Pomona Valley
ITS Project

Project Deliverable 6.1.2

Concept of Operations and Area Architecture Report

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November 14, 2002

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Concept of Operations and Area Architecture Report

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PROJECT DESCRIPTION

The County of Los Angeles, in cooperation with the cities within the Pomona Valley, has determined that development of an Intelligent Transportation System (ITS) in the Pomona Valley would help to reduce congestion, enhance mobility, provide traveler information during non-recurring and event traffic congestion, and manage event traffic. The Pomona Valley Intelligent Transportation Systems (PVITS) project was conceived as a recommendation from the Pomona Valley ITS Feasibility Study completed by the LACMTA in 1995. The ultimate objectives of the Project are to:

- Improve mobility by optimizing traffic management on arterials and freeways;
- Enhance Route 60 capacity by better coordinating freeway traffic with parallel arterials;
- Improve agency efficiency by coordinating management of operations and maintenance efforts among and between agencies; and
- Increase agency staff productivity by providing low-maintenance, high-quality communications and computational tools to assist in daily management and coordination activities.

Phase 1 of the PVITS project is the development of a conceptual design that defines solutions to enhance capacity, reduce congestion, and improve traveler information in the Pomona Valley.

1.0 BACKGROUND

1.1 Purpose of Report

With the completion of Task 5, Requirements Analysis, of the PVITS project, the needs of the project stakeholders and requirements of the systems proposed for deployment have now been documented. Once requirements are completed, the next step of a typical ITS project is to develop an architecture and concept of operations.

An architecture is a framework that describes how different systems, subsystems and ITS components interact and exchange information to achieve regional goals and objectives. An area architecture provides guidelines for interconnecting existing and future systems within the region. In doing so, the architecture framework provides the ability to accommodate technology changes, evolution, and growth of the system. Rather than installing technologies and implementing systems in a piecemeal fashion, it is important to have a framework in place in which the various systems will be designed and integrated to satisfy regional goals and objectives. By establishing this framework (the ITS architecture) for ITS deployment in the Pomona Valley, the project partners will be able to design and implement projects that meet both local needs and regional goals, and comply with Federal funding requirements.

The architecture must also address consistency issues between the ITS deployments in the Pomona Valley and demonstrate compliance with national architecture standards. This will minimize the risks involved in deployment of the ITS technologies, and improve inter-jurisdictional and public-private communications. As a part of the architecture, flow diagrams to identify the position and importance of the ITS elements within the regional ITS deployment should also be identified. The requirements for linking to each of the existing systems within the study area will address the standards and protocols required by each jurisdiction. The project architecture provides the framework within which the traffic control equipment would operate, will serve as a framework for regional ITS project development and design.

The purpose of the Pomona Valley area architecture is to ensure that ITS components and projects that are deployed are built in an integrated fashion; building on each other and capitalizing on the infrastructure and operational funding for the region. The proposed architecture lays the foundation for establishing communication links and seamless exchange of traffic and traveler information among different agencies and subsystems. The process of ensuring consistency with the architecture for other projects deployed in the Pomona Valley will ensure that an integrated system continues to be deployed into the future. Specifically, the ITS architecture:

- Identifies the different transportation management agencies in the Pomona Valley and describes how they will interact;
- Identifies telecommunications connections and transportation data flows required among participants;
- Supports the development of open systems (i.e., systems with interfaces that use standard or known ITS communication protocols);
- Incorporates existing and planned systems;
- Accommodates new technologies in the future;
- Provides a framework for multiple design choices; and

- Provides a structure for future planning and growth.

1.2 Definitions

The proposed Pomona Valley ITS Architecture was developed using the National ITS Architecture concepts and nomenclature. The following are terms used in the National Architecture and in this report to describe the data, processes, and infrastructure that form the existing and future elements of the Pomona Valley ITS architecture.

The ***logical architecture*** defines what needs to be done functionally to support the selected user services. It does so through the use of ***processes***, which perform ITS functions; ***terminators***, which define the end points of the architecture, and connecting ***data flows*** that are needed to support those user services. Many different processes must work together and share information to provide a user service. ***User services*** describe what functions ITS will provide to users (travelers, traffic managers etc.) to contribute to meeting the users' transportation needs. As such, the selection of the user services forms the basis for the logical architecture.

The ***physical architecture*** provides a high-level definition of the major system components and interfaces. The physical architecture is based on market packages. ***Market Packages*** describe the physical components required to implement a particular user service. A market package may meet one or more user services. A market package can be further broken down into ***subsystems***, ***terminators***, and their connecting ***architecture flows***, or data flows.

The ***institutional layer*** of the physical architecture represents the institutional arrangements that exist or will be required in the Pomona Valley Forum that form the context in which the architecture elements will be deployed. This layer deals with policies, working arrangements, and the jurisdictional structure that support the technical layers of the system architecture.

1.3 Methodology

The Pomona Valley ITS architecture development builds on the previously identified stakeholder objectives. User services that would have the potential of meeting those objectives were then selected from a predefined list in the National Architecture. This list of user services forms the basis of the logical architecture. The user services were mapped to market packages. The market packages were used to derive the physical architecture.

1.4 Report Organization

The information in this report is presented in the following sections:

Section 1 – Background

Section 2 – Concept of Operations

Section 3 – Existing Systems and Architectures

Section 4 – Proposed Pomona Valley Architecture (logical and physical)

2.0 CONCEPT OF OPERATIONS

The Concept of Operations for PVITS, describes in "story" terms:

- how the different systems and subsystems will work together;
- how the agencies and operators will interact in daily operational situations;
- how traffic gets managed; and
- how traveler information gets to the public.

The following sections describe typical daily operations for each system level as defined in other LA County projects in the subregion. For clarification purposes, these levels can be described as follows:

- Level 3 – Pomona Valley Subregional Traffic Management Center (TMC) and LA County TMC
- Level 2 – Local City Control Site (LCC)
- Level 1 – Local Monitoring Only Site

2.1 Level 3 – Pomona Valley Subregional Traffic Management Center (TMC) and LA County TMC

The TMC houses the PVITS Information Exchange Network (IEN) server and the ATIS server. The IEN server is a part of the County's integrated traffic management system that allows different types of traffic signals to communicate between jurisdictions. A server is located in each County Forum, or subregion, to enable this communication. The TMC also coordinates inter-jurisdictional responses to incidents and events within the subregion. CCTV cameras and other field equipment belonging to each of the Level 2 agencies can be accessed and controlled by any Level 2 or Level 3 agency that has been given proper permission.

On a daily basis, the subregional TMC operator (a position staffed by the city in which the subregional TMC is located) would perform local traffic signal maintenance for the city, just as an LCC operator would (scenario described below). When an incident is reported by emergency services, the LCC operator (Level 1 or Level 2) enters the pertinent information about the incident on the local IEN workstation. This information is then automatically disseminated through the IEN server to all local city IEN workstations in the subregion as well as to the ATIS server. The ATIS server then automatically updates the Internet site, kiosk feeds, and dial-in 511 service to reflect the reported incident.

