of the IAG association making the E-ZPass interoperable in all seven states (equivalent to inter-agency integrations, levels L4 though L5). With the toll authorities in seven states already accepting E-ZPass, the potential for nationwide integration (equivalent to L6 integration) for interoperable electronic toll collection may not be too far fetched.

This example simply manifests the importance of deploying the enabling integration technologies within the agency, agreeing to deploy interoperable technologies under the leadership of a regional consortium, and being part of a larger regional association to achieve integration in wider geographic areas.

This guidebook emphasizes that every implementer and participant aim at integrating and/or contributing at all six levels of integration, to the maximum extent feasible, as suggested in Table 7-1. For the local (county/city) and smaller agencies, their membership at higher levels of integration (L4 through L6) is less evident but exists as long as those

agencies remain committed to Levels L1 through L3. For larger and statewide agencies, just doing Levels L1 through L3 activities is not enough; they must lead the formation of multi-region/multi-state consortiums for transitioning to higher levels of integration (L4 through L6).

7.4 Funding Implications of Integration Levels and Approaches

Funding for ITS planning and implementation becomes available from various sources ranging from the traditional federal and state transportation funding programs to ITS discretionary program earmarks. Major ITS funding sources are:

- Federal-Aid National Highway Systems (NHS) Funds
- Congestion Mitigation and Air Quality (CMAQ) Funds
- Surface Transportation Program (STP) Funds
- Federal Transit Act Funds
- Local Funds
- Federal ITS Discretionary Program Earmarks

While all of the above funding sources are being utilized for ITS, many ITS integration projects in the last decade have been funded through various ITS discretionary earmarks provided by the U.S. DOT. On the other hand, ITS projects at the state and metropolitan levels also receive funding by competing against non-ITS projects. In other instances, ITS projects are deployed as part of comprehensive transportation facility construction projects, such as corridor capacity improvements, where ITS related funding can be relatively small with respect to overall project funding. This guidebook emphasizes mainstreaming the funding mechanism for ITS projects, rather than relying on any ITS discretionary program earmarks.

At levels L1 and L2, ITS integration funding can be available through each agency's capital program allocations at the state and metropolitan levels. However, for successful interagency integrations at levels L3 through L6, the state DOTS and other larger agencies will have to lead the ITS integration activities by developing innovative funding mechanisms that encourage coordinated deployment of ITS among all agencies in a region.

This guidebook recommends that innovative ITS funding and implementation programs be initiated by state DOTs. Such funding programs should encourage simultaneous and coordinated deployments of ITS by the state DOT districts as well as local agencies at selected corridors. To implement coordinated and integrated deployments, state DOTs can seek competitive multi-agency applications for funding of ITS projects from the state's metropolitan areas.

7.5 Integration Focus Areas

In order to achieve integration at levels L1 through L6, several high priority (H) focus areas of integration activities are suggested in Table 7-2. These focus areas are:

- ITS Strategic Plan
- Regional ITS Architecture
- ITS Integration Projects
- Legacy and Interoperability
- Integrated ITS Deployment Goal

- Integration Tracking and Reporting
- Formation of Regional Organizations/Consortiums

These focus areas are a measure of where an agency fits in the IRM, and are discussed below.

Table 7-2: Integration Levels and Focus Areas

Levels of Integration and Priority Focus Areas							
		Intra-agency Local Integration (Level L1)	Intra-agency Central Integration (Level L2)	Inter-agency Regional Integration (Level L3)	Inter-agency Statewide Integration (Level L4)	Inter-agency Multi-state Integration (Level L5)	Nationwide Integration (Level L6)
Focus Areas	ITS Strategic Plan	H	H	H	H		H
	Regional ITS Architecture	H	H	H	H		
	ITS Integration Projects	H	H	H	H	H	H
	Legacy and Interoperability	H	H	H	H	H	H
	Integrated ITS Deployment Goal	H	H	H	H	H	H
	Integration Tracking & Reporting	H	H	H	H		
	Formation of Regional Organizations			H	H	H	

H – High Priority

7.5.1 ITS Strategic Plan – A Necessary Step Towards Integration

An ITS Strategic Plan is a comprehensive planning study intended to identify and/or address regional ITS needs, goals and objectives, ITS stakeholders, a regional framework for ITS deployment, and potential ITS projects for short and long term deployments. The development of an ITS Strategic Plan should be treated as a necessary step in the ITS integration effort by any agency/region/jurisdiction. As shown in Table 7-2, the development of an ITS Strategic Plan should be considered a high priority for Levels L1 through L4, and at L6. The process of developing an ITS Strategic Plan has matured significantly over the years with the availability of various guidance documents from the U.S. DOT. One mature framework for developing ITS Strategic Plan was presented in Table 6-2.

Experience shows that the contents of an ITS strategic plan may vary significantly based on the development process used by various authorities and implementers. At the national and state levels (L6 and L4), an ITS strategic plan may be a high level document describing a broad set of policy, program and research activity themes for ITS planning and implementation. Specific ITS project details are usually not included in such national and state plans. Examples include: National Intelligent Transportation Systems Program Plan – A 10-Year Vision (January 2002, U.S. DOT); Florida's ITS Strategic Plan (August 1999, FDOT). On the other hand, at the local and regional levels a comprehensive ITS strategic plan may include, as a component, an ITS Implementation Plan (a step in Table 6-2) that includes the short-term and long-term ITS projects clearly identified. Subsequently, these projects can be incorporated in the MPO's Transportation Improvement Plan (TIP). At levels L1 through L3, an Implementation Plan should include deployable ITS projects for both intra-agency and interagency integration.

This guidebook recommends that, as a key step towards ITS integration planning, all governments involved in ITS develop an ITS Strategic Plan.

7.5.2 Architectural Framework and ITS Standards – A Required Step

The U.S. DOT has issued the ITS architecture conformity Rule (by Federal Highway Administration) and Policy (by Federal Transit Administration) in January 2001, effective April 2005. The Rule/Policy is meant to foster integration of ITS in the regions under the framework of a Regional ITS Architecture (RIA). The U.S. DOT Rule/Policy was discussed in detail in Section 3.2 of this guidebook. In summary, the Rule/Policy requires that:

- If a region is currently deploying ITS projects, then the region must have the projects consistent with RIA. If the region has no RIA but deploying ITS projects, then the region must develop a RIA by April 8, 2005.
- If a region has not deployed any ITS project yet, then the region must develop a RIA within the four years of the deployment of the initial ITS project in the region.
- If architectural consistency of projects is not established, the Rule/Policy sets restrictions on federal funding for deploying ITS projects.

As previously noted (Table 6-2), developing an ITS architecture is one of the several components of an ITS Strategic Plan. Although, a RIA can also be developed as a separate ITS study, it is preferable to develop a RIA in conjunction with an ITS Strategic Plan. As shown in Table 7-2, the development of a RIA should be considered a high priority for Levels L1 through L4. Additional guidance on RIA development is provided in Chapter 6.

This guidebook recommends that an RIA be developed as a key step towards integrating ITS in a region. Once the architecture is developed, the lead public agency responsible for developing the RIA must spearhead the establishment of an Architecture Maintenance and Conformity Committee (AMCC).

