Technical Memorandum

SOUTHERN CALIFORNIA REGIONAL ITS ARCHITECTURE
2011 UPDATE

Recommended Express Lane Subregional ITS Architecture Elements

Prepared for:

SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS

Prepared by:

Kimley-Horn and Associates, Inc.

Version 1.1
094152003

TABLE OF CONTENTS

SOUTHERN CALIFORNIA REGIONAL ITS ARCHITECTURE – 2011 UPDATE

RECOMMENDED EXPRESS LANE SUBREGIONAL ITS ARCHITECTURE ELEMENTS

TABLE OF CONTENTS

SOUTHERN CALIFORNIA REGIONAL ITS ARCHITECTURE – 2011 UPDATE
RECOMMENDED EXPRESS LANE SUBREGIONAL ITS ARCHITECTURE ELEMENTS

List of Tables

List of Figures

1. INTRODUCTION

The Southern California Regional ITS Architecture leverages long standing investments in Intelligent Transportation Systems (ITS) by fostering coordination and cooperation among public agency stakeholders. A Regional ITS Architecture provides a framework for ITS planning that promotes interoperability and communication across jurisdictional boundaries. Projects developed under a regional framework extend the usefulness of any single project by making information easily accessible for operators and users of the system.

In Southern California, there are several ITS architectures that may be applicable to an ITS project, depending on how far reaching the project is. Each County has developed a Regional ITS Architecture. In addition, as the Metropolitan Planning Organization (MPO), SCAG has developed a Southern California Regional ITS Architecture that addresses multi-county issues: those projects, programs, and services that require connectivity across county boundaries or are deployed at a multi-county level. A third "layer" is also in place at the state level: the California ITS Architecture and System Plan addresses those services that are rolled out or managed at a state level or are interregional in nature. Project sponsors are responsible for ensuring that their projects maintain consistency with the regional architectures, regardless of which architecture applies, as a requirement for federally funded projects.

In the time between 2005, when the Southern California Regional ITS Architecture was developed, and 2011, as it is being updated, there have been several changes. The National ITS Architecture has been updated to reflect new user services, Southern California has continued as a national leader in ITS deployment with extensive ITS investments, and new technology applications have emerged. The 2011 update to the Southern California Regional ITS Architecture reflects changes since 2005 and positions the architecture to guide future ITS deployments as new technologies emerge. Topics covered in this 2011 update include express lanes, Positive Train Control, technologies in support of non-motorized transport, and goods movement in addition to the updates for other cross-county services such as to address traveler information, regional data exchange and archiving of regional data. Additionally, recommendations are made to subregional (county-level) ITS Architecture champions for their consideration in the event that changes are desired to be made at the county level for the associated topic.

1.1 Purpose

A system of High Occupancy Vehicle (HOV) lanes has been part of the California freeway system for the past 30 years and express lanes are an innovation that has been implemented in the past 15 years. Currently, neither the Southern California Regional ITS Architecture nor most of the subregional (county-level) architectures address HOV lane management and/or electronic toll collection – the foundation of express lane operations.

In the past, express lanes have been regarded as a localized service with projects deployed within Orange County and upcoming in Los Angeles and Riverside Counties. The success of the 91 Express Lanes is paving the way for more projects throughout the state and across the country. The movement toward more express lanes – both from the perspective of being interconnected and crossing county boundaries in the near future makes change this to into a critical, multi-county issue.

Architecture elements related to express lanes are being developed for the updated Southern California Regional ITS Architecture. This Technical Memorandum provides recommendations for the county-level architecture owners to consider in the next update of their architectures to reflect express lanes.

1.2 Regional System

Through 2008, there were 10,400 lane miles in the freeway system in the SCAG region, including over 1,000 lane miles of HOV and express lanes. The 91 Express Lanes is the only express lane facility currently in operation within the SCAG region.

1.2.1 Existing Facilities

- The 91 Express Lanes is a four-lane, 10-mile-long express toll facility located entirely within the median of SR 91 in Orange County. With two toll lanes running in each direction, the 91 Express Lanes extends from the Costa Mesa Freeway (State Route 55) interchange in Anaheim to the Riverside County line. The facility is owned by OCTA and operated by a contractor. The 91 Express Lanes traffic operations center is located in the City of Anaheim.

