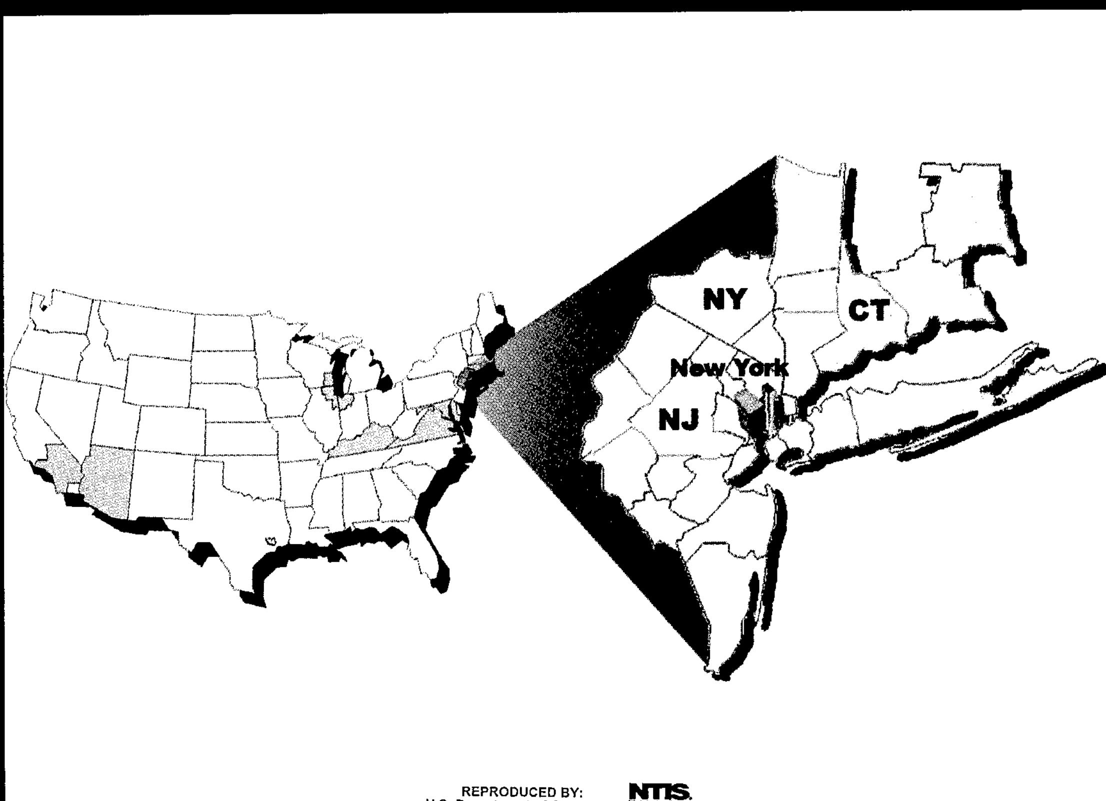
Regional ITS Architecture Development

A Case Study

New York–New Jersey–Connecticut Region



Building a Framework for Regional ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

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Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut Region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. The seventh study is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support by the Volpe Center.

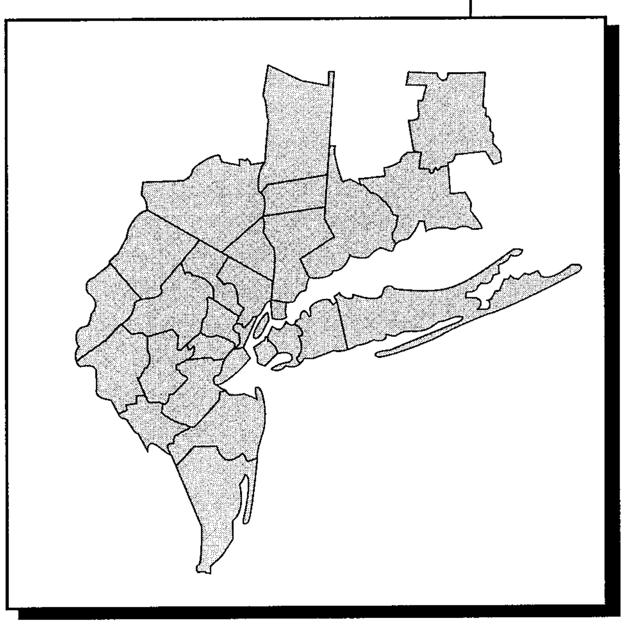
This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Case Study Overview

The New York-New Jersey-Connecticut Region covers 29 counties: 12 in New York, 14 in New Jersey, and three in Connecticut

The New York-New Jersey-Connecticut Region has been at the forefront of deploying Intelligent Transportation Systems (ITS). The development of this region's ITS architecture provides an instructive example because:

- The regional ITS architecture was developed with involvement from transportation, safety, and related agencies from three states,
- Transit agency involvement has been significant,
- The center of this region is a complex urban area with a complicated, intermodal transportation system, and
- The region adapted existing ITS architectures using the National ITS Architecture.



Background

29-County Region

New York Counties:
Bronx
Dutchess
Kings
Nassau
New York
Orange
Putnam
Queens
Richmond
Rockland
Suffolk
Westchester

New Jersey Counties:
Bergen
Essex
Hudson
Hunterdon
Mercer
Middlesex
Monmouth
Morris
Ocean
Passaic
Somerset
Sussex
Union
Warren

Connecticut Counties:
Fairfield
Hartford
New Haven

"Over time, representatives of the transportation agencies in the New York-New Jersey-Connecticut Metropolitan Area recognized and accepted that they could no longer build their way out of congestion."
— Michael Ascher, President MTA Bridges and Tunnels and Chairman of TRANSCOM

The New York – New Jersey – Connecticut Region is the most highly populated and one of the most highly congested metropolitan areas in the country. Like most major metropolitan areas, this 29 county region has to balance significant transportation needs with limited physical and financial resources. The need to improve the existing infrastructure has resulted in interagency coordination and planning for the deployment of new transportation technologies.

The complex geography of the region exacerbates transportation problems. The region's population and employment core includes the five boroughs that make up New York City and all or part of Bergen, Essex, Hudson, and Union counties in New Jersey. The "core of the core" is Manhattan, which includes the region's central business district. Many of these population and business centers are divided by waterways and four of New York City's five boroughs are located on islands.

This geography creates a unique challenge for the region's transportation system. In many metropolitan regions, the physical constraints of the built environment reduce the opportunities to build additional infrastructure. In this region, the built environment is itself highly constrained by the natural limitations imposed by the waterways. These waterways must be spanned to connect the different population and business centers. The bridges and tunnels used to accomplish those tasks invariably become constriction points on the flow of regional traffic. The region's major waterway, the Hudson River, also serves as a state line.

A complex geography, coupled with a complicated jurisdictional structure affects the transportation system. In this tri-state region, there are a number of agencies that maintain overlapping responsibility for managing the area's transportation flow.

The combination of significant demands for transportation services and complex natural and jurisdictional geography led policy-makers to identify cooperative, regional, and multi-modal approaches to improving the area's transportation system. This interest led to a number of coordinated efforts by operating and planning transportation agencies. This interest also led to an exploration of ITS technologies.

Operating and planning agencies in the region view ITS as the next step in developing and deploying regional and multi-modal solutions to meet the region's pressing transportation demands. Improving operational efficiency by better managing the existing transportation system is the focus of ITS efforts in the region's three state departments of transportation and the numerous transit agencies, transportation authorities, and local transportation agencies. These agencies understand that creating a well managed, cost-effective, and functional ITS requires intermodal, interagency, and interstate coordination.

Background

Interagency coordination and interest in ITS has fostered the development of a regional ITS architecture. Transportation agencies, along with police, emergency services, and other related agencies see a tangible benefit from cooperation in the deployment of the new ITS technologies. The desire to share deployment costs and responsibilities for ITS opened new lines of interagency communication. This helped form the basis for the regional ITS architecture. The desire to deploy ITS as a solution to operational problems led to an interest in the development of the New York – New Jersey – Connecticut Regional ITS architecture.

In addition to the regional ITS architecture effort, four ITS Early Deployment Plans (EDP) have been, or are being, completed in the region. These EDPs are plans for ITS deployments in specific parts of the region. One of the objectives of these plans is to link developing and planned local ITS projects to the regional ITS architecture. Although each of these EDPs is important to the region, this case study focuses attention upon the largest of these plans, the New York City EDP.

Early Deployment Plan Areas

- Garden State Parkway, NJ
- New York City, NY
- Newark, NJ
- New York State DOT Region 8 (Columbia, Dutchess, Orange, Putnam, Rockland, Ulster, Westchester counties)

The Region

The New York – New Jersey – Connecticut Region was settled at the intersection of major transportation routes. The commerce that flourished between the international seaports and the ever-expanding hinterland, as transportation improvements such as canals, railroads and interstate highways were developed supported a densely populated metropolitan region.

To manage the transportation needs of the vast population, an extensive system of roads, bridges, tunnels, and railways has been constructed. As transportation operating agencies attempted to meet the challenging needs of the area, they commissioned some of the world's most innovative feats of engineering. Currently, this region holds the nation's most patronized subway and bus system, as well as some of the largest and most used bridges in the world. The continuous traffic growth in the region places increasing demands on the existing infrastructure. These transportation demands have resulted in the "critical problems of congestion, travel mobility and safety, air pollution, and quality of life."[1]

NY-NJ-CT Fact Sheet (1996 Bureau of Census Estimates)

Number of Residents:
21 million
Number of Employees:
9 million
Number of Businesses:
600,000

The geographic constraints of this region make the costs of expanding the physical transportation network prohibitive. To address the need for improved transportation operations, the region developed a proactive incident management and construction coordination system in the mid-1980s. While this early system provided significant regional benefits, its capabilities were limited. The emergence of ITS technologies is enabling this early system to be greatly expanded across the region.

[1] Framework for the Strategic *Local ITS Plan* – Draft. New York City Department of Transportation. Prepared by the Urban ITS Center at Polytechnic University. August 1998.

Regional ITS Architecture Development Process

"You need to get everyone in the room; you can't work through intermediaries."
— **Matt Edelman, General Manager, TRANSCOM**

"The Port Authority took the lead on setting up TRANSCOM. They were a big champion of the project."
— **Paul Cuerdon, Assistant Regional Traffic Engineer, New York State Department of Transportation, Region 1**

TRANSCOM Members

- Connecticut DOT
- New York Metropolitan Transportation Authority (MTA)
- MTA-Bridges and Tunnels
- MTA-New York City Transit
- New Jersey Department of Transportation (DOT)
- New Jersey Highway Authority
- New Jersey Transit Corp.
- New Jersey Turnpike Authority
- New York City DOT
- New York State DOT
- New York State Police
- New York State Thruway Authority
- Palisades Interstate Park Commission
- Port Authority Trans-Hudson Corp.
- Port Authority of New York and New Jersey

A 16th agency, the New York State Bridge Authority, will join TRANSCOM as a full partner during 1999.

The seeds of the regional ITS architecture were sown in 1986 when 14 operational agencies[2] recognized the need for interagency coordination to proactively manage the impacts of incidents and construction on the region's multi-jurisdictional road network. These agencies formed the Transportation Operations Coordinating Committee (TRANSCOM). The TRANSCOM coalition provides cooperative, multi-agency response to regional incidents and coordinates construction projects among member agencies to avoid parallel closing of roadways. TRANSCOM pursues these activities while its member agencies maintain direct operational control of their facilities.

One of the earliest proponents of creating a regionally coordinated system was the Port Authority of New York and New Jersey (Port Authority). The Port Authority has a uniquely regional mandate and is responsible for maintaining all of the Trans-Hudson River connections that link New York and New Jersey. These tunnels and bridges are constriction zones within the regional transportation network. Because of its responsibility for such critical areas within the region, the Port Authority was concerned about incidents on either side of its facilities. Such incidents in New York or New Jersey further constrict the flow of transportation in the region.

TRANSCOM

This regional outlook, as well as the difficulty of expanding capacity on its river crossings, led the Port Authority to become an early champion of interagency coordination. Its leadership efforts resulted in the creation of the TRANSCOM coalition. Significantly, the Port Authority guaranteed funding for TRANSCOM while the coalition's formal structure was developed and the member agencies began to contribute financially. That guarantor function was crucial to the creation and development of TRANSCOM.

The members of the TRANSCOM coalition are the core stakeholders of the regional ITS architecture development process. This group includes a wide range of operational agencies and a particularly strong transit contingent. The participating transit agencies include New Jersey Transit, Metropolitan Transportation Authority (MTA)-New York City Transit, New York City DOT's bus and ferry operations, the Port Authority Trans Hudson, and, through the New York MTA, the Long Island and Metro-North Commuter Railroads and Long Island Bus.

Metropolitan Planning Organizations (MPOs), while not official members of TRANSCOM, are extremely interested in regional coordination and participate in TRANSCOM activities. MPOs are strong supporters of multi-state integration of systems through the regional ITS architecture. This interest and involvement is very appropriate, as the scope of those planning agencies, like the scope of metropolitan ITS deployments, is regional.

[2] The number of members has grown to 15 and will soon be 16.

Regional ITS Architecture Development Process

The regional construction coordination and incident management system relies on a manual transfer of data between representatives of the individual agencies and TRANSCOM. This arrangement, referred to as the "manual architecture," was the first attempt at defining the regional data flows. In this manual system, the transportation agencies within the region report major roadway and transit incidents on their facilities to TRANSCOM. Reports are usually made by telephone. These updates are logged and entered into the TRANSCOM computer system, which in turn disseminates the information to the relevant public agencies and interested parties via alphanumeric pagers. TRANSCOM also works with member agencies to fax weekly construction reports (with updates as needed) to coordinate responses to road closings. TRANSCOM also maintains a comprehensive database of construction projects that is updated twice yearly. This manual system is being phased-out as automated systems are deployed.

Participating Organizations:

15 members of TRANSCOM
Many other local governments, police, fire, emergency services, and planning organizations also participate in TRANSCOM activities.

E-ZPass and I-95 Corridor Coalition

The manual architecture provided the institutional and technical precedents to facilitate the development of further regional ITS integration. Two important examples illustrate the connection between institutional cooperation and regional ITS architecture development.

The first example is the E-ZPass electronic toll collection (ETC) system. In 1990, seven toll authorities worked together on the E-ZPass Interagency Group to create a regionally compatible ETC system that could be used for travel on the many distinct toll facilities throughout and beyond the region. The five toll authorities operating within the New York-New Jersey-Connecticut region were all TRANSCOM member agencies. Their success in selecting a technology and creating an institutional management and reimbursement arrangement provided an important working relationship for ITS integration and for regional ITS architecture development.

The second example is the region's involvement with the I-95 Corridor Coalition. In 1992, following the passage of the Intermodal Surface Transportation Efficiency Act of 1991, TRANSCOM was one of the leaders in providing regional coordination for the I-95 Corridor Coalition. TRANSCOM members felt that, as a multi-agency coalition, TRANSCOM was well suited to represent their concerns. TRANSCOM now serves as the interim communication center for the I-95 Corridor Coalition.

E-ZPass Agencies

- MTA Bridges and Tunnels
- New Jersey Highway Authority
- New Jersey Turnpike Authority
- New York State Thruway Authority
- Port Authority of New York and New Jersey
- Pennsylvania Turnpike Commission*
- South Jersey Transportation Authority *

** Not TRANSCOM Member*

Regional ITS Architecture Development Process

Developing the Regional ITS Architecture

The TRANSCOM manual architecture was the earliest framework for defining transportation information flows throughout the region. This framework demonstrated the benefits of coordination. As new ITS technologies and services were deployed by member agencies, TRANSCOM members identified the limitations of the manual architecture and began to investigate the potential for enhancing that architecture to create automated linkages. In 1993, the TRANSCOM coalition began to plan a strategy to implement an automated regional ITS architecture. The coalition published a request for proposals for consultants to chart the development of that enhanced regional ITS architecture.

The coalition's Technology and Operations Committee established an oversight committee to create a structure to improve and adapt the manual architecture. Members of the oversight committee are senior staff of the TRANSCOM member agencies. The objective of this effort was to improve the management of the region's complex interstate and intermodal transportation system. A consultant team provided the technical expertise and defined the regional ITS architecture's implementation strategy.

Use of the National ITS Architecture

The process to develop a new regional ITS architecture started with a review of the manual architecture. This process preceded the publication of the National ITS Architecture. TRANSCOM staff and partners were aware of and involved in the development of the National ITS Architecture. The manual architecture was subsequently reviewed for consistency with the developing National ITS Architecture.

Training and other tools created as part of the National ITS Architecture development process were effectively employed by agencies in the region. The partners in the regional ITS architecture are confident that the enhanced regional ITS architecture will be consistent with the National ITS Architecture. TRANSCOM maintains responsibility for updating the regional ITS architecture.

Pragmatic Approach to Architecture Development

The regional ITS architecture, currently consisting of the manual architecture and the planned automated enhancements, developed as a pragmatic response to the needs of operating agencies in the metropolitan area. This policy allowed form to follow function. The need for regional response to incident management, construction coordination, and special events resulted in the creation of TRANSCOM. That institutional framework provided the backdrop for development of the regional ITS architecture. The regional ITS architecture grew deliberately in response to the members' operational needs.

Regional ITS Architecture Development Process

Figure 1 demonstrates the elements and interconnects of the proposed regional ITS architecture.

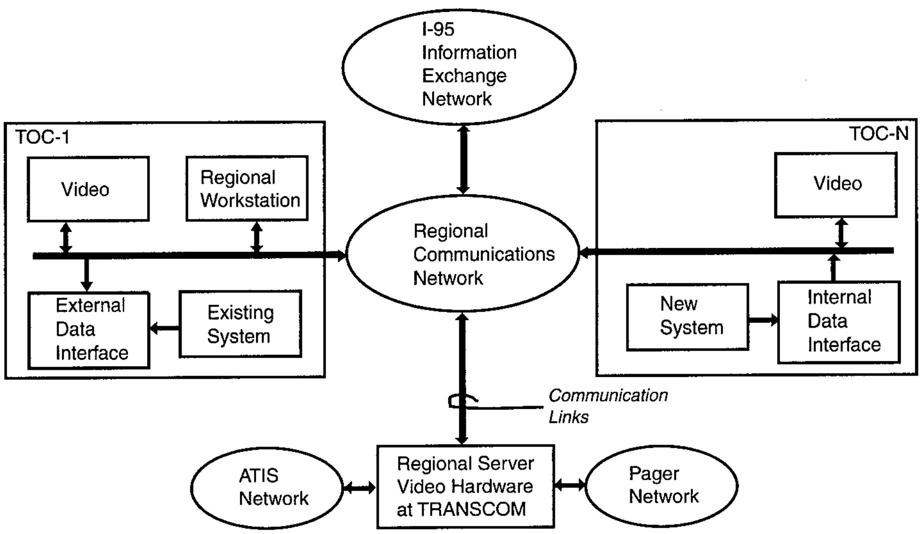


Figure 1 Model of TRANSCOM Regional ITS Architecture Configuration

The New York City Early Deployment Plan (EDP)

This case study emphasizes the TRANSCOM regional ITS architecture. It also considers the role of the sub-regional ITS architecture developed for New York City as part of the New York City EDP process. The development of TRANSCOM has helped bring transportation agencies throughout the region together to address transportation issues. The New York City EDP had the same impact on the many transportation agencies within New York City.

The NYC EDP is one of four EDPs completed or in process within the region. It is important because of the regional importance of New York City and its transportation system. Midtown and downtown Manhattan serve as the central business district for the region and New York City's five boroughs make up a significant portion of the region's population and employment center. The agencies leading the NYC EDP development are: the New York City Department of Transportation (NYCDOT); the New York Metropolitan Transportation Authority (MTA); the New York State Department of Transportation (NYSDOT); and the Port Authority of New York and New Jersey. These agencies, in addition to being members of TRANSCOM, are major transportation providers and ITS champions in the region.

New York City EDP Participants

- New York Metropolitan Transportation Authority
- New York City DOT
- New York State DOT
- Port Authority of New York and New Jersey

Regional ITS Architecture Development Process

"The NYC EDP is important because it provided the opportunity for transportation agencies in New York City to work together on ITS issues."
— Charles Ukegbu, Chief of Planning and ITS, Office of Planning and Urban Mobility, New York City Department of Transportation

In 1993, the NYSDOT Region 11 Office and the NYCDOT, in response to federal invitations outlined in ISTEA, jointly sought funds to investigate ITS deployments over their road and highway network. In a separate application, the MTA applied for ITS funding for its transit and river crossing facilities. These agencies were seeking to develop a strategic plan for ITS in New York City. They were interested in supplementing the forthcoming regional ITS architecture to address issues of more localized concern. The U.S. DOT encouraged intermodalism and integration by suggesting that the NYSDOT, NYCDOT, and MTA combine their ITS efforts.

The NYC EDP process began prior to the establishment of the National ITS Architecture. The partners involved in the NYC EDP process were aware of and involved with the development of the National ITS Architecture. Like the designers of the regional ITS architecture, the EDP partners relied on training and materials developed as part of the National ITS Architecture.

One product of the NYC EDP effort is a sub-regional ITS architecture. It is designed to address the specific information sharing needs of transportation agencies within New York City. This is also designed to work within the developing framework of the regional ITS architecture. To facilitate this interface, the same consultant team responsible for automating the existing regional manual ITS architecture was involved in the development of this sub-regional ITS architecture. TRANSCOM provided input and reviewed the work done by consultants to the NYC EDP.

PAAG Sub-groups

- Goals and Market Packages
- Information Linkages
- Traveler Information
- Interagency
- Implementation Phasing
- Public Outreach
- Operations and Maintenance
- Financing

The designers of the NYC EDP examined the user services in the federal EDP guideline. They then used the flow chart of the deployment process to design the sub-regional ITS architecture. They also reviewed the 53 market packages of the emerging National ITS Architecture and customized and created new market packages for parking, bicycling, and pedestrian use. Each agency then made a priority list, which ranked the market packages. The four agencies then worked together to prioritize a joint list of market packages.

Figure 2 demonstrates the recommended communication linkages for the NYC EDP.

Interagency Coordination in the NYC EDP

The NYC EDP process established a series of interagency roles to connect project deployment to these market packages. Fulfillment of these roles will not require additional staff. These deployments are established along a 20-year time frame and define the implementation of the NYC EDP. One exciting potential of this plan is to begin the joint control by NYSDOT and NYCDOT of the road network within New York City at a single dual-operating center.

Regional ITS Architecture Development Process

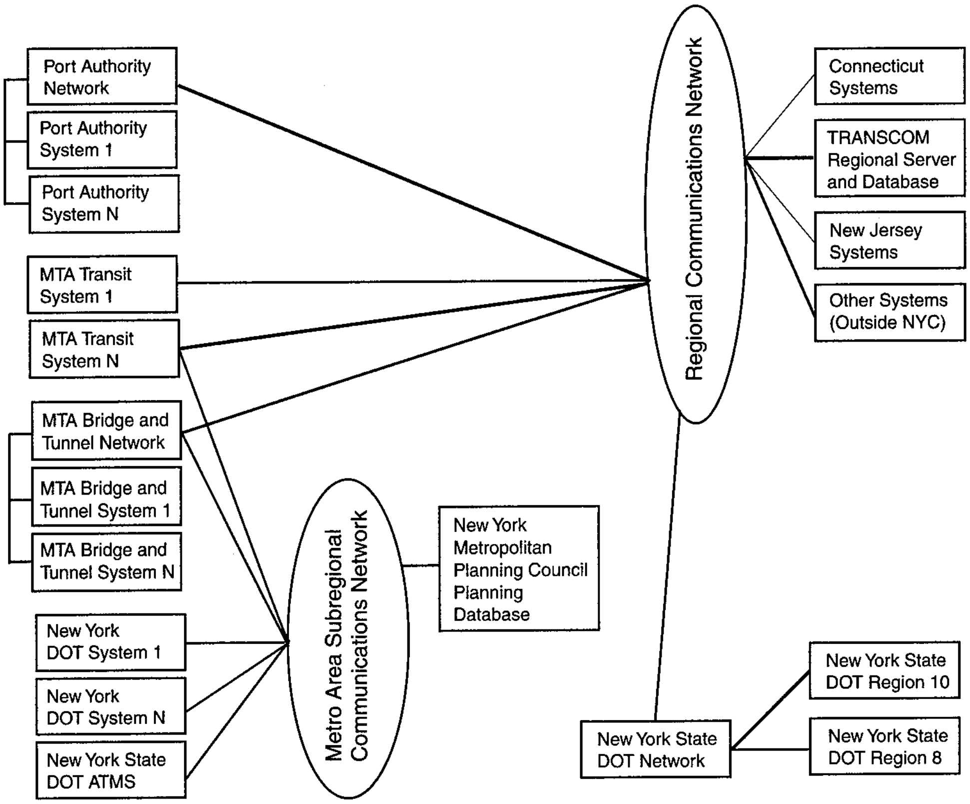


Figure 2 Recommended New York City EDP Sub-regional Architectural Concept

New York City Facts

Population: 7.5 million
Employment: 3 million
Employers: 300,000
(1996 Census Bureau Est.)

Daily Transit Ridership:
5.5 million people
Miles of Roads: 6,400

The Triborough Bridge and Tunnel Authority (TBTA) (MTA Bridges and Tunnels) serves more than a million people daily

Stakeholder Involvement in the NYC EDP

The NYC EDP development process reached out to a broad range of stakeholders. Organizations in the region were invited to join a Public Agency Advisory Group (PAAG). The PAAG members include a variety of government agencies, private organizations, and advocacy groups interested in incorporating surface transportation, planning, environmental, and related issues into the EDP process. Eight PAAG subgroups were formed to provide input into specific aspects of the process. Through this process, a broad swath of interested parties participated in the creation of the EDP.

Regional ITS Architecture Applications and Evolution

The regional ITS architecture will be used to improve the collection and dissemination of information to maximize performance of the existing transportation infrastructure. To accomplish this goal, the regional ITS architecture must enable an automated flow of data. The current manual system is not making full use of the technologies being deployed. As noted earlier, TRANSCOM is responsible for implementing, operating, and updating the regional ITS architecture. Currently, TRANSCOM is working to create an enhanced system through which data can flow automatically. Figure 3 provides a graphical illustration of the data flows between the different levels of the regional architecture.

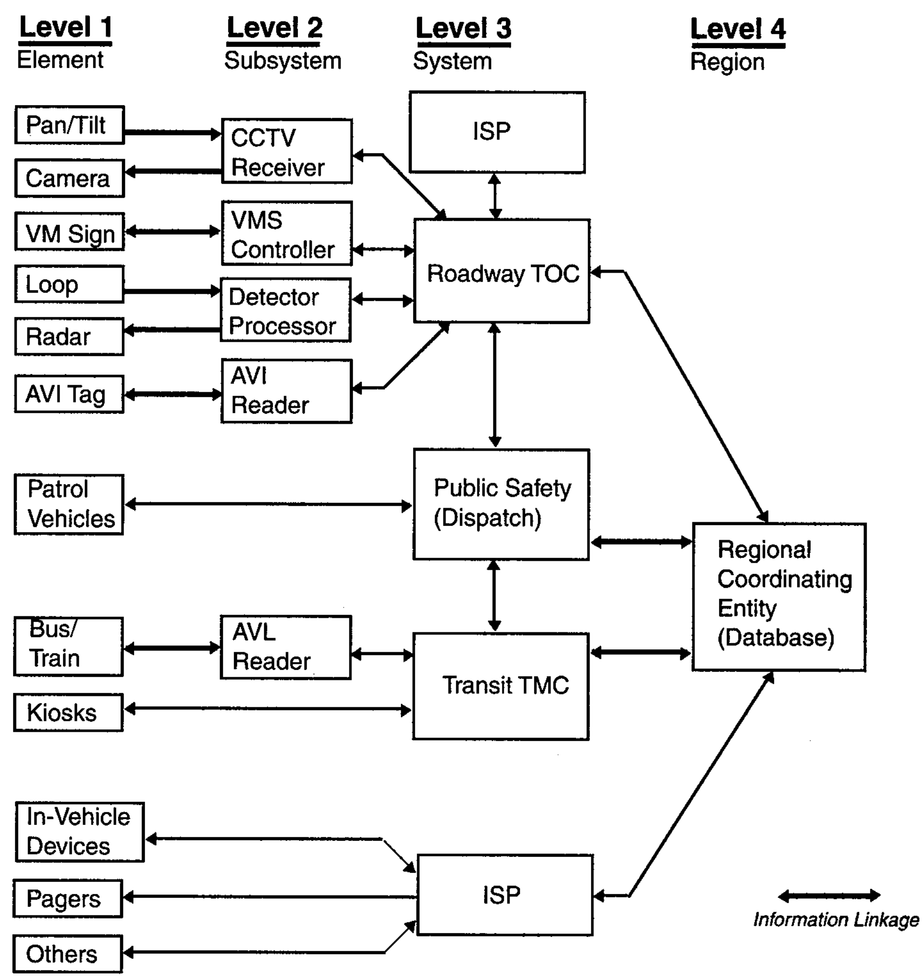


Figure 3 Automated Flow of Data

Regional ITS Architecture Applications and Evolution

Use of the Regional ITS Architecture for Transportation Planning

The New York-New Jersey-Connecticut Regional ITS architecture is designed to serve the operational needs of TRANSCOM member agencies. Systems connected by this architecture will provide a wealth of useful information for MPOs in the region. Planning agencies have been involved in this architecture development process and will incorporate the data collected by the various ITS projects into future planning.

Use of the Regional ITS Architecture for other ITS Projects

Each of the three states in the case study area have planned or developed ITS projects outside of the 29 county metropolitan region. The involvement of those states with TRANSCOM extends the influence of the regional ITS architecture as states employ compatible systems to these ITS deployment efforts outside of the study area. Conversely, ITS efforts in this 29 county region are influenced by outside efforts, such as the Commercial Vehicle Information Systems and Networks architecture and the I-95 Corridor Coalition.

Partnerships in New York City

The NYC EDP process has been useful in bringing together a variety of agencies in New York City to address a wide range of local transportation problems. The members hope that the same cooperation that facilitated the NYC EDP will continue for the implementation and maintenance of the ITS projects. The sub-regional ITS architecture is being developed to ensure continued cooperation of agencies by creating a structure to connect future ITS deployments. The NYC EDP is designed to anticipate future needs and potential future partners.

Maintaining the Regional and Sub-regional ITS Architectures

TRANSCOM has been responsible for operating and maintaining the manual architecture. In cooperation with the member agencies, it will retain this responsibility after the regional ITS architecture is finalized.

Both the regional and sub-regional ITS architectures establish a common foundation for ITS deployment. This framework is important since the operating agencies were concerned that deployment of incompatible systems may create new difficulties in managing the region's complex transportation system. In addition to the TRANSCOM and NYC EDP coalitions, several larger transportation agencies in the region have established in-house steering committees to insure that ITS deployments within their organizations are compatible.

The NYC EDP is a work in progress. Institutional issues, including maintenance of the architecture, need to be addressed by the four partners in this process. In its current form, the EDP is more specific to the NYC DOT and the NYS DOT. These agencies have identified the Urban ITS Center at the Polytechnic University to lead the development of their portions of the NYC EDP in the future. The New York MTA and the Port Authority will be responsible for updating their own portions of the NYC EDP.

"The proposed Interagency ITS Center for New York City should serve as the formal forum for continuing inter-agency technical coordination for multimodal ITS deployment projects beyond completion of the EDP."
— Ernest Athanailos, Director, ITS Engineering, New York City Department of Transportation

Lessons Learned

"An impetus for coordination was concern that deployment of incompatible systems would make transportation problems worse rather than better."
— Rob Hess, Senior Manager, Transit Projects, Capital Program Budgets, New York Metropolitan Transportation Authority

"Establishing the relationships between the different agencies provided the primary benefits. Those institutional links are probably more beneficial than the technical ones."
— Jim Paral, Director, Traffic Operations, New Jersey State Department of Transportation

"It's difficult to educate the stakeholders about the architecture. It's so high level it's sometimes tough to describe."
— Bill Stoeckert, Director of Highway Operations, Connecticut State Department of Transportation

The major lessons learned in the development of both the regional ITS architecture and in the NYC EDP follow.

- Early establishment of interagency relationships is important.
- Education about ITS and regional ITS architecture is needed within agencies to garner critical senior management involvement and support for ITS and regional efforts.
- Federal support, including education and the establishment of standards, has been and continues to be important.
- The National ITS Architecture is a useful tool for guiding the regional ITS architecture process.
- Institutional issues must be considered and respected.
- ITS has created a new regionally focused paradigm for transportation planning and operations.

Interagency Relationships Important

- The key to the success of both the regional and sub-regional ITS architecture development processes was the early establishment of interagency relationships. The impetus for these relationships was the need to maintain a level of operational performance in an environment of increasingly limited land and financial resources. ITS integration offered the benefits of performance improvements with shared financial burdens.

- While each agency was motivated by their own operational concerns, bringing those organizations together cultivated interest in regional ITS solutions. The interactions with different agencies benefited regional coordination and introduced the various agencies' key ITS champions to each other. This participation enabled the potential for partnerships.

- Various organizations held ITS at distinct priority levels. Understanding the institutional constraints of partner agencies is important to productive collaboration. Building relationships is necessary to reach this understanding.

Education and Senior Management Support

- Participants in both the regional ITS architecture development process and the NYC EDP process understood the importance of and the need for ITS integration. They often had difficulty translating its potential to their organizations.

- Most agencies reported a need for *inreach* to enable their own agencies to buy into the concept of a regional ITS architecture.

- In many agencies both senior management and operation staff found the idea of an "ITS architecture" a confusing and not easily explained concept.

- For a good idea to become reality it is crucial that it receives the support of senior management. This is particularly crucial since in many cases, ITS is not its own budget category. Lacking an exclusive funding source, it is relatively easy to reduce funding for ITS projects. This is especially true if people fear losing operational control to the new technologies and institutional arrangements.

- Agencies need interest and involvement in ITS at all levels. Senior management must see the benefits of ITS and of regional coordination for resources to be directed towards the development of ITS systems and a regional ITS architecture.

- Operation staff need to understand how the coordination of systems and information will help in meeting their operational responsibilities. Planning staff, who are often proponents of cooperation and regional involvement, need to understand the responsibilities of operational staff.

- Tangible interagency ITS successes such as the E-ZPass electronic toll collection system also helped illustrate the potential of an orchestrated ITS framework. Nonetheless, many agencies reported the need for further education and guidance at the outset of the regional ITS architecture development process. This outreach could also be fruitfully aimed at the public to encourage and support interagency initiatives.

Federal Support

- Many agencies found the support from the U.S. DOT very helpful for explaining the concept and benefits of a regional ITS architecture. Both the division offices and ITS training courses were cited as particularly useful.

- For some individuals, participation on national boards and task forces established with Federal support served as a vehicle for learning about ITS and its associated issues. Some agencies found their consultants able to provide a critical institutional education function.

National ITS Architecture a Helpful Tool

- Most respondents found the National ITS Architecture to be an excellent tool for planning a regional ITS architecture. It provides a framework from which innovation can occur and a language for discussing that innovation. However, regional stakeholders must still adapt the concepts of the National Architecture to address local needs.

- The National ITS Architecture is an important resource for regional ITS integration. Stakeholders also reinforced the need for standards as a crucial issue requiring attention at the national level.

"You need champions in the agency to move forward on ITS and on coordination with other agencies. It is important that high-level staff see the usefulness of ITS and coordination."
— Isaac Takyi, Director, Facilities & Equipment Planning/ITS Operations Planning, NYC Transit

"The acceptance and success of the E-ZPass has given agencies the confidence to both deploy new technologies and to work together."
— Abiyu Berlie, ITS Strategic Planner, New York Metropolitan Transportation Authority, Bridges and Tunnels

"Using the National ITS Architecture is helpful. It provides a common language."
— Eduardo Serafin, Formerly with the Polytechnic University of New York

Lessons Learned

"Get your ducks lined up first and establish necessary buy-ins and institutional relationships with the people responsible for operations before embarking on an inter-agency process to develop a regional ITS architecture."
— Ira Huttner, ITS Specialist, Information Services, Port Authority of New York and New Jersey

"Agencies developing an ITS architecture should not be afraid to involve as many organizations as possible."
— Louis Neudorff, Senior Vice President, TRANSCORE

"ITS is a new way of thinking. It's about systems, not projects."
— John C. Falcocchio, Professor and Head of the Department of Civil and Environmental Engineering, Polytechnic University of New York

"Each region is different. The key is to get the ball rolling."
— Matt Edelman, General Manager, TRANSCOM

Institutional Considerations

- Once convinced of the need for coordination, stakeholders were able to discuss common goals. There was some wariness among the participants about embarking on this process. Agencies were reluctant to open up their traditional jurisdictions to forms of joint control

- Working through these concerns was one of the major successes of the entire regional ITS architecture development process. This institutional bridge building helped the interagency planning process to create better coordination and avoid wasteful duplication for ITS deployment.

- Creating new lines of communication was seen as something that extended beyond the framework of just ITS. It was, as one agency reported, "an attitudinal shift towards the compounded benefits of coordination" in all spheres. This reflected the kind of thinking that some people in the region thought should be applied to discussions of ITS itself: ITS should be a part of a regional mobility strategy and not be viewed separately.

New Paradigm

- Many of the agencies interviewed discussed the importance of ITS as a new paradigm for transportation planning and operation. Unlike other transportation projects, which have often been done in isolation of the larger transportation system, ITS projects are designed to improve management of the larger transportation system. It is difficult to easily demonstrate the benefits of the interagency collaboration necessary to a system-wide outlook. Nonetheless, the interviewed agencies discovered that the regional ITS architecture has to be connected to existing needs and policies and institutional structures. The act of developing a regional ITS architecture created a new set of realities. Thus, the regional ITS architecture development process incorporates the status quo into a more integrated and connected future state.

References and Additional Resources

Web Sites

Connecticut DOT:
http://www.state.ct.us/dot/

New Jersey DOT:
http://www.state.nj.us/transportation/

New Jersey Transit:
http://www.njtransit.state.nj.us/

New York MTA :
http://www.mta.nyc.ny.us/

New York MTC:
http://www.nymtc.org/

New York City DOT:
http://www.ci.nyc.ny.us/html/dot/html/

New York State DOT:
http://www.dot.state.ny.us/

Port Authority:
http://www.panynj.gov

TRANSCOM:
http://www.xcm.org

Select Bibliography

About TRANSCOM. TRANSCOM. Undated brochure.

*Alternative Configurations for the TRANSCOM Regional Architecture: Working Draft No. 2.*TRANSCOM. Prepared by JHK and Associates. Revised January 1995.

Draft Strategic Deployment Plan. New York Metropolitan Transportation Council. August 1998.