Responsibilities and issues that an AMCC would address can be difficult to develop. They are largely dependent on which of the participants, especially the state DOTs and the local MPOs, participated in the RIA and what are the potential funding sources for the ITS projects. A few ground rules for an AMCC to address RIA consistency issues can be as following:

- Develop a simple and easy-to-understand "RIA Conformity Questionnaire", which an ITS project planner/implementer would fill out as part of a project's inclusion in the LRTP and TIP. Even though all RIAs in the U.S. are developed using the U.S. DOT's National ITS Architecture program materials, in practicality, no two RIAs are expected to be same (or similar) in their content and developmental approach. Therefore, the questionnaire must include elements of direct reference to the contents of the RIA in question in regards to the ITS project that an implementer agency is proposing to implement.
- Although the architectural consistency for planning purposes may be established via this questionnaire, another questionnaire should be developed and used to evaluate the consistency of project design.
- The questionnaire checklist for ITS implementation should establish adherence to the RIA's market packages and communications plan, as well as the use of ITS standards.

This guidebook recommends that the proposed AMCC develop simple and easy-to-understand "RIA Conformity Questionnaires" that an ITS project planner and, at different stage of development, an ITS implementer, would complete prior to inclusion of an ITS improvement in the LRTP or TIP, and prior to completing design.

7.5.3 ITS Projects for Integration – Systems Engineering Management Plan

While considering ITS integration, an agency must incorporate systems engineering into all its project development process. Employing systems engineering is an essential part of the process to achieve ITS integration.

Systems Engineering Approach for Projects. As previously discussed in Section 3.2.4, the U.S. DOT Final Rule/Policy requires that all ITS projects must be developed using a systems engineering approach. In accordance with Final Rule/Policy, the systems engineering analysis for an ITS project would include, at a minimum:

- Identification of portions of the regional ITS architecture being implemented (or if a RIA does not exist, the applicable portions of the NIA);
- Identification of participating agencies' roles and responsibilities;
- Requirements definitions;
- Analysis of alternative system configurations and technology options to meet requirements;
- Procurement options;
- Identification of applicable ITS standards and testing procedures; and
- Procedures and resources necessary for operations and management of the system.

The development of a systems engineering management plan (SEMP) that generalizes the process for ITS projects development should be considered a high priority at all levels (L1 through L6) of integration shown in Integration Levels and Focus Areas Matrix (Table 7-2). To the extent the SEMP influences agency's planning and design activities, it becomes the agency's working policy.

This guidebook recommends that ITS projects be planned and implemented via a process set by a systems engineering management plan (SEMP).

7.5.4 Legacy and Interoperability – The Challenges and Core of Integration

As the ITS technologies advance, systems and individual devices quickly become outdated. It is important to identify an appropriate course for integration of the legacy systems with new systems without creating the need for a system overhaul. In the past, each vendor providing a computer based ITS device and the associated software for managing the device had proprietary control for protocols of data communications. As a result, the expansion of a system can generally only be done using equipment of the same type and brand as in the initial deployment. This required extensive integration projects, at considerable costs, to mix equipment and software from different vendors in the system and to communicate between systems operated by adjacent agencies. To overcome this difficulty, all vendors and system developers are expected to use the NTCIP (National Transportation Communications for ITS Protocol) and other available ITS standards so that systems can become interoperable independent of specific vendors. Based on the NTCIP Guide *(38)*, presented below is a summary of several scenarios that an implementer may have to consider in the legacy characterization of the existing systems and the deployment of new systems.

> **Existing legacy system is too old - operate two separate systems during the transition period.** An approach to upgrading the legacy systems to NTCIP is to operate two very separate systems – one NTCIP and one non-NTCIP during a transition period. Field devices can gradually be switched over from one to the other as they are replaced or their software is upgraded. This may be the only choice if the current system is quite old and upgrading it for NTCIP is not practical because of constraints such as computing power, memory available, and cost of modification. The implementer will have to analyze the impact of these constraints and devise the most logical transition course to standardization.
>
> **Existing non-NTCIP and NTCIP devices require separate communications channels.** Generally, NTCIP and non-NTCIP devices cannot be mixed on the same communications channel. Therefore, all devices sharing a channel must be upgraded simultaneously. A case in example – a computer or master that communicates with both NTCIP and non-NTCIP devices will need to use a different communications port for NTCIP devices and for non-NTCIP devices, and will need to support both protocols. An implementer has to analyze the impact of maintaining two such channels in legacy characterization of the existing devices.
>
> **Discuss the upgrade options with the existing vendor first.** Any upgrade to an existing legacy system to add support for NTCIP is probably best designed in consultation with the system vendor. Each vendor will likely adopt an upgrade strategy that is applicable for the majority of its customers.
>
> **Consider new procurement for the existing proprietary system on favorable terms.** It is always prudent to ask the vendor to include the appropriate NTCIP protocol stack as an option. Even if a system continues to use a proprietary protocol, new devices and software packages should include the appropriate NTCIP protocol stack as an option.
>
> **New Systems.** If building from scratch, always procure hardware and software that use ITS standards recommended by the ITS Standard Development Organizations (SDO).

As shown in Table 7-2, legacy systems integration and interoperability of ITS systems are to be considered a high priority in all Levels (L1 through L6) of integration. While interoperability is desirable at all levels of integration, it is of paramount importance in L3 through L6.

This guidebook supports the federal Rule/Policy that ITS standards should be used at all levels of integration. An ITS implementer must give adequate consideration to NTCIP, and other applicable ITS standards, while upgrading legacy systems as well as building new systems. Additional guidance materials on ITS standards are available on the web site http://www.its-standards.net/.

7.5.5 Integrated ITS Infrastructure Deployment Goal

The U.S. DOT has set a goal to deploy integrated ITS infrastructure in 78 of the largest metropolitan areas by 2006. There are nine components of ITS that are targeted for integration: Freeway Management, Incident Management, Arterial Management, Electronic Toll Collection, Electronic Fare Payment, Transit Management, Highway-Rail Intersections, Emergency Management, and Regional Multi-modal Traveler Information. Subsequently, integration indicators were established to measure the progress of integration. Additional details on these integration components and their integration indicators could be found in Section 2.7 of this guidebook.

As shown in Table 7-2, the U.S. DOT goal of having an integrated ITS infrastructure deployment by the year 2006 should be considered a high priority at all Levels (L1 through L6) of integration.

This guidebook recommends that, to achieve the U.S. DOT goal of integrated ITS deployment by 2006 in major metropolitan areas, state DOTs encourage the formation of metropolitan ITS consortiums. A state DOT should provide incentive funding to metropolitan consortiums to deploy multi-agency integration projects in metropolitan regions.

7.5.6 Integration Tracking and Reporting Standardization

State DOTs should establish a standardized tracking process by developing a standard set of questions for each implementer. A reporting structure and process to track the progress of ITS integration should be established by state DOT. In such a reporting structure, local/regional agencies can be expected to report to state DOT ITS offices at the end of each calendar year. The state DOT will then make the results available in the middle of the following calendar year.