1.2.2 Planned Facilities

The following are the express lane projects that currently have legislative authority granted and are under development:

- The Riverside County Transportation Commission (RCTC) is developing two Express Lane facilities in Riverside County with the extension of the four-lane 91 Express Lanes from the Orange County line to I-15 and the addition of four express lanes on I-15 from the San Bernardino County line to SR 74.
- The Los Angeles Metropolitan Transportation Authority (LA METRO) is developing express lanes on I-10 and I-110 as part of the Los Angeles County Congestion Reduction Demonstration Project. The existing HOV lane on I-10 will become a part of this new Express Lane facility with an additional lane being added in each direction from Union Station to I-605. The existing HOV lanes on I-110 will become a part of the new Express Lane facility from the Artesia Transit Center to Adams Boulevard.

1.2.3 Other Projects

The following are future express lane projects under consideration as well as other related congestion pricing initiatives:

- SCAG is conducting a regional congestion pricing study to evaluate various pricing strategies to improve mobility, system performance, air quality and generate additional revenues for transportation. The strategies that the study is evaluating include: 1) Facility Pricing that charges a toll for vehicles using all lanes of a road, a bridge, or short roadway segment; 2) express lanes; 3) Cordon Pricing that charges a fee for vehicles that cross the boundary of a congested area; 4) Express Parking that charges variable parking rates depending on the supply and demand for parking spaces; 5) Area Wide Pricing that applies a charge to driving anywhere in a larger area such as a county or region; 6) VMT Fees that charge drivers based on the number of miles a vehicle has traveled; and 7) Emission Fees that charge variable fees to different vehicle classes based on the amount of pollutants that are emitted.
- As part of the Congestion Reduction Demonstration Project, the City of Los Angeles is implementing *Express*Park, a pilot project to charge variable pricing for parking in Downtown Los Angeles. The project will integrate parking meters, parking guidance

systems, vehicle sensors and control center operations to manage parking occupancy in real-time.

- Three express lane projects are included in the OCTA 2010 Long Range Transportation Plan (LRTP): 1) Two express lanes in each direction on the I-405 freeway between SR73 and I-605; 2) An HOV/Express Lane connector at the SR-241 and SR-91 interchange; and 3) A demonstration project to implement image-based toll collection on the TCA operated toll roads.
- The San Bernardino Association of Governments (SANBAG) is considering express lane facilities on I-10 and I-15 in San Bernardino County. The express lanes on I-10 would cover 34 miles from the Los Angeles County Line to Ford Street. The express lanes on I-15 would cover 33 miles from the Riverside County Line to US-395.
- Metro is studying the potential use of public-private partnerships (PPP) to accelerate the delivery of highway and transit projects. The PPP study has identified three highway projects that could feature some form of tolling or congestion pricing: 1) The High Desert Corridor that will construct a 50 mile east-west freeway/express way between Los Angeles and San Bernardino counties; 2) A freight corridor from the Ports of Los Angeles and Long Beach on 18 miles of I-710; and 3) A proposed tunnel option for the SR-710 Gap Closure project to connect the 710 freeway with Interstate 210.

2. STAKEHOLDERS

2.1 Express Lane Stakeholders

If the county architecture owners choose to add express lanes, the updated architecture needs to include agencies involved in express lane operations and maintenance:

- **Regional Express Lane and Toll Road Agencies** – agencies that operate existing and planned express lanes comprised of Metro, RCTC, SANBAG, the Transportation Corridor Agencies (TCA) and OCTA
- **Caltrans** – comprised of District 7, 8 and 12
- **SANDAG** – operates the I-15 Express Lanes in neighboring San Diego County
- **California Highway Patrol (CHP)** – responsible for enforcement and safety on express lane facilities

2.2 Roles and Responsibilities

Table 1 provides a summary of the stakeholders involved in the operation and maintenance of express lanes and their roles and responsibilities.

Table 1 – Stakeholder Roles and Responsibilities

Description	Roles/Responsibilities as Related to Express Lanes
Express Lane Agencies	▪ Lead role in planning, financing, design, and construction ▪ Oversees day-to-day operations ▪ Toll collection and violation enforcement ▪ Customer care and account management ▪ Distributes toll revenues ▪ Funds improvements to the express lane corridor
CHP	▪ Occupancy, access, and safety enforcement ▪ Role varies in toll violation enforcement ▪ Lead role in handling and clearance of incidents ▪ Direct traffic at incident scenes ▪ Request lifting of lane closures or opening HOV/ express lanes to single occupant vehicles during major incidents
Caltrans	▪ Owns freeway right-of-way ▪ Supports performance monitoring data collection and reporting ▪ Provides aid to CHP (such as incident information or traffic control) ▪ Implements and operates planned road closures ▪ Lead role in traffic diversion and implementation of traffic management schemes for incidents ▪ Shares real-time traffic information with other agencies ▪ Monitoring authority for Title 21 development ▪ Roadway maintenance and debris removal ▪ Operates and maintains fiber communications infrastructure along the freeway right-of-way