When the incident affects traffic on facilities belonging to multiple jurisdictions, the TMC operator's main task is to coordinate the responses of the LCC operators in the affected jurisdictions. The TMC operator submits a request via the IEN for the affected agencies to implement their pre-agreed plan changes. Normally, the LCC operators will approve the request and make the requested changes. Examples of possible changes would include using dynamic message signs to inform travelers of the incident and of suggested alternate routes, and implementing different signal timing plans to accommodate changes in traffic patterns due to the incident. If, however, the LCC operators believe the pre-agreed plan changes to be an inappropriate response to the incident at hand, they can use the IEN to send more appropriate recommendations to the TMC operator. The TMC operator takes these recommendations and submits a revised request to the affected jurisdictions.

When the LCC is not operational – for example, after hours – the TMC operator's responsibility increases. In the event of an after-hours (for the LCC) incident, the TMC operator is responsible for contacting the LCC operators via a pager or telephone and submitting a request, just as would normally be the case. However, the LCC operators may be unavailable or may not be able to quickly and easily access their local ATMS and IEN workstations. In such cases, the TMC operator will have the capability to implement the pre-agreed plan changes and analyze their effectiveness. In time, many of the LCC operators may decide to permit the TMC operator to make necessary pre-agreed plan changes for routine after-hours incidents without first consulting them to avoid having to return to the LCC after-hours.

The TMC operator, through various means such as the use of CCTV cameras, determines when the incident has been cleared, and alerts the LCC operators in the affected jurisdictions of the incident clearance. The LCC operators then use their local ATMS to return any changed equipment or timing plans to their normal settings. A notice is automatically sent to the other local city IEN workstations of the incident clearance and any accompanying changes. The ATIS server receives the same notice and automatically updates the traveler information sites.

In addition, the IEN would automatically file an event log describing the incident and what changes were implemented to minimize the effect of the incident on others. In the future, the performance of the incident response can be compared to other incidents and their respective responses to determine which implementation plans work best for a given situation.

2.2 Local Control Center

A Level 2 site at a city will consist of an IEN workstation and an ATMS workstation to control the city's own traffic signals. The LCC also maintains control of any field equipment, like CCTV cameras and dynamic message signs, within their jurisdiction. In most cases in the Pomona Valley, the LCCs will not be staffed by operators, but rather will be available for use on an as-needed basis by traffic and maintenance engineers in each city. A city traffic engineer, for example, could use the LCC on an as-needed basis to monitor its traffic signal operations through the ATMS and CCTV camera views. On a daily basis, the City can monitor the daily operations of the signals remotely through the ATMS/IEN workstation. Each ATMS would enable an LCC operator/ city engineer to upload and download plans directly to the traffic signal controllers in the field, thereby improving traffic management. Operators would also be able to monitor faults such as detectors that are down or permanent pedestrian calls and may be able to fix certain issues without making a trip to the field. Operators will get daily status reports of the system to be able to respond to issues. Operators will also be able to view timing plans live on the workstations to confirm or address citizen complaints more efficiently. Finally, the systems will allow for data archiving for better future planning. The operators would also be able to view video images from neighboring agencies on the workstations. As a part of daily activities, any planned events or construction could be manually input as desired by the City, on the workstation, in order to share this information with other agencies through the IEN and with the general public through the ATIS.

In some cases, a Level 2 city owns traffic signals, but, through agreement, has chosen for those signals to be controlled by another agency on a regular basis. For example, the City of Industry plans for the County of Los Angeles to continue their current agreement to operate traffic signals on their behalf. In these cases, the City will still have the ability to control its own signals at any time that it chooses to take back control.

For incident or daily traffic management, field element control can be relinquished, if desired, so another entity that can make needed changes, like the TMC, could do so after-hours. Level 2 stations, while unable to control the equipment of another Level 2 facility without permission, can view the current state of other agencies' equipment by using the IEN. For example, the LCC operator of City A can use the IEN workstation to view the CCTV cameras in adjacent City B to better gauge the impact of an incident in City B on City A.

As discussed in section 2.1, each LCC is responsible for reporting incidents or events to the TMC through the IEN workstation. Once the TMC has submitted a request for a pre-agreed plan change, each respective LCC operator must analyze the request. If the request is approved, the LCC operator makes the requested changes to signs or traffic signals to appropriately respond to the incident. If the request is denied, the LCC operator uses the ATMS workstation to evaluate possible solutions and make a recommendation to the TMC. As is the case with the TMC operator, any action taken by the LCC operator is automatically filed as an event log in the IEN system.

Over time, as trust in and cooperation with the TMC and other LCC facilities grow, and experience with incident response increases, the LCC operator may decide that reoccurring incidents can easily be handled by the TMC without needing to first consult the LCC operator. If such is the case, the LCC operator will reach an agreement with the TMC operator for which circumstances do not need Level 2 approval before implementing a plan change.

2.3 Local Monitoring Only Site

A Level 1 site is an agency or stakeholder with monitoring only capabilities that does not own field elements or traffic signals. These entities will have IEN workstations to monitor data from within and outside of the Pomona Valley. CCTV video can be monitored by these agencies via the Internet on a separate computer supplied by that entity. The video monitoring computer can be the same computer that is used for other office-related activities.

Local monitoring-only sites, such as Foothill Transit, would be able to watch the IEN workstation to observe field element status (e.g., the message displayed on an arterial-based DMS), traffic signal status, and events. This observation can be used by those entities on a daily basis for regular traffic management or during events or incidents. Since the Level 1 locations by definition do not own traffic signals or other field elements, it is unlikely that these entities would utilize the IEN workstation for daily operations (they are not performing any) but rather for special events, incidents, or other special circumstances. These agencies can also view video by selecting different cameras, owned by other agencies, via the Internet at any time on a separate computer. These agencies cannot control any of these elements.

If necessary, a Level 1 agency can input information into the PVITS system through the IEN workstation related to events. As with event input from Level 2 and 3 agencies via the IEN workstation, events would be automatically displayed on all of the IEN workstations in the subregion as well as sent to the ATIS for display on the dissemination media such as the Internet site.

3.0 EXISTING SYSTEMS AND ARCHITECTURES

Several systems are already planned or in place that affect traffic management in the Pomona Valley subregion. These systems will impact the way the Pomona Valley agencies would exchange information and manage recurring and non-recurring congestion in the region. Below are functions of systems that will be considered in defining an architecture for a region that would be impacted by these systems:

- Ability to exchange real-time traffic data and control (data and video images);
- Ability to communicate and exchange traffic and traveler information with the regional agencies;
- Communications;
- Operations, Management and Maintenance;
- Ability to grow with agencies' needs (scalability);
- Ability to be non-proprietary (openness);
- Future hardware and software upgrades; and
- Conformance with national and regional ITS architecture standards.

The following sections describe the architectural framework for the projects that were considered in developing the Pomona Valley architecture.

3.1 Los Angeles and Ventura Counties ITS Strategic Deployment Plan (SDP)

The Los Angeles and Ventura Counties ITS SDP, completed in 1998, is a comprehensive plan to define the ITS deployment needs and issues for the region over the next 20 years. The plan defines near-term, mid-term and long-term needs based on prioritized rankings by the region's stakeholders. Only the user services identified to meet the near-term needs (not the long-term user services) are listed here. These near-term user services will be filtered for inclusion in the Pomona Valley architecture.