This guidebook recommends that state DOTs develop a methodology for statewide tracking of ITS deployment and integration. This tracking process can be modeled, with meaningful modifications, after the metropolitan ITS deployment tracking questionnaires developed by the U.S. DOT ITS JPO. Additional information is available at http://itsdeployment2.ed.ornl.gov/its2000/default.asp

7.5.7 Formation of Regional Organizations/Consortiums for Inter-agency Integration

A Regional Operating Organization (ROO) is defined as a partnership among various transportation and public safety service agencies, collaborating with each other via computer networks and/or co-location of operations, to provide coordinated transportation operations in a region. Generally, a ROO includes the state DOT, city/county transportation divisions, transit agencies, toll authorities, public safety and emergency management services, MPOs, and private transportation stakeholders. In the Integration Relationship and Leadership Matrix (Table 7-1), a ROO is identified as an implementer for inter-agency integration. A ROO may operate via physical co-location of multiple agencies' operations, or via virtual co-location through regional data servers. The purpose of all ROOs is to improve transportation operations via inter-agency regional/multi-state (mostly metropolitan area based) integrations (levels L3 and L5 in Table 7-1). The roles of a ROO in inter-agency ITS integration is well manifested in examples of several ROOs currently operating in the U.S. and Canada. Table 7-3 shows the partners involved and operations in programs in six ROOs.

- TRANSCOM in New York, New Jersey, and Connecticut
- TransLink in Vancouver, British Columbia
- The Metropolitan Transportation Commission (MTC), San Francisco Bay Area
- The ITS Priority Corridor in Southern California
- TranStar in Houston
- AZTech in Phoenix

As evident in Tables 7-3, the ROOs have accomplished a significant level of inter-agency integration by involving multiple partners and undertaking various programs. Major characteristics of ROOs can be identified as follows:

Common Factors. The common driving factors that are often precursors to the formation of ROOs are, *(35):*

- Recognition of a critical regional need;
- Meeting need only through inter-agency cooperation;
- Visionary and influential leadership; and
- Availability of funding.

Leadership. Leadership is usually provided by one or a few organizations, which also provided the administrative support, contracting, and legal support to the ROO partnership. These responsibilities require staff time and resources.

Critical Elements. Most ROOs include the integration of resources, personnel, technical systems, and institutional processes among multiple partners in a region. *Resource integration* involves sharing of information, equipment, and pooled funding among multiple partners. This includes:

- *Operations integration* requires personnel from different organizations to act as a unified team to address problems and to implement programs effectively, through a common vision and common understanding of each other's missions and institutional cultures.
- *Systems integration* refers to a unified systematic approach to the application of technical tools to support operations. Electronic and telecommunication technologies provide data to operators and enable interagency information sharing and communication.
- *Institutional integration* refers to institutional processes that enable multiple jurisdictions to act using shared information and resources in a coordinated and cohesive manner. This type of integration includes a management structure and, within that structure, agreed upon operational processes and procedures.

As shown in Table 7-2, the formation of regional organizations/consortiums should be considered a high priority for interagency levels (L3 through L5) of integration.

This guidebook suggests that formation of ROOs be given consideration in order to achieve interagency ITS integration at regional/metropolitan levels.

Table 7-3: Partners and Programs in Six Regional Operating Organizations

AZTech	Priority Corridor	TranStar	TRANSCOM	MTC	TransLink
Members: ▪ 20 private companies ▪ 10 cities and towns ▪ 3 local police and fire departments ▪ 2 regional public ▪ Transit agencies ▪ 2 MPOs ▪ Maricopa County ▪ DOT ▪ Arizona DOT ▪ FHWA	Members: ▪ Caltrans (HQ and 4 Dists.) ▪ California Highway Patrol ▪ 6 county transportation authorities/commissions ▪ 2 MPOs ▪ 1 Air Quality Management District ▪ 3 regional ITS strategic planning subcommittees Other Participants: ▪ FHWA ▪ FTA	Members: ▪ State DOT ▪ METRO Transit ▪ Harris County ▪ City of Houston **Other Participants:** ▪ State research institute ▪ Private information service provider ▪ 3 television networks ▪ MPO	Members**:** ▪ 3 State DOTs ▪ Metropolitan Transportation Authority ▪ 3 regional transit authorities ▪ 5 toll authorities (turnpike, bridge, and tunnel) ▪ NY City DOT ▪ NY State Police ▪ Port Authority of NY and NJ ▪ 1 interstate park commission Other Participants: ▪ 100 local jurisdictions	Partners: ▪ ▪ Caltrans ▪ California ▪ Highway Patrol ▪ 27 area transit agencies ▪ Area cities ▪ Area counties ▪ County Congestion Management Agencies ▪ Air Quality Management District	Partners: ▪ Subsidiary corporations and contractors ▪ Area municipalities ▪ Regional planning district ▪ BC Ministry of Transportation and Highways ▪ BC Transportation Finance Authority Insurance ▪ Corporation of British Columbia ▪ BC Trucking Association ▪ Vancouver Port Authority ▪ Vancouver Airport Authority ▪ University of BC
Programs: Coordination of Regional ITS Programs Including: ▪ Regional ITS Architecture Development ▪ Integration of TOCs ▪ Development of centralized data server ▪ Instrumentation of multi-jurisdictional arterial corridors ▪ Instrumentation of transit fleet ▪ Incident response and emergency services coordination ▪ Privatized ATIS	Programs: ▪ Regional ITS strategic planning ▪ Corridor ITS architecture development ▪ Corridor communications network implementation ▪ Corridor ATIS ▪ Corridor ATMS ▪ Regional test projects	Programs: Coordination of ITS programs, Emergency Management Systems, and Public safety Activities including: ▪ HOV operations ▪ Regional traffic signal integration ▪ Freeway and arterial street incident management ▪ MAP ▪ Emergency management for evacuations and disasters ▪ Flood alert system ▪ ATIS ▪ Weather conditions monitoring	Programs: ▪ Construction coordination ▪ Incident response ▪ Regional ITS implementation and testing ▪ Incident detection ▪ Regional ITS architecture development ▪ Integration of partner TOCs ▪ ATIS ▪ Transit trip planning ▪ Kiosk program	Programs: ▪ Traveler information system ▪ Transit service coordination ▪ Smartcard transit fare collection ▪ Transit trip planning system ▪ Regional rideshare program ▪ Regional transportation marketing ▪ Pavement Management System technical assistance ▪ Traffic engineering technical assistance ▪ Freeway service patrol and call box program	Programs: ▪ Transportation planning ▪ Public transit services ▪ Major road network management ▪ Air quality management services ▪ Transportation demand management programs ▪ Regional ITS strategic planning, coordination, and implementation

BC – British Columbia FTA – Federal Transit Authority ATIS – Advanced Traveler Information Systems ATMS – Advanced Traffic Management System	FHWA – Federal Highway Administration HQ – Headquarters MAP – Motorist Assistance Program TOC – Traffic Operations Center