Description	Roles/Responsibilities as Related to Express Lanes
SANDAG	▪ Operates the I-15 Express Lanes ▪ Support seamless, inter-regional access for express lane users in Southern California

2.3 Agreements

The following are the types of agreements in place in the form of contracts or memorandums of understanding (MOUS) between the express lane operators and supporting agencies in the operation and maintenance of express lanes:

- **Toll Administration** – refers to the policies and procedures to coordinate back office operations among the express lane agencies to collect fees, exchange transponder tag information and transfer payments.
- **Enforcement** – refers to the agreements between the express lane operating agencies and CHP to clear incidents, maintain public safety and enforce occupancy and access violations on the express lane facility. CHP is typically reimbursed by the express lane operating agencies.
- **Maintenance** – refers to the agreements between the express lane operating agencies and Caltrans Districts for roadway maintenance and lane closure notification.
- **Private Operations** – refers to the agreements between the express lane operating agencies and a private contractor to carry out day-to-day operations and maintenance of the toll collection system, toll administration, violation processing and customer service functions.

3. ITS INVENTORY

This section describes the recommended ITS projects for express lanes, their associated market packages, and approximate timing.

3.1 ITS Elements

Express lane facilities in Southern California use Electronic Toll Collection (ETC) to automate toll payments and eliminate the need to collect payments at toll booths or toll collection plazas. Current and planned express lane facilities require users to carry a RFID transponder in the vehicle to track usage and assign charges to user accounts. For a regional express lane network to function, operational and technical interoperability is needed among express lane operators to enable seamless travel on express lane facilities across county boundaries.

In California, express lane systems are required to meet the current statewide communication standard, known as Title 21. Title 21 defines communication and equipment specifications for toll readers and transponders to identify and validate users on toll or express lane facilities in the state. Maintaining technical interoperability allows the use of one transponder and user account versus obtaining separate transponders and accounts with each operator.

The other facet to interoperability for ETC is the coordination of back office activities among the toll and express lane operators for account processing, enforcement and payment collection. As vehicles use different express lane facilities or cross county boundaries, the express lane operators need to exchange information about transponder tags, debit accounts and transmit payments to partner agencies. Agreements among the operating agencies spell out the business rules for the reciprocal exchange of data and the data formats for transmitting and receiving data.

If the county architecture owners choose to add express lane, the ITS elements in **Table 2** should be considered for inclusion to support express lane information flows and data exchanges:

Table 2 – ITS Elements

Element Name	Associated Stakeholder	Description	Mapped To:
Express Lane Traveler Information Interfaces	Information Service Providers (ISPs)	Provides various traveler information outlets with express lane related travel information such as travel time and real time toll rates.	Information Service Provider (Subsystem)
Express Lane Transportation Management Centers	Southern California Express Lane and Toll Road Agencies	Represents the traffic operations centers of the regional express lane operating agencies.	Traffic Management (Subsystem)
Electronic Toll Administration Centers	Southern California Express Lane and Toll Road Agencies	Represents the back office operations or administrative systems of the regional express lane operating agencies	Toll Administration (Subsystem)
In-vehicle	Travelling public	Represents the in-vehicle equipment, typically a transponder that communicates with roadside equipment that facilitates electronic toll collection without	Toll Collection (Subsystem)

Element Name	Associated Stakeholder	Description	Mapped To:
		the need to stop at a toll booth to make payment.	
Toll point equipment	Southern California Express Lane and Toll Road Agencies	Represents the roadside equipment that identifies the transponder in passing vehicles and communicates back to the toll administration center to assign usage to the account holder. License plate recognition is typically used to automate enforcement by identifying vehicles that do not have a valid transponder.	Toll Collection (Subsystem)

3.2 Market Packages

User services and market packages, standard terms defined by the National ITS Architecture, are intended to be comprehensive lists of the potential ITS applications or solutions to transportation problems. Each user service or market package is generic in nature (for example the user service "Pre-trip Travel Information" is a generic description of a traveler information service provided to travelers prior to their trips such as web-based applications). They are intended to be used as a starting point for ITS planning to ensure that all potential solutions are considered. In some regional ITS architecture developments, stakeholders develop solutions that are not addressed by the available lists of user services and market packages, in which case a custom definition would be developed.

