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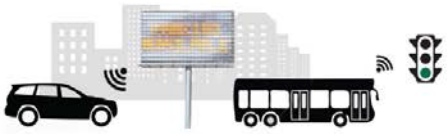


MULTIMODAL CORRIDOR MANAGEMENT PROJECT

Cover Page

Project Name	SR 91 Multimodal Corridor Management Project
Eligible Entity Applying to Receive Federal Funding	Riverside County Transportation Commission
Total Project Cost (from all sources)	$8,063,075
ATCMTD Request	$3,480,675
Are matching funds restricted to a specific project component? If so, which one?	No
State(s) in which the project is located	California
Is the project currently programmed in the: • Transportation Improvement Program (TIP) • Statewide Transportation Improvement Program (STIP) • MPO Long Range Transportation Plan • State Long Range Transportation Plan	No
Technologies Proposed to Be Deployed (briefly list)	• Multimodal trip planning application • Decision support system • Transit Eco-Drive application • Changeable message signs • Smart parking technology

i. Project Description

I. Introduction

The Riverside County Transportation Commission (RCTC) in partnership with the California Department of Transportation (Caltrans) District 8 is seeking discretionary federal grant funds to implement the SR 91 Multimodal Corridor Management Project, an innovative technology program for a critical and congested commuter link between the Inland Empire and coastal Orange County serving over 280,000 vehicles per day.

RCTC proposes to form partnerships with Caltrans District 8, Riverside Transit Authority (RTA), Metrolink commuter rail, the City of Riverside, and the University of California – Riverside (UCR) to deliver a proactive approach to offering multi-modal travel options to commuters prior to and during trips.

The proposed project will allow travelers to make informed decisions and comparisons regarding travel time and costs via driving, bus, and commuter rail, then facilitate diversion to those modes through in-app navigation to park-and-ride lots located just off the SR 91 Corridor, synchronization with real-time transit schedules, and signal priority for transit buses. Diversions to other modes during recurring peak hour congestion and non-recurring incidents and events will help manage travel demand.

Specific project elements include:

- A multi-modal trip planning application that is capable of integrating real-time information about highway conditions, rail and bus transit, rideshare options, and parking availability.
- A decision support system that fuses information about highway conditions from existing sensors, video cameras, and traffic data sources to provide recommendations to operators and transit bus drivers, with the potential to provide queue warnings and speed harmonization within the travel app as a future capability.
- Integration of Signal Phase and Timing (SPaT) information with the existing RTA bus AVL/GPS system to provide the Transit Eco-Drive suite of applications.
- Changeable message signs along SR 91 to provide information about the travel time and costs associated with multi-modal options.
- Parking detection and wayfinding technology at the Downtown Riverside and La Sierra park-and-ride lots.

This combination of project elements will use technology not only to better coordinate existing services and leverage recent infrastructure investments in the corridor by RCTC

and its state and local partners, but also to educate travelers about the availability of increasingly robust and competitive alternatives to driving in a single-occupant vehicle and to consolidate relevant travel information in a user-friendly way.

By delivering travel information in a visible, real-time manner via both changeable message signs and the enhancement of the IECommuter mobile app, the proposed program will increase awareness of the travel-time and cost advantages of services operating parallel to the SR 91 corridor. The proposed project targets travelers who might be receptive to using transit on an occasional or more regular basis, but encounter informational and logistical barriers that often dissuade them from undertaking a multimodal trip—barriers such as which service to use, where to park, how much the service will cost, how to pay for the service, and how to effectuate a return trip. The educational benefits of the proposed program is viewed as an important first step in driving conversion to transit and shared-use transportation options and achieving system performance improvements.

A February 2017 e-survey with 6,000 employee respondents in the Inland Empire distributed to a mix of county, municipal, health care, and private industry employers revealed valuable insights into commuter perspectives and attitudes regarding shared-use transportation (including transit, carpools, and vanpools). The e-survey results (see Figure 1) point to an underserved market opportunity for public transportation use among the roughly one-third of drive-alone commuters who identify as “practical and cost-conscious” and are responsive to rising fuel prices, worsening traffic congestion, and/or time-efficient transit alternatives. (On the other end of the spectrum are staunch, drive-alone travelers comprising 57% of the respondent pool who are unable or unwilling to give up their car for commute trips under any circumstances.)

