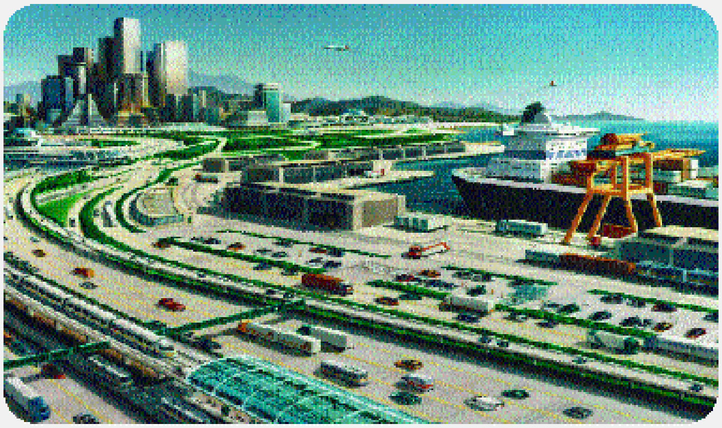
SOUTHERN CALIFORNIA ITS PRIORITY CORRIDOR
STRATEGIC DEPLOYMENT PLAN



INTERIM REPORT

Prepared for:
SOUTHERN CALIFORNIA ITS PRIORITY CORRIDOR
STEERING COMMITTEE

Consulting Services Provided By
TRANSPORTATION CORRIDOR CONSULTANTS
(A JOINT VENTURE OF PARSONS BRINCKERHOFF FARRADYNE, INC.
AND TRANSCORE)

In Association With:

Kaku Associates
Manuel Padron and Associates
The Kingsley Group
CCS Planning and Engineering, Inc.
Meyer Mohaddes Associates, Inc.
O'Rourke Engineering
Jacqueline Golob Associates

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CHAPTER 1

VISION OF THE SYSTEM

Background
Corridorwide Vision and Goals
Steering Committee, Mission and Responsibilities
Showcase
The Strategic Plan

CHAPTER 1.0
VISION OF THE ITS SYSTEM

There are many questions to be answered, problems to be solved and issues to be debated on the path to implementing Intelligent Transportation Systems (ITS) in Southern California. This chapter answers several basic questions, which set the stage for the rest of the Strategic Deployment Plan:

- How and why was the Southern California ITS Priority Corridor (Corridor) Defined?
- What are the vision and goals of the Corridor?
- What are the mission and responsibilities of the Southern California ITS Priority Corridor Steering Committee (Steering Committee)?

Through an aggressive California Advanced Transportation System (ATS) program, ITS is being researched, planned, built and tested for deployment to address today's transportation needs and those of the twenty-first century.

1.1 Background

Real impetus was added to the California ATS program with the 1991 enactment of the federal Intermodal Surface Transportation Efficiency Act (ISTEA) which established a national ITS program. ISTEA provided funding and direction for significant elements of the national ITS program, including research, strategic deployment planning, field operational tests and ITS Corridors. Congress established the ITS Corridors Program to:

- Provide multi-year funding for showcasing ITS applications and benefits;
- Establish national ITS testbeds;
- Advance ITS strategic planning;
- Leverage federal-aid and other funding sources;
- Expose the public to ITS potentials; and ,
- Evaluate ITS technologies.

Under this program new and innovative technologies provide traveler information services, advanced transportation and fleet management, vehicle control and collision avoidance, transportation systems automation and intermodal services/facilities. The intended result is the achievement of regional, state and national goals that improve mobility, safety and the economy as well as the reduction of energy and environmental impacts. The Corridors will be the cornerstone of ITS efforts in America for the immediate future. The other three Corridors selected by the United States Department of Transportation (USDOT) are the Northeast Corridor (roughly Boston, MA to Richmond, VA) the Midwest Corridor (Gary, IN –Chicago, IL – Milwaukee and the Southwest Corridor (Houston, TX).

The Transportation Equity Act for the 21st Century (TEA 21) was passed in May 1998 and replaces ISTEA as a funding source. The Corridor is well positioned to take advantage of funding under the new legislation because of their foresight in conforming to the National Architecture as much as possible in the original design for Showcase projects. The next step will be to adopt the approved (unfunded) projects in regional and state programming documents. Both strategies are required to be eligible for TEA 21 funding
.

The Southern California ITS Priority Corridor (Corridor), originally identified by the Federal Highway Administration (FHWA) on March 29, 1993, is bounded on the north by State Route 126, the northern boundary of Los Angeles County and Interstate 10; on the east by State Route 71 and Interstates 15, 210, 215, 805; on the south by the United States border with Mexico (which includes the Otay Mesa Border crossing and State Route 905); and on the west by the Pacific Ocean. The majority of this area lies within the major urbanized portions of Riverside, San Bernardino, San Diego and Ventura counties as well as all of Los Angeles and Orange counties (See Figure 1-1). This strategic deployment planning effort also addresses the areas surrounding the specific boundaries in order to include the entirety of the regional plans.

In an effort to move forward with the deployment of ITS technologies in the very diverse Corridor, the Steering Committee was formed to ensure that the key responsible agencies for each region were represented. As part of this effort, this Corridor was divided into four regions, three of which (San Diego, Los Angeles/Ventura County, and Inland Empire) are in the process of defining their needs and requirements for all modes of transportation and mobility through their own Early Deployment Planning efforts. The fourth region, Orange County, has already developed the equivalent of an ITS Early Deployment Plan (EDP), which is being updated as part of this project.

1.2 Corridorwide Vision and Goals

The vision, mission and responsibilities of the Steering Committee form the basis for a Corridorwide vision of the ITS system and the goals and objectives it should strive to accomplish. The Corridorwide vision and goals represent a consensus of the Steering Committee on merging each regional team's vision, goals and objectives with a Corridorwide perspective. This document attempts to merge the visions and goals from the regions into an evolving proposal at the Corridor level. General vision and goal statements are presented below. In addition, several "vision scenarios" are included in Appendix A to illustrate the Corridor vision.

Vision

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.

Goal

It is the goal of the Steering Committee to achieve the stated vision by preparing, on behalf of the member agencies, a strategic plan for the deployment and operation of advanced transportation technologies and integrated management systems in the Corridor and by recommending and securing state and federal policies and programs needed to support and carry out the deployment and operation of the Corridor Strategic Plan.

This plan will address ways to use cost-effective technologies and Corridorwide systems to:

- Increase overall speed and safety of travel;
- Improve performance of transit and ridesharing;
- Improve air quality and increase energy efficiency of transportation;
- Enable a competitive advantage to Southern California industry and commerce;
- Enhance transfer of passengers, goods and services from one mode to another;
- Facilitate automation in transportation facility construction and maintenance, and,
- Further development of the intelligent vehicle infrastructure and automated highway systems.

1.3 Steering Committee, Mission and Responsibilities

A consortium of major public transportation providers, air quality management districts, local governments, and law enforcement agencies formed the Steering Committee to participate with private industry in the planning and demonstration of interconnected communication systems that provide traveler information and traffic management capabilities. Strategic deployment planning was the impetus for the formation of the Steering Committee which built upon the success of four regional teams in Southern California, originally formed in response to federal Field Operational Test (FOT) solicitations. Involved agencies include: California Department of Transportation (Caltrans), California Highway Patrol (CHP), City of Irvine, City of Los Angeles, City of San Diego, Federal Highway Administration (FHWA) (Ex-Officio), Federal Transit Administration (FTA) (Ex-Officio), Los Angeles County Metropolitan Transportation Authority (LACMTA), Orange County Transportation Authority (OCTA), Riverside County Transportation Commission (RCTC), San Bernardino Associated Governments (SANBAG), San Diego Association of Governments (SANDAG), South Coast Air Quality Management District (SCAQMD), Southern California Association of Governments (SCAG), Southern California International Border and Commercial Freight Advisory Committee, and Ventura County Transportation Commission (VCTC).

Early in its existence, the Steering Committee articulated its vision of consideration and use of new and emerging ITS technologies becoming integral to the transportation planning process; through the use of these new technologies, additional benefits will be realized. The work of the Steering Committee–particularly through the deployment plans and the Showcase Program–has applicability to the rest of the state, especially in terms of institutional relationships and the interoperability (e.g., coexistence and interface capabilities) of the various modal systems. The Steering Committee also actively maintains national ties with the other Corridors, the Intelligent Transportation Society of America (ITS America) and USDOT.

It is the mission of the Steering Committee to provide a forum for the development of the Corridor Plan, four regional Early Deployment Plans, one Early Deployment Plan for the U.S. – Mexico border commercial vehicle operations and the Showcase Program. Showcase is a major Intermodal Transportation Management and Information System (ITMIS) demonstration/ initial deployment of ITS in the Corridor. Support for the mission of this Committee is reflected in the commitment of the executive officers of each represented organization.

The Steering Committee currently has the responsibility to:

- Represent the interests of the responsible transportation-related authorities which make up the Corridor;
- Initiate and coordinate agency review, approval and programming of the Corridor Plan;
- In developing the Corridor Plan:
    - Ensure coordination and integration of ITS activities (research, planning, programs, operational tests, demonstrations, etc.) with private and public entities (city, county, subregional, regional, state and national);
    - Conduct business in a manner that will ensure the fulfillment of the Public Involvement Program (PIP) requirements of ISTEA through the responsible transportation-related authorities which make up the Corridor;

- Address social, economic, environmental and institutional considerations as well as technical issues; and,
- Coordinate efforts to secure public and private funding for Corridorwide activities and early deployment projects.

In summary, the mission of the Steering Committee is to provide a process for planning, programming, and operating advanced transportation technologies and integrated management systems on behalf of the transportation agencies and partners which own and operate the Southern California transportation systems.

The purpose of this project is to develop a comprehensive Strategic Deployment Plan which addresses the needs and requirements for the entire Corridor by incorporating the information from the four regional plans addressing the needs and opportunities for Corridorwide deployment, based on the integration of the regional plans.

1.4 Showcase

The Showcase Program is a significant Intermodal Transportation Management Information System (ITMIS) demonstration aimed at optimizing and coordinating freeway and arterial operations with public and private transportation/transit systems within the Corridor. The purpose of Showcase is to demonstrate the feasibility and the benefit of integrating all modes of transportation and all roads of travel into a “system of systems”. To achieve this purpose will require both technical and institutional cooperation between the various agencies participating in the Corridor. Showcase is focused on center-to-center communications and does not address the implementation of center-to-field and field-to-vehicle elements.

The initial Showcase Program deployment results from the direction and leadership provided by the Steering Committee and formalized into a document based on the Showcase vision, the concept of operations and the recommended architecture. The guidance provided allows for a structured relationship between the efforts expended on the development and implementation of early start projects, the overarching Showcase architecture and the initial project deployments. Showcase architecture and implementation are consistent with the National Systems Architecture.

The goals and objectives of the initial Showcase Program include:

? Implement an environment that provides integrated capabilities throughout the Corridor in the management of transportation and traveler information;

? Plan the deployment of projects in a cost effective manner by designing specific projects to satisfy the National Architecture Market Packages and attempt to deploy the same design many times throughout the Corridor; and,

? Design and deploy a distributed architecture that allows multiple levels of agency participation as defined in the Showcase concept of operations document.

1.5 The Strategic Plan

The FHWA, through ISTEA and other related legislation and guidance, describes ITS planning as an element of statewide and metropolitan transportation planning. Development of the Corridor Strategic Deployment Plan has followed the ten-step ITS Planning Process developed by the FHWA. (This process is illustrated in Figure 1-2.) This deployment plan will be the “bludeprint” for agencies to follow to ensure that projects are designed and built to conform to the National ITS Architecture and Standards, a requirement for funding under TEA 21.

The federal ITS planning and deployment process emphasizes the significance of a strategic approach, a user-needs perspective and a strong institutional coalition. The deployment of ITS should be structured and strategic in order to protect against the inefficient allocation of resources and to ensure that ITS potential can be fully realized. Deployment should be based upon solving local user needs rather than simply looking for opportunities to utilize new technologies. Finally, successful deployment depends upon the development of an institutional framework and coalition of transportation agencies and other stakeholders. Such a coalition and the cooperation it fosters helps to ensure that each agency’s needs, constraints, opportunities and responsibilities are addressed and that the resulting system meets the needs and expectations of each agency, the public, and elected officials. In the Corridor, the Steering Committee provides the forum for this coalition.

CHAPTER 2.0

PROGRAM OF PROJECTS

Detailed Corridor Project Descriptions

CHAPTER 2.0
PROGRAM OF PROJECTS

This chapter represents the evolutionary next step in the planning process – how do we get to where we want to go? One facet of the path to take encompasses devising a program for implementation, i.e. a program of projects. Chapter 3 – Implementation Framework, takes this path one step farther by detailing partnerships and responsibilities for accomplishing the program of projects.

This chapter contains a list of projects that satisfy the existing Corridor needs for ITS. This program of projects has as its basis the existing and future systems that will make the Corridor function in a cooperative manner across all jurisdictions. Since this list is a method for administering, programming, and funding, it may be beneficial to first describe the Corridorwide system of systems that satisfy the vision.

The market packages (derived from the list of user services) that are of interest to the Corridor are in Table 2-1 below. (Market packages and user services are two of the steps contained in the federal deployment planning process. A definition of these two steps appears in Chapter 1, page 1-6.)

Table 2-1. Market Packages

Market Package
Advanced Transportation Management Systems(ATMS)
Advanced Traveler Information Systems (ATIS)
Advanced Public Transportation Systems (APTS)
Commercial Vehicle Operations (CVO)
Emergency Management Systems (EmM)
Advanced Vehicle Safety Systems (AVSS)
Event Management Systems (EvM)
Commercial Vehicle Information Systems (CVIS)
ITS Planning and Deployment

The first eight market packages comprise the definitive systems that make up the Corridor overall ITS system. In some cases, a system may be deployed at a regional level according to the architectural subsystems (detailed in Chapter 7) with the ultimate goal of inter-connection to other regions to comprise a Corridorwide system. For example, each region may be developing their own approach to an ATIS, but the ability to have regional ATISs communicate with one another is a Corridor function. In other cases, deployment may immediately be focused at the Corridor level, since a regional implementation doesn't capture the needs of the stakeholders. Commercial vehicle operations are an example of this scenario.

In addition, the implementation of Showcase implies that each region and, ultimately, the Corridor will have a set of standards to follow and, in many cases, a template for deployment that can be utilized. This will allow interoperability and interface connection for a true Corridorwide system of systems.

In the course of developing projects as logical breakouts of the systems noted above, it was determined that another descriptive umbrella category was required – ITS Planning and Deployment. The projects associated with this category, such as Configuration Management and Overall System Integration, transcended the other eight and this category was born of the need to group a specific set of projects accordingly.
The consultant embarked on a deliberate methodology to develop the list of projects for the Corridor. This methodology was directed by the Corridor Steering Committee, which

desired a compendium of all planned ITS projects in the Corridor. The regional plans have already identified numerous projects of regional importance and the consultant determined that this was a logical place to start compiling the Corridor list. The regional plans also provided assumptions on the supporting infrastructure at the regional level.

The consultant created a database of planned ITS projects based on six available Southern California ITS Plans:

? Los Angeles/Ventura ITS Plan (these projects will be added when authorized by the regional planning team);

? Inland Empire ITS Strategic Plan;

? Orange County ITS Master Plan Update;

? San Diego ITS Strategic Plan;

? Showcase Program Plan; and,

? Commercial Vehicle/Border Crossing Element of the Corridor Plan.

Each plan was reviewed and key project information was summarized in a comprehensive database. The key information summarized (where available) included the following:

? Source Plan

? Project Name

? Priority

? Purpose

? Market Package (ATMS, ATIS, APTS, etc.)

? Region (i.e. affected operating area)

? Concept

? Objectives

? Relationship to Other Projects

? Participating Agencies

? Deployment Plan

? Duration

? Funding

? Budget

The resulting database is over 100 pages in length and includes approximately 200 potential projects. This will be not only one of the first, but also certainly the largest undertaking of its kind in the nation. This ambitious goal, totaling over $2 billion in technology investments, represents the importance and dedication of this effort from the agencies involved. The deployment of the priority corridor network will occur over 20 years. A combination of systems that, at first, service primarily one region will “grow” across the corridor. Also, rudimentary systems spanning the entire Southern California area will be enhanced and expanded. Seven initial systems will be deployed in the short term (the next 5 years). Additionally a corridorwide backbone, the “Showcase” project, will also be constructed. These efforts will be the foundation of the priority corridor network.

(The entire database is available from Caltrans’ New Technology & Research staff and the California Alliance for Advanced Transportation Systems (CAATS) “Opportunity Bank”. A summary of this database is included as Appendix R.)

The next step was to identify Corridor level projects, i.e. those projects not included in the regional plans and deemed by the consultant to be crucial for the Corridor to accomplish widespread ITS success. The characteristics utilized by the consultant for Corridor project development encompassed the following:

- ? Abide by a "fill in the gap" philosophy (Gaps refer to those needs not addressed by the regional plans or those projects which are Corridorwide in nature.);
- ? Address all of the relevant user service/market package areas at the Corridor level;
- ? Span an implementation scenario of 20 years;
- ? Do not include Showcase early start projects in this project list; and,
- ? Do include Showcase projects that have not yet been funded.

With this credo and based on the ITS needs, stakeholder input, and team brainstorming, 18 projects were developed which focus on Corridor implementations. Each of the projects is described in detail on the following pages. Table 2-2 offers suggested deployment times and lead responsibilities for implementation.

TABLE 2-2

Market Package	Project Number	Project Name	Short Term	Med. Term	Long Term	Lead Respons.	Programming Respons.
ATMS	99	Corridorwide ATMS (Showcase)	x			Caltrans	State
	126	Corridorwide Decision Support/Expert Team		y		Caltrans	Corridor
ATIS	98/129	Corridorwide ATIS (Showcase)	x	x	x	Caltrans	State
	130	Coordinated VMS/HAR Strategies	y			Caltrans	Regional-Corridor
	127	Rural ATIS Deployment		z		Caltrans	Regional-Corridor
APTS	100	Corridorwide APTS (Showcase)	y			Caltrans	Regional-Corridor
	131	Inter-regional Transit Connection (En-route)		x		Caltrans	Regional-Corridor
	102	Inter-regional Rideshare Database (Showcase)	x			SCAG	Regional
	132	Smart Bus Stops/Rail Stations	y			Caltrans	Regional
	133	Corridorwide Transit Fare Integration & Automation	y			Transit Agencies	Corridor
CVO/ CVIS	128	ATIS for CVO (Showcase): CVIBOS	x			Caltrans	State
EmM	134	Emergency and Event Management System				CHP/Caltrans	Regional-Corridor
AVSS	142	Intelligent Vehicle Infrastructure Support	z			SCAG	Regional
	143	Integrated Intelligent Vehicle Highways & Arterials		z		SCAG	Regional
	141	Automated Highway Maintenance & Construction			z	Caltrans	State
ITS Plng	101	Corridorwide System Integration (Showcase)	x	x		Caltrans	Corridor
	137	Establish and Support the Priority Corridor Network	x	x	x	Caltrans	Caltrans

x=high priority y=medium priority z=low priority

During the course of system planning and project development, many other ideas were suggested. Some of these projects, while worthy endeavors, did not meet the Corridor-level criteria for system solutions and are not included in the Corridor plan. As an example, telecommuting was offered as an alternative to vehicle use and, while the concept is certainly an option for managing traffic, it was not part of the scope of this study. Also, not included were carpooling, bike riding, or other non-system solutions.

2.1 DETAILED CORRIDOR PROJECT DESCRIPTIONS

Each of the Corridor projects is characterized in a more detailed manner in this section, categorized by market package/system. Appendix R gives more information on all projects.

The Priority Corridor Network (PCN) is established and maintained in Project No. 137. The other Corridor projects flow from and integrate with the PCN.

Advanced Transportation Management Systems (ATMS)

The ATMS structure and architecture in the Corridor should provide real-time freeway and arterial traffic information, provide the ability to monitor and manage traffic operations, and provide incident status and guidelines (detection, response, clearance). The Corridorwide ATMS should also be intermodal in nature, moving beyond the roadways, to provide monitoring capabilities of other transportation modes, such as rail, air, and transit. But the Corridorwide ATMS should not be redundant to those at the regional levels and should not include infrastructure responsibilities.

Each region in the Corridor is pursuing the optimum ATMS for their locale. The task at the Corridor level is to assure that regional ATMSs communicate and exchange appropriate real-time data. This should be accomplished in a standard and consistent format and protocol. An integrated Corridorwide ATMS strategy involves multiple transportation management centers (TMCs) coordinating information and permitting shared control of various facilities. By definition, integrated ATMS operations involves the ability to share information on different system and travel modes among all operations agencies, plus public safety agencies including CHP. The projects outlined in this category are based on facilitating a Corridorwide ATMS.

Project No. 99: Corridorwide ATMS (Showcase)

This project defines, develops, and integrates the methodology for linkage of ATMSs throughout the Corridor for the purposes of coordinating regional transportation movement during recurring and non-recurring activities. This project will establish the operational means by which data, voice, and video are monitored at the Corridor level to facilitate inter-regional and inter-jurisdictional decisions for management of transportation facilities.

Detailed functional requirements for the Corridor ATMS will be defined. The project will also analyze resource requirements and operational characteristics, including space, staffing, and system maintenance. Specifications will be created for the Corridor ATMS. Design and integration scenarios will be developed and implemented. Memorandums of Understanding (MOU) will be developed for affected agencies.

This project was first defined under the Showcase Final Implementation Plan and is crucial for integrated Corridor operations.

Project No. 126: Corridorwide Decision Support/Expert System

The methodology for making appropriate Corridor decisions on transportation management for a higher level of efficient and flow quality needs to be developed. This algorithm development and implementation is the focus of this project. It involves application of computers to speed up implementation of management actions determined from interviews with professionals in traffic management.
The Corridorwide decision support/expert system will provide dynamic ability to balance the traffic flow between freeways and arterials and also between modes of transportation during times of both recurrent and non-recurrent activity. This methodology is for inter-regional and inter-jurisdictional purposes and is not redundant to those strategies implemented at the regional levels.

As noted, redundancy is to be avoided, but consistency is important. Therefore, this project will initially review the applicability of regional support/expert systems, the existing Smart Corridor concepts (such as the Santa Monica Smart Corridor), current efforts by Caltrans and Partners for Advanced Transit and Highways (PATH), and other similar nation-wide implementations of inter-regional applications. This project will then proceed through functional requirements, specification development, design, and implementation. The result will be a decision support system that includes integrated arterial and freeway operations.

Advanced Traveler Information Systems (ATIS)

The Corridorwide ATIS should provide the ability for travelers to access information regarding various transportation modes, services and facilities prior to or during a trip. The Corridor should encourage access to pre-trip information used for selecting transportation modes, identifying comparative travel times, and making route decisions before departure. En-route information for drivers includes driver advisories, congestion and routing messages based on real-time information, along with, potentially, in-vehicle signing to enhance safety.

Much of ATIS involves in-vehicle and private sector tools and activities developed and marketed to the public. The Coridor stakeholders are currently at a crossroads as to whether or not to charge the public for access to traveler information. The projects described below will provide a

Corridor system for traveler information and also help to chart a path for consensus on the issue of revenue generation.

Project No. 98: Corridorwide ATIS (Showcase)

Advanced traveler information systems currently exist at many levels of functionality and coverage with the Corridor.   Efforts are underway in the four regions of the Corridor to develop and integrate regional ATISs, with Orange County leading the way with the deployment of TravelTIP. In fact, TravelTIP is evolving to be the standard which other Southern California regions are planning to follow for their ATIS deployments. TravelTIP was initiated under Showcase, following the motto of “design once - deploy many times” and the investment in TravelTIP should benefit allCorridor stakeholders, as well as statewide efforts.

The benefits of TravelTIP at a regional level are based on the use of a standard approach that provides consistency in data format and compatibility of dissemination techniques. Distributed, regional ATISs are very important, but a seamless ATIS at the Corridor level is the focus of this project.

This project was first defined under the Showcase Final Implementation Plan and is founded on the development of an operational framework and definition of technical interface standards for a Corridor ATIS. (This project only goes to a certain point, so a follow-on project is defined below for continuation of the effort.)

This project provides for technical design of an integrated ATIS for access to traveler information from anywhere to anywhere throughout the Corridor and to lead development of a statewide standard. In addition, it establishes the management tools to maintain consistency throughout the Corridor and to ensure configuration management over traveler information format.

Project No. 129: Traveler Information Services in Corridor

Due to its relationship to Showcase, the previous project focused on the operational and technical aspects of a Corridorwide ATIS implementation. There are other aspects of ATIS in the Corridor that need to be developed and this project was created to take the Corridor ATIS the next steps beyond Showcase.

This project facilitates the integration of all the completed, on-going and planned traveler information systems in the Corridor into a comprehensive, Corridorwide traveler information system. This system brings the distributed, regional data onto the Coridor Network (PCN) for dissemination to users. The project tasks will be to determine the system requirements, develop the specifications, develop the design, determine the implementation parameters, and perform the system deployment and integration.

By implementing an ATIS standard for the Corridor, this project will allow Information Service Providers access to data from multiple systems throughout the Corridor. The ISPs can then fuse this information and provide a value-added service to consumers in the Corridor. To promote this feature, the project will focus on conducting specific outreach and partnering activities to expand the traveler information dissemination “network,” with special focus on these aspects:

? Ensuring that all regional and other ATIS in the Corridor are fully integrated with and transparent to each other;

? Coordinating strategies across the Corridor for vehicle-to-roadside communications;

? Providing components which allow commercial vehicle operators to access travel information reliably; and,

? Incorporating cellular phones and/or in-vehicle devices to expedite reporting and disseminating information in rural areas regarding incidents, emergencies and weather.

Another important task under this project is to develop a consensus on the issue of “to charge the public or not to charge the public ” for traveler information. By the time this project comes to fruition, the Orange County Travel TIP system will be operational and some significant lessons learned will be available. Also, there is an initiative being undertaken by CAATS to develop a statewide ITS plan with a particular focus on ATIS and the use of public/private partnerships. These efforts and others across the nation, especially the Model Deployment Initiatives, will serve the Coridor well in providing the necessary background information to make informed and cooperative decisions.

There is not enough current operational history to direct the decision one way or another at the time this plan is being generated. For those that feel strongly that traveler information should be considered an asset with a revenue generation capability and in order to sway them otherwise means awaiting case histories to facilitate new decisions. And for those who feel strongly that the information is for the public and they have a right to this information free of charge, there may be creative solutions yet to be investigated that will appease.

This issue is controversial and this project will provide the forum to work through the issues on a charted path to consensus. To stimulate and facilitate this process, this project will focus a steering committee on finding a compromise and creative solutions to resolving the differences of opinion on charging the public for traveler information.

Project No. 130: Coordinated VMS/HAR Strategies

This project will focus on the development of consistent and coordinated operational approaches and strategies for Corridorwide changeable message sign (CMS) and highway advisory radio (HAR) deployments and uses. From a user’s perspective, traveling across a regional boundary should be a seamless endeavor. If each region has their own rules for applying CMS and HAR, the traveling public can become confused and disoriented, perhaps becoming a traffic hazard.

This project will develop the system requirements, create the guidelines and strategies, develop the MOUs for regional indoctrination, and publish the results as a handbook for Corridor deployment.

Project No. 127: Rural ATIS Deployment

To meet the ATIS needs in rural Southern California, this project will determine the feasibility of using cellular phones, in-vehicle devices, smart call boxes, sensors, advisory mechanisms and other technologies to expedite reporting and dissemination of information regarding incidents, emergencies, and weather conditions within rural areas. The focus of this project will be on the Corridor applications as some of the rural regions traverse regional boundaries. The project will also be coordinated with other California and Nation wide efforts.

Advanced Public Transit Systems (APTS)

APTSs in the Corridor should provide real-time transit management capabilities through reporting of regional vehicle locations and schedule adherence, as well as providing information to users regarding transit schedules and real-time location (e.g., estimated time of arrival). Corridorwide APTS should address fixed-route and demand-responsive transit services, along with transit security and electronic fare collection. These projects will be coordinated with and through the Corridorwide ATMS and ATIS projects.

Project No. 100: Corridorwide APTS (Showcase)

This project was included in the Showcase Final Implementation Plan and is focused on providing the technical means of compiling regional transit activities and operations, including bus and train arrival and departures, at the Transit Management Centers. These Centers are being developed at the regional levels, but a consistent, Corridorwide approach needs to be determined and applied to achieve common methodologies and user interfaces. The tasks in this project include system requirements development, specifications and standards creation (such as transit geo-referencing standards), conforming database design, and system deployment/implementation.

Project No. 131: Inter-regional Transit Connection

This project will determine the implementation approach to achieve en-route transit information to provide travelers with the information on connecting services as well as any expected delays on their trip across regional and agency boundaries. This includes methodologies for both bus and train connections. Standard interfaces, dissemination protocols, and data fusion approaches will be defined, developed, and implemented in coordination with the regional transit systems.

Project No. 102: Inter-regional Rideshare Database (Showcase)

Under Showcase, it was determined that rideshare and transit databases are maintained separately by SCAG, SANDAG and various transit agencies on different hardware platforms using different software packages. No agency is able to provide “cross-border” information to employers, commuters, or other travelers.

SCAG’s Regional Transit Database Information Exchange Project, funded by AB 2766 discretionary funds allocated within the South Coast Air Basin, will provide the foundation for the comprehensive transit data element of the project. The rideshare databases are constantly updated by SCAG and SANDAG.

Without changing hardware, software or database structures, this project will allow the separately-maintained databases to exchange data in order to provide multi-agency rideshare information to intercounty travelers and cross-county commuters. Execution of the project will allow each agency to provide travelers and other organizations/employers/agencies with data for transit itineraries, rideshare partner matchlists, and vanpool information and coordinate the electronic exchange of transit and other rideshare information throughout Southern California.

The performance of this project will include:

- ? Define Data Requirements—the exact data elements and formats that are to be exchanged;
- ? Define Software/Hardware Requirements—develop specifications required to procure, develop procurement, installation and testing schedules and prepare estimates of procurement costs;
- ? Procure, Install and Test—prepare bid documents, evaluate proposals, install, design and supervise acceptance testing; and,
- ? Training—Produce a user's guide or manual and design/conduct training of customer service and data entry staffs in use of the system.

The database will allow all agencies to control input of their own data and to use any software they choose to disseminate the information. The data received will be translated into a public data format that all interested parties can utilize and made available to all interested persons, organizations, employers, agencies or kiosks.

Project No. 132: Smart Bus Stops/Rail Stations

The concept behind this project is based on the need to provide travelers with integrated, real-time information at regional transit and transfer centers. Project No. 131 addresses the methodology for disseminating inter-regional transit connections, but this project goes a step further and combines APTS and ATIS to achieve solutions focused on the unique aspects of real-time transit data to fully equip the traveling public with the information to make a travel decision on public transportation.

A "Smart Bus Stop/Rail Station" has the following characteristics:

- ? Access to real-time arrival and departure data for bus and train;
- ? Electronic announcement of bus/train arrival;
- ? On-line mode travel planning guides; and,
- ? Data fusion across boundaries and transit providers.

At the Corridor level, this project provides a path for development of a standard system approach for seamless access to transit information.

Project No. 133: Corridorwide Transit Fare Integration and Automation

This project will develop the Corridorwide strategy for fare structure integration across agencies and jurisdictions. Many regional plans have included automated fare payment implementations within their APTS deployments; therefore, this Corridor project will focus on promoting inter-operability of these methods. Strategies for revenue exchange, management, and options for privatization will also be investigated under this project.

Emergency Management Systems (EmM) and Event Management Systems (EvM)

Emergency Management systems support various emergency elements including CHP and local public safety agencies in addressing emergencies. The intent is for different agencies to utilize compatible vehicle tracking and management systems to support coordinated emergency response involving multiple agencies. Under this system, strategies for non-recurring and unplanned activities such as emergencies, incidents, and disasters are targeted. These projects will be coordinated with and through the Corridorwide ATMS and ATIS projects.

Planned events in the Corridor require a predetermined, agreed response which involves appropriate routing of traffic or demand shift, as well as improved traffic operations. These types of events require special interagency treatments, to the point of providing specific response strategic and operational plans which pertain to these events. Event Management will be coordinated with and through the Corridorwide ATMS and ATIS projects.

Project No. 134: Emergency and Event Management Systems

The CHP is responsible for state highway incident management, law enforcement, and assisting local government during emergencies when requested. The CHP uses the Standardized Emergency Management System (SEMS) to respond to and manage incidents (i.e., collisions, hazardous material spill, natural disaster, civil disturbance, etc.)

In order to respond to incidents which occur on the state highway system, the CHP and the California Department of Transportation (Caltrans) have established a partnership through the Transportation Management Centers (TMCs), which has been documented through a memorandum of understanding and the adoption of a TMC Master Plan. Both departments have combined their resources through the TMCs to expedite the detection, response, and coordination of services to incidents and event planning. A “regionalized” approach was formulated to provide coverage and support across boundaries and transportation facilities.

The Emergency and Event Management Systems project supports and implements the Caltrans and CHP TMC Master Plan goals by the following actions:

? Standardized systems, operations, and facilities to ensure cost effectiveness and uniform functionality statewide, and achieve economies of scale;

? Establish a regionalized structure that will provide an integrated, statewide framework for transportation management; and,

? Enhance public and private partnerships that promote multimodel activities and services.

Advanced Vehicle Safety Systems (AVSS)

This system has evolved into the USDOT's Intelligent Vehicle Infrastructure (IVI) Initiative and now focuses on advancing the state-of-the-art of safety and control of vehicles with implementations such as collision avoidance and vision enhancement. The Coridor recognizes that the responsibility for AVSS development rests with the vehicle manufacturers and should be market-driven as opposed to a grass roots effort by any one region or area. However, if intelligent vehicle movement is eventually desired, then public sector transportation system operators will need to provide infrastructure to support such movements. The projects in this category are intended to help the Coridor stakeholders determine the parameters of their involvement and responsibility. Also the Corridor is participating in a case study of IVI deployment needs which may lead to field operational tests.

<u>Project No. 142: Intelligent Vehicle Infrastructure Support</u>

This project is devoted to determining how the Coridor can benefit from AVSS evolution and what steps the Coridor should take to participate. This project undertakes the preparation of preliminary concepts and design in conjunction with the national intelligent vehicle infrastructure initiative.

Project No. 143: Integrated Intelligent Vehicles Highways and Urban Arterials

This project develops preliminary design parameters for applying intelligent vehicle infrastructure in the Corridor. This includes parameters such as the selection of an appropriate demonstration facility, the number of automated lanes (if any), the spacing of entrances and exits, and the vehicle speeds and traffic densities. These parameters will describe the transfer zones between any automated facility and the urban arterials within the Corridor.

<u>Project No. 141: Automated Highway Maintenance and Construction Activities</u>

This project will attempt to improve the efficiency and safety of highway maintenance and construction operations, which can restrict traffic capacity and present safety risks to workers as well as motorists. The program to automate highway maintenance and construction activities will address:

? Longitudinal crack sealing;

? Smart herbicide applicator;

? Telerobotic litter bag/debris collection;

? Infrastructure inspection; and,

? Road markings.

Commercial Vehicle Operational (CVO)

The Commercial Vehicle/Border Crossing Element discussed in Chapter 4 proposes establishing a market-based Southern California Premier Corridor to support CVO user services in the Coridor. The proposed the Commercial Vehicle/International Border Operations System provides the capability for improved management and tracking of commercial fleets as well as permitting automated administrative processing and hazardous material shipment monitoring. Commercial drivers and dispatchers could receive real-time routing and weather information and access databases containing traffic flow along truck routes as well as carrier, vehicle, cargo, and driver information. These projects will be coordinated with and through the Corridorwide ATMS and ATIS projects.

Project No. 128: ATIS for CVO (Showcase)

At the Corridor's numerous "gateways" for commercial freight, including the international border, sea- and airports, railroad facilities and truck terminals, there is a growing need for real-time traffic and other travel information to keep goods and vehicles moving through and around ever more congested parts of Southern California. At least two of the regions in the Corridor are developing CVO-related projects and the Corridor's International Border and Commercial Freight Advisory Committee is recommending a program of ITS projects.

This project provides a Corridorwide traveler information and management system which is tailored to suit the needs of the commercial vehicle operators who do business in Southern California. Using the Coridor network and the Corridorwide ATIS as a foundation, the project would allow dispatchers or drivers to send and receive messages when there is unusual traffic congestion or an incident on a route or at a specific facility of interest, e.g., inspection site, border crossing or intermodal facility. Methods of disseminating information might include radio, cellular phone, FM subcarrier, and stationary kiosk. All methods must be designed to be affordable, manageable, and useful by those responsible for moving freight and managing freight facilities and the international border.

This project will provide current traffic information and other data to truck drivers and other travelers as they prepare to cross the border or depart freight facilities to allow them to make optimum route choices as they proceed to any destination within or beyond the Corridor.

As part of this project, there remains a need to develop a partnership between the freight/commercial vehicle industry and information providers. The Corridor's Advisory Committee may serve as the forum for that effort.

The Premier Corridor ITS project accommodates other user services identified by the CVO Committee and takes into consideration existing/planned corridor ITS projects. This potential near-term project would address existing Premier Corridor needs and could be implemented relatively easily through existing institutional and technical arrangements. This project could be integrated into the Showcase Program helping to define and deploy the National System Architecture. This project addresses the CVO needs as well as those of the International Border Crossing systems.

Project No. 148: International Trade Centers (ITC)

The purpose of the International Trade Centers (ITC) project is to accommodate the cost-effective movement of safe and legal commercial vehicles in and out of sea ports, airports, freight handling facilities, and intermodal rail yards along the corridor and across the border. The ITC concept employs Intelligent Transportation System (ITS) and International Trade Data System (ITDS) electronic identification, tracking, security, credentials, and clearance technologies to quickly/effectively move trade goods into and out of "adjunct" or "virtual" intermodal centers apart from the current/traditional facilities. Containerized cargo imported or exported through the corridor ports-of-entry and intermodal rail yards could be positively identified, using Automatic Vehicle Identification (AVI) Systems. The status of their international trade records could be extracted from the ITDS Data Base and the inspector notified of the clearance status (Red/Green) of the transaction. Any targeted transaction, based on the analysis of the U.S. Trade Agencies and the ITDS, could be provided to the inspector for enforcement action. Once the goods are cleared, the responsible carriers could be notified of the goods availability for just-in-time pickup from the facility by the facility information management system-to-CVIBOS interface.

Project No. 149: Short Haul Carrier Needs Assessment

One of the characteristics of goods movement within the Southern California Priority Corridor is that short haul carriers make some 85% of goods movement trips. This is, to some extent, reflected in the fourth of the information-based needs identified in Section 3.2 that encompasses aspects of "Just-In-Time" (JIT) delivery.

It is important that, wherever relevant, the needs of short haul carriers are adequately addressed in future projects. This particular project would support that goal by specifically identifying such needs, deriving specific requirements, and recommending ways in which projects should address these requirements.

Project No. 150: Facility Goods Identification and Tracking System

The purpose of the Facility Goods Identification and Tracking System project is to accommodate the unimpeded movement of safe and legal commercial vehicles along the corridor and across the border. The integration of existing or planned facility management systems could support effective movement of trade goods throughout Southern California and Mexico. These would be modified to interface with the Priority Corridor Commercial Vehicle/International Border Operations System (CVIBOS) and Intelligent Transportation Systems/Commercial Vehicle Information Systems and Networks (ITS/CVISN) electronic credentials and clearance technologies. Commercial vehicles could be positively identified, using Automatic Vehicle Identification (AVI) Systems. Their cargo records would be validated electronically, and the facility management system notified of the arrival/departure of a cleared vehicle, driver, and cargo. Based on the analysis of their electronic credentials, an unsafe vehicle/cargo status could be provided to the facility inspector for regulation/enforcement action. Safe and legal vehicles could be allowed to operate throughout the facility, monitored, but unimpeded by inspectors and enforcement agents.

The system is responsible for monitoring the safety and security of the commercial vehicles and cargo while operating in the facility area. The facilities have established a security and inspection program and the criteria to which all commercial vehicles are required to adhere when operating in the facility. These safety and security regulations result in long waits to process shipments through the facility while traffic congestion on the limited approaches to and from the facility adds to this delay. The cost in time and enforcement resources is high, and efficient movement of goods is compromised.

ITS Planning and Deployment

As mentioned previously, in the course of developing projects as logical breakouts of the systems, the consultant determined that another descriptive umbrella category was required – ITS Planning and Deployment. The projects associated with this category, such as Corridorwide System Integration and Establishment and Support of the Corridor Network, transcended the other eight and this category was born of the need to group a specific set of projects accordingly.

Project No. 101: Corridorwide System Integration

This project will provide integration assistance for the large magnitude of ITS projects to be deployed at both the Corridor and regional levels over the next twenty years. The tasks to be undertaken include guidelines for compatibility with the Corridor and national architectures. Proven system engineering principles will be deployed to ensure a structured approach to integration and consistency in deployments across the Corridor.

In many respects, the Showcase Project is leading the way with the choice of object-oriented systems technology as the means for implementing ITS in the Corridor. Many agencies will need assistance in this relatively new approach as they revise legacy system interfaces to join the PCN.

Although the focus of the Showcase effort is to “design once – deploy many times”, there will be circumstances in which “one size does not fit all” and additional design and integration assistance will be necessary. This project is the means by which these systems can be integrated.

Project No. 137: Corridor Network Establish and Support

This project includes tasks to establish, operate and maintain the PCN which has evolved from the Showcase Project. This project also provides a means to add evolving and required functionality and additional capability to the network. Trouble shooting and on-line support for all system functions are included.

CHAPTER 3
IMPLEMENTATION FRAMEWORK

Policies for the Priority Corridor
Roles and Responsibilities
Facilitating Private Investment
Funding
Action Plan

CHAPTER 3.0
IMPLEMENTATION FRAMEWORK

This chapter describes the nature of the Corridor's framework for implementation and the roles and responsibilities necessary for success. It discusses some models for privatization of ITS, the types of products and services the private sector could offer and barriers to private participation in implementing this plan. In addition, sources for ITS funding are identified and alternatives for procurement are discussed.