ITS Model Deployment Initiative. Slide Presentation.

Let's Talk it Over Interagency Cooperation Facilitates Success – The New York, New Jersey, Connecticut Metropolitan Area TRANSMIT Operational Test, A Case Study (Draft). U.S. DOT ITS JPO.

New Haven-Meriden Metropolitan Area ITS Strategic Deployment Plan: Technical Memorandum Number 5 – Intelligent Transportation System Architecture. Connecticut Department of Transportation. August 1997.

References and Additional Resources

New York City ITS Strategic Deployment Plan. Slide Presentation from PAAG Meeting. October 1998.

New York/New Jersey/Connecticut Model Deployment Initiative. TRANSCOM. January 1999.

Policy Review of ITS Priority Corridors: Revised Draft. Thomas Horan, Ken Voorhies, Lawrence Jesse Glazer, and Lucille Chang. August 1996.

Request for Proposals: Implementation of the Regional Architecture. TRANSCOM. April 1998.

Review ITS Users Services Goals and Market Packages: Draft Technical Memorandum. New York State DOT. Metropolitan Transportation Authority. New York City DOT. Port Authority of New York and New Jersey. Prepared by Northeast Consultants. May 1997.

Subregional ITS Architectures. New York State DOT. Metropolitan Transportation Authority. New York City DOT. Port Authority of New York and New Jersey. Prepared by Northeast Consultants. May 1998.

TRANSCOM Region-wide IVHS Implementation Strategy: Draft Technical Memorandum: Task 2 – Agency Perspectives. TRANSCOM. Prepared by JHK and Associates. May 1994.

References and Additional Resources

Individuals Interviewed

The authors wish to thank the following individuals, who were interviewed and/or provided other support in the preparation of this case study:

Connecticut Department of Transportation:
Bill Stoeckert, Director, Highway Operations
Hal Decker, Supervising Engineer, Highway Operations

Federal Highway Administration:
Art O'Connor, New York Division

New Jersey State Department of Transportation:
Tom Fuca, Manager, ITS
Jim Paral, Director, Traffic Operations

New York Metropolitan Transportation Authority:
Abiyu Berlie, ITS Strategic Planner, Bridge and Tunnels
Phil Plotch, Manager, Policy and Planning
Rob Hess, Senior Manager, Transit Projects, Capital Program Budgets

New York City Transit:
Isaac Takyi, Director, Facilities & Equipment Planning/ITS Operations Planning

New York City Department of Transportation:
Ernest Athanailos, Director, ITS Engineering Unit
Charles Ukegbu, Chief of Planning and ITS, Office of Planning & Urban Mobility

New York Metropolitan Transportation Council:
Gerry Bogacz, Assistant Director, Planning Group
Mark Tobin, Transportation Planner

New York State Department of Transportation:
Paul Cuerdon, Assistant Regional Traffic Engineer, Region 1
Bob Knighton, Director, Passenger Policy & Program Evaluation Bureau, Passenger Transportation Division
Tom Werner, Regional Director, Region 1
James Davis, Transportation Analyst, Passenger Transportation Division
Ed Roberts, Director, ITS Group
Fong Lin, Regional Traffic Engineer, Region 11
Fred Lai, Traffic Engineer, Region 11

Polytechnic University:
John C. Falcocchio, Professor and Head of the Department of Civil and Environmental Engineering
Eduardo Serafin (Formerly of the Polytechnic University)

References and Additional Resources

Port Authority of New York and New Jersey:
Peter Rosenthal, Capital Program Manager (Information Technology)
Information Services
Ira Huttner, ITS Specialist, Information Services
Mark Muriello, Assistant Director, Tunnels, Bridges, and Terminals
Lee Home, Supervisor, Tunnels, Bridges, and Terminals

TRANSCOM:
Matthew Edelman, General Manager
Tom Batz, Manager, Technology Development

TRANSCORE:
Louis Neudorff, Senior Vice President

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

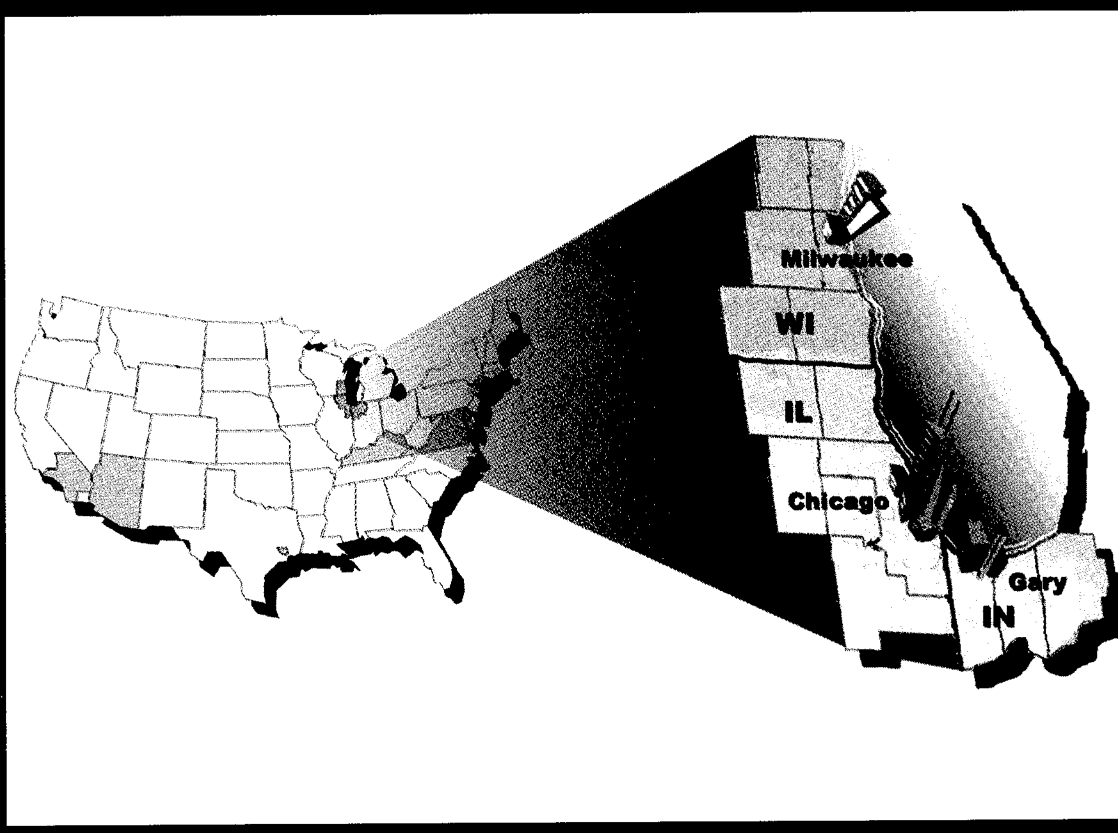
Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

Notes

Regional ITS Architecture Development

A Case Study

Gary–Chicago–Milwaukee ITS Priority Corridor



Building a Framework for Tri-State ITS Corridor Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

NOTICE

The United States Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the objective of this document.

Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/ statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. The seventh study is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support from the Volpe Center.

This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Case Study Overview

"The need for a framework or architecture helped to unify the Corridor—to link our data together."
**— John Corbin,
Freeway Operations
Engineer,
WISDOT**

The Gary-Chicago-Milwaukee (GCM) ITS Priority Corridor is a real-world study in intergovernmental cooperation to develop integrated, intelligent transportation services that serve a diverse constituency. This GCM Corridor case study reveals:

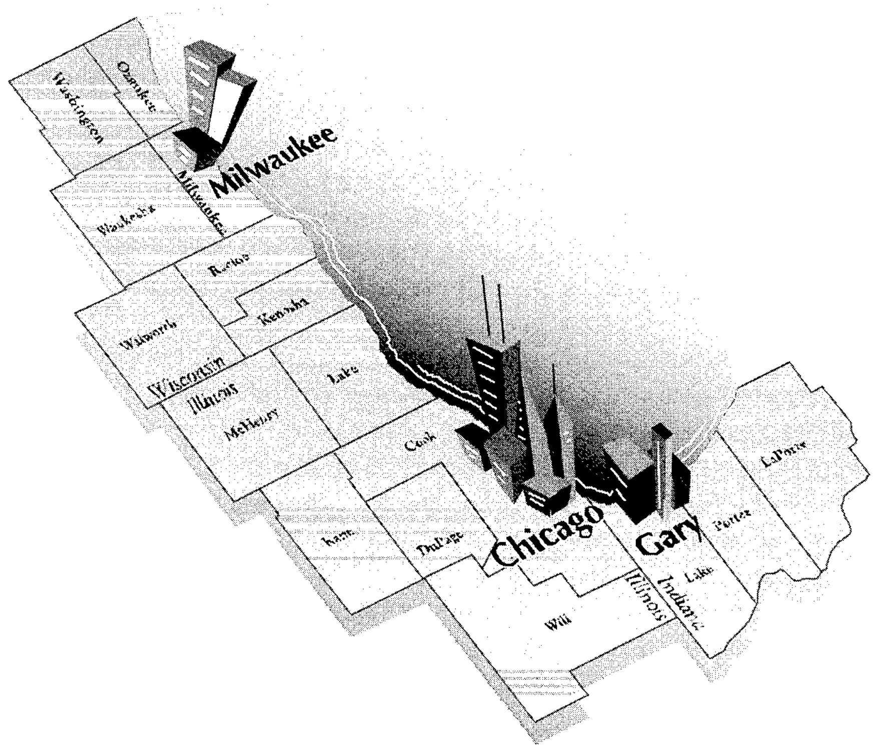
- An extraordinary partnership among three state departments of transportation: Wisconsin (WISDOT), Illinois (IDOT), and Indiana (INDOT)
- Cooperative efforts that transcend multiple metropolitan, county, and state jurisdictional boundaries to address major traffic demands, weather conditions, and infrastructure limitations
- Bringing together existing ("legacy") and planned systems and services into an integrated framework of corridor ITS services
- Effective use of an unconventional chronology of ITS planning and deployment.

This case study presents the circumstances found in the Gary-Chicago-Milwaukee (GCM) Priority Corridor. It begins with an insight into the circumstances found in the GCM Corridor and then discusses the basic approach employed by the Corridor to develop an ITS corridor architecture. The study examines the challenges and achievements of the Corridor's interagency partnership from its inception, and it offers a series of "lessons learned" to help others seeking to integrate ITS services across a region or corridor.

The methodology used in the preparation of this study included a review of the GCM Corridor (and related) literature, as well as a series of interviews with individuals from the numerous organizations that plan, implement, and monitor transportation services and operations along the corridor.

The GCM Corridor benefited from the special ITS priority corridor funding authorized in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. However, many of the institutional hurdles it has cleared—or is attempting to clear—are nearly universal and relevant to other regions or corridors not selected as part of the Priority Corridors Program.

Background



GCM Corridor Vision Statement:

This vision is one of enhanced transportation productivity, mobility, efficiency, and safety within the corridor with a reduction in energy use and negative environmental impact through the use of ITS technologies and systems.

Traffic Congestion Prompts Agency Collaboration

While formal collaboration along the GCM Corridor did not begin until the 1990s, there is a history of traffic management and traveler information services dating back almost 40 years. Most of these efforts were ad hoc arrangements, based on informal working relationships. Public organizations and individuals worked under differing operational and policy constraints. Growing congestion and limited resources in the 1970s and 1980s were harbingers of the need for inter-jurisdictional, cross-agency coordination, particularly with respect to traffic data.

During this period, traffic volume and corresponding congestion continued to grow in this highly industrialized corridor. Increased congestion impacted negatively on the area's infrastructure, as well as its accident rate, and the environment. The greater Chicago area, which includes major intermodal freight facilities, hosts the third largest volume of truck traffic in the nation. And, like many major metropolitan areas, the GCM Corridor is a severe ozone/air quality non-attainment area (as defined by the Clean Air Act Amendments of 1990), a condition that is exacerbated by stop-and-go traffic congestion. In addition to the Clean Air Act, other environmental laws slowed highway expansion and modifications. In addition, more media attention and public scrutiny resulted in greater public awareness of surface transportation issues. Ever-increasing construction costs and funding constraints prompted the search for alternatives to traditional remedies. It became apparent that traditional highway and transit system expansion solutions would not be sufficient to meet ever-growing transportation demands in a resource-limited environment.

Background

As the region's transportation professionals began to broaden their thinking from construction and maintenance to transportation system operations, management, and coordination, change did not always come smoothly. Agency missions and resources were not structured to support interagency data sharing and coordination. In some instances, transportation agency officials were forced into a new high-profile visibility. Public interest groups made new demands to either limit or terminate growth. In some instances, there were no market forces to support needed changes, so the responsibility was left to public agencies.

In the 1980s, before interagency collaboration and data sharing were in vogue in many other areas, the IDOT-sponsored Traffic Systems Center was initiated as a way to start sharing information. A conceptual plan looked at which entities should be involved, and provided the basic framework of what was to be accomplished. The regional system evolved into a core of active members, complimented by another less active group that was kept informed of activities. This allowed each player to determine his or her own role and level of participation. Generally, the commitment started with each state's DOT, first at the ranks of middle management and gradually ascending to more senior-level decision-makers.

GCM Corridor: By the Numbers . . .
(March 1999)

- Population: 10 million
- Employees: 5 million
- Geographic Area: 16 counties, 2,500 sq. miles
- The greater Chicago area has the 3rd largest volume of truck traffic in the nation.
- Milwaukee County Transit was second in the nation to deploy Automated Vehicle Location (AVL) technology on its bus fleet. Of its 602 vehicles, 558 are being equipped with AVL.
- Half of Chicago Transit Authority's 1,400 buses are equipped with AVL and GPS for emergency tracking.

ITS Before the Priority Corridor

By the early 1990s, several of the initial ITS projects within the GCM Corridor were either operational or under development, including:

- IDOT's Freeway Management Program in the greater Chicago area
- WISDOT's Milwaukee area Freeway Management Program (MONITOR)
- Automated Vehicle Location systems with Milwaukee Transit, Chicago Transit Authority and Pace (suburban Chicago area) bus fleets
- IDOT's operational test, which involved in-vehicle navigation technology and communication with the traffic management center (ADVANCE)
- INDOT's Borman Expressway Management Project
- Incident response programs by INDOT ("Hoosier Helpers"), IDOT ("Minutemen")
- WISDOT's Traffic Incident Management Enhancement, or "TIME" Program, which is a freeway operations and incident management program for Southeastern Wisconsin.

While informal interagency coordination was part of the planning and development of these early ITS services, these were largely stand alone, "stove-piped" projects. In 1992, with IDOT as a major proponent, representatives from the three states came together to evaluate their common transportation problems and examine potential corridor-wide initiatives and coordination that might benefit all three states. Since the three state DOTs had a history of informal coordination along the GCM Corridor, some helpful groundwork had already been laid for establishing an institutional GCM Corridor Coalition.

Priority Corridor Designation

In 1993, U.S. DOT designated the GCM Corridor as one of the four ITS Priority Corridors. With this designation came dedicated funding; the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 authorized over $500 million for ITS corridors, roughly half of which was to be divided among the four designated priority corridor sites over the six-year authorization. Through fiscal year 1997, priority corridor program funding for the GCM Corridor (including state contributions) totaled nearly $25 million. This funding has supported the following corridor priorities:

- expanding the coverage of existing ITS services
- enhancing ITS service capabilities
- connecting the ITS services and functions to support compatibility among information databases and operational procedures.

In addition to the special funding, the priority corridor designation was a major impetus for institutionalizing interagency data sharing, in large part through the establishment of the Corridor Transportation Information Center. This project, which is the "information hub" of the GCM Corridor, is the logical evolution of the Traffic Information Center associated with the ADVANCE operational test program.

As the GCM Priority Corridor began to take shape, the Corridor Transportation Information Center became an important "test bed" for corridor integration efforts. This project involved the immediate reuse of an existing system to serve the needs of the GCM Corridor until a corridor-wide system could be developed from the ground up. It was funded by IDOT, outside of the GCM Corridor funding. The current "Gateway" project, which includes "Datapipe" and "Information Clearinghouse" projects, was determined by the GCM Corridor Coalition to be both its top priority and the focus of its near term efforts at developing a GCM Corridor regional ITS architecture.

U.S. DOT ITS Priority Corridor Goals

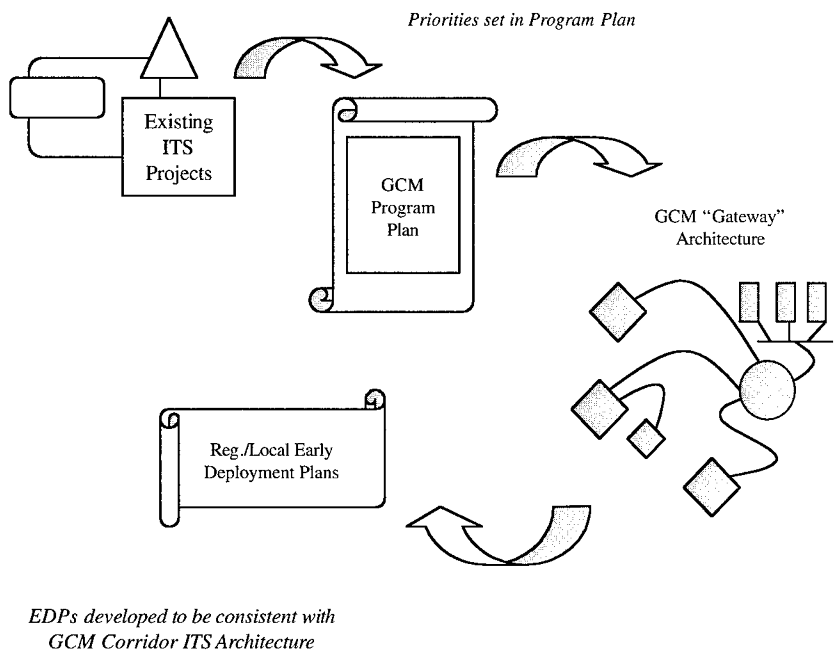
- Advance ITS strategic planning
- Serve as national ITS test beds
- Demonstrate the benefits of ITS
- Showcase ITS to the public
- Evaluate ITS concepts and technologies

ITS Architecture Development Process

In order to achieve integrated transportation systems and coordinated traveler information, public and private agencies and organizations throughout the corridor are working together to jointly develop solutions and link systems.
— GCM Corridor Communications Plan

The development process for the GCM Corridor ITS architecture includes a number of important elements, the remainder of which are introduced below. This section lays out a chronology of these elements, and suggests relationships between major process elements.

Highlights of GCM ITS Corridor Architecture Development Process



GCM ITS Priority Corridor Program Plan

In 1995, the *GCM ITS Priority Corridor Program Plan* was developed by BRW, Inc., under the guidance of corridor coalition technical and coordinating committees. It was formally approved by an executive committee comprised of the three state DOT executives and the acting Regional Administrator of the Federal Highway Administration. The program plan, which was updated in a formal planning process in 1997, offers a 20-year horizon for implementing some 100 corridor projects categorized in 10 major program areas:

- Multimodal Traveler Information
- Integrated Transit
- Incident Management
- Technical/Planning
- Traffic Management Systems
- Commercial Vehicle Operations
- Traffic Signal Integration
- Vehicle Transponder Systems
- Advanced Incident Reporting/Mayday Security
- Public/Private Partnerships

ITS Architecture Development Process

To determine these priority program areas, public outreach and agency coordination was obtained through coalition meetings, a series of workshops, and periodic newsletters to a wide circulation of public, private, and community organizations.

Stakeholders Set Corridor Priorities

Through the course of preparing the program plan, the GCM Corridor Coalition grew to over 700 members, representing some 70 public, private, and community organizations. With such a large pool of stakeholders, virtually every constituency interested in participating is represented in the coalition, from suburban municipal traffic engineers to urban transit operators to statewide emergency service agencies.

A few entities were conspicuous by their absence. Some stakeholders questioned the apparent lack of participation by the world's busiest airport, O'Hare International Airport, which is centrally located in the GCM Corridor and has the potential to significantly impact traffic conditions across a wide area. However, O'Hare and Midway airports are represented by Chicago's Department of Aviation, and as the corridor evolves, the airports are anticipated to play more active roles.

Participation among the coalition varies widely, but a core group exists that includes representatives from the three state DOTs, major city transportation and transit agencies, planning agencies, Federal Highway Administration and Federal Transit Administration, and private sector consultants.

With few exceptions, what drives most organizations' involvement in corridor committee activities and decision-making is the particular interest of individuals. This is due in large part to an individual's background or special interest in ITS, and a belief in the potential of an integrated system of ITS services.

Like an Early Deployment Plan (EDP), the Corridor Program Plan is serving an important and similar purpose by helping to further stimulate interagency coordination and data sharing considerations. And, perhaps most importantly, it has "codified" the corridor coalition's aim of building corridor integration by establishing project funding priorities.

The GCM Corridor Coalition is comprised of 700 members representing state, regional, local governments, transportation providers, industry, and non-profit organizations.

ITS Architecture Development Process

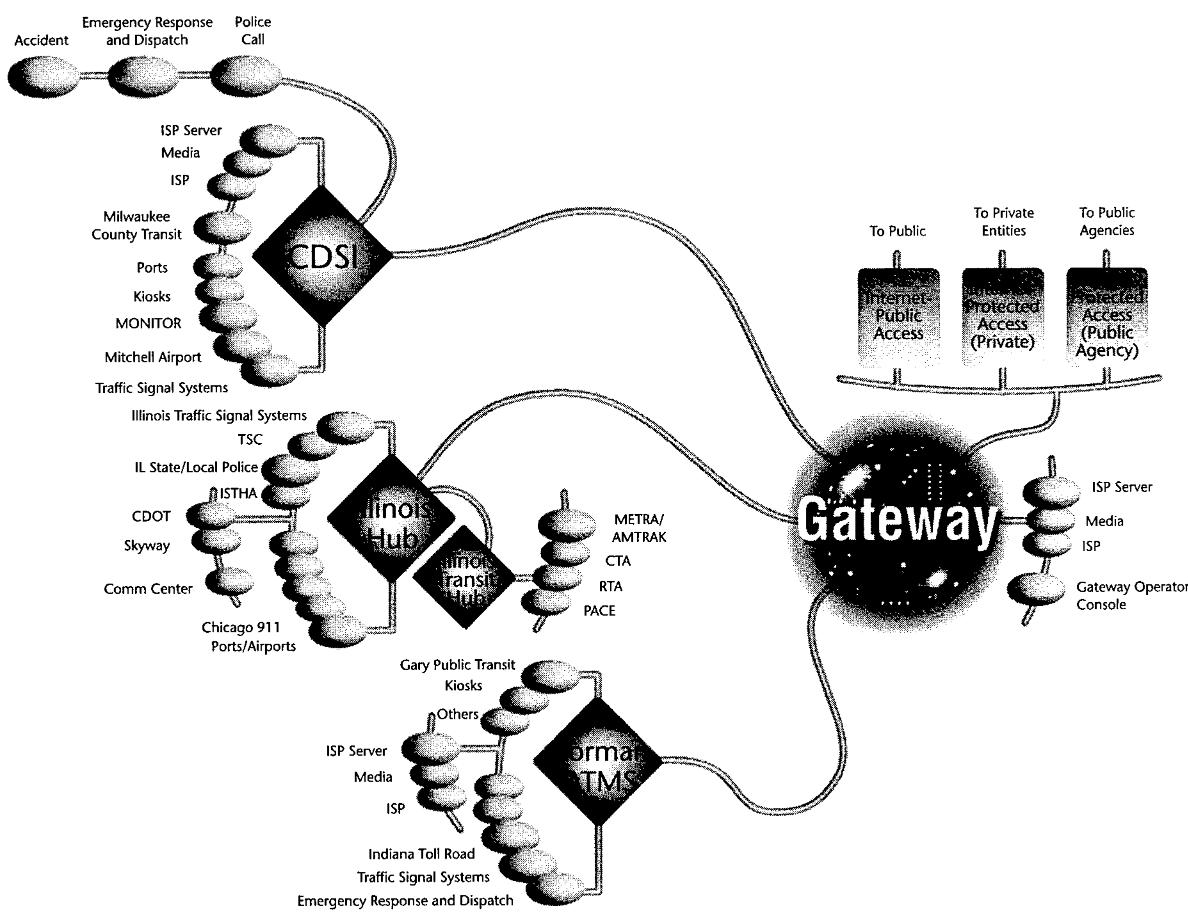
"It's hard to imagine diverse communication coordination and electronic data exchange without the GCM (Corridor) or National Architecture."
— **Ken Glassman, Coordinator of Engineering Services, Illinois State Toll Highway Authority**

The Gateway Program and the GCM Corridor ITS Architecture

The next step in the development process involved the creation of the Multimodal Traveler Information System, of which the Gateway Program is a crucial subset. As noted, the Gateway Program is the flagship of the GCM regional ITS architecture. It is an integrated information system that provides data to operating agencies and the traveling public throughout the GCM Corridor.

The Gateway Program was designed as a "distributed system," with regional hubs in each of the three states that collect transportation data and then pass it on to a main Gateway server. The server then distributes corridor-wide data back to each of the three state hubs. A fourth hub is dedicated for Illinois transit and stems from the Illinois hub. The Gateway server is the focal point for distributing such data as travel times, construction and maintenance, traffic incidents, and weather information to operating agencies, information service providers, planners and researchers, and to the public via the internet.

Diagram of the GCM Corridor Gateway



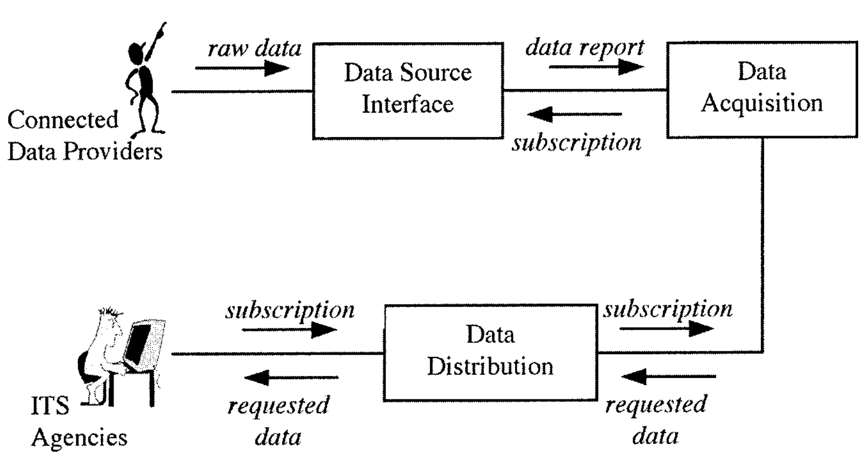
ITS Architecture Development Process

The GCM Corridor Coalition took advantage of a confluence of events in 1994-1996. As the ADVANCE operational test program was reaching completion and phasing down, the GCM Priority Corridor Program gathered additional momentum from the already-deployed communications infrastructure and other resources of the ADVANCE project.

Similarly, while early design work on the GCM (Gateway) corridor architecture preceded the 1996 release of the National ITS Architecture, a synergistic benefit resulted from the GCM system design consultants also being participants in the National ITS Architecture development process. Therefore, a corridor architecture design emerged that was influenced by the National ITS Architecture. Attention to the National ITS Architecture also eased concerns about an emerging issue: how to balance the demands for a flexible and open architecture that also ensures a sufficiently integrated system of compatible components.

Under an existing contract with IDOT, De Leuw, Cather and Company is finalizing the development and implementation of the *Gateway Traveler Information System, System Architecture Design*. This design document details a corridor-wide ITS architecture—including functions and specific information flows—for a fully deployed Gateway Traveler Information System, which is slated for implementation by the spring of 2000. System functions, subsystems, data flow diagrams, interfaces, and information flows are all reflected in the GCM Corridor's Gateway architecture design.

Example of GCM Gateway Architecture Data Flow Diagram



GCM Corridor ITS Architecture Timeline

1992 Tri-state DOT coordination of GCM corridor ITS activities

1993 GCM Priority Corridor est.

1995 GCM Corridor Plan approved

"TIME" Program initiated in SE Wisconsin

1996 National ITS Architecture Released

1998 Multimodal Traveler Info. System Completed by IDOT

1999 Anticipated completion of *Strategic Early Deployment Plan*

Anticipated Completion of *Gateway Trav. Info. System, System Architecture Design*

2000 Anticipated completion of Gateway system

ITS Architecture Development Process

"While efforts must be made to hear as many views as possible in the architecture development process, it is also important to allow room for imagination, to take a broader view of potential capabilities."
— **David Zavattero, Deputy for Operations, Chicago Area Transportation Study (Chicago MPO)**

Other Regional Planning Activities

Transportation planning efforts in Wisconsin, Indiana, and Illinois have in varying ways acknowledged, supported, or even affirmed the GCM Corridor architecture development efforts. One planning effort in particular is noteworthy. In 1996, a year after completion of the GCM Corridor Program Plan, the Chicago Area Transportation Study initiated the development of a Strategic Early Deployment Plan (SEDP) for northeastern Illinois. While the SEDP does not cover the entire GCM Corridor, major steps have been taken to link the SEDP to the Corridor Program Plan, as well as the 2020 Regional Transportation Plan.

Given its timing—the SEDP is scheduled for completion in 1999, the SEDP is playing a different role in supporting regional ITS architecture development. Instead of the foundation or "spring-board" role that some EDPs have played in other metropolitan areas, the SEDP will support the corridor ITS architecture by way of endorsement and affirmation. The task force that oversees coordination of the SEDP with the GCM Corridor has recommended that the SEDP formally adopt as its foundation the GCM Corridor architecture, based on the following rationale:

- The corridor ITS architecture will likely meet current and future corridor transportation data demands
- The National ITS Architecture was used to help define the corridor architecture
- Because it is an "open architecture," integration with additional corridor subsystems will be possible
- It has been developed to be compatible with legacy systems, as well as systems that are planned and currently being implemented
- Rather than replace or supercede (existing ITS), the corridor ITS architecture is a means to better disseminate and collect information of corridor-wide importance.

Architecture Applications and Evolution

Maintaining the Corridor Architecture

As the GCM Corridor ITS architecture moves from planning and design to deployment and implementation, working-level committees will continue to guide, evaluate, and resolve issues associated with corridor–wide integration. The Gateway Regional Integration Coordinating Committee is part of an institutional infrastructure that will aid in architecture maintenance and updating necessary to ensure that the corridor ITS architecture is sufficiently flexible to accommodate changing priorities and demands.

In addition to being an integral part of long-term corridor planning, the GCM Corridor ITS architecture supports the vision of allowing agencies to deploy ITS services they deem necessary, while still being consistent with the corridor ITS architecture. Like the National ITS Architecture, the corridor ITS architecture is not technology-specific. However, one recurring issue involves using standardized vs. specialized technology, such as buses using radios versus computers. As new technologies emerge, the possible impact on corridor compatibility is an issue that will require revisiting.

"The GCM (ITS) architecture is great, but it's not yet in practice, and vendors need time to catch up. You can only go as far as vendors are (able to support you)."
**— Troy Boyd,
Hoosier Helper Patrol Program, INDOT**

Architecture and Jurisdictional Barriers

There is often little jurisdictional flexibility to provide or share data, facilities, or services with other agencies, especially in different states. In this instance, a regional ITS architecture can bring interagency coordination and information sharing to a higher level because the functions and technologies involved can help to break down jurisdictional and other institutional barriers.

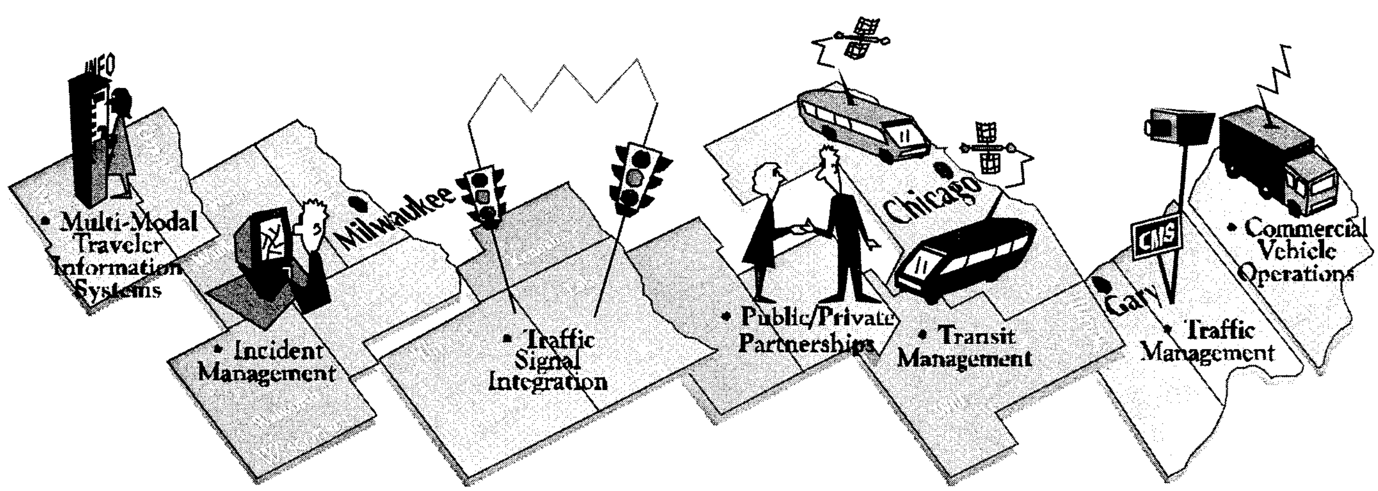
For example, Illinois and Indiana attempted to establish an agreement by which variable message signs (VMS) along an Illinois portion of I-94 would be operated by INDOT and maintained by the Illinois Tollway. The opposite arrangement was proposed in northwestern Indiana. This would enable motorists to receive up-to-date information about conditions ahead—in another state, while still preserving INDOT and Illinois Tollway Authority control over freeway access for maintenance purposes. Unfortunately, the arrangement could not be reached due to liability concerns.

"The (GCM) architecture is taking interagency coordination to another level. The technology is helping to break down jurisdictional obstacles."
**— Jeff Hochmuth,
ITS Program Manager,
IDOT**

Attempts are now underway, however, to achieve the same result via the Gateway system. Each state would be the operator of its own signs, and the information would be provided as a service to the motorist without regard to the state border. In the long run, this may be a better arrangement because it is simpler and poses less risk.

The resolution of other jurisdictional/institutional issues can be more elusive. For example, in Illinois the issue of interagency communications at the field operations level sometimes entails opposing viewpoints. For some state troopers and highway maintenance operators, having compatible radio communication capabilities ("radio interoperability") seems logical and long overdue. Such direct connection to other agencies' field units would empower personnel to redirect limited resources to meet the most immediate needs, in real time. Conversely, without coordinated deployment of field resources through centrally-dispatched communications and standardized procedures, the advantage of strategically deploying resources may be lost to hap-hazard, insufficient response. The GCM Corridor architecture effort may lend more support to the latter side of this argument. However, by linking field resources (such as state police, incident response, transit, highway maintenance, etc.) together via the Gateway architecture, the field unit role for incident response and data input becomes even greater. Ultimately, this issue is apt to be resolved at the operations management level within each agency.

GCM Corridor ITS Services



Courtesy of BRW, Inc.

Lessons Learned

As with any such endeavor, several topics, issues, and "lessons learned" have emerged from the GCM Corridor ITS architecture development process. In general, it is clear that the process itself yielded much more than a draft system architecture for the GCM Corridor. Bringing parties together through formal committee meetings and informal peer-to-peer contact stimulated its own institutional integration, while also establishing a cadre of public and private "champions," supportive of implementing the corridor ITS architecture. Below is a series of additional findings and comments, grouped in general categories.

"The GCM architecture effort stimulated interagency coordination between transit and Wisconsin DOT, as well as with incident management."
— Ronald Rutkowski, Manager of Program Development, Milwaukee County Department of Public Works (an FTA transit property)

Getting Started

- *Learn From Incident Response Teams:* Before developing an ITS architecture, find out what incident response teams are learning in the field. This will help reveal the true causes of traffic congestion, highway incidents, and travelers' information needs.

- *Use the National ITS Architecture:* Deployment would have been much faster had the National ITS Architecture (or GCM corridor architecture) been available when many early corridor ITS services were implemented. The National ITS Architecture helped to identify important and unanticipated linkages.

- *Let the Process Help Define the Region/Corridor:* Initiating the development process for the corridor ITS architecture helped to further define the Corridor—geographically, politically, and organizationally, thereby providing a stronger foundation from which to respond to federal requirements, requests for information, and funding opportunities.

Stakeholders: Cast a Wide Net

- *Link Stakeholder Participation to Specific ITS Services:* The state police (and others) may be more likely to get involved if you have a metropolitan-based traffic incident management system, in part because the relevance to their operational mission may be more apparent.
- *Look to Include the Media:* Getting the media involved in the architecture development process may yield benefits. There may be opportunities to complement regional ITS efforts with radio and television stations' traffic systems, services, and monitoring capabilities.
- *Note that Agency Participation Reflects its Representative's Interest:* While securing the support of organizations is important to set and implement the future corridor agenda, an organization's participation in the development process is largely determined by its individual representative's interest in ITS.

Lessons Learned

Agency and Public Education

- *Conduct "Inreach" as well as Outreach:* As the regional ITS architecture is developed, start educating a broader pool of staff and managers within the agency ("inreach") who need to understand what the effort seeks to accomplish. For example, state government procurement or capital budget personnel who do not understand basic ITS concepts and benefits may significantly hamper development and implementation schedules.
- *Understand that Terminology is Still Unfamiliar:* "Architecture" (and related terminology) is a term that can sometimes inhibit its very goal of broad agency participation from those who are not system architects.
- *Build Support Through Awareness:* Do not underestimate the importance of public relations and communications as tools to build public awareness and support. Highlight accomplishments if the value of the project is not clearly perceived by public and private interests.

Intergovernmental Cooperation

- *Focus on Region-wide Coalition Building:* The strong tri-state coalition has been crucial for ensuring regional participation in the corridor ITS architecture development process. The process can change attitudes among different levels of operations—as well as throughout the coalition, resulting in a "spirit of cooperation."
- *Capitalize on Partnership Opportunities:* The process builds vertical partnerships between public sector partners at various levels (i.e., federal, state, regional, and local), while incorporating horizontal partnerships among parties with similar program responsibilities, but different geographic turf.
- *Take Advantage of Organization Benefits:* The organization that emerges through the development process serves as an important clearinghouse for the partners, interested parties, and the general public. Just as important as the regional ITS architecture is the interagency coordination and cooperation fostered by the architecture development process.
- *Identify and Promote New Professional Capabilities:* The process in general highlights the needs of the transportation professional for the future, which includes a mix of computer, analytical, technical, communication, public policy, and human resource skills beyond traditional engineering backgrounds.

