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.

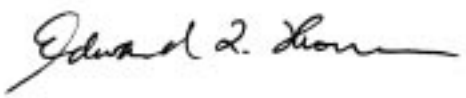
This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- **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



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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.

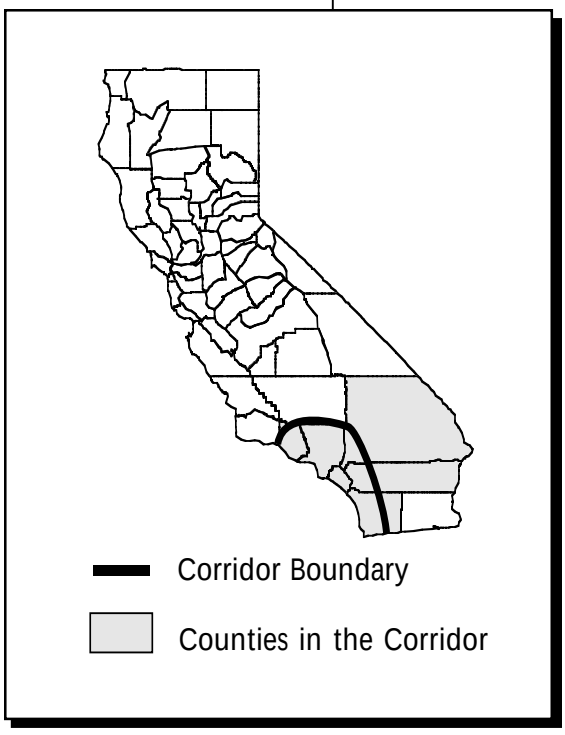
Six of the studies were conducted by U.S. DOT's Volpe National Transportation Systems Center under the sponsorship of U.S. DOT's ITS Joint Program Office, with guidance from the Federal Highway Administration and Federal Transit Administration. The Houston case study was conducted by Mitretek Systems,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

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.

Southern California Corridor Geography

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

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

Background

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 Caltrans on development team

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

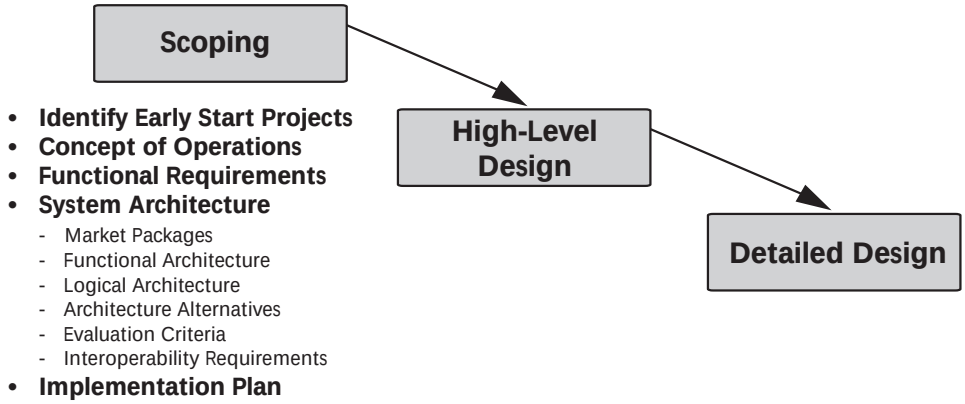
1995 Conceptual Architecture Completed
…Concept of Operations
…Functional Requirements
…Showcase Architecture

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

1999 Strategic Deployment Plan (Final Report)

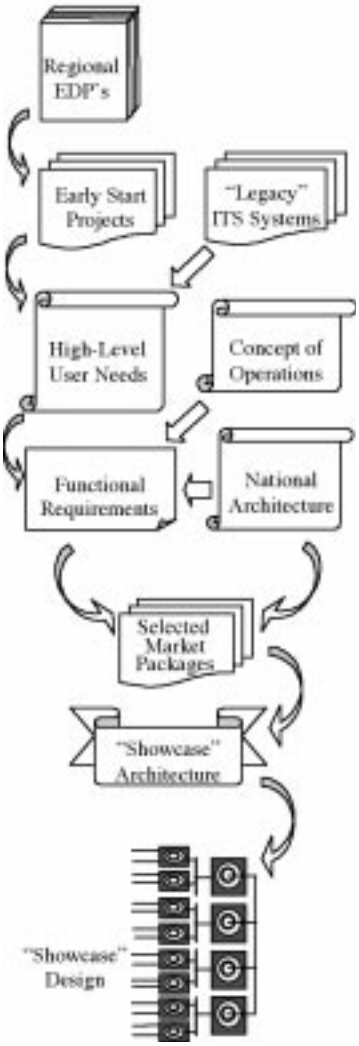
2001 Showcase Project ITS Architecture Validation to be completed