The implementation of this ITS Strategic Deployment Plan will be accomplished through the financing and operation of the program of projects outlined in Chapter 2. One path to implementation leads through the local, regional and state planning and programming processes. To be eligible for funding under TEA 21, the projects identified in this plan must be incorporated into the applicable programming documents (i.e., the State Transportation Improvement Program (STIP), Transportation Improvement Programs (TIP), the Interregional Improvement Program (IIP), the State Highway Operation and Protection Program (SHOPP), and other statewide transportation plans such as the Advanced Transportation Systems Program Plan and New Technology and Research Program of Caltrans.

Another path to implementation involves partnering for deployment. CAATS is developing an "Opportunity Bank" and embarking on a program of *ITS Deployment Initiatives* which will look at partnering to help finance and operate some of the program of projects listed in Chapter 2.

3.1 POLICIES FOR THE PRIORITY CORRIDOR

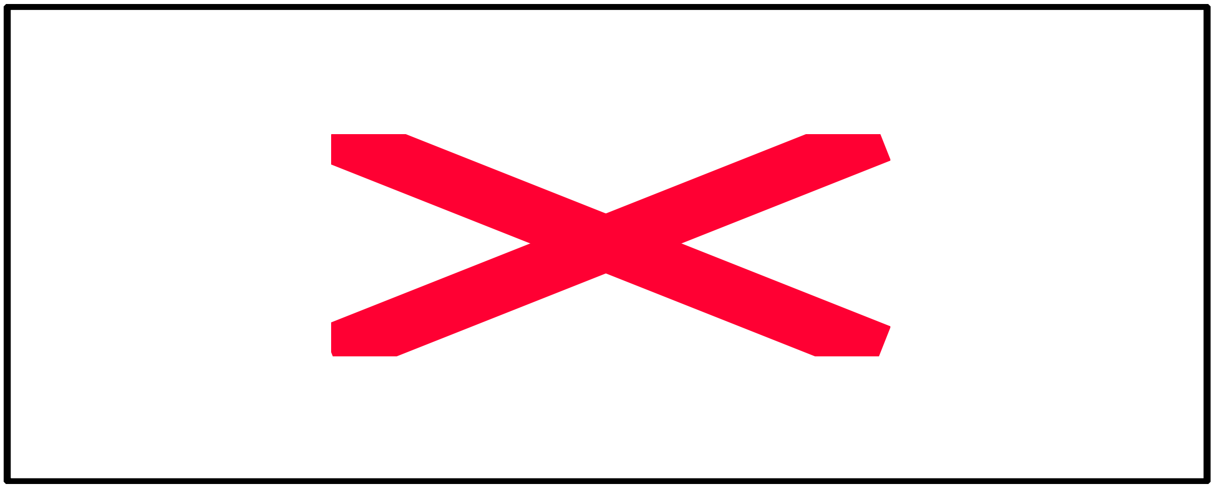
The following policies support successful implementation of the Corridorwide plan. The Steering Committee, consisting of the transportation agencies and stakeholders in Southern California, shall:

- Coordinate and support the implementation of the Southern California ITS Strategic Deployment Plan through a consensus approach;
- Oversee the deployment of ITS across all modes, to assure intermodal connectivity and interoperability, through existing planning and development processes;
- Assure an open, distributed system;
- Assure the philosophy of "design once, deploy often";
- Encourage creativity and efficiencies by both public and private sector participants;
- Focus on Corridorwide systems and projects while assisting and coordinating the regional development and implementation ITS deployment;
- Encourage the optimum performance and benefit to the citizens of Southern California;
- Leverage resources wherever possible; and,
- Share lessons learned with other regional, state and national interests.

3.2 ROLES AND RESPONSIBILITIES

The Priority Corridor Steering Committee's mission is to provide a plan for increasing the safety and efficiency of the transportation system through the cooperative and coordinated applications of advanced and intelligent transportation systems and technologies. This plan calls for a series of local systems each planned, designed, and implemented to operate in close coordination with each other to help improve performance and solve problems which stem from the operation of a complex multi-modal and multi-jurisdictional transportation system, The Priority Corridor coalition's mission also includes the development and maintenance of a coherent vision for the possible application of these technologies statewide and into the future.

The Corridor should adopt the following organizational model (illustrated in Figure 3-1). Please note that is a change from the current organizational structure. The Steering Committee will be called the Steering Committee and the "coalition" refers to the group of stakeholders that comprise the Alliance, the Execute Committee and the Steering Committee.



Role of Southern California ITS Deployment Alliance

The Southern California ITS Deployment Alliance (Alliance) is the multi-regional policy and programming committee for the Priority Corridor. The Alliance membership includes top level management each transportation programming agency in the Corridor—SCAG, SANDAG, the county transportation commissions and Caltrans. The Alliance recommends policy and program actions concerning ITS to their respective agencies for approval.

Role of the Executive Committee

To oversee and manage the day-to-day Corridor activities, an Executive Committee made up of an appointee from SCAG, SANDAG, the county transportation commissions and Caltrans would direct and coordinate the implementation of the Corridor ITS plans and program. This new Executive Committee would provide the long-range viewpoint and strategies to implement the Corridorwide development over the next 20 years.

Role of the Steering Committee

A Steering Committee consisting of representatives from all member agencies would include top level operational and engineering representatives of the member operating agencies and provide direction for operations, technical coordination and Showcase delivery. Staff and/or a general consultant could support the Steering Committee. The Steering Committee would oversee the work of the subcommittees as needed to focus on important features and day-to-day activities of the Corridor's ITS Program. Currently, these subgroups are active:

- Technical Management Subcommittee (TMS): this group advises the Corridor on technical and system management matters;
- CVO Subcommittee (CVO): this group advises the Corridor on commercial vehicle operations and implementation of CVO plans and programs;
- Outreach Subcommittee: this group advises the Corridor concerning outreach/ marketing activities for the Corridor; and,
- Evaluation Subcommittee: this group is responsible for managing the Evaluation Consultants who will evaluate the Showcase and other Priority Corridor projects.

The following groups, while not strictly subcommittees, play an important and integral part in the success of the Priority Corridor plans and projects:

- Users: users consist of the Regional Teams and others who participate in Corridor deliberations; and
- Private Sector: this group consists of our private sector partners, including California Alliance for Advanced Transporation Systems (CAATS), Southern California Economic Partnership (SCEP), Regional Transportation Technologies Alliance (RTTA), and others.

This structure is an institutional mechanism for deploying, operating, resolving conflicts and managing the configuration of the systems.

Role of Caltrans and the CHP

Caltrans and CHP currently operate the four Caltrans/CHP Transportation Management Centers in the Priority Corridor (LA/Ventura, Orange, Riverside-San Bernardino, and San Diego). Caltrans and the CHP are in the process of co-locating their communications centers within their TMCs (San Diego and Sacramento are currently co-located). The PCN, described in detail on page 26, provides Caltrans/CHP with a means of linking these regional centers together. It would enhance and expand the sharing of information to better manage the transportation infrastructure. This is consistent with the TMC Master Plan and would develop the capability to coordinate operations between districts; and, in the event a TMC becomes inoperable, to transfer control of that TMC to another TMC.

Role of Caltrans' Office of Southern California Advanced Transportation Systems Projects

Caltrans' Office of Southern California Advanced Transportation Systems Projects has been established to deliver the Showcase Program under the direction of the Steering Committee. Principle responsibilities include development, field testing, demonstration and evaluation of on-going and evolving Showcase projects.

Role of Other Public Agencies

Each public agency who joins the PCN will continue to be responsible for implementing and managing their respective transportation systems. All command and control processes will continue to reside at the local level with cooperative agreements allowing for shared management at the discretion of the parties to the agreement. Each agency would maintain a separate control center, communications desk, or dispatch facilities which may be linked to the PCN.

The communications link to the PCN would allow each agency to send and receive information from the PCN database. This link would enable multi-jurisdictional coordination and operation of systems and services. The PCN would support agency-to-agency communications independent of the regional database and operational coordination between adjacent municipalities or other localized needs.

The regional and local agencies are also expected to form partnerships for cooperative operations with other public agencies and with private/non-profit entities.

Role of Users

The consumers of transportation services in the Corridor will become involved in the deployment of ITS and technologies through their use of the Corridor transportation system. Users will look to the Corridor ITS to make transportation of people and goods safer and more efficient; they will find enhanced abilities to manage their journeys and shipments. ITS technologies would empower the user to better manage their own travel.

Role of Private/Non-Profit Entities

The Corridor ITS Deployment Plan anticipates that the private sector will play a role in the deployment of ITS in Southern California. Caltrans Traffic Operations Program Policy Number TOPP97-2 represents the states current thinking on business models.

In general, the public sector is responsible for collecting and integrating area-wide surveillance information (e.g., detectors) and then developing and implementing control strategies The public-sector ATMS contains the materials needed by advanced traveler information systems—either public or private-sector.

With the Corridor ATMS organized into the PCN, the opportunity exists for private and non-profit partners to participate in the packaging and dissemination of travel information. A primary role of the private sector would be to analyze raw data, tailoring the information to meet the unique requirements of the end users; and disseminate the traveler information through various traveler information markets, (i.e. radio and TV outlets, kiosks located at large travel generators, highway advisory telephone, and in-vehicle devices).

The retailing of information would be licensed by the public-sector data wholesalers through business agreements with the responsible regional and/or Corridor agency(ies).

Of course, there will be exceptions. For example, the public sector is already installing and operating variable message signs and information kiosks at key locations throughout the roadway and transit networks to provide traveler information. Moreover, public-private partnerships may also be utilized to provide communications, incident response, service patrols and operational support.

3.3 Facilitating Private Investment

Private investment in ITS deployment is expected in the Corridor, especially in the traveler information and CVO program areas. This section describes some models for privatization of ITS projects and the private sector’s possible roles, level-of-interest and barriers to partnership.

Private interests need government agencies to follow through on promises and agreements; this need should be acknowledged and fulfilled by the Corridor’s agencies.. Partnerships are needed at more than the ad hoc project level if collaboration is to occur in a systematic and comprehensive fashion. New relationships and approaches are needed at organizational, programmatic and project levels. Currently, few examples of partnerships exist at the agency and program levels. There are, however, a range of available project agreement models, which provide the foundation for a broader, more strategic approach to partnership development at the program and agency level.

What the Private Sector Offers

The private sector offers the Priority Corridor products and services necessary to deployment.

Traditionally, the public sector (state/local transportation agencies) has played a dominant role in basic transportation infrastructure. This role is changing today requiring public agencies to focus on safety, service and performance.

The private sector role is historically as a vendor of services where standards and specification are set by the public sector. This new focus on service should greatly expand the role of the private sector in transportation. (Within the transportation sector overall, including vehicles, equipment and operations, the private sector is dominant accounting for about 90 percent of the total expenditures. Infrastructure accounts for only about 10 percent).

A wide range of private sector entities of various sizes and orientations is likely to provide portions of the intelligent transportation system.

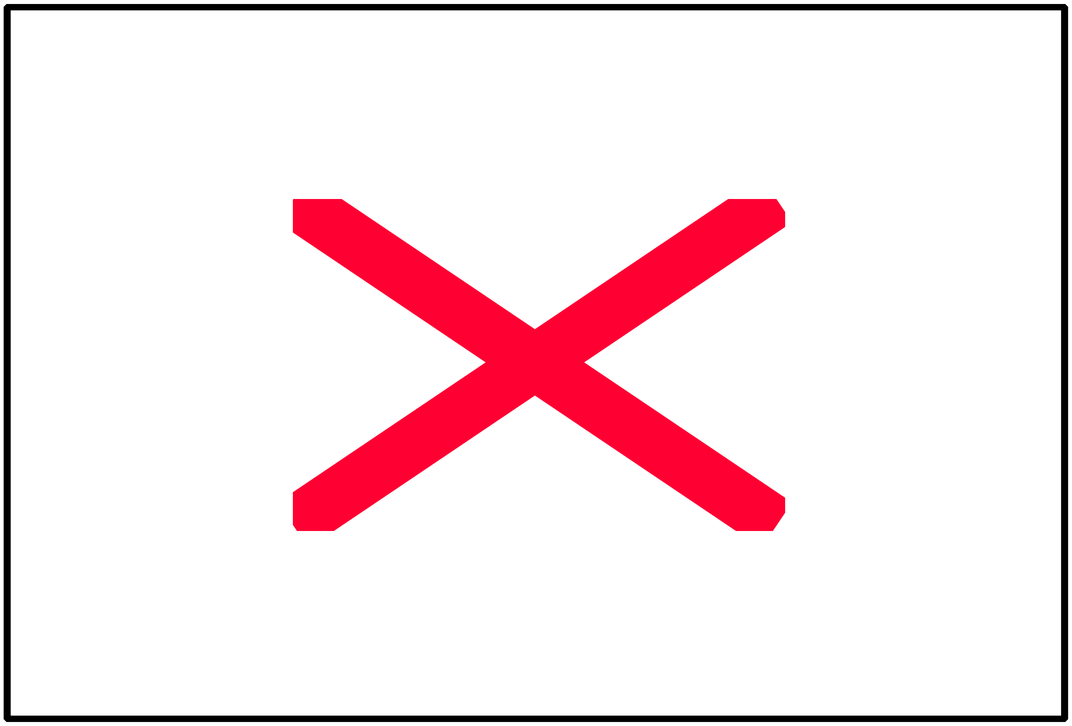
Key potential private sector players include:

- Technology/product manufacturers;
- System integrators, designers;
- Service providers; and,
- Communications.

The roles for private enterprise involvement in ITS are affected by three major considerations:

- The ITS element or function under consideration;
- Potential effectiveness of the public agency vs. the private entity; and,
- Available public resources.

Many of key elements of ITS are already in the private sector by virtue of being communications, personal communications devices, etc.). Figure 3-3 indicates the wide range of entities included under the generic label "private sector."



The Private Sector's Level-of-Interest

The interest of the private sector in participating in ITS deployment in Southern California will be different in the short-term than in the long-run. First of all, let us examine the different motives of the private and public sectors.

Although private industries meet important public interests, they are investor-and profit-driven, price-based, competitive, and respond to large (non-ITS) markets. These products and services are integral to facilitating ITS deployment, but are not created specifically for the ITS market. ITS is likely to be only part of the overall market for these products and services. For example, personal communications devices can provide users a wide range of information, which may include weather, financial and other information, in addition to real-time travel information.

ITS development, deployment and operations require a different set of roles and resources (financial, technical, consumer responsiveness, operation, etc.), much of which may already be well-established in the private sector.

The ability of an entity--public agency or private enterprise--to provide user-responsive service in a cost-effective manner will depend not only on the type of services, but also on inherent characteristics of the entity itself; its technical capabilities, motives, and how it defines and responds to apparent opportunities to provide services.

Many of the capabilities needed to develop and deploy ITS are in the private sector. While private-sector capabilities can be obtained through traditional public-sector-buyer/private-sector-vendor relationships, this may not be the most effective approach because:

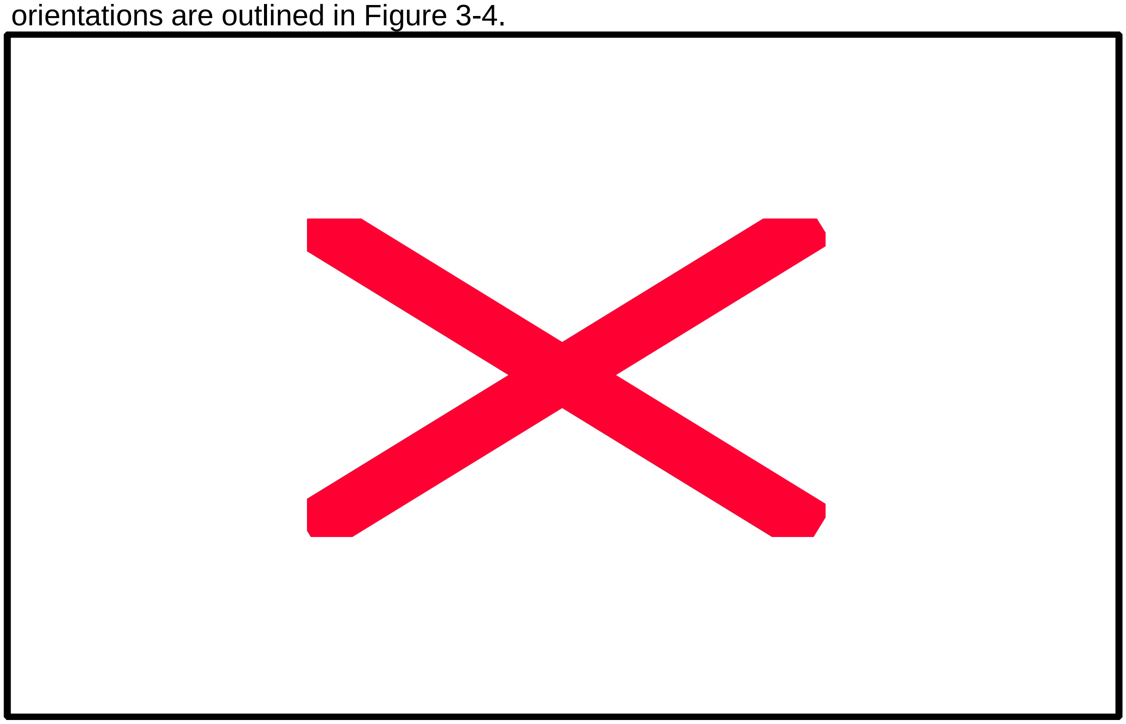
- The specialized skills required by such systems engineering/integration and program management are not generally resident in pubic agencies;

- The needed technology is dynamic and cannot be easily standardized. This evolving technology is developed and owned by private firms introducing burdensome procurement cycles to the complexity of dealing with private intellectual property as a procurement issue and risks that might better be borne by investors rather than taxpayers;
- ITS products and services are closely related to other industries in the economy such as telecommunications and to the automotive/electronics industry that are significantly larger and affected by changes that are independent of transportation. The modest leverage of ITS in these sectors suggests the efficiency benefits of leveraging and "piggybacking" relationships to other commercial network systems;
- Private sector entities are oriented to consumer markets. This orientation is needed to generate off-budget investment capital for cost-sharing. In addition, private enterprises are designed to provide full-time operations and maintenance services; and,
- Finally, private enterprise also offers an easy means of overcoming inter-jurisdictional limitations.

These features of the private sector suggest there are considerable benefits of capitalizing on private enterprise.

Successful partnership program roles must be linked to motives. These motives are linked to the orientation of private enterprise vs. government programs and agencies.

Typical motives and perspectives of the two sectors reflecting their basic institutional orientations are outlined in Figure 3-4.



Recognizing motives, now we move on to evaluate the technical risk of deployments against the expectation of direct payment.

To make these motives "work for" effective partnerships:

- Legal, administrative constraints and client/vendor traditions must be overcome; and,
- Market and business considerations must be accommodated.

However, from a public policy perspective, there may also be concerns about protecting the public interest via issues such as "baseline" services and non-exclusion, monopoly pricing, etc.

Value-added service features of ITS present both direct and indirect commercial opportunities for the private sector through a variety of revenue streams and resource sharing arrangements. ITS systems can be structured to maximize or minimize such opportunities.

Many potential revenue-generating opportunities exist within ITS, each of which carries its own technical, market or institutional risk. Figure 3-5 suggests that certain user services tend to have inherent risk/reward mixes.

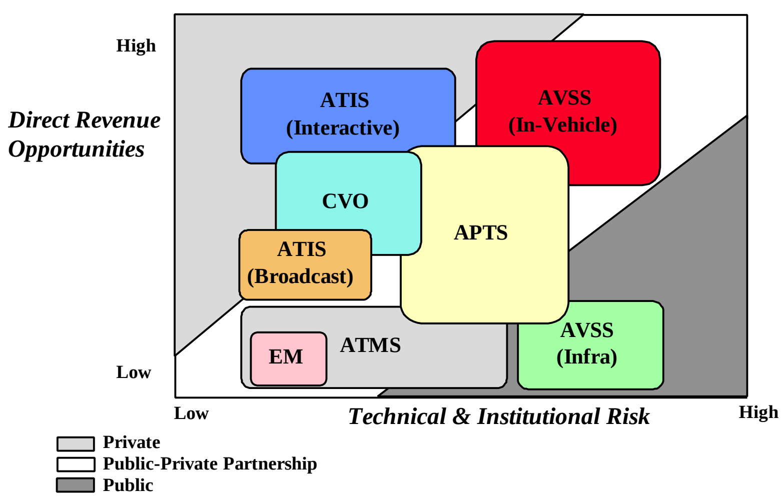


Figure 3-4: ITS Opportunities and Risks

Among the opportunities are:

- Revenues from the sale of products and/or services. These products and services may be stand-alone or may be added to existing automotive or personal information products (value added);
- Revenues from user fees for information or traveler assurance services through other billing mechanisms such as automatic vehicle identification or cell phone billing;
- Public-private investment cost-sharing as part of other businesses (shared communications through fiber optics);
- Commercial sponsorship of public services (affinity "public service exposure");

- Potential for private sector piggy-backing of commercial services on transportation-related ITS systems (electronic toll and traffic management commercial applications to defray costs);
- Operating contracts with various kinds of incentive arrangements that provide rewards for improved efficiency of service; and,
- Fees from franchises or contracts for operations or other services not directly recoverable, but based on public sector arrangements reflecting shadow prices and avoidable costs.

In some cases, the choice of technology will determine relative roles of public and private sectors. In other cases, ITS may not be stand-alone projects (where some strong public purpose is being met and cannot easily be priced). New forms of public-private partnerships need to be invented or adapted with co-funding and risk/reward sharing features.

Barriers to Private Participation

The barriers to participation by the private sector in Southern California deployment are both technical and economic. The previous discussion focuses on the natural strengths of government and private enterprise within the context of transportation services in a free enterprise economy. However, any reallocation of roles between the public and private sector in the provision of ITS invariably confronts the long-standing conventions in surface transportation infrastructure regarding the roles, relationships, laws and regulations, and even culture.

For every ITS project or activity, there are barriers to collaboration at several levels and within several institutions (including government, agencies and business). The most obvious barriers are legal and administrative as described in some detail in Appendix O. However, there are also more subtle but important barriers that are part of the traditional public works "culture" and organizational structure, that have developed over decades as effective instruments in capital-intensive facilities development, but which may be less appropriate for ITS systems.

Legal and administrative barriers derive from state legislation, Federal-aid regulations and even basic California constitutional restrictions. These include defined roles for private sector entities as consultants and contractors and a strong commitment to a competitive low bid procurement process. As a result, a series of issues arise when private investment in capital or in-kind is part of an ITS project such as private technologies (intellectual property), commingling of public and private real or cash resources (cost-sharing) or public actions to mitigate risk for private entities (exclusivity).

In California, public agencies lack clear legislative authorization to contribute public resources to a profit-making venture or engage in other forms of collaboration that may be necessary to participate in public-private partnerships. While many of the legal and administrative barriers to particular types of collaboration such as the treatment of intellectual property, the creation of exclusive franchises, and other arrangements can often be worked out with state administrative agencies and general counsel, although a substantial level of effort is typically involved. And legal uncertainties may still exist. Experience suggests that specific legislation authorizing collaboration in transportation (and ITS) partnerships can aid in public and political acceptance of public-private ITS interaction.

Commercial barriers flow from the motives of the private partner: to stay in business, to earn a profit, to expand markets, etc. The careful balance of risks vs. rewards (compared with alternative investments of resources) is a central feature of the private enterprise perspective that must be meshed with the public sector partners motive regarding serving the public interest. From the private perspective, the major barriers to effective partnerships include commercial risks and limits on the public sector's willingness to mitigate market and commercial risk. Barriers to public-private partnerships exist in different forms in every state and metropolitan area. The nature of these barriers and the appropriate strategy to mitigate them also will vary depending on the type of ITS project or market package, the natural advantages of each sector and the potential for commercializing the product or service. Commercial barriers, principally from the private sector perspective are described in Appendix O.

Beyond legal and financial issues, there are more subtle features of public and private sector partners that can impact their orientations toward public-private partnerships. These features relate to values, traditions and administrative procedures that, while not embodied in law, can form important barriers.

The public agency value placed on stability and public confidence may be in conflict with the risks involved in partnerships, especially in a new technology or systems arena. Bureaucratic procedures are also at odds with the "time is money" reality of private enterprise. The process-oriented public sector views a longer, more involved process as enhancing the result. The private sector views a longer time frame as resulting in higher costs and lower profits. In addition, cultural barriers may exist between various public sector agencies ("turf battles") that may impede cooperation in a partnership arrangement. A related if not more pervasive cultural barrier is the traditional distrust between the sectors, which can diminish each party's confidence in the feasibility of public/private partnerships. ITS deployment requires new ways of thinking and doing business, which may be difficult to achieve with organizations (both public and private) accustomed to conducting their activities in certain ways.

ITS projects will require new organizational arrangements. Such arrangements, challenging tradition may not come easily without the intervention of a champion or the change of agency mission priorities. The organizational position of ITS within a transportation agency may not position it well to compete for the necessary executive empowerment, for funds or for staff.

At the same time, new types of external relations may also be necessary. Government agencies previously accustomed to operating autonomously, may have to accommodate other agencies. Traffic managers and law enforcement may find themselves working together more closely as a result of ITS. Border control and immigration officials may now find themselves coordinating their activities with fleet managers and trucking interests. Businesses accustomed to dealing with individual public sector clients may now find that they must serve "collective clients," where these various agencies with divergent needs have joined together to initiate a project. This may require the private partner to restructure its own organization to accommodate these new client needs. These new collaborations will likely result in efficiencies, but may also raise concerns if the missions and interests of the collaborating agencies differ or compete with one another. These new collaborations also will likely result in new reporting arrangements and hierarchies.

Issues in Partnering

Table 3-1 lays out a number of the issues we have identified surrounding partnerships for different types of ITS activity. For comparison, the table includes issues relating to toll road development, the most widely-employed type of partnership in the transportation sector and in many areas related to ITS. Some of the most likely motives of the public and private sectors are shown for each ITS activity, then some issues likely to arise in partnership formation are identified. Finally, factors external to either party to the partnership are called out where relevant.

PARTNERSHIP ISSUES BY TYPE OF ITS PROJECT

ITS ACTIVITY	EXAMPLE	PUBLIC MOTIVES	PUBLIC ISSUES	PRIVATE MOTIVES	PRIVATE ISSUES	EXTERNAL
TECHNOLOGY DEVELOPMENT AND TESTING	• ATIS, AVL operations tests	• Technical capacity • Admin. Capacity • cost-share	• Scope clarity	• Product development	• Public unrealistic expectations • Intellectual property	• Small vendor market
CONSUMER PRODUCT SALES	• In-vehicle guidance	• Capitalize on public information	• Standards • Role/use of public data	• Market development/ penetration • positioning	• competition	
REVENUE-DRIVEN SERVICES	• ATIS • CVO operations & regulation • Mayday	• Technical capacity • Admin. Capacity • cost-share	• Willingness to pay • Exclusivity	• Market development • Positioning	• Exclusivity • Revenue uncertainty • Public access	• Some existing players
BARTER/RESOURCE-SHARING INFRA DEVELOPMENT	• Fiber communications • ATIS • Freeway service patrol	• Cost – avoidance • Service provision • Rapid deploy	• Valuation	• Market position	• Exclusivity • Rapid deployment	• Some major players • Federal deregulation
OUTSOURCING GOVERNMENT FUNCTIONS	• TMC operations • Facility maintenance • ETTM	• Operations burden • Technical capacity • Cost	• Cost comparison	• New market	• Cost comparisons	• Public sector labor
TOLL ROAD DEVELOPMENT (*for comparison)*	• Design-build • Finance/design/build/operate • Cofinance/design/build/M&O	• Financial capacity • Speed • Innovation	• Acceptability • Economic regulation	• Fee expansion • Return on investment	• Community acceptance • Risk mitigation • Permitting	• Local community

Table 3-1: Partnership Issues

Recommended Roles in Public-Private ITS Deployment

The three factors in public-private partnering—the ITS element, the effectiveness of the sector to provide the ITS element, and public policy and resource constraints--combine in various ways to determine the likely interest and effectiveness of typical public agencies and private enterprise entities regarding the key roles necessary to institutionalize ITS. Experience to date suggests the following roles:

- *Provider*: Government has a key role in provision through investment in R&D, provision of funds, policy, plans for investment in certain components--but other components are presently in the private sector (e.g., the vehicle, communications, personal communication devices). In reality, therefore, provision is shared--if not coordinated;
- *Producer*: Private sector produces most facilities/systems, some independent of public sector (in-vehicle equipment) in response to markets, with other components under contract to public sector; and,
- *Operator/Maintainer*--public, private or partnership: Operator/maintainer should provide service, finance services, price and sell service. These services are/can be public, private or mixed.

Figure 3-6 suggests a logical approach to role distribution based on the factors described above.

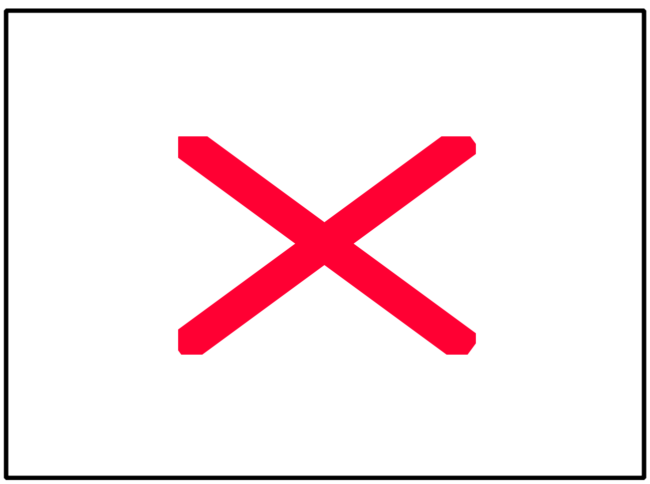


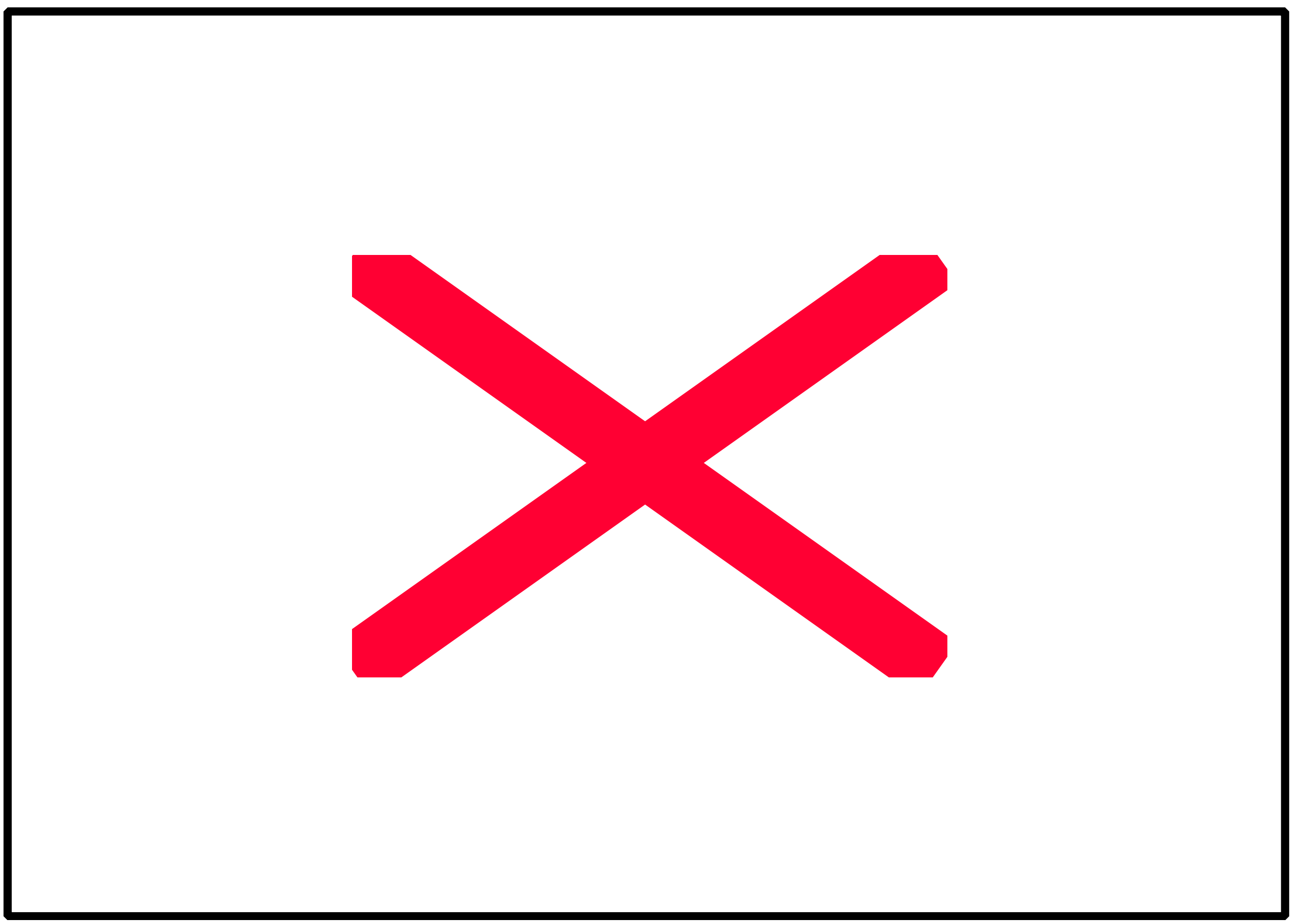
Figure 3-5: Functions and Roles

While certain functions are likely to be clearly suited to be a public responsibility or a private enterprise, certain functions may be either public or private. This middle ground, where both the public and private sectors may participate, defines and paces much of the deployment and effectiveness of ITS. These public-private arrangements can have significant impacts on public costs (by permitting cost sharing with the private sector), on incentives to private enterprise (by mitigating risks associated with certain activities), and on the quality of services provided (as a result of market responsiveness).
These partnerships also can affect the development of new products and markets and rate of product and service innovation. Effective partnerships that best capitalize on the main

strengths of each sector will not happen by accident. There are long-standing traditions and barriers in both sectors (discussed in the next section).

In moving towards a new and appropriate set of roles, the public sector controls significant components--especially the existing roadway and transit systems and physical access to them. Comprehensive public policy is therefore necessary to support private involvement and "open up" new roles to private enterprise by pushing back the partnerships "frontier."

Figure 3-7 indicates a large of number of ITS-related roles in terms of market packages. Many of these packages are "natural" for the private sector, particularly where there are potential revenues and controllable risks. Other packages appear to have limited revenues opportunities--other than fees paid through tax resources by public agencies, and in addition, may carry significant technical risks. These packages are best carried out by the public sector. However, there appears to be a "middle ground" including a large number of activities where supportive public policy can play a significant role in improving the suitability and attractiveness of packages to the private sector. Maximizing that middle ground--consistent with preserving other public interest objectives--is the domain of policy supportive of public-private partnerships.



At the most general level, Figure 3-7 suggests the Priority Corridor should adopt a policy which would have public agencies:

- Avoid competing with private sector in the left-most region. Make the most effective use of scarce public resources by leaving the obvious business opportunities to private enterprise;
- Support ITS by aggressively undertaking the "non-commercial" activities in the right-most region to provide the "core infrastructure" necessary to support the rest of ITS; and,
- Mitigate private risks to increase the penetration of private enterprise into activities with more evenly balanced risks and rewards--"foster" private access into areas on the diagonal.

This third segment for action--where a combination of public and private actions together is necessary to support private involvement--constitutes the potential set of opportunities where resources of both sectors may be most effectively combined to produce efficient deployment.

CAATS should take the lead in pursuing comprehensive, defined legislation to enable partnerships or, at the very least, pilot legislation to authorize a smaller effort to determine what specific legislation is needed to support a broad partnership program. To be able to execute viable agreements involving resource-sharing, cost-sharing and commingling, Caltrans will need clear, and perhaps, new contractual powers. Caltrans may need to obligate funds contractually to promote private involvement in transportation projects, and may also need authority to enforce non-compete zones or to ensure the private developer against tort liability.

Airports are probably the public institution with the longest, most successful record of public-private partnering. The public sector built most airports (using tax-exempt financing) and rents space to the private airlines, which improve and maintain and add value to the terminal areas. Furthermore, various arrangements with private concessionaires (for services like aircraft servicing and public parking to goods like duty–free shops) have been win-win situations for both the public and private sectors.

The California State University system has embarked on a partnering initiative in the telecommunications area, which may be indicative of the type of endeavor most applicable to ITS deployment. The outgoing chancellor of the University system has proposed a partnership with advanced technology companies to wire Cal State's 22 campuses with high-speed telephone and computer networks.

GTE, Hughes Communications, Fujitsu and Microsoft would put up $300 million for the networks in exchange for exclusive rights to control communications technology provided to the University's 325,000 students and 36,000 faculty members.

To obtain the best possible terms, the chancellor held many of the original negotiations with the private partners were conducted behind closed doors. When the proposed arrangement was made public, the system-wide faculty association and some campuses' academic senates felt the degree of public discussion and confidence in the project were insufficient to enable them to accept the arrangements. A detailed business plan is being prepared and many months will be spent in study and discussion.

This on-going attempt at partnership building at Cal State University may show the way through the technological, business and political processes that will have to be followed in California ITS deployment.

3.4 FUNDING

The work of the Southern California ITS Priority Corridor has begun to bear fruit in the deployment of projects in the Showcase Program, in the regional deployment plans, in the Commercial Vehicle/Border Crossing planning and, now, in articulating a strategy for the continuation of that work. Historic changes in the way transportation improvements are funded at both the state and federal levels afford the Priority Corridor a golden opportunity to capitalize on its accomplishments and pursue truly seamless and integrated transportation systems in Southern California.

The Governor recently signed into law Senate Bill (SB) 45, which significantly changes how California programs transportation funds. As part of the funding process, Caltrans prepares a fund estimate for the California Transportation Commission. This estimate takes into account the total funding available and based upon the ten-year State Highway System Rehabilitation Plan (commonly referred to as the ten-year plan or the State Highway Operation and Protection Program [SHOPP]). The SHOPP identifies transportation needs and projects to meet those needs. Based on the identified needs, a fund estimate is prepared and the money for the SHOPP comes off the top of the funding available. The remainder is programmed for project support and other needs including the State's Transportation Improvement Program (STIP). For the first time, the regions will get the majority (75%) of the STIP; Caltrans will program one quarter of the total STIP funding, probably for operation and maintenance of the transportation system. Now, regional priorities and those of the Priority Corridor can be directly brought to bear on the expenditure of transportation funds; this is an open opportunity to implement the Intelligent Transportation Infrastructure that Southern California needs. The combining of regional interests which the Priority Corridor has realized since its inception is not only unprecedented in California, it can be extremely powerful under the new process set by SB 45.

Federal Funding

ISTEA launched a program of research, testing and technology transfer of ITS aimed at solving congestion and safety problems, improving operating efficiencies in transit and commercial vehicles and reducing the environmental impact of growing travel demand. TEA 21, passed by Congress in June 1998, continues this research, testing and technology transfer program; and, it launches the integrated intermodal deployment of proven technologies that are technically feasible and highly cost-effective. The result will be a 21st Century national system using common standards and architecture.

TEA 21 provides that "the Secretary (of the Department of Transportation) shall conduct an ongoing intelligent transportation system program to research, develop and operationally test intelligent transportation systems and advance nationwide deployment of such systems as a component of the surface transportation systems of the United States". These tests and projects shall encourage and not displace public-private partnerships or private sector investment in such tests and projects.

TEA 21 provides overall appropriation authorization for the ITS program at $1.28 billion from 1998 to 2003. TEA 21 provides ITS funding across two broad categories: ITS standards, research and operational tests and ITS deployment.

ITS Standards, Research and Operational Tests (Sections 5204-5207)

Section 5207 of TEA 21 instructs the Secretary to carry out a comprehensive program of intelligent transportation system research, development and operational tests of intelligent vehicles and intelligent infrastructure systems and other similar activities. A higher priority will be given to funding projects that:

- Address traffic management, incident management, transit management; toll collection, traveler information or highway operations systems;

- Focus on crash-avoidance and integration of in-vehicle crash protection technologies with other on-board safety systems, including the interaction of air bags and safety belts;

- Incorporate human factors research, including the science of the driving process;

- Facilitate the integration of intelligent infrastructure, vehicle, and control technologies, including magnetic guidance control systems or other materials or magnetic research; or,

- Incorporate research on the impact of environmental, weather and natural conditions on intelligent transportation systems, including the effects of cold climates.

One noteworthy provision under the Standards section (5206) specifically restricts funding to those projects that "conform to the national architecture, applicable standards or provisional standards and protocols". The Strategic Deployment Plan provides the Steering Committee with the "blueprint" to accomplish this requirement.

The budget for ITS Standards, Research, Operational Tests and Development (sections 5204 through 5207) is $95 million to $110 million annually for a total of $603.3 million. The Federal share of funds shall not exceed 80% of the project total.

ITS Deployment - Sections 5208 (ITS Integration Program) and – 5209 (CVO Commercial Vehicle ITS Infrastructure)

Section 5208 provides for a comprehensive program to accelerate the integration and interoperability of intelligent transportation systems in metropolitan and rural areas. Under the program, the Secretary shall select for funding through competitive solicitation, projects that will serve as models to improve transportation efficiency, promote safety, (including safe freight movement), increase traffic flow (including the flow of intermodal travel at ports of entry), reduce emissions of air pollutants, improve traveler information, enhance alternative transportation modes, build on existing intelligent transportation system project or promote tourism.

- Funding for projects in metropolitan areas shall be used primarily for activities necessary to integrate intelligent transportation infrastructure elements that are either deployed or to be deployed with other sources of funds;
- For projects outside metropolitan areas, funding may also be used for installation of intelligent transportation infrastructure elements; and,
- Funding for rural areas shall be used to carry out intelligent transportation infrastructure deployment activities.

Among other criteria, priority will be given to funding projects that are part of approved plans and programs developed under applicable statewide and metropolitan transportation planning processes and applicable State air quality implementation plans, as appropriate, at the time at which Federal funds are sought.

Of the amounts available there is a limit on the amount that can be used in a singles area. In any fiscal year, not more than $15 million may be spent in one metropolitan area; not more than $2 million in one rural area; and not more than a total of $35 million in a state. At least 10% of the funds authorized under this program must be spent on ITS in rural areas.