Table 3-2 Los Angeles/Ventura SDP User Services

1.0 TRAVEL AND TRAFFIC MANAGEMENT
- 1.1 Pre-Trip Travel Information
- 1.2 En-Route Driver Information
- 1.3 Route Guidance
- 1.4 Ride Matching and Reservation
- 1.5 Traveler Services Information
- 1.6 Traffic Control
- 1.7 Incident Management
- 1.9 Emissions Testing and Mitigation
- 1.10 Highway-Rail Intersection

2.0 PUBLIC TRANSPORTATION MANAGEMENT
- 2.1 Public Transportation Management
- 2.2 En-route Transit Information

3.0 ELECTRONIC PAYMENT
- 3.1 Electronic Payment Services

4.0 COMMERCIAL VEHICLE OPERATIONS
- 4.1 Commercial Vehicle Electronic Clearance

5.0 EMERGENCY MANAGEMENT
- 5.1 Emergency Notification
- 5.2 Emergency Vehicle Management

3.2 Existing and Planned Pomona Valley ATMS

3.2.1 City of Pomona

The City of Pomona currently has a QuicNet II traffic control system. The traffic signals on regionally significant arterials are currently running fully traffic actuated within TOD coordination plans (WWV is used to synchronize the time clocks in the controllers).

3.2.2 LA County Planned Advanced Traffic Management System (ATMS)

The Los Angeles County Department of Public Works is currently procuring an advanced system to enhance traffic signal synchronization, operation, and maintenance; improve arterial traffic flow and bus speeds; reduce motorist delay; and lower fuel consumption and emissions for County owned traffic signals. The system will communicate with and operate signals in unincorporated areas throughout the county, and have the capability to provide operations for cities as requested on a contract-basis. The County is currently in the process of selecting a system for purchase/ implementation.

3.3 Information Exchange Network

In the 1990s, in an effort to improve regional arterial traffic flows and reduce traffic congestion Countywide, the MTA initiated a broad program for enhancing existing transportation infrastructure by combining traditional traffic engineering measures with state of the art technology to provide relief from traffic congestion on surface arterials through the better use of existing faculties. The first step of this program was the formation of area traffic forums. These forums consisted of working groups of local traffic professionals working cooperatively to discuss interjurisdicitonal issues and build consensus on regional traffic system improvements. After the forums were established, each area began the development of its own strategic traffic management plan that identified traffic system improvement opportunities and constraints. In 1995, Los Angeles County assumed the lead role in an effort to implement the improvements identified in these plans.

The subareas for which LA County is administering these identified improvements are as follows:

- Pomona Valley;
- Gateway Cities;
- South Bay; and
- San Gabriel Valley

The initiation of this multi-jurisdictional effort lead to the need for an integrated traffic management system whereby different types of traffic signals could communicate between jurisdictions to enable a multi-jurisdictional response to incidents and congestion. To meet this need, the County hired a consultant to develop the Information Exchange Network (IEN). The IEN software enables the connection of multiple traffic control systems into one network that provides for the sharing of second by second intersection data to support real-time traffic signal coordination between jurisdictions. The sharing of data will facilitate multi-jurisdictional arterial coordination and provide incident management capabilities. It will also allow traffic signals to be controlled and monitored from a remote location and provide the capability to relinquish control between jurisdictions. The development of the software has been completed and is now proposed for expansion countywide. The expansion of the system will result in a substantial improvement in the operation and synchronization of traffic signals countywide, reduced traffic congestion and delay, improved mobility, and reduced vehicle emissions, thus improving the overall quality of life for the residents of the County of Los Angeles.

Each cities' ATMS system and the County's would interface and exchange traffic and traveler information with each other by connecting to the LA County Information Exchange Network (IEN).

While the IEN does not provide any user services directly, it will provide the links required for the different agencies to talk to each other, share information, and share control capabilities as desired.

3.4 Caltrans District 7 ATMS

The Caltrans District 7 (LA/Ventura Counties) ATMS was defined and built before the National ITS Architecture was formally published. The system primarily supports the freeway traveler and system operator needs. Based on the system functionality and Caltrans' operational objectives, the following highlighted user services are assumed to be provided.

Table 3-4 Caltrans District 7 ATMS

1.0 TRAVEL AND TRAFFIC MANAGEMENT
- 1.1 Pre-Trip Travel Information
- 1.2 En-Route Driver Information
- 1.5 Traveler Services Information
- 1.6 Traffic Control
- 1.7 Incident Management

4.0 COMMERCIAL VEHICLE OPERATIONS
- 4.5 Hazardous Material Incident Response

4.0 Pomona Valley Area ITS Architecture

The area architecture defines how the systems and agencies will interact to better manage traffic in the Pomona Valley region. The architecture is defined in terms of functional, or logical, components and physical components. The physical view includes the institutional layer discussions as well.

The primary components of the area architecture and the overall functionality of each are as follows:

Local ATMSs Traffic Signal Control System	Each local ATMS is a system that will meet the transportation management needs of each local agency and the subregional needs of the Forum (such as inter-jurisdictional traffic signal coordination).
Subregional ATIS	The ATIS will provide traveler information to the general public via a variety of dissemination media. The majority of the data will be collected automatically from the individual ATMS at each city. Additional data can be input manually at each LCC through the IEN workstation event input log. ATIS functions could easily be addressed by existing staff (whether TMC staff, or even PIO/Government relations for the ATIS elements), as device-specific operational time requirements are minimal.

Communication Networks	The major communication network will be the IEN WAN, which will allow monitoring and data sharing on a second-by-second basis within and outside of the Forum. A second network will allow video sharing. The internet will be used for some video monitoring and for information dissemination to the general public.
Local City Control Sites (LCC)	The local LCCs will be offices or other such spaces at each city where the IEN workstation and (where applicable) ATMS workstation will be located. In some cases, the CTCS might have dedicated video monitors or a small video wall for viewing capabilities in addition to the viewing available on the ATMS workstations.
Subregional TMC	The subregional TMC will be the location of equipment that will perform subregional roles, including, but not limited to, the ATIS server and the PVITS IEN server. The subregional TMC will also likely have a larger staff than a local LCC.
Local ATIS	Local ATIS will consist of DMS.

4.1 Logical Architecture

A logical architecture defines what *functions* are needed in order to provide the user services of a region. It does not specify where these functions should reside. In other words, a logical architecture defines *what* system functionality is needed and not *where* or *how* these functions are performed or implemented. A logical architecture diagram breaks down a system into several functions and shows the data relationship between each function in the form of data flows.

A logical architecture is derived from user services and/ or user service requirements (more detailed functions required to accomplish each user service). The logical framework of the Pomona Valley area architecture defines some of the processes and data flows that are needed to provide the user services identified below. **Figure 4-1** depicts logical architecture for the PV-ITS. Processes are depicted as bubbles and data flows are labeled along the connecting arrows. Not all functions would be implemented by the local agencies. The functions depicted describe the services that will be provided in the region. The functions shown in the figure could be provided by a variety of different agencies and projects including Los Angeles County, as parts of other corridor-wide projects; Caltrans; California Highway Patrol; and other transportation management agencies and emergency service providers.