"The greatest value of the GCM Corridor lies in the fact that we now have a mechanism for pursuing regional projects. These projects ... need to function as though there were no state or local boundaries—the Gateway Program is a classic example. Without the GCM Corridor, funding and managing these projects is extremely difficult, if not impossible."
— Dan Shamo,
ITS Program Manager,
INDOT

Available Resources

- *Bridge the Resource Gap with Interagency Coordination:* The ITS architecture development process is an effective way of identifying needs, but it does not ensure coordination—in large part because most agency resources for such activities are scarce.
- *Recognize the Value Consultants Can Offer:* Capable consultants can be crucial when working through detailed architecture design and development stages of the process. While integration consultants represent an additional cost, their support may yield valuable dividends in time-savings and other efficiencies.

Institutional Considerations

- *Consider Liability Issues:* Liability continues to be an obstacle for corridor-wide integration and interagency sharing of resources. While some public agencies have liability waivers and exemptions, others do not. (Some stakeholders suggested that this is a role the federal government could play, to provide corridor-wide liability protection.)
- *Weigh Staffing Options:* When expanding agency operations in ITS, consider the potential impacts on internal hiring, training, and promotion practices, as well as use of consultants versus permanent staff.
- *Build a Long-Term Vision:* Continue to build a long-term vision so that immediate results turn into long term benefits.
- *Focus on Deployment:* Strategic planning is essential, but deploying ITS—to address specific local or regional needs—is the ultimate goal.

Additional Thoughts

These "lessons learned" convey the beneficial clarity of hindsight in a number of areas. From this case study another conclusion may be obvious, but still worth noting explicitly. It is very difficult to develop a regional or corridor ITS architecture without first going through the process of developing a program plan or an Early Deployment Plan.

In the case of GCM, these processes are where the priorities were identified and agreed to, and where public involvement is most likely. Because the SEDP followed the GCM Corridor architecture design, it will serve to confirm and affirm the priorities set by the corridor program plan, as well as the framework established by the Gateway architecture design effort.

Without such publicly-endorsed priority setting, it would be difficult to get wide public agency buy-in and participation in the development and deployment of a regional or corridor ITS architecture.

References and Additional Resources

Web Sites

Gary-Chicago-MilwakeeTravelinfo:
www.gcm.travelinfo.org

Illinois Department of Transportation:
www.dot.state.il.us

Wisconsin Department of Transportation:
www.dot.state.wi.us

Indiana Department of Transportation:
www.state.in.us/dot

U.S. Department of Transportation: Joint Program Office
www.its.dot.gov

Intelligent Transportation Society of America:
www.itsa.org

Association of Metropolitan Planning Organizations:
www.ampo.org

Institute of Transportation Engineers:
www.ite.org

American Public Transit Association:
www.apta.org

Select Bibliography

GCM ITS Priority Corridor Program Plan, BRW, Inc., Battelle, Alfred Benesch and Associates, Hughes Aircraft, June 1995.

GCM ITS Priority Corridor, Gateway Traveler Information System, System Architecture Design Document, De Leuw, Cather & Company, UIC-EECS, Transcore, January 1999.

ITS Fact Sheets, Illinois Department of Transportation, Office of Planning and Programming, Jeff Hochmuth, ITS Program Manager, December 1998.

GCM ITS Priority Corridor Program Communications Plan, BRW, Inc., JMS Communications & Research, January 1999.

Policy Review of ITS Priority Corridors, Thomas Horan, Ph.D., et al, Federal Highway Administration, 1996.

References and Additional Resources

Individuals Interviewed

The authors wish to thank the following individuals who were interviewed and/or provided other support in the preparation of this case study report:

Illinois Department of Transportation:
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John Corbin, Freeway Operations Engineer, MONITOR Traffic Operations Center
Curtis Pulford, Application Support Specialist, Bureau of Automation Services

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Dan Shamo, ITS Program Manager
Troy Boyd, Hoosier Helper Patrol Program

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Ken Glassman, Coordinator of Engineering Services, Illinois State Toll Highway Authority

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Jim Ranfranz, Executive Director, Northwestern Indiana Regional Planning Commission
Dan Gardner, Deputy Director, Northwestern Indiana Regional Planning Commission
Steve Strains, Director of Transportation Development, Northwestern Indiana Regional Planning Commission
Bill Brown, Transportation Planner, Northwestern Indiana Regional Planning Commission
Ken Yunker, Southeastern Wisconsin Regional Planning Council

Private Sector, Consulting:

Joe Ligas, Transportation Consulting Services

Syd Bowcott, Chief Engineer, ITS, DeLeuw, Cather and Company

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Jeff Benson, Vice President, BRW Inc.

Daryl Taavola, Senior Transportation Engineer, ITS & Traffic Engineering, BRW Inc.

Federal Highway Administration:

Pete Olson, Urban Mobility Engineer, Illinois Division Office

Bill Brownell, Infrastructure and Operations, Midwestern Resource Center

Ed Stillings, Midwestern Resource Center

JD Stokes, Chicago Metropolitan Office

Mac Lister, ITS Specialist, Midwestern Resource Center

Federal Transit Administration:

Doug Gerleman, ITS Specialist, Region 5

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

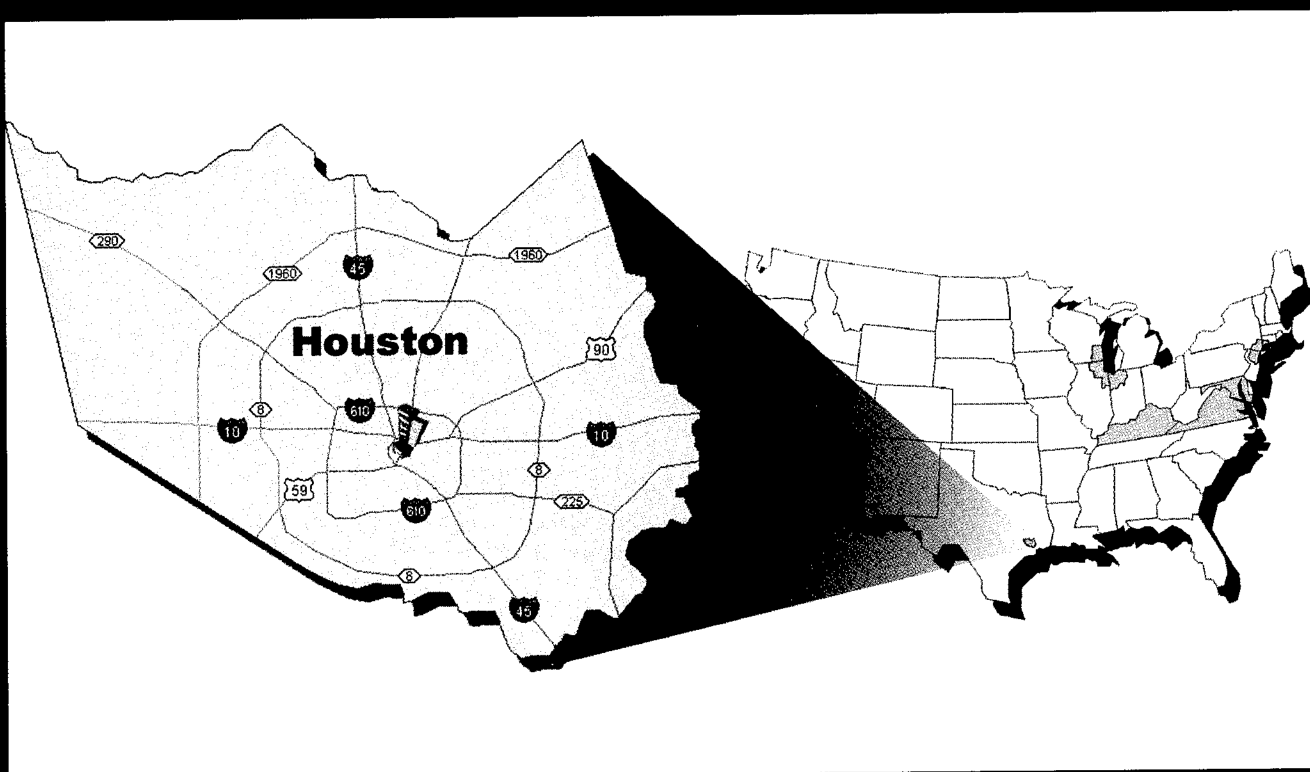
Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

Notes

Regional ITS Architecture Development

A Case Study

Houston ITS Priority Corridor



Building a Framework for Regional ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;

- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;

- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and

- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/ statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. The seventh study is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support from the Volpe Center.

This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Case Study Overview

In 1998, Houston transportation stakeholders from the state, county, city, and the transit agency worked together to map Intelligent Transportation Systems (ITS) projects to the National ITS Architecture. Houston was unique among the case studies in using agency staff, rather than consultants, to develop their architectures. This case study describes:

- Laying the groundwork for the development of project architectures during an initial two day meeting;
- Developing architecture mappings for specific projects during a two month-long process;
- The incorporation of architecture mapping into the transit agency's project development process; and
- Questions facing the area in its attempt to take the next step, the development of a regional ITS architecture.

The details of the Houston experience, including samples of architecture mappings and lessons learned are included in this case study, and will be of particular interest for those areas planning to use agency staff to develop ITS architectures.

Background

"Developing an architecture takes time, takes commitment, and the stakeholders must reach agreement on common goals and a common agenda, then stay focused on the goals. The process drew us together. It helped us see ourselves as a team."
— **Rita Brohman, ITS/ Priority Corridor Program Manager, Houston TranStar**

This case study, one of six, describes the specifics of the application of the National ITS Architecture to Houston ITS Priority Corridor projects. Since a regional architecture does not yet exist in the Houston area, Houston Priority Corridor Program projects were mapped directly to the National ITS Architecture. The mapping of projects continued the efforts to promote an integrated approach to ITS in the Houston area.

The information contained in this case study was developed through a review of the Houston ITS Priority Corridor and related literature, as well as a series of interviews with individuals from the key stakeholder agencies involved with ITS projects in the Houston area. The list of those interviewed is included at the end of this report. The findings of this study and the other five case studies will be useful to those public and private sector entities applying the National ITS Architecture to projects in their own regional or statewide programs.

History of Integration in the Houston Area

The first ITS project in the Houston area began in 1963. It was a freeway management project that included ramp metering and automated surveillance. In 1978 Harris County voters created the Harris County Metropolitan Transit Authority (METRO) and approved a local one-cent sales tax to support the construction and operations of a regional transit system. Beginning in the early 1980s, METRO and the Texas Department of Transportation (TxDOT) worked together on High Occupancy Vehicle (HOV) reversible lane projects on five major freeways in the city. METRO's contracting capabilities and the use of state right-of-way brought the two agencies together. Uncharacteristic of a transit agency, METRO is heavily involved in traffic management and capital projects, including HOV lane and road improvement projects. It has a 200-person police force that patrols the transit system, HOV lanes, and freeways.

ITS along the freeway network was managed and operated in the mid-1980s and 1990s by TxDOT. Three satellite Transportation Management Centers (TMC) were connected in the early 1990s. During the 1980s and 1990s, TxDOT and METRO also worked together to implement surveillance and Dynamic Message Signs (DMS) on the freeway and HOV facilities. In the early 1990s, TxDOT, METRO, the City of Houston, and Harris County began plans to build and construct Houston TranStar in order to provide a regional transportation management center for the Houston and Harris County metropolitan area.

Background

Houston ITS Priority Corridor and ITS in the Region

In 1993, U.S. DOT designated the Houston area as one of the four ITS Priority Corridors with dedicated funding authorized by the Intermodal Surface Transportation Efficiency Act. Through fiscal year 1997 (FY97), Houston Priority Corridor Program funding (including state and local agency matching contributions) totaled nearly $22 million.

Demonstration projects under this program provided a significant impetus for ITS in this region. Of the 26 projects initiated through this program, 14 are ongoing and 12 are planned for implementation within the next two years. TxDOT is the lead agency for about half of the projects; METRO has the second largest share. The Houston ITS Priority Corridor program is managed by TxDOT staff at TranStar through the Priority Corridor Technical Committee, and overseen by the TranStar Executive Committee.

TranStar Partners

TxDOT, METRO, Harris County, and the City of Houston formed a partnership in 1993 to guide transportation management and ITS activities in the Houston area. These four agencies, with staff located at the TranStar facility, are responsible for the collection, processing, and dissemination of traffic, transit, and traveler information in the Houston region. The service area encompasses 5,436 square miles and a population of approximately four million people.

TranStar is located in a 52,000 square-foot TMC specially constructed to accommodate the many high-technology components and integrated multi-agency personnel. The Director for Houston TranStar reports to the TranStar Leadership Team, and the TranStar Executive Committee is composed of a representative from each of the four member agencies. Each agency contributes to the annual operating budget of TranStar on a prorated basis relative to its occupancy and utilization of building components. Since the TranStar facility is staffed by the four agencies, each agency's staff is able to work more closely with other agencies in a "team" environment while still reporting to their home agency.

In addition to the four partner agencies in TranStar, the Texas Transportation Institute (TTI) of Texas A&M University has a long history of involvement in ITS in the Houston area. TTI is currently under contract to TxDOT to update the Priority Corridor Program plan. In the past, TTI has supported METRO, City of Houston, and other transportation agencies in the area, as well as the Houston-Galveston Area Council (H-GAC), which is the metropolitan planning organization for the Houston area and surrounding 13 counties.

In 1993, U.S. DOT designated the Houston area one of the four ITS Priority Corridors with dedicated funding authorized in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Demonstration projects under this program provided a significant impetus for ITS in this region.

Inventory of Components Managed by TranStar include:

- 160-mile Freeway Management System, out of projected 300 miles
- Freeway and Arterial Street Incident Management
- Flow Signals at 115 ramps
- 167 cameras with Closed Circuit Television Surveillance (CCTV)
- Dynamic Message Signs
- 63-mile HOV lane system, (out of the projected 105 miles)
- Regional Traffic Signal System 1,380 signals
- Mass Transit Bus Fleet 1,363 buses
- Emergency Management Operations for evacuations and disasters

ITS Architecture Development

Discussions of the development of regional architectures, especially those contained in high-level overviews, often lack the specifics and details of the development process that are useful to managers faced with developing ITS architectures in their regions. This case study attempts to fill that gap by providing a more detailed look at the process, focusing on the roles of individuals and agencies and the events that took place. It looks more closely than the other case studies at the individual-to-individual exchanges that are part of the process. The timing of the case studies was fortuitous for this approach. Most of those interviewed in Houston had used the National ITS Architecture recently, so many details were fresh in their minds.

Getting Started

In March 1998, U.S. DOT held one of ten National ITS Architecture outreach meetings in the Houston area. The impact of the National ITS Architecture, along with the expected Interim Guidance and eventual rulemaking, became a topic of discussion in the Houston ITS Priority Corridor Program meetings with Federal Highway Administration (FHWA) staff. In particular, Mark Olson, the ITS Specialist from the FHWA Texas Division, identified the potential benefits of applying the National ITS Architecture to the Priority Corridor Program projects. To gain experience with the National ITS Architecture, develop an understanding of its ability to support the integration of ITS projects, and ensure that Houston Priority Corridor Program projects would meet all requirements for continued Federal funding, the TranStar members participating in the Priority Corridor Program agreed on the goal of having an architecture in place for each project expecting to receive FY97 Priority Corridor funds. Architecture mappings would be attached to the Work Orders included in the Priority Corridor Program Quarterly Reports to FHWA. The Priority Corridor Program projects would also serve as pilot projects in Houston to facilitate mapping of future projects to the National ITS Architecture.

As a first step in creating an architecture for each project, potential stakeholders were identified for the 12 Priority Corridor Program projects expecting FY97 funds. Included in the list of stakeholders were:

- FHWA (Region and Division)
- TxDOT (Houston District Information Systems and Traffic Operations Division in Austin)
- METRO (Department of Traffic Management)
- Harris County (Engineering Department and Office of Emergency Management)
- City of Houston (Engineering Department and Office of Emergency Management)

- The metropolitan planning organization
- TTI
- Lockheed-Martin, the TranStar system integrator
- Federal Transit Administration (FTA) Region 6 Office

The level of expertise with the National ITS Architecture among these stakeholders was limited. Some staff had been introduced to it through U.S. DOT sponsored classes or through the outreach meeting in March. However, no one had significant experience applying the National ITS Architecture to local ITS projects.

The Initial Stakeholder Meeting

In May 1998, stakeholders met at the TranStar facility and began working with the National ITS Architecture. The goal of the meeting was to map the 12 Priority Corridor Program projects to the National ITS Architecture. In retrospect, this goal was extremely ambitious. Although the stakeholders did not achieve this goal during the two-day meeting, they did create detailed mappings for three existing projects, gain experience with the language and logic of the National ITS Architecture, establish stakeholder involvement, and set the foundation for mapping the projects.

"Some stakeholders may not think they have an interest, but often those who see themselves as the least likely to benefit from developing an architecture are the ones who, in fact, benefit the most."
— Susan Beaty, Senior Project Manager, Houston TranStar, METRO

The meeting format was informal. An FHWA Headquarters representative acted as the facilitator. During the first day, the stakeholders attempted to develop an architecture for the TranStar system, and then use it as a reference for the development of the individual project architectures. In 1996, an attempt had been made to document the TranStar architecture, but was not completed. This attempt was prior to the release of the National ITS Architecture. Even if it had been completed, significant revisions would have been needed to reflect both the current state of the TranStar system and the details of the National ITS Architecture.

The stakeholders began by identifying the National ITS Architecture subsystems and the stakeholder organizations associated with each subsystem. Since the stakeholders had limited experience with the National ITS Architecture, time was needed for them to become familiar with its details. Progress was slow and, after a few hours, the meeting lost momentum. It was at that time that John Olson, Manager of System Integration at METRO, distributed preliminary architecture mappings he had created for one of the Priority Corridor Program projects. He had gained experience using the National ITS Architecture prior to the meetings by creating project mappings. In retrospect, his mappings reflected physical components rather than National ITS Architecture subsystems, but having a sample map for the stakeholders to consider restored momentum.

ITS Architecture Development

The stakeholders refocused on developing a TranStar architecture and continued until the end of the day, when it became clear that TranStar was too large a system to complete a comprehensive architecture within the two-day meeting.

"For a first project, pick one large enough to have data flowing to or from most of the stakeholders. Using this as an example in an early meeting will bring more people into the process."
— Susan Beaty, Senior Project Manager, Houston TranStar, METRO

At the beginning of the second day, the stakeholders changed their focus to developing an architecture for an existing Priority Corridor project, the *Automatic Vehicle Identification (AVI) System—Phase IV Project.* The AVI Project proved to be a good choice for two reasons. First, it was already in the implementation phase, so differing opinions of what the project *should* be did not bog down the discussion. Second, it was a data source for many other projects, so most of those present at the meeting were stakeholders in its operation. By the end of the second day, a preliminary architecture for the AVI project had been completed. This architecture was then used, in the final minutes of the meeting, as a template for mapping architectures for two additional ITS Priority Corridor Program projects. The stakeholders found that once the AVI project had been mapped, it was relatively easy to add the components of the two additional related projects.

The National ITS Architecture CD-ROM and a projector were available at the meeting, but neither was very effective, given the size of the group and the dimensions of the meeting room. Hard copy handouts of the market packages were effective, allowing each member to page back and forth as needed. The stakeholders used the market packages extensively during the meeting. The actual mapping of the architecture for the AVI project was done on white boards and flip charts.

Architecture Development for Priority Corridor Projects

"We did the mapping with in-house staff; it was better to do it that way than to hire a contractor to do it. If we had hired a contractor, the mapping would have been theirs, without enough ownership from the agencies."
— John Gaynor, Manager, Houston TranStar, TxDOT

After the two-day meeting in May, the real work of mapping the remaining ITS Priority Corridor Program projects to the National ITS Architecture began. Stakeholder agencies identified staff to participate in the development of the architecture. Those active in leading the development effort were Rita Brohman (TxDOT), John Olson and Susan Beaty (METRO), and Wayne Gisler (Harris County). Each of the 12 ITS Priority Corridor Program projects to be mapped was managed by one of these agencies. The City of Houston, a participant in some of the 12 projects, supported the idea of developing an architecture, but staff resources limited their ability to participate. The metropolitan planning organization also supported the idea and reviewed the resulting mappings, but did not participate in their development. TTI provided support for the effort. In particular, Gene Goolsby was active in the development effort. Mark Olson from FHWA continued to provide encouragement and direction, responding to questions and acting as an information resource. These individuals, as well as the other participants, brought varied skills to the process including planning, system engineering, and traffic engineering experience. Significantly, they were all familiar with TranStar and the ITS Priority Corridor Program projects.

ITS Architecture Development

During a two-month period in the summer of 1998, the mapping of the projects accelerated, with participants committing 80 to 100 hours to the effort. During this time, a series of working meetings was held. In general, attendance was limited to staff from the stakeholder agencies who were decision makers or who had access to decision makers in their agencies. Rita Brohman coordinated the meetings and documented the activities of the group.

The Interim Guidance on the National ITS Architecture suggested that for areas without a regional architecture, conformance would be accomplished by defining ITS project(s) using the subsystems and information (architecture) flows from the National ITS Architecture. This was the approach used in Houston. Defining project architectures started with a brainstorming session to decide which market packages applied. In the National ITS Architecture, market packages identify one or more equipment packages that must work together to deliver a given transportation service, along with the architecture flows that connect them to other equipment packages and important external systems. Market package terminology became the common way for the group to discuss the projects.

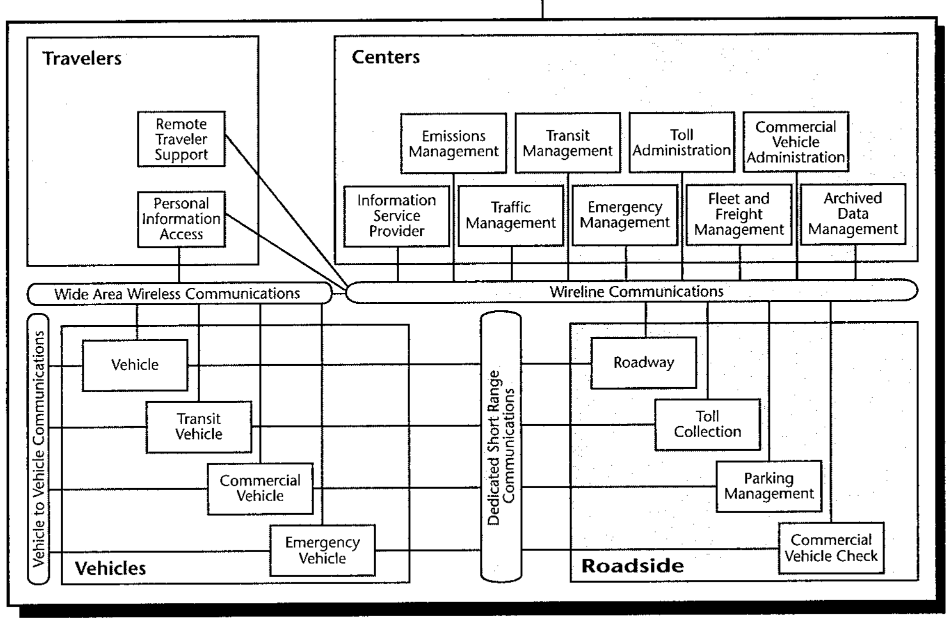
The discussions of the individual projects were led by the project's manager, using the two-or-three page project descriptions from the Work Order. Active participation in the discussion by everyone in the meeting was encouraged. During the discussions, participants learned from each other. Helping to map another manager's project often resulted in a better understanding of a manager's own project. The breadth of comments helped to define the boundaries of the architecture. Prior to these meetings, a Priority Corridor Program project would have only limited involvement from parties beyond the project lead.

"Because each of the participants in developing the project architectures had other responsibilities that couldn't be ignored, it was critical to get all stakeholders to agree to a clear goal and commit to a set time frame for completion. Without these, we might never have seen an end product or understood the value of the architecture."

— Rita Brohman, ITS/Priority Corridor Program Manager, Houston TranStar

Project Architectures

The end product contained four levels of architecture maps for each project. The highest level contained the physical architecture elements. This level was based on the "National ITS Architecture subsystems and communications" diagram from the National ITS Architecture CD-ROM. Usually referred to as the "sausage diagram," it contains the 19 subsystems, four communication systems, and their interconnections.



National ITS Architecture Interconnects

ITS Architecture Development

The participants easily completed this level based on their existing knowledge of the projects and their limited experience with the National ITS Architecture. To accomplish a mapping at this high level in a reasonable time, it was necessary to limit the discussion of details and stay focused on the level at hand.

Defining the stakeholders, the next level, was more difficult. All the appropriate stakeholders had to be included. It is critical to get "buy in" from the system "owners." Exactly what defines a stakeholder is difficult to say. The two defining criteria agreed upon in Houston were participation in funding for the project and responsibility for the implementation or the operations of the project.

The third level of mapping, identifying the equipment packages, required the participants to become more knowledgeable about the details of the National ITS Architecture. Projects were discussed in terms of the market packages and the equipment packages contained in them. Equipment packages from multiple market packages were selected and combined in a single drawing, with references to the parent market packages. Once the third level was complete, the data flows among the equipment package were defined in the fourth level. A sample mapping is presented in Appendix A.

In the Trenches at the Meeting

At the beginning of the process, none of the participants felt like an expert with the National ITS Architecture. The initial discussions of the projects made it clear that they were using slightly different terminologies or focusing on different levels of detail. To solve this problem, they agreed to learn the terms and definitions found in the National ITS Architecture, use them, support its process, and follow its logic. As they moved to greater levels of detail, participants were able to identify divergent views of the projects and negotiate solutions, either changing the way the project was described or revising the project itself.

"Each agency had a representative at the table who understood the Work Order and the concept of operation for the project. We took each project and walked through the architecture. Having everyone in the room helped each representative become familiar with the others' projects. At the end, participants would say: 'Because we had to map, we got a better understanding of our own project and were able then to take it to a greater level of detail.' "
— **Gene Goolsby, Research Engineer, TTI**

The meetings were held away from the TranStar facility. Moving off-site limited distractions and interruptions. It also limited other agency staff not familiar with the National ITS Architecture from casually participating in the meetings. Without an understanding of the National ITS Architecture's language and logic, their participation would have slowed the group's progress.

Having worked together in TranStar helped the group accomplish a significant amount during a limited time. Working relationships can take longer to establish than people anticipate. The group benefited from having worked together for some time. It allowed more productive discussion and reduced the need for formalities.

Having TranStar as a mature facility with equipment installed and many institutional roles and responsibilities defined also helped the group by underpinning the details of the proposed projects. If TranStar had been a less mature facility, many more of the finer points of the proposed projects would still have been open to discussion. Without the established roles, more negotiations on the specifics of the agencies' roles in the individual projects would have been needed. Both could have increased the time required to accomplish the mappings.

Another key to the success of the effort was the group's commitment to the common goal of ensuring that the ITS Priority Corridor projects would conform to the National ITS Architecture and receive funding. In the minds of the participants, this goal carried with it a real deadline, and that forced progress.

The process was not always easy. Disagreements had to be worked through and resolved. Many pitfalls were recognized. Letting the discussions focus on too much detail or on a specific technology could waste time. ITS standards are complex and prone to differing interpretations; people have strong opinions that could create lengthy discussions. Competition for specific roles in the projects could develop. Unwillingness to compromise, "politics," drawing unreasonable jurisdictional or functional boundaries, or letting the culture or bureaucratic procedures limit progress were all concerns. Flexibility in considering the mapping as "final" was needed; the participants had to recognize that these would be living, evolving documents. The key to successfully overcoming these pitfalls was effective communication. It was critical to ensure that everyone contributed during the meetings, that the agendas of all concerned were on the table, and that the group worked for win-win outcomes.

"While Federal funding was an impetus to proceed through the process and meet the deadline, the major reason for our participation was recognizing that the process is beneficial to our projects."
— Wayne Gisler, Traffic Management and Operations Engineer, Houston TranStar, Harris County

The National ITS Architecture CD-ROM and the National ITS Architecture website were used extensively as reference material during the meeting. These, however, could not simply be applied in a cookbook fashion. The specifics of the ITS projects in the Houston area had to be matched to the details of the National ITS Architecture. For example, emergency management operations have a different function in the TranStar facility than described in the National ITS Architecture. In TranStar, 911 issues are not addressed, but are included in the National ITS Architecture. In contrast, determining hurricane evacuation routes and clearing roads after a natural disaster are part of the responsibilities of Harris County and the City of Houston Office of Emergency Management at TranStar, but these are not included in the National ITS Architecture. If the emergency management functions had been restricted to the National ITS Architecture definition, some of the services that the TranStar facility provides would have been missed. Similarly, the use of automated vehicle identification to monitor trains could not be mapped to the National ITS Architecture, because the architecture does not list a train as

"In the past, one agency would take the lead on a project, so there would be a single focus for design and decision making. With ITS projects that isn't possible. Has the National ITS Architecture proved useful? It has helped identify overlap among projects that resulted in suggested changes incorporated into the project plans."
— John Olson, Manager, Systems Integration, Department of Police and Traffic Management, METRO

a vehicle. In situations such as these, the participants decided to focus on what existed in Houston, modifying what was found in the National ITS Architecture to accurately describe the project. The additions and changes were then noted on their mappings.

Staff time was needed to develop a computer-based design tool to document the mappings. Microsoft® PowerPoint® was selected for two reasons. First, it is a widely used tool with which the project managers and their staff were familiar. They could use it without having a detailed understanding of drafting standards. Second, PowerPoint provided the ability to easily convert the individual maps into presentation slides. A set of standard formats and templates was developed, then used for each project to ensure consistency among the products. The design included use of color for presentations, and black and white for inclusion in reports. These mappings have become part of the Priority Corridor Quarterly Reports to FHWA and are maintained as part of the Priority Corridor Program Manager's duties.

"Working with the National ITS Architecture requires practice. Experience in systems engineering is not enough; that must be supplemented with exposure to the National ITS Architecture."
— Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management, METRO

Applying the National ITS Architecture at METRO

In addition to participating in the development of architectures for the Priority Corridor Program projects, METRO staff has also been developing architecture mappings for METRO's ITS projects. Loyd Smith, Director of Planning and Development in the Department of Police and Traffic Management, is responsible for the integration function across ITS projects at METRO. Within METRO there are about two dozen engineers working on ITS related projects. This is roughly twice the number of engineers at the TranStar facility. Early in the summer of 1998, Loyd Smith established a two-person team to oversee project integration, led by John Olson. Earlier, in the spring of 1998, METRO had instituted new policies and procedures focusing on the use of the systems approach and a Quality Assurance/Quality Control initiative. Applying the National ITS Architecture was a natural addition to these initiatives. Not surprisingly, the process used to map ITS projects within METRO is similar to the one used to map Priority Corridor Program projects at TranStar. Each project is defined by a work order that includes a project description, schedule, budget, system diagram, and mapping to the National ITS Architecture.

"We underestimated the persistence needed to get project managers to embrace the architecture and understand it. Most are initially skeptical and see it as a paper exercise that doesn't help their project. These managers are now beginning to realize that they have a better project after going through the process."
— Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management, METRO

The system diagram presents a more physical representation of the project, while the architecture mapping focuses on the information flows. At METRO, it is taking time for the project managers to become accustomed to this change in perspective and the introduction of new architecture terms and titles. Initially, some project managers did not see the value of the architecture mappings. They prefer to view the projects in terms of functionality that can be bought off-the-shelf, basing their designs on what is available in the marketplace. Another reason managers were reluctant to use the National ITS Architecture, and the systems engineering approach in general, is that mapping and system engineering is time-intensive and must be done at the beginning of the project. Many managers do not want to make that time commitment so early in the project. Finally, project managers are reluctant to get other stakeholders involved in their projects, believing that with fewer participants, they had a better chance of getting the project finished on time.

METRO staff found that introducing architecture mappings with the information flows made it possible to discover relations that might not otherwise have been seen until later in the project development cycle, ultimately adding to time and cost. Project managers at METRO are now beginning to accept the architecture mappings and see them as more than just a paper exercise.

In mapping METRO projects, John Olson uses the "sausage diagram" to identify the subsystems; he then identifies stakeholders. He has downloaded copies of the market packages from the CD-ROM and uses them to identify the relevant equipment packages and architecture flows. These are documented in a composite drawing using a Computer Aided Design (CAD) tool that overlays the parts of the multiple market packages that apply to the project. The applicable elements from the market packages are included in the mapping; the others have been dropped.

All METRO ITS projects are currently being mapped to the National ITS Architecture, with about 50 percent of the work completed. The goal is to have all ITS projects completely mapped in 1999. The mappings are created and kept by John Olson, rather than the individual project managers.

Architecture Applications and Evolution

"It may not take years for a regional architecture to be developed or to incorporate it into the planning process, but it will take time."
— Rita Brohman, ITS/ Priority Corridor Program Manager, Houston TranStar

Regional ITS Architecture

For the region, the TranStar partners have mapped Priority Corridor projects valued at about $22 million. METRO is halfway through mapping $150 million worth of projects. Simply adding them to see what percentage of ITS projects in the region is mapped does not accurately measure the progress toward developing a true regional architecture. The mappings of individual projects do not provide the basis for a visionary use of the National ITS Architecture in the region.

The next step in the Houston area for the development of a regional architecture is addressing a number of questions on the specifics of creating such an architecture. These questions are presented below, along with a short discussion of the issues and options. Many of these, or similar questions, would have to be answered by any region embarking on an effort to develop a regional ITS architecture.

Who would lead the effort? With TranStar composed of four partner agencies, the source of leadership, staffing, and funding sources would have to be agreed upon, as well as the authority of the lead agency. It is one thing to work closely with another agency, but another to let that agency define a common vision. In addition to the TranStar partners, the metropolitan planning organization could also be considered to lead the development. Beyond the region, TxDOT has plans to map ITS projects at the statewide level, but the details are not settled.

What would be the boundaries for the regional ITS architecture? The TxDOT district covers six counties. The metropolitan planning organization covers a greater number of counties, some of which are in different TxDOT districts. The agencies that comprise TranStar cover different areas and the overall area served by TranStar may change with the expected addition of satellite TMCs, for example for I-45 south to Galveston. The issue of geographic boundaries must be pinned down before a regional architecture can be defined.

When will the products of related efforts be available to support the development of a regional ITS architecture? Related efforts include a five year ITS strategic plan by the TranStar partners, updates to the regional ITS plan by the metropolitan planning organization, a short-term strategic plan laying out the TranStar goals and objectives, the definition of user needs for data base warehousing and storage by the TranStar partners, the Priority Corridor Program project and TranStar architectures, architectures for METRO FTA ITS projects (not all of which are at TranStar), and a benefits analysis that TTI is performing for TxDOT. All of these would provide information needed for the development of a regional ITS architecture.

Who would hold and maintain the regional ITS architecture? Individual agencies currently maintain their own Priority Corridor Program project architectures. The Priority Corridor Program manager also maintains copies. METRO maintains the architectures for its projects outside of the Priority Corridor Program projects. Would a regional architecture be held and maintained centrally? Funding sources for maintaining the regional architecture would have to be identified.

How would the regional ITS architecture be related to the Transportation Improvement Program (TIP) and Statewide Transportation Improvement Program (STIP)? Would it be referenced or incorporated into it? In August 1998, all Priority Corridor Program projects were put into the TIP and by fall they were put into the STIP. However, since these projects were already approved, they did not go through the standard planning process. What would be the procedure in the future? Would projects be subject to certification reviews? Would completed projects be grandfathered or would architectures be needed for them? Answers to these questions could impact the decision-making process on all ITS projects.

"A regional ITS architecture cannot easily be developed within existing staffing and resource levels. Defining the vision and performing trade-off analysis will take a lot of work. A decision on who would do it and who would fund it is needed."

— Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management, METRO

Lessons Learned

Early Steps

- The decision to use the National ITS Architecture must be supported by management, particularly by providing sufficient resources to complete the task. Without a firm deadline and funding at stake, competing needs may have limited the staff and resources made available to develop the project architectures. In Houston's case, the participants in the meetings were motivated to successfully create the architecture mappings.

Agency and Public Education

- ITS projects are different than traditional transportation projects—they cannot be developed in isolation. ITS projects must be integrated. Using the National ITS Architecture encourages consensus-building. It drew the Houston stakeholders together as a team, creating a better understanding of the need for individual project managers to coordinate and work together, as well as the need for overall program management.

- Participants in the development of the project architectures learn by doing. Although the Houston stakeholders had some familiarity with the National ITS Architecture, the individuals reached a comfort level with the National ITS Architecture only after having used it. Only then did participants develop a respect for the process and an understanding of its value.

Stakeholders

- Gathering initial representation from any and all stakeholders in the present system, as well as the future system, is absolutely necessary. In Houston, this furthered the development process in two ways. First, it ensured accuracy and a common understanding of the projects. Even though staffs from the four agencies are co-located at TranStar, there are communication challenges and variations in plans across agencies. Second, it promoted ownership of the resulting architecture, a necessity if the architecture is to influence the system design.

- Identify those stakeholders that should be included in the detailed development work. When in doubt, invite a potential stakeholder to the initial meeting to determine his or her interest and commitment. Later, the number of direct participants must be limited to a working group size in order to allow focused, substantive discussions to occur. These participants must be decision-makers or have access to decision-makers.

- Drawing tools will be needed to document the architectures. Developing drawing tools takes time, but having a common format for all project managers pays off. Either a presentation or a CAD tool could be used; whatever users feel comfortable with.

"Communication and trust, not technology, is the key. The negotiations must lead to a win-win, or at least a win-neutral result among the agencies. The agreement is only worth what both sides are willing to live with. Will there be long term support for the decisions, through different administrations? We will have to wait and see."

— John Gaynor, Manager, Houston TranStar, TxDOT

Intergovernmental Cooperation

- Before a regional architecture can be developed, the roles of the different agencies and the architecture boundaries have to be defined. Funding, staffing, and oversight issues need to be discussed and negotiated among the agencies involved.

Available Resources

- Applying the National ITS Architecture requires a dedicated core of individuals representing the stakeholder agencies. In Houston, using the National ITS Architecture was intimidating at first. It required adapting to a new language and a new way of looking at the projects. However, the success could not otherwise have been accomplished, given the changing cast of characters.

- Leadership at the working level is needed. For both the ITS Priority Corridor Program projects and the METRO projects, the leaders in the effort to develop the architectures were
    - Credible and capable
    - Able to devote a significant amount of time to the effort
    - Experienced with the agencies involved
    - Sufficiently experienced with the technical aspects to avoid unrealistic solutions
    - Willing to become knowledgeable about the National ITS Architecture and systems engineering

- Consultants can be useful, but agency staff must be directly involved in developing project architectures. In Houston, consultants were not used to develop the project architectures, and the participants agreed that having stakeholder staff develop the architectures was the correct approach to begin with. A consultant cannot determine who the stakeholders are or resolve the issues surrounding inter-agency roles and responsibilities.