With the exception of the Orange County ITS Architecture, the subregional architectures do not reference tolling or express lanes. If the county ITS architecture owners choose to add ITS elements for express lanes, the following market packages should be considered for inclusion:

ATMS05 – HOV Lane Management: This market package manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.

ATMS10 – Electronic Toll Collection: This market package provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Field-Vehicle Communication between the roadway equipment and the vehicle is required as well as Fixed Point-Fixed Point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Toll violations are identified and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional and ultimately national interoperability for these services.

3.3 Project Sequencing

The ITS elements for express lanes in the updated subregional ITS architectures will be implemented through a series of projects led by both public sector and private sector agencies. Key

foundational systems will need to be implemented in order to support other systems and projects. Project sequencing identifies those foundation systems, projects, or infrastructure that are required to be in place for other projects to move forward. Further discussions among stakeholders regarding these particular projects will need to be held for consensus on project priorities across regions to be achieved. In some cases, studies may be required prior to full project development and implementation and operational agreements may be necessary for interregional projects to effectively work together.

A listing of the proposed projects is provided in **Table 3**. This list is a compilation of ongoing activities, currently planned activities and other proposed projects that are being recommended.

Table 3 – Project Sequencing

Project Title	Market Packages	Participating Stakeholders	Description	Timing
Title 21 Revision	Standards Development	▪ Caltrans ▪ Regional Express Lane and Toll Road Agencies ▪ Private Industry ▪ CTOC	Upgrades the statewide Title 21 specification for transponder equipment and communications to support advanced tolling operations and two-way communications	M
Toll Transaction Data Dictionary	Standards Development	▪ Regional Express Lane and Toll Road Agencies ▪ CTOC	Develop a data dictionary using open standards to coordinate the exchange of transponder information and account transactions between back office operations for toll administration	S/M
Integration into Regional Trip Planners	ATIS02 – Interactive Traveler Information ATIS 4 – Dynamic Route Guidance	▪ Regional Express Lane and Toll Road Agencies ▪ Regional 511 providers	This project will allow travelers to plan cross county trips that use express lane facilities. The user can access trip cost based on the tolling schedules for the express lane operators involved.	M
Integration with PeMS	AD3 – ITS Virtual Data Warehouse	▪ SCAG ▪ Caltrans	PeMS collects and reports performance data for Bay Area HOT facilities. This project will report performance data for Southern California express lane facilities.	S
Automated Enforcement Technologies	ATMS05 – HOV Lane Management ATMS10 – Electronic Toll Collection	▪ Caltrans ▪ Regional Express Lane and Toll Road Agencies ▪ Private Industry	This project will implement technologies to automatically detect the occupancy of vehicles in a reliable manner.	L
Integration with Regional Fare Systems	APTS04 – Transit Fare Collection Management	▪ Regional Express Lane Agencies ▪ Regional transit operators	Buses operate express or limited stop transit service on HOV and express lane facilities. This project will allow transit operators to apply express lane charges to transit user accounts.	L

Project Title	Market Packages	Participating Stakeholders	Description	Timing
Archived Congestion Pricing Performance Data	AD3 – ITS Virtual Data Warehouse	▪ SCAG	This project will archive sources of dynamic pricing data – parking and express lanes to support regional congestion pricing and planning	S
Integrated Account Services	ATMS10 – Electronic Toll Collection	▪ Regional Express Lane and Toll Road Agencies	This project allows express lane users to manage accounts for different operating agencies under a single point of access by phone or online.	S

4. OPERATIONAL CONCEPTS

The operational concepts in the Southern California Regional ITS Architecture (2011) outline the roles and responsibilities of participating stakeholders that are currently or will be involved with in the provision of interregional services related to express lanes.

A *concept of operations*, though similar in nature to an *operational concept*, defines in more detail the specifics of how a particular project or system operates in different scenarios. A *concept of operations* is part of a project-oriented systems engineering approach. Evolving from a project development environment, a *concept of operations* describes in detail not only the roles and responsibilities, but the information flows among stakeholders, scenarios for how a system operates, and required interactions and data sharing for a project. It enables later validation of the concept of what the system was meant to do (in addition to system testing to ensure that the system meets the specific requirements that were laid out). *Concepts of operations* for future projects of this ITS Architecture can be developed from the corresponding portion of this *operational concept*.

If the county architecture owners choose to include express lanes, operational concepts for the HOV Lane Management and Electronic Toll Collection market packages should be considered for inclusion. Operational concepts for the recommended market packages are provided in **Table 4**.