Source: Organizing for Regional Transportation Operations: An Executive Guide, Booz·Allen & Hamilton Inc., FHWA, July 2001, (Figure 1 p. 16 and Figure 2 p. 19), [*http://www.ite.org/library/ROOExecutiveGuide.pdf*](http://www.ite.org/library/ROOExecutiveGuide.pdf)

7.6 Conclusions and Recommendations

As presented in this Chapter, there are many possibilities of implementer involvements and degrees of achieving ITS integration. This guidebook is intended to assist the implementers in their decision making process for ITS integration within the agency as well as in a multi-agency regional context. As stated in Chapter 1, this guidebook is prepared based on extensive literature surveys, expert opinions of a peer review group of ITS professionals, and independent research conducted by the project team. Chapter 2 offers a definition of ITS integration and sheds light on the process of ITS integration in the context of National ITS Program goals and initiatives. Various legislative acts and federal rulings related to ITS integration are presented in Chapter 3. Chapter 4 provides an overview of the FDOT's ITS integration efforts. Five national case studies on ITS integration efforts are discussed in Chapter 5 in order to provide perspective on the current ITS integration efforts in the U.S. Chapter 6 offers a suggested process for attaining ITS integration at the planning and implementation levels. Finally, Chapter 7 presents an Integration Relationship and Leadership Matrix (IRM) showing various levels of integration and the needed focus and leadership of the ITS implementers. Key recommendations of this guidebook are summarized below:

- Every implementer and participant aims at integrating and/or contributing at all six levels of integration suggested in Integration Relationship and Leadership Matrix (Table 7-1). For the local (county/city) and smaller agencies, their membership at higher levels of integration (L4 through L6) is transparent but exists as long as those agencies remain committed to Levels L1 through L3. For larger and statewide agencies, just doing Levels L1 through L3 activities is not enough; they must lead the formation of multi-region/multi-state consortiums for transitioning to higher levels of integration (L4 through L6).
- An ITS funding and implementation program be initiated by state DOTs, requiring simultaneous and coordinated deployments of ITS by the state DOT as well as local agencies at selected regions/corridors. Under this program, state DOTs seek competitive multi-agency applications from the state's metropolitan areas for multi-agency ITS integration projects.
- Identification of Its Integration policies should be part of an agency's planning process. As a key step towards achieving ITS integration in planning, all levels of government develop an ITS Strategic Plan.
- A regional ITS architecture be developed as a key step towards integrating ITS in a region. Once the architecture is developed, the lead public agency responsible for developing the RIA must spearhead the establishment of an Architecture Maintenance and Conformity Committee (AMCC). The AMCC is to develop simple-easy-to-understand "RIA Conformity Questionnaires" that an ITS project planner would fill out prior to inclusion of an ITS improvement in the LRTP or TIP, and an ITS designer could use to assure project consistency with the RIA.
- ITS standards are to be used for project implementation. An ITS implementer must give consideration to NTCIP and other applicable ITS standards while upgrading legacy systems as well as while building new systems. Additional guidance materials on ITS standards are available at http://www.its-standards.net/.
- To achieve the U.S. DOT goal of integrated ITS deployment by 2006 in major metropolitan areas, state DOTs encourage the formation of metropolitan consortiums. State DOTs should consider providing incentive funding to the metropolitan consortiums to deploy multi-agency integration projects in each of the metropolitan regions of the state.

- The state DOTs develop a methodology for statewide tracking of ITS deployment and integration. This tracking process can be modeled after the metropolitan ITS deployment tracking questionnaires developed by the ITS JPO. Additional information is available on the web page- http://itsdeployment2.ed.ornl.gov /its2000/default.asp
- Formation of regional operating organizations/consortiums be given consideration in order to achieve interagency ITS integration in regional/metropolitan levels.
- The Integration Relationship and Leadership Matrix (IRM, Table 7-1) be used a policy tool to determine an organization's current status with regard to what ITS investments to make to achieve greater degrees of ITS integration.

APPENDICES

APPENDIX A: AZTECH INTERGOVERNMENTAL AGREEMENT

A.G. Contract No. KR97-2103TRN
ADOT File: JPA 97-124
Project: H4450 02X
Section: AZTech Project:
Signal Synchronization

INTERGOVERNMENTAL AGREEMENT
BETWEEN
THE STATE OF ARIZONA
AND
THE TOWN OF PARADISE VALLEY

THIS AGREEMENT is entered into ____________ 1997, pursuant to Arizona Revised Statutes, Sections 11-951 through 11-954, as amended, between the STATE OF ARIZONA, acting by and through its DEPARTMENT OF TRANSPORTATION (the State) and the TOWN OF PARADISE VALLEY, acting by and through its MAYOR AND TOWN COUNCIL (the "Town").

I. RECITALS

1. The State is empowered by Arizona Revised Statutes Section 28-108, 28-112 and 28-114 to enter into this agreement and has by resolution, a copy of which is attached hereto and made a part hereof, resolved to enter into this agreement and has delegated to the undersigned the authority to execute this agreement on behalf of the State.
2. The Town is empowered by Arizona Revised Statutes Section 48-572, to enter into this agreement and has by resolution agreed to enter into this agreement and has authorized the undersigned to execute this agreement on behalf of the Town.
3. The US Department of Transportation has allocated $7,500,000.00 to the metropolitan Phoenix area to be administered by the State and Maricopa County to accomplish the program via a State, Town and private sector partnership known as the "AZTech Project", for the expressed purpose of implementing an Integrated Regional Advanced Traveler Information System, and demonstrate intelligent transportation systems throughout the area and involve State, Town, regional and local jurisdictions

4. The AZTech concept is to integrate the existing intelligent transportation infrastructure into a regional system. The State with Maricopa County, regional and local jurisdictions, is jointly developing the AZTech Project to establish and implement an integrated traveler information system for the multimodal traveler. The Project will enhance the transportation management systems for the Phoenix metropolitan area by providing up-to-the-minute travel information and facilitate signal coordination across jurisdictional boundaries, thereby providing increased safety and improved regional mobility.

5. The State and Town are working together with other AZTech Project partners in a common goal of coordinating traffic management systems in direct consideration of a regional transportation system.

6. The State and the Town have identified potential areas where Intelligent Transportation System (ITS) technology can be applied to improve traffic management and establish a Traffic Traveler Information System in the valley for the AZTech Project. The intent of this agreement is to define the terms of the parties with regard to respective responsibilities related to the SMART Corridors instrumentation, (defined as "a systematically managed roadway, utilized at maximum efficiency.) The term of the AZTech Project is five (5) years.