- Consultants are expected to play a significant role in the development of a regional architecture. It was suggested by some Houston participants that a consultant would be very useful after the identification of stakeholders, agency responsibilities, and interfaces by agency staff. Once these are defined, a consultant would be valuable in documenting and developing the details. At the end of the process, though, the agency staff must again get involved to implement the multi-agency coordination identified in the detailed documentation.

"People are more cognizant now that their individual projects need to coordinate and work together. Projects can't be isolated. The National ITS Architecture helps raise awareness of the need to integrate."
— Gilmer Gaston, Agency Manager, Houston TranStar, City of Houston

Lessons Learned

"My suggestion to other areas is just do it. Architecture is a daunting concept. You have to sit down with the CD-ROM and use it in order to learn what it is and what it can do for you."
— **Mark Olson, ITS Specialist, Texas Division, FHWA**

Institutional Considerations

- Expect initial reluctance on the part of transportation engineers and project managers to embrace the National ITS Architecture. In Houston, some project managers were skeptical of the National ITS Architecture process, often viewing it as only a paper exercise. Transportation and civil engineers were comfortable discussing projects in terms of the physical equipment. Applying the National ITS Architecture was a different approach with a new language.

- Applying the National ITS Architecture makes project managers think through the projects earlier than they otherwise might. The architecture forced Houston's project managers to look at information flows, include more detail in the project descriptions, and tie down the details, limiting the possibility of unilateral, arbitrary changes in the future.

- The National ITS Architecture is not sufficient to ensure that a system will be non-proprietary. Standards are also needed. In the ITS projects in Houston, National Transportation Communications for ITS Protocol (NTCIP) and Transit Communications Interface Protocol (TCIP) are the standards of most concern. Architecture mappings did not reach this level of detail.

References and Additional Resources

Select Bibliography

"Regional Intelligent Transportation System (RITS) Strategic Plan For the Houston Galveston Transportation Management Area," Texas Transportation Institute, 1997.

"Houston ITS Priority Corridor Program Plan," Texas Transportation Institute (Research report 2931-2), 1995.

"National ITS Architecture Consistency Outreach Meetings: Summary of Findings," U.S. DOT, July 1998.

"Traffic Management Technology Projects, Project Development Manual," The Harris County Metropolitan Transit Authority, August, 1998.

The Houston TranStar Website; *http://traffic.tamu.edu/.*

"Incorporating ITS into Transportation Planning: Phase 1 Final Report," Mitretek Systems, 1997.

References and Additional Resources

Individuals Interviewed

The authors wish to thank the following individuals, who were interviewed and/or provided other support in the preparation of this case study:

TxDOT:
Rita Brohman, ITS/Priority Corridor Program Manager, Houston TranStar
Doug Lowe, Traffic Operations Division, Austin
John Gaynor, Manager, Houston TranStar

METRO:
Susan Beaty, Sr. Project Manger, Houston TranStar
John Olson, Manager, Systems Integration, Department of Police and Traffic Management
Loyd Smith, Director, Planning and Development, Department of Police and Traffic Management

City of Houston:
Gilmer Gaston, Agency Manager, Houston TranStar

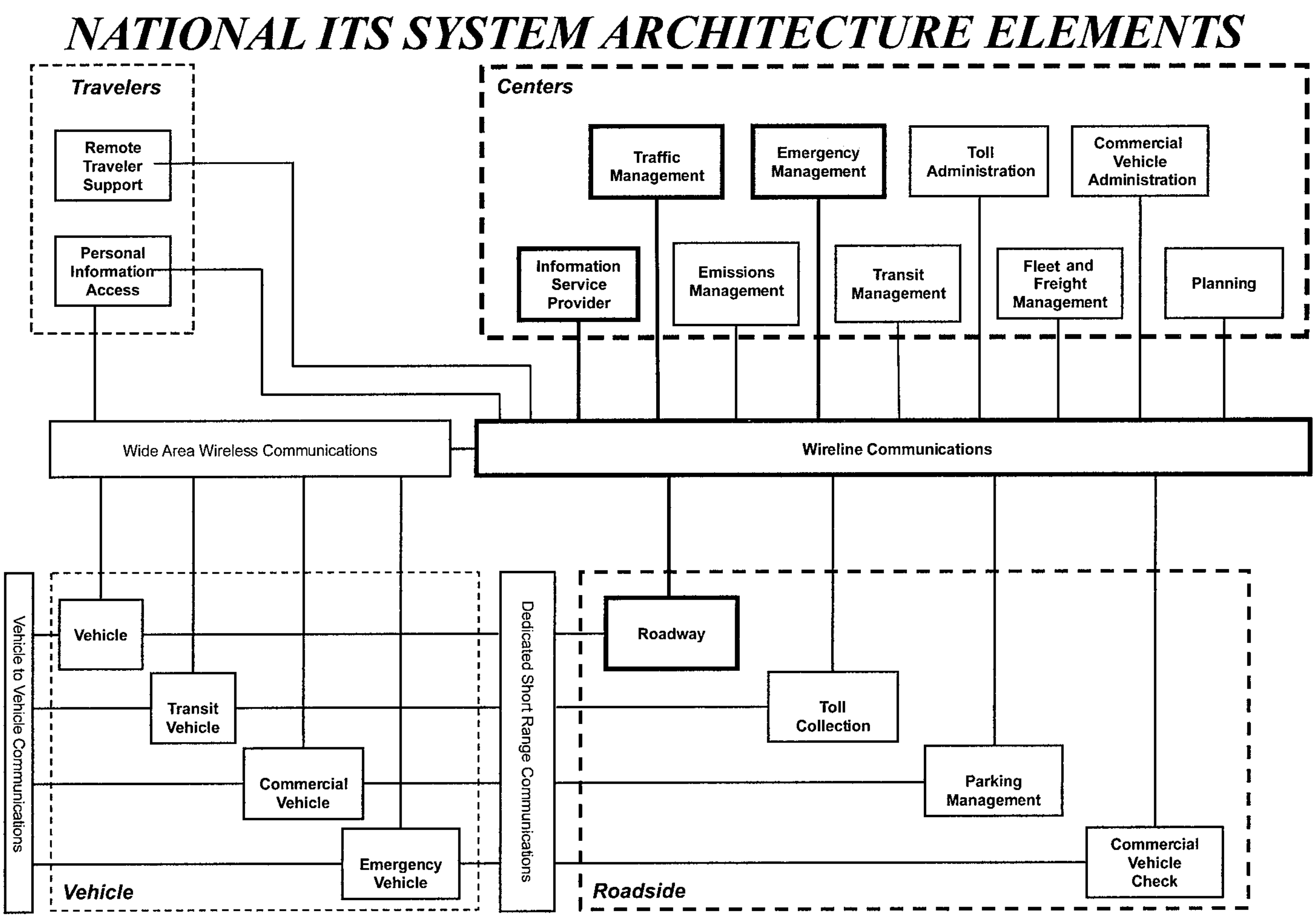
Harris County:
Wayne Gisler, Traffic Management & Operations Engineer, Houston TranStar

Houston-Galveston Area Council:
Jerry Bobo, Program Manager
Tung-Lung Cheng, Transportation Engineer

Texas Transportation Institute (TTI):
Merrell "Gene" Goolsby, Research Engineer

FHWA:
Mark Olson, ITS Specialist, Texas Division

Appendix A—Project Architecture Mappings

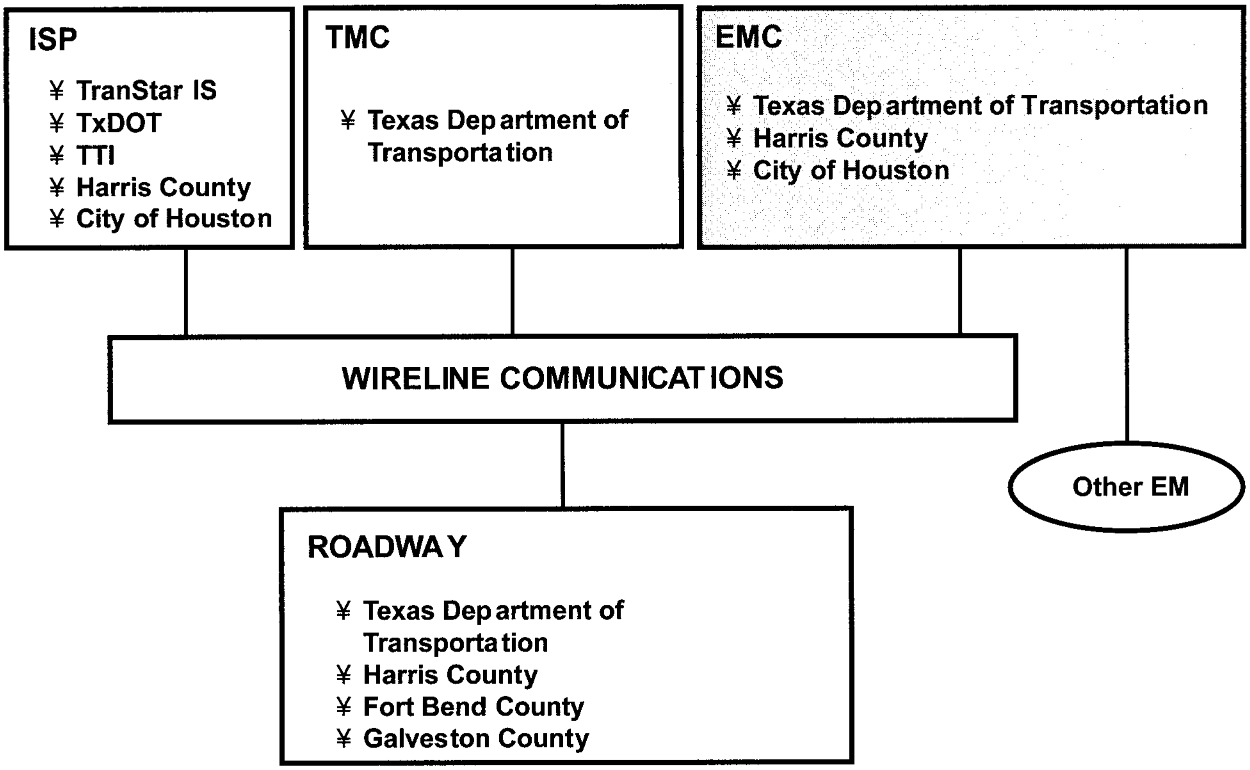


Priority Corridor W.O. #15: Traffic Management & Traveler Information

Lead Agency: Texas Department of Transportation

Appendix A—Project Architecture Mappings

STAKEHOLDERS

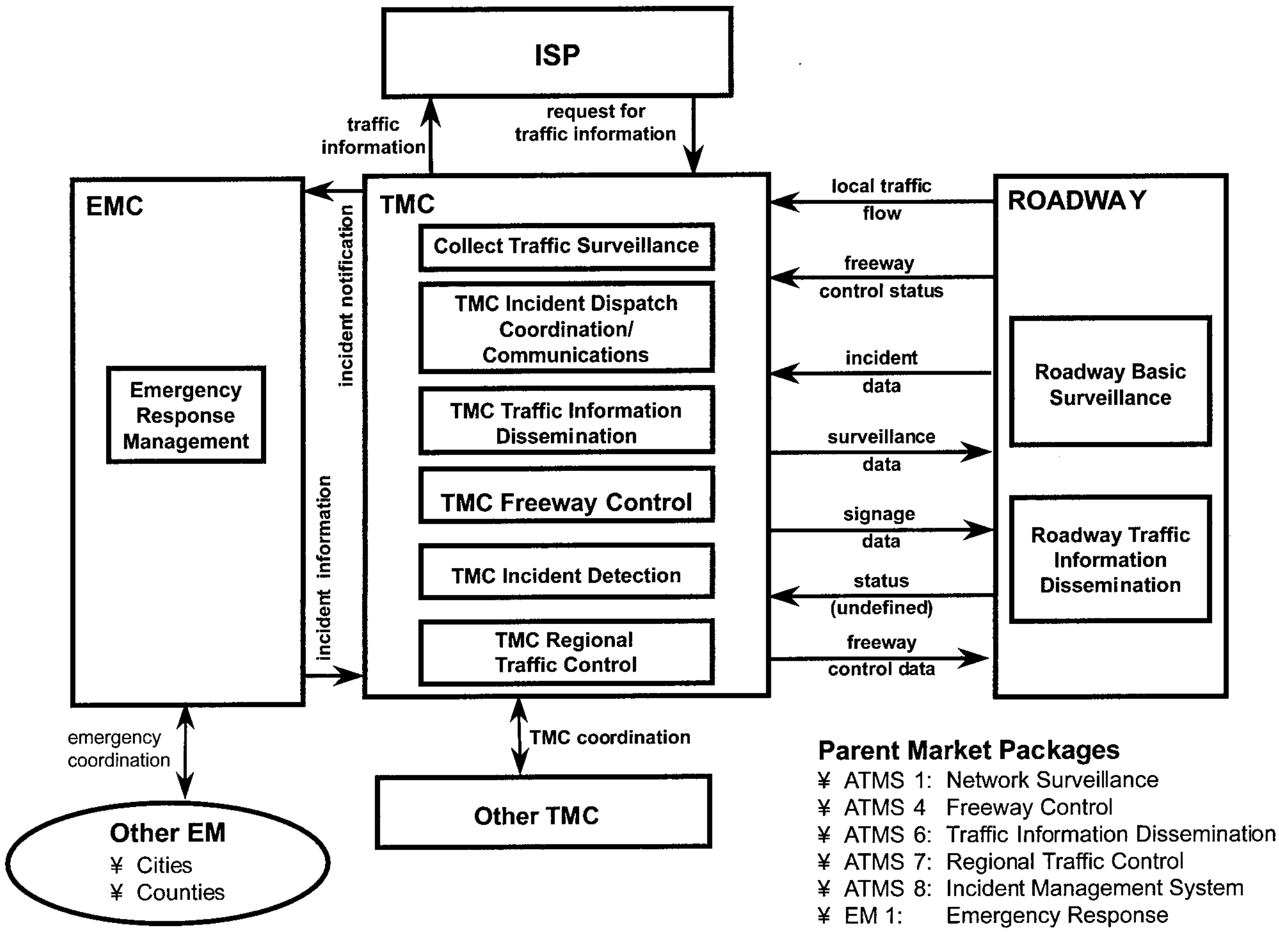


Priority Corridor W.O. #15: Traffic Management & Traveler Information

Lead Agency: Texas Department of Transportation

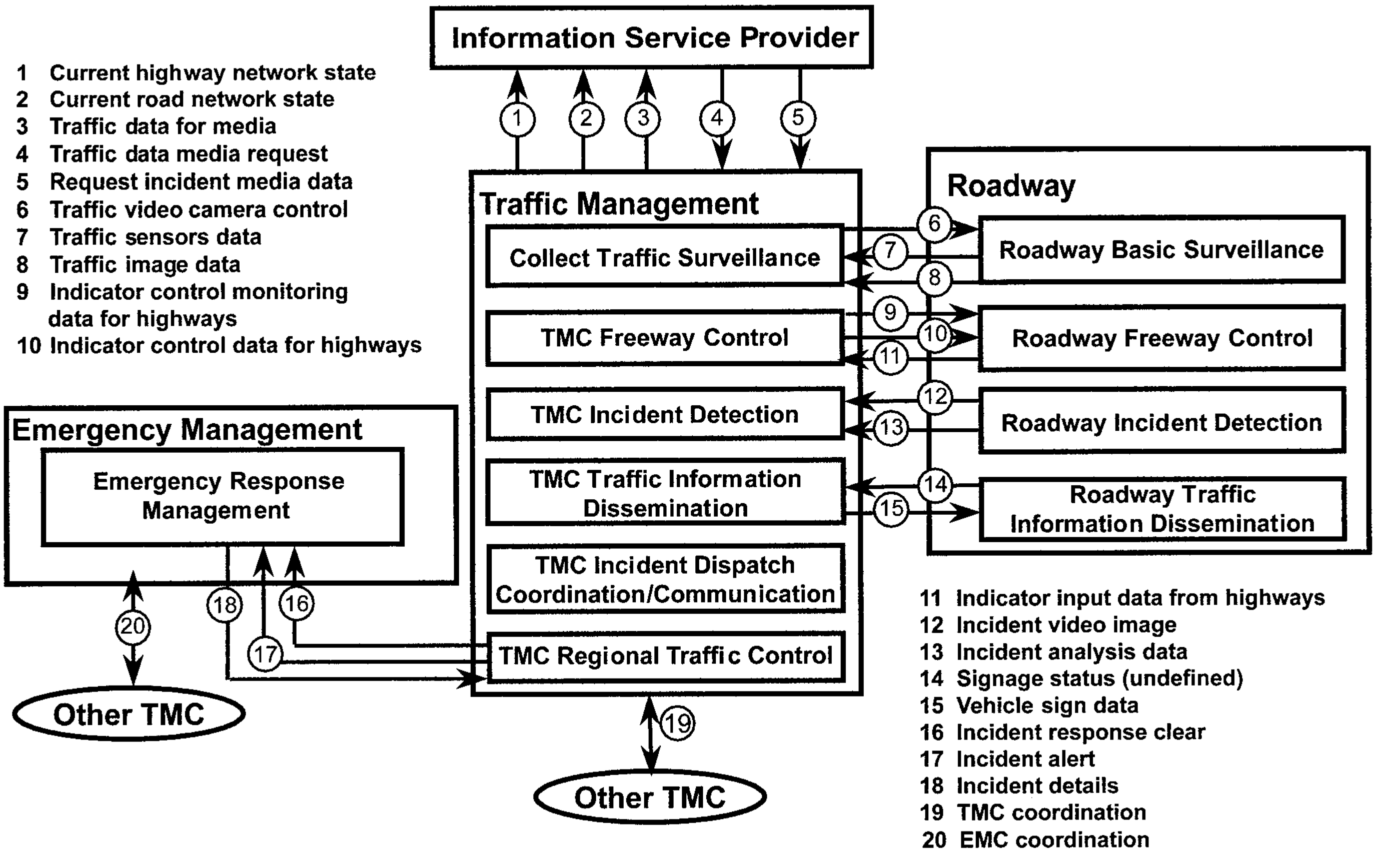
Appendix A—Project Architecture Mappings

IDENTIFICATION OF EQUIPMENT PACKAGES



Appendix A—Project Architecture Mappings

IDENTIFICATION OF DATA FLOWS



Priority Corridor W.O. #15: Traffic Management & Traveler Information

Lead Agency: Texas Department of Transportation

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

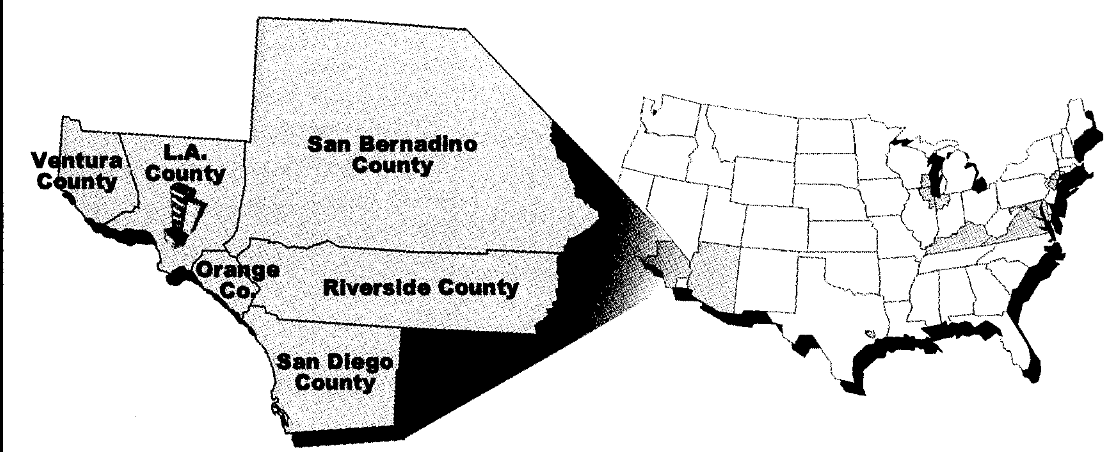
Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

Notes

Regional ITS Architecture Development

A Case Study

Southern California ITS Priority Corridor



Building a Framework for Regional ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. The seventh study is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

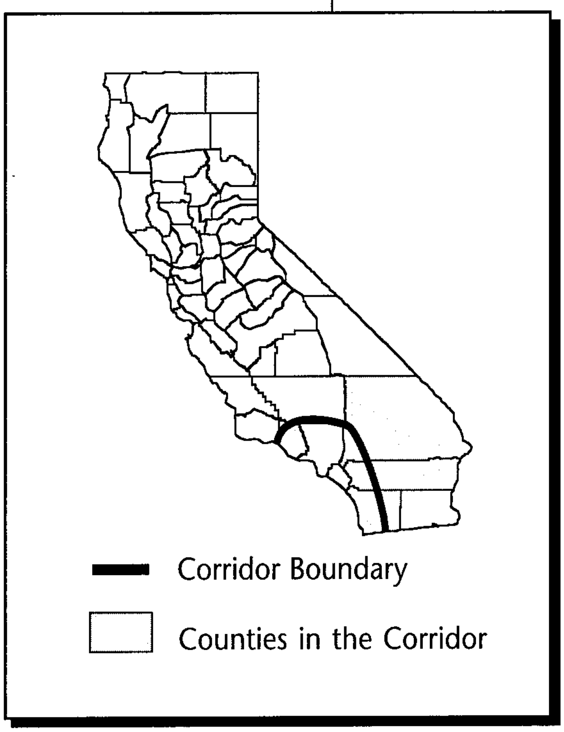
Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support by the Volpe Center.

This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Case Study Overview

The Southern California Priority Corridor provides a rich example of how agencies can apply the National ITS Architecture and Standards to achieve regional ITS coordination among numerous traffic and transit management and traveler information centers. The Southern California case study illustrates the following:

- Collaboration by multiple Metropolitan Planning Organizations (MPOs) and state and local transportation agencies in a complex, multi-jurisdictional setting.
- Integration of extensive "legacy" ITS infrastructure using an open architecture and interface standards to enable unprecedented levels of data and control sharing among traffic management centers.
- The participation of "highlighted" stakeholders, including the California Highway Patrol, South Coast Air Quality Management District, California Trucking Association, border crossing agencies, and Mexico.
- Opportunities for private sector information service providers to acquire and provide value-added regional traveler information.



Background

U.S. DOT Priority Corridor Program Goals

- Advance ITS strategic planning
- Serve as national ITS test beds
- Demonstrate the benefits of ITS
- Showcase ITS to the public
- Evaluate ITS concepts and technologies

Southern California Corridor Geography

- 10,000 square miles
- 124 communities
- 6 counties
- 16 million people
- 9 million jobs

The Southern California Intelligent Transportation Systems (ITS) Priority Corridor was established in March 1993 under provisions of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Southern California was one of four such corridors designated throughout the country.

Politically, the area encompassed by the corridor extends from the northern reaches of the Los Angeles metropolitan region in Ventura County, through the San Diego metropolitan region, to the U.S./Mexican border. Anchored by Interstate Highway 5, the area is bounded to the north by State Route 126, the northern boundary of Los Angeles County, and Interstate Highway 10; to the east by State Route 71 and Interstate Highways 15, 210, 215, and 805; to the south by the United States border with Mexico; and to the west by the Pacific Ocean.

The corridor includes all of Orange County, and the major urbanized and adjacent non-urbanized areas of Ventura, Los Angeles, San Bernardino, Riverside and San Diego counties. It also includes a major commercial vehicle port of entry at the Otay Mesa border crossing on State Route 905, as well as other international border crossings in the region.

The Southern California Priority Corridor is one of the nation's most populated areas. More than 16 million people live within the defined area, which has a diverse employment base of over 9 million jobs. Transportation systems in the region move individuals and goods from around the world to destinations in California and the rest of the nation. Although well developed, the existing intermodal transportation network suffers from complex travel patterns and peak-period over-utilization resulting in severe congestion and extreme air quality non-attainment.

The number of Southern California commuters increased by 2 million over the past 25 years, and the average work commute time is nearly 45% longer (from 48 minutes round trip to 69 minutes). International border traffic has also increased markedly since the enactment of the North American Free Trade Agreement (NAFTA), resulting in costly commercial vehicle delays and congestion at the border. However, the completion of the Glenn Anderson Freeway (I-105) in 1993 represents the last freeway Caltrans expects to build in Southern California. The inability to expand roadway infrastructure, combined with low transit usage, suggests that continued population and economic growth will lead to deteriorating environmental and driving conditions. This dire forecast has led Caltrans and local transportation agencies to consider using ITS technologies which can increase the efficiency of the existing infrastructure, as an integral part of any future transportation scenario.

The Southern California Corridor ITS Legacy

Caltrans, along with local transportation agencies and California academic institutions, were early proponents of applying advanced technologies to address surface transportation problems. In 1971, Caltrans opened the first freeway management center in the nation. By the early 1980's, the City of Los Angeles began developing the Advanced Traffic Signal and Control (ATSAC) System that allows city traffic engineers to monitor traffic and adjust signals in real-time. ATSAC's success in mitigating traffic concerns during the 1984 Olympic Games created a political and institutional awareness of the potential for increased capacity through information management strategies. It would be more than four years after California's pioneering experience with ATSAC before these technologies were given the name "ITS."

Inspired by the success of ATSAC, Caltrans and local agencies, working with the Southern California Association of Governments (SCAG), planned the Santa Monica Smart Corridor Project in 1989. The goal of the Smart Corridor was to integrate the traffic control systems of Caltrans, Los Angeles DOT, Culver City, and Beverly Hills. This integration unified signalization and monitoring on the Santa Monica Freeway and three other major arterials. Despite frustrations due to legacy system incompatibilities, and a seven-year integration struggle attributed to the limitations of 1980s technology, the project demonstrated the advantages of having an integrated ITS system in 1994, when traffic engineers were able to sustain traffic operations following the Northridge Earthquake that collapsed portions of the Santa Monica freeway. That event further galvanized political and institutional support for integrated Intelligent Transportation Systems in Southern California.

Caltrans was an early and ardent advocate of ITS integration and a leading public sector stakeholder calling for the development of a unifying National ITS Architecture. In fact, in 1992 when the U.S. DOT initiated development, Caltrans was an active participant on the team that created the National ITS Architecture.

For three decades, Southern California has actively sought ITS solutions to transportation problems. As a result, existing ITS infrastructure represents about half of the ITS systems ultimately planned for the Los Angeles metropolitan region. Legacy systems also exist in other parts of the corridor, but to a lesser extent.

Ironically, Southern California's pioneering efforts have resulted in legacy systems that can be neither easily integrated nor abandoned in favor of starting anew, given the substantial investment that has been made. The challenge, therefore, is to connect these diverse systems in a way that allows agencies to leverage past investments, while creating an integrated regional ITS network. To meet this challenge, the Southern California Priority Corridor is taking the necessary steps in the evolution of the corridor's ITS network to enable the connection of the region's ITS systems by establishing a common framework and communication standards that serve "all roads, all modes" within the corridor.

Southern California: A Legacy of ITS Leadership

1971 Caltrans freeway Traffic Management Center open in Los Angeles—first in the U.S.

1984 City of Los Angeles uses ATSAC to successfully accommodate increased traffic generated by Olympic games

1989 12-mile Santa Monica "Smart Corridor" initiated. First system to integrate freeway and arterial street traffic systems across multiple agency jurisdictions

1993 Southern California is designated by Congress as an ITS Priority Corridor

1994 Santa Monica freeway collapses in Northridge Earthquake. ITS Smart Corridor carries 75% of previous freeway traffic—yet travel time along the 12-mile corridor increases only 10 minutes

1996 Ventura "Smart Passport" program begins—first system to use a common fare card on multiple transit systems with different fare structures

1997 I-15 Automated Highway Systems Demonstration in San Diego

1998 Caltrans Advanced Transportation Systems Program Plan updated to incorporate National ITS Architecture

Vision

Southern California Priority Corridor Vision

Regional ITS Integration - "All Roads, All Modes"

Achieving the Southern California priority corridor vision of "all roads, all modes" requires evolving existing local and regional ITS infrastructure into a cohesive network. Objectives include: connectivity, integration, efficiency, safety, and air quality. Although this vision is shared among the major stakeholders, it took awhile to settle on a decentralized, "system of systems" approach rather than a centralized governing authority.

The fully integrated corridor envisioned for Southern California is one that respects individual agency authority, yet looks beyond jurisdictional boundaries to fully exploit information through inter-agency cooperation.

- Individual systems will remain intact, but connections will allow data and control sharing that appears "seamless" to users.
- The corridor architecture will be expandable in order to include future elements. It will be scalable to allow ITS applications to be "designed once, then deployed many times," to propagate successful applications throughout the region.
- Air pollution will be mitigated by reducing stop and go traffic, making low-polluting travel modes like transit easier to use, and incorporating real-time air quality data into traffic management decisions.
- Emergency responders will receive assistance in locating incidents, getting to the scene, and accessing critical data when hazardous materials are involved.

It is the vision of the Steering Committee to significantly improve the safety, efficiency and environmental impacts of the transportation system in southern California through the application of advanced transportation technologies and integrated management systems to and between all modes.
— Strategic Development Plan: Interim Report

Regional ITS Architecture Development Process

In the early 1990's, Caltrans established partnerships with local and regional agencies, academia, and the private sector to conduct ITS field tests. Then, after the Priority Corridor designation, Caltrans began a systematic effort to fund ITS deployment plans in Southern California. Since Caltrans worked with these partners on a regional basis, the regional boundaries correspond to Caltrans' district boundaries: one for each of the four regions (the Inland Empire/Riverside/San Bernardino region, the Los Angeles/Ventura region, Orange County, and San Diego County); one for commercial vehicle operations in the corridor and at the U.S./Mexico International Border; and one plan covering the entire corridor, filling gaps and identifying unique corridor-wide opportunities.

Early analysis showed that the priority corridor architecture and development process should be overlaid on the regional efforts. The necessary institutional relationships were already established and the agencies engaged in the regional process were also the essential stakeholders for developing the corridor ITS architecture. Under Caltrans leadership, the regional teams coordinated their regional plans and established an overall Priority Corridor Steering Committee to oversee preparation of a corridor-wide deployment plan.

Shortly after the Steering Committee began working on the deployment plan, it submitted a successful application to U.S. DOT for a major advanced transportation management and information system demonstration called "Showcase." This demonstration, in concert with the work being done on the ITS deployment plan, provides the foundation for the regional ITS architecture for the Southern California Priority Corridor.

The deployment process followed U.S. DOT guidelines issued for early deployment planning and priority corridor projects using Federal funds, although the guidelines were adjusted somewhat to suit local needs. The architecture development process, through Showcase and the deployment plans, also generally followed U.S. DOT guidelines. However, differences included identifying and using "Early Start" projects to identify initial functional requirements, and preparing a "Concept of Operations" document to achieve consensus on the approach to integration. Both activities involved convening the major corridor stakeholders, and ascertaining their transportation needs as an essential preparatory step to determining functional requirements.

As illustrated below, the Southern California effort goes well beyond establishing the basic ITS regional (corridor) architecture. It includes a "High Level Design" and a "Detailed Design" for integrated ITS deployment in the corridor. However, for the purposes of this case study, the architecture development process is considered to be those activities conducted as part of the "Scoping" phase leading to the development of a conceptual architecture.

Regional Architecture Development Timeline

1993 ITS Priority Corridor Designation

1995 Conceptual Architecture Completed
...Concept of Operations
...Functional Requirements
...Showcase Architecture

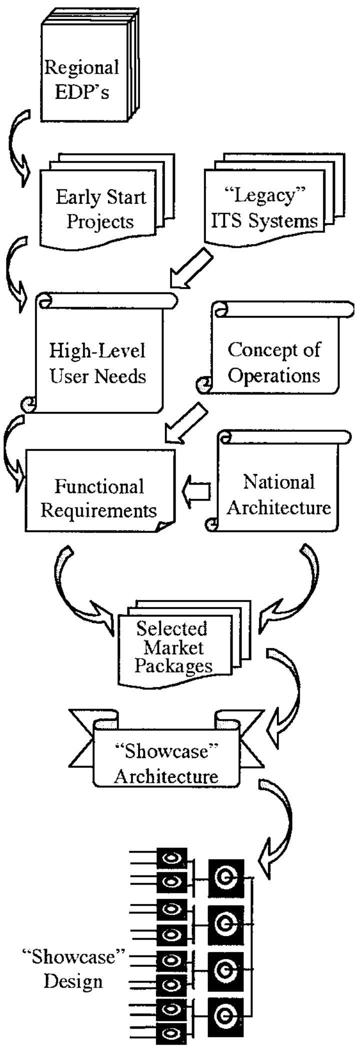
1998 Strategic Deployment Plan (Interim Report)
Functional Architecture Completed
...Interface Requirements,
...Kernel-Seed Description

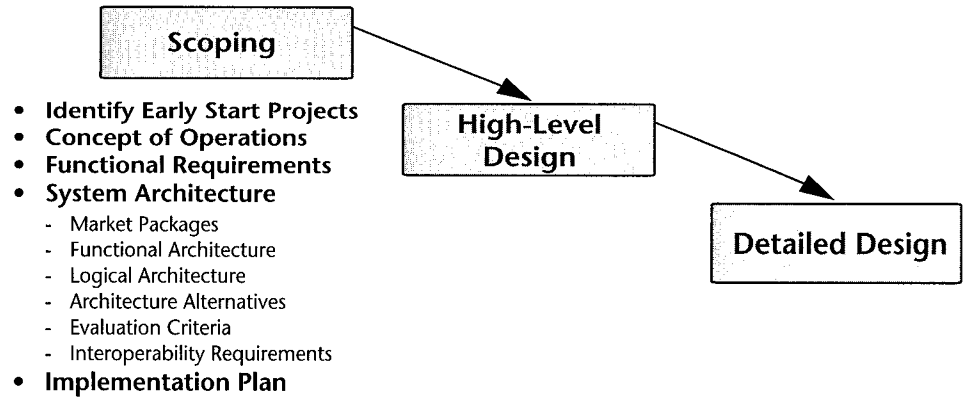
1999 Strategic Deployment Plan (Final Report)

2001 Showcase Project ITS Architecture Validation to be completed

Regional ITS Architecture Development Process

"Showcase" Architecture Development Process





Graphic Courtesy of Caltrans and Odetics ITS / NET

Work on the conceptual development of the Regional ITS Architecture began in June of 1995 and continued through October of 1996. The process included:

- A survey and three stakeholder workshops to identify existing systems, high-level user needs, and system requirements
- Three regional forums to formulate a consensus regional Concept of Operations
- Translation of the Concept of Operations and high-level user needs into functional requirements based on the National ITS Architecture
- Selection of National ITS Architecture "Market Packages" based on the functional requirements
- Establishment of an initial Showcase Architecture and traceability matrices of the logical (data, data flow, and processes) aspects to the National ITS Architecture
- Initiation of development of interoperability standards (product, regional, and national) to be completed as part of the subsequent high-level design effort.

Regional ITS Architecture Development Process

The initial effort was followed by the development of functional elements beginning in December of 1996 and concluding in September of 1998. This 21-month, follow-on effort included:

- Interface requirements based on the Early Start projects and functional requirements
- Validation of the logical architecture and development of an object-oriented Interface Definition Language (IDL) related to the User Services in the National ITS Program Plan, from which the National ITS Architecture was derived
- Defining integration requirements and design parameters for Early Start projects
- Plans for a limited incident management prototype to demonstrate the feasibility of regional integration based on the Showcase architecture (not including the prototype).

Southern California ITS Priority Corridor Stakeholders

"In LA, we found that the institutional barriers were actually greater than the technical ones."
— Pat Perovich, Office Chief, Caltrans District 7 (Los Angeles)

Stakeholder Involvement and Motivations

There are nearly one hundred and fifty public agencies in the Southern California corridor area that plan, implement, operate, or influence transportation in some way. These include the U.S. DOT, state agencies such as the California Department of Transportation (Caltrans) and the California Highway Patrol, metropolitan planning organizations, transit operators, regional air quality agencies, and county and city transportation agencies. In addition, there are numerous port agencies, private interest groups, and firms with transportation interests. These groups vary widely in their levels of ITS awareness, intent to implement ITS, and corridor-wide interests. However, most agencies have similar goals and all have a stake in the Southern California Corridor ITS Architecture.

Almost half of the area's major planning and operations agencies participated in the architecture development process in some way. Smaller agencies typically participated through subcommittees or regional teams. The four regional teams participate on the Priority Corridor Steering Committee through the regional team leaders. For other interested public agencies and private sector organizations not otherwise able to participate, a stakeholder mailing list is maintained to keep them informed of the process through periodic newsletters.

Individual agency participation was influenced by a number of factors, but often reflects the amount of resources (staff and funding) available. Limited transit agency participation has been attributed in part to the localized nature of transit usage and a traditional reliance on commercial "off the shelf" solutions that do not entail significant development or integration on the part of the transit agency. Currently, efforts are underway to energize the transit task force by focusing on the long-term operational benefits of integrated ITS from a transit provider's perspective. Active participation by Federal Transit Administration (FTA) Regional Office staff, in addition to FTA/Federal Highway Administration (FHWA) Metro Office staff, was considered essential in overcoming lingering impressions that ITS is predominantly for highway agencies.

"The California Highway Patrol/Caltrans Transportation Management Center Master Plan supports the National ITS Architecture and provides an excellent opportunity to develop and integrate ITS information and management projects in California."
— Kenneth Baxter, Senior Transportation Planner, California Highway Patrol

Highlighted Stakeholders

California Highway Patrol (CHP)
Although law enforcement agencies are typically considered non-traditional ITS stakeholders, the California Highway Patrol has been an active participant in California's ITS community for more than two decades. In recent years, CHP involvement has expanded to include programs focused on emergency response, commercial vehicle operations, and incident management. The CHP views its role in the architecture planning process as a logical next step in this evolving relationship with the transportation community.

South Coast Air Quality Management District (SCAQMD)
SCAQMD participation has waned as the focus on planning has given

way to deployment, and plans for air quality applications, such as roadside emissions monitoring, were slated for future deployment. However, near-term projects are expected to benefit air quality, due to smoother traffic flow and increased transit usage and ridesharing.