Given that 76% of Riverside County commuters currently drive alone for home-based work trips, this means that a significant subset of drive-alone commuters are open to alternatives, but need some additional support in figuring out how a multimodal trip can integrate into their everyday routines and travel patterns.

RCTC expects that the proposed technology program will capture some of these “practical and cost-conscious” users, resulting in modest levels of diversion and congestion relief on the SR 91 corridor, especially during major incidents or peak traffic patterns. More importantly, this ICM project provides a technological foundation for bringing out attitudinal shifts about transit in Riverside County and fully leveraging RCTC and its partners’ recent and ongoing investments in a truly integrated, multimodal transportation system of the future.

Value	Percent	Responses
No...there here are no circumstances under which I would commute to work using another travel mode.	56.5%	2,700
Yes..if gas prices went back up to $5.00 per gallon	13.4%	640
Yes..if parking were not available at my worksite	7.0%	333
Yes..if parking were not free at my worksite	6.7%	320
Yes..if worsening traffic increased my travel time by 25%.	8.4%	402
Yes..if a carpool or vanpool with fellow employees were available from my community to my worksite.	20.0%	957
Yes..if a transit option were available that took no more than 50% longer than driving alone.	10.7%	514
Yes..if there were a guaranteed ride home program – a free taxi or shuttle – in the event of an emergency.	19.5%	933
Yes..if there were easier connections from transit to my worksite	15.3%	732
Yes..if there were a significant incentive - cash or extra vacation time - for ridesharing or using transit.	22.9%	1,097

Conditions under which you can see yourself occasionally commuting by a mode other than driving alone

Figure 1. Motivation for Potential Use of Public Transportation, Inland Empire Employer E-Survey Results (Source: Southern California Association of Governments)

II. Description of Entity Managing the Project

Governed by a 34 member Commission that includes a mayor or council member from each of the incorporated cities within Riverside County, RCTC is the agency responsible for planning, implementing, and funding improvements for Riverside County's multimodal transportation system. RCTC plans and implements transportation and transit improvements, assists local governments with funding for local streets and roads, facilitates commuter and goods movement, and ensures that everyone has access to transportation and alternative commute information.

RCTC will be partnering with the California Department of Transportation (Caltrans) to manage and deliver the proposed project. Responsible for managing the state highway system (which includes the California Freeway and Expressway System), Caltrans District 8 will be the primary point of contact.

District 8 is the largest of 12 statewide Caltrans districts covering approximately 28,550 square miles and includes 49 incorporated cities, four interstates and 32 state routes totaling 7,200 lane miles.

Both agencies have previously partnered on advance technology and ITS programs, most notably through joint development and operation of the Inland Empire Transportation Management Center and expansion of the SR 91 Express Lanes. To execute these regionally significant projects, RCTC and Caltrans entered into multiple cooperative agreements and memorandums of understanding (MOUs) and developed strong working relationships with one another that will serve as the foundation for the successful implementation of the proposed project. Also, the City of Riverside and Caltrans have existing MOUs to allow City operation of State ramp interchanges, and are currently in the process of developing additional MOUs to expand State and City collaboration. The following co-op agreements and MOUs are anticipated to be needed and are already under discussion by the co-lead agencies:

- Cooperative Agreement with Caltrans District 8
- Memorandum of Understanding with City of Riverside
- Memorandum of Understanding with University of California Riverside
- Memorandum of Understanding with Riverside Transit Authority

Management of Project Funding

One of RCTC's primary responsibilities is to manage the revenues from the voter-approved Measure A half-cent sales tax, which will remain in place until 2039. Measure A revenues provide funds for highway, road, and transit projects throughout Riverside County. In addition to Measure A revenues, RCTC is also responsible for distributing state and federal transportation dollars and is a recognized direct FTA and FHWA recipient in good standing. In this position, RCTC has the capacity to implement the proposed Project and meet FHWA requirements for grant administration and compliance.

III. Geographic Area

The SR 91 corridor in Southern California is a critical lifeline for the region, connecting the housing-rich areas of Riverside and San Bernardino Counties with major employment centers in coastal Orange County. Separated by the Santa Ana Mountains, transportation linkages between these metropolitan areas are limited. Between 2010 and 2016, the Riverside-San Bernardino metropolitan area grew by more than 300,000 new residents.