Section 5209 provides for the advancement of technological capability and promotes the deployment of intelligent transportation system applications to *commercial vehicle operations*, including commercial vehicle, commercial driver and carrier-specific information systems and networks.

The budget for section 5208 is $101 million to $122 million annually for a total of $482 million. Section 5209 is funded at 25.5 million to $35.5 million annually for a total of $184 million. The federal share for this section shall not exceed 50% of the project total. The total Federal share of the cost of the project payable from all eligible sources shall not exceed 80%.

California-Specific **Provisions** (within the Southern California ITS Priority Corridor) include:

- I-5, Alameda Corridor East and the Southwest Passage were designated high priority Corridors (Southwest Passage is defines as I-10 from San Bernardino to Arizona state line and I-8 from San Diego to Arizona state line);
- Private expenditures on SR91, SR 57 and SR125 may be credited toward state matching share after routes are opened to traffic; and,
- Secretary to complete an assessment of infrastructure status and needs along the Southwest Border.

Other Key Provisions

TEA 21 provides other key elements including:

- Simplify metropolitan planning factors to seven goals to be considered as appropriate and adds emphasis on operation and management to support ITS;
- Generally move ITS programming from the earmarking of Priority Corridors to the mainstream of transportation funding programming;
- Develop a National Architecture and supporting standards and protocols to promote Interoperability among ITS technologies implemented throughout the States. Use of approved standards and protocols is required as a prerequisite for use of Federal-aid funds to implement ITS technology and services;
- Require life cycle cost analyses when Federal funds are to be used to reimburse operations and maintenance costs and the estimated initial cost of the project to public authorities exceeds $3,000,000; and,
- Expand technical assistance to include training and building of professional capabilities. TEA 21 includes $10 million per year for Corridor development and coordination.

State and Regional Funding

Under SB 45, Caltrans continues to be responsible for the operation, maintenance and rehabilitation of the state highway system; Caltrans will be responsible for programming improvement projects funded through the new Inter-regional Improvement Program (IIP), which accounts for about 25% of the State Transportation Improvement Program (STIP). IIP projects generally would be those "needed to facilitate inter-regional movement of people and goods."

About 75% of the STIP will be Regional Improvement Program (RIP) projects, selected by regions in their Regional Transportation Improvement Programs (RTIPs). For this portion of the STIP, Caltrans can only promote and recommend improvement projects to SCAG, SANDAG and the county transportation commissions for inclusion in their RTIPs.

The IIP and the RIP would replace most previous programs, including the state-local partnership program, the TCI and TSM programs and state funds match for Congestion Management/Air Quality (CMAQ). They would eliminate categories of funding such as flexible congestion relief and inter-regional road system.

Basically, for 25% of the state program, Caltrans can propose projects and programs that might benefit the entire Southern California Corridor. However, it will be up to the regions within the Corridor to use their new flexibility to propose projects and program 75% of the funding themselves. Neither Caltrans nor the California Transportation Commission (CTC) has "line-item veto" over any project in an RTIP, which must be accepted or rejected (for inclusion in the RIP) by the CTC in its entirety.

A Project Study Report (PSR—a state requirement) or Major Investment Study (MIS—a federal requirement) must be completed for every project—whether programmed by a region or the state. However, although guidelines have yet to be finalized by CTC, for smaller, non-capital-intensive projects such as those formerly funded under the TSM program, a Project Implementation Report (which is less extensive than a PSR or a MIS) may suffice.

Federal demonstration projects will be treated differently under SB 45 than they had been. These federal earmarks—usually not included in the STIP—would count against the county entitlement for the RIP. This treatment will remove an incentive for regional or local agencies to seek direct allocations by Congress that, in the past, have come at the expense of other areas of the state.

Another source of state funds, which historically have been allocated outside the STIP, is the Petroleum Violation Escrow Account (PVEA). While in the past regions have shared in these funds for projects like ITS deployments, it is not clear at this writing how PVEA funds will be allocated in the future.

The changes brought about by SB 45 apply only to state funds and federal funds flowing through the California Transportation Commission. The new law delegates much (about three-fourths) of the decision making on the funds to the regions.

Purely regional and local funds are an important component in ITS deployment. Most often these funds are utilized in a local match situation; utilization of such funds for ITS deployment is largely a decision made at a regional or local level. Three such funding sources are:

- Sales Taxes. All Corridor counties except Ventura have a transportation program funded through a local sales tax. These funds have already been programmed based on existing funding projections, and it is unlikely that these funds could be made available for any new ITS projects or systems deployments;
- AB2766. These funds consist of regional vehicle registration fees ($2 on each vehicle) and are administered by the Air Pollution Control Districts in Ventura and San Diego Counties and the South Coast Air Quality Management District for projects that reduce mobile source emissions. Competition for the funds is intensive; the APCDs and AQMD prefer projects offering known air quality benefits; and,
- Regional Transportation Impact Fees. The economic downturn of the early 1990's made impact fees unpopular as areas attempted to attract new growth and recover tax base. However, forecasts are that in Southern California over the next twenty years growth will once again reach the levels of the mid 1980's. If forecasts are borne out, a transportation impact fee may be a realistic consideration in some counties. The Corridor's county transportation commissions and local jurisdictions should work to ensure that ITS is specifically called out as eligible to receive consideration for funding in any transportation impact fee programs.

3.5 ACTION PLAN

Action Steps

A set of specific actions have been identified which must be taken to implement the Priority Corridor Network's ITS architecture and the program of projects designed to deliver Corridorwide user services. Recommendations for action and lead responsibilities are summarized in Table 3-2, along with existing efforts.

The Priority Corridor's mission is to provide cooperative coordination of ITS. This plan calls not for a master system operated by a single entity, but rather a series of local systems each planned, designed, implemented and operated in close coordination with the others, but under the jurisdiction of individual state and local government agencies and operational authorities.

Table 3-2: Action Plan

Recommended Action	Lead Responsibility	Existing Efforts
IMMEDIATE ACTIONS		
Step 1: Establish Executive Committee and Steering Committee , continue Deployment Alliance	Authorizing Agencies: Coalition	Deployment Alliance and Steering Committee
Step 2: Formally establish the Priority Corridor Network (PCN); secure commitments to manage the PCN	Coalition	Showcase Network, Red Team and Technical Advisory Committee (TAC)
Step 3: Establish new Subcommittees as necessary:	Coalition	Subcommittees: Outreach, Technical Management, AHS Case Study, Border/CVO
ACTIONS ON PLANNING AND PROGRAMMING OF PROJECTS		
Oversee implementation of recommended Corridorwide projects	Executive Committee	Steering Committee
Coordinate implementation of regional projects and provide assistance to regional teams	Executive Committee	Steering Committee and Regional Teams
Include recommended projects in State planning/programming documents	Caltrans, CHP	Caltrans, CHP
Work with authorizing agencies to include Corridor's Program of Projects in agencies' own program	Executive Committee	Steering Committee deliberations
Promote and coordinate full deployment of surveillance infrastructure for ATIS and ATMS	Steering Committee and Regional ITS Mgt. Teams	Regional teams' planning efforts
Include Corridor's Program of Projects in the RTP and RTIP	SCAG and SANDAG	SCAG and SANDAG participation in Steering Committee and Deployment Alliance
Include Program of Projects in	County	Participation in Steering

county priorities for funding	Transportation Commissions	Committee and Deployment Alliance
Help all agencies devise ways to fund ITS	Executive Committee.	Agencies' participation in Steering Committee and Showcase program
Fully deploy surveillance infrastructure on state highways	Caltrans	District and HQ work, New Technology and Research Program Offices
Program funding for communications technology in state highways	Caltrans and the CTC	SHOPP and new ITIP, New Technology and Research Program Offices
Work to ensure consistency with the National System Architecture and emerging standards.	Coalition	Steering Committee
Put top priority on Corridorwide projects for real-time transit management; emergency and planned-event management	Executive Committee	Regional efforts and Showcase projects
Recommended Action	**Lead Responsibility**	**Existing Efforts**
CORRIDOR OPERATIONS ACTIONS		
Adopt policy of decentralized Corridorwide system management	Steering Committee	Showcase project sponsors' management
Configure and administer the PCN	Technical Management Subcommittee	Showcase TAC/Red Team
Initiate, manage use of pre-planned and pre-approved responses	Technical Management Sub. and Steering Committee	Showcase projects
Standardize approach to traffic management Corridorwide	Steering Committee	Each operating agency's policies, procedures
Coordinate ITS for commercial vehicle operations statewide	CVO Subcommittee	CVISN, Caltrans' OS/OW, CVO/Border Advisory Committee
Be the clearinghouse for new ideas, issues, problems and solutions	Coalition	Caltrans NT&R and CAATS
Make deployment of intelligent transportation infrastructure a top	Executive Committee,	Authorizing agencies

priority in programming funds	Alliance	
Review this Plan from transit perspective	Steering Committee , public transportation operators	Transit workshops sponsored by Steering Committee
STANDARDS AND CONFIGURATION MANAGEMENT ACTIONS		
Make decisions regarding on-going deployment of technologies	Technical Management Sub., Steering Committee	Steering Committee decisions on Showcase and Corridor Plan
Collaborate with CAATS on ITS vision-setting and deployment initiatives	Coalition	CAATS Expert Team and other activities joined by members
Encourage proactive development of standards	Technical Mgt. Subcommittee	CAATS and Caltrans work
Decide which standards to influence first	Technical Mgt. Subcommittee	Ad hoc participation in standards setting including Showcase efforts
Develop voluntary consensus standards and protocols	Steering Committee	Ad hoc participation in standards setting including Showcase efforts
Standardize approach to licensing VARs throughout Corridor and State	Coalition	Caltrans, regional plans and projects taking tentative steps
Standardize transit management systems	Steering Committee	Transit workshops
Adopt National ITS Architecture and conform to emerging standards	All Corridor agencies	Ad hoc efforts

Table 3-2: Action Plan, Continued

Recommended Action	**Responsibility**	**Existing Efforts**
PARTNERSHIP ACTIONS		
Recommend stable, committed and consistent policies for partnerships	Coalition	Ad hoc efforts
Focus efforts on partnerships	Coalition	Ad hoc efforts
Implement program of Corridorwide outreach concerning ITS deployment	Outreach Subcommittee	Outreach Subcommittee and consultant devising the program
Formalize roles for CAATS, SCEP, RTTA	Executive Committee	They attend Steering Committee
Aggressively reach out to stakeholders under- or not represented to date	Coalition	CVO/Border Advisory Committee and Transit workshops; Regional planning
Place priority on bringing into Corridor TEA 21 provisions (e.g., for public-private toll roads) that could be adapted to ITS	Executive Committee	Regional and Corridor planning
Identify legislation need to support new forms of collaboration in ITS	Executive Committee	CAATS and others have begun to address the needs
Take the lead in pursuing comprehensive, defined legislation to enable partnerships	Executive Committee/CAATS	CAATS and others have begun to address the options
Develop consensus on the issue of access to information	Executive Committee	CAATS is addressing licensing of VARs in *ITS Deployment Initiatives*

Action steps recommended to implement this Corridorwide plan have been categorized into five top priority areas:

- Immediate action steps—establishes new committee structures and the PCN;
- Planning and programming of projects--addressing funding, programming, institutional and related administrative policy issues which face the Corridor coalition;

- Corridor operations--dealing with day-to-day operational issues;
- Standards and configuration management--defining the Corridor's technical needs and the appropriate short and long-term technology to deal with the requirements; and,
- Partnerships--addressing the sensitive issues of how coalition members, including private interests, can best work together and what their respective roles are.

Immediate Action Steps

Step 1: The first and most crucial step toward implementing this Corridorwide plan is for the Priority Corridor authorizing agencies, the coalition, to designate a new Corridor Executive Committee to support and enable a newly reorganized (Steering Committee) to provide day-to-day direction for the coalition. A small staff should support the coalition with assistance from a consultant when needed.

The Executive Committee will be comprised of representatives of programming agencies within the Corridor—SCAG, SANDAG, the county transportation commissions, and Caltrans, and will replace the existing Executive Committee. This Committee would report to the Southern California ITS Deployment Alliance and be responsible for implementing the Strategic Plan and drive the entire effort.

The current Steering Committee (which could be renamed the Coordinating Committee) will be reconfigured to include top operational and engineering people. There should be good representation from these areas to provide technical oversight of the work. These top level technical managers will make sure everything fits together successfully. The initial focus of the Steering Committee will be on successfully delivering the complex program of projects known as Showcase.

Step 2: The second step is for the Steering Committee to formally establish the Priority Corridor Network (PCN) as the communications and management network across which transportation information, management and command and control processes are relayed among Corridor agencies.

When formalizing the PCN, the Steering Committee would provide for its management. An important aspect of the PCN is that its role is independent of where it is physically housed in Southern California. Rather than create a new bureaucracy, the Steering Committee would administer and configure the PCN. However, actual management of the PCN should be the responsibility of a single agency.

THE PRIORITY CORRIDOR NETWORK

The PCN is a transportation management systems network (See Figure 3-1) across which transportation information and command and control processes are relayed. The PCN allows transportation agencies to retain maximum autonomy while providing a means for cooperation and coordination to help improve the safety and efficiency of the overall transportation system.

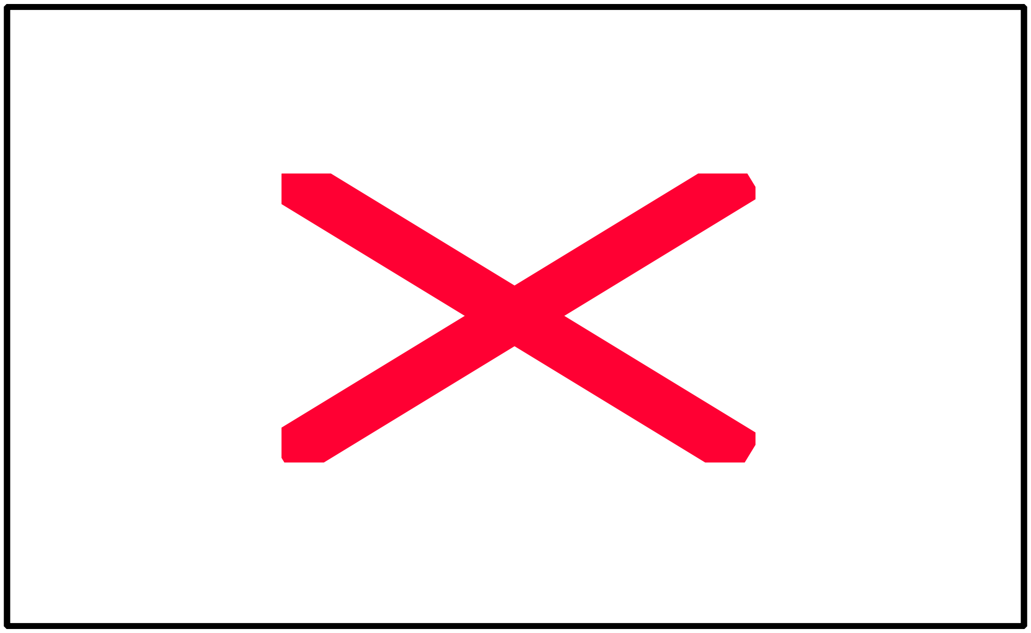


Figure 3-8: The Priority Corridor Network (Source: Odetics/NET)

The PCN would share real-time and static information on transportation conditions (e.g., speeds, travel times, transit schedules, incidents, congestion problems, construction and maintenance activities) within the Southern California Priority Corridor. It would enable the integration of to provide the foundation for ATMS and ATIS in Southern California. The PCN would provide each agency with a common method for disseminating information to the other agencies and private concerns, as well as means by which an agency can obtain current information on the transportation network beyond its jurisdictional boundaries.

The PCN is intended to improve the management of transportation and information management in order to increase the safety and efficiency of multi-modal transportation systems. Since applications for other than transportation management will have privacy implications, the PCN is not structured for them.

Consistent with the PCN concept of operations, the PCN would help to assure coordination and interoperability between transportation agencies. Examples include:

- Construction activities - planning construction/maintenance activities that may impact capacity;

- Managing traffic operations and traveler information elements (e.g. VMS, HAR);
- Managing change in system operational and control parameters (e.g., signal timing plan in effect, transit vehicle headway/frequency of service, ramp metering) in response to a projected increase in demand --such as travelers diverting from a facility experiencing a closure or other severe congestion;
- Managing the sharing of incident management resources (e.g., tow trucks, emergency service vehicles, clean-up, portable VMS) particularly during major incidents;
- Managing the sharing of available communications bandwidth -- both cable and radio spectrum -- for ITS-related transmissions; coordination and interoperability; and,
- Coordinating and managing traffic operations through institutional agreements,.

One outstanding issue associated with the Corridor's ITS Strategic Deployment Plan is defining the level of coordination necessary between the agency-specific TMC's, and the corresponding role of the PCN. Most transportation problems can be anticipated; however, when they occur can not be determined with any degree of accuracy. The corresponding regional strategies and agency-specific responses to these problems could be pre-arranged, pre-approved and documented.

The role of the PCN will be to implement and monitor these pre-planned Corridorwide responses. It is envisioned that this may be accomplished as follows:

- PCN would receive a "notice" of a transportation problem (e.g. major incident). This notification could be published manually (e.g., phone call from an agency) or automatically based on real-time information received.

- Each operating agency would identify an appropriate response plan to the notification based upon the problems (location, type and severity). It is envisioned that the knowledge base comprising the pre-approved response plans would be used to form a computer-based "expert system."

- Each agency would implement the appropriate strategies and contact the various entities in accordance with the response plan. The PCN would enable a "strategic" response, while the various TMCs are responsible for "tactical" response.

Responsibility for the Administration of Priority Corridor Network

The PCN would be administered and configured by the Steering Committee made up of primarily senior operations staff from each public agency involved in the Corridor architecture. The TMS would provide additional technical expertise and input to the Steering Committee, including managing the day-to-day technical activities and procedures regarding management of the PCN.

The TMS would recommend the kind of information included on the PCN, access and protections needed to safeguard sensitive data and privacy.

In addition, the TMS would be responsible for developing pre-planned and pre-approved responses to a wide variety of transportation plans within the network. Each response plan would include:

- Roles and responsibilities of each agency;
- Traveler information to be published;
- Responsible personnel to be contacted;
- Diversion planning (e.g., defining alternate routes and preparing maps, signal timings and ramp meter rates, guideline for implementing diversion);
- Evaluation of response plans; and,
- Guidelines for implementing the response plan by the PCN.

Step 3: In each critical area, the coalition must assign responsibility for following up on the recommended actions in that area. For that purpose, the Steering Committee should strengthen the existing subcommittees to serve as the working groups. Added to the existing Subcommittees (TMS, including configuration management and standards, the CVO Subcommittee and the Outreach Subcommittee), may be Transit and others.

The **TMS** will meet on a regular basis (e.g., monthly) to manage the day-to-day technical needs/activities in the Corridor. They will share ideas, deal with procedural matters and recommend to the Steering Committee decisions as needed on policy matters regarding operation of the Priority Corridor Network and the ongoing role of the Corridor in service of all member agencies of the coalition.

The **CVO Subcommittee** would continue to oversee the implementation of the Commercial Vehicle/International Border Strategic Deployment Plan; and, it would provide input on goods movement issues and opportunities affecting the Corridor.

The **Outreach Subcommittee** would oversee the marketing/public relations consultant in the development of the Corridor logo and marketing materials as well as a Corridorwide Outreach Plan.

The **Evaluation Subcommittee** would oversee the consultant who will perform the evaluations of the Corridor Projects and make recommendations to the Steering Committee.

The **Transit Working Group** would continue to champion the deployment of ITS in transit, paratransit, ridesharing, rail and other high-occupancy transportation activities.

Planning and Programming of Projects

Responsibility for Planning and Programming

Many of the most important tasks in the initial implementation of the Corridorwide projects will fall to the programming agencies in the Corridor. It will be the role of the Executive Committee to strongly support the inclusion of the projects in this Strategic Deployment Plan into the State Transportation Improvement Program, other state programming documents, the regional transportation improvement programs (RTIPs) and the regional transportation plans (RTPs). In addition, the search for funding will be led by them. Caltrans should also program funding to include communications technology) in new and upgraded state highways.

Recommended Actions on Planning and Programming

The Executive Committee should strongly encourage the programming agencies in the corridor to include the approved projects in RTIPs AND TIPs and Caltrans should include appropriate projects in their programming documents. In addition, the Executive Committee should oversee the implementation of the Corridorwide projects as well as coordinating the regional projects. The Executive Committee should also encourage agencies to put top priority on transit, emergency and event management systems.

The entire Coalition should work to ensure conformity with the National System Architecture and emerging standards. This will be critical to obtaining funding and the successful interoperability of the PCN.

The coalition should act to ensure full deployment (by public or private means) of the surveillance infrastructure necessary for ATIS as well as ATMS (e.g., speed-sensing detectors) on every state highway.

Corridor Operations

Responsibility for Corridor Operations

The responsibility for Corridor day to day technical oversight rests largely with the TMS and the CVO Subcommittee. It will be the task of the TMS to configure and administer the PCN. The CVO Subcommittee will coordinate ITS for commercial vehicle operations In the Corridor. However, the Alliance, the Executive Committee and the Steering Committee all play an important role in the day to day operations and deployment of the projects.

Recommended Actions on Corridor Operations

The Coalition, through the leadership of the Steering Committee , should adopt a policy of decentralized Corridorwide system management (per the recommended Corridor System Architecture) for deployment of the program of corridorwide ITS projects. This distributed architecture provides that each public agency which joins the PCN will continue to be responsible for implementing and managing ITS-based Systems for their respective transportation Systems. All command and control processes will continue to reside at the local level with cooperative agreements allowing for shared management at the discretion of the parties to the agreement.

The Steering Committee should standardize a Corridorwide approach to traffic management to enable quicker response time to incidents and support more efficient operation of the TMCs.

The public transportation operators and the Steering Committee should review this Plan from the Transit perspective to ensure the best possible use of technology and limited resources.

The TMS should develop and oversee the use of pre-planned and pre-approved responses to a wide variety of transportation plans within the network. Each response plan would include as a minimum:

- Roles and responsibilities of each agency and the PCN;
- Traveler information to be disseminated (e.g., VMS messages, media/private interface);
- Equipment and resources to be provided by each agency, and the personnel to be contacted;
- Diversion planning (e.g., defining alternate routes and preparing maps, signal timings and ramp meter rates, guideline for implementing diversion); and,
- Guidelines for implementing the response plan by the PCN.

The Subcommittee should also develop guidelines for PCN processes and operations when no plan exists for a particular problem and response must be developed "on the fly".

Standards and Configuration Management

Responsibility for Standards and Configuration Management

The TMS, comprised of representatives of all authorizing agencies in the Corridor (i.e., mirroring the composition of the Steering Committee) will meet on an as-needed basis to deal with procedural, policy and technical matters regarding additions or changes to the PCN. An important responsibility of the TMS will be to make recommendations to the Steering Committee regarding the on-going deployment of technologies to implement the Corridor architecture established by the Steering Committee in this plan; these responsibilities would include leading coalition consensus on:

- If and how the Corridor agencies can/will put values on information;
- What information and control responsibilities will be shared;
- Who will be allowed to access information and share control (free or at-a-fee?); and,
- Who pays for collection and distribution of information (especially on Corridorwide projects)?

In addition, the TMS should be the "keeper of standards and recommended practice" for deployment of ITS in the Corridor. It should coordinate Corridor input to standards-setting (at least at state level) and make sure CVO, transit and ISPs are represented at the standards-setting table.

Recommended Actions on Standards and Configuration Management

The Steering Committee should collaborate with CAATS in statewide vision-setting, planning and deployment. Effective ITS deployment requires commitment and a shared vision. CAATS is developing a statewide vision and a program of *ITS Deployment Initiatives*. If the Priority Corridor is to have coordinated, integrated deployment, a shared vision statewide is necessary.

All Corridor agencies should adopt and conform to the emerging standards for the Corridor.

The TMS should develop voluntary consensus standards and protocols to be used throughout the Corridor and through existing efforts of CAATS to work out statewide approaches to standards and protocols. Priority should be placed on the configuration of ATMS to produce traveler information Corridorwide.

Since some regions view traveler information as an asset to manage and charge for yet others don't, a comprehensive approach to partnering with value-added resellers (VARs) is necessary throughout California. **The TMS should recommend a standard approach to licensing VARs throughout the Corridor and carry that policy to statewide consensus efforts.**

For transit management systems, there should be standardization across the Corridor with respect to static databases, dynamic databases, fare collection media and accounting. **Transit operators should plug into TCIP and know if any TCIP standards or direction should be followed now to help with future potential technology investments**. Many operators are replacing or upgrading fare collection systems. They should make sure changes they make would be compatible with regional and Corridorwide fare collection integration, standardization and automation. This also applies to transit communications systems and vehicle location.

Partnership Actions

Responsibility for Partnerships

Partnerships are needed at more than the ad hoc project level if collaboration is to occur in a systematic and comprehensive fashion. New relationships and approaches are needed at organizational, programmatic and project levels. The Federal government has initiated a number of legislative and administrative changes to encourage the participation of the private sector with the public in transportation projects. USDOT policy is explicit in its interest in providing incentives to collaboration with the private sector in transportation facility development. The ISTEA Section iOi2 loan program--as amended by the National Highway System Designation Act of 1g95 (NHSDA)—provided enhanced opportunities for public-private partnerships. Section 1012 allowed states to make loans to both toll and non-toll facilities with revenue-generating potential, negotiate interest rates with project sponsors at subsidized levels, offer favorable repayment terms, take loan repayments and make new loans to other transportation projects with revenue potential. TEA 21 continues this commitment to partnerships.

The State Infrastructure Bank pilot program also is providing encouragement to private sector participation by allowing states to create banks to make project loans, enhance credit, subsidize interest rates and provide other assistance for eligible highway and transit projects. Recipients of the assistance can be both public and private entities. The Department has also revised a number of administrative and procurement procedures to make private sector participation easier.

Operational tests for ITS and the recent Model Deployment Initiative have required private sector participation by applicants in order to receive Federal funding for these projects. Some of the ISTEAITEA 2i provisions for public-private toll roads can be adapted to ITS where revenue potential exists.

Recommended Actions on Partnerships

While federal actions have made private participation easier where federal aid is involved, **California may also have to enact enabling legislation to take advantage of these changes as well as create additional incentives**. The enabling legislation must comprehensively support public/private partnerships, provide adequate agency powers and must be flexible enough to deal with unforeseen needs. **The Executive Committee and CAATS should take the lead in**

pursuing comprehensive, defined legislation to enable partnerships or, at the very least, pilot legislation to authorize a smaller effort to determine what specific legislation is needed to support a broad partnership program.

To be able to execute viable agreements involving resource-sharing, cost-sharing and commingling, Caltrans may need dear, and perhaps, new contractual powers. Key features of legislation supportive of partnerships include the authority to enter into flexible types of procurement; the use of design/build methods; the definition of regulatory approaches, if any; and the framework far resolving tort liability issues and defining safety and design standards. **Caltrans may need to obligate funds contractually to promote private involvement in transportation projects, and may also need authority to enforce non-compete zones or to ensure the private developers against tort liability**.

3.6 Public Agency Responsibilities

The listing of actions outlined above call for Corridor agencies to revisit current policies and added new responsibilities. Current policies on free access to information and limited use of changeable message signs are examples of policies that need to be revisited and evaluated in terms of enabling the ATIS projects to work towards some level of cost recovery if not complete sustainability.

New responsibilities include closely examining projects coming on line for the opportunity of including ITS components in the beginning phases such as infrastructure construction and equipment purchases rather than retrofitting at a later date. New policies on Corridorwide data sharing and traffic management should be developed. The National ITS Architecture should be adopted and projects should be closely scrutinized to guarantee they conform to the national standards in order to be eligible for funding under TEA 21.

These are only a few of the changed and new areas of policies and responsibilities. The coalition should take the lead in looking at all relevant policies to be sure they address this important fast-growing ITS arena.

CHAPTER 4
COMMERCIAL VEHICLE/crossing BORDER ELEMENT

Vision
Background
Corridor Needs and Issues
Deployment Plan
Recommendations
Conclusion

CHAPTER 4.0
COMMERCIAL VEHICLE / BORDER CROSSING ELEMENT

This chapter is based on the stand-alone ITS early deployment plan for commercial vehicle operations and international border crossing prepared in parallel with the Corridorwide deployment planning. Results and recommendations of the commercial vehicle/border crossing plan are summarized here and have been fully integrated into the other chapters of the Corridorwide deployment plan.

4.1 Vision

The vision of the Southern California ITS Priority Corridor Steering Committee is to significantly improve the safety, efficiency and environmental impacts of the intermodal transportation system in Southern California through the application of advanced transportation technologies and integrated management systems. A key element of this vision is the use of these technologies to enhance the operational efficiency of goods movement throughout the state. In everyday terms this means that commercial vehicles should be able to move quickly, efficiently and safely over our transportation network through the coordinated use of reliable real-time and predictive traveler information and efficient transportation management techniques.

4.2 Background

In 1994, Southern California transportation authorities, in cooperation with the CHP, Caltrans and the Federal Highway Administration, established the Southern California ITS Priority Corridor Steering Committee. The Steering Committee oversees the development of an important multi-regional strategic transportation plan to help improve the safety and efficiency of the transportation system through the application of intelligent and advanced transportation technologies and integrated management systems. This chapter, the CVO element of the Corridor ITS Strategic Plan, was developed through the cooperative efforts of more than 250 private industry representatives and transportation officials from the western United States and Mexico. The CVO Element as presented here is an integral part of the ITS strategy for meeting the transportation needs of the Southern California Priority Corridor. The application of ITS technologies will help transportation officials to meet southern California's mobility needs of the 21st Century.

The CVO element of the Southern California Priority Corridor ITS Strategic Plan identifies the needs of the commercial freight industry and recommends appropriate advanced transportation systems and technologies to meet them. Commercial vehicle operators have led the way in the use of new technologies to increase the efficiency and effectiveness of their operations. The integration and coordination of these new technologies with the public sector transportation infrastructure and traffic management systems will provide important new advances to improve the safe and efficient operation of commercial vehicles and movement of goods.

4.3 Corridor Needs and Issues

It was clear to the Committee that the user's greatest "need" was for tailored CVO information. Accurate and timely information tailored to specific areas of the Corridor and to specific carriers/vehicles currently using the Corridor to move trade goods would be of great use. The Corridor should collect, process (tailor) and distribute CVO information to the users to accommodate user fleet management functions.

4.4 Deployment Plan

Deployment Goal

Based on the results of the ITS planning process, the deployment goal of the Commercial Vehicle/International Border Operations System Plan is to provide user services to the trade goods movement community operating along the Priority Corridor. The planned system will support the enhanced management of CVO activities along the Corridor by integrating the traffic management and transportation information system into a Corridorwide "system of systems." This "Premier Corridor" system will provide the services necessary to empower the intermodal transportation providers to efficiently and cost-effectively manage their trips, time, and resources.

Achieving the goal requires categorization and prioritization of user needs. After careful analysis, the advisory committee categorized its user needs into three groups: regulatory, safety and information based.

Regulatory needs are largely being addressed through electronic clearance and credentialing programs such as the Pre-Pass System and the Commercial Vehicle Information Systems and Networks (CVISN) demonstration, both of which have active California state agency participation. Likewise, the California Safety and Fitness Electronic Records (SAFER) initiative is addressing automated roadside safety through electronic validation. International trade and immigration are continually being improved and have significant state, federal and international involvement.

Information needs are going unmet, however, and they reside in two primary areas: 1) tailored information for the goods movement and international border communities, and 2) an architecture and vision that enables integration and, where desirable, interoperability of various ITS systems: a system of systems. CVIBOS enables the stakeholders in the Priority Corridor to address these needs.

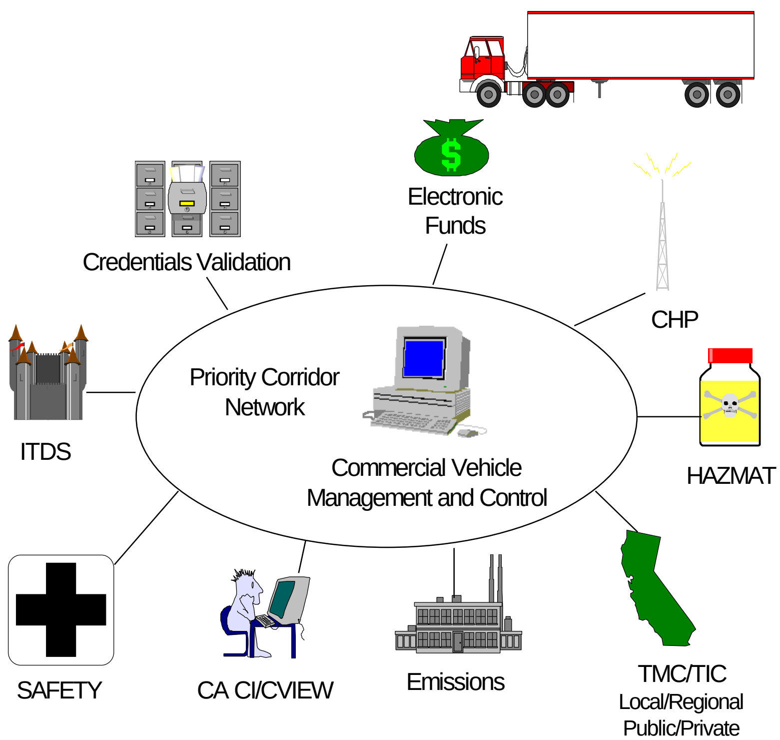
The CVO ATIS also enables the private sector to take a leading role in the design and implementation of an information system, and implementation could directly affect the current operations of Caltrans and other governmental agencies. For example, Caltrans historically has been involved with the CVO industry primarily as a regulator. Implementation of the CVO ATIS could stimulate Caltrans to develop new, customer-oriented roles in the provision of transportation facilities and services.

Deployment Objective

Users would request this "service" to accommodate their business operations along the Southern California Priority Corridor and through international Ports of Entry (POE).

The ability to collect, manage and distribute information, much of it in real-time, will be an essential platform upon which to build systems and services to address the user needs. This initiative will identify and evaluate opportunities for a public-private partnership deployment of Commercial Vehicle/International Border Operations System Advanced Traveler Information System (CVO) that would represent such a platform. See Figure 4-1 for an illustration of the concept.

Figure 4-1 Potential Integrated Commercial Vehicle/ International Border Operations System



4.5 Recommendations

The CVO Element recommends developing a Commercial Vehicle Information and Management Operating System (CVO Management System) as the cornerstone to electronically link and integrate commercial vehicle management and operational information. The CVO Management System would link new Corridorwide advanced traveler information functions and advanced transportation management systems to form a network of services necessary to support safer and more efficient commercial vehicle operations and international trade in the 21st Century.

The CVO Management System includes:

- ? CVO Travel Information System - A direct communication link between transportation management agencies and commercial vehicle operators (in-vehicle or dispatch) that would provide CVO requested information concerning travel conditions, route selection, support services, and special clearance and delivery instructions for areas such as ports of entry, airports, intermodal facilities and special CVO corridors or routes. Approximately $1 Million has been captured for this project.
- ? Expanded TMC Support of CVO - Caltrans/CHP Transportation Management Centers (TMCs) would expand services to include operation of the CVO Travel Information System and strategic management and coordination of goods movement at both the District and State level.
- ? Access to Regulatory Activities – Caltrans/CHP will provide access to information and services provided by regulatory agencies through an interface with the California CVISN pilot (CI/CVIEW) and the CVO Travel Information System.

CVO Management System Development Oversight includes the following activities of the CVO Advisory Committee, a subcommittee of the Steering Committee:

- ? **Continuation as a forum** advising public and private stakeholder on further development and refinement of the CVO Element and the implementation of services and infrastructure improvements in the Corridor.
- ? **Coordination among Corridor stakeholders** - providing a forum to coordinate public and private sector CVO activities, including the commercial vehicle operators, state and regional transportation agencies, sea and airport facilities, United States Customs, freight rail operators, and others.
- ? **Coordination with the International Border Crossing System** (IBCS) sponsored by FHWA's Office of Motor Carriers.
- ? **Coordinate Activities with Other CVO Initiatives and Improvements** such as the I-5 Joint Powers Authority (JPA) to ensure coordination of key CVO ITS strategies within the Southern California ITS Priority Corridor.

In addition, other potential CVO projects have been identified and described in Chapter 2, page 2-11. It is important to note that initial elements in the CVO plan are a part of Showcase.

4.6 Conclusion

Agencies in Southern California have voluntarily banded together to form a long range plan that identifies the use of ITS to improve transportation. This 20-year plan provides the roadmap for the integration of systems and the creation of a network that stretches from Ventura to Mexico. The CVO Element of this dynamic plan will move us forward in providing quality information and more efficient transportation management for the goods movement industry while strengthening the foundation of the system for enhancing non-truck travel within the region.

Key to the long-term success of efforts identified in this plan will be acceptance from the agencies operating these systems. These agencies will have to reach consensus on standards, policies, technologies and funding. Just as the technology that is being proposed will change the transportation system, agencies too must embrace change and be willing to try new ways of conducting business. These changes will be necessary to solve the numerous problems encountered on the transportation system and improve the economy and quality of life in Southern California.

CHAPTER 5
CORRIDOR OVERVIEW

Transportation Problems, Needs and Opportunities
User Services Plan

CHAPTER 5.0
CORRIDOR OVERVIEW

In many ways the Southern California area has been at the forefront of ITS planning and deployment. For this Strategic Deployment Plan to build on past success we must know the status of existing ITS infrastructure, programs and plans, as well as understand the problems, needs and opportunities associated with the existing condition. This chapter documents problems and opportunities. In addition, objectives and priorities are determined for each type of ITS service to guide the planning process.

5.1 Corridor transportation problems, needs and Opportunities

In the context of the Corridor transportation problems, needs and opportunities take on a broad focus. Instead of looking at a location specific ITS related facility or application, the system is analyzed as a whole to identify gaps and/or constraints in the development of ITS strategies. This section identifies and defines problems, needs and opportunities associated with implementing a seamless system of ITS elements which as a whole improve the mobility, safety, and environmental welfare of the Corridor travelers. The analysis focuses on the 'gaps' in the Corridorwide ITS system as well as opportunities for improvement and enhancement.

Identification and Definition

Based on input from each of the regions involved and the inventory of existing and planned/programmed ITS related systems and facilities, gaps in the system's continuity and other problem areas were identified. These identified problems, needs and opportunities provide the basis for defining ITS services, which are needed, or would have merit if applied, in the Corridor. The problems, needs and issues are summarized by ITS User Service type in Table 5-1.

It is important to remember that the focus of this analysis is Corridorwide travel and issues such as air quality, energy and other environmental impacts. Problem, need and opportunity identification is focused on gaps or needs in the existing or planned transportation system that affect inter-regional travel throughout the Corridor. Inter-regional Corridor travel includes trips having both origin and destination within the Corridor, trips having one end of the trip in the Corridor, and trips with both origin and destination outside the Corridor but passing through the Corridor.

The Corridor transportation problems, needs and opportunities are defined and discussed in Appendix J. When addressing these issues, both users and customers of the transportation system need to be considered. The users of the information include public agencies and governmental entities (transportation related and associated groups such as Air Quality Management Districts), transportation professionals, data analysts and private sector interests (marketing, traffic reports, etc.). The customers could include motorists, transit passengers, commercial vehicle operators affected businesses and property owners as well as the general public at large.

Table 5-1 TRANSPORTATION PROBLEMS, OPPORTUNITIES AND USER SERVICES

Problems and Opportunities	User Service Name
Traffic and Travel Management	
There is a lack of en-route information in the Corridor.	En-route Driver Information
Lack of pre-trip traveler information in the Corridor.	Traveler Service Information
Lack of timely traveler information in the Corridor and across jurisdictional boundaries.	Route Guidance
Lack of signal coordination locally and across the jurisdictions.	Traffic Control
No comprehensive linkage between TMCs to allow effective coordination between them.	
Lack of coordinated (interagency) traffic management for special events.	
Urban and rural highway surveillance is needed to detect incident and road condition.	Incident Management
Air quality impacts increase with amount of travel and congestion and vehicles emitting high levels of pollution.	Emissions Testing & Mitigation
Single occupancy vehicle trips increase congestion throughout the Corridor.	Demand Management and Operations
Transportation Demand Management (TDM)	
Lack of coordinated pre-trip transportation information throughout the Corridor.	Pre-Trip Travel Information
There is a need to link and/or integrate the two TDM database (rideshare and travel information) in the Corridor.	Ridematching and reservation
Public Transportation Operations	
Limited use of automated / computerized scheduling and dispatching programs within the Corridor, which limits the ability to communicate this information across jurisdictional boundaries.	Public Transportation Management
All forms of public transit should be cooperatively and jointly marketed on a Corridor and local basis.	
Limited use of advanced technologies to communicate with adjacent transit agencies regarding scheduling changes and coordination.	En-Route Transit Information
There is a need for a universal means of two-way communication among transit agencies regarding schedule changes.	
Data generated by TMCs needs to provide input into scheduling, additional bus requirements, a potential route deviation and on-time performance.	
There is a need to outfit the major transit transfer centers with equipment that can also display real time transit schedule information.	