THEREFORE, in consideration of the mutual covenants expressed herein, it is agreed as follows:

II. SCOPE

1. The Town will:

a. Provide representatives to the AZTech Project committees and working groups. Allow for and assist in the communication between the Traffic Operation Centers (TOCs). Allow timely access to the Town's traffic system databases. Participate in the development and implementation of a system evaluation plan. Participate in the development and implementation of multi-jurisdictional signal system timing plans and establish inter-operability between Town, State and other jurisdictions. Participate in system training as required.

b. Participate in the design, provide staff assistance for construction and maintenance of approximately five (5) field detector stations, as well as provide ongoing operations support and maintenance for the 5 year duration of the AZTech Project.

c. Be responsible for, construction assistance and maintenance of a closed circuit television system for monitoring traffic on the AZTech SMART corridors.

d. Provide right-of-way, utility and environmental clearances as required. Contribute in-kind services, which include, but are not limited to, approval of detector construction plans and/or work orders, construction, and contract administration for any sub-contracted work, necessary to implement the AZTech SMART corridors.

e. Provide locations for the installation of the initial KIOSK at the State's expense, at an estimated cost of $20,000.00 per KIOSK, at the location proposed by the Town and agreed upon by the State. Provide ongoing operations support and maintenance for the 5-year duration of the AZTech Project and be responsible for all costs beyond the initial expenditure by the State. Be responsible for additional KIOSKS at a fifty percent (50%) match, at an estimated cost of $10,000.00 per KIOSK, at the location proposed by the Town and agreed upon by the State, provided additional funding is available through the AZTech Project, should the Town desire additional KIOSKS.

f. On a monthly basis, maintain and provide, to the State AZTech Project Administrator, on an approved format, an itemized accounting of all contracts, in-kind services and materials, necessary to implement the AZTech SMART corridors.

g. Be responsible for all video and data communications cost beyond the initial 36 month implementation of the AZTech program at an estimated cost of $500.00/month. At the end of the INITIAL 36 month period, the Town may negotiate with U S West Communications, (the video and data services provider), for video and data service needs beyond the initial implementation period at the current or a reestablished service level.

h. Be responsible for any contractor claims for extra compensation due to delays or whatever reason attributable to the Town.

2. The State will:

a. Allow timely access to the AZTech Server system data bases to facilitate integration into the AZTech Project. Participate in the development and implementation of a system evaluation plan.

b. Provide project planning, design review and construction, to the extent necessary, to implement the AZTech SMART corridors.

c. Be responsible for the initial KIOSK, at an estimated cost of $20,000.00 per KIOSK. Support and maintain all operating systems and traveler information software on the AZTech KIOSKS, at an estimated cost not to exceed $3,000.00 per KIOSK, for the 5 year duration of the AZTech Project. Be responsible for additional KIOSKS at a fifty percent (50%) match, at an estimated cost of $10,000.00 per KIOSK, at the location proposed by the Town and agreed upon by the State, provided additional funding is available through the AZTech Project, should the Town desire additional KIOSKS.

d. Be responsible for all video and data communications costs between traffic operations centers for the initial 36 month implementation of the AZTech program, at an estimated cost not to exceed $20,000.00.

e. Be responsible for any contractor claims for extra compensation due to delays or whatever reason attributable to the State.

III. MISCELLANEOUS PROVISIONS

1. This agreement shall remain in force and effect until 30 June 2003, or until cancelled by either party upon thirty (30) days written notice to the other party, or by other competent authority.
2. This agreement shall become effective upon filing with the Secretary of State.
3. This agreement may be cancelled in accordance with Arizona Revised **Statutes Section** 38-511.
4. The provisions of Arizona Revised Statutes Section 35-214 are applicable to this contract.
5. In the event of any controversy which may arise out of this agreement, the parties hereto agree to abide by required arbitration as is set forth in Arizona Revised Statutes Section 12-1518.
6. All legal notices or demands upon any party relating to this agreement shall be in writing and shall be delivered in person or sent by mail addressed as follows:

Arizona Department of Transportation
Joint Project Administration
205 South 17 Avenue, Mail Drop 616E
Phoenix, AZ 85007
Town of Paradise Valley
Transportation Department
6401 E. Lincoln Drive
Paradise Valley, AZ 85253-4399

7. Attached hereto and incorporated herein is the written determination of each parties legal counsel that the parties are authorized under the laws of this State to enter into this agreement and that the agreement is in proper form.

IN WITNESS WHEREOF, the parties have executed this agreement the day and year first above written.

TOWN OF PARADISE VALLEY	**STATE OF ARIZONA** Department of Transportation
By MARVIN DAVIS Mayor	By THOMAS G. SCHMITT State Engineer

ATTEST

By
LENORE P. LANCASTER
Town Clerk

97-124doc
10 Oct 97

APPENDIX B: POTENTIAL USES OF ITS DATA FOR STAKEHOLDERS APPLICATIONS

Stakeholder Group	Application	Method or Function	Collection and Use of:	
			Current Data	ITS-Generated Data
MPO and State Transportation Planners	Congestion Management Systems	Congestion Monitoring	Travel times collected by "floating cars": usually only a few runs (small samples) on selected routes. Speeds and travel times synthesized with analytic methods (e.g., HCM, simulation) using limited traffic data (short counts). Effect of incidents missed completely with synthetic methods and minimally covered by floating cars.	Roadway surveillance data (e.g., loop detectors) provide continuous volume counts and speeds. Variability can be directly assessed. Probe vehicles provide same travel times as "floating cars" but greatly increase sample size and area wide coverage. The effect of incidents is imbedded in surveillance data and Incident Management Systems provide details on incident conditions.
	Long-Range Plan Development	Travel Demand Forecasting Models	Short-duration traffic counts used for model validation. O/D patterns from infrequent travel surveys used to calibrate trip distribution. Link speeds based on speed limits or functional class. Link capacities usually based on functional class.	Roadway surveillance data provide continuous volume counts, truck percents, and speeds. Probe vehicles can be used to estimate O/D patterns without the need for a survey. The emerging TDF models (e.g., TRANSIMS) will require detailed data on network (e.g., signal timing) that can be collected automatically via ITS. Other TDF formulations that account for variability in travel conditions can be calibrated against the continuous volume and speed data.
	Corridor Analysis	Traffic Simulation Models	Short-duration traffic counts and turning movements used as model inputs. Other input data to run the models collected through special efforts (signal timing). Very little performance data available for model calibration (e.g., incidents, speeds, delay).	Most input data can be collected automatically and models can be directly calibrated to actual conditions.
Traffic Management Operators	ITS Technology	Program and Technology Evaluations	Extremely limited; special data collection efforts required.	Data from ITS provide the ability to evaluate the effectiveness of both ITS and non-ITS programs. For example, data from an Incident Management System can be used to determine changes in verification, response, and clearance times due to new technologies or institutional arrangements. Freeway surveillance data can be used to evaluate the effectiveness of ramp meters or HOV restrictions.
		Pre-Determined Control Strategies	Short-duration traffic counts and "floating car" travel time runs. A limited set of pre-determined control plans is usually developed mostly due to the lack of data.	Continuous roadway surveillance data makes it possible to develop any number of pre-determined control strategies.
		Predictive Traffic Flow Algorithms	Extremely limited.	Analysis of historical data form the basis of predictive algorithms: "What will traffic conditions be in the next 15 minutes?" (Bayesian approach).
Transit Operators	Operations Planning	Routing and Scheduling	Manual travel demand and ridership surveys; special studies.	Electronic Fare Payment System and Automatic Passenger Counters allow continuous boardings to be collected. Computer-aided dispatch systems allow O/D patterns to be tracked. AVI on buses allows monitoring of schedule adherence and permits the accurate setting of schedules without field review.
Air Quality Analysts	Conformity Determinations	Analysis with the MOBILE Model	Areawide speed data taken from TDFs. VMT and vehicle classifications derived from short counts.	Roadway surveillance provides actual speeds, volumes, and truck mix by time of day. Modal emission models will require these data in even greater detail and ITS is the only practical source.