Table 4 – Operational Concepts

Market Package	Description
ATMS05 – HOV Lane Management	Caltrans: ▪ Implement and operate HOV lanes on freeways, in partnership with regional agencies. ▪ Provide preferential treatment to HOV lanes using bypasses, reserved lanes and exclusive rights-of-way. ▪ Monitor and control freeway sensors and video surveillance. ▪ Provide system to system interfaces to share real time traffic data with other Caltrans Districts and regional partners. ▪ Coordinate the operation of ramp meters and freeway connector signals. ▪ Coordinate with other Caltrans Districts and regional partners to maintain consistent signage and striping for HOV and express lanes. ▪ Assume a lead role in developing and implementing traffic management plans for incidents and planned closures. ▪ Provide advanced information to travelers on incidents and construction notices. ▪ Work with regional operating agencies, enforcement agencies and private industry to research automated enforcement technologies. Regional Agencies: ▪ Utilize traffic sensors and data shared by partner agencies to monitor express lane usage. ▪ Make adjustments to Express Lane tolling rates to maintain free flow operations. ▪ Work with Caltrans to implement variable occupancy requirements on HOV lanes.

Market Package	Description
	▪ Work with Caltrans to develop robust performance monitoring and reporting capabilities. ▪ Support trip planning by disseminating dynamic pricing and occupancy information to the public using the various traveler information outlets. CHP: ▪ Enforce HOV and express lane occupancy requirements ▪ Enforce proper use of transponders in vehicles ▪ Lead role in handling and clearance of incidents
ATMS10 – Electronic Toll Collection:	Caltrans: ▪ Act as the monitoring authority for Title 21. ▪ Work with partner agencies to update Title 21 standards for enhanced transponder capabilities and support for two-way communications. Regional Agencies: ▪ Operate and maintain local toll collection on respective agency-owned facility/facilities. ▪ Define fare structures. ▪ Select and implement technologies and policies regarding toll evasion (for example, video capture of license plate information). ▪ Identify and process toll violations. ▪ Provide anonymous toll usage data to support other agency planning or operations (i.e., travel times) ▪ Support standards allowing interoperability of FasTrak on facilities throughout the state. ▪ Administer and manage back office functions to process payments, service accounts, and transmit violation notifications to enforcement agencies. ▪ Establish agreements with other operating agencies to coordinate back office operations. ▪ Agree to common data standards with operating agencies to support interoperability of back office data transfers. ▪ Develop integrated electronic payment services that allow a single user account to pay for tolls, parking and transit. ▪ Work with partner agencies, Caltrans and CTOC to update Title 21 standards for enhanced transponder capabilities and support for two-way communications.

5. ITS STANDARDS

The Southern California Regional ITS Architecture provides recommended current, relevant standards for each information exchange between ITS projects. Their use is not mandatory. However, in some instances, there may be funding requirements or regional policies that mandate project-specific standards such as for real-time transit information.

Table 5 identifies the ITS standards that are possible for express lanes based on the identified interfaces and information flows.

Table 5 – Applicable ITS Standards for Express Lanes

SDO	Document ID	Standard Title	Standard Type
AASHTO/ITE/NEMA	NTCIP 1201	Global Object Definitions	Message/Data
AASHTO/ITE/NEMA	NTCIP 1207	Object Definitions for Ramp Meter Control (RMC) Units	Message/Data
AASHTO/ITE/NEMA	NTCIP 1209	Data Element Definitions for Transportation Sensor Systems (TSS)	Message/Data
AASHTO/ITE/NEMA	NTCIP C2C	NTCIP Center-to-Center Standards Group	Group
AASHTO/ITE/NEMA	NTCIP C2F	NTCIP Center-to-Field Standards Group	Group
ASTM	DSRC 915MHz	Dedicated Short Range Communication at 915 MHz Standards Group	Group
ASTM/IEEE/SAE	DSRC 5GHz	Dedicated Short Range Communication at 5.9 GHz Standards Group	Group
IEEE	IEEE 1455-1999	Standard for Message Sets for Vehicle/Roadside Communications	Message/Data
IEEE	IEEE P1609.11	Standard for Wireless Access in Vehicular Environments (WAVE) - Over- the-Air Data Exchange Protocol for Intelligent Transportation Systems (ITS)	Communications Protocol

6. FUNCTIONAL REQUIREMENTS

Functional requirements are high-level description of the functions or activities of the ITS elements related to express lanes. They are developed for two reasons:

- To provide input to the identification of interfaces and information flows of the architecture; and
- To provide a resource for project deployers in defining activities and functional relationships of the systems that may be developed or upgraded to provide interregional ITS services.