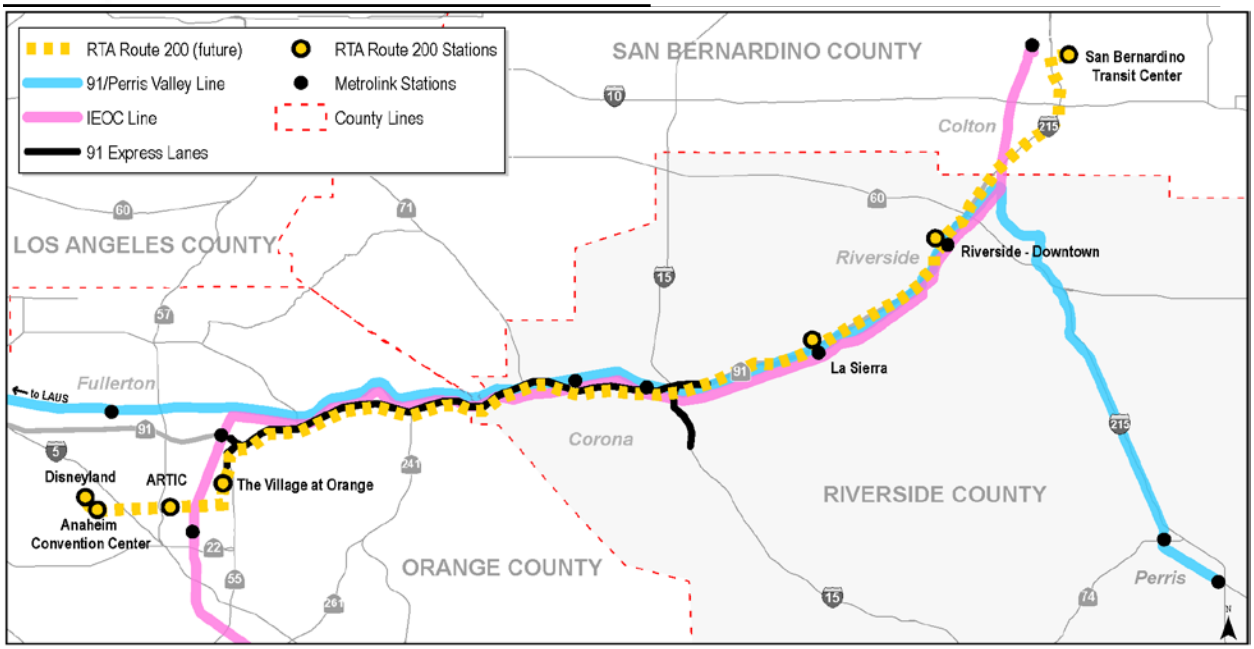


Figure 2. SR-91 Corridor Connecting Riverside County with Orange County

IV. Real-World Issues and Challenges

Over the last several decades, the Inland Empire has experienced vertiginous population growth, far outpacing many other regions of California. Riverside County has tripled in size since 1980. Because roadway capacity has not kept pace with vehicle demand, Riverside County also experiences some of the worst congestion in the State. It currently ranks as the tenth most congested region in the country according to the Texas Transportation Institute, measured by hours of travel delay. Traffic volumes on SR 91 are projected to increase by nearly 50 percent from current levels by 2030. It is therefore critical that existing infrastructure be optimized to the greatest extent possible utilizing advanced transportation technology.

The economic and environmental costs of congestion are substantial. The average annual delay of 59 hours is equivalent to approximately almost $800, based on the hourly value of time for commuter travel. The additional tailpipe emissions associated with traffic congestion also result in the Inland Empire having the worst particulate air pollution in the United States, an issue compounded by the region's mountainous topography and wind patterns that push polluted air eastward from Los Angeles.

In the face of mounting congestion and diminished quality of life, RCTC has demonstrated its strong commitment to improving transportation options for residents through robust investment in commuter rail, transit bus system, roadway and HOV lane enhancements and managed lane facilities. Two new general purpose lanes and a tolled express lane were recently added to SR 91. RTA will also be launching a new express bus Route 200 utilizing the tolled express lanes. The route will parallel the SR 91 corridor and provide a fast, cost-effective commuting option between major cities in Riverside and large employment centers including those located out of county.

Through these investments, RCTC has created travel alternatives at a range of price points for both low- and middle-income residents. A commuter utilizing the SR 91 express lanes during weekday peak times in both directions might expect to pay up to $6.40 for an approximate time savings of 20 minutes. The fare for a one-way ticket on RTA Route 200 estimated to be approximately $3.00 (with discounts available for senior citizens, veterans, and children).