(Table 5-1 continued)
TRANSPORTATION PROBLEMS, NEEDS AND OPPORTUNITIES

Problems and Opportunities	User Service Name
Public Transportation Operations	
Real-time accurate transit service information on board of vehicle is needed.	
Enhance opportunity to use transit on Corridors with and without regular fixed route services.	Personalized Public Transit
Transit vehicle should be equipped with AVL capabilities as well as a common verbal communication link to the TMC and the travel information center.	Public Travel Security
How to address discounts that are typically inherent in monthly or multiple trip passes, and how to address transfers on interregional trips.	Electronic Payment Services
Transit fare systems, should be seamless, simplified and uniform in order to encourage maximum usage and customer satisfaction.	
Commercial Vehicle Operations (CVO)	
Lack of CVO specific ATMS application for freeway and arterials; and incident related management.	Traffic Control (CVO) & Incident Management
Considerable time and fuel can be saved through use of a comprehensive electronic system for monitoring, enforcement and inspection.	CV Electronic Clearance
Considerable time can be saved through automated processes for roadside safety inspection.	Automated Roadside Safety Inspection (On-Board Safety Monitoring)
Credentialing process should be simplified. Comprehensive regional databases with near-real time update capabilities are needed to support CVO tracking, scheduling and coordination.	Commercial Vehicle Administration Processes
Lack of electronic tracking for commercial vehicles in the Corridor.	Hazardous Material Incident response
Commercial operation and interaction between road condition information and communication with trucking industry is necessary.	Commercial Fleet Management
There is a need for traffic information capabilities which could generate alternative route information for commercial vehicles.	
Emergency Management	
The integration of transportation disaster response requires	Emergency notification and personal security
Lack of emergency call-in capability in rural areas	
The requirements of persons with special needs shall be satisfied.	Emergency Vehicle Management

(Table 5-1 continued)

TRANSPORTATION PROBLEMS, NEEDS AND OPPORTUNITIES

Problems and Opportunities	User Service Name

Advanced Vehicle Control and Safety Systems	
There are significant opportunities to increase vehicular safety through application of advanced vehicle control systems.	Automated Highway System
	Longitudinal Collision Avoidance
	Lateral Collision Avoidance
	Intersection Collision Avoidance
	Vision Enhancement for Crash Avoidance
	Safety Readiness
	Pre-Crash Restraint Deployment
Highway-Rail Intersection	
At grade highway-rail intersections present a high potential for serious auto and train collisions.	
Lack of coordination with traffic signal and crossing barrier systems for operational efficiency.	
Rural	
Uncontrolled intersections and narrow two-lane roadway segments present a high potential for serious auto collisions.	
Automated Highway Maintenance and Construction	
Maintenance and construction activities restrict traffic capacity and present safety risks to workers and passing vehicles.	

5.2 USER SERVICES PLAN

In formulating the ITS program, USDOT developed the concept of “User Services” to describe individual ITS tools used by travelers and transportation providers. This section identifies the User Services needed in the Corridor to accommodate all public and private users of the transportation system. These User Services are prioritized and mapped to Corridor transportation problems, needs and opportunities.

The purpose of the User Services Plan is to identify prospective Corridorwide ITS activities, which would address specific transportation problems impacting the entire Corridor. Based on the identification problems, needs and opportunities, objectives were developed for each User Service category. This mapping of User Services to problems, needs and opportunities provides an indication of possible ITS services, which would have merit/benefit if applied in the Corridor.

User Services

This section identifies candidate ITS User Services, which may address transportation problems, needs and opportunities in the Corridor. To assure that ITS programs developed for a region or locality have been developed to address specific User needs, the FHWA has identified seven bundles of 29 User Services in the ITS National Program Plan, dated March 1995. The January 1997, National ITS Architecture added Highway-Rail Intersection to the user services. Two additional User Services were included to address the needs of the Corridor: Rural, and Automated Highway Maintenance and Construction.

User Services are defined to meet the safety, mobility, environmental and other transportation-related needs of a specified user or group of users, not along lines of common technologies. Users of a particular service might include travelers of the various modes, traffic management center operators, transit operators, state and local governments, and many others who will benefit from the deployment of ITS.

The consideration and analysis of User Services is more manageable and meaningful when they are grouped into bundles based on functional similarities. User Service bundling identifies common, related functions and provides a means for illustrating how the integrated deployment of User Services could be accomplished more efficiently and cost effectively.

The categorization of services by bundle is shown in Table 5-2. A brief description of the User Services that comprise each of these bundles is provided in Appendix K.

Table 5-2

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

User Service Objectives

User Service Objectives represent the desired impacts and actions of each of the User Services with respect to addressing the Corridor's transportation problems. This is developed by first mapping the relationship of each of the User Services to the problems and opportunities previously identified, and secondly, developing objectives for each User Service specific to resolving these problems.

Objectives were developed based on the definition of problems in the Corridor. These objectives define the overall directions to address transportation problems and opportunities in the Corridor through ITS technologies (FHWA User Services previously introduced in this chapter). "User Services Objectives," those generic actions that identify "what" the Corridor ITS needs to do in order to accomplish the stated goals and objectives, will be defined in this section. These User Service Objectives define a "typical" response to specific problem. They are generic in nature so development of the Corridorwide program is not prejudiced toward a particular "favorite " problem, project, or program.

The User Service Objectives presented in Table 5-3 are the result of analysis of each Regional Team's input on User Services and any priorities placed on them; these recommendations also benefit from the discussion of User Service held by each Regional Team and by the Steering Committee. In developing this set of objectives and priority recommendations, it was attempted to merge the "top down" of Corridorwide issues with the "bottom up" of Regional Teams' planning.

User Services Priority Assessment and Definition

"Phasing Priority" (near-term, etc.) proposes a relative order in which User Services should begin to be addressed at the Corridorwide scale. It does not indicate the status of deployment in any one region or precisely when a project would be implemented. Those issues will be resolved in the program of projects. "Phasing Priority" has been assigned based on these criteria:

? User Services deployed or enhanced in the Showcase demonstration are so indicated (earliest implementation, less than five years);

? Those given high priority by at least two of the Regional Teams or provide the foundation for other User Services or their elements are designated for near-term deployment (that would be in approximately five years);

? User Services on which the Regional Team place some priority for implementation are indicated as medium-term; generally speaking, they would begin to be addressed after the near-term category (approximately ten years); and,

? Those with little or no priority given by Regional Team (or which require significant further development) are designated for long-term deployment (up to the 20-year horizon of the planning).

Table 5-3

USER SERVICE OBJECTIVES

User Service	Objectives	Phasing Priority
Traffic and Travel Management		
En-route Driver Information	Improve coordinated en-route information to travelers.	Near-term
Traveler Service Information	Disseminate information including travel mode options, location of services (commercial / hospital / public), scheduling and real-time congestion	Near-term
Route guidance	Provide information, both static mapping and real-time to support autonomous (e.g. in-vehicle handheld device) route guidance.	Medium-term
Traffic Control	Manage freeway and surface street operations to reduce overall congestion, support management of incidents, promote public safety and reduce air emissions.	Near-term, (Showcase)
Incident Management	Manage non-recurring congestion by reducing frequency, responsive, duration and severity of incidents.	Near-term, (Showcase)
Emissions Testing & Mitigation	Provide testing systems and implement strategies to reduce overall emissions.	Near-term
Demand Management and Operations	Facilitate provision of HOV facilities, implementation of congestion pricing on new facilities, and trip substitution / and advanced strategies.	Near-term
Transportation Demand Management (TDM)		
Pre-trip Travel Information	Deploy system that enables coordinated multi-modal, regional and Corridorwide trip information.	
Ridematching and reservation	Facilitate real-time ride-matching for regional and inter-regional trips, including non-publicity-operated and ad-hoc ridesharing programs	Near-term, (Showcase)
Public Transportation Operations		
Public transportation Management	Coordinate connections/transfers, facilitate schedule adherence, provide real-time schedule information, and emplacement advanced technologies for fleet management.	Near-term, (Showcase)
En-Route Transit Information	Provide real-time inter-regional transit information (all carriers) at transit centers and stops, rail stations and in vehicles	Near-term, (Showcase)
	There is a need to outfit the major transit transfer centers with equipment that can also display real time transit schedule information.	
	Real-time accurate transit service information on board of vehicle is needed.	
Personalized Public Transit	Facilitate flexible on-call transit services.	Medium-term
Public Travel Security	Provide direct and convenient access to emergency services from any transit vehicle, stop or station.	Medium-term
Electronic Payment Services	Integrate payment methods for transportation services.	Medium-term
	Transit fare systems, should be seamless, simplified and uniform in order to encourage maximum usage and customer satisfaction.	
Commercial Vehicle Operations (CVO)		
CV Electronic Clearance	Manage commercial vehicle delays at international border crossing, inspection and weigh stations, port facilities, and intermodal yards.	Near-term

Table 5-3 (Continued)
USER SERVICE OBJECTIVES

User Service	Objectives	Phasing Priority
Commercial Vehicle Operations (CVO)		
Automated Roadside Safety Inspection (On-Board Safety Monitoring)	Implement internal safety/operator monitoring systems for commercial fleets and independent operators.	Near-term
Commercial Vehicle Administration Processes	Implement automated credentials procurement, fuel and mileage recording capabilities for commercial fleets and independent contractors.	Near-term
Hazardous Material Incident response	Provide Corridorwide electronic tracking (registration/location) of Hazmat shipments and disseminate this information to law enforcement and emergency services.	Near-term, (Showcase)
Commercial Fleet Management	Facilitate Corridorwide communication between drivers, dispatchers and intermodal transportation providers.	Near-term, (Showcase)
Emergency Management		
Emergency notification and personal security	Provide Corridorwide integrated response capability for in-vehicle or automated emergency service requests.	Near-term
Emergency Vehicle Management	Encourage Coordinated emergency vehicle fleet to provide faster coordinated response regardless of jurisdiction.	Near-term, (Showcase)
Advanced Vehicle Control and Safety Systems		
Automated Highway System	Automate Highway travel	Long-term
Longitudinal Collision Avoidance	Promote the development of in-vehicle equipment to reduce the number and severity of longitudinal collisions.	Long-term
Lateral Collision Avoidance	Promote the development of in-vehicle equipment to reduce the number and severity of lateral collisions.	Long-term
Intersection Collision Avoidance	Promote the development of in-vehicle equipment and systems for reducing the number and severity of collisions at intersections. Provide for the implementation of physical infrastructure necessary to support in-vehicle systems.	Long-term
Vision Enhancement for Crash Avoidance	Promote the development of in-vehicle equipment and physical infrastructure for the enhancement of vision and crash avoidance for obstructions in or along the roadway.	Medium-term
Safety Readiness	Promote the development of in-vehicle equipment to provide warnings concerning the condition of the drives, the vehicle and the roadway.	Long-term
Pre-Crash Restraint Deployment	Promote the development of in-vehicle equipment for anticipation of imminent collisions and activation of vehicle safety devices to reduce number and severity of injuries in the event of collisions.	Long-term
Highway-Rail Intersection		
	Integrate rail traffic control systems with arterial traffic control systems at grade crossings, to improve public safety and to enhance traffic flow through highway/rail intersections.	Near-term, (Showcase)
Rural		
	Enhanced traveler safety systems and resident mobility in rural areas.	Medium-term
Automated Highway Maintenance and Construction		
	Improve the efficiency and safety of traditional highway maintenance and construction operations.	Medium-term

CHAPTER 6

TECHNOLOGY REVIEW AND EVALUATION

Technology Deployment
Relationship of Market Packages to User Service Objectives
Functional Areas
Alternative Technologies
Detailed Technology Evaluation

CHAPTER 6.0
TECHNOLOGY REVIEW AND EVALUATION

There is currently a very broad spectrum of ITS technologies which is emerging and evolving at a very rapid pace. This fluid environment poses serious questions for those planning the deployment of ITS systems:

- ? What technologies are available?
- ? How do the technologies compare?
- ? How to select a technology or a system of technologies that meet the identified needs?
- ? What functions must a proposed system serve?
- ? How to package the basic components of a physical ITS system for deployment?

This chapter presents a description of ITS technologies, the functions served by these technologies, factors to be considered in deploying each technology and the Market Packages defined for deployment.

The intent of this section is to define a methodology and a configuration for deploying recommended technologies. Guidelines are outlined below, but it is important to note that it is not the intent of this Corridor plan to duplicate the detailed design work performed under Showcase that sets up de facto Corridor standards. Detailed flow charts and message flow diagrams have resulted from Showcase and the Corridor plan has adopted those concepts and interfaces.

In addition, our study has shown that a ranking of the technologies as listed in Tables 6-7 through 6-11 may not be as meaningful as desired. At any point in time, any of the technologies may be viable for deployment depending on project requirements. Most, if not all, of the technologies are currently deployable and are proven with enough test data to thoroughly understand the limitations and benefits. What would drive a decision on use is most likely cost and reliability, items which can vary depending on project circumstances.

Therefore, the role of this plan should not be to recommend one technology over another, but to provide a step by step process, using the plan results, to determine the appropriate technology alternatives.

This concept could work as follows:

- ? Step 1. Identify a problem or opportunity;
- ? Step 2. Categorize this problem/opportunity under a User Service (as listed in Table 2- 4);
- ? Step 3. Relate User Service to market package (Table 7-2);
- ? Step 4. Track the User Service and market package to a functional area (Table 7-5);
- ? Step 5. Map the functional area to technology categories (Table 7-6);
- ? Step 6. Select alternative technologies from list, which best suits requirement (Table 7-7 through 7-11);
- ? Step 7. Create a project definition; and,
- ? Step 8. Submit project for funding and deployment.

6.1 TECHNOLOGY DEPLOYMENT

Market Package Definitions

The implementation of the User Services Objectives defined in Chapter 5 will occur through a number of public and private sector activities. These activities on a national level have been directly defined as "Market Packages", a concept which was developed as part of the National ITS Architecture effort and is being incorporated into future ITS planning initiatives.

Market packages are a collection of equipment capabilities, which satisfy a market need and are likely to be deployed as a group. These “Market Packages” provide discrete “deployable’ elements which are technology dependent (they require the use of advanced technology) but are not technology specific (any of a number of technologies could be used to implement the market packages). Market packages are, in essence, the means by which User Services are implemented. These packages are intended to provide consistency in the development of ITS elements and standards throughout the U.S. They also provide a cost basis for evaluation of ITS alternatives. The market package concept was introduced by the FHWA National ITS Program Plan and incorporated into the National ITS Architecture of January 1997. The concept is used as an organizing and planning tool for implementing technology solutions to transportation problems in a manner that ensures that these technology applications work in concert with one another. The Market Packages as described by FHWA, act as “Building Blocks” which can either stand alone or work in combination with other packages. The packages encompass “real world” elements to address transportation problems and needs. They are also dependent on external factors such as technology advancement, public policy development and revision and development of common interface standards. Based on the FHWA-defined relationship of Market Packages to User Services, Market Packages can then be prioritized relative to the User Services.

Recommended Market Packages

In order to determine which market packages should be deployed in the Corridor, problems and concerns identified by Corridor stakeholders were reviewed and the User Services required to be provided throughout the Corridor were defined. Then those User Services were compared to the applications to be implemented through the market packages. Those market packages, which were deemed to be appropriate solutions to the Corridor’s needs, were selected for deployment. A matrix, associating Market Packages to User Services, is presented in Table 6-1.

Table 6-1

Market Package Bundles

Market Packages can be classified into six bundles of activities. The following provides a brief description of these bundles.

Advanced Transportation Management Systems (ATMS)

ATMS Market Packages provide real-time traffic information along with incident status, current response plans in operation, and recommended changes to operations. It develops an improved multi-agency incident and response capability focused upon the development of clearly understood responsibilities and shared goals and objectives. ATMS includes thirteen Market Packages as follows:

- ? Network Surveillance;
- ? Probe Surveillance;
- ? Surface Street Control;
- ? Freeway Control;
- ? HOV and reversible Lane Management;
- ? Traffic Information Dissemination;
- ? Regional Traffic Control;
- ? Incident Management System;
- ? Traffic Network Performance Evaluation;
- ? Dynamic Toll/Parking Fee Management;
- ? Emissions and Environmental Hazard Sensing;
- ? Virtual Vehicle Tracking; and,
- ? Rail Tracking.

ATMS is primarily implemented by agencies currently operating roadways and traffic control devices - these would include Caltrans Districts, counties, and all local municipalities with roadway and traffic control operations and maintenance responsibilities. ATMS Market Packages provide the ability to monitor and manage traffic operations as well as provide appropriate incident management (detection, response, and clearance). ATMS by nature involves multi-agency coordination of management strategies, including coordination of freeway and arterial operations (signal timing, ramp metering and traffic routing strategies), along with identifying incident and special event activities.

ATMS also facilitates intermodal system management, integrating and coordinating operations with other modes such as rail, transit, ports, etc. Such coordination is achieved through the implementation of a number of market packages, including: rail tracking, incident management system and traffic information dissemination, among others.

ATMS activities require the definition of the roles of the different agencies involved in recurrent as well as incident or event response activities. An integrated regional ATMS strategy also involves one or more traffic management centers (TMCs) coordinating information and permitting shared control of various facilities. By definition, integrated ATMS operations involves the ability to share information on different systems and travel modes among all operations agencies, plus public safety agencies including CHP.

Advanced Transportation Information Systems (ATIS)

Advanced Transportation Information System (ATIS) Market Packages provide travelers with the ability to access information regarding various transportation modes, services and facilities prior to or during a trip. Pre-trip information would be used for selecting transportation modes, identifying comparative travel times, and making route decisions before departure. En-route information for drivers includes driver advisories, congestion and routing messages based on real-time information, along with, potentially, in-vehicle signing to enhance safety. En-route transit information provides the capability for travelers to get information on connecting service as well as any expected delays on their trip.

ATIS information will include information obtained through the Commercial Vehicle International Border Operations System (CVIBOS). Thus, CVIBOS will have access to other travel-related information of interest to commercial drivers and information service providers (both public and private) will have access to relevant travel information from CVIBOS.

Much of ATIS involves in-vehicle and private-sector-developed tools and activities which are developed and marketed to the public; this Market Package bundle thus requires development of standard interfaces between public-sector-derived information sources and private sector information distributors and providers.

ATIS includes nine Market Packages as follows:

- ? Broadcast Traveler Information;
- ? Interactive Traveler Information;
- ? Autonomous Route Guidance;
- ? Dynamic Route Guidance;
- ? Information Service Provider-Based Route Guidance;
- ? Integrated Transportation Management/Route Guidance;
- ? Yellow Pages and Reservation;
- ? Dynamic Ridesharing; and,
- ? In-vehicle Signing.

Advanced Public Transportation Systems (APTS)

Advanced Public Transportation Systems(APTS) provide improved real-time transit management capabilities through tracking of vehicle locations and schedule adherence, as well as providing improved information to users regarding transit schedules and real-time location (e.g., estimated time of arrival). APTS addresses both fixed-route and demand-responsive transit services, along with transit security and electronic fare collection. Overall attractiveness of transit services is improved through increasing connectivity of operations, including common, time-saving methods of payment for each service, as well as improved real-time connections and reduced transfer time between routes and modes.

Advanced Public Transportation system includes seven Market Packages as follows:

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- ? Transit Vehicle Tracking;
- ? Transit Fixed-Route Operations;
- ? Demand Response Transit Operations;
- ? Transit Passenger and Fare Management;
- ? Transit Security;
- ? Transit Maintenance; and,
- ? Multi-model Coordination.

Commercial Vehicle Operations (CVO)

Commercial Vehicle Operations Services (CVO) provide improved management and tracking of commercial fleet vehicles as well as permitting automated administrative processing of trucks and hazardous material shipment monitoring. In general, the two major concerns in CVO in the region are:

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- ? Assuring that goods movements can be expedited through the region in a manner which is least disruptive to other traffic; and,
- ? Assuring that incidents, especially those involving commercial vehicles and those involving hazardous materials, are cleared in an expeditious fashion and that proper operation strategies are implemented to reduce any economic impacts related to delays to commercial vehicles.

A particular concern among fleet providers is the use of ITS technologies as a means to further regulate the trucker and increase government intervention into private freight carrier operations. It is desired by many private sector firms that the emphasis on ITS activities in CVO be focused upon providing information on traffic conditions at downstream destinations (e.g., providing traffic information in the Los Angeles area to truckers in advance of crossing Cajon Pass). Therefore, the next Section proposes new Market Packages with respect to CVO activities.

Commercial Vehicle Operations includes nine Market Packages as follows:

- ? Fleet Administration;
- ? Freight Administration;
- ? Electronic Clearance;
- ? International Border Electronic Clearance;
- ? Weigh-in-Motion;
- ? Roadside CVO Safety;
- ? On-board CVO Safety;
- ? CVO Fleet Maintenance; and,
- ? HAZMAT Management.

Emergency Management (EM)

Efficient management and operation of emergency services will improve safety and facilitate operations of the transportation system. Emergency Management systems would assist various emergency supporting elements including CHP and local public safety agencies in addressing emergencies. Different agencies would utilize compatible vehicle tracking and management systems to support coordinated emergency response involving multiple agencies. EM activities would include multi-agency system facilities which could create, store, and utilize emergency response plans to facilitate coordinated response activities.
Real-time traffic information received by emergency services agencies could be used to further aid the emergency dispatchers in selecting the emergency vehicle(s) and routes that will provide the most timely response. The interface

with other elements of ITS allows strategic coordination in tailoring traffic control to support en-route emergency vehicles.

EM includes three Market Packages as follows:

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- ? Emergency Response;
- ? Emergency Routing; and,
- ? Mayday Support.

Advanced Vehicle Safety Systems (AVSS)

Many of the advanced vehicle Market Packages are autonomous systems and do not interact with other systems. They are a series of collision avoidance and vision enhancement-related Market Packages which are specifically oriented toward in-vehicle implementation. Future regulations may require that some of these types of devices become mandatory equipment on certain vehicles. The Intelligent Vehicle Initiative (IVI) is being established as a major new component of the USDOT's ITS Program. The intent of the IVI is to improve significantly the safety and efficiency of motor vehicle operations by reducing the probability of motor vehicle crashes.

AVSS includes eleven Market Packages as follows:

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- ? Vehicle Safety Monitoring;
- ? Driver Safety Monitoring;
- ? Longitudinal Safety Warning;
- ? Lateral Safety Warning;
- ? Intersection Safety Warning;
- ? Pre-Crash Restraint Deployment;
- ? Driver Visibility Improvement;
- ? Advanced Vehicle Longitudinal Control;
- ? Advanced Vehicle Lateral Control;
- ? Intersection Collision Avoidance; and,
- ? Automated Highway System.

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? Within the ITS Program, USDOT has conducted research and development to improve driving safety and efficiency. These include the Driver Vehicle Interface, Collision Avoidance, Automated Highway Systems, and Motor Carrier Research Programs. The IVI will take advantage of these maturing USDOT programs and the synergism into a common framework focusing on multi-functional integration of proven systems using autonomous vehicle-based technology complemented by highway-based technologies. The mix of desirable and cost-effective technologies may vary among passenger vehicles, trucks and buses.

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Additional Market Packages (Non-FHWA)

Where Market Packages developed by FHWA as discussed above did not address the problems presented previously for Corridor, additional Market Packages, specific to the Corridor area, were developed. A summary and description of "Non-FHWA" Market Packages is presented next.

Event Management System (EvMS)

As with "Incident Management", planned events require a predetermined, agreed response which involves appropriate routing of traffic or demand shift, as well as improved traffic operations. These types of events require special interagency treatments, to the point of providing specific response strategic and operational plans which pertain to these events.

"Planned events" may consist of construction and road work, as well as special sporting or cultural events. These include short-term events such as a basketball game, as well as extended events such as major construction. Use of certain tools such as adaptive traffic control can assist in implementation of responses, such that actual conditions, if less severe or more severe than anticipated do not require constant returning or refining of the responses. Such strategies, if successful and deemed potentially cost-effective for managing recurrent congestion, could be used permanently as well.

EvMS includes four Market Packages as solutions:

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- ? Public Awareness;
- ? Event status monitoring;
- ? Event traffic control; and,
- ? Event parking management.

Commercial Vehicle Information System (CVIS)

The "Commercial Vehicle Information" Bundle provides the capability for commercial drivers and dispatchers to receive real-time routing and weather information and access databases containing traffic flow along truck routes as well as carrier, vehicle, cargo, and driver information. The location and availability of food, lodging, and truck parking along truck route are a few example of pertinent information provided for truckers. The CVO information may be a public entity, a contracted private entity, or a combination of the two.

CVIS includes four Market Packages as follows:

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- ? Traffic flow information dissemination along truck routes;
- ? Inter-model access information;
- ? Room and parking information; and,
- ? Weather information.

6.2 RELATIONSHIP OF MARKET PACKAGES TO USER SERVICE OBJECTIVES

Each of the recommended National ITS Market Packages was reviewed with respect to the User Services Objectives. This is done through mapping the Market Packages to the specific Users Services Objectives. Market Packages capable of carrying out the ITS goal and objectives were identified. A matrix, associating Market Packages to Users Service Objective, is presented in Table 6-2.

Table 6-2
Market Packages vs Users Service Objectives
Southern California ITS Corridor

User Service Name	Objectives	Market Package
Traffic And Travel Management		
En-Route Driver Information	Improve coordinated en-route information to travelers.	? Broadcast Traveler Information ? Interactive Traveler Information ? Autonomous Route Guidance ? Dynamic Route Guidance ? Information Service Provider-Based Route Guidance ? Integrated Transportation Management/Route Guidance ? In-Vehicle Signing
Route Guidance	Provide Information, both static mapping and real-time to support autonomous (e.g., in-vehicle) route guidance.	? Interactive Traveler Information ? ? Autonomous Route Guidance ? Dynamic Route Guidance ? Dynamic Ridesharing
Traveler Service Information	Disseminate information including travel mode options, location of services (commercial / hospital / public), scheduling and real-time congestion.	? Interactive Traveler Information
Traffic Control	Manage freeway and surface street operations across jurisdictional boundaries to reduce over congestion, support management of incidents, promote public safety and reduce air emissions.	? Network Surveillance ? Probe Surveillance ? Surface Street Control ? Freeway Control ? HOV and Reversible Lane Management ? Traffic Information Dissemination ? Traffic Network Performance Evaluation ? Virtual TMC and Smart Probe Data ? Rail Tracking
Incident Management	Manage non-recurring congestion by reducing frequency, responsive, duration and severity of incidents.	? Probe Surveillance ? Incident Management System
Emissions Testing & Mitigation (Air Quality Improvement)	Provide testing systems and implement strategies to reduce overall emissions.	? Emission and Environmental Hazard Sensing
Transportation Demand Management (TDM)		
Ridematching and Reservation	Facilitate real-time ride-matching for regional and inter-regional trips, including non-publicity-operated and adhoc ridesharing programs	? Dynamic Ridesharing ? HOV and Revisable Lane Management
Pre-Trip Travel Information	Develop tools which facilitate coordinated multi-modal, regional and Corridorwide trip information.	? Broadcast Traveler Information ? Interactive Traveler Information ? Autonomous Route Guidance ? Dynamic Route Guidance ? Information Service Provider-Based Route Guidance ? Integrated Transportation Management/Route Guidance

		? Yellow Pages and Reservation ? Dynamic Ridesharing

Table 6-2 (Continued
Market Packages vs Users Service Objectives
Southern California ITS Corridor

User Service Name	Objectives	Market Package
Ridematching and Reservation	Facilitate real-time ride-matching for regional and inter-regional trips, including non-publicity-operated and adhoc ridesharing programs	? Dynamic Ridesharing
Demand Management and Opera	Facilitate provision of HOV facilities, implementation of congestion pricing on new facilities, and trip substitution/ and advanced strategies.	? Demand Response Transit Operations
Public Transportation Operations		
En-Route Transit Information	Provide real-time inter-regional transit information (all carriers) at transit centers and stops, rail stations and in vehicles	? Transit Vehicle Tracking
Personalized Public Transit	Facilitate flexible on-call transit services.	? Demand Response Transit Operations
Public Travel Security	Provide direct and convenient access to emergency services from any transit vehicle, stop or station.	? Transit Security
Electronic Payment Services	Integrate payment methods for transportation services.	? Transit Passenger and Fare Management
Commercial Vehicle Operations (CVO)		
CV Electronic Clearance	Manage commercial vehicle delays at international border crossing, inspection and weigh stations, port facilities, and intermodal yards.	? International Border Electronic Clearance ? Weigh-In-Motion
Automated Roadside Safety Inspection (On-Board Safety Monitoring)	Implement safety/operator monitoring systems for commercial fleets and independent operators.	? International Border Electronic Clearance ? Roadside CVO Safety ? On-Board CVO Safety
Commercial Vehicle Administration Processes	Implement automated credentials procurement, fuel and mileage recording capabilities for commercial fleets and independent contractors.	? Fleet Administration ? Freight Administration
Hazardous Material Incident response	Provide Corridorwide electronic tracking (registration/location) of Hazmat shipments and disseminate this information to law enforcement and emergency services.	? Hazmat Management
Commercial Fleet Management	Facilitate Corridorwide communication between drivers, dispatchers and intermodal transportation providers.	? Fleet Administration ? CVO Fleet Maintenance
Emergency Management		
Emergency notification and personal security	Provide Corridorwide integrated response capability for in-vehicle or automated emergency service requests.	? Emergency Response ? May-day Support
Emergency Vehicle Management	Encourage coordinated emergency vehicle fleet to provide faster coordinated response regardless of jurisdiction.	? Emergency Response ? Emergency Routing

Table 6-2 (Continued)
Market Packages vs Users Service Objectives
Southern California ITS Corridor

User Service Name	Objectives	Market Package
Advanced Vehicle Control and Safety Systems		
Automated Highway System	Automated Highway travel	? Automated Highway System
Longitudinal Collision Avoidance	Promote the development of in-vehicle equipment to reduce the number and severity of longitudinal collisions.	? Longitudinal Safety Warning ? Advance Vehicle Longitudinal Control
Lateral Collision Avoidance	Promote the development of in-vehicle equipment to reduce the number and severity of lateral collisions.	? Lateral Safety Warning ? Advance Vehicle Lateral Control
Intersection Collision Avoidance	Promote the development of in-vehicle equipment and systems for reducing the number and severity of collisions at intersections. Provide for the implementation of physical infrastructure necessary to support in-vehicle systems.	? Intersection Safety Warning ? Intersection Collision Avoidance
Vision Enhancement for Crash Avoidance	Promote the development of in-vehicle equipment and physical infrastructure for the enhancement of vision and crash avoidance for obstructions in or along the roadway.	? Driver Visibility Improvement
Safety Readiness	Promote the development of in-vehicle equipment to provide warnings concerning the condition of the drives, the vehicle and the roadway.	? Vehicle Safety Monitoring ? Driver Safety Monitoring

6.3 FUNCTIONAL AREAS

Functional Areas specify what technology functions need to be performed to address Corridor needs and User Service Objectives. Defining the general function required necessitates a brief review of the typical operational requirements in implementing the various User Services. To accomplish this, the regional requirements were reviewed and the Corridor requirements were identified, and this information was consolidated to map the User Service Objectives, previously identified in the User Services Plan, to the identified Functional Areas.

Identification of Technology Functional Areas

Implementation of different User Service Objectives often requires common functions to be performed. The National ITS Program Plan recognized this issue and identified 17 functional areas. As can be seen from Table 6-3, these functional areas have been defined very broadly; it is left up to individual implementers to narrow down the definition as they see fit for their defined User Service Objectives. Each functional area is comprised of one or more separate technologies, which can be used interchangeably in system deployment to provide a User Service. For example, two-way mobile communications could be provided by either digital cellular telephones or two-way satellite communications.

TABLE 6-3
Functional Areas
Southern California ITS Corridor

Technology Functions	Descriptions
Traffic Surveillance	Surveillance technologies that collect information about the status of the traffic stream. Possible technologies include loop detectors, infrared sensors, radar and microwave sensors, machine vision, aerial surveillance, closed circuit television, acoustic, in-pavement magnetic, and vehicle probes.
Vehicle Surveillance	Surveillance technologies that collect a variety of information about specific vehicles. These technologies include weigh-in-motion devices, vehicle identification, vehicle classification, and vehicle location.
In-vehicle Sensor/Devices	Technologies providing a range of sensing functions to be located within vehicles. Functions addressed by these technologies include monitoring of vehicle performance and driver performance, determination of vehicle position relative to roadway, other vehicles, and obstacles, improvement of vision in adverse conditions, and on-board security monitoring.
Payment Systems	Technologies that enable electronic fund transfer between the traveler and the service provider. The technology areas include Automated Vehicle Identification (AVI), smart cards, and electronic funds management systems. This function overlaps with the Electronic Payment User Service.
Individual Traveler Interface	Devices that provide information flow to a specific traveler. Technologies meeting this function include touch screens, keypads, graphics displays and computer voices at Kiosks, computer voice and on-board display systems in vehicles, personal communications devices carried with the traveler, audiotex from any phone, and TV in the office or home.
Variable Message Displays	Technologies that allow centrally controlled messages to be displayed or announced audibly to multiple users at a common location, such as a roadside display or display board in a transit terminal. These technologies would typically be applied to provide information on highway conditions, traffic restrictions, and transit status.
Navigation	Technologies that determine vehicle position in real time. Technologies that provide this function include GPS, LORAN, dead reckoning, localized beacons, map database matching, and cellular/radio triangulation.
Signalized Traffic Control	Technologies that allow for real-time control of traffic flow. Possible technologies include optimized traffic signals, ramp metering, reversible lane designation, and ramp/lane closures.

TABLE 6-3 (Continued)
Functional Areas
Southern California ITS Corridor

Technology Functions	Descriptions
Restrictions Traffic Control	Operational techniques that restrict the use of roadways according to regional goals. Techniques include HOV restrictions, parking restrictions, and road use (congestion pricing).
Stationary Communication	
1-way Mobile Communications	Any communication technology that transmits information to potentially mobile reception sites but cannot receive information back from those sites. Possible technologies providing this function include highway advisory radio, FM subcarrier, spread spectrum, microwave, infrared, commercial broadcasts, and infrared or microwave beacons.
2-way Mobile Communications	Any communication technology that transmits information to potentially mobile reception sites and allows receipt of information from those sites. Possible technologies providing this function include cellular telephone, 2-way radio, spread spectrum, microwave, infrared, and 2-way satellite.
Inter-Agency Coordination	Technologies that connect travel-related facilities to other agencies such as police, emergency service providers, weather forecasters and observers, Traffic Management Centers (TMCs), transit operators, etc.
Database Processing	Technologies that manipulate and configure or format transportation-related data for sharing on various platforms. General-purpose data base software currently exists and is currently being adapted to transportation needs, such as data fusion, maps, and travel services.
Routing Data Processing	Data processing related to routing of vehicles including the generation of step-by-step driving instructions to specified destination. Algorithms under development include the scheduling of drivers, vehicles, and cargo, route selection, commercial vehicle scheduling, route guidance, and multi-model dispatching.
Traffic Control Data Processing	Data processing related to real-time control of traffic. Algorithms under development include optimal control and incident detection, and the interaction of route selection and traffic control.
Traffic Prediction Data Processing	Data processing relating to prediction of future traffic situations. Algorithms under development include areas such as real-time traffic prediction, and traffic assignment.

Mapping Technology Functional Areas To User Services

Full implementation of a User Service typically requires that a number of technology functions be carried out. In Table 6-4, User Services' categories were mapped to the broad functional areas of technologies which might be applied to meet User Service Objectives. The Market Packages, which seem to have the potential for incorporating those technologies for implementation are listed. One Market Package may serve the implementation of more than one User Service. Examining broadly the inter-relationship between User Services and Market Packages may help to define specific technology functional areas.

In Table 6-5, we begin relating User Services and User Service Objectives to technology functional areas required to satisfy those objectives. The purpose of the table is to illustrate how the technological means required to meet User Service Objectives can naturally group into common functions which will be performed within the system architecture. (For an explanation of system architecture, please see Chapter 7.)

This section of the Strategic Deployment Plan is intended to serve as a guide to stakeholders wishing to implement specific applications, both locally and at the Corridor level. For example, if LADOT wishes to provide its riders with real-time travel information at bus stops or en-route, it can refer to this material to determine what market packages may be used to implement such a service, what functional areas are involved in providing the service, and the technologies available to implement the market packages required to provide the service.

User Services and Market Packages (and the technology required to implement them) often cross jurisdictional boundaries and functional responsibilities. The Program of Projects (Chapter 2 of this plan), defines specific projects to be implemented throughout the Corridor. Projects identified as "Corridor-level" projects are, among other considerations, those which require substantial investment and coordination by a wide range of stakeholders. Technology considerations, as discussed in this chapter, played a significant role in determining which applications are best implemented at the Corridor level.

Insert Table 7-4 (was 3-4 or 6-4)

Insert Table 6-5 (was 3-5 or 7-5)

Table 7-5, page 2 (3-5 or 6-5)

Table 7-5, page 3 (was 3-5 or 6-5)

Table 7-5, page 4 (was 3-5 or 6-5)

Table 7-5, page 5 (was 3-5 or 6-5)

Table 7-5, page 6 (was 3-5 or 6-5)

Table 7-5, page 7 (was 3-5 or 6-5)

6.4 ALTERNATIVE TECHNOLOGIES

A major concern when developing and implementing ITS-based systems is the potential impact and influence of technology. New technologies and devices are being brought to the ITS area which were not considered, in some cases, as recently as one year ago. Many of these technology enhancements -- particularly in the areas of surveillance, processing, and communications -- appear to offer better and/or more cost-effective methods for achieving general transportation objectives; although it must be emphasized that many of these potential system elements have not yet been proven in the operational transportation management system. This influx of "better" technology, coupled with intense marketing by ITS product vendors, can lead to a situation where the ITS deployment process becomes an exercise of "technology looking for a problem." Instead, the process should concentrate on developing solutions to problems, and then selecting the appropriate technologies for implementing the solutions.

Considering the rapid pace of change in the technology marketplace, it is a fair assumption that many of these products, services, and technologies will continue to evolve, improve, and be superseded by others. These advancements will continue to be fueled by market demands of the transportation industry worldwide. As such, this section provides a snapshot of available technologies and strategies at the time of this writing.

Available ITS Technologies and Their Evaluation

For the purpose of evaluating technologies, functional areas have been mapped into five categories as shown in Table 6-6:

Table 6-6
Mapping of Functional Areas to Technology Category

Technology Category	***Functional Areas***
Surveillance	? Traffic Surveillance ? Vehicle Surveillance ? In-Vehicle Sensors/Devices ? Payment Systems
Traveler Information	? Individual Traveler Interface ? Variable Message Displays ? Navigation
Control Strategies	? Signalized Traffic Control ? Restrictions Traffic Control
Communications	? Stationary Communication ? 2-way Mobile Communications ? 1-Way Mobile Communications ? Inter-Agency Coordination
Data Processing	? Database Processing ? Traffic Prediction Data Processing ? Routing Data Processing ? Traffic Control Data Processing

For each of the above categories, available technologies have been identified and a brief description of the various technologies, their respective features and characteristics (and potential drawbacks) is presented. The identified technologies are also analyzed and evaluated using the following criteria:

? Feasibility of deployment: This depends on the availability and acceptability of the technology;

? Reliability of technology: The level of accuracy of the data collected using the particular technology;

? Initial deployment cost: The initial cost includes all costs involved with the deployment of the particular technology;

? Operations Costs and Maintenance: The cost of operations and the ease or difficulty in providing routine maintenance.

Technologies were rated for each of the above categories with a value of low, medium or high. As an example, the feasibility of the Internet would be rated “high” as it is a proven technology which is beginning to become widely deployed as means to access traveler information. On the other hand, the feasibility of Interactive Television would be rated as “low” as it is a relatively new technology that has been tested in a very limited basis. While the ability exists to deploy Interactive Television, it has yet to be deployed even in a limited manner.

The trade off analyses performed for each group of technologies evaluates each technology objectively, without regard to whether the public or private sector is likely to implement it. As Prioirity Corridor stakeholders are from both sectors, the intent of this document is for it to be used as a resource by both.

Surveillance

Until the last decade, the primary roadway surveillance technologies included roadway inductive loop detectors, pneumatic road tubes, temporary manual counts for both real-time and historical traffic data collection. However with technological innovations, several new designs of different types have been developed and are being field tested. The available surveillance technologies are described below.

Roadway Oriented Technologies

The effectiveness of roadway oriented technologies depends on collecting, processing and managing information on the transportation network. These data may be a combination of speed, volume, density, travel time, queue length, and vehicle identification information or a collection of all. These data are used in making real-time traffic management decisions, selecting traveler information displays and messages, and implementing the appropriate control strategies to improve traffic flow throughout the roadway system. Data may also be stored for planning and historical analysis. The examples of roadway oriented technologies include:

? In-pavement sensors (Loop (inductive loop detectors, magnetic detectors/magnetometers, self-powered vehicle detector), and piezo-electric film); and,

? Overhead mounted and/or side-fired detectors (microwave, ultrasonic, infrared, passive acoustic, Video Detection/Image Processing (VIDs), Video Enforcement Systems (VES), laser).

In-pavement technologies are the most widely used and have been in-use for decades. They are more cost effective as compared to other surveillance devices. Their drawbacks include high maintenance cost and unsuitability of use on bridge decks, overpasses and roadbeds.

Other technologies like laser have not been in use for many years and hence no substantial data on their reliability is available. Also they do not always provide all the required data, for example microwave radar detectors provide only speed data, and can't be used in places where volume and occupancy data is required.

Vehicle Surveillance Oriented Technologies

The need for more dynamic traffic information requires the use of vehicle surveillance technologies to monitor and provide timely information regarding travel conditions. There are three types of systems for monitoring vehicle movements for collection of traffic information. These systems are:

- ? Autonomous - no communications;
- ? Advisory systems - one way communications; and,
- ? Fleet management - two-way communications.

Vehicle surveillance will permit automatic vehicle identification. A probe vehicle provides information, such as speed or travel time, to the central system. These data are then used as one source of information concerning traffic conditions. By inference, this information can be used to detect congestion and incidents in the traffic stream. If found to be effective, vehicle probes may be useful in monitoring surface street or freeway traffic where conventional detector installation is not cost effective.

Probe vehicles need to have a location system and communications hardware in order to provide data to a central system. In ATIS projects developed to date, packet radio has been used to transmit data to and from vehicles. There are ranges of such communications systems on the market and any of these can be used with any of the location systems.

Probe technologies have two major disadvantages. For any type of system that requires probe vehicles, the disadvantage of the system is the dependence on probe vehicles in the system coverage area. The other major disadvantage is the data must remain anonymous to maintain privacy among the users of the probe technology.

However, there are two advantages to probe technologies. The first advantage is the reliability of the data. Since the data is so accurate, it can be used for messages to motorists regarding travel times, incident detection, and route diversion. Secondly the quality of the data collected allows for faster determination of traffic congestion as there is no algorithm checking (which is needed in data) which would create a delay in the transmission of the data to the system operator.

Examples of vehicle surveillance oriented technologies include:

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- ? Automated Vehicle Location (AVL);
- ? Automated Vehicle Identification (AVI), Automated Equipment Inventory (AVE);
- ? Cellular telephone, Cellular Digital Packet Data (CDPD), mobile data and wireless;
- ? Differential and Non-differential Global Positioning Systems (DGPS and GPS); and,
- ? Dead reckoning, signpost technology, LORAN-C, radio multi-laceration.