A list of requirements that describe the functions covered by the architecture is a requisite component of the architecture according to the FHWA Final Rule for Architecture and Standards. This list of requirements describes the functionality of the existing and planned elements of the architecture for providing interregional services for express lanes. **The architecture does not prescribe that future projects meet any or all of the requirements.**

For all projects that are funded with Highway Trust Funds the Final Rule states that the project should be based on a system engineering analysis, and specifically states that the analysis shall include requirements definition. The intent of the functional requirements is to provide a set of requirements that can be used to assist project implementers in the development of functional requirements definition as required by the Final Rule. This does not preclude future projects from identifying different or additional functions, but rather, provides requirements for implementation of the regional architecture.

Future projects may choose to utilize the lists of requirements as a reference or tool to develop specific requirements that address each individual project's needs. If a project is developed that has additional functions not documented in the current list, future updates of the Southern California Regional ITS Architecture can add those requirements. This update to the architecture would assist in identifying the interconnects and information flows that may also be changed, added, or implemented as a result of future technological developments. The interconnects should also be revised in the process of updating the architecture.

A list of functional requirements defined for the express lane ITS elements is provided in **Table 5**.

Table 6 – Functional Requirements

Functional Areas	Function (Equipment Package)	Requirement
Toll Administration	Toll Administration	The center shall calculate traffic flow based on time stamped toll transactions for vehicle travel between successive toll plazas and send to other agencies.
Toll Administration	Toll Administration	The center shall exchange data with other toll agencies to coordinate toll transactions and pricing.
Toll Administration	Toll Administration	The center shall support wide-area alerts from emergency centers by passing on the information to its toll plazas and the Toll Administrator.
Toll Administration	Toll Administration	The center shall support toll transactions by commercial fleet operators.
Toll Administration	Toll Data Collection	The center shall collect toll operational data and pricing data.
Toll Administration	Toll Data Collection	The center shall assign quality control metrics and meta-data to be stored along with the data. Meta-data may include attributes

Functional Areas	Function (Equipment Package)	Requirement
		that describe the source and quality of the data and the conditions surrounding the collection of the data.
Toll Administration	Toll Data Collection	The center shall receive and respond to requests from ITS Archives for either a catalog of the toll data or for the data itself.
Toll Administration	Toll Data Collection	The center shall be able to produce sample products of the data available.
Toll Administration	Toll Operator Alert	The center shall receive wide-area alerts and advisories from emergency management centers for emergency situations such as severe weather events, civil emergencies, child abduction (AMBER alert system), military activities, and other situations that pose a threat to life and property.
Toll Administration	Toll Operator Alert	The center shall provide an interface with the toll administration center personnel to present wide-area alert notifications and to allow the center personnel to acknowledge the input and control the dissemination of the information.
Toll Administration	Toll Operator Alert	The center shall distribute wide-area alert notifications to toll plazas to keep toll operators informed of identified threats that may impact toll operations or public safety on a toll facility.
Toll Administration	Toll Operator Alert	The center shall return status back to the emergency management center that initiated the wide-area alert with information indicating the status of the alert from the toll operators including the information systems that are being used to provide the alert notification.
Toll Collection	Toll Plaza Toll Collection	The field element shall read data from passing vehicles to support toll payment transactions.
Toll Collection	Toll Plaza Toll Collection	The field element shall update the stored value after debiting the toll amount and send a record of the transaction to a center.
Toll Collection	Toll Plaza Toll Collection	The field element shall read the credit identity from the passing vehicle and send that identity and the amount to be debited to a center.
Toll Collection	Toll Plaza Toll Collection	The field element shall support advanced toll payment by checking the vehicle's toll information against a stored list of advanced payments, and debiting the toll from the list in the case of a match.
Toll Collection	Toll Plaza Toll Collection	The field element shall control cameras, obtain images, and forward images of toll violators to a center.
Toll Collection	Toll Plaza Toll Collection	The field element shall forward wide-area alert information to the Toll Operator.
Vehicle	Vehicle Toll/Parking Interface	The vehicle shall respond to requests from toll collection equipment for credit identity, stored value card cash, etc.
Traffic Management	TMC HOV Lane Management	The center shall remotely control sensors to detect high-occupancy vehicle (HOV) lane usage.