Based on the previously summarized objectives outlined in **Deliverable 4.1.2 – Stakeholders Objectives Report**, user services have been selected to form the basis of the architecture for the Pomona Valley. The **Appendix** includes a comprehensive list (and definitions) of user services as defined by the National Architecture. **Table 4-1** provides a summary of the user services that have been selected to form the basis of the Pomona Valley architecture.

Table 4-1 PVITS Area Architecture User Services

User Service Category (Bundle)	Project User Services
Travel and Traffic Management Services	1.1 Pre-Trip Travel Information 1.2 En-route Driver Information 1.5 Traveler Services Information 1.6 Traffic Control 1.7 Incident Management 1.8 Travel Demand Management 1.10 Highway-Rail Intersection
Information Management	7.1 Archived Data Function

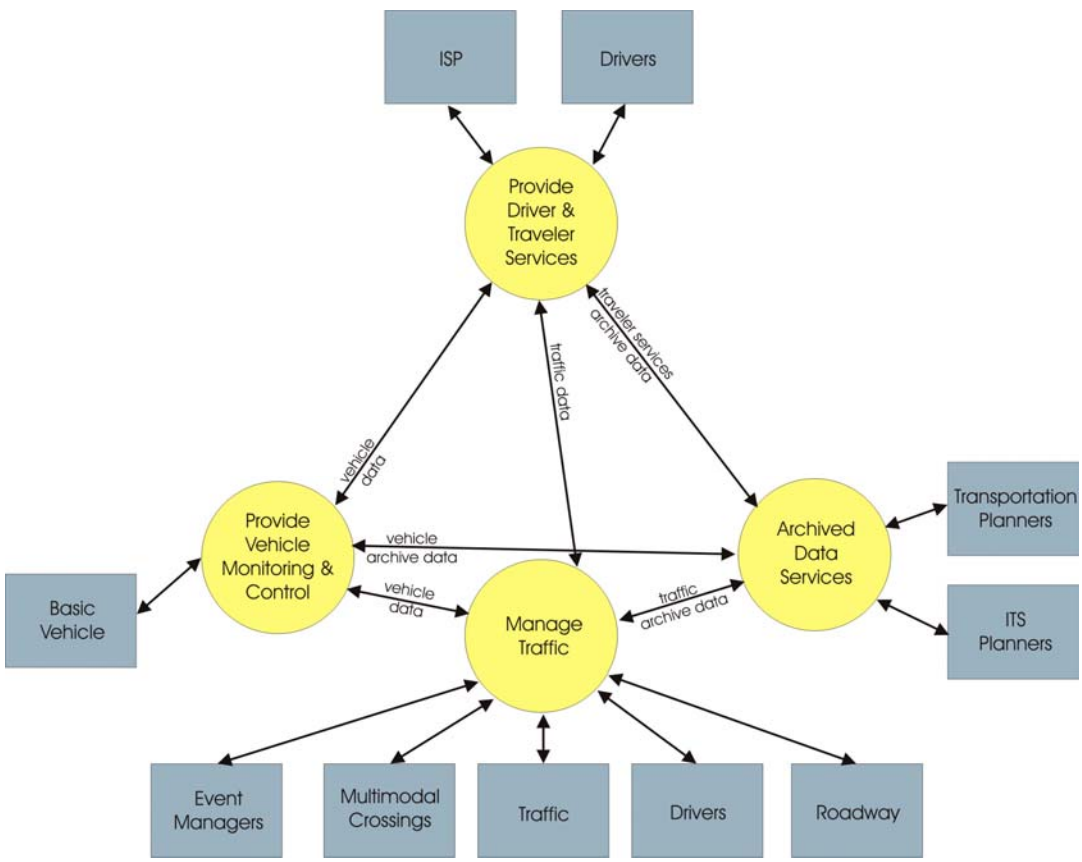

Figure 4-1 Pomona Valley Area Logical Architecture

4.2 Physical Architecture

A physical architecture shows "how" a region or system would achieve the desired functionality and "where" the functions will be performed. A physical architecture defines physical interfaces and distributes the desired functionality among the different stakeholders and systems in the architecture. It shows how the different subsystems connect and what type of data would be shared over those links.

The National Architecture defines four systems (Traveler, Center, Roadside, and Vehicle) and nineteen subsystems. The subsystems and generic communication connections that pertain to the I-5 ICSS are highlighted in **Figure 4-2**.

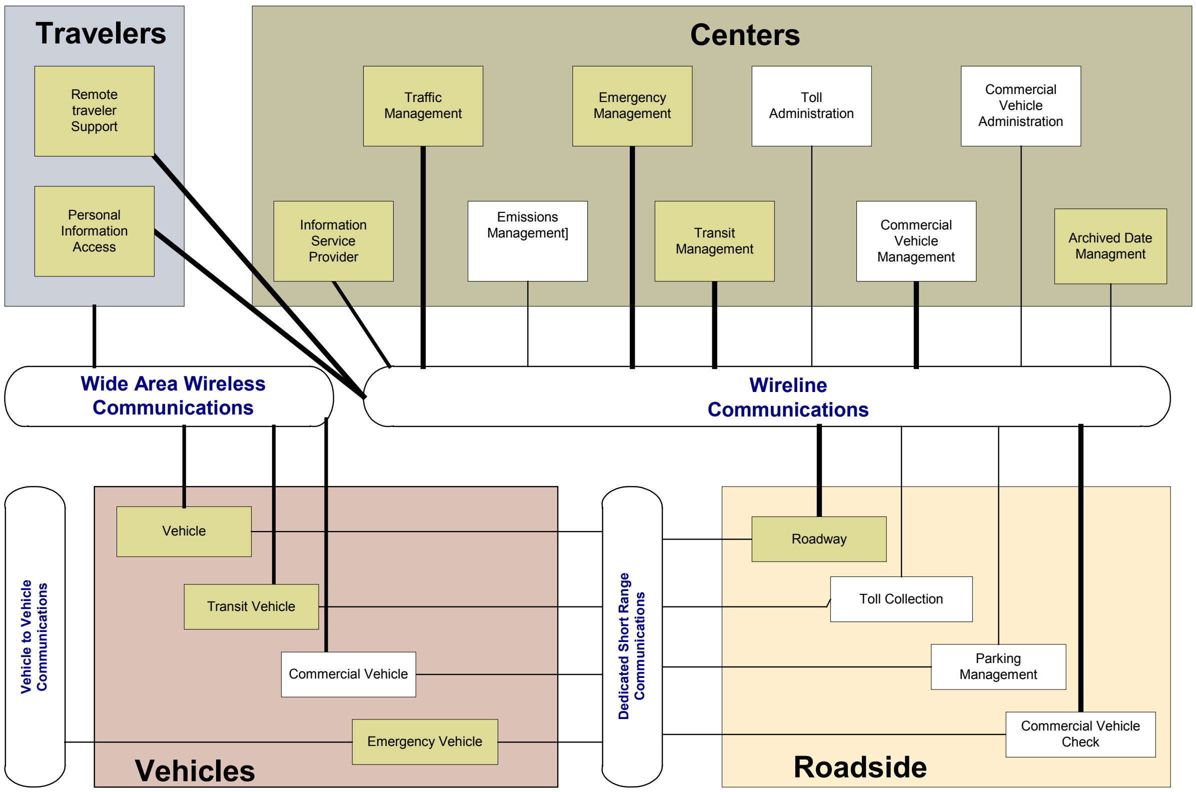

Figure 4-2 Pomona Valley Area Interconnect Diagram

The physical architecture description in this section is organized based on the three primary components, or layers, of the physical architecture:

- **Transportation Layer** which shows what transportation subsystems transfer what information;
- **Communication Layer** which shows how information is transferred between subsystems; and
- **Institutional Layer** which describes the supporting institutional structure, policy, and strategies.