Pavement and Weather Surveillance

Road Weather Information Systems (RWIS) have been proven to be effective devices in providing real-time information to those who maintain, operate and construct highways. RWIS have also aided in relaying accurate weather conditions to travelers, especially in areas prone to severe and highly variable weather conditions. Pavement and weather detection systems have been installed and used throughout the world. These systems are used to notify operators at the traffic operations center (TOC) of inclement weather or poor roadway conditions. Weather sensors collect data about weather conditions and about roadway conditions affected by the weather while also collecting information that is necessary for accurate trip planning, routing, route divergence, safety and warning advice. In the future these systems will be able to send an alarm back to the TOC to alert the operator and automatically transmit a warning message to be posted on a variable message sign (VMS) or to be broadcast to an in-vehicle unit or on highway advisory radio (HAR).

Environmental Surveillance

The application of new technologies to monitor the emissions of vehicles will help detect the high emitting vehicles. Implementation will involve technologies such as remote sensing, on-board diagnostic systems connected to data transmission devices such as transponders and satellites.

Increasing traffic densities in urban areas, tunnels and underpasses have drawn attention to potentially hazardous levels of carbon monoxide found in these areas. Regulations regarding the accumulation of gas concentrations have been mandated around the world and equipment is needed to find and monitor these locations to record the traffic flow and determine the amount of pollution. For implementation in ITS, the data collected by this equipment will be automatically collected, processed and measures taken to reduce the levels of pollutants in these areas. Ventilation systems can be connected to these systems that can be activated to disburse these pollutants to make them less hazardous. With the addition of high-speed photography, enforcement of emissions standards can be facilitated by these systems.

Closed Circuit Television (CCTV) Cameras

Closed circuit television (CCTV) provides the most effective means of visually surveying the operations of a traffic management system. The use of visual surveillance has gained popularity in recent years, by providing the identification of incidents from a remote location. The particular functions performed by the CCTV system are:

- Verify incidents detected by the central computer incident detection algorithm;
- Detect incidents, specially under light traffic conditions when automatic incident detection algorithms become less effective;
- Verify that incidents have been cleared;
- Verify messages and displays on dynamic signs (where possible); and,
- Provide visual information on adjacent roadways such as major cross streets.

Table 6-7 presents a summary of trade-off analysis for the Surveillance Technologies.

Table 6-7
Summary Of Trade-Off Analysis For Surveillance Technologies

Technology	*Feasibility*	*Reliability*	*Initial Cost*	*Operating Cost*	*Maintenance*
Inductance Loop	High	High	Moderate	Low	High
Magnetometer	High	High	Moderate	Low	High
SVPD	High	High	Moderate	Low	High
Piezo-electric film	High	High	Moderate	Low	High
Laser	Moderate	High	Moderate	Low	High
Ultrasonic	Moderate	Moderate	High	Low	High
Passive Infrared	Moderate	Moderate	High	Low	High
Active Infrared	Moderate	Moderate	High	Low	High
Microwave Doppler Detector	High	High	High	Low	High
Microwave Radar Detector	High	High	High	Low	High
Passive Acoustic Detector	High	High	High	Low	High
Video Tracking Systems	Moderate	Moderate	High	Low	High
Video Image Processing	Moderate	Moderate	High	Low	High
Toll Tags	High	High	Moderate	Moderate	Low
Signpost Technology	Moderate	High	High	Low	Moderate
Loran-C Technology	Moderate	High	High	Low	Moderate
Radio Multi-Laceration Technology	Moderate	High	High	Low	Moderate
Differential GPS Technology	High	High	High	High	Low
Dead Reckoning Technology	Moderate	Moderate	Moderate	High	High
Video Cameras	High	High	High	Low	Moderate
Cellular Phones	Moderate	Moderate	Moderate	Low	Low
AVI Technology	High	high	High	High	Low

Technology	Feasibility	Reliability	Initial Cost	Operating Cost	Maintenance
Silent Alarms	High	High	Moderate	Low	Low
Detectable Warning Systems	High	Moderate	Moderate	Low	Moderate
Vehicle Monitoring Systems	Moderate	High	High	Moderate	Moderate
Side-Door Monitoring Systems	Moderate	High	High	Moderate	Moderate
Collision Avoidance	High	Moderate	High	High	High
Automatic Passenger Counter	High	Moderate	High	Moderate	Moderate
Surface Sensors	High	High	High	Low	Moderate
Sub-surface Sensors	High	High	High	Low	High
Traffic Pollution Monitors	High	High	High	Moderate	Moderate
Atmospheric Sensors	High	High	Moderate	Low	Moderate
Tube/Loop Sensors	High	Moderate	High	Low	Moderate

Note: For surveillance technologies that involve cameras, the type of communications backbone available is also a determining factor in determining initial, operating and maintenance costs.

Traveler Information

Traveler information technologies provide the means by which the traveler (and soon-to-be traveler), using public or private transportation, receives real-time information regarding the roadway and transit network. Most information is obtained by the surveillance elements (discussed earlier in this report) and processed by central hardware elements in an operations center for dissemination utilizing a variety of audio and visual techniques. As summarized in Table 6-8, pre-trip and en-route traveler information technologies can be disseminated in the visual or audio manner, and can be based in the home, workplace, automobile, transit vehicle, public transit station, or in the case of personal communication devices, upon a person.

Table 6-8
Traveler Information Technologies

Type of Information	*Type of System*	**Visual Dissemination**	***Audio Dissemination***
Pre-Trip Information	Computer Based Systems	? Internet ? Electronic Bulletin Board Services ? Videotex	N/A
	Telephone Based Systems	? ? ? N/A	? Audiotex ? Traveler Advisory Telephone ? Automated Trip Planning Services
	Television Based Systems	? Television Media ? Teletext ? Television Monitors ? Cable Television ? Interactive Television	? N/A
En-Route Information	Roadway Based Systems	? Variable Message Signs (VMS)	? Highway Advisory Radio (HAR)
	In-Private Automobile Based Systems	? Mayday Calling Systems ? Active Warning Systems ? Route Guidance Systems	? Radio Data Systems (FM Sideband) ? AM Radio
	In-Transit Vehicle Based Systems	? Message Boards	? Automated Enunciating Systems
	In-Transit Station Based Systems	? Kiosks ? Display Monitors ? Message Boards	? PA Systems
	Personal Based Systems	? Personal Communications Devices ? FM Subcarrier	? Phone

Regardless of how traveler information is provided, to be effective the data must be timely, complete, accurate, credible, and perceived by the individual traveler as providing a personal advantage when followed; otherwise, the information will be ignored. In general, for each inaccurate piece of information promulgated by the traveler interface elements, it will take numerous occurrences of accurate information to recapture the traveler's faith in the system. As discussed in the following section, traveler information can be categorized into pre-trip and en-route.

Pre-Trip Traveler Information

Pre-trip traveler information can provide the traveler with current roadway and/or transit information prior to deciding upon the time, mode, and route of travel. Whether provided to travelers at home, the workplace, park-n-ride facilities, transit stations, or multi-modal locations, this capability can help relieve congestion by giving the traveler the information to reroute, delay start of the trip, shift modes, or avoid travel altogether. Often, this information can support itinerary planning which can provide information on a whole trip from one point to another, even if it involves multiple modes. Reliable pre-trip traveler information also tends to spread the travel over space and time, making it more balanced.

Getting travelers to give up the convenience of driving their own cars is a difficult task. In doing so, it is essential to focus on a change in travel behavior, which entails providing accurate and timely information to travelers before their trip. Convenience of obtaining pre-trip information is essential to successfully implementing pre-trip traveler information systems. Touch-tone telephones, personal computers, pagers, personal communications devices (PCDs), kiosks, and automated data retrieval systems which augment existing human-operator interfaces have the potential to substantially improve the accessibility of desired traveler information, thus impacting travel behavior. As an example, pre-trip information accessible via the Internet from the home or workplace can include map displays of the service area based on geographic information systems (mostly for the operator providing information to the customer who has requested information) and schedule information.

Dissemination of pre-trip traveler information for those using transit systems is more complicated than disseminating information for those who choose to travel the highway. Providing pre-trip information at either the home or workplace is sufficient for those choosing vehicular travel, as the information requirements at both locations are basically the same. Disseminating transit oriented pre-trip traveler information is different, as the required data varies from location to location. Some of these differences include:

? At the home and workplace, pre-trip transit information would include schedule adherence, expected arrival times, fare structure, destinations, potential connections, and trip itinerary planning capabilities. The same type of information would also likely be available at park-n-ride facilities; and,

? In transit stations, the type and availability of pre-trip traveler information would vary by location. For example, expected arrival times and destination information is applicable for platform locations. In the main lobby, the same information is applicable for dissemination, but so is schedule adherence, expected departure times, and potential connections. Ticketing booths would need to provide the full spectrum of pre-trip transit oriented information.

En-Route Traveler Information

En-route traveler information can provide the traveler with current roadway and transit information while traveling en-route. Information is typically provided via devices deployed along the side of the roadway, or from devices mounted on the dashboard of the vehicle.

Along the roadway, VMS and HAR messages typically provide information regarding traffic congestion, incident and construction locations, weather advisories, special events which may impact travel on a particular section of roadway, and alternative routes. Dashboard devices can provide a variety of en-route traveler information to both the traveler as well as transportation providers. Mayday calling systems can alert emergency response and transportation system providers of a stranded or disabled vehicle's location. Active warning systems can alert motorists of an impending adverse or potentially dangerous travel condition, such as a sub-standard curve or the low clearance of a bridge located en-route. Sophisticated route guidance systems can assist motorists in route planning as well as providing timely directions via a computer synthesized voice. Lastly, new radio advisory systems exist which can override standard radio broadcasts to provide real-time traveler information, such as the location of incidents.

Table 6-9 presents a summary of trade-off analysis for the Traveler Information Technologies.

Table 6-9
Summary of Trade-off Analysis for Traveler Information Technologies

Technology	Feasibility	Reliability	Initial Cost	Operating Cost	Maintainability
Internet	High	High	High	Low	Low
Electronic Bulletin Board Services	High	High	High	Low	Low
Videotex	Moderate	High	High	Low	Low
Audiotex	Moderate	High	High	Low	Low
Travelers Advisory Telephone	Moderate	High	High	High	High
Automated Trip Planning Services	High	High	High	High	High
Television Media	High	High	High	Low	Low
Teletext	Low	High	High	Low	Low
Television Monitors	Low	High	High	Low	Low
Cable Television	Moderate	High	High	Low	Low
Interactive Television	Low	High	High	Low	Low
Variable Message Signs	High	High	High	Moderate	Moderate
Highway Advisory Radio	High	High	Low	Low	Low
Mayday Calling Systems	Low	High	Moderate	Low	Low
Active Warning Systems	Low	High	Moderate	Low	Low
Route Guidance Systems	Low	High	High	Low	Low
Radio Data Systems	Low	High	Moderate	Low	Low
AM Radio	High	High	Low	Low	Low
Message Boards	High	High	Low	Low	Low
Kiosks	High	High	Moderate	Low	Low
Display Monitors	High	High	Low	Low	Low
Public Announcement Systems	High	High	Low	Low	Low
Personal Communications Devices	Moderate	High	Moderate	Low	Low
FM Subcarrier	Low	High	Moderate	Low	Low
Telephone	High	High	Low	Low	Low
Automated Annunciation Systems	High	High	High	Low	Low

Control Strategies

Several of the emerging ITS technologies relate to control strategies that may be implemented to provide improved efficiencies on the roadway network, reduce or spread out demand, enhance traveler safety, and improve commercial vehicle operations (CVO). Specific roadway and transit oriented strategies are addressed in this section.

Roadway Oriented Strategies

Specific roadway oriented strategies presented and discussed herein include:

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- Ramp metering;
- Signal systems;
- Lane-use control systems;
- Variable speed limit sign control;
- ? Electronic toll collection;
- Diversions;
- Congestion pricing;
- Incident management; and,
- Downtown parking advisories.

Ramp Metering

Ramp metering is the primary tool used in addressing recurring congestion, and is a useful tool for minimizing traffic at incident situations. Ramp metering is a method of regulating traffic flow. When applied as a form of entrance ramp control, metering is used to limit the rate at which traffic can enter a freeway. Maximum practical signal lane rate is generally 900 vehicles per hour, with a practical minimum of 240 vph. When the metering rate is not directly influenced by mainline traffic conditions, the control is referred to as "pretimed metering." This does not, however, necessarily imply the absence of vehicle detectors. Traffic responsive metering is directly influenced by the mainline and ramp traffic conditions during the metering period. Metering rates are selected on the basis of real-time measurements of traffic variables indicating the current relation between upstream demand and downstream capacity. Though it may seem paradoxical, by controlling traffic at the ramps such that the freeway's throughput is maximized, more vehicles can enter from the ramps than if the mainline flow was allowed to break down.

Another benefit of ramp metering is its ability to break up platoons of vehicles released from a nearby intersection. While the mainline, even when operating near capacity, can accommodate merging vehicles one or two at a time, queues of vehicles attempting to force their way into freeway traffic create turbulence and shockwaves that cause the mainline flow to break down. Reducing the turbulence in merge zones can also lead to a reduction in the sideswipe and rear-end type accidents associated with stop-and-go, erratic traffic flow.

Ramp metering can also serve other purposes, including:

- Discouraging drivers from using the freeway for very short trips. Ramp metering is more likely to divert short trips to the arterial streets rather than long trips because the time savings resulting from improved freeway flow will be smaller (or non-existent) for short trips as compared to longer trips.
- Providing incentives for bus ridership and carpooling by allowing high occupancy vehicles (HOV) to bypass the ramp meter. Typically, the time savings is one to three minutes.

In essence, ramp metering redistributes the freeway demand over time -- storing any excess demand on the ramp, instead of on the freeway as stop-and-go traffic. While this mode of control is used primarily to reduce the impacts of recurring congestion during peak traffic periods, ramp metering can also be implemented to combat incident-related congestion. For example, meters upstream of the incident area would operate at low metering rates, limiting the number of vehicles entering the freeway. Using surface-street VMS and other driver information devices, entering vehicles would be diverted to on-ramps downstream of the incident. These downstream on-ramps would operate with relaxed metering rates (or no metering) to handle the increased demand.

Traffic Signal Control Systems

A major task in controlling traffic in any major city is signal timing. There are many different considerations that must be given thought when timing signals. Most importantly, the safety issues associated with traffic signal control must be given highest priority.

Numerous studies have pointed out the benefits of signal timing improvements and coordination. Furthermore, these benefits can be achieved at minimal costs. Before and after studies often indicate benefit to cost ratios in excess of 25:1 for these kinds of projects, even when significant signal upgrade costs are included. Perhaps an even more interesting fact about signal timing and coordination is the scalability of these projects. For example, accurate time-based coordination can often provide excellent benefits for their minimal costs. However, even expensive centralized systems (e.g., Automatic Traffic Surveillance and Control System - ATSAC) will show impressive benefit to cost ratios when implemented in the right environment. Further, the costs associated with these more expensive systems continue to decrease due to new technologies.

Some of the primary benefits of traffic signal systems are their ability to store multiple timing plans, monitor system failures, and provide a central location for operator interface. These are basic elements that should be included in any traffic control system. Many cities have implemented systems with an elaborate set of features without using many of the basic features previously mentioned. The most common example of this situation is the installation of actuated closed-loop systems that are never monitored or even maintained for years.

Most traffic signal control strategies fall into two categories: Urban Traffic Control Strategies (UTCS) or Advanced Adaptive Control. The UTCS project, funded by FHWA in the 1960's and 1970's, was the most detailed study conducted in the United States at the time. The outcome of the study was the development of four different generations of traffic control. The four generations provided different levels of coordination and operational considerations all aimed at reducing stops and delays.

In an effort to provide greater functionality and improved performance advanced adaptive control strategies have been developed. These control strategies operate in real-time using data collected from the street network to determine the optimum signal timing. The advanced adaptive control strategies use more data than the UTCS systems and provide increased information.

Lane-Use Control Signals

Most transportation agencies recognize that urban traffic congestion cannot be overcome strictly through additional roadway construction. Therefore, ways must be found to make more effective use of the roadway capacity that is already available. One way many agencies are making better use of available freeway capacity is through the implementation of computerized traffic management systems.

Traffic management systems involve both the collection of real-time traffic data and the control and management of that traffic. Traffic management and control is accomplished with ramp metering, incident response programs, signal timing adjustments on adjacent surface streets, and real-time motorist information systems to warn motorists of downstream traffic conditions and/or provide suggestions to alter their travel routes. This information can be disseminated through various mechanisms, including changeable message signs, highway advisory radio, and overhead Lane-use Control Signals (LCS).

LCS has been in existence for over 30 years. The purpose of these signals is to symbolically portray the current status of each freeway lane. Historically, the most prevalent use of LCS has been for the operation of reversible lanes. However, the Manual of Uniform Traffic Control Devices (MUTCD) does allow LCS on freeways when it is desirable to keep traffic out of certain lanes at certain hours, to indicate that a lane ends at the terminus of a freeway or to indicate that a lane is temporarily blocked by an accident, stalled vehicle, etc.

Variable Speed Limit Control

A Variable Speed Limit System (VSLS) is a responsive traffic control system in which motorists are provided with speed limit and advisory messages based on current traffic and environmental conditions. The VSLS was developed in response to the need for increased safety on the nation's freeways. The standard speed limits, which are often based on worst case conditions, are often not observed because motorists do not consider them reasonable. Since so many motorists do not obey the legal limit, enforcement is not effective.

A VSLS posts a speed limit which corresponds to the current road conditions. It may also warn motorists of upcoming changes in the speed limit due to upstream road conditions. These traffic responsive regulations are more likely to be accepted and followed by motorists.

The VSLS utilizes traffic detectors and environmental sensors from stations along the freeway to obtain data, such as speed, light level, and amount of precipitation. The data is transmitted to a central location at which a computer algorithm uses the data to determine the appropriate speed limit at that station. Speed limits and pertinent messages are displayed on electronic road signs, which are located downstream of the station from which the data was collected.

Electronic Toll Collection

Electronic toll collection (ETC) enables the collection of fees from drivers without requiring the vehicle to stop at toll plazas. Elements of an ETC system typically include:

- AVI tags on vehicles and AVI readers at the toll plazas. Each vehicle is identified as it goes through the plaza. The appropriate amount is debited from an established toll account, or the charges are accumulated and a bill is sent for payment;
- Video monitoring system/license plate reader to identify violators, including vehicles with no tags, tags with insufficient funds in their respective account, and/or vehicles with an inappropriate tag (e.g., truck using an auto tag); and,
- Central processing hardware to maintain the accounts of each equipped vehicle.

Congestion Pricing

Congestion pricing is viewed increasingly by transportation policy makers as an important part of the solution to growing highway congestion in urban areas. Congestion pricing differs from other forms of road user charges, such as gasoline taxes and vehicle registration fees, in that the charges are made at both the time and point of road use. The charges levied may be based on a variety of factors including the distance traveled, the direction of travel, the geographic area(s) into which the vehicle travels (i.e., cordon pricing), the time spent on the roadway and/or in the cordon area, vehicle type, vehicle occupancy, vehicle load, time-of-day/day-of-week, and current congestion levels. Congestion pricing is not a single mechanism, but an array of means for charging motorists in direct or rough proportion to motor vehicle use. Congestion pricing encompasses any mechanism for charging road users in relation to their vehicle use. Congestion-pricing mechanisms include parking charges, weight-distance charges and fuel taxes, deployed singly or in combination.

Congestion pricing appears to have considerable potential to achieve many of the aims of ITS, such as matching traffic flow to highway capacity, reducing the need to build additional capacity, and reducing vehicular emissions. For many pricing mechanisms, ITS technologies facilitate implementation by removing some of the obstacles -- the most obvious being the use of ETC that minimizes the delay and emissions associated with conventional toll collection. ITS can help effectuate congestion pricing in a variety of ways:

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- ITS technologies can "meter" driving, and some of the social costs that driving generates (such as emissions), thus providing a more accurate basis for pricing;
- ITS can accomplish this metering without impeding traffic flow, thus making pricing more acceptable to motorists; and,
- Because ITS promises clear benefits for drivers, it could support the rationale for pricing as a revenue generator for transport infrastructure.

The rationale for congestion pricing is primarily economic. As demand to use the road network increases, speeds fall and the costs borne by individual users rise. These "private costs" primarily involve vehicle operations (e.g., gas) and increased travel time resulting from congestion. In theory, people will travel only if the benefits from travel exceed these costs. However, each additional user further increased congestion and reduces speeds, thereby imposing additional costs on those already on the road who are slowed down by the additional user's presence. Moreover, there are "social costs" associated with increased accidents, pollution, noise, and public services (e.g., police, emergency medial services, etc.).

Individual drivers do not perceive these "marginal costs" -- the additional costs that would not be incurred if their trip was not made. Accordingly, they may decide to travel even though the total costs imposed by the journey exceed the benefits. Congestion pricing attempts to correct this by exposing drivers to these additional or marginal costs before they decide to drive.

Congestion pricing can help pay for roadway facilities. Historically, the basic road infrastructure has functioned as a common carrier, and therefore offered a public good to be funded, at least in part, from general tax revenues. In recent years, however the roadway network has grown to where user financing may be required to sustain it. Weight-distance charges offer a possible solution in this regard.

Incident Management

Non-recurring congestion is the result of “incidents” that block travel lanes or otherwise reduce capacity, thereby impeding traffic flow on the freeway. These freeway events are relatively unpredictable, and can take on several forms including accidents, disabled vehicles, spilled loads, bad weather, special events, construction activities etc.

Due to increased side friction, weaving to avoid the blocked lane(s), and rubber-necking, the impact of an incident on roadway capacity goes well beyond the simple subtraction of the number of blocked lane(s).

Strategies for reducing the impact of freeway incidents on traffic congestion are categorized as “incident management.” Incident management is defined as a coordinated and pre-planned use of human and mechanical resources to restore full capacity as soon as possible after an incident occurs, and to efficiently manage traffic during the incident. Incident management does not eliminate all congestion caused by incidents; though an FHWA study indicated an average 37 percent reduction in incident-related delay following implementation of comprehensive incident management programs. The incident management process, and the goals of the incident management process, involves the following activities:

?

- Reducing the time required to detect the occurrence of an incident (i.e., awareness);
- Reducing the time required to verify the incident, identify the types of vehicles involved, and to determine the proper response (i.e., identification);
- Reducing the time required to notify the necessary agencies and organizations, and then for the appropriate equipment and personnel to arrive on the scene (i.e., response);
- Reducing the time required for the incident to be cleared from the roadway, restoring full capacity, while exercising proper on-scene management of traffic flow (i.e., clearance); and,
- Providing traveler information throughout the process.

Although these activities have been presented as discrete entities, they frequently overlap or are performed simultaneously. For example, in an incident where a freeway service patrol vehicle locates a disabled vehicle by the side of the road and rectifies the problem, the time required for verification and response is almost zero. At a major incident involving several organizations, the first units to arrive at the scene typically begin their clearance activities while the other units are still on their way.

Downtown Parking Advisory

An Advanced Parking Information (API) System guides motorists to available parking spaces. Systems often use VMS to provide real-time information regarding the parking situation. They are intended to reduce the vehicle queues and spill-over into travel lanes that can occur when the demand of a particular parking facility exceeds its capacity.

An API system typically consists of VMS at entrance points to parking facilities to indicate to motorists the available vacancies. VMS are also located at the approach to a facility to indicate the parking status of that facility. If it is full, the sign may direct the motorist to the nearest facility with space.

API systems may also be integrated with downtown traffic signal systems and freeway management systems. Traffic signals are timed to provide preferential flow to underutilized parking facilities. Parking and transit information is displayed on freeway signs operated by a freeway management system.

API systems have been installed in the United States, Japan, Germany, and the United Kingdom. They are usually located in urban areas that experience congestion and attract a large number of visitors. Some of the benefits of an API system include:

? Increased occupancy rates at parking facilities - Occupancy rates at a parking facility are increased because motorists know where the facilities are located and when spaces are available. Directions to a parking facility becomes valuable to motorists who would otherwise not have parked there because they did not know of its existence. In addition, an API system might increase the use of centrally located parking facilities, which are sometimes overlooked by people who assume that they will be full;

? Decreased illegal parking - The provision of a simple method for locating parking spaces can reduce the number of illegally parked vehicles within a city. Drivers are able to locate legal parking spaces of which they might not have known the existence;

? Decreased travel time - Motorists searching for parking may experience a shorter travel time due to a decrease in search time and a decrease in delay from parking facility queues. Search time is minimized by preventing motorists from attempting to park in full lots and by providing directions to available parking spaces. High demand at a facility often results in queues of vehicles waiting for a parking space to open up. When these back up onto the travel lanes, they cause delay for other motorists as well; and,

? Decreased congestion - Eliminating queue spill-overs may reduce congestion on the city streets. An API system may also decrease congestion by eliminating the need for motorists to circle blocks looking for parking. Studies have shown decreases in on-street parking and increases in off-street parking after the implementation of an API system.

Transit Oriented Strategies

Specific transit oriented strategies presented and discussed herein include:

- ? Paratransit and Mobility Manager;
- ? Fare Payment;
- ? Transit Priority;
- ? HOV Facility Monitoring; and,
- ? Real-time Ridesharing.

Paratransit and Mobility Manager

One of the most significant service innovations in public transportation systems in recent years has been the introduction of demand-responsive transportation services (often referred to as Paratransit). Paratransit has received considerable attention following enactment of the 1990 Americans with Disabilities Act (ADA), which requires fixed-route transit operators to provide complementary paratransit service for persons with disabilities who are unable to use fixed-route services. One method of improving the performance of demand-responsive systems is the use of computer technology. Several activities in paratransit operations, such as trip reservation, scheduling, financial management, and reporting lend themselves to computer assistance.

The term “mobility manager” was coined in 1991 in a Federal Transit Authority (FTA) report that identified the potential for market-oriented local transportation. Mobility Manager was defined as “a mechanism for achieving the integration and coordination of transportation services offered by multiple providers--public, private for-profit, and private non-profit--involving a variety of travel modes and multiple sources of funding. This integration is accomplished through electronic technologies, allowing the programmatic integrity of all participants to be preserved, while at the same time automating most of the transactions -financial and otherwise - which occur in the system. Mobility Manager's function resembles that of a travel agency and a financial clearinghouse.” Recently, this term has been expanded to cover all services offered by public transportation agencies outside of the traditional services that have been offered throughout history.

Critical research and practical applications of mobility management are being conducted in a Transportation Research Board Transit Cooperative Research Program (TCRP) project entitled “Strategies to Assist Local Transportation Agencies in Becoming Mobility Managers.” Also, an increasing number of transportation agencies are embracing the concepts of mobility management, and are beginning to implement innovations that identify them as mobility managers.

Fare Payment

Transit systems across the country are exploring and adopting advanced fare payment system concepts that promise greater flexibility in fare structures, less expense in money handling, greater convenience for riders, and more efficient cooperation between fellow transit providers. Three types of integration of fare payment systems are currently being pursued by transit operators across the country.

- ? One type is the integration of fare payment systems for different modes of transportation, such as distance-based fare systems for trips involving rapid transit and bus operated by a single transit provider;
- ? A second type involves integration of the financial systems and instruments involved in fare payment, with the rest of the nation's consumer financial system. This type includes creating commonalties and interfaces between transit systems, transit rider accounts and fare cards on the one hand; and banks, customer accounts, and credit, debit, and ATM cards on the other hand; and,
- ? A third type of integration involves fare payment systems operated jointly by a number of transportation operators, allowing riders to pay a single fare for a journey involving more than one transit provider.

These advanced fare payment systems concepts rely on the use of electronic fare media. Electronic and automated fare payment systems employ electronic communication, data processing and data storage techniques in the process of fare collection. Over the years, transit operators have adopted many innovations incorporating advanced electrical and automated technology in their fare payment systems, in order to achieve a variety of objectives, including:

- ? More sophisticated fare pricing systems, based on distance traveled, time of day, and user profile (e.g., school children, elderly, frequent users);
- ? Elimination of cash and coin handling, to improve security and lower costs;
- ? Automation of the accounting and financial settlement process to lower costs;
- ? Elimination of moving parts in fare boxes to increase reliability and maintainability; and,
- ? Creation of multimodal and multi-provider transportation networks that are seamless for the rider but operationally and organizationally sound for the multiple modes and providers.

A number of these have been adopted by North American transit systems in their quest for greater efficiency and operational effectiveness in their fare payment systems. In general, each of these advances is only one part of a transit operator's overall fare payment system, and each one can be employed as part of more than one overall systems approach.

Typically, within the Corridor, each transit agency deals only with its own fare media. There are, of course, exceptions, including fare collection and transfer policies of Metrolink, LADOT, MTA and others. Many of the transit agencies support the concept of a uniform stored value card. However, some of the issues regarding such a concept present challenges to implementation, including: procurement, start-up costs, clearinghouse arrangements and management, among others.

Several agencies are currently involved in a smart card demonstration program, testing contactless radio frequency (“proximity”), stored value debit and monthly pass cards. The card readers provide passenger counts by route, time of day and stop. Smart card technology establishes electronic records of initial and subsequent boardings made by the same card, making linked trip data available for the first time for planning and marketing purposes. There appears to be support for the concept of a single medium for paying regional travel fares and reducing the necessity for customers and public agencies to handle money.

Radio frequency cards could be an effective strategy for public transit to assist with increasing overall regional coordination. Magnetic stripe technology is becoming obsolete because of its low data-handling capacity and higher exposure to fraud. (While increased encryption is available, it is possible to fraudulently create new cards or add value to existing cards.) The presence of moving parts in the read/write unit also makes readability a problem on the bus, where re-swiping is sometimes required, slowing down the boarding process. Radio frequency cards are still fairly new to transit, however. And many transit agencies are reluctant to pay for the higher priced RF cards. Costs for the cards continue to decline, with analysts expecting them to fall to about $3 per card in the next year or two, and possibly at or near the $1 target price for transit agencies.

RF technology is also an improvement over magnetic stripe cards because of the following:

- Cards can be read while safely in a wallet or purse;
- RF cards can handle zone fares by deducting the maximum fare at entry and deducting the appropriate increments when riders wave the card again before exiting;
- RF cards can manage more complex fare and transfer tables (as opposed to swipe cards whose data-storage and handling are much more limited);
- Having stored value, RF cards can assist less-frequent riders whose purchase of monthly passes would not make sense financially;
- RF cards can be used by persons to pay tolls and parking fees; and,
- With RF cards, it is possible to create an open system with non-transportation providers issuing and accepting cards (such as fast food restaurants and gasoline stations), thus sharing the costs with others.

Transit Priority

Traffic signal priority and preemption are signal system related control strategies. Traditionally, preemption results in signal indications that provide or extend a clear path (i.e., green indication) for emergency vehicles, thereby enforcing the clearance of cross street traffic from the vehicle's path.

Signal priority may be applied to bus operations to reduce transit delays. A successful transit priority implementation requires development of control strategies that satisfy all constituents that desire service at the signalized intersection. Transit priority may have negative impacts on the overall efficiency of a roadway system. Control strategies to implement traffic signal priority can vary widely and can be implemented from intersection to intersection, thus allowing agencies with overlapping transit service to select a control strategy which best suits their operating policies.

High Occupancy Vehicle Facility Monitoring

HOV lanes on access controlled roadways have proven to be popular because of their potential to provide faster travel times to and from the central areas of cities. Due to the travel time advantage that HOV lanes offer, some drivers will use these lanes with less than the minimum number of passengers allowed. In order for these lanes to serve the intended purpose of increasing carpooling, vanpooling, and bus transit usage, violators of the minimum passenger requirement must be deterred. A number of enforcement approaches have been tried. These have included motorists reporting of violators, remote apprehension, use of trained individuals rather than enforcement officers for violation detection, and stationing enforcement officers at the entrance to or somewhere along the lane. The last approach is the most effective method but it is costly as well as a potential safety hazard. This has led some agencies to look for a technological solution to the problem.

A number of automated methods of vehicle occupancy detection have been considered, and a few have been the subject of limited testing. Potential technologies include video cameras, transponders, near infrared, millimeter wave, and thermal infrared. Except for transponders, all would have to be complemented with image processing and pattern recognition in order to have a completely functional and automated process. They also have definite technological limitations, including difficulty in detecting small children or passengers lying down.

Presently, transponders appear to be the only technology that can be readily implemented. However, the potential for fraudulent use of HOV lanes with transponders makes this approach suspect. Other technologies, if adequately funded for research and development, seem at least a year away from a deployment stage. The accuracy of passenger identification is the critical element. It must be very high in order for any of these approaches to be selected for implementation.

Table 6-10 presents a summary of trade-off analysis for the Traffic Control Technologies.

Table 6-10
Summary of Trade-off Analysis for Control Strategy Technologies

Technology	*Feasibility*	*Reliability*	*Initial Cost*	*Operating Cost*	*Maintenance*
Ramp-to-Ramp Metering	High	High	Moderate	Moderate	Moderate
Freeway-to-Freeway Metering	Low	Moderate	Moderate	Moderate	Moderate
HOV By-Pass Metering	Moderate	High	Moderate	Moderate	Moderate
Mainline Metering	Low	Moderate	Moderate	Moderate	Moderate
UTCS Generation Traffic Signal Systems	High	High	Moderate	Moderate	Moderate
Advanced Traffic Signal Control Strategies	Low	High	Moderate	Moderate	Moderate
Lane-use Control Signals	High	High	Low	Low	Low
Variable Speed Limit Control	Low	Moderate	Low	Low	Low
Electronic Toll Collection (ETC)	High	High	Moderate	High	High
ETC/Parking Systems	Moderate	High	Low	High	High
Congestion Pricing	Low	Moderate	Low	High	High
Incident Management	High	Moderate	High	High	High
Downtown Parking Advisories	Low	Moderate	Low	Low	Low
Paratransit/Mobility Manager Systems	High	High	Moderate	Moderate	Moderate
Computer Aided Dispatch Systems	High	High	Moderate	Moderate	Moderate
Display Monitors	Moderate	High	Low	Low	Low
Public Announcement Systems	High	High	Low	Low	Low
Fare Payment – Magnetic Stripe Cards	High	High	High	Low	Low
Fare Payment - Smart Cards	High	High	High	Low	Low
Fare Payment – Proximity Cards	Moderate	High	High	Low	Low
Fare Payment – Capacitively Coupled Cards	Moderate	High	High	Low	Low
Fare Payment - Transit Passes	Moderate	High	High	Low	Low
Fare Payment – Stored Value Cards	Moderate	High	High	Low	Low
Fare Payment – Passenger Accounts	Moderate	High	High	Low	Low
Fare Payment – Multi-use Coin Purses	Moderate	High	High	Low	Low
Fare Payment - Cashless Purchase	Moderate	High	High	Low	Low
Transit Priority Systems	Moderate	Moderate	Moderate	Low	Low
HOV Facility Monitoring	Moderate	High	Moderate	Low	Low
Real-time Ridesharing	Moderate	Moderate	Moderate	Moderate	Moderate

Communications

The communications function provides for the transmission of all information, data, video and voice, between the various elements within the ITS infrastructure, and between vehicles and the system infrastructure. Communications to and from vehicles have been addressed in previous sections (e.g., AVL, AVI, navigation/guidance). This section focuses on technologies that may be utilized to connect field components (e.g., detectors, CCTV, AVI readers, VMS, signals, ramp meters) and vehicles with the system control center, and provide interties between control centers.

The communications network is an integral part of the total ITS design affecting (and being affected by) system architecture, configuration, and the operational strategies. The communications network, containing some of the most complex and advanced technology deployed in the system, is probably the costliest element of an ITS-based system. The operational requirements of an ITS-based communications network include:

- Concealed Network Operation - Though the operation of any large network is necessarily complex, it must appear simple to the system users who primarily will be engaged in non-network tasks;
- Support of a Wide Range of Uses - The ITS communications network will likely have requirements to support voice, data, data networks, images, and video channels, each with separate requirements;
- Support of a Wide Range of Topologies - The network topology is determined by the need for field equipment at particular locations; therefore, there will be few common distances between nodes;
- Use of Communications Standards - Standards are critical to diverse equipment use of the network and to future enhancements and migration;
- High Availability - The requirement is for a continually operating system with a very low probability of system failure and equipment failures;
- Maintainability - The ability to maintain the system must be in line with reasonable agency staffing and resources;
- Network Modularity - The communications system must allow for a phased implementation and asymmetrical growth; and,
- Future Enhancement Capability - The network will need to handle equipment and messages yet unplanned for. Therefore, the network's standards and protocols must have a high expectation of meeting the interface and protocol requirements of these future enhancements.

Media technologies can be categorized into one of two types -- land line technology and wireless technology.

Land Line Technologies

Fiber optics, leased telephone, twisted pair cable, and coaxial cable land line technologies are discussed in further detail in this section.

Fiber Optics

Light represents a form of electromagnetic energy similar to radio waves, but at a much higher frequency. The optical fiber confines the path of the electromagnetic energy (i.e., light) as it travels along the fiber. This path may be classified in one of two modes; single mode and multimode. In general, single mode fiber supports wider bandwidth and has lower attenuation than multimode fibers, thereby allowing longer cable runs without signal regeneration. For example, a single mode fiber operating at 1310-1550 manometer wavelength can provide optical spans of up to 50 miles without repeaters.

Fiber optic cable has numerous advantages when considered for a communications network, including large bandwidth, immunity to electromagnetic and RF interference, a small flexible lightweight cable, and the capability to transmit data, voice, and video. The electronic equipment required (e.g., multiplexers, video transceivers) is commonly available in a robust market with a good future. The SONET standards, which define transmission capacity, optical interconnects, and internal formatted signals, are well established with multiple vendors offering compatible multiplexers and related hardware. Moreover, when installed in a "SONET ring" topology (e.g., fiber trunks installed to create a loop on both sides of the freeway), redundant opposite-direction (or counter-rotating) paths are provided that allow each node to communicate with every other node even when a cable is cut or otherwise disrupted.

Asynchronous Transfer Mode (ATM) is a form of data transmission that allows voice, video and data to be sent along the same network. In the past, voice, video and data were transferred using separate networks. ATM is a cell-based, connection-oriented switching and multiplexing technology designed to be a fast, general purpose transfer mode for multiple services. ATM is asynchronous because cells are not transferred periodically. Cells are given time slots on demand. It offers the advantage of almost unlimited transmission speeds. It is ideal for applications that support bursty traffic including multimedia and video/teleconferencing. As advanced transportation systems become more sophisticated and their data needs increase, ATM is becoming an increasingly attractive option for data transmission.

Leased Telephone

Leased telephone circuits are mostly wire to the end user and possess the flexibility, speed, and bandwidth required for an ITS communications network. A wide variety of circuits are available from the region's telephone companies including:

- Voice-grade data channels providing full-duplex multi-point analog service at 1200 bps. These circuits can be used to provide communications between the operations center and VMS, ramp meters, detector stations; and for camera control. Dial-up voice-grade circuits may also be used for the transmission of slow-scan images.
- Two-way digital data channels transmitting at rates between 2.4 kbps and 56/64 kbps (DS-O). These circuits can be used for low-speed multi-point data channels operating at rates between 2400 and 9600 bps. These circuits can also be used for data trunking in which several low-speed channels are collected at a "hub," multiplexed together in a higher speed trunk, and transmitted to the control center. They may also support digital video transmission with a proprietary 56 kbps CODEC.
- T-1 (DS-1) channels operating at 1.544 Mbps. These circuits might be used for transmitting digitized video or as high-speed data trunks.

- DS-3 links operating at 44,736 Mbps may be used for extending LANs or transmission of studio quality CCTV.

Additional services, such as fractional T-1 and dial-up ISDN, are offered in other areas of the country. Recently, several new services have been developed for high bandwidth requirements. These services, such as Frame Relay (FR) and ATM, are slowly being deployed throughout the country. They do hold promise for applications such as video transmission over networks.

Leased telephone is a very reliable communications solution in that some grid redundancy is incorporated into the carrier's network. One potential advantage over a dedicated fiber network is that maintenance responsibilities are shifted from the transportation agency to the telephone company, although determining who is responsible for a particular failure can be problematic. It also ensures upward compatibility over time as new communications hardware and updated standards are introduced. Leased telephone service can generally be abandoned at any time, thereby providing flexibility to change the communications media should the need or opportunity arises.

The major drawback associated with leased telephone communications is cost, particularly the recurring expenses. These monthly charges vary depending on the telephone company, the type of service provided, and the distance between the end-points of the circuit. Additionally, there is no guarantee that recurring charges will not significantly increase in the future. Several systems have converted from leased telephone to a jurisdiction-owned network because of previous rate increases and the uncertainty of future hikes.

It is possible to reduce these recurring charges. One approach is to enter into a contract with the appropriate telephone company to provide the required services for a predetermined period of time, usually 3 years or greater. Such a long-term commitment by a customer often results in a slight reduction in the monthly charge. This arrangement also protects the agency from rate hikes during the contract period.

Another possible approach is to work out an arrangement with the telephone companies whereby the recurring charges are reduced, with a concomitant increase in the one-time charges. The life-cycle costs for such an arrangement tend to be “financially equivalent” to the standard tariffs. However, the higher up-front costs can be treated as a capital expense for which it may be easier to obtain funding as compared to monthly “operational” charges. The costs might possibly be further reduced by providing highway right-of-way to the carrier, similar to the resource sharing between the Garden State Parkway and AT&T/Bell Atlantic. The value of this right-of-way will vary widely depending on the location and carrier’s right-of-way requirements.

Another potential disadvantage is expressway access. The leasing agency is typically required to provide the telephone company with a conduit between the field cabinet and the nearest telephone facility. Along some segments, this distance may be significant, and could result in an extensive conduit network being installed as part of the ITS implementation.

Switched Multimegabit Data Service (SMDS) is a public, packet switched data service offered by telecommunications carriers to meet evolving wide-area data connectivity needs. It supports a broad spectrum of data applications that increasingly depend on high-speed communications. SMDS extends the performance and efficiencies of Local Area Networks (LANs) over a wide area. Among the benefits of SMDS are:

? Transparent LAN interconnection supporting a number of applications;

? A shared public network;

? A flexible service that allows for easy growth and change to the network;

? Security and high reliability; and,

? Public connectivity.

SMDS is likely to be used by Showcase for its communications needs.