California Trucking Association (CTA)
CTA participation is an extension of its mission to represent fleet operators and the 40,000 truckers who travel in the corridor daily. In fact, their participation has been instrumental in forming the Commercial Vehicle Operations (CVO) subcommittee and getting Mexican participation in addressing driver information, permitting, and international border crossing issues. Generally, fleet operators were interested in traffic information and more predictable border crossings, but suspicious of public agencies that they typically view as regulators not facilitators. They do realize the benefits, however. For example, accurate traffic information from ITS technologies could allow trucking firms to improve fleet utilization by 15% or more.

"I believe it is crucial for air quality agencies to be aware of ITS projects and be able to analyze their potential impacts."
— Michael Nazemi, Transportation Research Manager, South Coast Air Quality Management District

"We sold the CVO community on the priority corridor process by showing them the benefits to their bottom line, efficiency gains, and improved safety."
— Mike Morgan, Chief Executive Officer, AFM Transportation Services, Inc.

Southern California ITS Priority Corridor Organizational Relationships

Organizational Structure

Coordination across an extensive array of transportation planning and implementation agencies has resulted in a complex organizational structure. The primary governing body is a Steering Committee made up of major planning and implementing agencies, as well as a representative of the trucking industry. Agencies who wish to join may be added to the Steering Committee by a majority vote of the members. After receiving federal ITS funding, the City of Inglewood and the I-5 Commercial Vehicle Operations Joint Powers Authority (I-5 JPA) Committee began actively participating in Steering Committee meetings.

A Steering Committee chairperson is selected by and from the committee members, and serves a nominal term of one year. The Steering Committee has a twofold mission:

1. To prepare a corridor-wide ITS Strategic Deployment Plan* for adoption by sponsoring agencies that would define mutually beneficial technologies; and

2. To oversee the scoping, design and deployment of Showcase, a national demonstration project, for the corridor agencies.

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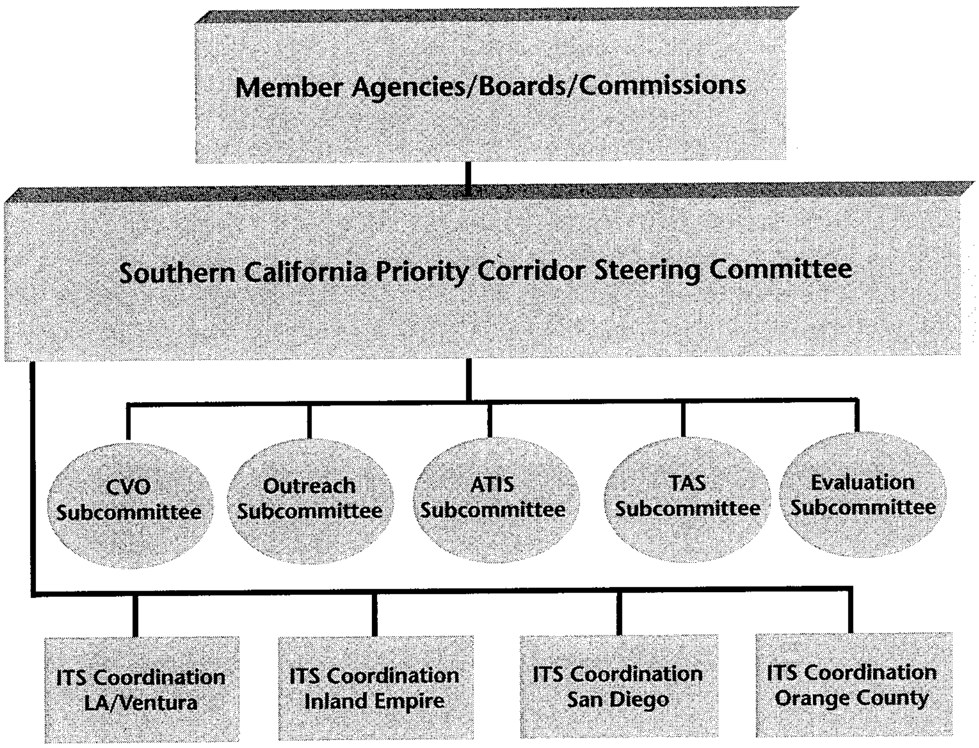
* *Inherent to developing the Strategic Deployment Plan is the establishment of a regional architecture, based on the National ITS Architecture, to be demonstrated as part of the Showcase initiative.*

Southern California ITS Priority Corridor Organizational Relationships

Southern California ITS Priority Corridor Organizational Structure



Within the Steering Committee, an Executive Committee had been used to initially develop strategies and frame policy positions that then are taken to the full committee for consideration. The Executive Committee was also tasked with addressing pressing items that would otherwise await full Steering Committee action. This is a role a General Manager may be hired to play in the future, as is the case in the I-95 Corridor Coalition, one of the other ITS Priority Corridors.

Southern California Priority Corridor Steering Committee

U.S. DOT Agencies

- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)

State Agencies

- California Department of Transportation (Caltrans)
- California Highway Patrol (CHP)

Regional Organizations

- Southern California Association of Governments (SCAG)
- San Diego Association of Governments (SANDAG)
- South Coast Air Quality Management District (SCAQMD)

County Transportation Commissions

- Los Angeles County Metropolitan Transportation Authority (LACMTA)
- Orange County Transportation Authority (OCTA)
- Riverside County Transportation Commission (RCTC)
- San Bernadino Association of Governments (SANBAG)
- Ventura County Transportation Commission (VCTC)

Cities

- Anaheim
- Los Angeles
- San Diego

Private Stakeholders

- California Trucking Association

Southern California ITS Priority Corridor ITS Legacy Systems

Legacy Systems Investment

In Los Angeles alone, legacy ITS infrastructure covers 330 miles of the 550 miles of roadway slated for traffic management coverage. Similarly, about 2,500 of the city's 4,000+ traffic signals are already connected and controlled using the ATSAC network.

Regional ITS Inventory

In preparation for developing a regional (corridor) ITS architecture, an inventory was taken to determine the existing regional ITS infrastructure. A survey was distributed to agencies in the corridor, which were asked about existing systems, communications technologies, and uses of data collected by their systems. The survey confirmed that an extensive array of ITS infrastructure based on a wide range of technologies had already been deployed in the corridor. Communications media, for example, ranged from simple twisted pair wiring to fiber-optic and satellite links. The extent and incompatibility of such legacy systems presented a significant challenge in ITS integration.

Center Subsystems

	LA/Ventura	Inland Empire	San Diego	Orange County
Information Service Providers				
	LACDPW Com-TV SCAG Countywide GIS LA Smart Traveler Private Radio	SCAG Countywide GIS Private Radio	SANDAG Private Radio	Travel Tip SCAG Countywide GIS Santa Ana's ITIS Private Radio
Traffic Management				
	Caltrans/CHP District 7 TMC ATSAC Smart Corridor	Caltrans/CHP District 8 TMC SANBAG's Smart Call Box	Caltrans/CHP District 11 TMC	Caltrans/CHP District 12 TMC Anaheim TMC Irvine TMC Santa Ana TMC
Emergency Management				
	Ventura CC Los Angeles CC	Barstow CC Inland CC	Border CC	Santa Ana CC
Transit Management				
	LACMTA Regional Rail Control Center LA Smart Shuttle Project LA Department of Airports Long Beach Transit LA Smart Card Foothill Transit	Athena RCTC SunLine Transit Omnitrans Ontario Airport	NCTD MTDB	OCTA John Wayne Airport
Toll Administration				
				TCA CPTC
Fleet and Freight Management				
	Marine Exchange of LA-Long Beach			
Commercial Vehicle Administration				
	Caltrans District 8 CVO	Caltrans District 8 CVO	Caltrans District 8 CVO	Caltrans District 8 CVO
Planning				
	LACDPW			

Acronyms:

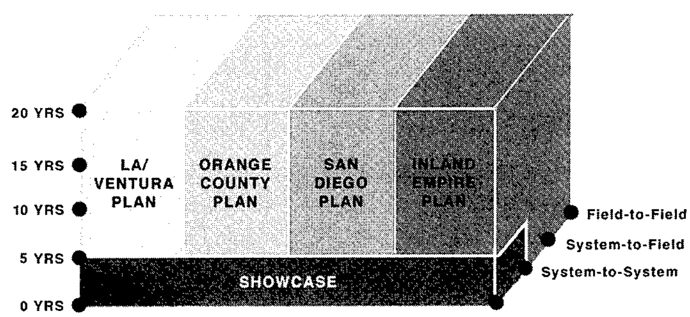
ATSAC – Advanced Traffic Signaling and Control
CC – Control Center
CHP – California Highway Patrol
CPTC – California Priority Toll Commission
CVO – Commercial Vehicle Operations
GIS – Geographic Information System
ITIS – Intelligent Transportation Information Systems
LACDPW – Los Angeles County Department of Public Works
LACMTA – Los Angeles County Metropolitan Transportation Agency
MTDB – Metropolitan Transit Development Board
NCTD – North County Transit Development
OCTA – Orange County Transportation Authority
RCTC – Riverside County Transportation Commission
SANBAG – San Bernardino Association of Governments
SANDAG – San Diego Association of Governments
SCAG – Southern California Association of Governments
TCA – Transportation Corridor Agencies
TMC – Transportation Management Center

Southern California ITS Priority Corridor "Showcase" and Early Start Projects

The Showcase Initiative and Early Start Projects

The Southern California Showcase initiative provides for the initial integration of the corridor's legacy ITS systems, as well as the foundation permitting future ITS deployments to connect on a corridor-wide basis. It represents a five-year building block upon which the long-term (20-year) ITS deployment in the corridor will be based. The Showcase architecture will evolve to serve as the corridor architecture. The Showcase initiative includes seven "Early Start" projects that were drawn from the four regional early deployment plans, based on their readiness for near-term deployment and appeal for eventual corridor-wide implementation.

The Showcase initiative begins the process of corridor integration based on system-to-system integration needs identified during the Showcase Scoping and Design process. This process will coordinate with the initial five-year projects in the corridor development plans: the four Regional Plans, the CVO/International Border Plan, and the Corridorwide Plan. The Showcase effort will cost an estimated $125 million, a fraction of the $2-3 billion of ITS infrastructure investment the regional plans identify over the next 20 years.



Graphic Courtesy of Caltrans and Odetics ITS / NET

Early Start projects in the San Diego region were championed by SANDAG, the Metropolitan Planning Organization (MPO), which benefited from strong political support and direction from its governing board, and an energetic professional staff that prides itself on incorporating ITS into regional transportation plans and programs. SANDAG's Transportation Improvement Program includes $250 million of ITS investments over a five-year span. Moreover, SANDAG is serving as the contracting agent for Showcase project activities, and works closely with the Caltrans Showcase project manager, who provides technical oversight and direction to the contractors who have been awarded Showcase projects. By comparison, the driving Showcase initiative force in Orange County comes from the OCTA planning staff and strong support from the "citizen representative" on the OCTA board. Whereas in the Los Angeles and Inland Empire regions, Caltrans provides much of the leadership with support from the city, county, and SCAG.

Early Start Projects

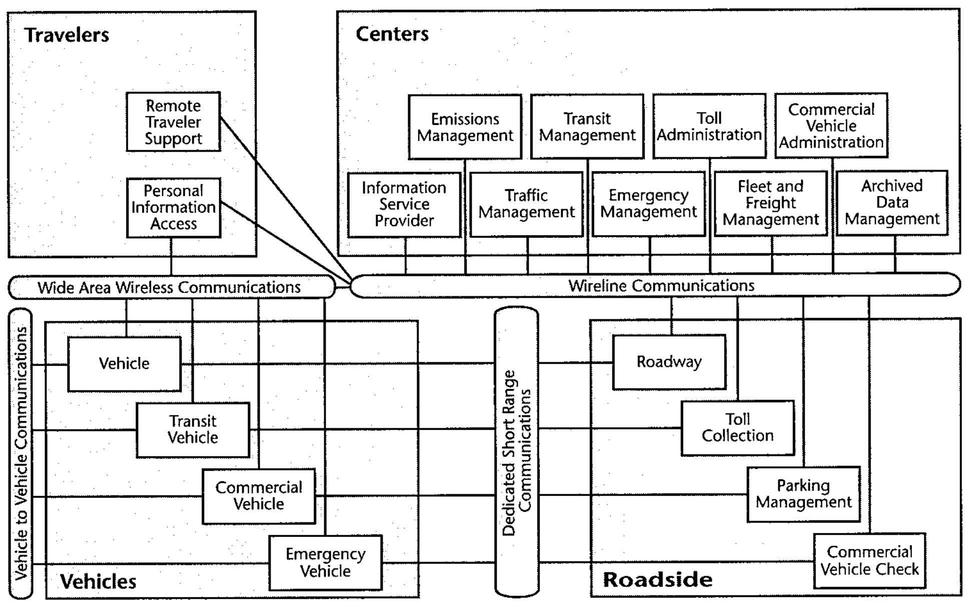
- Showcase Architecture– Integration framework for legacy systems and new ITS corridor applications.
- Integrated Modal-Shift Management– Interagency traveler information in the Los Angeles / Ventura Co. region.
- Transit Management Information System– San Diego Metropolitan area.
- Intermodal Transportation Management Center (TMC) and Information System– San Diego TMC prototype to demonstrate the Showcase Architecture.
- Orange County TravelTIP Project– An advanced Traveler Information System to provide travel information to travelers via kiosks, cable TV, and the Internet.
- IMAJINE (Intermodal and Jurisdictional Network Environment)– Integration of Los Angeles County traffic and transit agency legacy systems.
- Mission Valley ATIS– Provides motorists with information about traffic conditions in vicinity of Qualcomm Stadium.
- InterCAD– Interconnected Computer Aided Dispatch among law enforcement agencies: CHP, San Diego Police Department, and the Co. Sheriff's Department.

Southern California ITS Priority Corridor Showcase Initiative

The Strategy of Progressive Integration

After the Showcase initiative, the level of integration will expand to include system-to-field elements, and ultimately, the integration of individual field elements.

As depicted below, the Showcase architecture targets the integration of transportation management and information centers such as, Traffic, Emergency, and Transit Management centers, and Information Service Providers. It also provides the necessary extensions for roadside, vehicle, and remote access elements within the National ITS Architecture. Caltrans and the other participants realized that attempting to integrate everything in the corridor was infeasible. Thus, they focused on integrating the corridor's legacy traffic signal control and transit management systems.



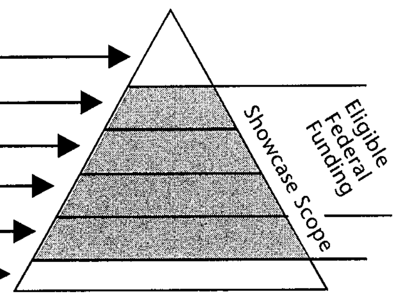
Graphic Courtesy of Caltrans and Odetics ITS / NET

Concept of Operations

A Concept of Operations was prepared to document the consensus views among stakeholders on transportation management strategies and the range of interagency coordination, hence integration, that should be targeted. The Concept of Operations delineates six levels of possible interaction, as shown in the diagram below.

Level of Interagency Operations

6. Centralize some / all functions
5. Share control during emergencies
4. Share data / video day-to-day
3. Share data / video during special events
2. Share data / video on "view only" basis
1. Operate Independently



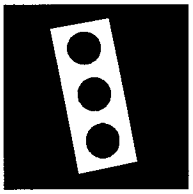
Stakeholders agreed that each agency or user would be allowed to choose the level (between 2 and 5) at which they wish to participate in the Showcase initiative. FHWA California Division impressed upon the stakeholders the need for integration beyond Level 2, considering the large infrastructure base already in place in Southern California along with the challenge of the Priority Corridor designation. Moreover, stakeholders accepted that limited federal dollars entering the Priority Corridor for the Showcase initiative would be directed to activities between Levels 3 and 5. Level 6 was ruled out for the time being, given that it necessitated agencies ceding control to a central regional authority.

Functional Requirements and "Market Packages"

The functional requirements for the corridor architecture were derived using the Concept of Operations and the National ITS Architecture "Market Packages" (equipment and system requirements associated with typical ITS deployments) that would be needed to implement the Showcase projects. Of the 60 Market packages identified in the National ITS Architecture, 53 could be used as building blocks in developing a regional ITS architecture to serve the corridor's particular needs. A quick check revealed that the functionality associated with 27 of the 53 packages could be found in one or more legacy systems within the corridor. A decision was made that the functionality associated with12 of these, and five other packages (* see below) would be implemented throughout the corridor as part of the Showcase initiative. Ultimately, all but 14 of the market packages identified in the National ITS Architecture will be deployed corridor-wide.

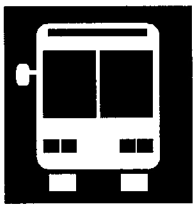
Southern California ITS Priority Corridor Showcase Initiative

ITS "Market Packages" Selected for Showcase Implementation



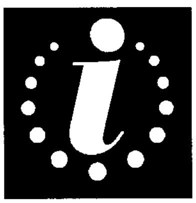
Traffic Management

1. Network Surveillance
2. Regional Traffic Control*
3. Incident Management System



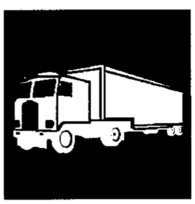
Transit Management

4. Transit Vehicle Tracking
5. Transit Fixed-Route Operations
6. Demand Response Transit Operations*
7. Transit Passenger and Fare Management
8. Transit Security
9. Multi-modal Coordination



Traveler Information

10. Broadcast Traveler Information
11. Interactive Traveler Information
12. Dynamic Route Guidance*
13. ISP Based Route Guidance*



Commercial Vehicle Operations

14. HAZMAT Management*

Emergency Management

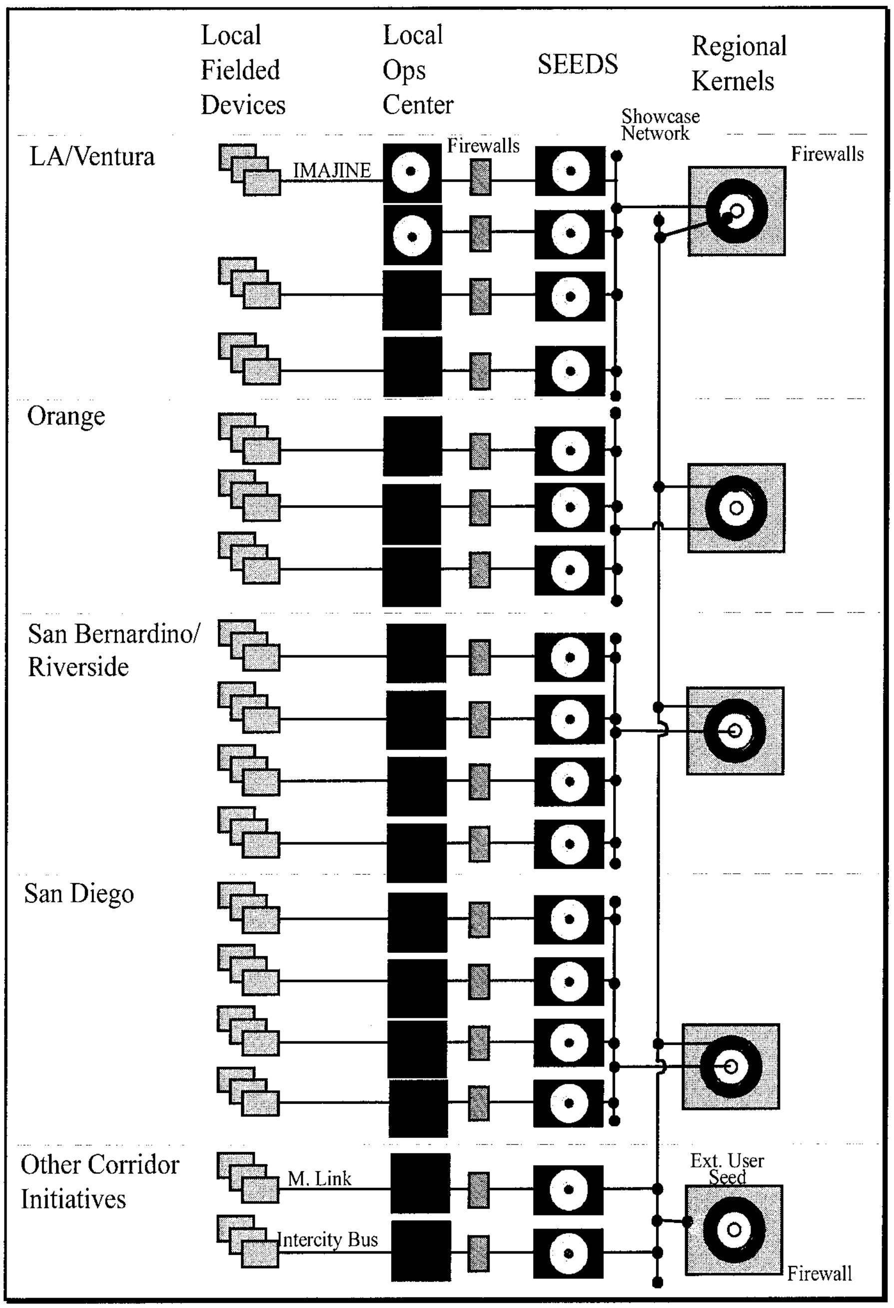
15. Emergency Response
16. Emergency Routing
17. Mayday Support

* Added functionality within the corridor

Southern California ITS Priority Corridor Showcase Architecture

The Showcase Architecture

The Showcase architecture provides an initial link between existing regional systems through a "kernel and seed" structure. "Seeds" are adapters that convert data and control signals from local legacy systems into a form that conforms to the Showcase design. The converted signals are then transmitted through a regional "kernel" to other centers. During the Showcase architecture demonstration and validation phase a Regional Kernel will be deployed in each of the four regions within the corridor as a common integration point for agencies to use in developing and validating interfaces to the Showcase network.



"The largest benefit of a unified Regional Architecture will be cost savings to the agencies that operate Southern California's transportation network. This is particularly true because the Showcase architecture is flexible enough to allow the subscription of legacy systems without having to go back and redesign old ITS or reinvest in new versions of the old systems."

— Ali Zaghari, Showcase Project Manager, Caltrans

"The architecture was built on well recognized principles, which, once demonstrated to agencies and the public, will bring enough benefits to be self-sustaining."

— Ali Zaghari, Showcase Project Manager, Caltrans

Object Oriented Approach

The Showcase Architecture employs an object-oriented approach rather than specifying individual data elements, data flows between system elements, and data processing performed by system elements. In an object-oriented approach, objects consist of data and processes that are used to provide services to, and invoke services from, other objects within the system. Both approaches work. However, the object-oriented approach is gaining favor because complex systems can be constructed using objects as modular building blocks.

The decision to adopt an object-oriented approach was weighed seriously. Object-oriented software development methods and tools were not well established. However, due to the large number of legacy systems in the corridor, it was estimated that integrating all the data and process flows using traditional methods would have required the development of approximately one million separate interfaces that would need to be updated as changes of regional significance were made. With an object-oriented approach, only 80,000 interfaces would be necessary to accommodate the legacy systems. The decision to go with an object-oriented approach, however, entailed translating and mapping National ITS Architecture data flows into an object-oriented model. It also increased the importance of demonstrating and evaluating the Showcase architecture under field conditions in advance of widespread ITS deployment.

Intended Uses and Benefits of the Regional ITS Architecture

Fostering Interagency Communication

The single most significant benefit of the architecture development process has been its positive influence on interagency cooperation. Previously, there was no common forum for discussing corridor-wide issues, and agencies lacked common terminology. The planning process has enabled the diverse member agencies to develop a common lexicon and begin viewing the corridor from a holistic perspective. The implementation of a Regional ITS Architecture is expected to continue this process of cooperation and alliance building.

Achieving Cost Savings

Since "Develop Once, Deploy Many Times" was a core element of the regional architecture design, operators can expect significant economies of scale. The ability to use the same framework for multiple ITS implementations will reduce the cost of developing new projects by a factor of 10 to 100. With $1.2 million already budgeted to project development under the current repeatable architecture, it is easy to imagine the additional costs that would have been incurred by designing a separate architecture for each project.

Enabling Contingency Control

Historically, there was no hope of integrating systems control because the individual architectures had not been designed with that possibility in mind. The regional architecture creates the option for inter-agency control and contingency coordination. For example, if a unique event (such as the Olympics) is expected to place high demands on one area of an agency's network, a neighboring agency can take control of peripheral systems. This leaves the primary agency free to focus on the problem at hand. In the event of an earthquake or other natural disaster, surviving control centers can take over for disabled ones. This maintains the efficient flow of traffic at the time when it is most critical.

Creating a Framework for Evaluating Projects

A more subtle benefit of developing a regional architecture is that it forced the corridor agencies to create a complete vision of the corridor's overall ITS plan. This also acts as a framework for assessing individual ITS projects. The agencies have found that it is much easier to secure state and Federal funding when they can point to the function that a proposed project serves in this framework. Funding agencies, on the other hand, can more easily evaluate the merits of proposed deployments that fit properly into a predefined regional framework.

"Although the majority of tangible benefits are yet to come, the Regional Architecture development process has laid the groundwork for unprecedented integration by plotting a common course."
— Jim Kerr, Vice President of Systems Engineering, NET Corporation

"The regional architecture set the stage for long-term plans and projects that we have ongoing in Orange County, in particular, and also in the Southern California region. It helped create a roadmap for a lot of the activities that we have planned or even just on the drawing board at this point. The architecture sets the framework for us to make better investment decisions and ensures that projects are compatible across jurisdictions."
— Dean Delgado, Principal Transportation Analyst, Orange County Transportation Authority

Lessons Learned

Lessons Learned: Key Factors to Success

- Federal ITS funding and policy encourage integration
- Interagency governance structure for management and oversight of regional ITS initiatives
- Local ITS champions and commitment to interagency cooperation
- Demonstrable success of initial ITS deployments
- Involvement of both MPO and operational agencies in actual deployment
- Outreach and "In-reach" to inform stakeholders about integrated ITS deployment and the National ITS Architecture
- Executive scanning tours for key decision makers
- Knowledgeable and qualified systems integrator
- Object-oriented approach for integrating legacy systems

The Southern California Priority Corridor experience in developing a regional ITS architecture provides useful insights and lessons learned that are of interest to others. Although the stakeholders had an advantage in that Caltrans and their consultants were actively involved in developing the National ITS Architecture, were aware of national developments, and were able to keep the regional effort closely aligned, these technical advantages were mitigated by the formidable institutional issues involved in the cooperative development of a Regional ITS Architecture. Development is a learning process, and the lessons learned in California may help streamline current and future efforts.

- *Seek-Out Champions.* It is helpful to have champions in stakeholder organizations to help generate and sustain interest among less passionate participants. Southern California benefited from strong local champions, such as Caltrans' New Technology and Research Division, Odetics ITS, and the city of Los Angeles that are nationally recognized ITS leaders. The Corridor also benefited from having champions among decision-makers both in regional planning organizations and in local government.

- *Conduct Inreach and Outreach.* Uneven stakeholder knowledge of ITS, expected benefits, and the advantages of integrated deployment slowed initial progress. This was compounded by unfamiliarity with ITS architecture terminology and architecture development process guidelines. Workshops and stakeholder training sessions were used to develop basic stakeholder awareness of ITS and the value of integrated deployment throughout the corridor. The Steering Committee also used "scanning tours" to allow decision-makers to see ITS implementations in other cities.

- *Set a Governance Structure.* The Southern California Priority Corridor has operated under an ad hoc committee structure that relies upon the good faith efforts of members, who have varying authority to act on behalf of their agency. The corridor Steering Committee has struggled to overcome problems that stem from this lack of a formal governance structure. For example, although stakeholders appreciate Caltrans headquarters' contribution of staff resources, Caltrans field offices and local agencies are concerned about becoming overly dependent on headquarters staff. The Steering Committee is exploring ways to transition primary governance from Caltrans' centralized research and development office to the regional operations staff.

- *Develop a Concept of Operations.* The development of a formal Concept of Operations by the key stakeholders is considered a watershed accomplishment by many participants—in particular the systems integration contractor, who benefits from a clear understanding of how the systems are intended to work together. Importantly, developing the Concept of Operations document allowed the operational staffs from various agencies to focus on how ITS would be used, and in turn how existing and planned ITS management centers should be interconnected. Until this time, it was difficult for operations staff to appreciate the rationale for linking their systems together.

- *Use the National ITS Architecture.* The National ITS Architecture was used as a starting point for the design process, and provided the basic structure and terminology that allowed stakeholders to adopt a consensus ITS vision. However, operational staff from stakeholder agencies were quick to point out that deployment and design specifics were needed for implementation. While the committee still needed to establish design guidelines and specifications to be able to actually build something usable, the National ITS Architecture saved time and resources that otherwise would have been required to develop a comparable framework for integration.

- *Make Appropriate Use of Systems Integrators.* A systems integrator can help with the overall system design concept and project definition, and also can play a critical role in ongoing configuration management. In Southern California, the systems integrator ensures that the architectural decisions of the four regional teams are consistent with the corridor ITS architecture and, in turn, with the National ITS Architecture. The systems integrator also provides technical guidance to project level designers and assists in establishing regional ITS standards. It is important, however, to avoid over reliance on the integrator so that the stakeholders remain sufficiently engaged to comfortably provide meaningful technical direction.

- *Target Deployment.* Although agencies are willing to participate in regional planning exercises, there is nothing like deployment to capture the interest and commitment of operations staff. In the Corridor's case, Federal and state mandates that corridor funding should be used for integration rather than adding discrete ITS technologies was an important factor in sustaining focus on the broader regional issues. It is a delicate balancing act because the need to implement ITS projects that demonstrate progress is often at odds with corridor interests in validating the integration strategy before committing precious deployment funds.

- *Use Existing Institutions.* The Southern California Corridor's stakeholders used existing institutions and relationships where possible. The prominent involvement of SCAG and SANDAG is one of the perceived successes of the deployment planning process that resulted in a regional ITS architecture. Both MPOs have incorporated ITS into their regional transportation plans and improvement programs.

"Scanning tours proved to be phenomenally successful. I believe they were the best instrument for the money. For example, after we took the SANDAG chair to view ITS projects in Detroit, he gave $50 million to the corridor a few weeks later."
— Mike Morgan, Chief Executive Officer, AFM Transportation Services, Inc.

"Using the National Architecture allows consultants and agencies the flexibility to go to any vendor and build and deploy as they desire."
— Jim Kerr, Vice President of Systems Engineering, NET Corportation

"Bringing together existing institutions rather than creating brand new ones was a major reason for the success of the development effort."
— George Smith, Program Manager, New Technology and Research, Caltrans

Lessons Learned

The transit task force was able to focus on key operational issues that are of particular interest to transit.

"If we develop a traffic sensor, will that be used for management purposes? Information purposes? How does it relate to commercial vehicles? To the public? And so on. So with the National Architecture setting the framework for these activities it creates a smoother process going from vision to actual implementation."
— **Dean Delgado, Principal Transportation Analyst, Orange County Transportation Authority**

- *Tailor the Process to Stakeholders.* In the case of Southern California, the regional teams each coincided with a Caltrans district office jurisdiction, and thus include stakeholders who were already familiar with one another and had interacted with the Caltrans district and MPO through past studies. This arrangement drew stakeholders together based on traditional affinities. It also allowed local agencies the opportunity to focus on issues involving nearby jurisdictions, which were of greater interest than distant ones. In addition, task forces organized by focus topic allowed stakeholders with a common interest to meet and discuss themes of mutual interest. For example, the transit task force was able to focus on key operational issues that are of particular interest to transit.

- *Consider an Object Oriented Approach.* Use of an object oriented design approach was considered essential in Southern California due to the large number of legacy systems to be integrated rather than scrapped.

References and Additional Resources

Web Sites

Caltrans New Technology and Research Program Homepage:
http://www.dot.ca.gov/hq/newtech/

Southern California Priority Corridor Strategic Deployment Plan (1998):
http://www.dot.ca.gov/hq/newtech/docs/deploy_plan.pdf

Corridor Steering Committee Meeting Minutes (Beginning July 1996):
http://www.dot.ca.gov/hq/newtech/arc_cht.html

Southern California Showcase Project / Architecture Documentation:
http://www.odetics-its.com/showcase

Select Bibliography

"Advanced Transportation Systems Program: Summary". Prepared by the California Department of Transportation, New Technology and Research Program (January 1998).

"Crossroads: A Newsletter of Southern California Rideshare". Southern California Association of Governments: Los Angeles, CA (January 21, 1999).

"Los Angeles and Ventura Region Intelligent Transportation Systems Strategic Deployment Plan: Technical Memorandums". Prepared by: National Engineering Technology Corporation, La Miranda, CA (October 1998).

Horan, Thomas, et al "Policy Review of ITS Priority Corridors: Revised Draft". Prepared for COTR (August 1, 1996).

"Review of the Transportation Planning Process in the Southern California Metropolitan Area", RSPA/VNTSC-SS-TM392-03. Prepared by the US Department of Transportation Research and Special Programs Administration, Volpe National Transportation Systems Center (August 1993).

"Showcase: Intelligent Transportation Systems (ITS) Strategic Deployment Plans for the Southern California Priority Corridor". Prepared by: Odetics: ITS, Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (March 1998).

"Southern California ITS Priority Corridor Strategic Deployment Plan: Interim Report". Prepared by the Southern California ITS Priority Corridor Steering Committee (August 1998).

"Southern California Priority Corridor Intermodal Transportation Management and Information System (Showcase) Scoping and Design: Task 2 – System Architecture Working Paper". Submitted by Transportation Systems: Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (November 15, 1996).

References and Additional Resources

"Southern California Priority Corridor Intermodal Transportation Management and Information System (Showcase) Scoping and Design: Task 3.1 – Draft Implementation Plan". Submitted by Transportation Systems: Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (January 10, 1997).

"Southern California Priority Corridor Intermodal Transportation Management and Information System (Showcase) High Level Design: Task 8 – Final Kernel to Early Start Interface Requirements". Prepared by Odetics ITS: Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (July 16, 1998).

"Southern California Priority Corridor Intermodal Transportation Management and Information System (Showcase) High Level Design: Task 9 – Final Candidate Architectures Trade-Off". Prepared by Odetics ITS: Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (July 11, 1998).

"Southern California Priority Corridor Intermodal Transportation Management and Information System (Showcase) High Level Design: Task 10 – Final Kernel System Design Report". Prepared by Odetics ITS: Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (April 24, 1998).

"Southern California Priority Corridor Intermodal Transportation Management and Information System (Showcase) High Level Design: Task 11 – Draft Kernel Design Document". Prepared by: Odetics ITS: Anaheim, CA; and National Engineering Technology Corporation: La Miranda, CA (August 17, 1998).

References and Additional Resources

Individuals Interviewed

The authors wish to thank the following individuals who were interviewed and/or provided other support in the preparation of this case study report:

CALTRANS:
George Smith, Program Manager, New Technology and Research
Patrick Conroy, Rural/Multimodal Research Chief
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Ali Zaghari, Showcase Project Manager
Hamed Benouar, Program Manager, Traffic Operations

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Regional Agencies:
Robert Huddy, Senior Transportation Planner, Southern California Association of Governments/Steering Committee Transit Task Force Chair
John Duve, Advanced Transportation Systems Manager, San Diego Association of Governments
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Cities / Counties:
Anson Norby, Principal Transportation Engineer, Bureau of Field Operations, City of Los Angeles DOT
Verej Janoyan, Senior Transportation Engineer, City of Los Angeles DOT
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Frank Cechini, Statewide ITS Manager, FHWA California Division
Pam Marston, ITS Engineer, FHWA/FTA Los Angeles Metro Office
Ervin Poka, Team Leader, FHWA/FTA Los Angeles Metro Office

Consultants:
Ed Rowe, Vice President, Odetics ITS
Arya Rohani, Regional Vice President, Odetics ITS
Jim Kerr, Vice President of Systems Engineering, NET Corporation

Notes

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

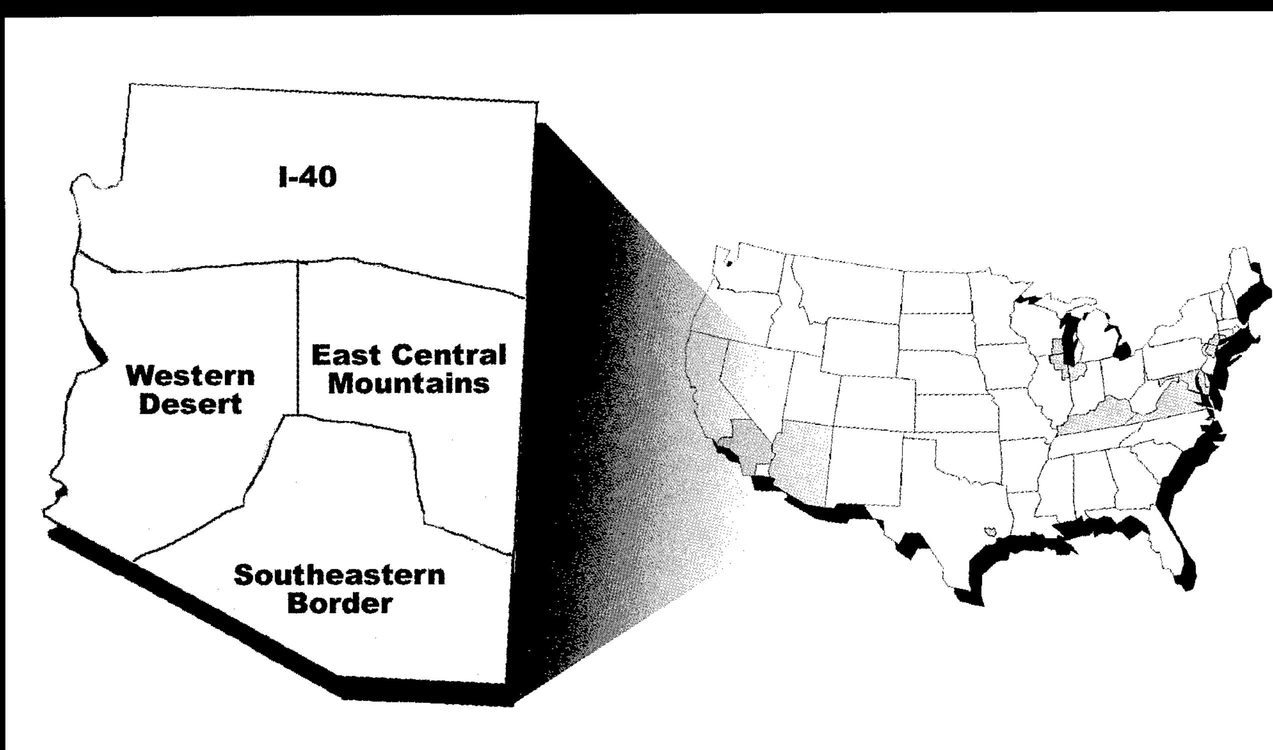
Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

Statewide ITS Architecture Development

A Case Study

Arizona's Rural Statewide ITS Architecture



Building a Framework for Statewide ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

NOTICE

The United States Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the objective of this document.

Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/ statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. The seventh study is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support by the Volpe Center.

This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Case Study Overview

In December 1998, the Arizona Department of Transportation (ADOT) completed a comprehensive effort to develop a *Strategic Plan for Statewide Deployment of Intelligent Transportation Systems* (ITS). As one of the first in the nation, Arizona's Statewide ITS Strategic Plan represents the culmination of an institutional commitment to build a statewide ITS infrastructure to improve both the safety and efficiency of the state's transportation system. This case study offers insights on:

- How using the National ITS Architecture can save time and resources, guarantee that potential links between systems are not overlooked, and assure consistency with federal-funded requirements.
- How ADOT used their Community Relations Office to solicit input from a large and diverse group of stakeholders which contributed to the success of both the statewide and earlier I-40 Corridor architecture development efforts.
- How incorporating input from non-traditional stakeholders such as the National Park Service, the National Weather Service, and the railroad agencies created a final product diverse and flexible enough to meet, and prioritize, the short and long-term needs of the entire state.
- How the lessons learned during development of the Early Deployment Plan for the I-40 Corridor in northern Arizona served as the framework for the subsequent statewide effort.

Background

In Arizona, 57% of all fatal crashes occurred in rural areas although this accounts for only 19% of the total crashes in the state.

Rural roadways account for over 70% of total roadway mileage in Arizona and over 90% of ADOT's highway network. Arizona also contains the second highest percentage of federally or Native American controlled land in the country. Dealing with sovereign Indian nations, and the land use restrictions on federally protected parklands, further complicates transportation planning efforts.

Extreme weather and geography, coupled with few urban centers, makes thousands of miles of Arizona's rural transportation network difficult to access. Safety is a primary concern since emergency services are limited. On average, the emergency response time in Arizona's urban areas is 6.7 minutes compared with 16.2 minutes in rural regions, almost 2.5 times longer. Statewide crash statistics show that 57% of all fatal crashes ocurred in rural areas although this accounts for only 19% of the total crashes in the state.

Since Arizona is predominately rural, ADOT was an early and active participant in the development of the national Advanced Rural Transportation Systems (ARTS) strategic plan. Hosted by the Intelligent Transportation Society of America (ITS America), these efforts addressed distinctly rural needs in the context of the National ITS Architecture that, although developed with both metropolitan and rural context in mind, initially provided more detail only on metropolitan applications.

ITS Architecture Development Process

Pre-Statewide ITS Architecture Deployments

The Arizona Department of Transportation, in conjunction with the Federal Highway Administration (FHWA) Arizona Division Office, has spent the last portion of the decade deploying various elements of the statewide Intelligent Transportation System. These include the following:

Advanced Traveler Information Systems (ATIS) Initiatives:

- *Arizona TripUSA.* ADOT negotiated with private companies to build a traveler information system for Northern Arizona that includes information on road closure, weather, local attractions, and services to travelers in that region. The information is disseminated through kiosks, personal computers, radios, televisions, a toll-free number, and the Internet.
- *The Trailmaster Highway Closure and Restriction System (HCRS)* allows transportation and highway patrol personnel to enter real time highway closure and restriction information into a central system and then provide that information to the traveling public through toll free phone numbers, the Internet, and strategically placed kiosks.
- *AZTech kiosks for I-40.* Four kiosks were installed at truck stops and tourist information centers along Interstate 40 as part of the Phoenix metropolitan Model Deployment Initiative (MDI).
- *Variable Message Signs (VMS) in Rural Areas.* To date, ADOT has installed 7 VMS units to provide motorists with information on incidents, weather, and traffic conditions. The signs advise motorists of upcoming hazards and alternative routes. Due to the success and cost-effectiveness of the initial 7 VMS units, ADOT plans to install 24 more signs in the next 2 to 3 years, followed by an additional 24 signs in the future.

Commercial Vehicle Operations (CVO) Initiatives:

- *The Heavy Vehicle Electronic License Plate Program (HELP)* is a multi-state, multi-national effort to design and test an integrated heavy vehicle monitoring system based on ITS technologies. Arizona was a partner in this project and served as an operational test site.
- *PrePass* is a technology that electronically weighs trucks and verifies their identities as they approach weigh stations. In 1996, Arizona added to the existing California and New Mexico PrePass network by adding ten Arizona sites and introducing the service to Arizona ports of entry.
- *Expedited Crossing at International Borders (EPIC)* is an automated truck clearance system set up to electronically check vehicles at the increasingly congested Nogales crossing of the U.S.-Mexican border.

Arizona Statewide ITS Architecture Timeline

1994 Strategic Plan for ITS Communications initiated

1995 ARTS Workshop

1996 I-40 Corridor ITS Strategic Plan initiated

Rural ITI Plan developed

1997 ADOT receives $250,000 from U.S. DOT for statewide ITS Early Deployment Plan

Statewide ITS Strategic Plan initiated

1998 Statewide ITS Strategic Plan completed

1999 ADOT considering options for incorporating metropolitan ITS deployment plans to establish a comprehensive statewide ITS deployment framework

ITS Architecture Development Process

More information about the Intelligent Variable Speed Limit Device is available at: http://www. cse.nau. edu/~adot

Communications and Standards Initiatives:

- *The ITS Communications for Arizona* project identified communication technologies that are suitable to support the deployment of ITS service in the state.

- *ENTERPRISE and the International Traveler Information Interchange Standard (ITIS).* As a member of ENTERPRISE (a coalition of states with rural ITS interests), ADOT sponsored the research and evaluation of communications standards for traveler information dissemination. The ITIS standard, which is used in Arizona's traveler information systems, allows ATIS systems to exchange traveler information between in-vehicle systems, traffic and transit information providers, traffic control centers, police and fire departments, and transit authorities.

Traveler Safety Initiatives:

- *Intelligent Variable Speed Limit Device* is an ADOT-sponsored Northern Arizona University research project to develop a fuzzy logic control algorithm for highway speed limits. By analyzing road condition and weather variables, the algorithm can change speed limits to meet safe speed guidelines developed by highway maintenance staff and state public safety officers.

- *Road Weather Information System.* Ten weather stations were installed along areas of the I-40 corridor most prone to snowstorms and freezing. Collected between October and May, the weather and road condition data allows District Engineers to optimize their allocation of snowplows to areas that need it most.

All of these projects improved the safety and efficiency of rural transportation and raised the awareness of ITS technologies. However, because of the constraints associated with rapid advancements in ITS technology, funding, institutional coordination, and evolving state level ITS program guidelines, these deployments have been made without a detailed plan or underlying architecture. Moreover, since the majority of these projects were developed to address specific, often regional, needs that were identified under separate studies, the synergy associated with an integrated ITS network could not be realized.

The Early Deployment Plans

In an attempt to create an integrated ITS infrastructure, several ITS champions at ADOT led efforts to develop three Early Deployment Plans (EDPs) — one each for the Phoenix and Tucson metropolitan areas and, significantly, one for the rural I-40 corridor in northern Arizona.

ITS Architecture Development Process

The federally funded plans played a pivotal role in building awareness of ITS technologies. The prospect of receiving federal funds brought together a broad array of decision-makers from federal, state, and city transportation and planning agencies. The 1996 selection of Phoenix as one of only four MDI sites further increased the awareness of ITS technologies at ADOT headquarters. However, because many of the issues dealt with in the metro areas were unrelated to the rural context, the lessons learned from the I-40 experience established the impetus and framework for the subsequent statewide ITS planning effort. The following section examines in detail many of the dynamics of the I-40 process to enable readers to benefit from that experience, as well as the statewide architecture development process.

"Without federal funding for the earlier EDPs, the statewide ITS architecture would probably never have been developed."
— Timothy Wolfe, ADOT Assistant State Engineer and Director of ADOT ITS Projects

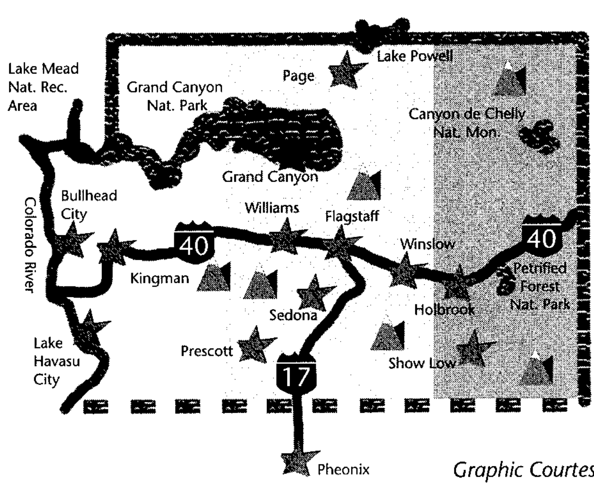
The I-40 Corridor ITS Strategic Plan

Begun in March 1996, the I-40 ITS strategic deployment planning and architecture development process is a story of influential ITS champions, dedicated stakeholder participation, diverse roadway users, and, most of all, common interests based on a 359-mile stretch of highway.

The I-40 corridor stretches across Northern Arizona, traversing some of the most variable terrain in the country. From an elevation of approximately 600 feet at its desert beginnings in Western Arizona, the corridor rises to 7,330 feet at its highest point near Flagstaff. This variability makes it possible that, within only a few hours, a driver will experience both warm weather and winter driving conditions along different portions of the highway.

Temperatures along the corridor can range from over 100 degrees Fahrenheit in the summer to subzero winter lows, with Flagstaff receiving an average annual snowfall of 100 inches.

Besides weather variability, the I-40 corridor frequently experiences the full gamut of weather phenomena ranging from winter blizzard conditions to severe thunderstorms that can produce large hail and winds in excess of 60 mph. These winds pose particular hazards to high profile vehicles such as trucks and recreational vehicles. Winds throughout the corridor can also shift unexpectedly, causing smoke from controlled forest burns or desert dust to blow across the roadway and reduce visibility. The steep grades also reduce sight distances and create hazardous speed gradients between truck and passenger car traffic.



Graphic Courtesy of Arizona TripUSA

ITS Architecture Development Process

"Pileups kill 6, hurt dozens on icy I-40 near Flagstaff: Lawmen describe carnage as worst they've ever seen."
— The Arizona Republic, December 31, 1989

I-40's weather and geography affect an unusual range of drivers. As one of the nation's primary east-west interstate corridors, large commercial vehicles account for 35-40% of I-40's traffic, 70 -80% of which are "long-haulers" traveling through the state. With thousands of trucks carrying goods across northern Arizona every week, any I-40 delays can disrupt commerce from Southern California to the Midwest.

Tourist traffic also makes up a significant portion of I-40 users. Northern Arizona is blessed by a remarkable diversity of natural treasures, many of which are preserved in protected areas accessible along the length of the corridor. These include nearly 20 major parks including the Grand Canyon and the Petrified Forest National Parks. The Grand Canyon alone receives nearly 5 million visitors a year.

Architecture for the I-40 Corridor

Graphic Courtesy of Arizona TripUSA

Other tourist attractions along I-40 include the longest remaining segment of U.S. Route 66 which parallels the corridor, as well as the Hopi, Navajo, Hualapai, and Havasupai Indian tribal communities that adjoin the corridor and also attract visitors. The special needs of tourists for travel information, coupled with the reliance of I-40 communities on tourist dollars, played a driving role in development of a rural ITS architecture for the I-40 corridor.

I-40's combination of weather and geography, commercial traffic, and tourist destinations made the corridor an excellent location for rural applications of ITS technologies. Begun in March 1996, the goal of the 12-month effort was to create a strategic plan for ITS technologies along the I-40 corridor while creating a cohesive coalition of stakeholders in both Arizona and neighboring corridor states (California and New Mexico), with the possibility of expanding it along the entire route.

Funding came from a combination of state and federal sources. ADOT contributed $80,000 of its federal-aid highway planning and research funding, and received an additional $200,000 in ITS funds (plus state matching funds) to begin what was then one of the first rural EDP efforts in the country.

The first task was to identify the people, organizations, and agencies with vested interests in finding solutions to transportation needs along the I-40 corridor. This was a considerable undertaking. The consultant compiled a list that contained around 450 individuals representing a wide cross-section of public and private stakeholders who were invited to participate in the process. About 50 people responded and became the core constituency. The others who did not express interest in being active participants were kept updated through quarterly newsletters.
The consultant also worked closely with the ADOT Community

Relations Office, which has a full time staff member assigned to ITS-related projects. Together they organized a series of public forums and a public workshop which helped introduce ITS and the goals of the I-40 Strategic Plan to interested stakeholders. The most effective means of coalition building proved to be bringing in influential "key stakeholders" early on in the process because they were the most effective recruiters of other participants.

Key Stakeholder Involvement

The development of the I-40 strategic plan and statewide architecture is a testimonial to the importance of ITS advocates. From the very beginnings of the process, a few influential stakeholders used their foresight and awareness of the benefits of an integrated ITS architecture to catalyze the development process. Convened with the help of a dedicated and enthusiastic ITS consultant, and united in their appreciation of the potential of ITS applications to solve their unique transportation problems, these stakeholders defined the needs of their community and created a realistic blueprint to achieve it. The ITS champions involved in the I-40 Strategic Plan illustrate three categories of advocates for a successful development of a rural ITS architecture and strategic plan:

"ITS Technology has the potential to greatly improve the safety and efficiency of rural transportation systems."
— Rodney E. Slater, Secretary of Transportation

Early Champions

The first category is **early champions**, often transportation professionals who successfully convinced their peers to consider adopting and integrating ITS technologies to make the existing transportation system safer and more efficient. Of the several dozen people interviewed for this study, the vast majority mentioned that they were initially introduced, and brought into the process, by a relatively small group of individuals. These few people were the early visionaries, individuals with the foresight, enthusiasm, and drive necessary to motivate the development effort. In the Arizona case, the early champions also went on to play leading roles throughout the process by providing technical, political, or policy support to the Technical Advisory Committee, the primary executive oversight group.

"To have new, innovative ITS technologies operational throughout the I-40 corridor, providing a safer and more efficient intermodal transportation system, meeting the short and long-term needs of visitors, local communities, commercial operators, and the traveling public."
— I-40 Corridor Vision Statement

The earliest visionaries came out of ADOT's Transportation Research Center. Their position as managers of most of the ITS research and planning in ADOT allowed them to appreciate the benefits of developing a statewide strategic deployment plan. Moreover, they understood how an underlying architecture could help ensure that future projects would be designed to accommodate existing ITS technologies and be deployed in a coordinated way. The statewide architecture's short-term (1999-2001), mid-term (2002-2007), and long-term (2008 and beyond) plans also created the necessary blueprints showing how to best prioritize and integrate future ITS projects.

ITS Architecture Development Process

The ADOT Transportation Research Center managers were also aware of the development of the National ITS Architecture and could see that future ITS projects funded with federal dollars eventually needed to fit within the national framework. Expected to continue their leadership role at ADOT post-development, several observers felt that the Transportation Research Center is now the de facto custodian of the statewide architecture, and are confident that the Center would continue to be a positive unifying force during the 20-year implementation phase.

The primary consultant was also instrumental in both the I-40 and statewide efforts. By all accounts, the consultant went "above and beyond" what was expected of a consultant, and further championed the process through leadership roles with ITS Arizona, a public/private organization formed as a state chapter of ITS America.

The Federal Highway Administration's (FHWA) Arizona Division office also was essential to early facilitation of the development process. Cognizant of the intent of the National ITS Architecture development process, the FHWA worked hard to get the Arizona transportation community thinking about ITS, and supplied them with useful information. As part of this effort, FHWA representatives served on the Technical Advisory Committees and attended many of the outreach sessions. Another important contribution from the Arizona FHWA division was arranging for the U.S. DOT National ITS Architecture course to be given in support of the development of the statewide architecture. Many of the stakeholders cited the architecture course as extremely significant in developing their own awareness and understanding of the National ITS Architecture.

Federal EDP guidelines determined much of the development process. Moreover, although a strong initial motivation for developing the statewide architecture was the availability of federal EDP funding, the process allowed stakeholders to realize the inherent value of an ITS architecture, and they are now considering how to integrate the statewide and metropolitan frameworks.

The transportation planning community also played an important role by contributing a planning perspective emphasizing that the process could never reach its full potential unless it was very open and extremely participatory. These views were consistent with the intent of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and its 1998 reauthorization as the Transportation Equity Act for the 21st Century (TEA-21), which emphasizes public review and participation in transportation planning efforts. The planning perspective also advocated focusing on multimodal strategic plans, rather than just on highways.

ITS Architecture Development Process

Local Advocates

The second category is local advocates, transportation professionals who appreciated the potential of ITS applications to solve their local issues and actively participated in the planning effort. Without buy-in from local and regional transportation professionals, developing and implementing a regional ITS architecture would be impossible. Local governments know best the unique needs of their regions and know who needs to participate in the process for it to be successful. During the I-40 plan, local ADOT staff used their established professional and personal relationships to bring together a diverse group of stakeholders.

Local governments know best the unique needs of their regions and know who needs to participate in the process for it to be successful.

With no alternative routes and the corridor's severe weather and geography, the local District Engineers already had a history of relying on technology to improve traveler safety and minimize road closures. As early as twenty years ago, radios were used by the state police and highway districts to share road condition information, however, this tapered off as the agencies upgraded independantly to incompatible systems. Over the years, the districts added other technologies such as weather sensors and variable message signs (VMS) and have continued to improve their communication links along the corridor. In fact, some of the District Engineers were such strong ITS advocates they were using their limited discretionary funds for ITS technologies even before the development of the I-40 Strategic Plan.

"We used our discretionary funds on ITS projects because I-40 incidents can cause life and death situations. Once you get a major accident, there is no way to access people stuck in the queue and they have no access to facilities. People have had heart attacks and even babies while stuck out there."
— Jeff Swan, Holbrook District Engineer

The District Engineers were also instrumental in gathering the third category of ITS advocates, the proactive stakeholders. With decades of experience working in the area, the Engineers were able to access their professional and personal networks to include interested parties into the development process.

Proactive Stakeholders

The third category is **proactive stakeholders**, interested parties who are not directly involved in building or maintaining the transportation infrastructure. Typically, they are individuals associated with transportation issues, politicians or concerned citizens, or other interested parties who understand how ITS applications can help solve their own issues and concerns.

Non-traditional Stakeholders

Beyond ADOT transportation professionals, other stakeholders contributed valuable perspectives to the development of the I-40 Strategic Plan. The Arizona Department of Public Safety (DPS) was all too aware of the unusual and sometimes hazardous driving conditions in Northern Arizona. Having dealt with tourists stuck in snowstorms wearing only the summer clothing they had on when they headed to the mountains from desert regions, DPS staff recognized how ITS technologies could help disseminate weather and road condition

"The key to the success of the I-40 Plan was that people felt like they were in this together."
— Lt. Jim Gerard, Flagstaff Patrol District Commander, Arizona DPS

information. Moreover, deployment promised to create a more efficient system that better utilized the existing work force and gave the traveling public a better appreciation and trust of the law enforcement community. Existing relationships played a significant role in DPS's participation. The DPS, which in the past had been co-located with ADOT district offices, had a history of working closely with ADOT on issues such as snowplow coordination.

"I-40 stakeholders participated as professionals, but everyone at the table had friends, family, and loved ones who use the corridor and will benefit from the process."

— Michael McCallister, BNSF Field Engineer, and I-40 Coalition Chairman and TAC Member

Burlington Northern Santa Fe Railway (BNSF) was another proactive stakeholder. Although not readily apparent, BNSF has significant interactions with the I-40 Interstate. Their tracks parallel much of the corridor allowing them to benefit from highway-based ITS advances such as accurate weather information. Additionally, BNSF relies on the I-40 to shuttle train crews to where they are needed. In fact, the enthusiastic participation and ability to engage others made a participating BNSF Field Engineer the consensus pick for chairing the I-40 Coalition. In many ways, he was an ideal choice. He was an objective facilitator who did not support any pet projects at the expense of others and he listened to the diverse input of Technical Advisory Committee participants. The chair benefited from having the time and support necessary to prepare for meetings and related responsibilities. Burlington Northern Santa Fe supported his efforts, while the consultant provided logistical and secretarial support and handled the technical details of architecture development.

Non-transportation Stakeholders

A number of non-transportation stakeholders also collaborated to develop the I-40 Strategic Plan and Architecture. The National Oceanic and Atmospheric Administration (NOAA), which maintains a weather service forecasting office near Flagstaff that covers the I-40 corridor, was invited to participate by the Flagstaff ADOT District Office. This was another example of the admirable diversity of the I-40 stakeholder coalition.

For NOAA, their participation furthered their public safety mission to disseminate timely weather information to the public.

The relationship turned out to be beneficial for everyone involved. ADOT and the I-40 coalition realized that they could receive and utilize weather forecasts rather than just current weather conditions. Additionally, NOAA helped ADOT determine optimal sites for weather-related road sensors. For NOAA, their participation furthered their public safety mission to disseminate timely weather warning and forecast information to the public. Incorporating weather services into the regional architecture also allows them to receive data back from the field that can be incorporated into their forecasting models. For example, since NOAA collaborated with ADOT's northern districts, ADOT has installed upgraded radios in snowplows that allow operators to hear the latest warnings and forecasts via NOAA's Weather Radio. Additionally, the operators can now relay real time meteorological information back to NOAA's forecast office allowing the meteorologists to verify the accuracy of their information as well as provide input to improved warning and forecast models.

The Grand Canyon National Park was also very interested in the potential to share information using ITS technologies. As the region's major tourist attraction, the Grand Canyon is having trouble accommodating the millions of visitors it receives each year. For example, tourists will often travel hundreds of miles to the park assuming that lodging will be available for them when they arrive. Park officials saw using ITS technologies such as Variable Message Signs (VMS), traveler information kiosks, Internet-based dissemination, and weather information systems as innovative and cost-effective ways to help manage the growing number of visitors. Moreover, they realized that linking themselves to the I-40 regional architecture would allow them to better disseminate their own information such as lodging availability, park hours, road conditions, and event notices.

Local politicians were another constituency critical to the success of the I-40 Strategic Plan. Virtually every interviewee cited the mayors of Winslow and Bullhead City as real champions of the development process. Since both cities adjoin I-40 and rely heavily on income provided by tourist traffic, the mayors understood instinctively the opportunities presented by ITS technologies. VMS signs could steer stranded passengers to their city motels or kiosks, and in-vehicle information devices could advertise their businesses and attractions. Moreover, because I-40 was literally their lifeline to the outside world, they welcomed any technologies that could help ease winter travel. As community leaders, the mayors were also able to represent local interests and provide the local support crucial for community acceptance and adoption of ITS technologies. Flagstaff, the de facto capital of Northern Arizona, also participated but to a lesser extent. Although interested in rural applications such as traveler information kiosks, they felt their more immediate needs were best solved by urban ITS technologies like traffic signal controls. Their participation did, however, assure that future projects were equally dispersed between I-40 cities and created an awareness of the regional ITS architecture that will be incorporated into their Transportation Improvement Program (TIP).

Brought in by the ADOT District Engineers in their respective regions, the mayors understood instinctively the opportunities presented by ITS technologies.

Tribal communities adjacent to the I-40 corridor also participated in the development process. Although their attendance was inconsistent, it was impressive given their need to travel at least 6 hours in each direction to attend. Their story is noteworthy. Initially, the Native American governments felt that ITS technologies were not that relevant to their needs because of their low traffic volumes. However, by participating in the process, the tribes became more aware and interested in ITS, particularly in the areas of Incident Management and MAYDAY technologies.

"It's important to get the communities on board and interested in implementing the technology. It allows us to take advantage of many opportunities to inform the public about our communities."
— Norm Hicks, Mayor of Bullhead City

Limited Participants

There were, however, notable exceptions:

- Some smaller communities did respond to initial invitations, but most dropped out because, with few staff, they had trouble making the time to take the day off to attend a meeting or read the considerable amount of background material.

- Involvement from the business community was also limited. Although they participated occasionally in the I-40 and statewide development process, their involvement was infrequent.

- The transit community was also involved in the process and their needs were incorporated into the Statewide ITS Architecture. This is significant because transit services are limited in many rural areas of the state.

- The trucking community adopted a wait-and-see attitude to the development process. Their reasons were probably multifaceted. Many of the biggest firms are based in Phoenix and are less interested in Northern Arizona activities. Ironically, with so many trucks relying on the I-40 corridor, truckers have the most to gain from ITS technologies such as weather and road closure information. Additionally, they have a lot of local knowledge and experience to potentially contribute. The lessons learned during the I-40 effort led ADOT and its consultant to intensify their efforts to draw in truckers by contacting trucking company owners and handing out newsletters and information at ports of entry. However, despite their efforts, the trucking community did not participate in the subsequent statewide effort either.

Ironically, with so many trucks relying on the I-40 corridor, they have the most to gain from ITS technologies such as weather and road closure information.

Rural ITS Infrastructure Needs

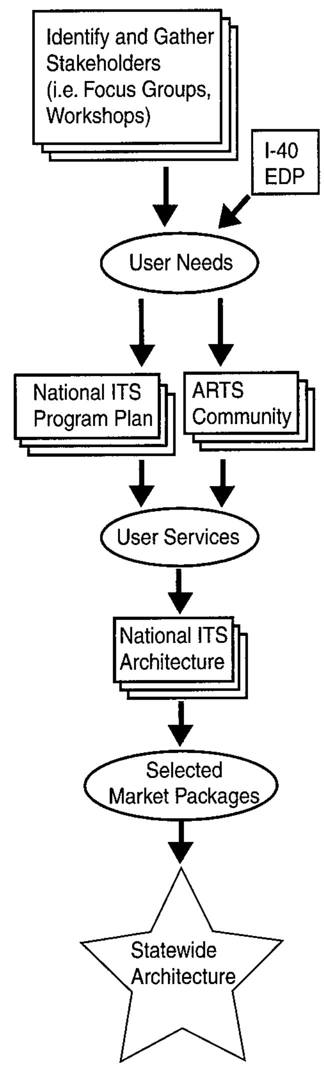
An ADOT initiative to take stock of its rural intelligent transportation infrastructure needs was another important interim step towards the eventual statewide architecture development effort. Begun a few months after the initiation of the I-40 effort, the initiative resulted from a recognition of the need for a more systematic approach to assessing statewide ITS needs. As a requirements assessment, the study evaluated statewide needs related to 16 different ITS components. For each technology, ADOT identified a specific purpose and criteria with which to identify potential locations for future installations.

The initial meeting to assess ITS infrastructure needs was held at ADOT headquarters in August 1996. Every ADOT District Engineer, Maintenance Engineer, Maintenance Supervisor, and ITS-related stakeholder in the state was invited to attend. In the months that followed, the ADOT Intermodal Transportation Division Technology Group that headed the effort, traveled across Arizona and met with each

District Engineer to identify the unique needs of their districts. After compiling all of the data they received, ADOT sent each district a list of ITS needs and asked them to rank each need as high (within one to three years, something the district would be willing to fund with their discretionary project money), medium (within four to seven years, to be included in the ADOT 5 year program), or low priority (eight-plus years, would be initiated whenever funds became available). Responses were then analyzed and a 10-year, $33 million ITS strategic deployment plan for rural areas was developed and published in February 1997.

The success of the needs assessment initiative in establishing a comprehensive view of ITS technologies, its recognition of the unique needs of diverse areas, and the incorporation of input from a large number of stakeholders, all laid the foundation for the subsequent statewide deployment planning/architecture development effort.

Statewide Rural Architecture Development Process



Statewide ITS Architecture Development

The Strategic Plan for Statewide Deployment of Intelligent Transportation Systems was launched in October 1997, shortly after successful completion of the I-40 Strategic Plan. Although the statewide process built upon the I-40 project, a major effort was made to consider the unique needs of various regions of Arizona rather than accept the I-40 framework. In addition, the Statewide Plan provided an opportunity to affirm ADOTs internal ITS infrastructure needs assesment through broader stakeholder involvement.

An objective of the Statewide Strategic Plan was to create a comprehensive, statewide architecture for deploying integrated and interoperable ITS technologies. The project study area was defined as the state of Arizona, excluding areas already covered by EDPs — Phoenix, Tucson, and I-40. Since Arizona is predominantly rural outside Phoenix and Tucson, the statewide plan focuses almost exclusively on rural issues.

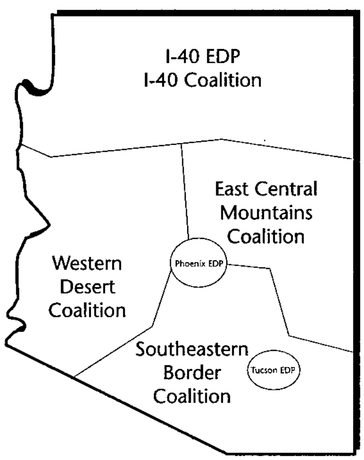
With many of the same key players providing direction and input through a statewide Technical Advisory Committee, the procedural aspects of the effort went smoothly. In fact, the I-40 consultant (who also proposed successfully on the statewide project contract) was able to apply the lessons learned in the 18-month I-40 effort to complete the more extensive statewide process in about a year.

The Strategic Plan consisted of the nine tasks based on the ITS deployment planning process, as outlined in the National ITS Program Plan. These nine steps were collapsed into the following five tasks:

1. **Identify Stakeholders and Develop Public Information Campaign**

   As with I-40, considerable effort went into gathering stakeholders to establish a strong technical and policy-oriented base of support for future ITS deployments. ADOT's Community Relations Office led the

Regional ITS Architecture Rural Coalition Areas



Graphic Courtesy of ADOT / Kimley-Horn

outreach effort with consultant support. In late 1997, ADOT and FHWA sponsored two Rural ITS Workshops and four focus group meetings around the state that provided attendees with an in-depth look at ITS deployments in rural areas. An effective outreach strategy proved to be getting on the agendas of other meetings that potentially interested stakeholders attended. These efforts identified over 900 potential members for the statewide ITS development coalition, of which about 100 actively participated. Interestingly, the 10% participation ratio was similar to the I-40 effort.

Project fact sheets and quarterly newsletters were the primary means of keeping the 800 or so non-participating stakeholders informed of the process. ADOT also received positive coverage from the news media. Stories were focused primarily on the technologies and how these could affect people's lives, rather than on the integration and architecture aspect.

2. **Assessing Rural Arizona's Transportation Needs**

The needs identified from the focus group and coalition meetings formed the basis for the technology assessment and Strategic Plan. From over 200 needs cited, 76 independent need statements were developed. Traveler information based on real-time roadway conditions, such as route information, weather warnings, or detour directions dominated the concerns of the participating rural transportation users. Other desired applications included improved emergency service communications and response time and improved information sharing and communication among agencies. It is important to note that, like the earlier I-40 effort, almost all of the stakeholders focused on particular ITS applications, rather than on systems integration, interoperability, or conformity.

Three regional architectures were created, one for each of the areas in the statewide effort: the Western Desert Coalition, the East Central Mountains Coalition, and the Southeastern Border Coalition. These divisions show a recognition that the ITS solutions for each area would vary based on the unique needs of each region. In fact, ADOT originally divided the statewide effort into two regions, but as the process went along they realized that the state divided more naturally into three regions, in addition to the I-40 corridor.

3. **Integrated User Needs Plan**

With its needs identified, the study team began matching needs with the 31 ITS user services described in the National ITS Program Plan, and the six supplemental user services defined by the ARTS program. User services were then prioritized and grouped into common deployment timeframes based on common technologies or similar objectives.

Market packages were then selected to provide these services. Market packages provide an accessible deployment-oriented perspective to the National ITS Architecture. They are tailored to fit real world transportation problems and needs. Out of the 56 market packages outlined by the National ITS Architecture, 49 were selected as candidates for deployment in Arizona.

This complex process resulted in a comprehensive set of ITS objectives, technologies, and timeframes that served as the basis for the subsequent system architecture. However, several interviewees felt, in hindsight, that it might have been wiser to exempt stakeholders from the convoluted process of matching needs to user services and market packages. Besides stalling the momentum of the coalition, which caused some people to drop out, direct stakeholder involvement is not critical since trained staff or a consultant can follow the guidelines articulated in the National ITS Architecture and come out with essentially the same results.

4. System Architecture

As in the I-40 effort, the consultant took on the technical burden of mapping user needs to the user services, market packages, and the regional ITS architecture. The consultant relied heavily on the National ITS Architecture and a database that was created to map architectural relationships. Thanks to the National ITS Architecture, some data flows that were not originally considered were identified and included. The chart on the next page graphically represents the Statewide ITS Architecture Concept and shows the interconnections between various agencies and other subsystems.

5. Deployment Funding Requirements

By completing a detailed deployment plan, ADOT was also able to formulate their future budget requirements. They based it on the current prices for communications, field hardware components, and the cost of constructing, operating, and maintaining the system for the next 15 years. The following table is based on the recommendations of the Statewide Strategic Plan:

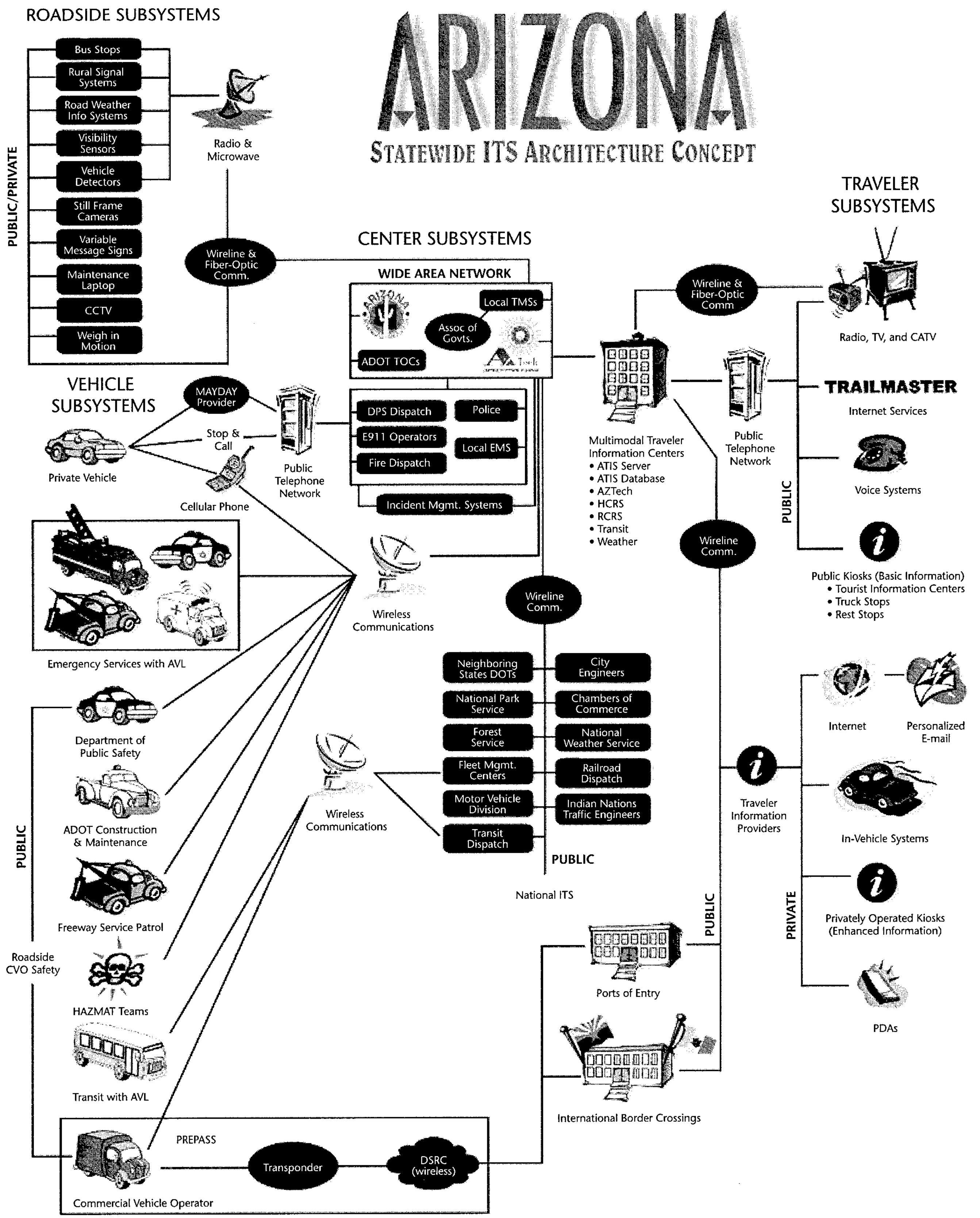
ITS Communication Infrastructure	- $4,015,000
Field Hardware/Software	- $45,940,000
Other Deployment Efforts	- $500,000
System Design, Contingency, Construction Engineering	- $20,182,000
Operations and Maintenance	- $37,841,000
TOTAL	**- $108,478,000**

Corresponding private investments, estimated to be about twice as much as public investment, are expected to total around $200,000,000 over the next 15 years.

An ITS architecture describes how system components fit together and interact or communicate between themselves.

- The functions that will be performed by a system
- The physical subsystems where those functions reside
- The interfaces and information flows between the physical subsystems
- The communications requirements for the information exchanges.

ITS Architecture Development Process



Graphic Courtesy of ADOT / Kimley-Horn

ITS Architecture Development Process

The statewide ITS strategic plan and architecture is the culmination of a 12 month data collection, technology identification, and feasibility analysis effort. Having a comprehensive, long-term view helps convince legislators of the utility of providing timely, project-specific funding; a dynamic confirmed in the aftermath of a June 1998 accident on Interstate 17, the primary route between Phoenix and Flagstaff. After a collision in the southbound lane, 25,000 people returning home to Phoenix from a weekend in the cooler northern mountains were stuck in a 30-mile queue in the middle of the desert without any services. With cars running out of gas, one boy having to be airlifted for medical treatment, and a woman being airlifted to give birth, the media had a field day. The Governor called for immediate action. ADOT officials responded by showing their statewide ITS strategic plan and promptly received $5 million for new VMS signs to advise drivers during future situations. More importantly, the allocated funds will serve as an investment in Arizona's entire statewide ITS architecture and add value as a piece of an integrated system.

ADOT officials responded with their statewide ITS strategic plan and promptly received $5 million for new VMS signs to advise drivers during future situations.

The next step being contemplated by ADOT is the integration of the statewide/rural architecture with those for Phoenix and Tucson. This would create a common blueprint from which to deploy intelligent transportation systems throughout Arizona for the next 15 years. When completed, the comprehensive plan will include detailed ITS project evaluation criteria, a business plan, a management structure for the ongoing statewide implementation efforts, and a framework for integrating existing legacy systems.