Stakeholder Group	Application	Method or Function	Collection and Use of:	
			Current Data	ITS-Generated Data
MPO/State Freight and Intermodal Planners	Port and Intermodal Facilities Planning	Freight Demand Models	Data collected through rare special surveys or implied from national data (e.g., Commodity Flow Survey).	Electronic credentialing and AVI allows tracking of truck travel patterns, sometimes including cargo. Improved tracking of congestion through the use of roadway surveillance data leads to improved assessments of intermodal access.
Safety Planners and Administrators	Safety Management Systems	Areawide Safety Monitoring; Studies of Highway and Vehicle Safety Relationships	Exposure (typically VMT) derived from short-duration traffic and vehicle classification counts; traffic conditions under which crashes occurred must be inferred. Police investigations, the basis for most crash data sets, performed manually.	Roadway surveillance data provide continuous volume counts, truck percents, and speeds, leading to improved exposure estimation and measurement of the actual traffic conditions for crash studies. ITS technologies also offer the possibility of automating field collection of crash data by police officers (e.g., GPS for location).
Maintenance Personnel	Pavement and Bridge Management	Historical and Forecasted Loadings	Volumes, vehicle classifications, and vehicle weights derived from short-duration counts (limited number of continuously operating sites).	Roadway surveillance data provide continuous volume counts, vehicle classifications, and vehicle weights, making more accurate loading data and growth forecasts available.
Commercial vehicle enforcement personnel	Enforcement of Commercial Vehicle Regulations	Hazardous Material Inspections and Emergency Response	Extremely limited.	Electronic credentialing and AVI allows tracking of hazardous material flows, allowing better deployment of inspection and response personnel.
Emergency Management Services (local police, fire, and emergency medical)	Incident Management	Emergency Response	Extremely limited.	Electronic credentialing and AVI allows tracking of truck flows and high incident locations, allowing better deployment of response personnel.
Transportation Researchers	Model Development	Travel Behavior Models	Mostly rely on infrequent and costly surveys: stated preference and some travel diary efforts (revealed preference).	Traveler response to system conditions can be measured through system detectors, probe vehicles, or monitoring in-vehicle and personal device use. Travel diaries can be imbedded in these technologies as well.
		Traffic Flow Models	Detailed traffic data for model development must be collected through special efforts.	Roadway surveillance data provide continuous volume counts, densities, truck percents, and speeds at very small time increments. GPS-instrumented vehicles can provide second-by second performance characteristics for microscopic model development and validation.
Private Sector Users	Truck Routing and Dispatching	Congestion Monitoring	Current information on real-time or near real-time congestion is extremely limited.	Roadway surveillance data and probe vehicles can identify existing congestion and can be used to show historical patterns of congestion by time-of-day. Incident location and status can be directly relayed.
	Information Service Providers	Trip Planning	Information on historical congestion patterns is extremely limited. This information could be used in developing pre-trip route and mode choices, either alone or in combination with real-time data.	

Source: ITS as a Data Resource, Preliminary Requirements for a User Service, Richard Margiotta, Science Applications International Corporation, for the FHWA, Office of Highway Policy Information, April 1998, *http://www.fhwa.dot.gov//ohim/its/tab2_1.pdf*

APPENDIX C: GLOSSARY

Architecture
A framework within which a system can be built. An Architecture functionally defines what the pieces of the system are and the information that is exchanged between them. An Architecture is not technology specific which allows the Architecture to remain effective over time. It defines "what must be done," not "how it will be done".

Champion
Person or persons who serves as a point-of-contact and provides leadership in the development and maintenance of a Regional ITS Architecture.

Concept of Operations (Operational Concept)
An operational concept identifies the roles and responsibilities of participating agencies and stakeholders. It defines the institutional and technical vision for the region and describes how the system will work at a very high-level, frequently using operational scenarios as a basis.

Corridor/Sub-area Study
Also known as "Major Investment Studies," these studies are used to flesh out transportation strategy and project recommendations on a geographic basis. A Corridor or Sub-area is a context for evaluating how specific transportation conditions, problems, and needs should be addressed within the defined geographic area. A wide range of multimodal strategies, including ITS, are considered as candidate solutions for those problems.

Data Flow
Data Flows represent data flowing between Processes or between a Process and a terminator. A Data Flow is shown as an arrow on a Data Flow Diagram and is defined in a Data Dictionary Entry in the Logical Architecture. Data flows are aggregated together to form high-level Architecture Flows in the Physical Architecture view of the National ITS Architecture.

Equipment Package
Equipment Packages group like Processes of a particular Subsystem together into an "implementable" package. The grouping also takes into account the User Services and the need to accommodate various levels of functionality. Since Equipment Packages are both the most detailed elements of the Physical Architecture view of the National ITS Architecture and tied to specific Market Packages, they provide the common link between the interface-oriented Architecture definition and the deployment-oriented Market Packages.

Functional Requirements Specification
A description of WHAT a system must do to address the needs or provide the services that have been identified for the region. The description should use formal "shall" language and document the functions in terms that the stakeholders, particularly the system implementers, will understand. In a Regional ITS Architecture, the Functional Requirements focus on the high-level requirements that support regional integration.

- **Functional Requirement** - A requirement that specifies a function that a system or system component must be able to perform.
- **Functional Specification** - A document that specifies the functions that a system or component must perform. Often a part of the requirements specification.
- **Performance Requirements** - A requirement that imposes conditions on a functional requirement.

- **Requirements Specification** - A document that specifies the requirements for a system or component. Typically included are functional requirements, performance requirements, design requirements and development standards.

Information Flow
Information that is exchanged between Subsystems and Terminators in the Physical Architecture view of the National ITS Architecture. In this document, the terms “Information Flow” and “Architecture Flow” are used interchangeably.

Integration
Integration can be defined as the process through which products and services are planned, specified, designed, and assembled into a single and complete system to achieve the intended functionality

System integration - process through which products and services are planned, specified, designed, and assembled into a single and complete system that will achieve the intended functionality.
Functional integration - the purpose of each subsystem and the necessary interfaces for data sharing.
Data Integration **-** ensures that data are interpreted the same in different parts of the system, or that a translation mechanism exists that resolves data inconsistencies allowing for exchange of information across subsystems.
Deployment Integration - integration of technologies that support the transfer of data among the subsystems.
Institutional Integration - Institutional Integration represents the process of combining existing and emerging institutional constraints and arrangements. Integration is at least two-fold in a region; technical integration involves the functional act of integration while institutional integration addresses the agency and/or regional environment for integration. Both are necessary components for interoperable systems.
Technology Integration - binds systems through automatic data transfer, common database structures, and well-defined communication interfaces which increases the potential for inter-operability and lowers costs associated with system procurement and integration.
Product/Service Integration - deals with the synergistic potential in deploying ITS products and services.