Twisted Pair Cable

Another wire technology, agency-owned twisted pair cable, has been widely used for the low-speed transmission (e.g., 1200-9600 bps) of data especially in traffic signal control systems and between hubs and field elements. This type of technology may also be found in leased telephone lines. In such an application, the network is usually configured with between eight and 16 field drops on each two-pair (four-wire) channel. The exact number of drops depends on the amount of data to be transferred between the central hub and the field locations and the rate of transfer. Twisted-pair cable can support low-speed transmission distances of 6-10 miles before repeaters become necessary. DS-O signals can be transmitted over twisted-pair for distances up to two miles.

Twisted pair cable is a reliable and proven technology. A properly designed and installed twisted-pair communications system features reasonably low maintenance requirements in terms of average time between failures, the average time to repair, and the necessary levels of skill and equipment. Like fiber optics, it does require right-of-way and conduit, the latter often resulting in significant costs.

Coaxial Cable

Coaxial cable is a radio frequency wave-guide designed to carry or channel RF signals for transport between distant sites. The signals are restricted to the wave-guide and are thus prevented from radiating through space and causing interference with other RF transmissions. Radiating coaxial cable, on the other hand, operates as an antenna which radiates low power RF to the immediate surroundings where it is placed, much the same as a perforated, “leaky” garden hose does when spread out on a lawn. This “leaky coax” is able to distribute RF to select locations where localized transmissions are required. Radiating coaxial cable will also serve as a receiver antenna for two-way radio communications.

Two areas for use of radiating coaxial cable in ITS are for maintaining radio communications where normal transmission is impaired, such as in tunnels, and for localized low power operation along right-of -way.

“Leaky coax” is being evaluated as a medium for wireless telephone systems. It is presently installed in some highway tunnels to provide uninterrupted radio reception for travelers.

Wireless Technologies

Spread spectrum radio, microwave, satellite, cellular radio, cellular digital packet data, mobile data, and wireless messaging technologies are discussed in further detail in this section.

Spread Spectrum Radio

The chief advantage of radio-based communications is that no physical connection is required between the transmitter and receiver. This can translate into a significant cost savings over the capital intensive cost of installing a cable conduit network, or the unpredictable ongoing costs for a leased facility. One promising radio alternative is spread-spectrum radio. Spread-spectrum was originally developed for the military to prevent the enemy from jamming or intercepting transmissions. This is accomplished by spreading out the data signal over a wide frequency band, and then reversing the process to recover that data at the receiving end. Spreading the signal out across a wide frequency band reduces the potential for the signal to interfere with other transmissions since the spreading process reduces the power density of the signal at any frequency within the transmission band. Moreover, any noise interfering with a spread-spectrum signal will tend to obscure only a very small fraction of the entire band. Since the signal is divided and spread over the entire spectrum, the transmitted signal can still be reliably reconstructed at the receiver.

Microwave

Microwave frequencies are those frequencies in the range above 1 GHz (gigahertz). The frequencies currently allocated by the Federal Communications Commission (FCC) for private and common carrier use are in the 4, 6, 10, 11, 12, 13 18, 23, and 28 GHz bands, with the lower GHz channels (2-12) being used for long-haul transmissions.

Microwave signals radiated from an antenna propagate through space along a line-of-sight path. The frequencies used must be unique to that area to prevent interference from other microwave transmissions. Because of this constraint, microwave frequencies are licensed by the FCC. Therefore, it can be very difficult to obtain a microwave frequency allocation in crowded urban areas. When frequencies are available, they are usually in the higher frequency bands (18 and 23 GHz) which have reduced transmission distances. Additionally, if two-way transmission links are required, two different transmit/receive frequencies are required.

Microwave communication provides an alternative to leased line and fiber optic point-to-point backbones, offering high data transmission capacity and the capability to transmit video. In areas where conduit is expensive or impossible to install and a connection to a leased line is not practical, microwave should be considered. To obtain a microwave license, a "path search" is required. The search will determine if line-of-sight is available, what antenna heights are required, and what frequencies can be used. This search is an additional up front expense to be considered when choosing microwave radio.

Satellite

Satellite is similar to terrestrial microwave in that it uses some of the same frequencies for transmission through space. With satellite, however, instead of using a line-of-sight transmission path, the signal is directed at a transponder located on the satellite. Satellite service has been available for many years for voice, data and video transmissions. Very Small Aperture Terminal (VSAT) satellite systems are a part of a mature, robust satellite industry that has a good record for availability and reliability. VSAT systems operate within the KU-band, with the uplink (i.e., transmissions from the earth to the satellite) using 14 GHz, and the downlink (i.e., transmissions from the satellite to the earth) using 12 GHz. The satellites themselves are in a geosynchronous orbit above the Earth's equator, thereby appearing stationary in the sky and providing 24-hour a day coverage. These high-altitude satellites also avoid various earth-level interferences.

Cellular Radio

Cellular radio is a technique for frequency reuse in a large radio communications system. It is primarily used for mobile telephone networks. It gets its name from an area being divided into cells that are two to 20 miles in diameter. In the center of each cell is a control radio that bundles the network management functions, including the assignment of frequency sub-channels. A radio requests a frequency over a control channel and one is assigned by the cellular control system. The cellular layout allows frequencies to be reused in non-adjacent cells.

Due to the demand for car telephones, a second generation of systems is emerging that will be characterized by digital speed transmission and enhanced network control. The new system will provide greater bandwidth and frequency reuse capability. In North America, standard IS-54 has been written to govern digital cellular. This standard specifies that a time-division multiple access (TDMA) scheme be used to split the bandwidth of each of the existing cellular channels into three channels. Each channel would then carry compressed digitized voice. Though the initial standard did not address data transmission, the latest revision does.

Recent advances in an alternate technology, code division multiple access (CDMA), have stalled the acceptance of IS-54 and the changeover to digital cellular. CDMA is a spread-spectrum technique distributing the signal over a range of frequencies. The governing standard for cellular systems using CDMA is IS-95. In the interim, an alternate technology, cellular digital packet data (CDPD), that permits the transmission of data over the existing cellular network, is being introduced by McCaw, IBM, and several other companies. In CDPD, data is formed into packets which are transmitted at a data rate of 19.2 kb/s over idle voice channels.

With the new networks likely having the same or similar rate structure, cellular radio would be economically unsuitable for constant connections with fixed (as opposed to mobile) devices such as ramp meters and detectors. On the other hand, devices such as VMS and HAR, where communications are needed only on an as-needed basis, may be suited to cellular radio.

Table 6-11 presents a summary of trade-off analysis for the Communication Technologies.

Table 6-11
Summary of Trade-off Analysis for Communications Technologies

Technology	Feasibility	Reliability	Initial Cost	Operating Costs	Maintainability
Fiber Optics	Moderate	High	High	Low	Moderate
Leased Line	Low	Moderate	Low	High	High
Twisted Pair	Moderate	Low	Low	High	Low
Coaxial Cable	Moderate	Low	Moderate	Moderate	Low
Spread Spectrum Radio	Low	Low	Low	Moderate	Low
Microwave Radio	Low	Low	High	High	Low

Satellite	Low	Moderate	High	Moderate	Low
Cellular Radio	Moderate	Moderate	Low	Low	Moderate

6.5 DETAILED TECHNOLOGY EVALUATION

After the initial evaluation of ITS technologies, the Corridor team decided that all technologies could feasibly be implemented within the next 20 years. However, technologies to be used for early deployment projects still needed to be determined. Consequently, a detailed evaluation of the technologies for these projects was performed using the following criteria:

- System performance: The known operating accuracy and longevity of the system;
- Reliability of technology: The level of accuracy of the data collected using the particular technology;
- Maintainability: This involves the ease or difficulty of providing routine maintenance;
- Compatibility with existing and proposed systems: The ability to use with existing systems;
- Compatibility with proposed architecture: The ability to use within the architecture;
- Expandability: The ability to increase the coverage area or uses of the technology;
- Enhanceability: The ability to upgrade the technology with minimal detrimental affects;
- Flexibility: The adaptive nature of the technology;
- Environmental considerations: The impact on the environment due to implementation and operation;
- Human factors potential impact: The affect on the user of the technology;
- Operability: The ease of use of the technology from a system operator's perspective; and,
- Life-cycle costs: The cost of the technology from implementation to termination of use.

Technologies were rated for each of the above categories with a value of low moderate, or high. Tables 6-12 through 6-15 summarize the results of the evaluation and are provided next.

Table 6-12
Summary Of Detailed Trade-Off Analysis For Surveillance Technologies

Technology	System Performance	Reliability	Maintain-ability	Compatibility E/P Systems	Compatibility Prop. Arch	Expand-ability
Inductance Loop	High	High	High	High	High	Moderate
Magnetometer	High	High	High	Moderate	Moderate	Moderate
SVPD	High	High	High	Moderate	Moderate	Moderate
Piezo-electric film	High	High	High	Moderate	Moderate	Moderate
Laser	Moderate	High	High	Moderate	Moderate	Moderate
Ultrasonic	Moderate	Moderate	High	Moderate	Moderate	Moderate
Passive Infrared	Moderate	Moderate	High	Moderate	Moderate	Moderate
Active Infrared	Moderate	Moderate	High	Moderate	Moderate	Moderate
Microwave Doppler Detector	High	High	High	Moderate	Moderate	Moderate
Microwave Radar Detector	High	High	High	High	High	Moderate
Passive Acoustic Detector	High	High	High	Moderate	Moderate	Moderate
Video Tracking Systems	Moderate	Moderate	High	Moderate	Moderate	High
Video Image Processing	Moderate	Moderate	High	Moderate	High	High
Toll Tags	Moderate	High	Low	High	High	High
Signpost Technology	Moderate	High	Moderate	Moderate	Moderate	Moderate
Loran-C Technology	Moderate	High	Moderate	Moderate	Moderate	Moderate
Radio Multi-Laceration Technology	Moderate	High	Moderate	Moderate	Moderate	Moderate
Differential GPS Technology	High	High	Low	Moderate	Moderate	High
Dead Reckoning Technology	Moderate	Moderate	High	Moderate	Moderate	Moderate
AVI Technology	High	High	Low	High	High	High
Video Cameras	High	High	Moderate	High	High	High
Cellular Phones	Low	Moderate	Low	Low	Low	Moderate
Silent Alarms	Moderate	High	Low	Moderate	High	Moderate
Detectable Warning Systems	Moderate	Moderate	Moderate	Moderate	High	Moderate
Vehicle Monitoring Systems	High	High	Moderate	Moderate	High	Moderate
Side-Door Monitoring Systems	Moderate	High	Moderate	Moderate	High	Moderate
Collision Avoidance	Moderate	Moderate	High	Moderate	High	Moderate
Automatic Passenger Counter	Moderate	Moderate	Moderate	High	High	Moderate
Surface Sensors	Moderate	High	Moderate	High	High	Moderate
Sub-surface Sensors	High	High	High	High	High	Moderate

Table 6-12 (Continued)
Summary Of Detailed Trade-Off Analysis For Surveillance Technologies

Technology	***Enhance-ability***	***Flexibility***	***Environ-ment***	***Human Factors***	***Operability***	***Life-Cycle Costs***
Inductance Loop	Low	Low	Moderate	Low	High	Moderate
Magnetometer	Low	Low	Moderate	Low	High	Moderate
SVPD	Low	Low	Moderate	Low	Moderate	Moderate
Piezo-electric film	Low	Low	Moderate	Low	Low	Moderate
Laser	Moderate	Moderate	Low	Low	Moderate	Moderate
Ultrasonic	Moderate	Moderate	Low	Low	Moderate	Moderate
Passive Infrared	Moderate	Moderate	Low	Low	Moderate	Moderate
Active Infrared	Moderate	Moderate	Low	Low	Moderate	Moderate
Microwave Doppler Detector	Moderate	Moderate	Low	Low	Moderate	Moderate
Microwave Radar Detector	Moderate	Moderate	Low	Low	High	Moderate
Passive Acoustic Detector	Moderate	Moderate	Low	Low	Moderate	Moderate
Video Tracking Systems	Moderate	Moderate	Low	Moderate	Moderate	Moderate
Video Image Processing	Moderate	High	Low	Moderate	Moderate	Moderate
Toll Tags	High	Moderate	Low	High	High	Low
Signpost Technology	Moderate	Low	Low	Low	Moderate	Moderate
Loran-C Technology	Moderate	Moderate	Low	Low	Moderate	Moderate
Radio Multi-Laceration Technology	Moderate	Moderate	Low	Low	Moderate	Moderate
Differential GPS Technology	High	High	Low	Low	Moderate	High
Dead Reckoning Technology	Moderate	Moderate	Low	Low	Moderate	High
AVI Technology	High	High	Low	Moderate	High	High
Video Cameras	High	High	Low	High	High	Moderate
Cellular Phones	Low	Moderate	Low	High	Moderate	Moderate
Silent Alarms	High	High	Low	Low	High	Moderate
Detectable Warning Systems	High	Moderate	Low	Moderate	Moderate	Moderate
Vehicle Monitoring Systems	High	Moderate	Low	Moderate	High	High
Side-Door Monitoring Systems	High	Moderate	Low	Moderate	Moderate	High
Collision Avoidance	High	Moderate	Low	Moderate	Moderate	High
Automatic Passenger Counter	Moderate	Low	Low	High	High	High
Surface Sensors	Moderate	Low	Moderate	Low	High	Moderate
Sub-surface Sensors	Moderate	Low	Moderate	Low	High	Moderate

Table 6-13
Summary Of Detailed Trade-Off Analysis For Traveler Information

Technology	*System Performance*	*Reliability*	*Maintain-ability*	*Compatibility E/P Systems*	*Compatibility Prop. Arch*	*Expand-ability*
Internet	High	High	Low	High	High	High
Electronic Bulletin Board Services	Moderate	High	Low	High	High	High
Videotex	Moderate	High	Low	Moderate	High	High
Audiotex	Moderate	High	Low	Moderate	High	High
Travelers Advisory Telephone	High	High	High	High	High	High
Automated Trip Planning Services	High	High	High	High	High	High
Television Media	High	High	Low	High	High	High
Teletext	Moderate	High	Low	Moderate	High	High
Television Monitors	High	High	Low	High	High	High
Cable Television	High	High	Low	High	High	High
Interactive Television	Moderate	High	Low	Low	High	High
Variable Message Signs	High	High	Moderate	High	High	High
Highway Advisory Radio	High	High	Low	High	High	High
Mayday Calling Systems	High	High	Low	Low	High	High
Active Warning Systems	Moderate	High	Low	Low	High	High
Route Guidance Systems	High	High	Low	Low	High	High
Radio Data Systems	High	High	Low	Low	High	High
AM Radio	Moderate	High	Low	Moderate	High	High
Message Boards	Moderate	High	Low	High	High	High
Automated Annunciation Systems	High	High	Low	Moderate	High	High
Kiosks	High	High	Low	High	High	High
Display Monitors	High	High	Low	High	High	High
Public Announcement Systems	High	High	Low	Moderate	High	High
Personal Communications Devices	High	High	Low	Low	High	High
FM Subcarrier	High	High	Low	Moderate	High	High
Telephone	High	High	Low	High	High	High

Table 6-13 (Continued)
Summary Of Detailed Trade-Off Analysis For Traveler Information

Technology	Enhance-ability	Flexibility	Environ-ment	Human Factors	Operability	Life-Cycle Costs
Internet	High	High	Low	High	High	Low
Electronic Bulletin Board Services	Moderate	High	Low	High	Moderate	Moderate
Videotex	Moderate	Moderate	Low	High	Moderate	Moderate
Audiotex	Moderate	Moderate	Low	High	Moderate	Moderate
Travelers Advisory Telephone	Moderate	Moderate	Low	High	High	High
Automated Trip Planning Services	High	High	Low	High	High	High
Television Media	Low	Moderate	Low	High	High	High
Teletext	Moderate	Moderate	Low	High	Moderate	High
Television Monitors	Low	Low	Low	High	High	High
Cable Television	Low	Moderate	Low	High	High	High
Interactive Television	High	High	Low	High	Moderate	High
Variable Message Signs	Moderate	Moderate	Moderate	High	High	High
Highway Advisory Radio	Moderate	High	Moderate	High	High	Low
Mayday Calling Systems	High	Moderate	Low	High	Moderate	Low
Active Warning Systems	High	Moderate	Low	High	Moderate	Low
Route Guidance Systems	High	High	Low	High	Moderate	Moderate
Radio Data Systems	High	High	Low	High	Moderate	Low
AM Radio	Low	Low	Low	Low	Moderate	Low
Message Boards	Low	Low	Moderate	Moderate	High	Low
Automated Annunciation Systems	High	High	Low	High	High	Moderate
Kiosks	High	High	Low	High	Moderate	Low
Display Monitors	Moderate	Moderate	Low	High	Moderate	Low
Public Announcement Systems	High	High	Low	High	High	Low
Personal Communications Devices	High	High	Low	High	Moderate	Low
FM Subcarrier	Moderate	Low	Low	Low	High	Low
Telephone	Low	Low	Low	High	High	Low

Table 6-14
Summary Of Detailed Trade-Off Analysis For Control Strategies

Technology	System Performance	Reliability	Maintain-ability	Compatibility E/P Systems	Compatibility Prop. Arch	Expand-ability
Ramp-to-Ramp Metering	High	High	Moderate	High	High	High
Freeway-to-Freeway Metering	Moderate	Moderate	Moderate	High	High	High
HOV By-Pass Metering	High	High	Moderate	High	High	High
Mainline Metering	Moderate	Moderate	Moderate	Moderate	High	High
UTCS Generation Traffic Signal Systems	High	High	Moderate	High	High	High
Advanced Traffic Signal Control Strategies	High	High	Moderate	High	High	High
Lane-use Control Signals	High	High	Low	High	High	High
Variable Speed Limit Control	Moderate	Moderate	Low	High	High	High
Electronic Toll Collection (ETC)	High	High	High	High	High	High
ETC/Parking Systems	High	High	High	High	High	High
Congestion Pricing	Moderate	Moderate	High	High	High	High
Incident Management	High	Moderate	High	High	High	High
Downtown Parking Advisories	High	Moderate	Low	High	High	High
Paratransit/Mobility Manager Systems	High	High	Moderate	High	High	High
Computer Aided Dispatch Systems	High	High	Moderate	High	High	High
Display Monitors	High	High	Low	High	High	High
Public Announcement Systems	High	High	Low	High	High	High
Fare Payment – Magnetic Stripe Cards	High	High	Low	High	High	Moderate
Fare Payment - Smart Cards	High	High	Low	Moderate	Moderate	High
Fare Payment – Proximity Cards	High	High	Low	Moderate	Moderate	High
Fare Payment – Capacitively Coupled Cards	High	High	Low	Low	Low	High
Fare Payment - Transit Passes	High	High	Low	High	High	Moderate
Fare Payment – Stored Value Cards	High	High	Low	High	High	High
Fare Payment - Passenger Accounts	High	High	Low	High	High	High
Fare Payment – Multi-use Coin Purses	High	High	Low	High	High	Moderate
Fare Payment - Cashless Purchase	High	High	Low	High	High	High

Table 6-14 (Continued)
Summary Of Detailed Trade-Off Analysis For Control Strategies

Technology	Enhance-ability	Flexibility	Environ-ment	Human Factors	Operability	Life-Cycle Costs
Transit Priority Systems	Moderate	Moderate	Low	Moderate	High	Moderate
HOV Facility Monitoring	High	High	Low	High	High	High
Real-time Ridesharing	Moderate	Moderate	Moderate	Moderate	High	Moderate
Ramp-to-Ramp Metering	High	Moderate	Moderate	High	High	Moderate
Freeway-to-Freeway Metering	High	Moderate	Moderate	High	High	Moderate
HOV By-Pass Metering	High	Moderate	Moderate	High	High	Moderate
Mainline Metering	High	Moderate	Moderate	High	High	Moderate
UTCS Generation Traffic Signal Systems	Moderate	Moderate	Low	Moderate	High	Moderate
Advanced Traffic Signal Control Strategies	High	High	Low	Moderate	High	Moderate
Lane-use Control Signals	Moderate	High	Moderate	High	High	Low
Variable Speed Limit Control	High	High	Moderate	High	High	Low
Electronic Toll Collection (ETC)	High	High	Low	High	High	High
ETC/Parking Systems	High	High	Low	High	High	Moderate
Congestion Pricing	High	High	Low	High	Moderate	Moderate
Incident Management	High	High	Low	Moderate	High	High
Downtown Parking Advisories	High	High	Low	High	High	Low
Paratransit/Mobility Manager Systems	High	High	Low	Moderate	High	Moderate
Computer Aided Dispatch Systems	High	High	Low	Moderate	High	Moderate
Display Monitors	Moderate	High	Low	Moderate	High	Low
Public Announcement Systems	High	High	Low	High	High	Low
Fare Payment – Magnetic Stripe Cards	Moderate	Moderate	Low	High	Moderate	Moderate
Fare Payment - Smart Cards	High	High	Low	High	High	Moderate
Fare Payment – Proximity Cards	High	High	Low	High	High	Moderate
Fare Payment – Capacitively Coupled Cards	High	High	Low	High	High	Moderate
Fare Payment - Transit Passes	Moderate	Moderate	Low	High	High	Moderate
Fare Payment – Stored Value Cards	High	Moderate	Low	High	High	Moderate
Fare Payment - Passenger Accounts	High	High	Low	High	High	Moderate
Fare Payment – Multi-use Coin Purses	Moderate	Moderate	Low	High	High	Moderate
Fare Payment - Cashless Purchase	High	High	Low	High	High	Moderate
Transit Priority Systems	High	Moderate	Moderate	High	Moderate	Low
HOV Facility Monitoring	High	Moderate	Low	High	High	Low
Real-time Ridesharing	High	Moderate	Low	High	Moderate	Moderate

Table 6-15
Summary Of Detailed Trade-Off Analysis For Communications

Technology	System Performance	Reliability	Maintain-ability	Compatibility E/P Systems	Compatibility Prop. Arch	Expand -ability
Fiber Optics	High	High	Moderate	Moderate	High	High
Leased Line	Moderate	Moderate	High	Moderate	Moderate	Low
Twisted Pair	Moderate	Low	Low	Low	Moderate	Low
Coaxial Cable	Low	Low	Low	Low	Low	Low
Spread Spectrum Radio	Moderate	Low	Low	Moderate	Moderate	Moderate
Microwave Radio	Moderate	Low	Low	Low	Low	Low
Satellite	Moderate	Moderate	Low	Moderate	Moderate	High
Cellular Radio	Low	Moderate	High	Moderate	Moderate	Low

Life-Cycle Costs

The cost to design, implement, operate, and maintain each technology forms the life-cycle cost of the technology. Life-cycle costs are used to promote technologies that may be more expensive to implement at first, but over the long run will be more beneficial in terms of reduced maintenance and operating costs.

Surveillance

Surveillance detectors for measuring highway traffic tend to have moderate life-cycle costs with the overhead and side-fire mounted detectors tending to have higher initial costs, but lower maintenance and operations costs as compared to in-pavement detectors.

Automatic vehicle location systems tend to have higher life-cycle costs, as the equipment is expensive to purchase and then to operate and maintain.

Traveler Information

The Internet will have a low life-cycle cost as it is easy to maintain and enhance and relatively inexpensive to implement. Devices requiring outside parties or leased communications such as telephone systems and interactive television will require higher life-cycle costs. Also, technologies that require integration with the road network such as VMS will have higher life-cycle costs.

Control Strategies

The life-cycle cost of control strategies greatly depends on the complexity of the system. Signal systems including ramp metering and transit priority systems have moderate to low life-cycle costs. Incident management and electronic toll collection systems have higher life-cycle costs.

Communications

Fiber optic cable will tend to be the most expensive land-line communication media to implement and operate. Wireless technologies tend to be more expensive, less reliable and harder to maintain. Subsequently, the life-cycle cost for wireless technologies are rather high.

Recommended Technologies for Early Deployment

Based on the needs of the Corridor and the detailed evaluation of the available technologies, several technologies are recommended for early deployment. These technologies provide benefits both locally and regionally and can easily integrate within the existing systems and the recommended architecture.

Surveillance

Several regional and Corridorwide projects are recommended to increase the surveillance on major highways within the Corridor. CCTV cameras are the most flexible and widely used devices for overall surveillance. CCTV cameras can be used for incident management, HOV lane management and traveler information systems.

With the increase in toll facilities in the region, incident management using vehicle probes based on automatic vehicle identification will be beneficial. Motorists with toll tags often used both toll facilities and other non-toll facilities. Studies have shown that as little as 5% penetration of probe vehicles can provide accurate travel time information for incident management purposes. Toll tags also have other potential uses, such as parking management applications.

Traveler Information

An Internet site should be established to provide traveler information regarding the PCN. Internet sites have a low life-cycle cost, are flexible, easy to enhance and fit within the recommended architecture. Internet sites are being implemented throughout the country to provide travelers with access to information from their home or work. The sites can provide general overview information about the region, or specific information in a certain area using links to the TravelTip project, or other Internet sites within the region. CCTV images can be placed on the Internet as well as transit schedule information and real-time AVL information.

Additional VMS and HAR stations should be installed throughout the region. Information can be provided both locally and regionally on HAR stations. VMS placed at major decision points will help motorists choose the quickest route to their destination. VMS can also be linked to ramp metering systems to control traffic on facilities with ramp meters.

Control Strategies

Continued implementation of ramp metering, advanced signal timing, incident management, and transit CAD/AVL systems is recommended. Integration of theses systems with traveler information devices will help provide the public with additional information, while improving system capacity, vehicle speeds, and air pollution.

Communications

The implementation of communication media will be based on the overall requirements of the Corridor. No single communications technology should be considered as a panacea for the myriad of requirements demanded by a modern ITS architecture. Twisted pair cable, for example, serves well in a local distribution environment where distances are relatively short. When the copper cable length exceeds attenuation limits, however, then a trade off with fiber optic (FO) cable or wireless systems should be evaluated in terms of cost of terminating equipment versus line amplification of the TWP. Potential future bandwidth requirements of the local facilities should also be considered when selecting the communication medium.

In general, the best communications technology application is intimately related to the specific requirements dictated by the devices to be connected to a distant location. For example, an informed decision on backbone architecture cannot be made until immediate and future device types and their distribution are determined. A mix of FO, leased lines, and wireless can become the composite backbone after all immediate and estimated future system elements for the design period are taken into account.

Future system expansion is a key element in the definition of a cost efficient long term ITS architecture. Investment in a communications system accommodating the entire spectrum of possible expansions is imprudent. A balance must be struck to provide for immediate needs, while allowing for expansion in a timely manner, so that the future can be served when that time arrives.

Some of the advantages and disadvantages for the available technologies are listed in the following table.

Table 6-16
Communication Implementation Issues

Technology	*Advantages*	*Disadvantages*
Fiber Optics	High bandwidth capability Low failure rate; High RAM Ideal for long & short haul transmission Impervious to EMI Well developed standards for vendor interoperability	High initial construction cost
Leased Line Service	Low embedded (up front) costs Limit costs by cancellation of lease agreement No long term capital commitment Most maintenance costs are included with the lease	High life cycle costs with possible increases Bandwidth limited to only the type of service leased Maintenance in contention with other customers Limited control over system configuring & management
Twisted Pair cable	Proven reliability for short haul & low bandwidth reqs. Simple circuit design	Bandwidth & distance limit Needs conduit support system Not recommended for high volume backbone
Coaxial Cable	For CCTV, Networks, & other high bandwidth uses	Limited adaptability Prone to lightning damage
Spread Spectrum Radio	For LOS low power uses Limited infrastructure reqd. Useful where there is no easy access to roadside devices	Not recommended for long distance & multiplexing channels
Microwave Radio	For long haul high volume transmission with few drop off points Compatible with digital backbone systems (e.g. FO)	Towers may present EPA issues FCC approval required High construction cost
Satellite	Ubiquitous access within footprint of satellite VSAT has low bandwidth application	Dishes may present EPA issues Transponder lease may be cost prohibitive
Cellular Radio	Useful for intermittent, on demand communications Limited infrastructure reqd.	High cost for point-to-point dedicated service Must be leased from a network service provider

Chapter 7, System Architecture, will provide a high level framework for integrated ITS implementation throughout the Corridor.

CHAPTER 7

System Architecture

Introduction
Architecture Considerations
Architecture Definitions
System Integration
Architecture Summary

CHAPTER 7.0
SYSTEM ARCHITECTURE

7.1 INTRODUCTION

In the context of ITS, an "architecture" describes what a system does and how it does it. Providing the general framework within which the various system components are deployed it identifies the processes to be performed by the system, allocates these processes to subsystems, and defines the flows of information and the interfaces between the subsystems and components.

Multiple strata or layers of architecture exist within an ITS network. Each of the individual system elements -- be they hardware devices (e.g., detectors, processing cabinet, VMS) or software programs (e.g., incident detection algorithm, transit schedule monitoring, expert system) -- possess their own architecture. These elements are combined into subsystems as required to perform a variety of ITS processes (e.g., incident detection and response, traveler information, transit fleet management), with the communications and interface between the various elements defined as part of the subsystem architectures. Complete ITS-based systems are formed by combining subsystems.

In an area such as Southern California, where the massive roadway network is managed and operated by several different entities with additional agencies responsible for transit and enforcement, a Corridor architecture, which identifies the various transportation management systems and the linkages between these systems, is necessary to provide a "seamless" transportation network from the perspective of the traveler. The Corridor architecture will electronically link and integrate most transportation systems in Southern California. There are four important pieces that will make up the Corridor architecture:

- Existing systems
- Showcase Architecture
- Regional Architectures
- Commercial Vehicle/International Border Operations System (CVIBOS)

Existing systems are integrated into the Corridor architecture. The open architecture framework provides a “seed/kernel” approach (described below) which allows existing infrastructure to easily connect to the Corridor’s information and management network.

Another building block of the architecture is the Showcase architecture, which focuses on the integration of traffic management, emergency management and transit management centers within the Corridor. These four centers are just part of the 19 interconnected subsystems defined by the National ITS Architecture.

Regional architecture development has tended to follow the Showcase architecture approach. To date, nothing in the Corridor architecture is inconsistent with the regional architectures as they currently exist. Thus, these architectures are also accommodated by the Corridor architecture.

The *CVIBOS* architecture, developed as part of the Corridor architecture, integrates the commercial vehicle aspects of the system and also follows the Showcase and Corridor architecture design.

Through the Market Package selection process, the Corridor has identified a need to implement all 56 Market Packages within the next 20 years. Therefore, the evolution of the five-year Showcase architecture will include the remaining subsystems identified in the National ITS Architecture. Consequently, a comprehensive architecture deployment of all ITS applications will exist in Southern California. Figure 7-1 illustrates the subsystems that will be implemented in Southern California.

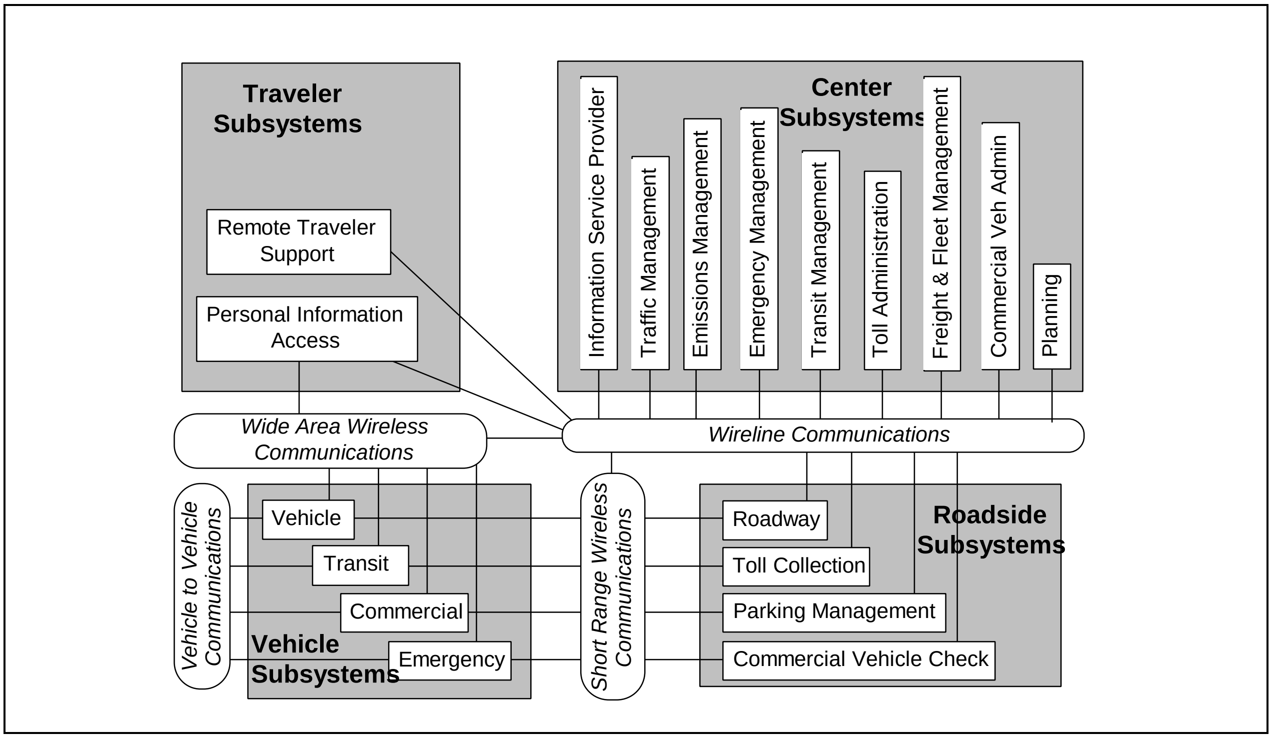

Figure 7-1. Corridor Architecture Subsystems

7.2 ARCHITECTURE CONSIDERATIONS

Defining a Corridorwide ITS architecture requires an understanding of the User Services and processes to be provided by the ITS network, the institutional framework and constraints in which the ITS-based system must exist, technology availability, and the relationship between the public and private sectors. In addition to defining the technical elements of an ITS system, a good architecture must illustrate the institutional relationships required to implement the system. The considerations addressed in defining the architecture are discussed below.

Institutional Framework

An ITS architecture -- particularly at the Corridor level -- must fit within the existing organizational infrastructure. It is unlikely that the various jurisdictions and entities who are involved or affected by ITS will significantly change, other than to build logical extensions to the existing framework. In essence, the architecture must provide for a seamless transportation network while respecting local autonomy -- a win-win solution.

User Services and Market Packages

The development of a Corridorwide ITS architecture is primarily based on the User Services it will provide and the Market Packages needed to provide them. Market Packages (the building blocks of the architecture) that are to be provided in the Corridor were defined in Chapter 6. The architecture will provide the framework upon which these Market Packages are deployed.

Technology Availability and Implementation Phasing

Another issue, which impacts architecture development, is the availability of key enabling technologies within the needed areas. Certain systems strategies and processes (e.g., in-vehicle, real-time routing) require hardware and/or software which is not yet fully developed and tested, and prerequisite information (e.g., real-time surveillance) which is not currently available. Accordingly, the system architecture must be flexible such that these (and other) enabling technologies may be readily incorporated into the ITS network in the future.

An ITS architecture must be "open" to ensure compatibility with existing/proposed systems and with future technologies. Open architectures utilize standards and non-proprietary interface protocols, thereby allowing various (and conceivably dissimilar) systems to interact with one another, and allowing modular replacement and upgrading of system elements and subsystems with minimal impact on other components. Openness allows multiple vendors to supply the same type of element, thereby preventing the operating agency from becoming locked into a single proprietary component. Moreover, standards and protocols typically provide upward compatibility for accommodating new technologies in the future. The architecture is targeted to cover a 20-year time frame.

Public/Private Responsibilities

A key issue in defining and developing ITS-based transportation networks is the concept of public/private partnerships, and the respective roles of each in implementation, operation and maintenance of these systems. To date, nearly all ITS implementations within North America have been based on the philosophy that most, if not all, surveillance, management, and traveler information processes should be provided by government (i.e., the public side). In essence, ITS has been viewed as an advanced technology/electronic extension of the road signs, street lighting, and traffic control operations which are currently being provided by government. Within this context, "public/private" partnerships have involved the public agency hiring a private entity to perform work that cannot be effectively accomplished with in-house staff or resources.

A new role of public/private partnership exists -- one in which the private entity still provides ITS services and/or systems elements; but, instead of direct (and presumably complete) reimbursement from the public agency, some or all of the private entity's costs for these processes are recouped by selling ITS-based services to other private entities (i.e., collecting a user fee), or by receiving a non-monetary consideration for these services from the public agency.

7.3 ARCHITECTURE DEFINITION

A distributed architecture seems most appropriate for the Corridor, based upon an assessment of the Corridor's transportation goals and objectives and the consideration of system constraints and sensitivity issues. The distributed but highly configured concept is used predominantly in Corridor systems, particularly when cooperation exists among local jurisdictions/agencies. This approach allows the autonomy needed for localities to effectively operate their own systems. All command and control processes remain with the individual agencies. Yet, by establishing a Corridorwide information network, this approach also provides the data and information sharing and inter-agency coordination/cooperation processes necessary to meet transportation needs on a Corridorwide basis. The concept also provides a single Corridor interface to encourage the future participation of private ITS service providers and to serve as a contact for external ITS entities.

This approach is consistent with the approach taken by Showcase. The Showcase architecture allows various levels of operations for Corridor. The first four levels were considered consistent with the Corridor's principles, while the last two levels were inconsistent and are not supported by either the Showcase or Corridor architecture. Those levels are:

- Share data/video; single function operations;
- Share data and video; imbed modal and cross-jurisdictional responses
- for major/special events;
- Same as level three but with extensions to provide day to day operations;
- Same as level four but with added redundancies to compensate for failed
- Systems and components;
- Centralize some or all management functions (not supported); and,
- Operate independently (not supported).

As noted in the introduction, an architecture explains how the various ITS systems are to interact with each other, identifies needed interfaces and data sharing requirements, and broadly illustrates institutional relationships. Importantly, it identifies issues to be addressed in the implementation of a Strategic Deployment Plan.

Architectures do not identify specific technologies, define standards, discuss specific design issues or make specific design recommendations. They also do not "solve" institutional or policy issues that must be addressed by stakeholders. But the institutional/organization layer of the architecture does provide a framework for resolving these issues.

The process of developing the architecture has identified a number of policies, institutional, standards and management/control issues, as discussed in Section 2. Finding solutions to these issues requires leadership, commitment and creativity on the part of all stakeholders. If the Corridor vision is to be realized, a more formal structure will be necessary to resolve these issues and to cooperatively plan and manage ITS deployment in the region.

The recommended ITS architecture for the Corridor is presented in this section and conceptualized in Figure 7-2.

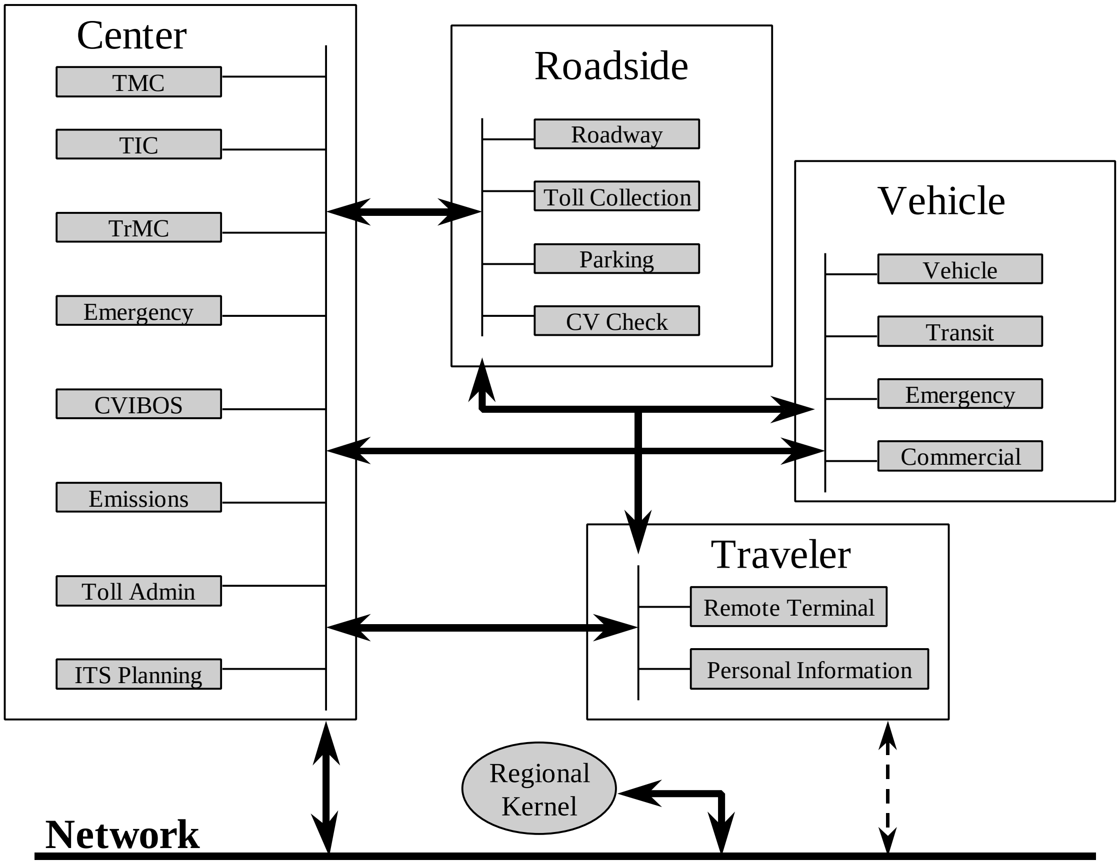

Figure 7-2. Corridor Architecture

The preliminary system architecture involves a three level structure. The upper level consists of the information sharing PCN, the middle level consists of the operations coordination performed for individual regional facilities coordinated largely through the four Caltrans/CHP regional TMCs, and by transit authorities and MPOs, and the third level consists of the individual operating agencies or facilities, which maintain control and management responsibility. The architecture also supports agency-to-agency data sharing independent of the PCN.

The Corridor architecture will be compatible with the proposed Showcase software architecture recommendation – a “Kernel/Seed” concept with distributed objects. Kernels and Seeds are software interfaces that will be developed to integrate existing and future systems. Figure 7-3 illustrates the Kernel and Seed approach.