Functional Areas	Function (Equipment Package)	Requirement
Traffic Management	TMC HOV Lane Management	The center shall remotely control driver information systems to notify users of lane status for lanes that become HOV or express lanes during certain times of the day on freeways.
Traffic Management	TMC HOV Lane Management	The center shall remotely control freeway control devices, such as ramp signals and mainline metering and other systems associated with freeway operations that control use of HOV lanes.
Traffic Management	TMC HOV Lane Management	The center shall collect traffic flow measures and information regarding vehicle occupancy (i.e., lane usage) in HOV lanes.

7. INTERFACES

One of the key components of the Southern California Regional ITS Architecture is the definition of interfaces and information flows that define the connections between ITS systems to support the desired operational concepts and services for goods movement. The interfaces are a detailed view of system interconnections. These interconnections are described in diagram, table, and database formats. The information can be generated from a Turbo Architecture database which defines the entire Southern California Regional ITS Architecture.

While the various systems and stakeholders are identified as part of the Southern California Regional ITS Architecture, a primary purpose of the architecture is to identify the *connectivity* between transportation systems. The customized market packages from the previous section represent services that can be deployed, and the market package diagrams show the information flows between the systems. High-level views of the interconnections and data flows for the customized express lane market packages are provided in **Figure 1** and **Figure 2**.