Regional ITS Architecture Development Process



Graphic Courtesy of Caltrans and Odetics ITS / NET

"Showcase" Architecture Development Process



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:

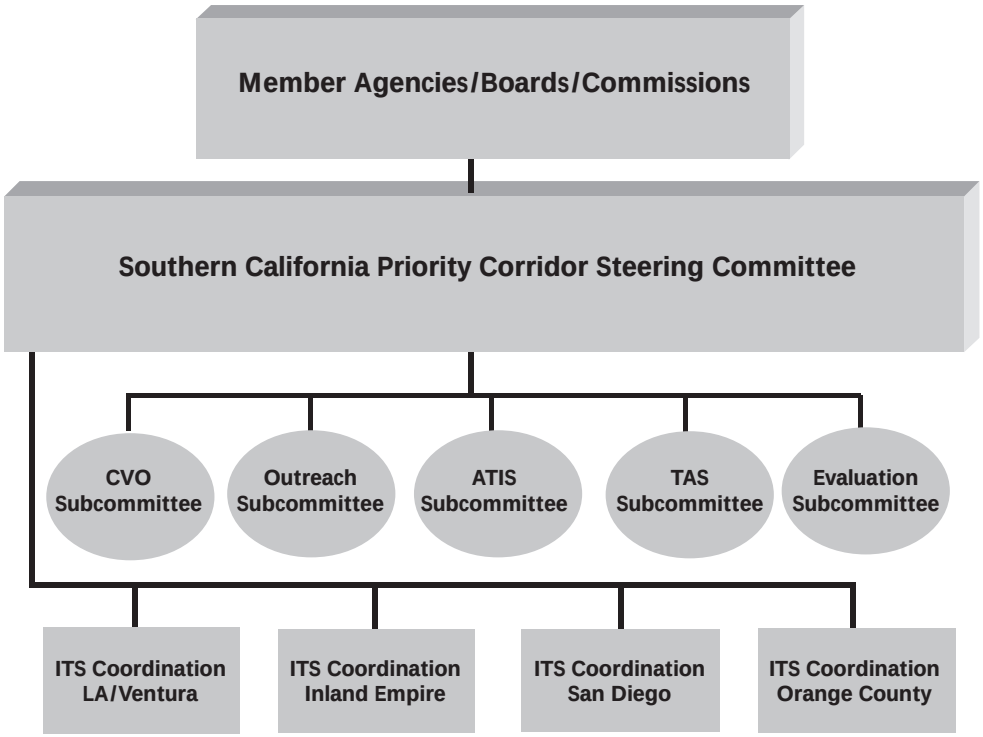
1. To prepare a corridor-wide ITS Strategic Deployment Plan* for adoption by sponsoring agencies that would define mutually beneficial technologies; and

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

* *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			Travel Tip
	Com-TV			
	SCAG Countywide GIS	SCAG Countywide GIS	SANDAG	SCAG Countywide GIS
	LA Smart Traveler			Santa Ana's ITIS
	Private Radio	Private Radio	Private Radio	Private Radio
Traffic Management				
	Caltrans/CHP District 7 TMC	Caltrans/CHP District 8 TMC	Caltrans/CHP District 11 TMC	Caltrans/CHP District 12 TMC
	ATSAC	SANBAG's Smart Call Box		Anaheim TMC
	Smart Corridor			Irvine TMC
				Santa Ana TMC
Emergency Management				
	Ventura CC	Barstow CC	Border CC	Santa Ana CC
	Los Angeles CC	Inland CC		
Transit Management				
	LACMTA	Athena	NCTD	OCTA
	Regional Rail Control Center	RCTC	MTDB	John Wayne Airport
	LA Smart Shuttle Project	SunLine Transit		
	LA Department of Airports	Omnitrans		
	Long Beach Transit	Ontario Airport		
	LA Smart Card			
	Foothill Transit			
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:

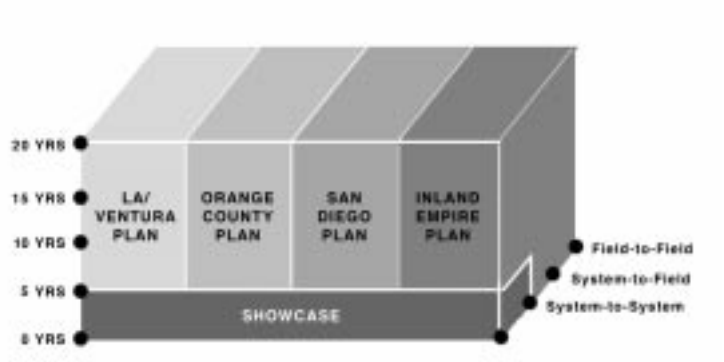
ATSAC – Advanced Traffic Signaling and Control
CC – Control Center
CHP – California Highway Patrol
CPTC – California Priority Toll Commission
CVO – Commercial Vehicle Operations
GIS – Geographic Information System
ITIS – Intelligent Transportation Information Systems
LACDPW – Los Angeles County Department 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

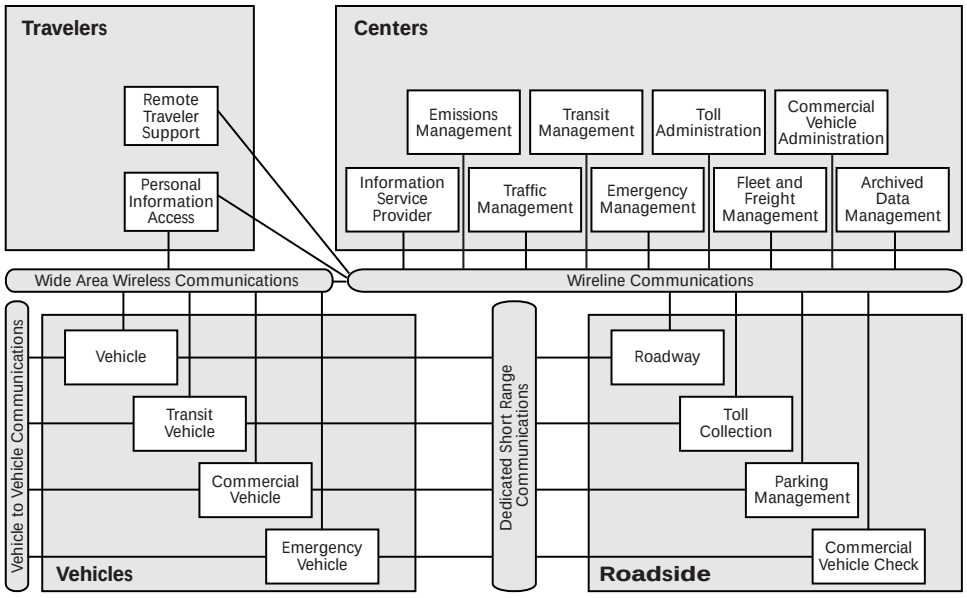
- Showcase Architecture– Integration framework for legacy systems and new ITS corridor applications.
- Integrated Modal-Shift Management– Interagency traveler information in the Los Angeles / Ventura Co. region.
- Transit Management Information System– San Diego Metropolitan area.
- Intermodal Transportation 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.

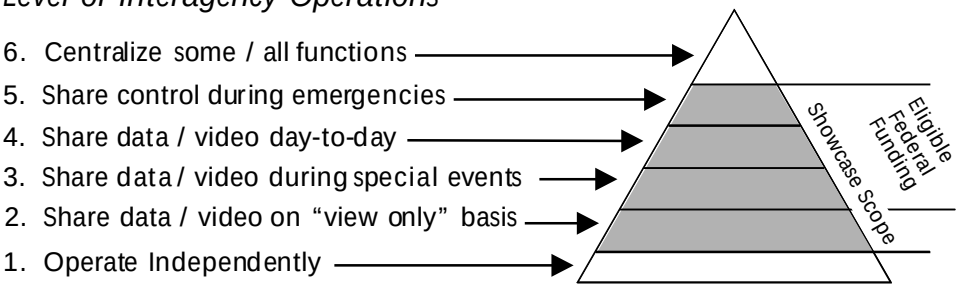


Graphic Courtesy of Caltrans and Odetics ITS / NET

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

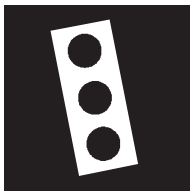


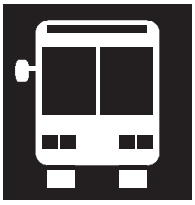
Stakeholders agreed that each agency or user would be allowed to choose the level (between 2 and 5) at which they wish to participate in the Showcase initiative. FHWA California Division impressed upon the stakeholders the need for integration beyond Level 2, considering the large infrastructure base 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