"I would estimate that using the National ITS Architecture cut our development time in half. All you have to do is take the National ITS Architecture and throw out what doesn't apply — what's left is the basis for your architecture."

— Timothy Wolfe, Assistant State Engineer and Manager of ADOT ITS Projects

Lessons Learned

This case study is designed to help transportation planning and operations organizations considering developing statewide or rural ITS architectures to learn from the experiences of the state of Arizona. The Arizona experience shows definitively that although developing a ITS statewide architecture is a complex task, with appropriate scope and leadership it can be accomplished. The findings of this case study are:

Pre-development Steps: Create Manageable Regional Coalitions

- Developing appropriately sized regions based on a common set of transportation issues is essential for building a manageable stakeholder coalition. The unique aspects of the I-40 corridor (weather, geography, tourism, and trucking traffic) provided a common set of issues that united the otherwise diverse I-40 coalition.
- Similarly, localized processes help assure that user needs appropriate to that area are identified. ADOT realized early on that adapting metropolitan architectures to the rest of the state would not have worked because the rural statewide needs and issues were fundamentally different from urban ones. For example, rush hour congestion and air quality are not issues in Arizona's rural regions.
- Although previous ITS deployment helped create an awareness of the benefits of ITS technologies, the difficulty of incorporating existing "legacy" ITS systems (based on proprietary technologies) can hinder the regional architecture development process.

Stakeholders: Cast a Wide Net

- Participation from three types of stakeholders/advocates proved essential in creating the necessary momentum and buy-in to carry the process forward. Moreover, a diverse group of advocates helped assure that user needs were correctly identified. Early Champions, Local Advocates, and Proactive Stakeholders all played vital roles.
- Using ADOT's Community Relations Office from the beginning of the process assured the participation of the widest possible spectrum of stakeholders. Working together with the consultant, they found that personal telephone calls were the most effective means of getting participants. Similarly, using simple graphical representations proved to be the best way to communicate the concepts behind the National ITS Architecture.

Creating and Maintaining Agency and Public Buy-in

- Showing non-traditional stakeholders how a Statewide Deployment Plan can be mutually beneficial will help create and maintain diverse coalitions. For example, NOAA was able to better realize their public safety mission while providing the I-40 effort with essential weather information. Likewise, since many non-traditional stakeholders are motivated by financial considerations, emphasizing the cost-effectiveness of ITS technologies proved to be beneficial. Allowing non-traditional stakeholders to assume leadership positions is another way to validate the contribution of diverse participants. It also helped alleviate concerns that ADOT was controlling the process.

- Maintaining coalition momentum proved difficult during the complex and somewhat abstract exercise of mapping user needs to user services, market, and equipment packages. The vast majority of stakeholders were focused on ITS applications and deployment, rather than architecture development. Since the process is relatively straightforward and does not require public input, having a competent consultant, or agency staff, map the user needs to the National ITS Architecture may be a more expeditious approach.

Utilizing Resources

- The complex yet short-term nature of developing a statewide architecture makes it a suitable task to contract out to a consultant. Several of the interviewees for this case study emphasized the value of hiring a competent consultant with demonstrated experience.

- The National ITS Architecture is a superb resource. By taking the National ITS Architecture and extracting what was relevant to the needs of Arizona, the developers saved time and resources, assured eligibility for future federal funding, and gained confidence that the statewide architecture contained all possible links between components.

- Given the vast geographical separation of many stakeholders (including representatives of remote and Native American communities) technological alternatives to face-to-face meetings can facilitate more active participation. While available technology in rural areas is often a limiting factor, the potential benefits of enhanced stakeholder participation can help justify the costs of procurement.

References and Additional Resources

Web Sites

ADOT's Trailmaster:
http://www.azfms.com

Arizona Dept. of Transportation:
http://www.dot.state.az.us

ADOT ITS Projects:
http://www.azfms.com/About/ITSRD/its_rd.html

The Arizona Transportation Research Center [ATRC]:
http://www.dot.state.az.us/ABOUT/atrc/Index.htm

ITS Arizona:
http://www.azfms.com/About/Its/main.html

Arizona TripUSA™:
http://arizona.tripusa.com

U.S.DOT Rural ITS Resource Page:
http://www.its.dot.gov/rural/rural.htm

The Complete National ITS Architecture:
http://www.odetics.com/itsarch

References and Additional Resources

Select Bibliography

Strategic Plan for Statewide Deployment of Intelligent Transportation Systems in Arizona, Kimley-Horn and Associates, Inc, Report #: FHWA-AZ-98-457, December 1998.

Arizona's Successful Statewide ITS Initiatives, Kimley-Horn and Associates, Inc, September 1998.

Arizona Rural ITS, ADOT, Volume 1, Issue 1-3, February 1998-December 1998.

ADOT Statewide Plan Intelligent Transportation Infrastructure, ADOT, Intermodal Transportation Division Technology Group, February 1997.

Strategic Plan for ITS Communications, Kimley-Horn and Associates, Inc., March 1996.

Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor, Kimley-Horn and Associates, Inc., Report #: FHWA-AZ-97-431, May 1997.

Strategic Plan for Early Deployment of ITS on the I-40 Corridor, Swan, J., Harper, J., Joshua, S., National Rural ITS Conference, Spokane WA, September 30-October 1, 1996.

ITS Time!: Intelligent Transportation Systems for Arizona's I-40 Corridor, Arizona Transportation Research Center, Volume 1, No, 1-4, July 1996-May 1997.

Advanced Rural Transportation Systems (ARTS), Strategic Plan, FHWA, August 1997.

National ITS Program Plan, Euler, G., Robertson, H.D., Report #: DTFH61-94-R-00076, March 1995.

References and Additional Resources

Individuals Interviewed

Arizona's Highway Closure and Restriction Information System:
http://www.azfms.com/HCRS/arizona.html
(Toll Free Number: 1-888-411-ROAD)

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ADOT Field Offices:
Jeff Swan, Holbrook District Engineer
Don Dorman, Flagstaff District Engineer
John Harper, Flagstaff District Maintenance Engineer
Carlton Hill, Region Manager, ADOT, Motor Vehicle Division

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Michael McCallister, Field Engineer, Burlington Northern Santa Fe Railway
Lt. Jim Gerard, Flagstaff Patrol District Commander, Arizona Department of Public Safety
Jim Tuck, Transportation and Information Director, Grand Canyon National Park
Michael Campbell, Meteorologist in Charge, Weather Forecast Office, Flagstaff, National Oceanic and Atmospheric Administration
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FHWA Arizona Division:
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Jessie L. Yung, Highway Engineer

Consultants:
Henry B. Wall, Vice President, Project Manager, Kimley-Horn and Associates
Andrew Kolcz, Transportation Analyst, Kimley-Horn and Associates
Tom Fowler, Transportation Engineer, Kimley-Horn and Associates, Inc.

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

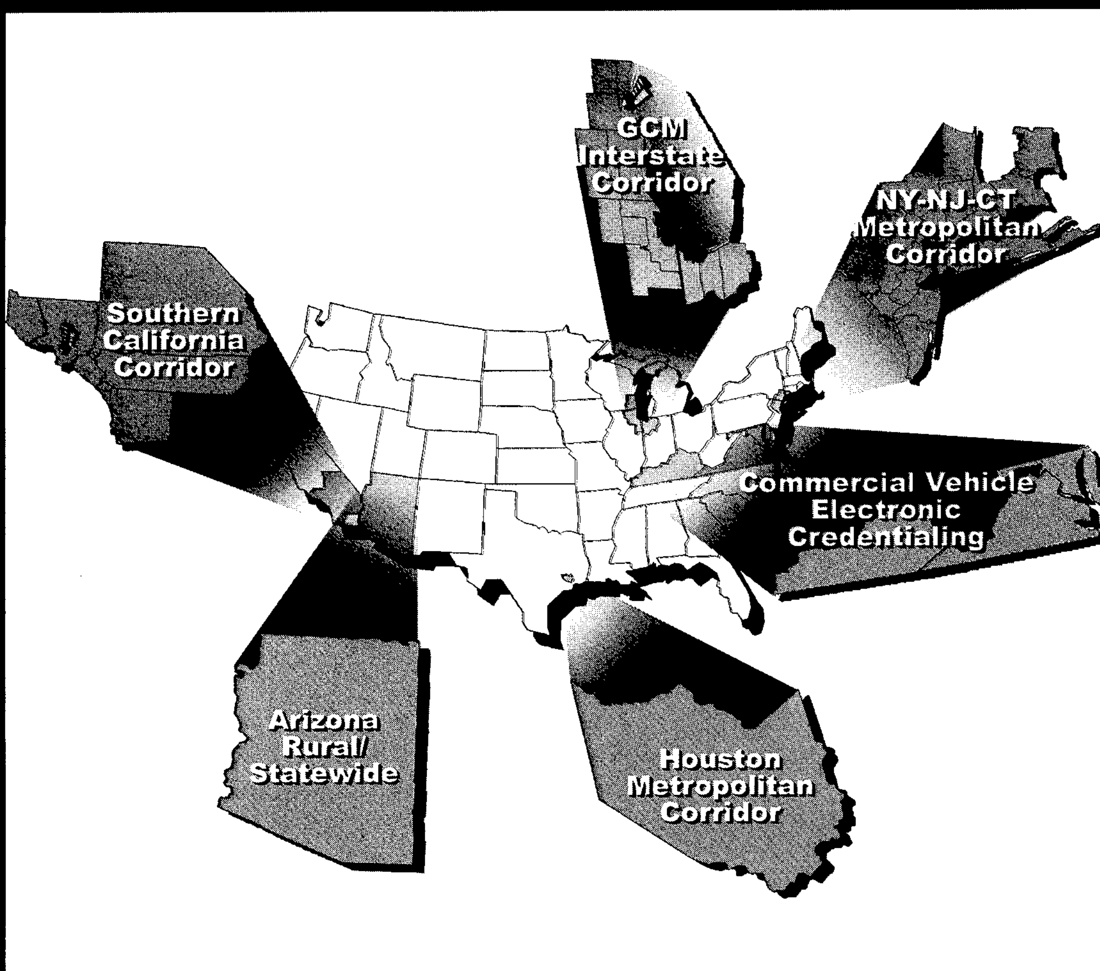
Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

Notes

Developing a Regional ITS Architecture

A Cross-Cutting Study



Building a Framework for Regional ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut (NY-NJ-CT) region; Gary-Chicago-Milwaukee (GCM); Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/statewide ITS architecture. This particular study highlights the cross-cutting findings and perspectives of the five case studies. The seventh study in the series is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

This study was prepared for a broad-based, non-technical audience. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Contents

Overview

A regional intelligent transportation systems (ITS) architecture provides states and localities with a framework for sharing information and a structure for integrating new ITS projects with existing systems. Sharing information helps to maximize the ability of agencies to meet specific transportation management needs. A basis for addressing these needs has been established through such initiatives as the National ITS Architecture and special incentive funding. These initiatives, along with a growing understanding of the value of sound systems engineering practices, are making a strong case for regional and statewide ITS integration.

This report highlights cross-cutting findings and perspectives gleaned from a series of case studies that examined the development processes of regional and statewide ITS architectures. In selected instances, relevant findings from the commercial vehicle cross-cutting study of electronic credentialing in Kentucky, Virginia, and Maryland also are included in this report.

Five of the six studies were conducted by the U.S. Department of Transportation's (U.S. DOT) Volpe National Transportation Systems Center, under the sponsorship of U.S. DOT's ITS Joint Program Office, and in coordination with the Federal Highway Administration and the Federal Transit Administration. The Houston study was conducted by Mitretek Systems, with support from the Volpe Center. Credit and appreciation goes to stakeholders at each site who took the time necessary to tell the story of their site's regional ITS architecture development process.

"The need for a framework or architecture helped to unify the Corridor—to link our data together."
— John Corbin,
Freeway Operations Engineer,
Wisconsin DOT

Each of the cases is unique. What is compelling about them is the way in which each site dealt with the main issues inherent in the regional ITS architecture development process. Generally, these issues can be grouped around steps toward regional ITS architecture development: laying a foundation, gathering stakeholders, organization and governance, outreach and education, resources, and implementation and maintenance. Cross-cutting findings specific to these topics are discussed in the following pages.

Laying a Foundation: Getting Started

While the approach or process for developing a regional ITS architecture is bound to be different for each region or state, one thing is clear: the process includes much more than producing a systems architecture design document. Preparing Early Deployment Plans (EDPs) and corridor program plans, gathering a wide range of stakeholders to assess what is needed and to explore options for electronic data exchange, building interjurisdictional partnerships, and identifying the interfaces necessary to ensure that systems can communicate with each other—all these and more are part of a broad-based, dynamic process of often concurrent activities. What this suggests is that developing a regional ITS architecture is both incidental to such activities, and purposeful—in large part to gain regional benefits that are otherwise elusive.

Deploying compatible transportation management systems to improve traffic and transit operations provides a strong motivation to strive toward regional ITS integration. The following are important factors that can help agencies get started.

- *Strengthen Existing Partnerships:* Existing partnerships for sharing information to improve traffic and transit operations and management also help in laying a foundation. For example, specific to the Gary-Chicago-Milwaukee (GCM) Corridor, the Illinois, Indiana, and Wisconsin state DOTs (as well as other transportation agencies) have formally and informally coordinated information sharing for many years.

- *Look to Neighboring Jurisdictions*: One agency's decisions can alleviate or confound transportation problems in neighboring jurisdictions. A concern in Southern California and the New York-New Jersey-Connecticut region was that deployment of incompatible systems would make traffic management increasingly more difficult.

- *Build on Deployment Successes:* Once a history of traffic management successes emerges, the demand increases for additional ITS deployment. For example, after the 1984 Summer Olympics in Southern California, the early use—and success—of ITS services prompted interest in more ITS deployment. Other events from which enhanced ITS coordination and integration opportunities emerged include the Northridge earthquake in Southern California, and winter highway closures in Arizona.

- *Share Information:* Information sharing often precedes the use of ITS technologies to improve traffic and transit operations. The regional ITS architecture development process in turn provides opportunities to build on information sharing arrangements through electronic information exchange to a broader base of interested stakeholders. For instance, those states that are participating in a special ITS commercial vehicle program, known as the Comercial Vehicle Information Systems and Networks (CVISN), will be able to exchange safety and credentialing information from roadside inspection sites to state information systems.

"An impetus for coordination was concern that deployment of incompatible systems would make transportation problems worse rather than better."
—Rob Hess,
Senior Manager, Transit Projects, Capital Program Budgets, New York Metropolitan Transportation Authority

"It's hard to imagine diverse communication coordination and electronic data exchange without the GCM (Corridor) or National Architecture."
— Ken Glassman,
Coordinator of Engineering Services, Illinois State Toll Highway Authority

Laying a Foundation: Getting Started

ITS SERVICES ADDRESSED IN REGIONAL ITS ARCHITECTURE (TO DATE)

	So.Cal.	*GCM*	*NY-NJ-CT*	*Houston*	*Arizona*	*CVO*
ATMS	**X**	X	X	**X**		
ATIS	X	**X**	**X**	X	X	
CVO	x	x	X		x	**X**
APTS	x	X	X	**X**		
ARTS					**X**	
Incident Mgmt.	X	X	**X**	X	X	

X Priority ITS Services
X Services Also Addressed
x Services Planned

(ATMS=traffic management, ATIS=traveler information, CVO=commercial vehicles, APTS=advanced transit, ARTS= rural ITS)

This chart illustrates how regions tend to develop ITS architectures in an incremental, evolutionary way.

Gathering Stakeholders

It is crucial that a wide range of stakeholders participate in the development process, to ensure consideration of the broadest range of integration opportunities and legitimacy in the effort's outcome. Beyond the essential traditional transportation agencies, the range of organizations with a stake in improved transportation system management and operations includes police, fire, and other safety-related agencies; planning organizations; even agencies charged with promoting tourism. While an entity's purpose or mission is often a determining factor in its participation, other considerations apply, such as the availability of staff and resources—or even an individual's particular interest in ITS. Case study interviewees provided additional insights regarding:

- *ITS Champions:* "Champions" are a crucial ingredient in the successful development of a regional ITS architecture. They are leaders and advocates that bridge institutional gaps, educate and inform others, and help cultivate additional resources. In the case of electronic credentialing for commercial vehicle operations, champions in each state sought to keep stakeholders "on the same page" as the program moved forward.

- *Range of Organizations:* Broadening stakeholder involvement is important because the value of the information disseminated through the systems (connected by way of the regional ITS architecture) is progressively enhanced as it is used more. Of course, the purpose and scope of the regional ITS architecture greatly determines which stakeholders are motivated to participate.

"For a first project, pick one large enough to have data flowing to or from most of the stakeholders. Using this as an example in an early meeting will bring more people into the process."
— Susan Beaty
Senior Project Manager,
Houston TranStar,
METRO

Gathering Stakeholders

- *Role of Transit Agencies:* Transit's role in identifying integrated solutions to improved management of the transportation system varies. The Metropolitan Transit Authority of Harris County (METRO) has taken a leadership role in ITS in Houston and has worked closely with others through their transportation coordination organization (TranStar). Several transit agencies have been actively involved in the (NY-NJ-CT) region's efforts, while transit's role is still emerging in Southern California.

ITS STAKEHOLDER AGENCY PARTICIPATION AT EACH SITE*

	So.Cal.	*GCM*	*NY-NJ-CT*	*Houston*	*Arizona*	*CVO*
State DOT	**X**	**X**	**X**	**X**	**X**	**X**
Fed. Agency	**X**	**X**	X	X	**X**	X
MPO	**X**	**X**	X	X		
Transit	x	X	**X**	**X**		
Other State Ag.	X	X	X			X
Reg. Authority	x	X	**X**			
County Ag.	**X**	x		X		
City Agency	**X**	X	**X**	X	X	
Private Firm (Incl. consultant)	**X**	X	X	x	**X**	x

X Champion
X Active Participant
x Participant

*Designation is representative of the given stakeholder category as a whole. However, if one agency in a category is considered a champion, the entire category is listed as "champion".

- *Various Levels of Participation:* Not all organizations that could be involved in the ITS architecture development process will be involved equally. Keeping all organizations informed, regardless of their level of commitment, can help overcome those institutional, resource, or other factors that make active or sustained participation problematic.

- *Multiple Interests:* Stakeholders have different operational and organizational uses for ITS data. A major benefit of having a regional ITS architecture is that it facilitates the flow of information. Stakeholder participation will help identify what information is needed and ensure its eventual availability. Metropolitan planning organizations along the GCM Corridor and in New York are (or plan to) use ITS-generated data to improve transportation modeling.

"You need champions in the agency to move forward on ITS and on coordination with other agencies. It is important that high-level staff see the usefulness of ITS and (interagency) coordination."
**— Isaac Takyi,
ITS Operations Planning Director, New York City Transit Authority**

"Developing an architecture takes time, takes commitment, and the stakeholders must reach agreement on common goals and a common agenda, then stay focused on the goals. The process drew us together. It helped us see ourselves as a team."
**— Rita Brohman
ITS Priority Corridor Program Manager, Houston TranStar, Texas DOT**

Organization and Governance

Development of a regional ITS architecture requires coordination with, and the cooperation of, multiple organizations. This often takes the shape of a coordinating committee. Generally, these committees rely on the sharing of member-agency resources, as is the case for the GCM Corridor and Southern California. Notably, Southern California is considering establishing a more formal governing body with dedicated funding and staff similar to the I-95 Corridor Coalition, one of the other priority corridors. Larger issues of governance, such as the relationship between state and local agencies, coordination of activities across state lines, and participation by agencies not usually involved in traditional transportation planning and decision-making all affect the regional ITS development process. Suggestions from study sites include:

- *Designate a Lead Agency:* Progress is more likely if one (or more) agency agrees to lead activities. Within the coordinating committee environment, different approaches reflect regional realities. For example, the chief working-level GCM Corridor committee is chaired by one of the three state DOT ITS program managers, by annual rotation.

- *Build on Existing Methods for Regional Cooperation:* Developing a regional ITS architecture is a cooperative effort that assumes existing regional cooperation. Using an existing organization that has worked to develop regional solutions to regional problems is a good starting point. That structure can be adapted for regional ITS architecture development purposes, or a new structure can be developed from that base. This is true in many cases. Southern California sought to work within a working environment already established by the two key metropolitan planning organizations in the region. NY-NJ-CT built on the regional operations foundation set previously. The GCM Corridor capitalized on existing informal relationships, especially among the tri-state DOTs. And, Houston has adapted and expanded from the innovative, interagency coordination of TranStar.

"The (GCM) architecture is taking interagency coordination to another level. The technology is helping to break down jurisdictional obstacles."
— Jeff Hochmuth,
ITS Program Manager,
Illinois DOT

- *Establish Governance Agreements and Understandings:* A Memorandum of Understanding, letter of agreement, or other formal mechanism is usually required when participation includes sharing resources. These agreements are not the only way to structure cooperative efforts. Informal arrangements, such as staff-to-staff contact, sometimes can be as effective as formal relationships. An important exception to this observation, however, relates to funding and financial arrangements.

- *Create a Committee Structure:* Committees established to address specific elements of the regional ITS architecture and to ensure participation by a wide variety of stakeholders are useful in the development process. The regional ITS architecture development effort in Southern California and the GCM Corridor used sub-committees to bring stakeholders from a wide variety of organizations together, often focused within affinity groups (such as commercial vehicles, transit, etc.).

- *Agree on the Role of Consultants:* Consultants can play an important role in this process, especially in supporting the system integration effort. That role should be agreed to by agencies involved in the development process. Issues to consider include separation from design, implementation experience in architecture development, and systems integration and configuration management. In addition, Houston has demonstrated that it is possible for a group of stakeholders to work through many of the technical architecture design activities often tasked to consultants.

- *Be Prepared for the Impact of External Events:* Outside political events can influence the development process. Political change can affect the level of participation by agencies and organizations. The structure of government and organization of agencies in a region requires adapting a development process that suits the region.

"Bringing together existing institutions rather than creating brand new ones was a major reason for the success of the development effort."
— George Smith,
New Technology and Research Program Manager,
California DOT

Outreach and Education

Targets for Agency Inreach

The following are examples of organizations within an agency that can impact ITS deployment efforts.

- Capital Budgeting
- Procurement
- Field Offices
- State Capitol/ Headquarters
- Public/Community Affairs
- Research

Having deployed ITS projects and established information sharing arrangements, both agencies and staff in the areas studied were knowledgeable about the benefits of ITS and of information sharing. However, this knowledge was not consistent across job functions or across, and within, agencies. Developing a regional ITS architecture requires broad participation and resource sharing; education and outreach can help.

- *Focus on Outreach and Inreach:* Outreach to non-traditional stakeholders and the public should focus in large part on "demystifying" ITS architecture efforts. Limiting the technical terminology and jargon, and emphasizing regional integration, are crucial. "Inreach," education within an organization, is crucial to get both decision-makers and other staff educated, involved, and interested in the development process.

- *Target Materials:* Educational materials and information should be tailored for specific audiences. High-level information is most appropriate for decision-makers, while technical information is needed for operations staff. Agency public/community affairs staff can play a crucial role in this, as was the case in Arizona, where ADOT's public affairs office played a leading role in the highly 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 a regional ITS architecture. In Arizona, 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 this process. The "E-ZPass" (automated toll collection) program in the NY-NJ-CT Region gave solid evidence of the advantages of both ITS and interagency coordination to decision-makers and the public throughout the region.

Anticipated Institutional Benefits of a Regional ITS Architecture

- Roadmap of ITS services
- Legacy systems inventory
- Framework for integration
- Basis for funding
- Improved agency coordination
- Enhanced access to information
- Guide for future expansion

- *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 are an often-used and effective tool in accomplishing this goal.

Resources

Federal funding provided resources to the case study areas for regional ITS architecture development. That funding alone, however, was not sufficient to make these efforts successful. State and local resources were also necessary. Resources included funds, facilities, and junior level to senior management staff. Sharing resources and work products from Early Deployment Plan (EDP) efforts and similar projects added resources, and some complexity, to the regional ITS architecture development process in several areas.

- *Federal Participation is a Motivation:* Federal guidelines and funds provide motivation to develop an ITS architecture but are not sufficient to move areas forward. An understanding of the benefits is needed for organizations to commit to a regional ITS architecture effort.

- *Using the National ITS Architecture Can Save Time:* The National ITS Architecture identifies major elements that should be included in a regional ITS architecture, and therefore provides a starting point for developing a regional ITS architecture. In study areas where regional ITS architecture development efforts preceded completion of the National ITS Architecture, the National ITS Architecture proved to be a valuable check on agency efforts. Using the National ITS Architecture can also save considerable development time. The Arizona DOT estimated that adapting the National ITS Architecture to their unique needs cut development time in half.

- *EDPs Add Resources and Complexity:* EDP resources were important in the areas included in this study. An EDP can lead to the development of a regional ITS architecture or can come out of the regional ITS development process. Coordinating regional ITS architecture development with EDP efforts can add complexity to both efforts, but will also ensure that local and regional systems can be integrated with one another.

- *Consultants Can Reduce Design and Development Time:* It is certainly possible to perform regional ITS architecture design work without the support of system integration consultants, though of the sites studied, Houston was the only site that attempted this. Consultants represent an additional cost "up front," but they can reduce the amount of time needed for ITS architecture development.

- *Cost and Time Will Vary:* These two factors vary widely depending on the size and population of the area, and the level of ITS services that are in operation, under development, or planned. Costs specifically tied to the development of a regional ITS architecture are commensurate with the scale of efforts. In addition, these are "up front" costs that, theoretically, will easily be recovered over time as a result of more efficient system design and implementation. Regional ITS architecture development time ranged from 12 to 24 months.

"The largest benefit of a unified Regional Architecture will be cost savings to the agencies that operate Southern California's transportation network. This is particularly true because the Showcase architecture is flexible enough to allow the subscription of legacy systems without having to go back and redesign old ITS or reinvest in new versions of the old systems."

**— Ali Zaghari,
Showcase Project
Manager, California DOT**

"I would estimate that using the National ITS Architecture cut our development time in half. All you have to do is take the National ITS Architecture and throw out what doesn't apply—what's left is the basis for your architecture."

**— Timothy Wolfe,
Assistant State Engineer
and ITS Projects
Manager,
Arizona DOT**

Implementation and Maintenance of the Regional ITS Architecture

Completion of a regional ITS architecture is an important step in establishing a structure for ITS planning, deployment, and decision-making. But, to ensure flexibility to adapt to changing transportation—and political—needs and demands, maintenance of the regional ITS architecture is crucial. The ITS architecture will need to be used as advanced transportation management technologies are deployed and maintained, as new opportunities for sharing information are identified, and as regional approaches to integrated transportation system management and operations evolve.

"People are more cognizant now that their individual projects need to coordinate and work together. Projects can't be isolated. The National ITS Architecture helps raise awareness of the need to integrate."
— Gilmer Gaston,
Agency Manager
Houston TranStar,
City of Houston

- *Mainstreaming ITS:* All of the areas studied have received federal funds designated for ITS projects and regional ITS architecture development. These areas are now looking at how to mainstream both ITS deployment and their regional ITS architectures. Mainstreaming is also the focus of a formalized program for ITS commercial vehicle operations.

- *Competing for Resources:* A major challenge identified in most areas is that as special ITS corridor program funding expires, ITS projects have to compete for resources with other transportation projects. With the development of strategic deployment plans, regional ITS architectures, and the participation of key metropolitan or state planning organizations, areas are confident that ITS projects will compete favorably. In Southern California, the Metropolitan Planning Organizations in the Los Angeles and San Diego areas have been incorporating ITS projects into their long range transportation plans and improvement programs in keeping with the corridor planning and ITS architecture development processes.

- *Maintaining the Regional ITS Architecture:* Responsibility for long-term maintenance of a regional ITS architecture has been firmly identified in some areas, and less firmly in others. The organization instituted for the development process is usually viewed as the most suitable structure for maintaining the regional ITS architecture.

- *Developing Maintenance Plans:* All areas included in this study have identified maintenance as a long-term issue. Some have adopted long-term ITS plans that specifically address this issue; others are only beginning to look at long-term ITS architecture maintenance.

- *Determining Design and Standards:* Development of a regional ITS architecture is crucial for identifying those standards necessary to ensure compatibility among systems and their interfaces at the local level. Southern California, largely because of the progress already gained in developing a regional ITS architecture, is giving much attention to those ITS standards deemed essential to ensure that systems will be able to communicate and exchange data smoothly.

Concluding Thoughts

Finally, the following points are included to stimulate continuing thought regarding the development of a regional ITS architecture. These items represent both points of emphasis and additional considerations.

- A regional ITS architecture is a means, not an end. It is crucial that any regional ITS architecture development process be based on addressing real needs, identified from EDPs, corridor program plans, special commercial vehicle project plans, or other similar planning initiatives.

- The development process itself can yield as much benefit as the product, especially for nontraditional stakeholders. For example, through the Arizona statewide ITS architecture development process, the National Weather Service became an active stakeholder, sharing weather data essential to reliable, up-to-date traveler information.

- The importance of agency inreach, as well as outreach and education, cannot be overstated in supporting a successful development process.

- A regional ITS architecture is the most effective means of providing for regional ITS integration. Moreover, the National ITS Architecture is a valuable and versatile tool with which to make smart decisions throughout the regional ITS architecture development process.

"The regional architecture set the stage for long-term plans and projects that we have ongoing in Orange County, in particular, and also in the Southern California region. (It) sets the framework for us to make better investment decisions and ensures that projects are compatible across jurisdictions."

— Dean Delgado, Principal Transportation Analyst, Orange County Transportation Authority

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

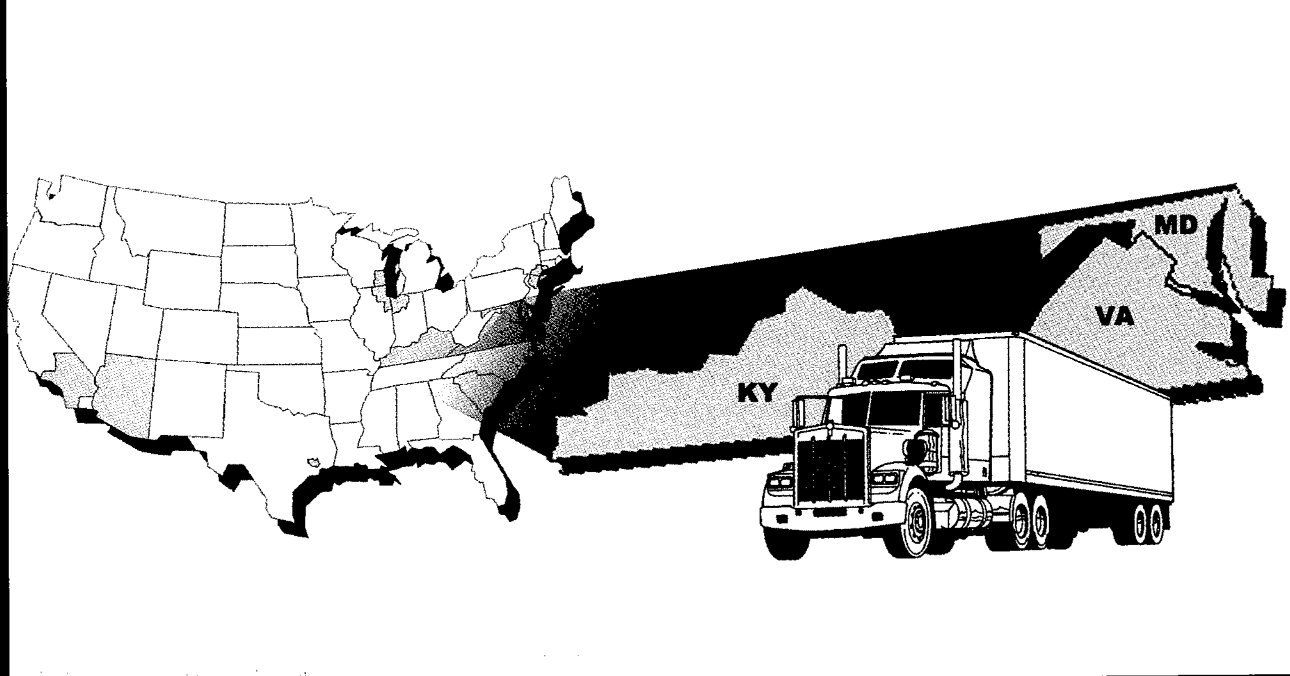
Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

ITS Architecture Development

A Cross-Cutting Study

Electronic Credentialing for Commercial Vehicle Operations



Building a Framework for ITS Integration

September 1999

Foreword

Dear Reader,

We have scanned the country and brought together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **Benefits Brochures** let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas;
- **Cross-Cutting Studies** examine various ITS approaches that can be taken to meet your community's goals;
- **Case Studies** provide in-depth coverage of specific approaches taken in real-life communities across the United States; and
- **Implementation Guides** serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you don't have to go it alone. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the next century.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation infrastructure decisions.

Christine M. Johnson
Program Manager, Operations
Director, ITS Joint Program Office
Federal Highway Administration

Edward L. Thomas
Associate Administrator for
Research, Demonstration and
Innovation
Federal Transit Administration

Purpose

This is one of seven studies exploring processes for developing ITS architectures for regional, statewide, or commercial vehicle applications. Four case studies examine metropolitan corridor sites: the New York, New Jersey, and Connecticut region; the Gary-Chicago-Milwaukee Corridor; Southern California; and Houston. The fifth case study details Arizona's process for developing a rural/statewide ITS architecture. A cross-cutting study highlights the findings and perspectives of the five case studies. This particular study (the seventh in the series) is a cross-cutting examination of electronic credentialing for commercial vehicle operations in Kentucky, Maryland, and Virginia.

Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems, with support by the Volpe Center.

This study was prepared for an audience already familiar with the basic elements of ITS Commercial Vehicle Operations. Readership is anticipated to include mid-level managers of transportation planning and operations organizations who have an interest in learning from the experiences of others currently working through ITS architecture development issues.

Overview

This cross-cutting study examines how Maryland, Virginia, and Kentucky have used the Commercial Vehicle Information Systems & Networks (CVISN) Architecture to develop state CVISN system designs for electronic credentialing. It focuses on the CVISN Project Plan and Top-Level System Design phases with lessons learned from these states. Sequences of activities based on the three sites' deployments frame the technical and institutional issues addressed. The purpose of the study is to assist those who are planning or currently deploying electronic credentialing systems to understand the activities and challenges that might be encountered when developing state system designs using the CVISN Architecture.

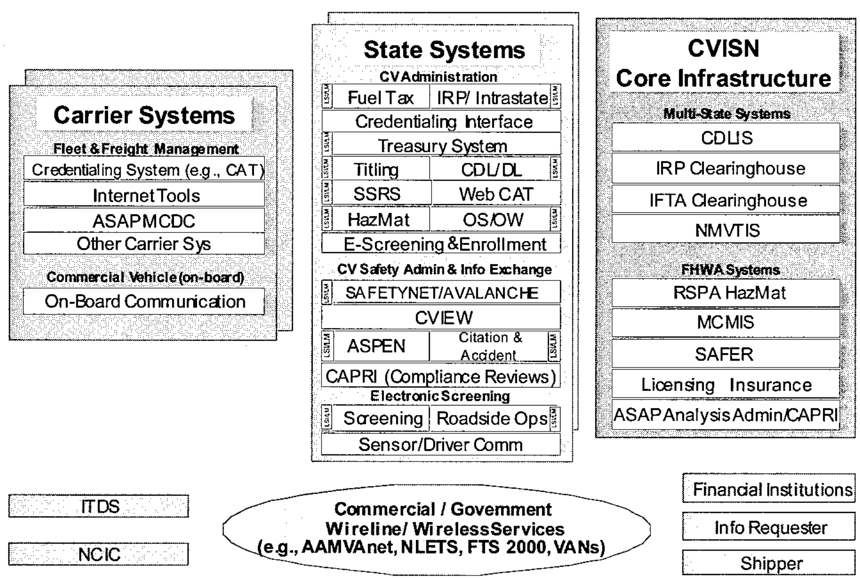
Background

"The CVISN Architecture is the ITS/CVO information systems and networks portion of the National ITS Architecture and adds more detail in some areas such as operational concepts and message requirements to facilitate further development."
— **Valerie Barnes, CVISN System Architecture Project Lead, Johns Hopkins University Applied Physics Laboratory**

National ITS and CVISN Architectures

The National ITS Architecture is a tool for states to develop their own system designs by defining the functions performed by different Intelligent Transportation Systems (ITS) components and ways in which they should be interconnected. "The CVISN Architecture is the ITS/ Commercial Vehicle Operations (CVO) information systems and networks portion of the National ITS Architecture and adds more detail in areas such as operational concepts and message requirements to facilitate further development," states Valerie Barnes, CVISN System Architecture Project Lead at Johns Hopkins University applied Physics Laboratory. It thus serves as guidance for stakeholders in the commercial vehicle community to develop systems and interfaces to support identified user services. These user services were based upon stakeholder needs and requirements and were an outgrowth of analyzing operational scenarios within the commercial motor vehicle environment.

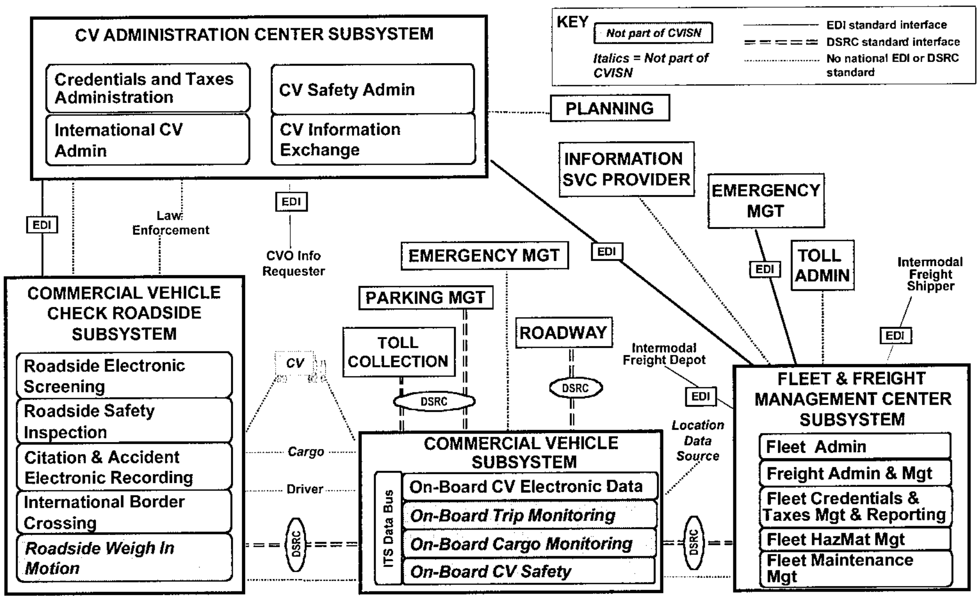
CVISN System Design - Stakeholder View



In sum, the CVISN Architecture defines:

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

The CVISN architecture includes the information systems and networks in the ITS/CVO architecture



Thus, the "CVISN Architecture states who should be connected to whom and what types of things they need to be telling each other," (Statement of Direction, FHWA Office of Motor Carriers and Highway Safety.). To assure interoperability, the CVISN architecture requires the use of Electronic Data Interchange (EDI) standards for communications technologies. Details regarding the deployment of CVISN projects remain in state hands, including decisions regarding institutional arrangements and specific technologies.