4.2.1 Transportation Layer

The transportation layer defines the physical subsystems that comprise the architecture, such as the roadway, the vehicles, and the traffic management subsystem (which would include multiple agencies' advanced systems). The Transportation Layer groups various functions into subsystems. Each subsystem corresponds to a physical transportation system and identifies major system interfaces with other subsystems.

4.2.1.1 Center Subsystems

Center Subsystems deal with those functions normally assigned to public/private administrative, management, or planning agencies. The Center Subsystems that are applicable to the PVITS area architecture are described below:

Traffic Management – Various agencies would perform traffic management in the PVITS subregion, including the local cities (primarily traffic signal control), Caltrans District-7, Los Angeles County (including traffic signal control for local cities such as Industry, as well as the signals in unincorporated County areas). The Fairplex would also fall into this category for traffic management during events.

Information Service Provider – The ISP would provide the traveler information services to travelers. The ISP function can be provided by public agencies and/ or private entities.

Archive Data Management – In the future, the subregion may choose to archive data historically for future planning purposes. One of the traffic management agencies (likely the location of the subregional TMC) would be the most likely candidates for performing this function on behalf of the subregion. Data will be archived by the ATMS at each local agency, but a subregional approach to compiling the data into a single location would add value. Subregionally, the agencies would be able to utilize data for a broader area than just their own city. This would be helpful to see what is happening on major arterials continuing to or entering from adjacent jurisdictions and for planning or modeling on a subregional level.

4.2.1.2 Roadside Subsystems

These subsystems include functions that require convenient access to a roadside location for the deployment of sensors, signals, message signs, or other interfaces with travelers and vehicles. The Roadside Subsystem that is included in the PVITS area architecture is described below:

Roadway – Provides traffic management surveillance, signals, and signage for traveler information. This subsystem also includes the devices at roadway intersections and multi-modal intersections to control traffic. All existing and future ITS field elements will be part of the roadside subsystem.

4.2.1.3 Vehicle Subsystems

The Vehicle Subsystems that are included in the PVITS area architecture are described below:

Vehicle – Functions that are common to all vehicle types (personal vehicles, commercial vehicles, transit vehicles, and emergency vehicles) are included in this subsystem.

4.2.1.4 Traveler Subsystems

These subsystems represent platforms for ITS functions of interest to travelers or carriers (e.g., commercial vehicle operators) in support of multi-modal traveling.

They may be fixed (e.g., kiosks or home/office computers) or portable (e.g., a palm-top computer), and may be accessed by the public (e.g., through kiosks) or by individuals (e.g., through cellular phones or personal computers). The two Traveler Subsystems are described below:

Remote Traveler Support – Provides traveler information at public kiosks. This subsystem includes traveler security functions.

Personal Information Access – Provides traveler information and supports emergency requests for travelers using personal computers/telecommunication equipment at the home, office, or while en-route.

4.2.2 Communications Layer

The National ITS Architecture provides the framework that can be applied to tie the transportation and communication layers together to enable the development and effective implementation of the identified ITS user services in the PVITS subregion. There are multiple communications options available to provide user services. One of the fundamental guiding philosophies in the development of the National ITS Architecture has been to leverage the existing and emerging transportation and communication infrastructures in its design. The PVITS area architecture will utilize the Los Angeles County IEN as the basis for center-to-center communications, supplemented by a CCTV video network for control, transfer and sharing of video and the Internet for some video monitoring and traveler information dissemination to travelers and the cities.

These three communication networks (IEN, video network and internet) will allow each Center Subsystem in the PVITS subregion to collect, integrate, control and disseminate information to all other center, traveler, roadside, and vehicle subsystems, resulting in improved inter-jurisdictional communications and coordination that in turn will directly affect the efficiency and effectiveness of all center subsystem operations in the PVITS subregion.

The proposed PVITS area architecture is consistent with the National ITS Architecture and other current ITS projects in the area, such as the IEN. **Figure 4-3** represents a top-level summary of the center-to-center communications for the Pomona Valley.