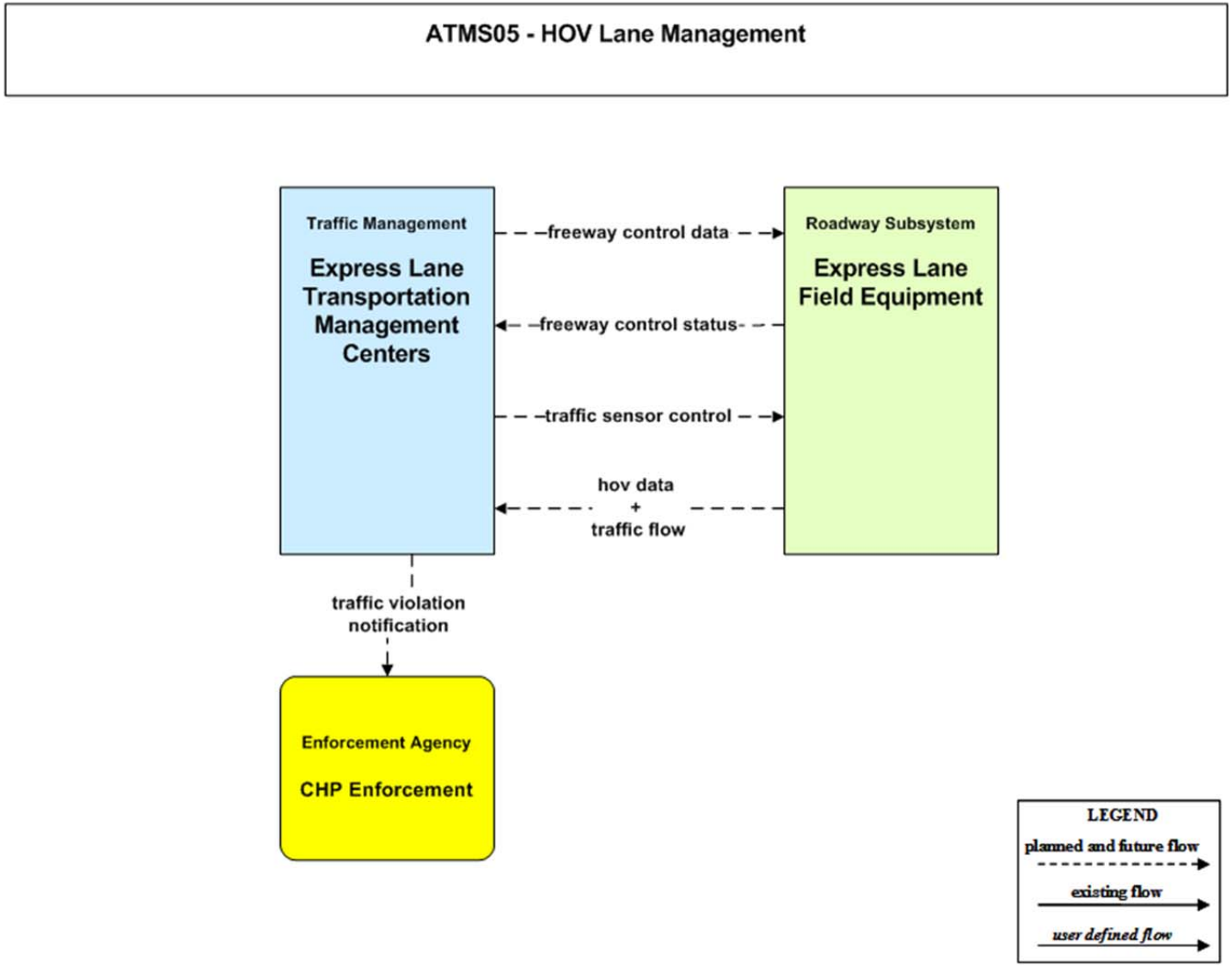

Figure 1 – HOV Lane Management

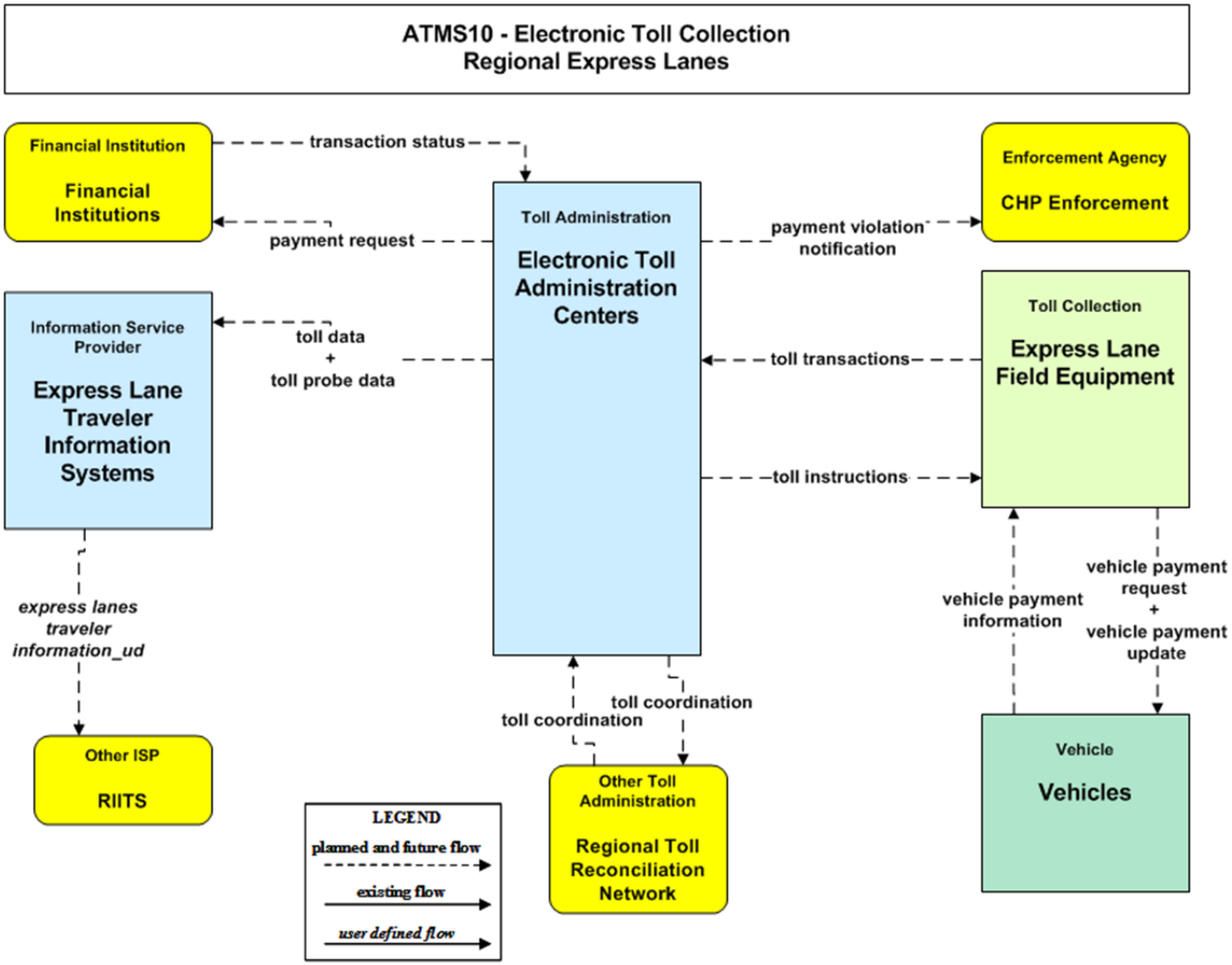

Figure 2 – Electronic Toll Collection