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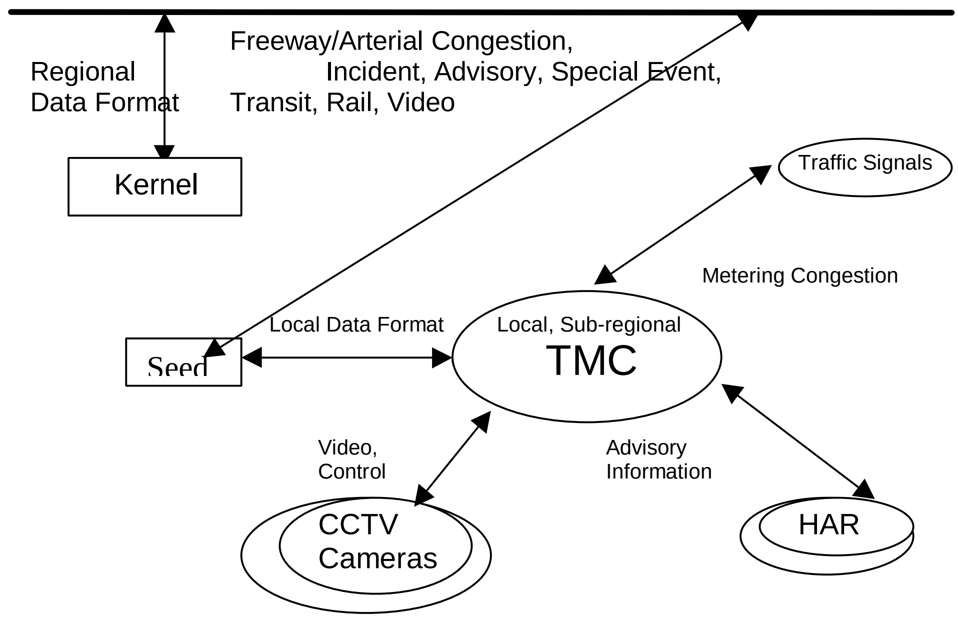

Figure 7-3. Kernel and Seed Example Data Flow Diagram

Kernels are the interface by which existing and new systems connect to the regional network. The Kernel establishes:

- A consistent look and feel to user interfaces;
- A standard format for naming data and services;
- A security check for the system; and,
- Information management service responsible for providing information on who is requesting data, submitting data, age of the data, confidence of the data, and frequency of data delivery.

Legacy systems will require a Seed to connect to the Kernel interface. Generally, legacy systems will have their own unique protocols and data structures. Consequently, a Seed is used to translate the legacy system's data into a format by which the Kernel can read, understand, and forward the data to other systems. Over the course of time, as the legacy systems are upgraded to new systems, seeds would no longer be needed and the new systems would directly communicate with the PCN.

This object-oriented software architecture distributes processing to manageable, real-world elements. For example local agencies can maintain control of their VMS, however, the Corridor architecture will provide additional information to the agency that can be used to formulate a message to display on the sign. Application and data objects will be tailored to meet the processes required along the Corridor.

The recommended architecture approach will allow for integration, a consistent configuration management system, establishment of interface standards and protocols, and consistency in deployments across the Corridor. The Seeds provide an interface standard that each regional project can design in order to communicate with the Corridor Network. In this manner, each

Seed is unique in its interface with the regional system, whether proprietary or not. However, each Seed is similar and redundant in how it interfaces with the regional Kernels. Firewalls are used to prevent sensitive information from being distributed throughout the system.

7.4 SYSTEM INTEGRATION

The Corridor will initially be a "system of systems" with each system gaining access to the Corridor Network via a regional Kernel. However, the architecture supports system to field element and field element to field element functionality should the Corridor require it. Currently, the Corridor only requires four Regional Kernels: Los Angeles / Ventura County, Orange County, Inland Empire, and San Diego County. The integration of the subsystems identified by the Corridor is described in this section.

Center Subsystems

Eight center subsystems will be part of the Corridor: Intermodal Transportation Management Center, Traveler Information Center, Emergency Management Center (InterCAD), Transit Management Center, Commercial Vehicle Administration and Fleet and Freight Management, ITS Planning, Emissions Management, and Toll Administration. The subsystems provide management, administration and support processes for the transportation system. The integration of the subsystems enables coordination between modes and across jurisdictions within the Corridor. Center subsystems are a means of grouping like processes together. These terms are not intended to suggest that each center subsystem be an actual physical building. In fact, a number of center subsystems may reside in one building, such as a TMC. For example, emergency management and transportation management centers are often co-located. The main data flows between the center subsystems are shown in Figure 7-4. Figures 7-5, 7-6, 7-7 and 7-8 provide examples of the integration of the center subsystems in each region. The projects and agencies named in the figures are illustrative only; they are not a complete listing of all projects and agencies within a given region.

Transportation Management Center

The regional and local city/county TMCs will all tie into the appropriate regional Kernel. The regional Kernel will be co-located with the Caltrans/CHP TMC. The city/county TMCs will either tie in directly to the regional Kernel or first to a subregional or countywide system that then connects to the regional Kernel. Integrated TMCs will allow the Corridor system to support "real-time" collection, management and access of current traffic surveillance and control parameters. The ITMC also will support the deployment of market packages required to provide event management activities.

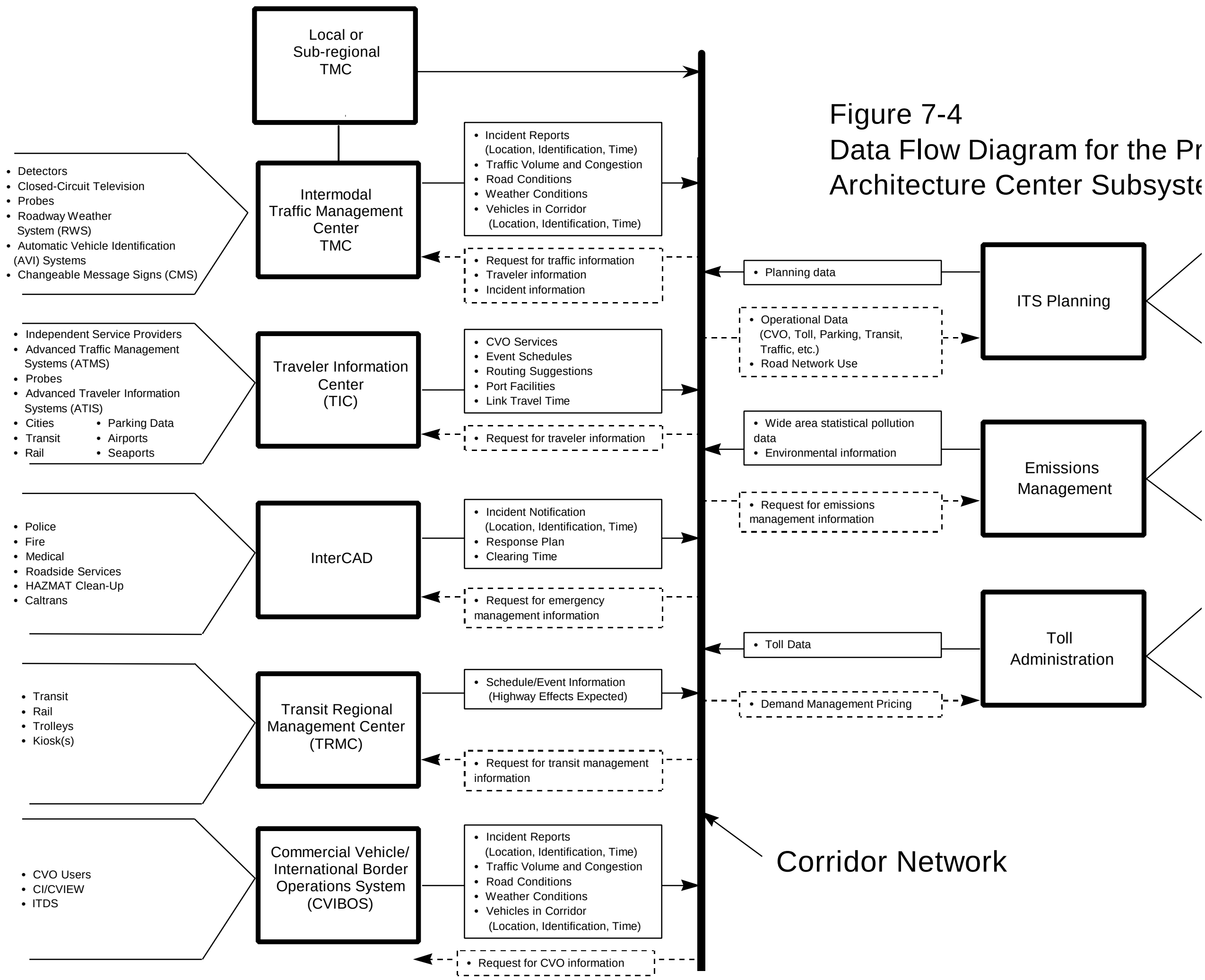

Figure 7-4. Data Flow Diagram for the Corridor Architecture Center Subsystems

San Diego County Example

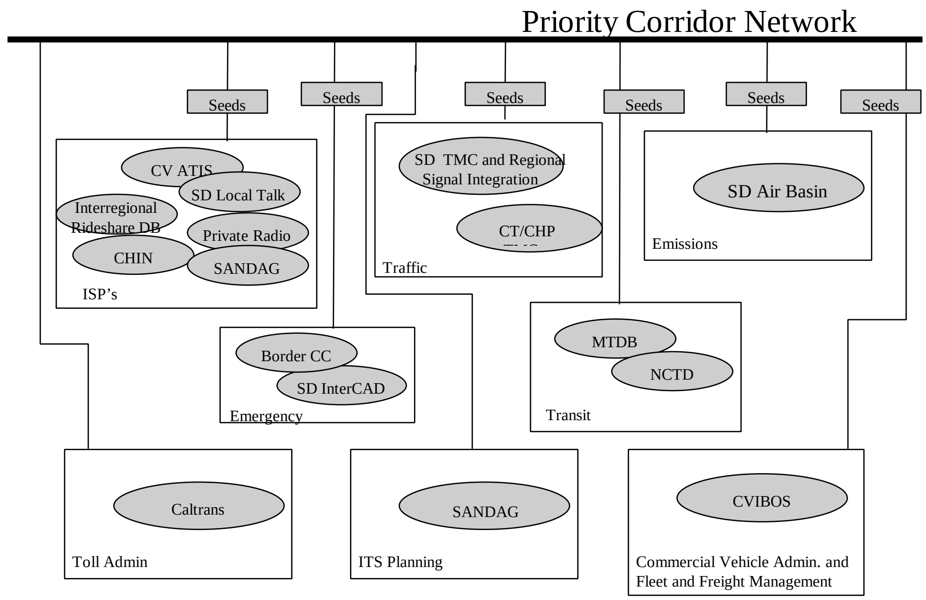

Figure 7-5. Example of a regional Kernel and Seed Integration - San Diego County

LA/Ventura County Example

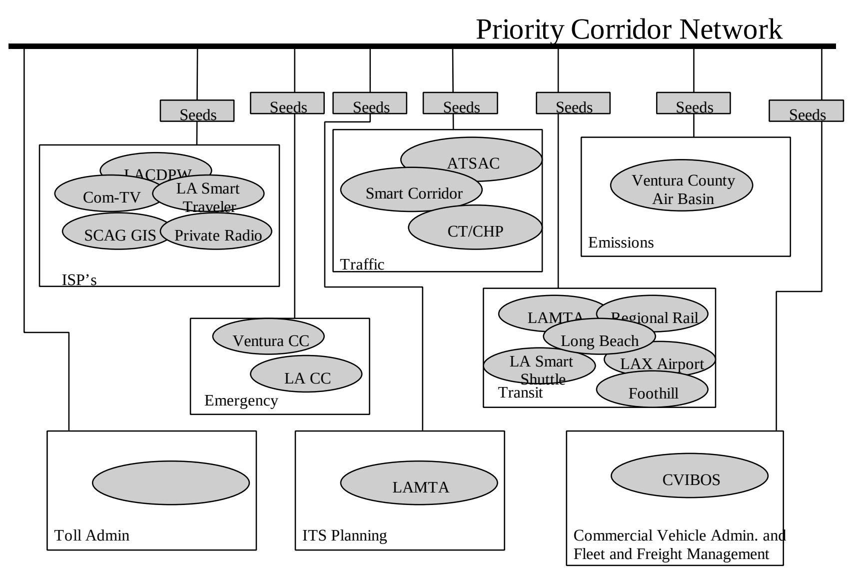

Figure 7-6. Example of a regional Kernel and Seed Integration - Los Angeles / Ventura County

Orange County Example

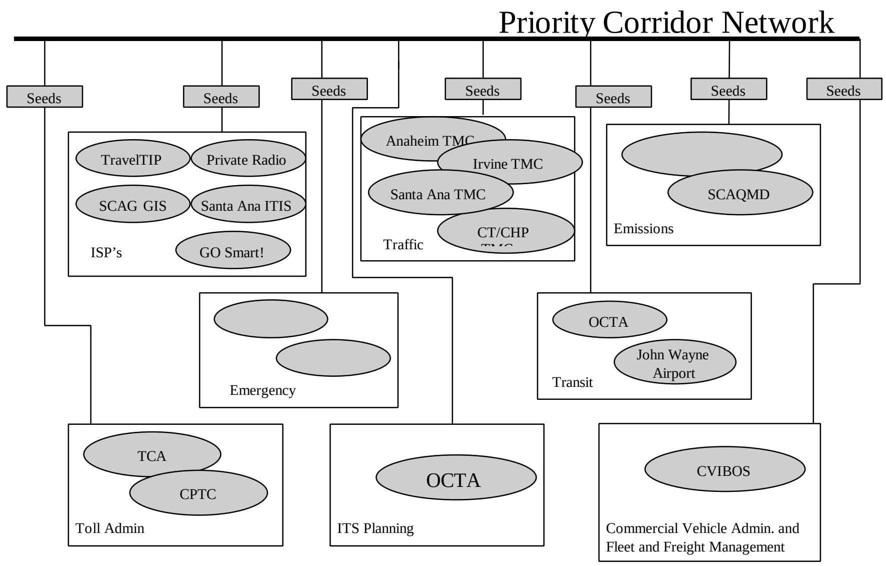

Figure 7-7. Example of a regional Kernel and Seed Integration - Orange County

Inland Empire Region Example

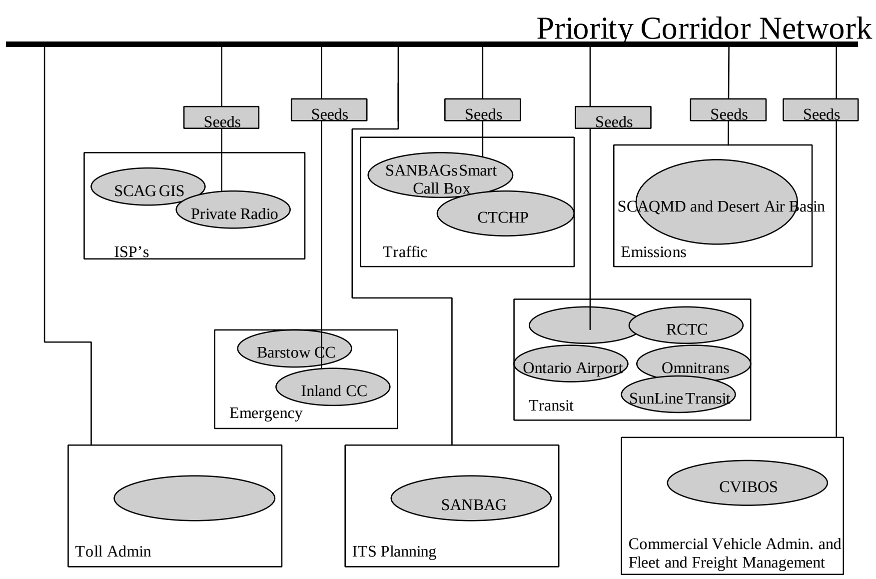

Figure 7-8. Example of a regional Kernel and Seed Integration - Inland Empire Region

Traveler Information Center

The traveler information centers (TICs) will be a combination of public and private ISPs. The private ISPs will either connect directly to the Corridor network, or will connect through the regional TICs. Each TIC will connect to the regional Kernel. The TIC will allow Corridorwide ability to collect, manage and access current information on available services, traffic conditions and trip planning. The system will also provide transit-scheduling information.

Emergency Management Center (InterCAD)

The InterCAD emergency management system will provide an integrated emergency management system throughout the region. The system will provide real-time incident verification capabilities. For example, incident/media information would be drawn from the Internet web page where the CHP CAD system is currently accessible. The system will facilitate incident classification, response, and coordination. The system will alert the appropriate agencies (i.e., law enforcement, emergency medical services, fire, HAZMAT, towing agencies, city, county, and state transportation managers, etc.). The system will allow a Corridor approach to traffic management during incidents.

Transit Management Center

The TrMCs will also connect to the Corridor network via the regional Kernel. The TrMCs will be able to coordinate operations with the other systems. Ride matching and reservation services will be provided. Scheduling information can be sent to the TICs. The transit management centers and the TMCs can coordinate signal priority operations.

Commercial Vehicle Administration and Fleet and Freight Management

The implementation of the specific CVIBOS processes, which are primarily oriented to management and information services, the possible future interaction with the State CVO regulatory and enforcement agencies and the Federal international trade compliance agencies will bring to the Corridor a robust CVO ATIS. A user friendly Internet interaction for CVO users will be provided. The “users” of the CVIBOS include: carriers, drivers, traders, freight handlers, commercial vehicle regulatory/ enforcement government agencies, regional/city/county traffic engineers, and commercial vehicle ISPs. This implementation will allow the CVIBOS to access and tailor the information collected and generated from the other Corridor applications. The CVIBOS information collected and processed by the CVIBOS application will be available to all Corridor applications. Redundant operations will be minimized. Control actions and CVO-specific information will be distributed to existing signals or signs used by the Corridor applications for traffic management along the Corridor. The CVO/International Border Operation-specific regulation and enforcement tasks would be accommodated by the CVIBOS application and its specific interfaces. This implementation approach will be consistent with an integrated Corridor Transportation System.

ITS Planning

ITS Planning will be added to the integrated system via the Corridor architecture. The implementation of the ITS Planning processes will allow transportation planners throughout the region to:

- ? Evaluate data collected and determine areas needing transportation; improvements;
- ? Evaluate the potential to modify toll fares;
- ? Evaluate potential to modify CVO operations;
- ? Adjust signal timing plans; or,
- ? Modify transit schedules and routes.

Medium sized and large agencies will access regional and Corridorwide data for use in their own planning and management. Some small agencies may find the integrated Corridorwide system useful in performing planning functions on their behalf.

Emissions Management

Major portions of the Corridor are designated as non-attainment areas and are required to reduce vehicle emissions. The integration of an emissions system will allow the Corridor to address both local and Corridor wide emissions reduction strategies. Air quality managers will be able to monitor and manage air quality using sensors within the roadway subsystem. General air quality can be monitored along with emissions of individual vehicles. Pollution levels within regions can be monitored and the data can be forwarded to toll administration, traffic management, and transit management systems to implement strategies needed to reduce emissions.

Toll Administration

Public and private toll facilities in the Corridor will be able to use this system to provide data related to electronic toll collection. The toll administrators will be able to use data collected throughout the Corridor to assess toll fare structures. The subsystem supports traveler enrollment and collection of both pre-payment and post-payment transportation fees in coordination with the existing and evolving financial infrastructure supporting electronic payment transactions. The toll administration subsystem generally interacts with the toll collection subsystem, parking management subsystem, and transit management subsystems to support fee collection operations.

Roadside Subsystems

By incorporating the roadside systems into the Corridor Network, the Corridor architecture will allow for eventual field equipment to field equipment integrated “control,” should Corridor managers find such control necessary or desirable. Distributed infrastructure roadway subsystems provide the direct interface to vehicles traveling on the roadway network. Roadside subsystems interface with one or more center subsystems. Roadside subsystems can include direct interfaces to drivers and other travelers on the roadway network. Figure 7-9 shows an example roadside subsystem integrating with TMC and vehicle subsystems. The toll collection equipment is used to communicate with vehicles equipped with electronic toll collection devices. The vehicles also serve as probes and can be used by the TMC to monitor traffic conditions on the freeway.

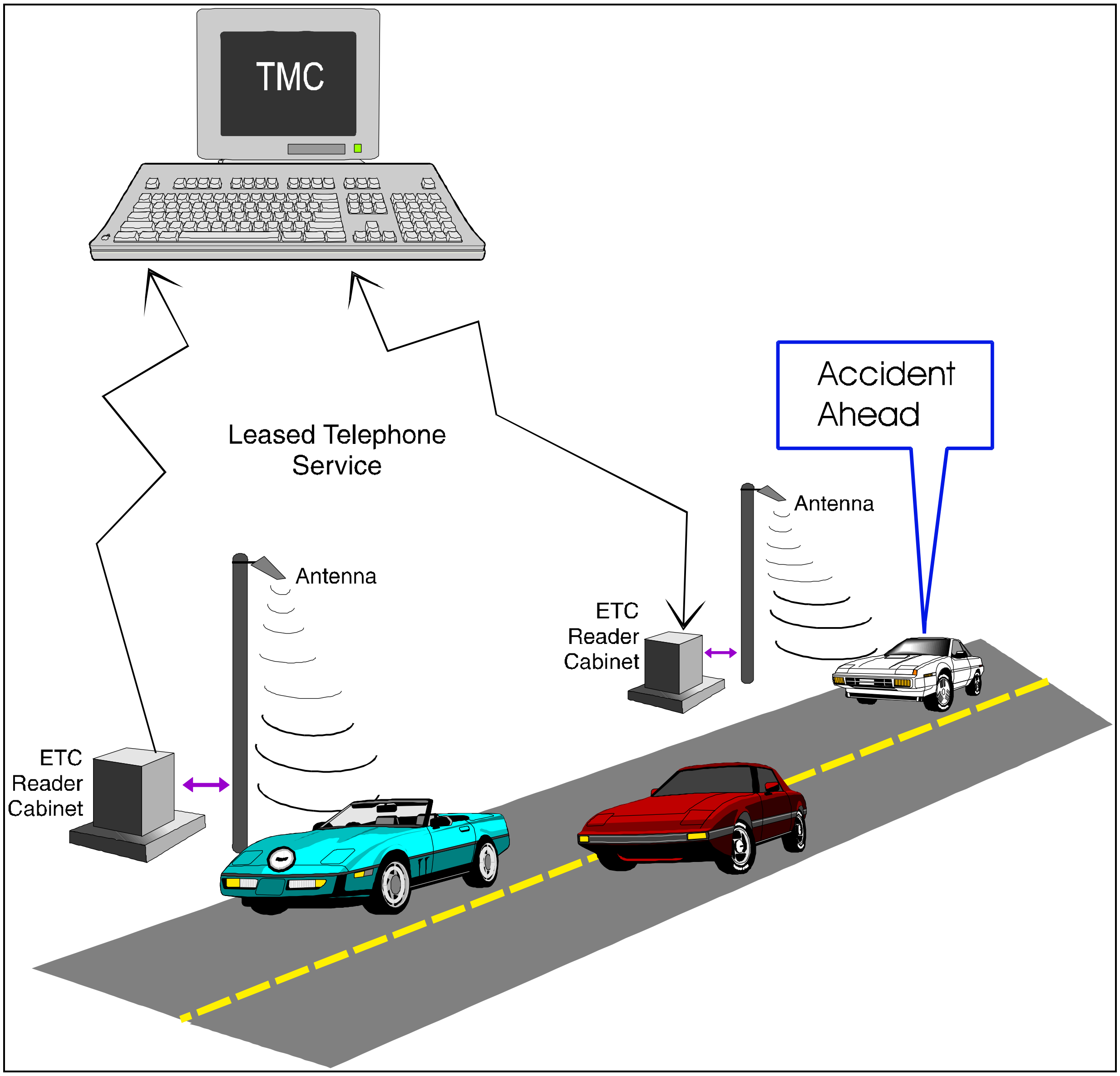

Figure 7-9. Sample Roadside Subsystem

Toll Collection

Toll collection subsystems will mainly be connected with the toll administration, TMC and TIC subsystems. Toll collection subsystems allow vehicles to pay tolls without stopping. The hardware used to provide automatic toll collection can also be used to gather traffic data and through another interface to provide in-vehicle traffic information.

Parking Management

The parking management subsystem provides the capability to provide parking availability and parking fee information, allow for parking payment without the use of cash with a multiple use medium, and support the detection, classification and control of vehicles seeking parking. The parking management subsystem will integrate with the TICs, and TrMCs. The parking management subsystem could also be integrated with the CVIBOS system to provide information on the availability of loading zone-parking spaces.

Commercial Vehicle Check

The commercial vehicle check subsystem is part of the CVIBOS system. The subsystem provides automated vehicle identification at mainline speeds for credential checking, roadside safety inspections, and weigh-in-motion using two-way data exchange.

Roadway

This subsystem includes the equipment distributed on and along the roadway, which monitors and controls traffic. Equipment includes HARs, VMS, cellular call boxes, CCTV cameras and video image processing systems for incident detection and verification, vehicle detectors, traffic signals, grade crossing warning systems and ramp metering systems. This subsystem also provides the capability for emissions and environmental condition monitoring including weather sensors, pavement icing sensors, fog etc. HOV lane management and reversible lane management processes are also available. Automatic vehicle safety systems will also be integrated through the roadway subsystem.

Traveler Subsystems

As the Corridor transportation system unfolds, reliable, real-time traffic data will become available. Traveler subsystems are used to provide this data to the public prior to a trip or while en-route. Some of the equipment used in traveler subsystems are owned and operated by the public, while other equipment is owned and operated by transportation providers and information providers. The Corridor ATIS subsystems will interface with the TICs and vehicle subsystems. Figure 7-10 illustrates an example traveler subsystem.

Remote Traveler Support

Remote traveler subsystems provide information at fixed locations, such as transit stations, transit stops, and major trip generators. Information can be accessed from kiosks, signboards, and other information displays supporting varied levels of interaction and information access. Personalized route planning may be performed at the information access point. Fare card maintenance, and other features which enhance traveler convenience, may also be provided at the discretion of the Corridor/deploying agency.

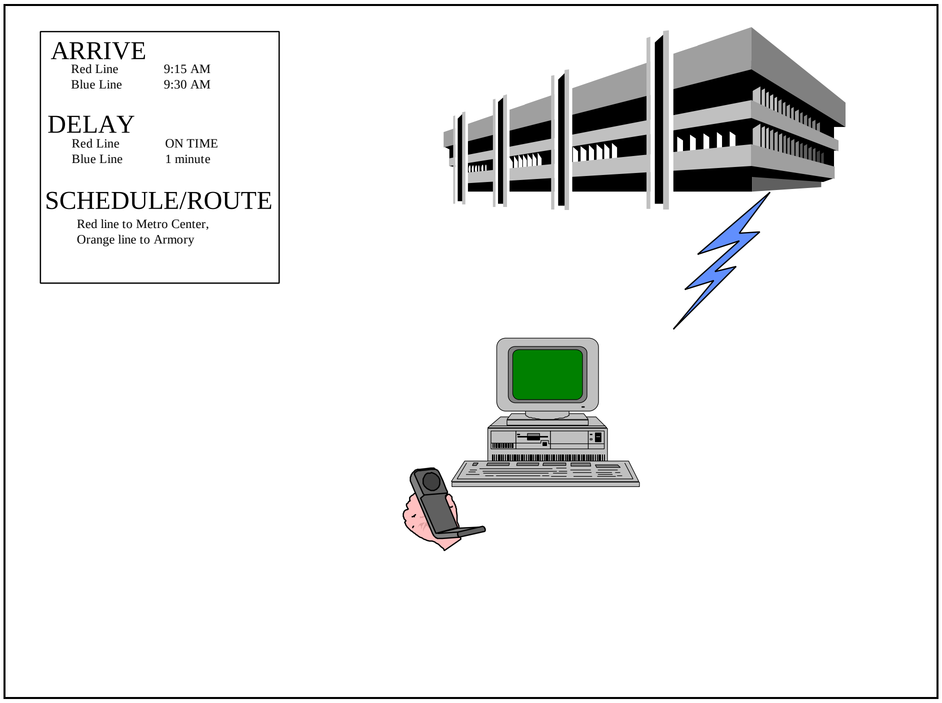

Figure 7-10. Traveler Subsystem Integration Example

Personal Information Access

The public will be able to gain information from the Corridor network using personal fixed and portable devices over multiple forms of electronic media. Radio, television, personal computers, personal digital assistants, telephones and other commercially available consumer products can be used. The systems may provide only receipt of traveler information, or may enable users to interact with the system to obtain route plans and user-specific information.

Vehicle Subsystems

Vehicle subsystems will be used to enhance general driver information, vehicle navigation, and advanced safety system processes. The Automated Highway System (AHS) will tie into the Corridor network via the vehicle subsystem interface. The CVIBOS will interact with the commercial vehicle subsystem providing sensory, processing, storage and communications processes necessary to support safe and efficient freight movement. Emergency vehicle and transit vehicle subsystems are also a part of the vehicle subsystem.

Automated Highway Systems and Automated Highway Maintenance and Construction

The AHS program is currently shifting direction to focus on safety applications, infrastructure-based deployments and near-term effects. As a result of this shift, efforts are currently underway to develop User Services (the "what") and MarketPackages (the "how") for the AHS. Once these Market Packages are developed, they can be "mapped" to the existing Corridor architecture to identify which subsystems are affected and what data flows are required. Given the synergy with AHS, the development of Market Packages for automated highway maintenance and construction User Service has been referred to the AHS Consortium. This will ensure that automated highway maintenance and construction Market Packages are appropriately linked to other elements of the AHS program.

Some preliminary AHS Market Packages include:

? Automated Stop Annunciator – as the vehicle travels, it will receive a signal from a roadside source. A processor will determine the appropriate message and present it to the rider.

? Excessive Speed Warning – in-vehicle devices will monitor vehicle load and diagnostics as well as the roadway. The vehicle transmits the roadway information to the roadside. This information, along with the information from other vehicles is transmitted to the traffic management subsystem where it is processed. The traffic management subsystem transmits compiled data to the roadside which relays it to the vehicle. Information is received from the roadside on speed limit and roadway conditions. An onboard processor determines the safe sped for that specific vehicle and advises the driver.

? Obstacle Detection and Information Sharing – a vehicle detects an obstacle in the roadway. It transmits the information to the roadside that relays the information to the traffic management subsystem. The traffic management subsystem collects the data and compiles and processes it. This data is then transmitted to the roadside for distribution to all vehicles.

These preliminary draft Market Packages do not require additional subsystems to be created in order to support them. They rely on existing architecture elements. What may be required by new AHS Market Packages are new data flows to and from these subsystems which may not currently exist. These new additions should require only minimal adjustments to the architecture.

7.5 ARCHITECTURE SUMMARY

One of the key elements of this plan is the system architecture depicted in Figure 7-11. For the Corridor, the architecture achieves a number of useful purposes. Local autonomy of key areas is maintained. A major portion of the Corridor architecture design is in place or planned for implementation shortly through existing systems, the Showcase Program and the regional Early Deployment Plans. Information will be supplied (two-way) on both a regional and Corridorwide basis. Many of the regional processes can be staged for implementation or can be easily expanded onto local TMCs to limit financial constraints. Finally, more effective and coordinated involvement of the private sector can be accomplished.

CHAPTER 8
MEASURES AND EVALUATIONS

Performance Criteria
Benefit/Cost Evaluation

CHAPTER 8.0
MEASURES AND EVALUATIONS

Although there has been a substantial push for the deployment of ITS, empirical data regarding the performance, benefits and costs of ITS applications is still rather limited. Benefits and costs can be estimated for specific proposed ITS projects for the purposes of evaluating merit. However, these estimates will become more useful when based on actual implementation costs and system performance as applied in the Priority Corridor. Measures of actual performance will be critically important to the planning and deployment of additional ITS systems. This chapter presents an analysis of benefits and costs for the Priority Corridor. It also outlines specific measures of performance to be applied to ITS deployment here in Southern California.

8.1 PERFORMANCE CRITERIA

The purpose of performance criteria is to provide tools/measures for the evaluation of the User Services as they are deployed in the Priority Corridor. The transportation agencies in the Corridor (SANDAG, SCAG, the county-level transportation agencies, CHP, DOT's, etc.) may apply these criteria to evaluate the effectiveness of the programs which are deployed. Based on these performance evaluations, services may be modified and additional deployments may be recommended.

It is important to identify/establish versatile performance criteria, whether quantitative or qualitative, which can be readily applied to evaluate the effectiveness of the ITS systems on a regional, Corridor and individual service plan element basis, as they are deployed and operated. While it may be simple to identify performance criteria which could be used to evaluate ITS system performance, other factors must be considered. The criteria must be based on the agency's willingness and ability to gather the data needed for the evaluation. In addition, the criteria should be coordinated with other informational requirements of the system(s) being deployed.

Performance criteria are defined below for each of the User Services identified for deployment in the Corridor. The program of projects defined in Chapter 2 includes a variety of specific deployments which in many cases overlap in terms of the benefits/results gained. The measurements of performance outlined below are most appropriately evaluated at a user service level rather than a market package or project by project basis. The data requirements to support the criteria are also described.

Traffic And Travel Management

En-route Driver Information

The performance of En-route Driver Information systems is measured by determining the validity and the usefulness of the information provided to the traveler and the general travel time savings. The following criteria and measurements could be applied.

Criteria and Measurements:

Perceived accuracy of information

- % of users finding information accurate/useful

Use of information

- % of users changing travel plan (i.e., route/mode)
- # of users, # of repeat users

Reduction in travel time

- % change in vehicle hour traveled
- % change in vehicle mile traveled
- % change in travel speeds

Data Requirements:

The main source of data to evaluate the performance of such a system is user surveys. These provide information to determine the satisfaction level of the users with this service. Perception of travel time savings could be measured based on user surveys and further verified with travel data retrieved through speed and count information. The value of system-wide travel time and delay measurements may be marginal for this User Service.

Route Guidance

The performance of Route-Guidance systems is measured by determining the validity and the usefulness of the information provided to the traveler and the general travel time savings. In addition, the convenience of obtaining the information may also be an issue.

Criteria and Measurements:

Validity of the information

- # and frequency of changes in transportation network (e.g., new links, new signals)
- frequency and accuracy of updates to Advanced Route Guidance suppliers
- % of users finding the information accurate/useful

Use of information

- % of users changing travel plan (i.e., route/mode)
- # of users

Reduction in travel time

- % change in vehicle hour traveled
- % change in vehicle mile traveled

- % change in travel speeds

Data Requirements:

Again, the main source of data to evaluate the performance of such a system is user surveys. These provide information to determine the satisfaction level of the users with this service. Perception of travel time savings could be measured based on user surveys and further verified with travel data retrieved through speed and count information. The value of system-wide travel time and delay measurements may be marginal for this User Service.

Traveler Services Information

The performance of Traveler Services Information systems is measured by determining the validity and the usefulness of the information provided to the traveler and the general travel time savings. In addition, the convenience of obtaining the information may also be an issue.

Criteria and Measurements:

Validity of Traveler Services Information (TSI)

- Frequency of use
- % of users finding the information useful
- % of users finding the information accurate

Use of information

- % of users changing travel plan (i.e., route/mode)
- # of users, # of repeat users

Reduction of secondary incidents

- # of secondary incidents

Reduction in travel time

- % change in vehicle hour traveled
- % change in vehicle mile traveled
- % change in travel speeds

Data Requirements:

Again, the main source of data to evaluate the performance of such a system is user surveys. These provide information to determine the satisfaction level of the users with this service. Perception of travel time savings could be measured based on user surveys and further verified with travel data retrieved through speed and count information. The value of system-wide travel time and delay measurements may be marginal for this User Service.

Traffic Control

The performance of the Traffic Control User Service could be measured in a variety of ways including delay, number of stops, productivity, travel time, travel speed, driver frustration, person/vehicle throughput, fuel consumption and air quality. The most useful measures deal directly with congestion such as delay, travel times and speeds.

Criteria and Measurements:

Reduction in travel time

? % change in vehicle hours traveled

? % change in vehicle miles traveled

? reduction in stops/delays

? increase in average speeds

? diversions to other routes

Data Requirements:

For Traffic Control, the data requirements include traffic volume counts, surveys, spot speeds, stopped delay, queue lengths, queue duration, approach stops, travel diaries, fuel consumption data, emissions measurements and travel times.

Incident Management

The Incident Management User Service performance criteria include incident response and service times, frequency and severity of secondary accidents, delay and travel times, and general quality of incident response and handling procedures.

Criteria and Measurements:

Reduction in frequency and severity of incidents

? # and severity of initial incidents

? # and severity of secondary incidents

Reduction in the duration of incidents

? detection time

? response time

? clearance time

Reduction in delay and travel time

- ? % change in vehicle hour traveled
- ? % change in travel speeds

Data Requirements:

The data requirements for the Incident Management User Service include accident records; incident frequencies, types, duration, and location; actual time to detect, verify, respond, and service incidents; traffic volume counts; traffic speeds; stopped delay; queue length; queue duration; and general responses to quality of incident response and handling procedures.

Emissions & Mitigation Testing

The effectiveness of Emissions and Mitigation Testing services can be measured through monitoring the amount of emissions and the number of violations both before and after the programs are established or new services and techniques are applied.

Criteria and Measurements:

Emissions

- reported emission violations (before & after)
- emission reductions (annual change in pollutants) relative to VHT, VMT changes

Data Requirements:

The data requirements focus on regular collection of air quality/pollutant data and emission violation data.

Transportation Demand Management

Pre-Trip Travel Information

The effectiveness of Pre-Trip Travel Information from a traveler's perspective is the impact on his/her travel time and delay. From a system perspective the travel time and delay are also relevant measures of performance, as are the mode shares and vehicle miles of travel. Clearly the traveler's perspective/perception is of primary importance, since a poor perception of the service results in limited or no use of the service.

Criteria and Measurements:

Perceived accuracy of information

- % of information users finding information accurate

Use of information

- % increase in number of users having access to information
- % of users finding information useful
- % of users changing travel plan (route/mode)
- # of users, # of repeat users

Reduction in travel time

- % change in vehicle hour traveled
- % change in vehicle mile traveled
- % change in travel speeds

Data Requirements:

To gain insight on the traveler's perspective, a qualitative assessment via user surveys during peak travel periods is a useful approach. The key assessment in the user survey would be the comparison of expected delay versus actual delay. To determine the impacts on the system as a whole, travel time and delay data can be gathered in the field via travel time runs during peak periods, or estimated from the system operational data being gathered at transportation management centers. However, the value of the system wide data as a measurement of Pre-Trip Travel Information may be marginal at best.

Ride Matching and Reservation

Performance criteria for Ride Matching and Reservation services focus on the usage of these programs and the extent to which they impact an overall modal shift to higher vehicle occupancy.

Criteria and Measurement:

Extent of ridesharing

- # of ride matching programs across the regional jurisdictions
- # of people using service (subscribe vs. rideshare)
- vehicle occupancy

Data Requirements:

Data requirements for this service consist of usage/subscription information from the program providers (whether public or private), HOV facility traffic volumes, vehicle occupancy counts and user surveys.

Demand Management and Operations

Performance criteria that can be used to evaluate the effectiveness of the Demand and Management Operations User Service focus on quantitative measures of modal shift such as vehicle occupancy, HOV/toll facility usage and transit ridership.

Criteria and Measurements:

Extent of modal shift

- HOV lane volumes compared mixed flow lane volumes
- vehicle occupancy
- transit ridership
- use of toll facilities
- diversions to other routes

Data Requirements:

Data requirements for this User Service include vehicle occupancy counts, traffic volumes along key routes/facilities, highway mileage, and attitudinal survey data.

Public Transportation Operations

Public Transportation Management

Two distinct types of performance criteria need to be included under the Public Transportation Management User Service. One type relates to the operator/management side, while the other relates to the user/consumer side. Performance criteria could include vehicle occupancy, vehicle miles of travel, passenger miles of travel, public transit ridership, schedule adherence, paratransit response time, consumer attitudes, and a variety of cost effectiveness measures. However, from the user's perspective the key criteria are schedule adherence and predictability.

The cost effectiveness related performance criteria include measures of changes in both public transit revenue and cost. Specific criteria include revenue cost ratios, cost per passenger carried, and cost per unit of service provided, measured on either a per mile or per hour basis.

Criteria and Measurements:

Schedule adherence and predictability

- reduction in wait time for transfers (AVL, CCTV, Survey info)
- reduction in wait time at bus stops (standard deviation between schedule and actual departure)
- availability of transfer options

Cost effectiveness

- increased revenue cost ratios
- reduced cost per passenger

Data Requirements:

The data requirements specific to Public Transportation Management include transit ridership counts, system performance checks, system revenue and cost data and transit user surveys.

En-Route Transit Information

The performance of En-route Transit Information systems is measured by determining the validity and the usefulness of the information provided to the transit user and the general travel time savings. In addition, the convenience of accessing this data also contributes to the usefulness of the service.

Criteria and Measurements:

Perceived accuracy of information

- % of information users finding information accurate/useful

Use of information

- % of information users changing travel plan (route/mode)

Data Requirements:

The main source of data to evaluate the performance of such a system is transit user surveys. These provide information to determine the satisfaction level of the users with this service. Perception of travel time savings could be measured based on user surveys and further verified with travel data retrieved through speed and count information. The value of system-wide travel time and delay measurements may be marginal for this User Service.

Personalized Public Transit

The performance criteria for Personalized Public Transit is primarily the extent to which the service is used. It will also be necessary to evaluate the composition of the ridership to determine the viability of this service as an alternative to auto travel. Cost effectiveness should also be evaluated based on revenue cost ratios and cost per passenger or per mile measures.

Criteria and Measurement:

Use of Service

- ridership of personalized public transit versus fixed route service
- Who comprises ridership?

- former SOV users
- former fixed-route transit users
- those not making trips previously

Data Requirements:

The data requirements specific to Personalized Public Transit include transit ridership counts, route logs, system revenue and cost data, and transit user surveys.

Public Travel Security

Performance criteria for Public Travel Security focus on the timeliness of response to an incident and traveler's perception of his or her own safety while accessing and using public transit.