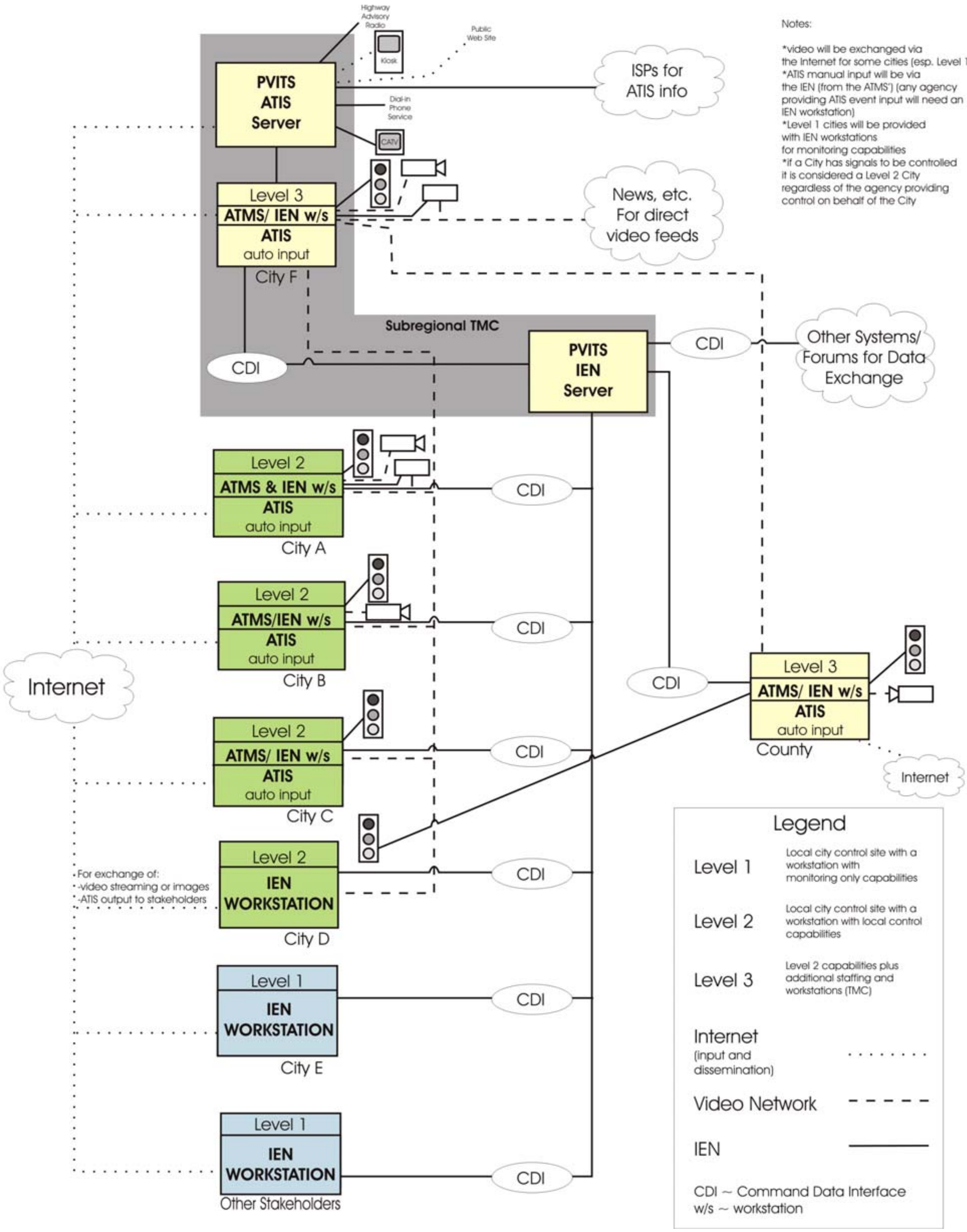
Highway Advisory Radio
Kiosk
Public Web Site
Dial-in Phone Service
CATV
PVITS
ATIS
Server
ISPs for
ATIS info
Notes:
*video will be exchanged via
the Internet for some cities (esp. Level 1)
*ATIS manual input will be via
the IEN (from the ATMS') (any agency
providing ATIS event input will need an
IEN workstation)
*Level 1 cities will be provided
with IEN workstations
for monitoring capabilities
*if a City has signals to be controlled
it is considered a Level 2 City
regardless of the agency providing
control on behalf of the City
Level 3
ATMS/ IEN w/s
ATIS
auto input
City F
News, etc.
For direct
video feeds
Subregional TMC
CDI
PVITS
IEN
Server
CDI
Other Systems/
Forums for Data
Exchange
Level 2
ATMS & IEN w/s
ATIS
auto input
City A
CDI
Level 2
ATMS/IEN w/s
ATIS
auto input
City B
CDI
Internet
CDI
Level 3
ATMS/ IEN w/s
ATIS
auto input
County
Internet
Level 2
ATMS/ IEN w/s
ATIS
auto input
City C
CDI
For exchange of:
-video streaming or images
-ATIS output to stakeholders
Level 2
IEN
WORKSTATION
City D
CDI
Level 1
IEN
WORKSTATION
City E
CDI
Level 1
IEN
WORKSTATION
Other Stakeholders
CDI
Legend
Level 1
Local city control site with a workstation with monitoring only capabilities
Level 2
Local city control site with a workstation with local control capabilities
Level 3
Level 2 capabilities plus additional staffing and workstations (TMC)
Internet
(input and dissemination)
Video Network
IEN
CDI ~ Command Data Interface
w/s ~ workstation

Figure 4-3 PVITS Center-to-Center Communications

The physical location for the Pomona Valley subregional TMC has not yet been selected, but the subregional TMC will play a key role in the center-to-center communications and other management activities in the subregion. The proposed architecture would enable the local cities and other stakeholders to exchange traffic and traveler information using the Pomona Valley IEN server that will be located at the subregional TMC. In order to exchange data among and between different agencies using the Los Angeles County IENa piece of software, called the Command/Data Interface (CDI), will be required. The CDI provides a translation between each agency's ATMS. The deployment of a CDI enables each agency's traffic signal data to be displayed on the IEN network in a seamless manner. It also provides flexibility in that each agency can have different ATMS systems and the second by second traffic signal data will be transmitted between jurisdictions, and displayed in a uniform manner through the IEN. **Figure 4-4**, adapted from the IEN System Overview Manual developed by TransCore, depicts the detail at a local level of how the different system components fit together within each level of CTCS/ TMC.

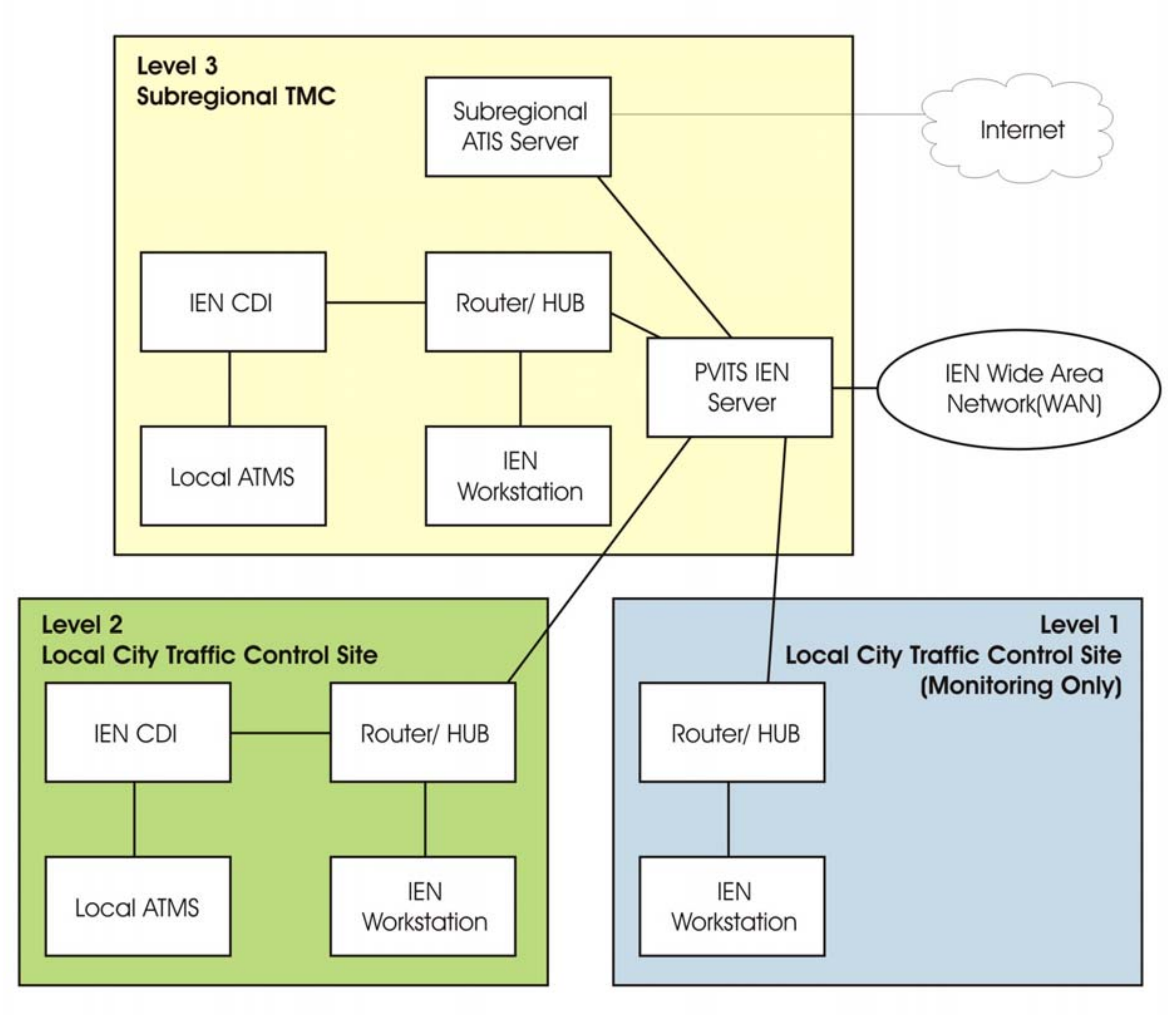

Figure 4-4 Local CTCS Interconnect Detail

Center-to-field communications will need to be addressed following development of concept designs.