ITS Architecture
Defines an Architecture of interrelated systems that work together to deliver transportation Services. An ITS Architecture defines how systems functionally operate and the interconnection of information exchanges that must take place between these systems to accomplish transportation Services.

ITS Project
Any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS User Services.

ITS Strategic Plan
A guide for long term implementation of ITS in the state, metropolitan area, or region. A Strategic Plan will normally include identifying regional transportation needs and then defining ITS Elements to be implemented over time, aimed at meeting those needs. A regional ITS architecture is typically a core component of an ITS Strategic Plan.

Interface
The connection between two systems. In the regional ITS architecture, an interface is described by the architecture interconnect – the line of communications between the two systems – and the information flows that define the types of information that will be shared over the interconnect.

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.

Legacy System
Existing transportation systems, communications systems, or institutional processes.

Maintenance Plan
Description of configuration control and update guidelines for Regional and/or Project ITS Architectures. The primary purpose of the Maintenance Plan is to maintain an Architecture Baseline.

Major ITS Project
Any ITS project that implements part of a regional ITS initiative that is multi-jurisdictional, multi-modal, or otherwise affects regional integration of ITS systems.

Market Package
Market Packages identify the pieces that are required to implement a particular transportation service. They provide an accessible, service oriented, perspective to the National ITS Architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs. Market Packages collect together one or more Equipment Packages that must work together to deliver a given transportation Service and the Architecture Flows that connect them and other important external systems.

National ITS Architecture
A common, established framework for developing integrated transportation systems. The National ITS Architecture is comprised of the Logical Architecture and Physical Architecture, which satisfy a defined set of User Services. The United States Department of Transportation (USDOT) maintains the National ITS Architecture.

National ITS Program Plan
Jointly developed by the USDOT and ITS America with substantial involvement from the broader ITS community. The purpose of the National Program Plan was to guide the development and deployment of ITS. It defined the first 28 User Services that were the basis for the National ITS Architecture development effort.

Project ITS Architecture
A framework that identifies the institutional agreement and technical integration necessary to define an ITS project and its interfaces with other ITS projects and systems.

Project Sequencing
The order in which projects are deployed. An important part of the transportation planning process is the sequence or order that ITS projects are deployed. The Regional ITS Architecture provides a new way to look at these ITS projects relationships or “dependencies”. By taking

these dependencies into account, an efficient sequence can be developed so that projects incrementally build on each other.

Region
The geographical area that identifies the boundaries of the Regional ITS Architecture and is defined by and based on the needs of the participating agencies and other Stakeholders. In metropolitan areas, a Region should be no less than the boundaries of the metropolitan planning area.

Regional ITS Architecture
A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular Region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them.

Standards
Documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently as rules, guidelines, or definitions of characteristics for the interchange of data. A broad array of ITS Standards is currently under development that will specifically define the Interfaces identified in the National ITS Architecture.

Statewide Transportation Improvement Program (STIP)
This is a document prepared by each state that is a staged, multi-year, statewide, intermodal program of transportation projects which is consistent with the Statewide Transportation Plan and planning processes and Metropolitan Transportation Plans, TIPs and processes.

Statewide Transportation Plan
This document is the official statewide, intermodal transportation plan that is developed through the statewide transportation process.

Systems Engineering
A structured process for arriving at a final design of a system. The final design is selected from a number of alternatives that would accomplish the same objectives and considers the total Life-Cycle of the project including not only the technical merits of potential solutions but also the costs and relative value of alternatives.

Transportation Improvement Program (TIP)
This is a document prepared by each Metropolitan Planning Organization (MPO) listing projects to be funded with FHWA/FTA funds for the next one to three year period. It is consistent with the Metropolitan Transportation Plan.

Transportation Plan
Also called the “Long Range Transportation Plan”, this plan defines the state or metropolitan area's long-term approach to constructing, operating, and maintaining the multi-modal transportation system.

User Services
User Services document what ITS should do from the user's perspective. Broad ranges of users are considered, including the traveling public as well as many different types of system operators. The initial User Services were jointly defined by USDOT and ITS America with significant Stakeholder input and documented in the National Program Plan (NPP). Over time, new or updated User Services will continue to be developed and the National ITS Architecture will be updated to support these User Service changes.

APPENDIX D: LIST OF ACRONYMS

APTS	Advanced Public Transportation System
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AVCS	Advanced Vehicle Control System
AVI	Automated Vehicle Identification
AVL	Automated Vehicle Location
CCTV	Closed Circuit TV
CMS	Congestion Management System
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
DMS	Dynamic Message Sign
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
EDL	Electronic Document Library
EDP	Early Deployment Plan
EMC	Emergency Management Center
ETTM	Electronic Toll and Traffic Management
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HAR	Highway Advisory Radio
HRI	Highway Rail Intersection
ISO	International Standards Organization
ISP	Information Service Provider
ISTEA	Intermodal Surface Transportation Efficiency Act
ITE	Institute of Transportation Engineers
ITI	Intelligent Transportation Infrastructure
ITS	Intelligent Transportation Systems
IVHS	Intelligent Vehicle Highway Systems
IVIS	In-Vehicle Information System
JPO	U.S. DOT Joint Program Office
L1	Level 1 - Intra-agency Local Integration
L2	Level 2 - Intra-agency Central Integration
L3	Level 3 - Inter-agency Regional Integration
L4	Level 4 - Inter-agency Statewide Integration
L5	Level 5 - Inter-agency Multi-state Integration
L6	Level 6 - Nationwide Integration
LRTP	Long-Range Transportation Plan
MDI	Model Deployment Initiative

MMDI	Metropolitan MDI
MOE	Measure Of Effectiveness
MOU	Memorandum of Understanding
MPA	Metropolitan Planning Area
MPO	Metropolitan Planning Organization
NIA	National Intelligent Transportation Systems (ITS) Architecture
NPRM	Notice of Proposed Rule Making
NTCIP	National Transportation Communications for ITS Protocol
PSPEC	Process Specification
RIA	Regional Intelligent Transportation Systems (ITS) Architecture
SDO	Standards Development Organization
SIA	Statewide Intelligent Transportation Systems (ITS) Architecture
SIP	Statewide Implementation Plan
STIP	Statewide Transportation Improvement Program
TDM	Travel Demand Management
TEA-21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Program
TM	Traffic Management
TMA	Transportation Management Area
TMC	Transportation Management Center
TOC	Traffic Operations Center
UPWP	Unified Planning Work Program
USDOT	United States Department of Transportation

REFERENCES

1. *Building the ITI: Putting the National Architecture into Action*, Mitretek Systems, FHWA, April 1996, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPT_MIS/BJ01!.PDF.

2. *Merriam-Webster Collegiate Thesaurus, 2002*, Merriam-Webster, Inc., http://www.m-w.com/

3. *The National ITS Program Plan, Volume 1, First Edition,* U.S. DOT ITS Joint Program Office and ITS America, 1995, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/2yb01!.pdf.

4. *Benefits from Integrated Technologies,* U.S. DOT ITS Joint Program Office, August 1998.