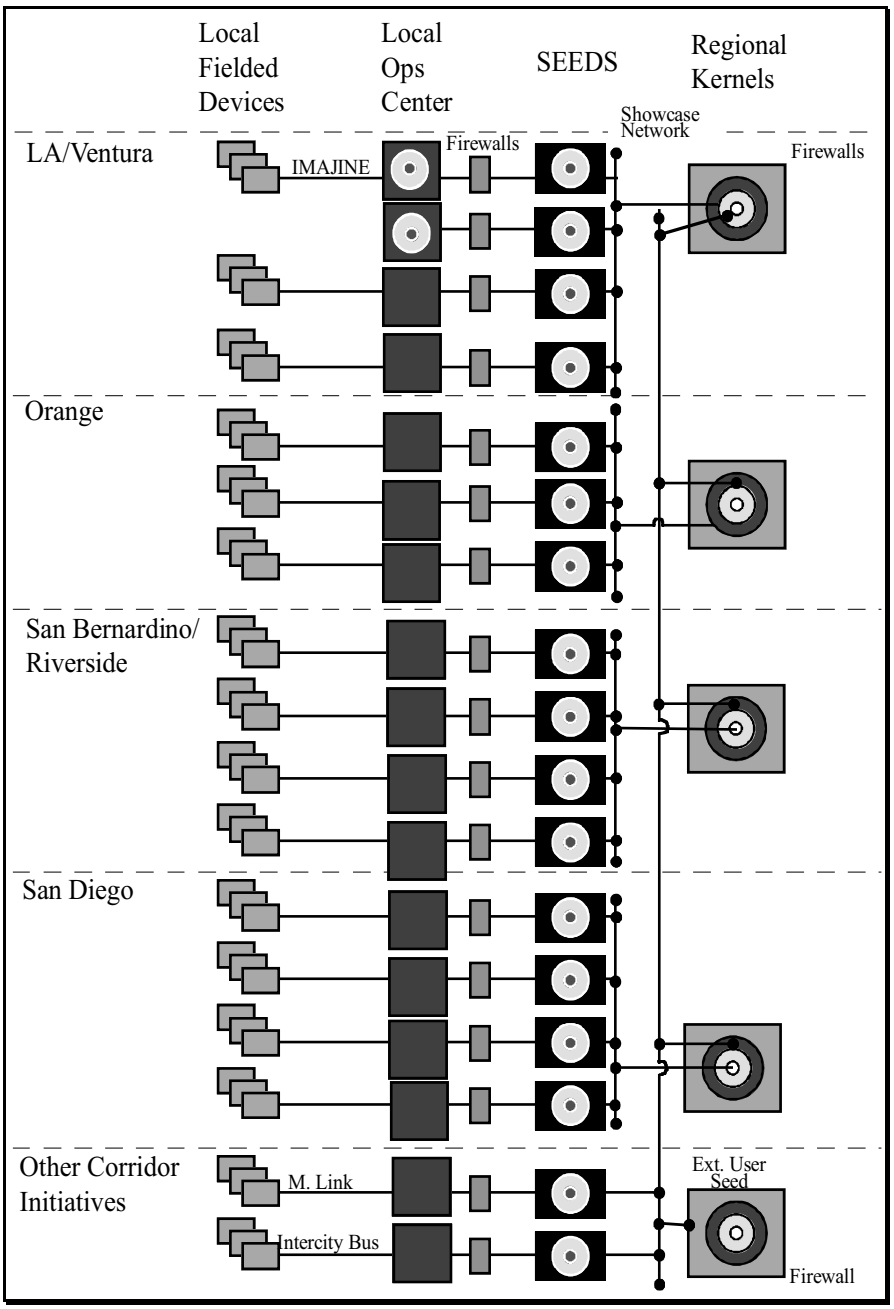
15. Emergency Response
16. Emergency Routing
17. Mayday Support

***** 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.

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Web Sites

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http://www.dot.ca.gov/hq/newtech/docs/deploy_plan.pdf

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http://www.odetics-its.com/showcase

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Individuals Interviewed

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