4.2.3 Market Packages

The Market Packages were selected by mapping the selected PVITS area architecture user services to the list of potential National Architecture-defined market packages. This mapping translates user services from functional to physical descriptions. A Market Package often includes capabilities that span more than one user service. Conversely, several user services require multiple Market Packages to implement. The relationship between the PVITS area user services and the resulting matches of market packages is presented in **Table 4-2**. Table 4-2 PVITS Area User Services Mapped to Market Packages.

User Service / Market Package	Pre-Trip Travel Information	En-Route Driver Information	Traveler Services Information	Traffic Control	Incident Management	Travel Demand Management	Highway-Rail Intersection	Emergency Notification and Personal Security	Archived Data Function
Network Surveillance				X					
Probe Surveillance				X					
Surface Street Control				X	X		X		
Regional Traffic Control				X					
Incident Management System					X				
HOV Lane Management				X		X			
Traffic Information Dissemination				X			X		
Traffic Forecast and Demand Management				X		X			
Electronic Toll Collection						X			
Virtual TMC and Smart Probes		X		X	X				
Parking Facility Management						X			
Regional Parking Management						X			
Standard Railroad Grade Crossing							X		
Advanced Railroad Grade Crossing							X		
Railroad Operations Coordination							X		
Reversible Lane Management				X	X				
Road Weather Information System		X		X	X				
HAZMAT Management					X				
Broadcast Traveler Information	X	X							
Interactive Traveler Information	X	X	X						
Autonomous Route Guidance		X							
Dynamic Route Guidance		X	X		X				
ISP-based Route Guidance	X	X							

User Service / Market Package	Pre-Trip Travel Information	En-Route Driver Information	Traveler Services Information	Traffic Control	Incident Management	Travel Demand Management	Highway-Rail Intersection	Emergency Notification and Personal Security	Archived Data Function
Integrated Transportation Management/Route Guidance		X							
Yellow Pages and Reservation	X	X	X						
In-vehicle Signing		X		X			X		
Intersection Safety Warning							X		
Intersection Collision Avoidance							X		

Using this mapping along with engineering judgment based on the needs of the subregion, the following market packages have been chosen for implementation in the subregion. Not all of the market packages that were mapped above have been chosen.

- Network Surveillance;
- Surface Street Control;
- Regional Traffic Control;
- Incident Management System;
- Traffic Information Dissemination;
- Traffic Forecast and Demand Management;
- Standard Railroad Grade Crossing;
- Multi-Modal Coordination;
- Broadcast Traveler Information;
- Interactive Traveler Information;
- Yellow Pages and Reservation; and
- Emergency Response.

4.2.4 Institutional Layer

As part of the ITS deployment and the need for interjurisdictional cooperation, operations and maintenance issues will need to be addressed and resolved before implementation. A separate Operations and Maintenance Plan will be prepared in Task 10 of this project. It should be noted while funding for operations and maintenance is limited, some federal funding sources do allow funding of operations and/ or maintenance, but the MTA currently disallows use of these funding sources for operations and/ or maintenance in LA County.

The operations and maintenance funding will be a critical issue to running the individual systems as well as maintaining the integration components (communication connections and related equipment) and shared equipment (ATIS and IEN servers) in the subregion. It is important to have clearly defined roles and responsibilities for agencies with respect to the costs of operation and maintenance. Initially the cities will need to agree to operate and maintain the infrastructure.

In the future the partner agencies will need Standard Operating Procedures (SOP) and a Memorandum of Understanding (MOU) in order to coordinate efforts and share information and control. Agencies should be bound by an MOU with the SOPs as attachments. Due to the multi-jurisdictional nature of the project, it is important to have well-defined roles and responsibilities for each agency in the subregion. The complex nature of control hierarchy of ITS elements and sharing devices through software functions will also require clearly defined roles and responsibilities. SOPs should be developed that clearly define the roles and responsibilities for each agency in terms of financial, legal and other operational issues. The SOPs and MOU should be updated annually and on an as-needed basis.

LIST OF ACRONYMS

ACE	Alameda Corridor East Construction Authority
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
Caltrans	California Department of Transportation
CAMS/IEN	Los Angeles County Countywide Arterial Management System/ Information Exchange Network
CCTV	Closed Circuit Television
DMS	Dynamic Message Sign
ITS	Intelligent Transportation System
LA	Los Angeles
LACDPW	Los Angeles County Department of Public Works
LACMTA	Los Angeles County Metropolitan Transportation Authority
LCC	Local Control Center
MOU	Memorandum Of Understanding
NTCIP	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
PC	Personal Computer
PTZ	Pan, Tilt and Zoom
PVITS	Pomona Valley Intelligent Transportation System
TMC	Traffic Management Center
TOD	Time-of-Day
UFR	User Functional Requirements
UIR	User Interjurisdictional Requirements
UOR	User Operational Requirements
USR	User Supplementary Requirements
WWV	National Institute of Standards and Technology Time & Frequency shortwave radio station that broadcast accurate real time

APPENDIX – USER SERVICES

User Service	Definition
1. Travel and Traffic Management	
1.1 Pre-trip Travel Information	ITS shall include a Pre-Trip Travel Information (PTTI) capability to assist travelers in making mode choices, travel time estimates, and route decisions prior to trip departure. It consists of four major functions, which are, (1) Available Services Information, (2) Current Situation Information, (3) Trip Planning Service, and (4) User Access. Information is integrated from various transportation modes and presented to the user for decision making.
1.2 En-route Driver Information	ITS shall include an En-Route Driver Information (DI) function. Driver Information provides vehicle drivers with information, while en-route, which will allow alternative routes to be chosen for their destination. Driver Information consists of two major functions, which are, (1) Driver Advisory and (2) In-vehicle Signing. The potential decrease in traffic may also provide benefits in highway safety, reduced air pollution, and decreased congestion.
1.3 Route Guidance	ITS shall include a Route Guidance (RG) function. Route Guidance will provide travelers with directions to selected destinations. Four functions are provided, which are: (1) Provide Directions, (2) Static Mode, (3) Real-Time Mode, and (4) User Interface.
1.4 Ride Matching and Reservation	ITS shall include a Ride Matching and Reservation (RMR) function. Ride Matching and Reservation will provide travel users with information on rideshare providers. Three major functions are provided, which are, (1) Rider Request, (2) Transportation Provider Services, and (3) Information Processing. This will also include a billing service to the providers.
1.5 Traveler Services Information	ITS shall include a Traveler Services Information (TSI) function. Traveler Services Information provides travelers with service and facility data for the purpose of assisting prior to embarking on a trip or after the traveler is underway. The functions which are included in this capability are Information Receipt and Information Access. This will provide the traveler with a "yellow pages" type of capability.