5. *ITS Performance and Benefits Study*, Lockheed Martin Federal Systems by Odetics Intelligent Transportation Systems Division for FHWA, U.S. DOT, June 1996, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/45z01!.pdf

6. *Measuring ITS Deployment and Integration*, U. S. DOT ITS JPO, January 1999, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/3dg01!.pdf.

7. *Metropolitan Model Deployment Initiative National Evaluation Strategy*, U.S.DOT ITS JPO, November 1998, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/4v501!.pdf

8. *Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY 2000 Results*, July 2001, http://itsdeployment2.ed.ornl.gov/its2000/default.asp

9. *TEA-21 - H2400: The Transportation Equity Act for the 21st Century*, *ITS Integration Program*, Public Law 105 – 178, June 9, 1998, http://www.its.dot.gov/tea21/tea21.htm

10. *FHWA 23 CFR Parts 655 and 940 Resource Guide - Policy on Intelligent Systems Architecture and Standards*, January 2001, http://www.its.dot.gov/aconform/20010108.pdf

11. *FTA Notice Resource Guide - Policy on Intelligent Systems Architecture and Standards*, January 2001. http://www.its.dot.gov/aconform/fta-pol.pdf.

12. *Guidelines for Participation in the FY 02 Integration Component of the ITS Deployment Program,* U.S.DOT, 2002. http://www.ops.fhwa.dot.gov/Travel/Deployment_Task_Force/GUIDE_A2.htm - Summary.

13. FHWA Operations Office Website: ITS Integration Program, http://www.ops.fhwa.dot.gov/Travel/Deployment_Task_Force/EarAppD.htm

14. *National ITS Architecture Documents*. U.S. Department of Transportation, Lockheed Martin Federal Systems, Odetics Intelligent Transportation Systems Division, http://www.its.dot.gov/arch/DOCUMNTS.htm

15. *National ITS Architecture Documents: Executive Summary*; U.S. Department of Transportation, Lockheed Martin Federal Systems, Odetics Intelligent Transportation Systems Division, December 1999, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/45_01!.pdf

16. *Successful Approaches to Deploying A Metropolitan Intelligent Transportation System*, John A. Volpe Transportation Systems Center Economic Analysis Division, FHWA, U.S.DOT, 1999, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/6JN01!.PDF.

17. *Integration of ITS into the MPO Transportation Planning Process Issue Paper* – Florida ITS Strategic Plan, FDOT, 1999, http://www.dot.state.fl.us/planning/systems/sm/its/PDFs/MPO%20Planning%20&%20ITS%20Final.pdf.

18. *Florida's ITS Planning Guidelines*, *Integration of ITS into the Transportation Planning Process*, Center for Urban Transportation Research, FDOT, June 2000, http://www.dot.state.fl.us/planning/systems/sm/its/PDFs/Guidelines_080700.pdf.

19. The Statewide Architecture encompasses the FDOT Districts Architecture published on Jaffe Engineering website at http://www.jeng.com

20. *ITS Master Corridor Plans: Concept of Operations, Technical Memorandum 4.1,* PBS&J, FDOT, May 8, 2002, http://www.floridaits.com/TWO3-Final_Deliverable/020627%20Final%20Concept%20of%20Operations.pdf.

21. *ITS Integration Strategy for Central Ohio,* MPORC, Ohio Department of Transportation, July 1999*, http://209.57.154.225/trans/its/ITS%20Integration%20Strategy%20for%20Central%20Ohio.PDF*

22. *Regional ITS Architecture Development, New York-New Jersey-Connecticut Region*, *Building a Framework for Regional ITS Integration, ITS JPO,* September 1999. http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/7fv01!.pdf

23. *San Antonio Metropolitan Model Deployment Initiatives Evaluation Report*, U.S. DOT, Publication No. FHWA-OP-00-017, May 2000,http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/9xv01!.pdf.

24. *San Antonio's Medical Center Corridor, Lessons Learned from the Metropolitan Model Deployment Initiative: Integrated Freeway/Arterial Management Corridor*, Science Applications International Corporation, U.S. DOT Joint Program Office, 2000, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@7801!.pdf.

25. *Phoenix Metropolitan Model Deployment Initiative Evaluation Report* (Draft), U.S. DOT, April, 2000, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/9TZ01!.PDF

26. *Cross-Jurisdictional Signal Coordination in Phoenix & Seattle - Removing Barriers to Seamless Arterial Travel,* Science Applications International Corporation, ITS JPO, 2000, *http://www.itsdocs.fhwa.dot.gov/jpodocs/edlbrow/@701!.pdf* .

27. *System Integration Case Study, FAST-TRAC,* University of Michigan, February 12, 1999, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/7JR01!.PDF.

28. *Faster and Safer Travel Through Traffic Routing and Advanced Controls, ITS Field Operational Test Summary for FAST-TRAC*, FHWA Office of Traffic Management and ITS Applications, March 30, 1998.

29 *Developing a Regional ITS Architecture – A Crosscutting Study: Building a Framework for Regional ITS Integration*," ITS Joint Program Office, FHWA, September 1999, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/7g101!.pdf .

30. *Inside ITS* is a biweekly newsletter published by Alexander Communications Group, Inc.

31. Turbo Brochure by McTrans, Center at the University of Florida, http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/9sv01!.pdf

32. Florida Statutes, sections 339.115, 339.175, and 339.177, http://www.leg.state.fl.us/Statutes/

33. *IVHS Institutional Issues and Case Studies: ADVANCE Case Study*, John A.Volpe National Transportation Systems Center Economic Analysis Division, Cambridge, Massachusetts, April 1994, p.13 http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/9MW01!.PDF.

34. *Demonstration Project No. 105, Moving America More Efficiently: Advanced Transportation Management Technologies*, Office of Technology Applications, FHWA-SA-97-058, April 1997.

35. *Organizing for Regional Transportation Operations: An Executive Guide*, Booz·Allen & Hamilton Inc., FHWA, July 2001, http://www.ite.org/library/ROOExecutiveGuide.pdf

36. *Developing Freeway and Incident Management Systems Using the National ITS Architecture*, U.S. DOT, 1998, p.4-14, http://www.fhwa.dot.gov/////tfhrc/safety/pubs/its/architecture/devfreeway.pdf.

37. *The E-ZPass Regional Consortium Website*, May 15, 2002, http://www.ezpass.com/interagency.shtml#map,

38. *NTCIP Guide,* National Transportation Communication for ITS Protocol, September 1999. The Pre-Publication draft was made available, pending final approval by AASHTO, ITE, and NEMA at http://www.ntcip.org/default.asp.

CENTER FOR URBAN TRANSPORTATION RESEARCH
College of Engineering
University of South Florida
4202 E. Fowler Avenue, CUT 100
Tampa, Florida 33620-5375
(813) 974-3120, fax (813) 974-5168
http://www.cutr.eng.usf.edu

Patricia G. Baptiste
Publication Design and Layout

CENTER FOR URBAN TRANSPORTATION RESEARCH
College of Engineering
University of South Florida
4202 E. Fowler Avenue, CUT 100
Tampa, Florida 33620-5375
(813) 974-3120, fax (813) 974-5168
http://www.cutr.eng.usf.edu