"The CVISN Architecture states who should be connected to whom and what types of things they need to be telling each other."
— CVISN Statement of Direction, FHWA Office of Motor Carriers and Highway Safety

CVISN & Credentialing Administration

The CVISN program provides a framework that enables government agencies, the motor carrier industry, and other parties engaged in commercial vehicle safety assurance and regulation to exchange information and conduct business transactions electronically. CVISN Level 1 is comprised of three elements—credentialing administration, electronic screening, and safety information and exchange. To give focused depth to this case study, one topic has been chosen—electronic credentialing. (Further information regarding the other elements can be found on the FHWA Office of Motor Carriers and Highway Safety web page noted in the References & Additional Resources Section.)

The goal of electronic credentialing is to offer motor carriers the ability to apply and pay for credentials, registration, and fuel taxes electronically.

The goal of electronic credentialing is to offer motor carriers the ability to apply and pay for credentials electronically. This includes state registration, fuel taxes, and base state (International Registration Program—IRP and International Fuel Tax Agreement—IFTA) registration and taxes. Carriers would then receive electronic notification of credentials status and an invoice of payments due. Electronic payments for credentials and taxes may be an option. As well, there could be electronic distribution of credentials or an in-house inventory at large carriers' offices much like what is done with passenger vehicle registration at car dealerships. Some states are also looking at electronic application of hazardous materials and oversize/overweight permits. Information collected from these processes can be shared with roadside inspectors and law enforcement officials to enforce up-to-date registration and tax payments.

To achieve CVISN Level 1 capabilities in electronic credentialing, specific activities must be completed:

CVISN Level 1 Capabilities in Electronic Credentialing

- Automated processing (i.e. carrier application, state application processing, tax filing, credentialing issuance) of at least IRP & IFTA credentials and ready to extend to other credentials (intrastate, titling, oversize/overweight, carrier registration, hazardous materials). Processing does not include electronic payment.
- State system connection to IRP & IFTA Clearinghouses.
- At least 10% of the transaction volume is handled electronically and the system is ready to bring on more carriers as carriers sign up and to extend to branch offices where applicable.

Electronic Credentialing Benefits

Expected benefits resulting from electronic credentials administration capabilities are more efficient and responsive administrative processes for carriers and government agencies.

Expected benefits resulting from electronic credentials administration are more efficient and responsive administrative processes for carriers and government agencies. Since data interchange among states, carriers, and other stakeholders will be electronic, it will be more timely, accurate, and less expensive. Credentials issuance, tax filing, interstate reconciliation, and audits will be automated to proceed more effectively and efficiently. Both administrators and enforcement personnel will have rapid, electronic access to required data. All this will result in better enforcement of registration, licensing, and tax regulations and better customer service to motor carriers and drivers.

A case study involving eight states estimated that the deployment of ITS/CVO technologies for electronic credentialing would have up to a 6:1 benefit cost ratio. Labor costs for administrative compliance would be reduced significantly for medium and large-sized carriers using EDI, showing a benefit/cost ratio of 4.2:1 and 19.8:1, respectively. Deterred tax evasion could save an estimated $500,000 to $1.8 million per state ("What Benefits are Expected from CVISN?").

Background

State CVISN Architecture Development Process: Electronic Credentialing

The state CVISN architecture development process includes the completion of a CVISN Project Plan and Top-Level Design. The Project Plan spells out program goals, objectives, and priorities. The Top-Level Design charts the state's system design. The following is a cross-cutting composite of three states' experiences in deploying electronic credentialing focused on the CVISN Project Plan and Top-Level Design activities. The planning section starts by looking at why states choose to deploy electronic credentialing, and then follows through a sequence of planning and organizing activities that culminate in the final product of a CVISN Project Plan. The Top-Level Design section focuses on how these states developed their state system design, which technologies they chose and why, and what have been some technical challenges they have faced along the way. Suggestions from interviewees of what to do and what to look out for are included.

The State CVISN Architecture Development Process includes the completion of a CVISN Project Plan and Top-Level Design. The Project Plan spells out program goals, objectives and priorities. The Top-Level Design charts the state system design.

Planning

"CVISN is not a project, not a deliverable. It's a different way of looking at how you do business, and a means to broaden customer services."
— Judy Vesely, Electronic Credentials Administration Lead, Virginia Department of Motor Vehicles

Why Deploy Electronic Credentialing?

There are many reasons states choose to deploy electronic credentialing. Among them are the goals to offer better customer service to motor carriers while increasing efficiency in agency operations. As Judy Vesely, Virginia's Electronic Credentials Administration Lead says, "CVISN is not a project, not a deliverable. It's a different way of looking at how you do business and a means to broaden customer services." Given the importance of the motor carrier industry in many states in which most everything is transported by truck except water and electricity, and state governments' goal to "do more with less", streamlining and automating administrative processes can be a solution. Benefits include decreased administration expenses, increased tax collection, and increased targeting of non-compliant carriers. Often times, these objectives are boosted by governor-led statewide initiatives to provide "one-stop shop" services and the offering of electronic ways to do business with the state.

This was the case in Kentucky with the Empower Kentucky program begun in 1996. Championed by the governor who promised large, recurring cost savings, the Empower Kentucky program's goal was to simplify and automate processes within all government agencies. For the Transportation Cabinet, this meant a "one-stop shop" where motor carriers can register, pay fees, and taxes at one location. Given Empower Kentucky's goals, CVISN is an integral part of the state's transportation technical solution. As a result, many of the tasks associated with CVISN system development, for example, system definition and requirements analysis, were addressed by the Empower Kentucky initiative. A similar "one-stop shop" concept is found in Virginia's Virtual Customer Service Centers begun in 1996. Passenger and commercial vehicle customers can go to one of 80 Customer Service Centers throughout the state to do all their transportation-related transactions.

Governor-led statewide initiatives have also focused on establishing a web presence to offer the public the option to do business with the state electronically. In Virginia, customers can do driver's license renewals, vehicle renewals, and address changes over the web. In Maryland, applications for commercial driver's licenses and certificates of titling can be downloaded and on-line vehicle registration renewals can be done on the web. Maryland's primary impetus to deploy electronic credentialing, however, came from the desire to extend the same electronic registration options offered to passenger vehicle dealers to commercial vehicle operators.

Which Agencies are Involved in Electronic Credentialing?

The State Departments of Transportation Motor Carriers Divisions are often the lead agencies that deploy electronic credentialing. Other agencies are sometimes in charge of tax collection and permit issuance. Maryland's Department of Transportation Motor Vehicle Administration is the lead agency for electronic credentialing and IRP while the

Comptroller of the Treasury is in charge of IFTA. The Department of the Environment issues hazardous materials permits and the State Highway Administration issues oversize/overweight permits.

In Virginia, the Department of Motor Vehicles is charged with electronic credentialing, IRP, IFTA, and some oversize/overweight permits. The Department of Transportation does larger oversize/overweight permits. Unlike many states, Kentucky's transportation functions are organized and co-located under one entity, the Transportation Cabinet's Department of Vehicle Regulation, that is charged with all credentials administration. As noted in interviews, a single centralized agency greatly enhances planning and day-to-day operations, however, a strong champion and cooperative interagency working group can also facilitate smooth implementation.

How to Start an Electronic Credentialing Program?

For states deploying electronic credentialing, interviewees recommended that CVISN participants follow these steps:

Designate A Champion. Often noted in interviews was the important role of a champion. This person, generally the project manager, has the authority to make decisions and establish a core working committee. The champion will ensure that all stakeholders are kept "on the same page" as the program moves forward. It was recommended that a champion be appointed by the Secretary of Transportation or State Legislature to ensure that he/she has the decision-making power to do such activities. This person also manages legislators' expectations and secures financing.

Establish a Credentials Administration Working Committee. Interviewees recommended that all agencies affected by the program be involved from the beginning to formulate business and project plans collectively. It is then easier to acquire approvals and implement plans. This is especially important for states that have multiple agency participants. Maryland, which has ten agencies involved in all CVISN elements, formed the Inter-Agency Coordinating Group (IACG). This group is comprised of operations managers who routinely meet to discuss deployment issues. Any issue that cannot be resolved on the operations level, for example budget allocations, is brought to the advisory board composed of administrators. The IACG is then divided into sub-committees based on functions which do the actual deployment work. States that have centralized motor carrier operations, such as Kentucky, still benefit from working committees. Kentucky's Motor Carrier Task Force also includes members from the University of Kentucky Transportation Center and the motor carrier industry.

Planning

"The worst thing you can do is automate a bad credentialing process."
— Commissioner Ed Logsdon, CVISN Project Manager, Kentucky Transportation Cabinet

The key to a good system design is to focus on solving people's actual problems.

Follow a Methodology. In order to keep all parties on the same track, interviewees noted the importance of following a methodology. Having this is crucial especially with personnel turnover since it quickly brings new participants up-to-speed on the project. The following is a sample methodology:

- *List Key Goals and Objectives.* The working committee should decide which goals and objectives the agencies collectively want to achieve. For example, the goal is electronic credentialing and the objective is to offer small, medium, and large carriers an alternative method of registration. Then, an action plan should be written for each goal and objective. For example, for medium sized carriers, the Personal Computer Carrier Automated Transaction (PC CAT) is a good option. Large carriers can enhance their fleet management software packages to handle the new commercial vehicle credentials transaction set and integrate electronic credentialing processes with other existing business functions. The action plan should document how the program's business and technical requirements satisfy these goals and objectives.

- *Baseline Business Requirements.* First the working committee should look at what the business demands and assess what is currently being done and what agencies want to do. Then they should determine what CVISN Level 1 capabilities will give in terms of an operable functional system and how these match the state's needs for an operable system. Finally, the committee should document the differences and decide on priorities. Often electronic credentialing programs require a reengineering of business transactions to simplify forms and processes. "The worst thing you can do is automate a bad credentialing process, " says Commissioner Ed Logsdon, Kentucky's CVISN Project Manager. In Kentucky, eleven forms were consolidated into one before they were available electronically. It is good at this stage to look at other states' electronic credentialing programs and apply lessons learned that are relevant to one's own state.

- *Baseline Technical Requirements.* With business requirements in hand, the working committee should have a thorough examination of existing information technology infrastructure done. Questions such as, "Which connections currently exist between systems and agencies and how are they conducive to what the state wants to do as documented in the business requirements?" should be asked and answered. For example, with the Internet, analysis should be done to see if there is sufficient infrastructure to support web transactions. If not, how much modification is needed to make the system compatible for such activities? It is also important to think about the future. For example, should hooks be built in now for possible expansion later? As several interviewees noted, the key to a good system design is to focus on solving people's actual problems as noted in the business requirements. Once system changes are documented, they should be assessed on how they are compatible with the CVISN Architecture.

Lastly, business and technical requirements that meet goals and objectives must be prioritized. For example, the state may choose to implement a PC CAT first to let medium sized carriers submit electronic credential applications using EDI since EDI capability is required for CVISN Architecture conformance. The system design then should be approved by the CVISN working committee, state senior executives, and the state's Conformance Assessment Team.

Get Senior Executive Support. Statewide initiatives such as Kentucky's Empower Kentucky and Virginia's Virtual Customer Service Centers made getting governor and commissioner approval for electronic credentialing simpler. Such programs also assist in acquiring state resources such as information technology department staff support in assessment and system enhancements, computer training for staff personnel, changes in laws to allow for electronic commerce and payments, and financing. Interviewees noted that high level decision-makers must view electronic credentialing as a value-added effort that takes priority over other projects. To do this, it was recommended to have the Chairs of the Transportation Committees of both the state House and Senate attend the first couple of CVISN meetings. Here, officials could explain the program's objectives. Managing senior executives' expectations throughout the project can be a challenge. Nonetheless, by setting realistic goals, for example, a year-and-a-half to reengineer business processes and another year to implement the technology, and by showing small successes quickly, senior executive support can be more easily maintained.

Get Motor Carrier Buy-In Early On. Interviewees noted the importance of bringing motor carrier industry representatives on board from the start, such as on working committees. This was primarily to make them feel like partners in the project as well as for cheerleading to other carriers, lobbying to State Legislature for program funds, and testing of products. Generally speaking, larger carriers are eager to try electronic credentialing systems given the great benefits of saved time and effort. Carriers like the fact that they don't have to calculate taxes and can pay fees and taxes electronically. It was noted in one interview, that some carriers may not like the program because it makes avoiding taxes and surcharges more difficult.

Secure Resources. It is important to acquire enough financial and human resources to address all priorities in all phases of the project. For example, sufficient funding is needed to provide staff training and information technology support once the electronic credentialing system is operational. In addition, competing project priorities, such as Y2K, can create delays by diverting information technology staff efforts.

Look at Legislation. Electronic credentialing might require changes in statutes to allow for electronic commerce and electronic funds transfers. To assess if this is needed, registration laws and the appropriate section of the regulations should be referenced. In Maryland, since they already had electronic registration for passenger car dealers, no changes in laws and regulations were needed. On the other hand, some states like Kentucky had to make a regulation to allow for electronic payments. For electronic payments such as credit cards, there is also an issue of who pays the credit card surcharge—the state or the customer. It was recommended in interviews that the State Legislature give the State Department of Transportation authority to do electronic registration and titling by regulation to make such changes easier.

Assess What Staff Will Be Needed. A core electronic credentialing team includes a project manager, system architect, and credentials administration managers. Given the myriad of elements and tasks associated with CVISN, a full-time project manager is needed and often comes from the lead agency. Regarding system architects, one interviewee noted the importance of hiring a non-commercial system architect since it is easy to misrepresent technical issues as political especially with procurements. Credentials administration managers continue in their roles but now must learn about new systems. As one interviewee noted, although it is ultimately the project manager who is responsible for the success of the project, middle managers ensure that steps to that success are achieved. Therefore, it is very important to have their input at the early stages of project planning. Another interviewee recommended that for states with multiple agencies, a planner who can juggle different schedules with agencies, vendors, and contractors is also helpful.

In addition to this core CVISN team is support staff. Information technology staff members play a major role in writing requirements and specifications. Depending on the state's in-house resources, system design may be done in-house or contracted out. In either case, in-house information technology staffers ensure that the system design meets the state's business requirements. They will also most likely maintain the system. Operational users of the system have a significant role in the business and technical requirements stage. They are asked what they need to do to complete transactions. Some staff members initially may not be amenable to electronic credentialing fearing that technology might replace their jobs. Actually, what has happened in one state is something quite different. Since new skills were required to do the work, clerical positions have become professional ones as level of responsibilities have increased. For example, instead of employees completing transactions themselves, employees guide customers in filling out applications electronically, resolve banking issues, and do preliminary audits. Training on the systems as well as courses on basic computer operations and letter writing, will help staff with the new tasks.

Schedule Deployment Activities. With both business and technical requirements completed and priorities agreed upon, agency responsibilities and work orders are easy to set. Often schedule priorities are driven by what is required to attain CVISN Level 1 capabilities. Usually, states first do electronic credentialing then they connect to the IFTA and IRP Clearinghouses. Once these CVISN Level 1 capabilities are met, states often do intrastate registration and oversize/overweight permits. Oversize/overweight permits are a priority because of the volume of permits issued daily and consequent cost savings. Several interviewees noted the importance of showing successes early on to manage State Legislators' expectations and maintain funding. Therefore, focusing on small segments of one function, for example, connecting to the IFTA Clearinghouse, is recommended. The use of Gantt charts can aid in scheduling.

Assemble All into a Project Plan

The Project Plan will be the document that CVISN working committee members can reference to ensure that original goals and objectives are being met. In conjunction with the Top-Level Design, a work breakdown and responsibility chart, a schedule of deliverables, and required resources will emerge. A list of possible institutional and technical difficulties and contingency plans is very important. Often, local universities assist in the production of CVISN Project Plans. The University of Kentucky helped with Kentucky's Project Plan and Johns Hopkins University Applied Physics Laboratory helped with Maryland's Project Plan.

Top Level–Design

The Top-Level Design, or system design, explains new transaction operational flows, what existing state systems will be modified, what computers and networks will be upgraded, and what new computers or network segments and other products will be added. The Top-Level Design also identifies where open standards will be used to support new or modified interfaces.

To explain the steps taken in developing a Top-Level Design, it is helpful to view how a credentials administration transaction is processed through a system. (See the IRP Renewal Operational Scenario diagram below.) Starting from the left, an applicant enters information via a Carrier System such as a CAT. From here, the information can be transferred to a Credentialing Interface (CI) and then passed on to the state's legacy system where data is checked and a response is sent back to the CAT via the CI. Information then goes to the Commercial Vehicle Information Exchange Window (CVIEW) and on to the SAFER data mailbox for roadside inspections. Based on the technical requirements, changes to current systems known as modifications to legacy systems, must be done. As well, new technologies must be bought such as a CI and CAT.

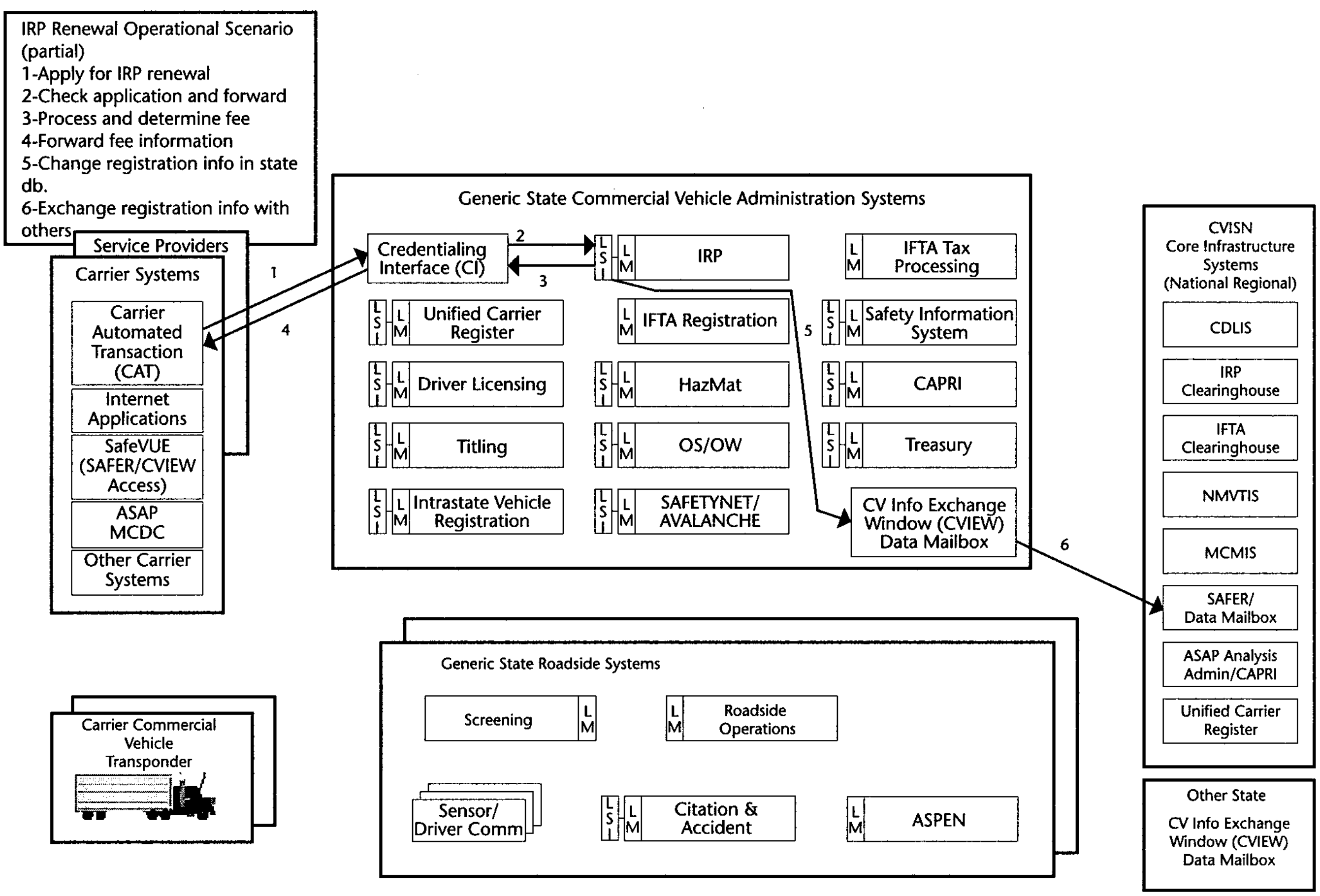


Diagram courtesy of Johns Hopkins University Applied Physics Laboratory

It was recommended by a system architect to build small sections of the system first, connect to things that already work, then extend the reach and replace things as needed. In this way, "Like petrified wood, it crystallizes throughout the structure and after awhile all the wood has been replaced by stone. Now it has a new structure but it will always carry the traces of the original structure," says D.J. Waddell, Maryland's System Architect.

State Technology Options

Technology decisions are based on the state's computing environment and accepted communications protocols. There are several requirements for a good system design: uniformity, accessibility, flexibility, and expandability. Uniformity can be accomplished with a common platform and standards. In Maryland, a common platform was achieved by purchasing personal computers and software that were given to the state's ten participating agencies. Standard communications protocols that allow data to be sent and interpreted by various parts of the system must be used. EDI open standards are required by the CVISN Architecture and are common standards used by carriers to transmit data. According to the "Technology in Trucking Operations" study conducted by the American Trucking Associations Foundation, between 1996 and 1998, EDI had a 47% increase in motor carrier usage. Second, multiple motor carrier access points to the state systems could be offered to increase electronic credentialing accessibility and usage. Quoting the same study, eight out of ten large fleets are EDI capable and three quarters have Internet access. As well, one in three small to mid-sized fleets are EDI capable and/or have Internet access. Therefore, offering EDI capable and/or internet accessable options will increase electronic credentialing usage. Lastly, the system architecture must be flexible enough so that it can have manual supplements with the ability to expand later for more automation. For example, Legacy System Interfaces (LSI) can be built into the CI to accomplish this. In all technology choices, assessments of the technology as "leading edge" versus nearing obsolescence must be made.

There are several requirements for a good systems design among them are uniformity, accessibility, flexibility and expandability.

Several electronic credentialing options are being explored by CVISN states and many of them are planning to try more than one option. Since the use of open standards is a key CVISN architectural concept, at least one electronic credentialing option must support EDI transactions.

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Carrier Credentialing Systems

For carriers, the three most common choices are the Personal Computer Carrier Automated Transaction (PC CAT), World Wide Web (the Web), and Fleet Management Systems. Descriptions of each choice include requirements needed to conform to the CVISN Architecture.

Top Level–Design

1. **PC CAT**

   An applicant (motor carrier or independent service provider) uses stand-alone software that provides a user interface to enter application information and transmit/receive state responses via a personal computer using EDI standards. Such an example is InterCAT produced by a private company.

   Advantages

   - It is a simple software package that is installed on a personal computer.

   - PC CAT software is commercially available.

   Disadvantages

   - Software must be installed on each personal computer.

   - PC Cat software needs to be updated with new legislation and tax changes.

2. **World Wide Web**

   An applicant (motor carrier or independent service provider) uses commercial web browser software for access to a state or service provider's web site that accepts application information and forwards information to state systems. The CVISN Architecture recommends that if a state offers a Web-CAT, the state should consider using EDI for the interface between the web site and CI.

   Advantages

   - Information is under the control of the state and can be changed anytime to reflect new legislation, taxes, and requirements.

   - It is easily accessible especially for small and medium-sized carriers.

   Disadvantages

   - No Web-CAT software is commercially available now.

   - There is a slow processing time to complete a transaction.

   - There is no storage capability for information on the web page. Therefore there is an issue of who will maintain carrier databases—the state or carrier?

- It isn't known if the web can support high volume transactions which is especially bad for large fleets who send their applications in large batches.
- There is an issue of disencryption of data. Security of information transmitted over the web is not assured.
- Standards are changing quickly. HTML is currently the web standard but will likely switch over to the richer XML. HTML is not rich enough to describe EDI syntax.
- To conform to the CVISN Architecture, an EDI option must also be provided. If the Web CAT-CI interface is not EDI, then the state must maintain two interfaces—state-specific and EDI.

3. **Fleet Management Systems**

Using EDI, motor carriers can send messages from their fleet management systems to a CI.

Advantages

- Motor carriers continue using their own systems that use EDI.

Disadvantages

- System software will have to be modified to interact with the CI. Choices will have to be made regarding whether to embed CAT software within an existing fleet management system or make an interface with other CAT options.

What Should a Good CAT Software Program Have?

When choosing off-the-shelf software, assess how much modification would be needed to satisfy business requirements.

In choosing CAT software for any of the above options, the first decision must be whether to buy off-the-shelf software and modify it to fit the state's needs or develop software from scratch. When making this decision, it is important to review off-the-shelf software closely and assess how much modification would be needed to satisfy business requirements. Every modification could entail another modification and depending on the program design—if it is modular or not—making modifications may be very difficult. Virginia had difficulties with a software product that was designed for another jurisdiction and was not modular. Attempts were made to modify the software to accommodate Virginia's business processes and regulations, but given its non-modular design, the modification process was fraught with difficulties and a fully operational product was never delivered.

A state developing its own software has its own basket of concerns as well. The ability of in-house information technology staff to write the software or oversee vendor software development must be taken into account. The associated costs can also be dramatic. Whether a state decides to develop its own software or buy it off-the-shelf and modify it, it is crucial that potential users of the system be asked what they need from the system at the early stage of a functional requirements assessment.

Based on interviews with operational managers and users, the following considerations were suggested for inclusion in CAT software programs:

CAT Software User Recommendations

- Once an U.S. DOT number is entered, the operational user should be able to go from one program to another to access information. For example, one should be able to go between IRP and IFTA files to access common information to avoid entering data twice.

- Carriers should not have to enter their own tax rate. If a carrier does an IFTA transaction, the tax rate for that quarter should be supplied. If they do an IRP transaction, the fee should be there. The carrier should not have to look up rates and fees on a piece of paper and enter it. Tax rates should also be automatically calculated for the carrier and be linked to a mainframe so that they can be easily changed when legislation requires.

- Instructions should be available on screen. Users should also be able to go back to the last screen and make immediate changes and to double check entire applications before sending them.

- The program should have open-ended tables built into the source code so application developers don't have to rewrite the code when changes are needed. Thus, changes to tables could be done by simply adjusting parameters.

Finally, interviewees noted that if modifying software, it is recommended to see a sample demonstration of the product using state data before hiring vendor services.

"EDI and the web are like the telephone and Internet. We use the telephone to get on the Internet or use the telephone over the Internet. They interweave. Currently, we are using email to transfer EDI files."
— D.J. Waddell, System Architect, Maryland Department of Transportation

EDI and the Web

There is a debate among system architects whether to use EDI or the web to access state legacy systems. As D.J. Waddell, Maryland's System Architect, states and Valerie Barnes, CVISN System Architecture Project Lead at Johns Hopkins University Applied Physics Laboratory concurs, there is no dichotomy between the two. "EDI and the web are like the telephone and Internet. We use the telephone to get on the Internet or use the telephone over the Internet. They interweave. Currently we are using Internet email to transfer EDI files." In other words, the choice is not between using EDI or the web. EDI is the language in which the data is recorded. The web is a mode through which that data is transferred. The web says little about structuring or interpreting the data.

Modifications to Legacy Systems

The next step is to decide which modifications are needed to state legacy systems. Legacy Modifications (LM) represent changes to the legacy systems or new functionality built into systems when they are redesigned. Once the modifications are made, they become a part of the legacy system and are no longer separate interfaces. A Legacy System Interface (LSI) provides an interim interface between the CI and legacy systems. LSIs are implemented when the state chooses not to modify the legacy system to handle the open standard interfaces.

A common approach is to modify legacy systems to handle electronic applications, but use a CI system to interact with applicants' systems via EDI.

A common approach is to modify legacy systems to handle electronic applications, but use a CI to interact with applicants' systems via EDI.

Credentialing Interface (CI)

Once CAT options are chosen and state legacy system modifications determined, the next step is to choose how these systems will interface. Most states have chosen to do a CI that acts as an interpreter of data between the CAT and legacy systems. In this case, applicants use a CAT of their choosing and, via EDI, transmit to a single computer address located on the CI. From the CI, data is transferred to the state's legacy credentialing system. The advantage is the state makes minimal modifications to its legacy systems.

Connections to IRP and IFTA Clearinghouses

Connections between the state and IRP and IFTA Clearinghouses are CVISN Level 1 capability requirements. The IFTA is an agreement among states, Canadian provinces, and Mexico that allows carriers to register and pay motor fuel taxes in the carriers' home or base jurisdictions. The base jurisdiction is responsible for disbursing the appropriate fuel taxes to other jurisdictions where the carriers operate. The IRP is a registration reciprocity agreement among states, Canadian provinces, and Mexico providing for the payment of license fees based on the number of fleet miles operated in participating jurisdictions.

Commercial Vehicle Information Exchange Window (CVIEW)

To enable credentialing information to be accessed by roadside inspectors and law enforcers, "snapshot segments" of safety and credentials data are sent from the CI or state legacy systems to CVIEW using EDI. Carriers that have bad safety records as reported in roadside inspections can then be accessed by state credentialing systems. Thus, renewals of credentials to these carriers can be suspended. EDI is required between CVIEW and Safety and Fitness Electronic Records System (SAFER), an interstate safety data exchange system. EDI is recommended, but not required, for the interactions between CVIEW and other state systems.

Maryland, Virginia, and Kentucky System Designs Comparison

Both Kentucky and Maryland use the PC CAT product InterCAT. Kentucky plans to have PC CAT accessibility at a weigh station, library, and county clerk's office located in various parts of the state. Kentucky is also working on providing a Web-CAT. After many software difficulties with a PC CAT, Virginia has decided to halt this development and develop a Web-CAT using EDI. All three states use the CI.

For Maryland and Virginia, the Vehicle Information System for Tax Apportionment/Registration Services (VISTA/RS) system sends IRP data to the IRP Clearinghouse. The Vehicle Information System for Tax Apportionment/Tax Services (VISTA/TS) sends financial data for Virginia to the IFTA Clearinghouse. Maryland connects to the IFTA Clearinghouse via a Regional Processing Center. Kentucky's legacy system connects to the IRP Clearinghouse and the state will connect to the IFTA Clearinghouse via a Regional Processing Center in the future.

A key difference between Maryland and Virginia's designs is that in Virginia, the IRP processing system generates updates directly to CVIEW. In Maryland, the CI is the only system that communicates with the back-end systems including CVIEW. Maryland is also one of a few states that has the data from the IRP database incorporated into its mainframe database. This is in contrast with other states that keep intrastate and IRP databases separate. In this way, Maryland has policy control over the database to do "flag and conditions" checks. So, for example, if officials want to revoke a carrier's plates, they can do so directly through their mainframe.

System Interoperability

After CAT and CI options have been selected and an assessment of legacy modifications done, the question becomes, "How will these systems interact?" Architecturally, this means that various pieces that were developed by different vendors over time to meet certain business needs must be able to talk to each other to process new transactions. System interoperability lessons learned include the following:

Data Requirements between the CAT and CI. During the life cycle of an application, that is, how the application flows through a system from one point to another and returns, certain business processes are invoked. These business processes, in return, require certain data requirements. Most of the state's processes, regulations, weight rules, and taxes must be embedded in the CAT and match with the CI. However, the majority of state regulations and rules should be in the CI and not in the PC CAT so that any software company could develop PC CAT software. Since different vendors are going to develop PC CAT software and CI (except one private company that is currently developing both), data requirements may not match. This has proved a challenge for some states.

Data Validation Checks Throughout the System. There are various checkpoints in different systems during the life cycle of an application to validate that data is correct. For example, verifying to see if a carrier is in good standing could involve checking if the carrier is a title bearer, has paid IRP fees, and IFTA taxes. Architecturally, it is best to put validation checks as close to data entry points as possible so the system and customers' time is not wasted. Nonetheless, these checkpoints must also be embedded at different parts of the life cycle especially since different vendors have developed separate parts of the system. Therefore, when hiring a vendor to build a CAT, CI, or modify legacy systems, one must ensure that data uses the appropriate logic at the appropriate place with periodic system data checkpoints.

State Systems Maintenance

Once state systems have been modified to allow for electronic credentialing, measures to maintain them must be established. This is especially important if the systems were modified by contractors and in-house information technology staff members will be in charge of maintenance. Furthermore, assistance plans for operational users should be clearly spelled out. For example, in the case of production problems while walk-in customers are waiting, users can contact an "on call" program analyst who can fix the problem.

Changing Technology and CVISN Architecture Maintenance

Given public agencies' constrained finances, the life cycle of technology procurements is generally five years or more. This can be a difficult challenge for agencies when assessing technology options. In the credentials administration arena, technology changes are taking place in computers, open standards, and network communications options. The CVISN Architecture will be periodically updated to keep up with technology innovations. For example, as new technologies such as the web standard XML are proven for commercial vehicle applications, they will be incorporated into the CVISN Architecture.

The CVISN Architecture will be periodically updated to keep up with technology innovations.

Conclusion

Electronic credentialing broadens motor carrier customer services while streamlining and automating administrative processes. The CVISN Architecture has been used as a framework to develop state system designs to allow for these new services. To facilitate program deployment, institutional and technical changes must occur as discussed in this study. Such changes have also been catalysts for other transportation projects. Interagency working groups can be forums to discuss extensions of electronic credentialing to passenger vehicles or tracking of mandatory insurance compliance. Inter-state relations are also deepened, for example, regional oversize/overweight permitting may be done in the Southeast. Finally, CVISN can be a catalyst for systems integration work, in particular, remote client server communications structures. In sum, developing state system designs in conformance with the CVISN Architecture has resulted in benefits specific to credentialing administration and to other transportation projects.

References and Additional Resources

Web Sites

Virginia's Department of Motor Vehicles web page:
www.dmv.state.va

Maryland's Department of Transportation web page:
www.mdot.state.md.

Kentucky Transportation Cabinet web page:
www.kytc.state.ky

FHWA Office of Motor Carriers and Highway Safety web page:
www.fhwa.dot.gov/omc

Johns Hopkins University Applied Physics Laboratory web page:
www.jhuapl.edu/cvisn

Select Bibliography

National ITS Architecture and Standards Resource Guide. U.S. Department of Transportation Federal Transit Administration, Federal Highway Administration. September 1998.

Guidance for Architecture Conformance: Commercial Vehicle Electronic Credentialing. Johns Hopkins University Applied Physics Laboratory. Presentation by Valerie B. Barnes. November 3, 1998.

CVISN System Design Description. The Johns Hopkins University Applied Physics Laboratory. www.jhuapl.edu/cvisn

CVISN Statement of Direction, from Electronic Data Library, ITS Joint Program Office web page. www.its.fhwa.dot.gov

"What Benefits are Expected from CVISN?" Johns Hopkins University Applied Physics Laboratory. February 22, 1999. Draft copy.

"Technology in Trucking Operations" by Dan Stock. American Trucking Associations Foundation. March 1999. Draft copy.

Intelligent Transportation Systems Field Operational Test Cross-Cutting Study: Commercial Vehicle Administrative Processes. Prepared by Booz·Allen & Hamilton Highway and Vehicle Technology Group. McLean, Virginia. September 1998.

Commonwealth of Virgina ITS/CVO Business Plan. Virginia Department of Transportation, Virginia Department of Motor Vehicles, Virginia State Police. May 1998.

Virginia CVISN Prototype System Design Document-Top Level Design. Draft Copy. December 1998.

Maryland/Virginia CVISN Prototype Project Status Summary Presentation. David Hajduk, Virginia System Architect, Hadjuk & Company Consulting.

References and Additional Resources

Maryland Motor Carrier Program Strategic Plan. February 27, 1998.

Maryland CVISN Prototype Project Plan. Johns Hopkins University Applied Physics Laboratory.

Kentucky Project Plan 1997-99. Kentucky Transportation Cabinet, Department of Vehicle Regulation. April 15, 1997.

Individuals Interviewed

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Tim Adams, Clearinghouse Interfaces, Department of Vehicle Regulation

Federal Highway Administration, Office of Motor Carriers and Highway Safety:
Jeff Loftus, Transportation Specialist, CVISN Program

Johns Hopkins University Applied Physics Laboratory:
Valerie Barnes, CVISN System Architecture Project Lead

For further information, contact:

Federal Highway Administration Resource Centers

Eastern Resource Center
10 S. Howard Street, Suite 4000 – HRA-EA
Baltimore, MD 21201
Telephone 410-962-0093

Southern Resource Center
61 Forsyth Street, SW
Suite 17T26 – HRA-SO
Atlanta, GA 30303-3104
Telephone 404-562-3570

Midwestern Resource Center
19900 Governors Highway
Suite 301 – HRA-MW
Olympia Fields, IL 60461-1021
Telephone 708-283-3510

Western Resource Center
201 Mission Street
Suite 2100 – HRA-WE
San Francisco, CA 94105
Telephone 415-744-3102

Federal Transit Administration Regional Offices

Region 1
Volpe National Transportation Systems Center
Kendall Square
55 Broadway, Suite 920
Cambridge, MA 02142-1093
Telephone 617-494-2055

Region 2
1 Bolling Green
Room 429
New York, NY 10004
Telephone 212-668-2170

Region 3
1760 Market Street, Suite 500
Philadelphia, PA 19103-4124
Telephone 215-656-7100

Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Suite 17T50
Atlanta, GA 30303-3104
Telephone 404-562-3500

Region 5
200 West Adams Street
24th Floor, Suite 2410
Chicago, IL 60606-5232
Telephone 312-353-2789

Region 6
819 Taylor Street
Room 8A36
Fort Worth, TX 76102
Telephone 817-978-0550

Region 7
6301 Rockhill Road, Suite 303
Kansas City, MO 64131-1117
Telephone 816-523-0204

Region 8
Columbine Place
216 16th Street, Suite 650
Denver, CO 80202-5120
Telephone 303-844-3242

Region 9
201 Mission Street, Suite 2210
San Francisco, CA 94105-1831
Telephone 415-744-3133

Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, WA 98174-1002
Telephone 206-220-7954

Notes