Criteria and Measurements:

Response time to incident

Perceived safety at transit facilities

Data Requirements:

The main source of data to evaluate Public Travel Security is transit user surveys. The survey data provide information to determine the satisfaction level of the users with this service and the perception of non-users. Incident logs would also be required.

Electronic Payment Services

The performance criteria for measuring the effectiveness of Electronic Payment Services include measures of cost effectiveness and operational effectiveness. Cost effectiveness measures focus on system costs per rider as compared to estimated travel time savings per rider. Operational effectiveness focuses on the ability to assess and collect toll for all users.

Criteria and Measurements:

Cost and operational effectiveness

- traffic volumes using toll facilities
- cost of fare collection for transit agencies (including enforcement costs)
- # of cheaters (people who don't pay)
- transaction processing time

Data Requirements:

The data requirements for Electronic Payment Services include traffic count data, system costs, assessment records, and violation records.

Commercial Vehicle Operations

Commercial Vehicle Electronic Clearance

The Commercial Vehicle Electronic Clearance User Service performance criteria focus on truck delay and travel times as well as the general quality of truck travel in the Corridor.

Criteria and Measurements:

Delay reduction

- reductions in congestion at border crossings
- delay reduction at weigh stations and inspection points
- reduction in cargo theft
- average vehicle delay time computed by carrier

Effectiveness and efficiency

- cost of processing transaction in dollars and time
- percent of vehicles inspected who are non-violators

Data Requirements:

The data requirements for this service include delay and travel time data for trucks along specific routes, at weigh stations and border crossings as well as general responses from truck drivers and other operators on quality of truck travel and service. Some of the data could be collected through careful location of roadside transponders and surveillance equipment. A potentially less objective source of travel time data would be the trucking firms and operators themselves. Data regarding the effectiveness of enforcement activities may be readily available from agency files.

Automated Roadside Safety Inspection (On-Board Safety Monitoring)

The performance criteria for Automated Roadside Safety Inspection focus on the extent to which this service is used and the extent to which this service eliminates or mitigates road side breakdowns or equipment failure related accidents.

Criteria and Measurements:

Use of program

- # of active vehicles monitored with on-board safety devices

Safety Improvement

- reduction in number of road side breakdowns for vehicles equipped with these devices
- reduction in equipment related accidents

Data Requirements:

The data requirements for this service include records of equipment installations, accident reports and maintenance records or user surveys to determine the frequency of road side breakdowns.

Commercial Vehicle Administration Process

The performance criteria for Commercial Vehicle Administration Process are aimed at the usefulness and efficiency of the service. Measures include the extent of use, perceived usefulness and costs versus revenue of the system.

Criteria and Measurements:

Usefulness and cost effectiveness of program

- Cost of program versus revenues
- Cost of investigations

Data Requirements:

The data requirements for this service include the number of users, user surveys, system costs and system revenues.

Hazardous Material IncidentResponse

The Hazardous Material Incident Response User Service performance criteria include incident response and service times, and general quality of incident response and handling procedures.

Criteria and Measurements:

Reduction in frequency and severity of incidents

- # and severity of initial incidents

Reduction in the duration of incidents

- detection time
- response time
- clearance time

Data Requirements:

The data requirements for the Hazardous Material Incident Response User Service include accident records; incident frequencies, types, duration, and location; actual time to detect, verify, respond, and service incidents, and general responses to quality of incident response and handling procedures.

Commercial Fleet Management

The performance criteria for Commercial Fleet Management focus on the perceived usefulness of the service to the commercial carriers. The criteria assess to what extent the service is being used, to what extent the carriers apply the service and whether or not the service reduces delay at transfer facilities.

Criteria and Measurements:

Usefulness of the information

- % of users changing travel patterns

Reduction in wait time at intermodal facilities

Reduction in illegally parked trucks

Data Requirements:

The data requirements for this system rely primarily on user surveys. Information from both dispatchers and drivers would be useful.

Emergency Management

Emergency Notification and Personal Security

The performance criteria for Emergency Notification and Personal Security focus on the ability to report an emergency or threatening situation and the response time to that report. The total response time is a function of the time required for reporting, dispatching and completing the service.

Criteria and Measurements:

Reduction in response time

- reporting time
- dispatch time
- resolution time

Notification/reporting capability

- ease and speed of reporting

Data Requirements:

The data requirements for this service include response time logs, incident data, user surveys and surveillance data.

Emergency Vehicle Management

The performance criteria for Emergency Vehicle Management should focus on the response time. The total response time is a function of the time required for reporting, dispatching and completing the service. Other factors affecting the response time are interagency cooperation and routing.

Criteria and Measurements:

Reduction in response time

- reporting time
- dispatch time
- resolution time

Data Requirements:

The data requirements for this User Service include response time logs, accident data, user surveys and surveillance data.

Advanced Vehicle ControlAnd Safety Systems

Automated Highway System

The Automated Highway System User Service performance criteria addresses the improvement of traffic throughput, safety improvement and reliability of the system.

Criteria and Measurements:

Effectiveness of system

- VHT change in relation to VMT
- reduction in accidents per million vehicles

Reliability of system

- changes in VMT and VHT during period of automated highway system (AHS) failure
- frequency and duration of AHS failures

Data Requirements:

The data requirements for this service include traffic volume counts; accident data and reports; and the frequency, duration and nature of system interruptions.

In-Vehicle Safety Systems

The term In-Vehicle Safety Systems is used in this report to represent several collision avoidance and safety related UserServices which would be deployed in the vehicle itself. These services are Longitudinal Collision Avoidance, Lateral Collision Avoidance, Intersection Collision Avoidance,Vision Enhancement for Crash Avoidance, Safety Readiness, and Pre-Crash Restraint Deployment. Clearly, the primary performance criteria for evaluation would be safety in terms of reduction of the number and severity of accidents. However, more extensive system performance specifications and criteria should be applied that would require data from the vehicle and manufacturer. These User Services are viewed as being deployed in the long term and will require further development of performance criteria as these systems are further defined.

Highway-Rail Intersection

The performance criteria for the Highway-Rail Interface User Service focus on the reduction of the number and severity of accidents at highway-rail intersections. The traffic flow through these intersections is also addressed.

Criteria and Measurements:

Safety

- # and severity of accidents

Traffic Flow

- improved traffic throughput at highway-rail intersections

Data Requirements:

The data requirements for this service include accident reports, traffic volume counts, train and traffic volumes, length and frequency of trains, traffic stop duration and general site layout information (# of tracks, skew, grades, etc.).

Rural

The Rural User Services can be measured according to two main criteria: safety and mobility. Safety is addressed through the number and severity of accidents while mobility can be addressed through travel time and convenience.

Criteria and Measurements:

Safety

- # and severity of accidents
- incident response time

Mobility

- improvement in travel time

Data Requirements:

The data requirements for this service include user surveys and accident data.

Automated Highway Maintenance and Construction

The performance criteria for the Automated Highway Maintenance and Construction include reduction in construction related traffic accidents and reduction of duration of typical construction and maintenance relatedactivities which hinder traffic flows and create safety problems on highways.

Criteria and Measurements:

Safety

- # and severity of accidents

Traffic flow

- increase in traffic flows in or near construction/maintenance activities
- reduction in time per construction/maintenance task

Data Requirements:

The data requirements for this service include accident data, traffic volume counts and surveillance/observation.

8.2 BENEFIT/COST EVALUATION

This section presents the process and key parameters for assessing ITS benefits and costs in the Corridor. As with other elements of the Priority Corridor ITS Strategic Deployment Plan, the benefits and costs of ITS systems implemented in the Corridor are a function of specific regional systems, systems implemented at the Corridorwide level, and the cumulative effect of various systems working in concert throughout the Corridor. This section presents benefit and cost values/parameters for the User Services systems considered in the Priority Corridor. These values represent per system benefits and costs.

The purpose of the benefit/cost analysis is to provide a summary of anticipated benefits and costs for proposed ITS project/systems in the Corridor. Identification of benefits and costs of each of the User Services is necessary for prioritizing and planning the implementation of ITS projects. The benefits associated with a specific project drive its Corridorwide integration and the costs drive the projects implementability and timing and will become more quantifiable and more valid as specific projects are defined, developed, and implemented. This information will prove useful in funding applications and assist in further assessment of project priorities.

Benefits for each of the User Services groups are identified and described below. Benefits for some of the technologies and services that are still in the early stages of development are difficult to quantify and will require monitoring and re-evaluation prior to implementation. More detailed benefit/cost evaluations should be performed once work plans or more definitive projects or systems are developed.

Anticipated Benefits

In developing a strategic plan for deployment of ITS technologies in the Priority Corridor it is useful to identify and define the likely benefit of the potential deployments. Information regarding the benefits and costs provide context for the investment and prioritization decision making process. In Table 8-1 the anticipated benefits of ITS developments are outlined according to the user service categories used throughout this document. The information contained in Table 8-1 was taken from Caltrans Advanced Transportation Systems Program Plan: 1996 Update.

Table 8-1
ANTICIPATED BENEFITS

SERVICE	ANTICIPATED BENEFITS	CONTEXT WHERE BENEFITS MAY ACCRUE
Traffic and Travel Management		
Traveler Services Information	? Reduced uncertainty in travel ? Potential reduction of up to 2% of Vehicle Miles Traveled (VMT) spent searching for trip destinations	? Benefits highest for visitors and other unfamiliar travelers
En-Route Driver Information	? Reduced uncertainty and variability in travel times and conditions ? 5-10% reduction in travel time for travelers ? 5-10% increases in speeds, decrease in number of stops for travelers with the service ? Small level of benefits for travelers without the service (1-5% of travel time)	? Primary value for incident-related (accidents, weather, special events, etc.) traffic delays, in all geographic areas ? Higher benefits to travelers with long trips, multiple mode and route alternatives

Route Guidance	? 5-10% reduction in travel time for equipped travelers ? 5-10% increases in speeds, decrease in number of stops for equipped travelers ? Small level of benefits for non-equipped travelers (1-5% of travel time) ? Associated speed increases, decrease in number of stops ? Minimal impact on emissions ? Decreasing benefits with higher market penetrations ? Small (under 2%) decreases in VMT	? Primary value for incident-related (accidents, weather, special events, etc.) traffic delays, across all geographic areas ? Higher benefits to travelers with long trips, multiple mode and route alternatives ? Benefits highest for visitors and other unfamiliar travelers

Table 8-1 (Continued)
ANTICIPATED BENEFITS

SERVICE	ANTICIPATED BENEFITS	CONTEXT WHERE BENEFITS MAY ACCRUE
Traffic and Travel Management		
Ridematching and Reservation	Increase in average vehicle occupancy and personal mobility	Significant density of related trips is necessary to ensure timely and responsive ride matching
Pre-Trip Traveler Information	? Reduced uncertainty and variability in travel times and conditions ? 5-10% reduction in travel time for travelers with this service ? 5-10% increases in speeds, decrease in number of stops for travelers with the service ? Small level of benefits for travelers without the service (1-5% of travel time) ? Small impact on emissions ? Small increases in transit and higher-occupancy travel ? Some shift of travel out of congested (peak) travel times	? Primary value for incident-related (accidents, weather, special events, etc.) traffic delays, in all geographic areas ? Higher benefits to travelers with long trips, multiple mode and route alternatives

Traffic Control Incident Management	***Surface Streets:*** ? 3-10% reduction in travel time ? 5-15% reduction in queue time ? 3-10% increase in speeds ? 5-15% reductions in stops ? 2-4% reductions in VMT ? 10-15% reduction in fuel consumptions ? 5-10% reductions in HC and CO emissions ? 5-10% reduction in intersection-related accident rates, with higher reduction for left-turn accidents ***Freeways:*** ? 10-25% increase in freeway speed (before-after) during congested peak hours, depending on level of congestion and ramp spacing ? 5-20% increase in freeway throughput ? 0-4% reduction in emissions	• Most surface street systems will benefit from this market package • Cities with major traffic generators such as theme park or stadium will benefit more • It is expected that signal coordination tailored to specific local traffic patterns can have significantly higher benefits

Table 8-1 (Continued)
ANTICIPATED BENEFITS

SERVICE	ANTICIPATED BENEFITS	CONTEXT WHERE BENEFITS MAY ACCRUE
Transportation Demand Management (TDM)		
Demand Management and Operations	? Small improvements in incident detection and verification times may be possible ? 5-10 minute reduction in incident response times for large urban areas (30-50% reduction) ? FSP programs report significant reductions (40-50 vehicle hours) of incident-related delay ? Significant benefit to cost ratio (over 3:1) ? Reduce peak hour congestion ? Reduce incident rate ? Improve air quality ? Quantitative values depend on types of services that are implemented in each specific location	? Regions with high frequency of incidents ? Regions where incident delays constitute a substantial part of delays
Public Transportation Operations		
Personalized Public Transit	? Improved productivity of vehicles, labor ? Efficiencies in routing and trip scheduling ? Limited evidence to date	
Electronic Payment Services	***Roadway and Parking:*** ? Reduction in peak hour congestion ? Reduction in toll plaza operating costs ***Transit:*** ? Convenience of common fare instrument ? Reduction in cash handling losses ? Reduction in costs of data collection and fare processing	

En-Route Transit Information	? Reduced uncertainty in travel times ? Small increases in transit and higher-occupancy travel	

Table 8-1 (Continued)
ANTICIPATED BENEFITS

SERVICE	ANTICIPATED BENEFITS	CONTEXT WHERE BENEFITS MAY ACCRUE
Public Transportation Operations		
Public Transportation Management	? Improved productivity of vehicles, labor ? Efficiencies in routing and trip scheduling ? Reduction in costs of data collection ? Effective scheduling of maintenance activities ? Reduction in maintenance and system repair costs ? Limited discussion of quantitative benefits	?
Public Travel Security	? Faster response to incidents ? Record of security incidents ? Possible prevention of security incidents	? High benefits in less secure areas (e.g. large urban areas)
Commercial Vehicle Operations (CVO)		
Hazardous Materials Incident Response		
Automated Roadside Safety Inspection / On-board Safety Monitoring	? Reduction in safety inspection times ? Reduction in commercial vehicle accidents ? No quantitative evidence to date ? Reduction in accidents and breakdowns ? Reduction in maintenance costs ? Reduction in incident-related delays	
Commercial Vehicle Electronic Clearance	? Reduction or elimination of border clearance times ? Reduction in commercial and public administrative costs ? Improvements in vehicle/driver productivity ? No quantitative evidence to date	Highest benefits for long-haul carriers

Commercial Fleet Management	? 5-20% improvements in vehicle and driver productivity ? 5-20% increase in loaded miles	Local and long-haul systems
Commercial Vehicle Administrative Processes	? Reductions in commercial and public administrative costs ? Improvements in vehicle and driver productivity ? Largely unknown level of benefits	

Table 8-1 (Continued)
ANTICIPATED BENEFITS

SERVICE	ANTICIPATED BENEFITS	CONTEXT WHERE BENEFITS MAY ACCRUE
Emergency Management		
Emergency Notification and Personal Security	? Faster response to incidents ? Possible prevention of security incidents ? Little quantitative evidence to date	? High benefits in less secure areas ? High benefits in rural and other remote areas
Emergency Management		
Emergency Vehicle Management	? Assumed reduction in response times through system-coordinated response ? Anticipated faster response times to incidents ? Little quantitative evidence of benefits to date	? Higher level of benefit realized in areas with multiple jurisdictions and independent response agencies
Advanced Vehicle Control and Safety Systems		
Safety Readiness	? 1-2% lower accident rates due to driver impairment	?
Pre-Crash Restraint Deployment	? Reduction in accident severity ? No quantitative evidence to date	?
Vision Enhancement for Crash Avoidance	? Reduction in accidents due to vision impairment ? 3-4% reduction in night vision impairment accidents	? Higher benefits in night driving, inclement weather ? Significant benefits for visually challenged drivers
Intersection Crash Warning and Control	? 2% of intersection-related accidents may be avoided	? Possible higher value at unsignalized intersections

Corridorwide Parameters and Assumptions

The definition of basic benefit parameters is necessary to ensure the common basis for the benefit/cost analysis. These parameters are comparable across time and between geographic areas. Also, they are multimodal and applicable to all modes of transportation. The parameters are utilized to determine the likely benefits of each User Service in terms of its equivalent monetary values. These values reflect the savings each User Service would provide and are compared to their respective cost to determine the benefit-to-cost ratio. The key assumptions regarding specific transportation parameters are summarized on Table 8-2. The system benefit parameters are summarized in Table 8-3.

Table 8-2
Transportation Parameters/Assumptions

Transportation Parameter	?	*Value*	*Source/Notes*
Average Trip Length (Work Trip Travel Distance)	? ?	12.79 miles (SCAG Region)	1997 RTP Performance Indicators Technical Report
Average Trip Travel Time (Work Trip Travel Time)	? ?	21.25 minutes (SCAG Region)	1997 RTP Performance Indicators Technical Report
Average Speed (MPH)	?	37.12 mph	1997 RTP-PITR
Number of Incidents per Year (fatal, injury, other)	? ? ?	1,583 fatal accidents 155,835 injury accidents (SCAG & SANDAG)	1997 RTP Performance Indicators Technical Report
Average Incident Durations (Minutes)	? ?	42.6 minutes (SANDAG Region)	Based on three months of 1995 Caltrans incident data as provided by Caltrans District 11
Average Cost per Gallon of Gasoline	?	$1.50 per gallon	Assumed based on existing prices
Average Mile per Gallon	? ?	18.12 MPG (SCAG Region)	1997 RTP-PITR
Cost per Hour of Travel Time	?	$10.40	Equivalent of 80% of average wage rate (FTA guideline)
Average Vehicle Occupancy (AVO)	? ?	1.431 (SCAG Region)	1997 RTP-PITR
Cost of Emissions Reduction by Type - CO - HC - NOx	? ? ? ? ?	 $1.525/lb. $0.15/lb. $1.375/lb.	SANDAG Signal Optimization Study
Operations and Maintenance (O&M) Cost Savings per Hour	?	$60.00	Conservative estimate based on average hourly repair billable
Cost per Accident	?	$12,600	Urban average accident USDOT
Vehicle Hours Traveled (VHT)	? ?	8,131,785 hours (SCAG Region)	1997 RTP-PITR
Vehicle Miles Traveled (VMT)	? ?	278,973,355 miles (SCAG Region)	1997 RTP-PITR
Vehicle Hours of Delay	? ?	1,720,65 hours (SCAG Region)	1997 RTP-PITR

The initial capital costs of the technologies compiled have been identified on a per-unit basis. The unit cost data are based on the cost of commercially available products and services or engineering estimates of the long-term costs of these technologies. In addition, the annual recurring costs for operations and maintenance are determined from the assumed lifespans of each system. The lifespans are estimated based on the type of system and its potential users. Ultimately, when projects are defined, the total cost of each system will be compared to its total benefit in order to calculate the benefit-to-cost ratio. The cost and life span assumptions are presented for each User Service category in Table 8-4.

The methodology for this benefit / cost analysis is patterned after that prepared for the San Diego Region. The benefit/cost information was obtained from several federal documents as well as the Caltrans Advanced Transportation Systems Program Plan. While parameters such as average travel time, VMT, VHT, etc. that are used to determine the system benefits are obtained from SCAG's and SANDAG's 1997 RTP Performance Indicators Technical Report and the San Diego Region ITS Strategic Plan.

CHAPTER 9
CORRIDOR INVENTORY

Corridor Systems Inventory

CHAPTER 9.0
CORRIDOR INVENTORY

9.1 CORRIDOR SYSTEMS INVENTORY

The first step in developing any plan of action is to understand the current situation. In this case that means knowing what ITS capabilities and resources exist and what ITS capabilities and activities are planned within the Priority Corridor, and understanding, as context, the transportation system on which the ITS capabilities are placed. This section documents the existing and planned ITS related infrastructure and activities within the Southern California Priority Corridor region to build the foundation for the Strategic Deployment Plan.

Roadway Systems and Infrastructure

The roadway systems and infrastructure inventory consists of key elements of existing and planned infrastructure related to roads in the Priority Corridor region. It is based on inventory work performed by the Odetics/NET consultant team for the Southern California Showcase demonstration project. The elements addressed are traffic control systems, physical communication infrastructure and field ITS devices. Although the information presented is based on the inventory from the Showcase program, it has been updated whenever more information was available from regional teams. The inventory presented in this report has been organized into four geographic areas to match the work being done by the four regional teams – Los Angeles (encompassing Los Angeles and Ventura Counties), Orange, Inland Empire (encompassing Riverside and San Bernardino Counties), and San Diego.

Central Traffic Contrd System

A “Central Traffic Control System” is a traffic control system in which the master computer, communication facilities, and operator interface all reside in one central facility. This type of traffic control system is different from a “Non-Central” Type Traffic Control System, in that the Central Traffic Control System provides a two-way communication to a remote site. The master computer enables the control center staff to carry out virtually all functions related to control and monitoring of the traffic control system from the central facility. This system also facilitates data gathering and data processing efficiently. This inventory consists of existing and planned traffic control systems for each of the regions within the Corridor.

A graphic and tabular summary of traffic control systems by jurisdiction in the Priority Corridor is provided in Appendix B. It is evident that a number of different traffic control systems are in use within the Priority Corridor region. Differences in the traffic control systems exist more between the counties than within a county. For example, about 50% of the cities surveyed in Los Angeles County have either Multisonics or Bitrans systems; in Orange County, 60% of the cities surveyed have Multisonics systems and 34% have either Econolite or Traconex systems; in the Inland Empire, about 75% of the cities surveyed have Econolite or Traconex systems; whereas in San Diego County, most cities have a Bitrans system. The survey also shows that in general, more cities in Los Angeles and Orange counties have a traffic control system compared to the cities in the Inland Empire and San Diego Counties.

Communication Infrastructure

Communication infrastructure is a backbone to any TMC. This facilitates the TMC's communication with the traffic surveillance devices (traffic controllers, detectors, etc.), other field devices (CCTV, VMS, HAR, etc.) and other organizations (TMCs, ISPs, news media, law enforcement, etc.). Different types of communication media include fiber, twisted-pair copper wire, telephone lines, satellite, etc.

A graphic and tabular summary of the different kinds of communications means available in different jurisdictions in the Corridor is provided in Appendix C. All the four regions use a variety of communication mediums from Dial-Up to satellite. Fiber is becoming a more prevalent form of communication because of the increased use of ITS elements (For example Closed Circuit Television) requiring higher communication bandwidth. For the cities, twisted pair still remains the main medium of communication, though some cities in Los Angeles, Orange, and San Diego Counties also have fiber.

Field ITS Elements

For the purpose of this inventory, field ITS elements include CCTV, CMS, HAR and highway advisory telephone (HAT). These devices are installed in the field and used by the TMC staff for incident detection, providing information to the motorists about traffic conditions and for general transportation management and control.

A graphic and tabular summary of different ITS elements available in different cities in the Corridor are provided in Appendix D. A number of ITS devices are currently deployed and future plans include adding more. Among the cities, the ones in Los Angeles County are more actively seeking to install more ITS devices than other regions. In Inland Empire, none of the Cities surveyed have either existing or planned ITS devices. Among all ITS devices, there is more emphasis on acquiring CCTVs.

Advanced Testbed

In addition to the activities outlined above there is also a test project currently being implemented in Orange County. The testbed is an integrated state/local traffic management system (TMS) in Caltrans District 12, which uses real-time, computer-assisted transportation management of freeways, local arterials and transit operations, with communication links to the university laboratories for performance monitoring and evaluation. The TMS is being structured to allow testing of near-term intelligent transportation system technologies, products and strategies in a real-time, real-world environment.

The testbed project involves the following partners: Partners for Advanced Transit and Highways (PATH) (comprised of UC Irvine and California Polytechnic State University, San Luis Obispo), Federal Highway Administration, the cities of Anaheim and Irvine, Orange County Transportation Authority, CHP, and others, including private firms, when operational.

Public Transportation

This section presents an inventory of some key operational features of agencies providing public transportation in the Priority Corridor region. The information presented here is based on the survey conducted by a consultant team. The survey included telephone as well as personal interviews with the key agency staff.

In the Corridor, both rail and buses are used as means of public transportation services. Many local and regional agencies provide this service. Since the emphasis of this report is to document the inter-regional transportation facilities, the agencies, which provide services at the local level, were excluded from this survey.

Apart from collecting the basic inventory information regarding the fleet size, the route information, the survey concentrated on collecting information on the operational characteristics of these agencies. The purpose was to gauge the level of interoperability among the agencies at the technical as well as institutional level. For this purpose, information was collected in six categories: Transit Connections, Scheduling, Fare Collections, Traveler Information, Maintenance, Inter-Agency Operations. A brief description of the survey findings is provided next and is also summarized in Table 9-1.

The interregional transit agency service areas are illustrated in Appendix E. The major interregional rail and bus routes and intermodal passenger stations are illustrated graphically in Appendix F.

Transit Connections

The purpose of collecting this information was to find out how each individual regional transit agency provides connections to other transit agencies. As can be seen from the table most agencies provide connections to local transit services, Amtrak and Metrolink, where these services are available. The regional connections are mostly provided by trains--Metrolink or Amtrak. Not many bus connections exist for interregional travel except between Los Angeles and Orange Counties.

Scheduling

Though the agencies surveyed all provide fixed route service, real-time scheduling is important in case of delays, or breakdowns of buses or trains. The purpose of collecting this information is to find out what kind of facilities are available with agencies to schedule their services in the first place and what possibilities exist to perform any automated re-scheduling in cases of emergencies. The regional transit agencies in the Corridor use traditional methods for scheduling purposes, except Riverside Transit Agency, which plans to be fully automated in next two years.

Fare Collection

Cash, tokens and passes are the most prevalent form of fare collection for all agencies. Most agencies support the need to handle less money but they do not have any other means of fare collection in place except for Amtrak. Amtrak uses a debit card and a satellite ticketing facility for their fare collection. Ventura County Transportation Commission is sponsoring a debit-card demonstration.

Traveler Information

Traveler information is an important element of transit operations. The purpose here is to find out how travelers get information about the schedule of these transit operations for their trip planning as well as once the trip has begun, i.e. after they arrive at a bus stop or train station. The survey showed that many means of traveler information are available for pre-trip planning; from simple maps and timetables to information available on telephones and websites. None of the agencies provide any scheduling information on train stops or bus stops regarding time of arrival of next train or bus. Some agencies have fleets equipped with automated vehicle location (AVL) systems using global positioning systems (GPS) (for example LADOT) but do not have means to communicate the information to travelers. Metrolink and Amtrak could display the information on CMSs at Metrolink Stations but their fleets are not equipped withAVLs. The California Smart Traveler initiative has developed interactive kiosks, which were tested in a few locations in Los Angeles County after the 1991 earthquake and will soon be deployed as part of Orange County's Transit Probe and Travel Tip projects.

Maintenance

The purpose of collecting information on this feature is to find out if any on-board automated diagnostics system exist on the fleets to warn the crew about any potential problems with the vehicle. Except Amtrak, none of the agencies surveyed have this capability.

Inter-Agency Operations

For regional travel, this is one of the most important features. This includes any agreements between transit agencies to allow transfers, uniform fare structure, sharing of scheduling information, an attempt to synchronize the schedules, etc. The survey found that most transit agencies have some arrangement for passengers to transfer with connecting services as far as fares are concerned. But this is not uniform either across the regions or within a region. Some agencies allow free transfers, some at discount prices; some allow monthly passes, some do not. There is normally information available for transfers at the starting point. Except for LADOT and RTA, most agencies do not support the idea of a uniform fare structure for regional travel.

Table 6-1, Page 1 (Make into 9-1)

Table 6-1, Page 2 (make into 9-1)

Freight and Goods Movement

This section documents the major attributes and characteristics of goods movements which are relevant to the Priority Corridor. Extensive analysis of good movements for the SCAG region and for the State of California have been undertaken and reported by others. For purposes of this system inventory, we rely on the following recent and concurrent studies to provide a comprehensive description of goods movement and trade flows in Southern California:

- A DRI/Mercer study of goods movement within the SCAG region. The limitation of this data is that it does not include San Diego County;
- Continuing collaborative efforts by SCAG and San Diego Association of Governments (SANDAG);
- A statewide study of goods movement by Reebie Associates. This study divides California into eight business economic areas (BEAs). The combination of the BEAs for Los Angeles and San Diego include all of the Priority Corridor, but also include areas outside the Priority Corridor such as Santa Barbara, San Luis Obispo, and the Owens Valley; and,
- Special emphasis on the CVIBOS.

Summary of Regional Goods Movement

In 1992 an estimated 277 million tons of freight originated in the SCAG region and 332 million tons were destined for the SCAG region. The freight tonnage for San Diego County approximats 22 million tons of originating freight and 38 million tons of destination freight. Thus in aggregate, the Priority Corridor is estimated to have at least 300 million originating tons and 370 million destination tons of goods movement.

Trucking is the dominant mode of Corridor goods movement with more than 80% (truckload, less-than-truckload and private carriers) of the total originating goods movement and 70% of the destination good movement by tonnage. Rail accounts for 13% of total tonnage while waterborne freight comprises 6% of total tonnage; not surprising air freight represents a very minor share by tonnage (but a much more significant proportion of dollar value of all freight).

Over 60% of all freight tonnage originating in the Corridor alsoreaches destinations in the Corridor; thus the majority of freight movements are truck trips and involve intra-regional trips. Freight interchanges with the remainder of California represent the second largest tonnage segment - 18% of tonnage with origin and 13% of destinations.

Inter-continental import and export tonnage is the next largest segment accounting for 9% - 10% of the total. Freight tonnage with Canada and Mexico is surprisingly small - despite the fact that Canada and Mexico are California's second and third largest trade partners respectively.

Airports

Los Angeles International Airport (LAX), the third busiest airport in the world, is by far the busiest cargo airport in California. Major Southern California airport air cargo activity levels are illustrated in Figure 9-1. Leading cargoes handled at LAX include clothing, electronic equipment, household goods and fish. Major trading partners include Japan, Taiwan, South Korea, the United Kingdom, Germany, and Australia.

Ontario airport is the next busiest air cargo facility in Southern California. In addition to other cargoes, Ontario serves as a large regional hub for United Parcel Service. The remaining Southern California airports provide important local goods movement services, but lag well behind LAX and Ontario in terms of regional significance.

Marine Port Facilities

There are three major marine ports in the Southern California Priority Corridor study area: Los Angeles, Long Beach, and San Diego. The relative location and 1994 annual freight tonnage handled by each port are illustrated in Figure 9-2. The ports of Los Angeles and Long Beach are the two busiest ports on the West Coast and, if considered together are the single busiest ports in the United States. By comparison, the Port of San Diego serves special markets, but is not a major player in the waterborne shipping industry. Of the top 30 container-handling ports in the US, Long Beach and Los Angeles rank first and second in terms of volume.

The Los Angeles/Long Beach port complex plays an important role in the national transportation network. Much of the containerized traffic moving through the ports is handled by rail to inland points including Chicago, Dallas, Houston and Atlanta. However, a large portion of the port freight business consists of goods being consumed in the local Southern California market, which are moved from the ports by truck. Accordingly, the Los Angeles/Long Beach port complex is a major generator of truck traffic on the regional highway and rail network.

It is significant to note that a large portion of the Los Angeles/Long Beach port volume is being handled by rail, but requires a truck drayage movement in Southern California to make the intermodal connection. This is due to the locations of the intermodal terminals of all three major railroads serving the region.

In the case of the Burlington Northern Santa Fe, the majority of the port volume moves by truck between the ports and their East Los Angeles terminals on the I-710 freeway. For Union Pacific, the containers are handled through the ICTF at Carson.

Highways

Trucks account for over 68% of all goods movement tonnage within the Priority Corridor area. The region's freeway network handles the majority share of the trucking activity. The average daily truck volume range on the various segments of the regional highway network is documented in Appendix G. The busiest route segments carry as many as 35,000 trucks per day; a hefty mileage of freeway routes carry in excess of 15,000 trucks per day.

The aggregate boundary crossings represent a small fraction of total truck trip activity, again confirming earlier data showing the preponderance of freight movements are intra-regional. Average daily truck volume across the northern Priority Corridor boundary is approximately 23,300 to 32,300 vehicles, across the eastern boundary about 7,600 trucks, and across the California - Mexico border, about 3,900 trucks.

Figure 6-1 (9-1)

Figure 6-2 (9-2)

Southern California Weigh-in-Motion Sites

Caltrans has deployed approximately 40 automatic high-speed weigh-in-motion (WIM) stations on mainline highway lanes throughout California. These planning and data collection stations capture vehicle classification and vehicle weight data continuously. They are distinct and separate from facilities at which commercial vehicle enforcement is conducted.

The vehicle classification/weigh data is stored in a roadside controller which is periodically (often daily) polled by the Data Center in Sacramento. The Data Center retrieves and analyzes the data for anomalies, which fall outside of expected value boundaries. Fourteen of these planning/data surveillance sites gather data for the Strategic Highway Research Program (SHRP).

The weigh-in-motion scale sites in Southern California are included in Appendix H. A total of twelve planning or SHRP WIM sites lie within the Priority Corridor region.

Commercial Vehicle Enforcement Facilities

Commercial vehicle enforcement functions performed at enforcement facilities typically include enforcement of weight/dimension limits, verification of vehicle registration, fuel tax, driver qualification and related credentials, and examination of vehicles for compliance with motor carrier safety regulations. The existing and planned facilities are presented in Table 9-3.

Table 9-2
Enforcement Facilities by Class Type

California Commercial Vehicle Enforcement Facilities					
Class	Existing	Future			Ultimate
		Decrease due to upgrade or closure	Increase due to upgrade	New	
A: Port of Entry Facility	2	0	0	6	6
B: Inspection Facility	15	0	2	2	18
C: Platform Scale with Racetrack	15	3	1	1	14
D: Platform Scale, no Racetrack	23	2	0	0	21
TOTAL	53	5	3	9	59

Weight enforcement includes confirmation of allowable weights for single axle, tandem axle, bridge formula, and gross vehicle weight. A "Level 1" North American Standard Safety Inspection typically takes about 30 minutes to complete, and includes inspection of the vehicle's brakes, steering, wheels, tires, trailer connecting devices, frames/suspension, lights and hazardous materials/waste compliance as well as examination of the driver's license, medical certificate, number of hours of operation log and commercial operator's license.

Rail Freight Corridors

Southern California is served by two major U.S. rail systems; the Burlington Northern Santa Fe Railroad (BNSF) and Union Pacific Railroad (UP). The recent merger of the Southern Pacific (SP) and UP systems reduced the number of railroad companies serving the region from three to two, and resulted in consolidation of freight movements into fewer high capacity facilities. The principal rail network within the Los Angeles basin is included in Appendix I. The San Diego and Imperial Valley railroad, owned by San Diego’s MTDB, envisions expanded border-related freight activity.

The Southern California freight rail network consists of several types of lines, each of which have different characteristics:

Principal Mainlines are the main routes for the owning carrier to access the region and can be thought of as comparable to the interstate highway network. These lines are an integral part of the national railway structure and primarily handle traffic moving into, out of or through the region. While rail using industries may be located along these lines, their primary purpose is for the movement of high speed, heavy trains through the region.

Secondary Mainlines are routes which access a sub-region or which provide additional capacity for a parallel Principal Mainline. These routes extend the reach of their owner within the region but are not critical components of the national rail structure. These lines are comparable to multi-lane surface arterials on the highway network.

Branchlines are routes which reach into local areas primarily for the purpose of reaching industries who use direct carload services. These lines are comparable to the surface street network.

Over the last several decades, a significant number of branchline routes have been abandoned as freight hauling facilities. This has occurred as land uses along those Corridors shifted from industrial to retail, office or residential uses and by the concurrent expansion of the trucking industry. While many of the old routes have been broken up, many more have been incorporated into the region’s roadway network. In addition, some of these Corridors have been acquired by the Southern California Regional Rail Authority (SCRRA) and have been revitalized as part of a regional passenger transportation system. One example is the BNSF coastline from Los Angeles/Anaheim to San Diego (only one freight train per day is operated on this line).

Rail/Highway Intermodal Hubs

Intermodal (truck/rail) traffic is an increasingly important component of the rail freight transportation system in the region. Each of the rail systems has high volume intermodal terminals in the region and has plans for expansion of existing facilities or the development of new ones.

Historically, rail traffic was handled in a carload configuration (boxcars, gondola cars, etc.) and moved into its destination area on a Principal Mainline to a major railroad yard. From that point, it was switched onto a local hauler train to move to a sub-region, and frequently, was hauled onto a branchline for final delivery to the receiving industry.

With the development of intermodalism, freight is loaded into containers, which are transferred between truck chassis and rail cars at intermodal terminals. In a simplified sense, local truck drayage services using the regional roadway network replace the major railroad yard, the local hauler train and the extensive branchline network needed to provide rail freight services to customers. The locations of the primary rail-truck intermodal facilities are documented in Appendix I. The Santa Fe's Hobart terminal and the Southern Pacific's ICTF, each with over 50,000 lifts per month, have significantly higher monthly activity than do the others.

There are two efforts underway which will have a significant impact on the port related truck traffic using the highway system to effect the marine-rail transfer. First, the ports and the railroads are jointly developing a consolidated rail Corridor between downtown Los Angeles and the port complex. This Corridor, known as the "Alameda Corridor" will follow the current SP route along Alameda Street but will be used by all three railroads. As the Corridor will be fully grade separated, vehicular congestion (even with an increased number of trains on the route) will be reduced.

Second, there are new "on-dock" terminals being developed within the ports which will enable the marine shipping companies to transfer containers onto railcars *within their terminals* for movement via any of the three railroads. As these facilities are developed, significant truck volumes, particularly along the I-710 route, will be reduced; the movements will shift to rail movements using the Alameda Corridor to reach the primary route of the hauling railroad near downtown Los Angeles.

Approximately 50% of the current rail volume is handled by the BNSF and UP railroads. Most of this traffic is expected to shift to all-rail movement to/from the port complex with the implementation of the Alameda Corridor and the development of new on-dock transfer terminals.

Goods Movement to/from Mexico

Goods movement from the SCAG Region to Mexico is highly concentrated to the state of Baja California Norte, which borders California. Conversely, goods movement from Mexico to the SCAG region shows no dominant concentration from any particular state, but comes from a wide distribution of locations within Mexico. Existing Southern California highway-crossing facilities along the international border with Mexico include:

- San Ysidro
- Otay Mesa
- Tecate
- Calexico/Mexicali
- Andrade/Algodones

Trucking is the dominant mode for goods movement between the Priority Corridor region and Mexico. Data for the SCAG region show that truck tonnage accounted for 93.7% of the mode share in the 1992 base year. Rail had a 5.6% mode share while other modes captured only 0.7%. Of the trucks which cross the border, approximately 16% had origins or destinations in San Diego and Imperial Counties, 59% had origins or destinations within the rest of California, and 25% were out of state. This suggests that truck border crossings are an issue of state and national importance, not solely a matter of concern and interest within the border region.

Currently, Otay Mesa handles 59% of the commercial truck traffic crossing the California/Mexico border, while Calexico/Mexicali handles 33%, and Tecate 8%. The Andrade/Algodones crossing is relatively insignificant in terms of border crossing traffic. The San Ysidro border crossing handles only pedestrian and passenger vehicle movements. A new border crossing known as the East Calexico Port of Entry (POE) was opened in the spring of 1997. Feasibility studies have been conducted for a potential new border crossing a few miles east of the existing Otay Mesa POE.

Transborder Rail Freight Corridors

There are two railroad border crossings in California between the US and Mexico; one at San Ysidro/Tijuana and the other at Calexico/Mexicali. Calexico is reached by Union Pacific and connects to the Ferrocarriles Nacionales de Mexico (FNM) Pacific Route. This is the only connection with the Mexican railway system, which allows for freight movement to points throughout Mexico.

The San Ysidro crossing connects with the Tijuana & Tecate (T&T) Railroad in Mexico. This line is owned by FNM but is isolated from the rest of its system. In previous years, the T&T was used by the San Diego & Arizona Eastern Railway as part of a through route between San Diego and a connection with UP near El Centro. The through route is not currently operational as a result of extensive storm damage. The small amount of rail freight traffic moved across the border at San Ysidro is destined to points near the border between Tijuana and Tecate. A recent study by SANDAG established the feasibility of rehabilitating and re-opening the through route between San Diego, Tijuana and Tecate to Plaster City where the line connects with UP. Re-opening of the route could permit rail handling of certain products through port facilities at San Diego for movement to Mexico.

Although these two lines serve local rail traffic needs, the majority of rail goods movement between California and Mexico crosses the border outside of California. Data compiled by Caltrans indicates that 19% of the California - Mexico rail goods tonnage moves through Calexico, 6% through Nogales, Arizona, and 75% occurs through Texas. (The relatively small goods movement occurring at the San Ysidro crossing was too small to register in this comparison.) Although the rail distance from Los Angeles to Mexico City is slightly shorter through Mexicali than through Texas, the superior infrastructure available on the Texas route makes this the preferred path.

Transportation Demand Management (TDM)

Regional Transportation Demand Management (TDM) Programs are currently administered within the Priority Corridor by SCAG and SANDAG. SCAG maintains a database of approximately 650,000 commuters in the five county regions. Of those 650,000 commuters approximately 450,000 are currently ridesharing to some extent. In addition to matching commuters for carpooling and vanpooling, SCAG also offers the commuter extensive information regarding Park & Ride locations, bus and train schedules, and real time traffic congestion information via telephone, mail and website. In addition, seven telecommuting workcenters have been established in the SCAG region, which allow employees to travel to work locally instead of driving long distances.

SANDAG maintains a TDM service/database called Ridelink, which includes employer transit programs, commuter efficiency programs and employer carpool/vanpool programs. Ridelink operates a regionwide rideshare matching service and has available staff to assist employers in developing worksite commuter efficiency programs to address the San Diego area transportation needs of employees and improve mobility throughout the region.

Currently, the Priority Corridor Steering Committee is pursuing an inter-regional rideshare database linkage. This project will link the separate SCAG and SANDAG databases and enable individuals to obtain transit itineraries, vanpool information, and ridsharing information. Execution of the project will allow each agency to coordinate the electronic exchange of transit and other rideshare information throughout Southern California -- from Santa Barbara to San Diego. In addition, SCAG is overseeing the Regional Transit Database Information Exchange project (RTDIE). This project, in coordination with Ventura and San

Diego County, will result in widespread public accessibility to coordinated, up-to-the-minute, reliable transit information through the Internet.