User Service	Definition
1.6 Traffic Control	ITS shall include a Traffic Control (TC) function. Traffic Control provides the capability to efficiently manage the movement of traffic on streets and highways. Four functions are provided, which are, (1) Traffic Flow Optimization, (2) Traffic Surveillance, (3) Control, and (4) Provide Information. This will also include control of network signal systems with eventual integration of freeway control.
1.7 Incident Management	ITS shall include an Incident Management (IM) function. Incident Management will identify incidents, formulate response actions, and support initiation and ongoing coordination of those response actions. Four major functions are provided, which are, (1) Incidents Identification, (2) Response Formulation, (3) Response Implementation, and (4) Predict Hazardous Conditions.
1.8 Travel Demand Management	ITS shall include a Travel Demand Management (TDM) function. Travel Demand Management will generate and communicate management and control strategies that will support and facilitate the implementation of TDM programs, policies and regulations. It consists of two major functions, which are, (1) Increase Efficiency of Transportation System and (2) Provide Wide Variety of Mobility Options.
1.9 Emissions Testing and Mitigation	ITS shall include an Emission Testing and Mitigation (ETAM) Function. The ETAM function will provide state and local governments with the capability to enhance their air quality control strategies. The ETAM will provide both wide area and roadside emissions monitoring. Information gleaned from ETAM will be used by Traffic Demand Management (TDM) in the Traffic Management Center (TMC) to mitigate pollution and may be provided to enforcement agencies to compel offenders to comply with standards.
1.10 Highway Rail Intersection	ITS shall include a Highway-Rail Intersection (HRI) function to control highway and rail traffic in at-grade HRIs. Two sub-services are supported: Standard Speed Rail Subservice which is applicable to light rail transit, commuter rail and heavy rail trains with operational speeds up to 79 miles per hour (MPH); and High Speed Rail Subservice which is applicable to all passenger and freight trains with operational speeds from 80 to 125 MPH.
2. Public Transportation Management	
2.1 Public Transportation Management	ITS shall include a Public Transportation Management (PTM) function.

User Service	Definition
2.2 En-route Transit Information	ITS shall include an En-Route Transit Information (TI) function. En-Route Transit Information provides travelers with real-time transit and high-occupancy vehicle information allowing travel alternatives to be chosen once the traveler is en-route. It consists of three major functions, which are, (1) Information Distribution, (2) Information Receipt, and (3) Information Processing. This capability integrates information from different transit modes and presents it to travelers for decision making.
2.3 Personalized Public Transit	ITS shall include a Personalized Public Transit (PPT) function.
2.4 Public Travel Safety	ITS shall include a Public Travel Security (PTS) function to create an environment of safety in public transportation.
3. Electronic Payment	
3.1 Electronic Payment Services	ITS shall include an Electronic Payment capability. Electronic Payment Services allows travelers to pay for transportation services by electronic means. Four functions are provided, which are, (1) Electronic Toll Collection, (2) Electronic Fare Collection, (3) Electronic Parking Payment, and (4) Electronic Payment Services Integration.
4. Commercial Vehicle Operations	
4.1 Commercial Vehicle Electronic Clearance	ITS shall include a Commercial Vehicle Electronic Clearance (CVEC) capability.
4.2 Automated Roadside Safety Inspection	Vehicle System shall provide the capability for each individual vehicle's or carrier's participation in the process to be on a voluntary basis.
4.3 On-board Safety Monitoring	ITS shall include an On-Board Safety Monitoring (OBSM) function, that provides monitoring and warnings of safety problems. Of primary importance is to inform the driver, as soon as possible, of any problem that has been detected. Of secondary importance is notifying the carrier of detected safety problems. Last in importance is the notification of appropriate enforcement agencies.
4.4 Commercial Vehicle Administrative Processes	ITS shall include a Commercial Vehicle Administrative Process (CVAP) function consisting of 3 subservices to include Electronic Purchase Of Credentials, Automated Mileage and Fuel Reporting and Auditing, and International Border Electronic Clearance.
4.5 Hazardous Material Incident Response	ITS shall include a Hazardous Materials (HAZMAT) Incident Response (HIR) service.

User Service	Definition
4.6 Commercial Fleet Management	ITS shall include a Hazardous Materials (HAZMAT) Incident Response (HIR) service.
5. Emergency Management	
5.1 Emergency Notification and Personal Security	ITS shall include an Emergency Notification and Personal Security (ENPS) function that provides for faster notification when travelers are involved in an incident.
5.2 Emergency Vehicle Management	ITS shall include an Emergency Vehicle Management (EVM) Service.
6. Advanced Vehicle Safety Systems	
6.1 Longitudinal Collision Avoidance	ITS shall include a Longitudinal Collision Avoidance Service.
6.2 Lateral Collision Avoidance	ITS shall include a Lateral Collision Avoidance Service.
6.3 Intersection Collision Avoidance	ITS shall include an Intersection Collision Avoidance Service.
6.4 Vision Enhancement for Crash Avoidance	ITS shall include a Vision Enhancement for Crash Avoidance Service.
6.5 Safety Readiness	ITS shall include a Safety Readiness Service.
6.6 Pre-crash Restraint Deployment	ITS shall include the Pre-Crash Restraint Deployment Service.
6.7 Automated Vehicle Operation	ITS shall include an Automated Vehicle Operation Service (AVO).
7. Information Management	
7.1 Archived Data Function	ITS shall provide an Archived Data Function to control the archiving and distribution of ITS data. The Archived Data User Service provides the Historical Data Archive Repositories and controls the archiving functionality for all ITS data with five major functions: 1) the Operational Data Control function to manage operations data integrity; 2) the Data Import and Verification function to acquire historical data from the Operational Data Control function; 3) the Automatic Data Historical Archive function for permanently archiving the data; 4) the Data Warehouse Distribution function, which integrates the planning, safety, operations, and research communities into ITS and processes data products for these communities; and 5) the ITS Community Interface which provides the ITS common interface to all ITS users for data products specification and retrieval. ADUS helps achieve the ITS information goal of unambiguous interchange and reuse of data and information throughout all functional areas.

User Service	Definition
8. Maintenance and Construction Management	
8.1 Maintenance and Construction Operations	ITS shall provide Maintenance and Construction Operations (MCO) functions to support monitoring, operating, maintaining, improving and managing the physical condition of roadways, the associated infrastructure equipment, and the required resources. MCO shall focus on four major functions: 1) the Maintenance Vehicle Fleet Management function, to monitor and track locations and conditions of fleets of maintenance, construction, and specialized service vehicles; 2) the Roadway Management function, to monitor and forecast conditions and manage treatment of roadways during various travel conditions; 3) the Work Zone Management and Safety function, to support effective and efficient roadway operations during work zone activities; and 4) the Roadway Maintenance Conditions and Work Plan Dissemination function, to coordinate work plans and to communicate conditions. This User Service will utilize ITS systems and processes to support interchange of information among diverse groups of users, to improve efficiency and effectiveness of operational, maintenance, and managerial activities.