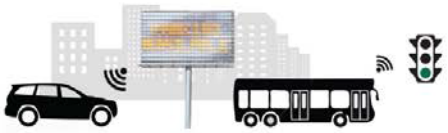
While RCTC has made substantial investment in congestion relief, there is more work to be done to integrate these investments in a way that is user-friendly, equitable, and impactful on people's day-to-day lives. The proposed project will address these real-world issues head on and provide a meaningful impact that is focused on alleviating societal challenges.

Alignment with Initiative Goals

RCTC's proposed project fully aligns with many of the FHWA initiative goals with respect to the strategic use of real-time travel information, improved system performance, and enhanced use of existing transportation capacity. In addition to achieving the goals summarized in Table 1 below, the proposed project aims to **promote social equity** by providing transit riders a travel experience at once cost- and time-competitive with the experience afforded to SOVs traveling in the SR 91 Express Lanes. As a result of a regional jobs-housing imbalance, many Riverside County residents are deprived of efficient, affordable transportation links to major employment centers. The proposed technology deployments will, among other things, enhance the transit signal priority status accorded to RTA commuter buses and help to "level the playing field" between transit and highway users.

Table 1. Project Alignment with Initiative Goals

INITIATIVE GOALS	PROJECT POTENTIAL	KEY PROJECT ATTRIBUTES OR BENEFITS
Reduced costs and improved return on investments, including through the enhanced use of existing transportation capacity;	High	Signal priority will result not only in faster travel times but also reduced fuel consumption and operating costs for RTA; diversion to Metrolink services will improve passenger load factors on rail vehicles.
Delivery of environmental benefits that alleviate congestion and streamline traffic flow;	Low	Reductions in VMT associated with trip diversion are expected to result in some emissions benefits.
Measurement and improvement of the operational performance of the applicable transportation networks;	Medium	Project partners will actively measure operational performance on both transit and freeway networks using quantifiable metrics such as ridership, duration of peak-hour delay.
Reduction in the number and severity of traffic crashes and an increase in driver, passenger, and pedestrian safety;	Low	Multimodal corridor management will encourage some users to divert from SR 91 during periods of peak congestion, when crash risk is typically highest. The number of vehicle-related injuries/fatalities prevented is likely to be low based on the forecast VMT reductions.
Collection, dissemination, and use of real time transportation related information to improve mobility, reduce congestion, and provide for more efficient and accessible transportation;	High	Traffic conditions and travel options via the IECommuter app and CMS will use real-time information to guide user decision-making on the best mobility options for trip completion.
Delivery of economic benefits by reducing delays, improving system performance and throughput;	Medium	Modest reductions in SOVs may alleviate peak-period or incident-related congestion and improve travel time performance.
Integration of advanced technologies into transportation system management and operations;	High	The proposed system integrates recent advances in transit ITS technology and connected eco-driving applications.



INITIATIVE GOALS	PROJECT POTENTIAL	KEY PROJECT ATTRIBUTES OR BENEFITS
Demonstration, quantification, and evaluation of the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, and sustainable movement of people and goods; and	Medium	IECommuter app usage activity will provide some data on technology adoption and impact. RTA ridership data will capture increases in transit use attributable to the project. RCTC and Caltrans will also measure safety benefits using before/after crash rates on the corridor.
Reproducibility of successful systems and services for technology and knowledge transfer to other locations facing similar challenges.	Medium	RCTC has a robust plan to monitor the effectiveness of its technology deployments and offer “lessons learned” to peer agencies. Caltrans has also been an active facilitator of knowledge transfer amongst its regional districts.

Proposed Technology Deployments

The proposed project will include the following technology elements. The functional and operational relationships between these elements are further outlined below in Figure 3.

- A multi-modal trip planning application that is capable of integrating real-time information about highway conditions, rail and bus transit, rideshare options, and parking availability.
- A decision support system that fuses information about highway conditions from existing sensors, video cameras, and traffic data sources to provide recommendations to operators and drivers, including queue warnings and speed harmonization.
- Integration of Signal Phase and Timing (SPaT) information with the existing RTA bus AVL/GPS system to provide a Transit Eco-Drive application.
- Preemption of Ramp Metering at designated ramps to allow the Express Bus to bypass any ramp queues.
- Changeable message signs along SR 91 and City roadways to provide information about the travel time and costs associated with multi-modal options.
- Parking detection technology at the Downtown Riverside and La Sierra park-and-ride lots.

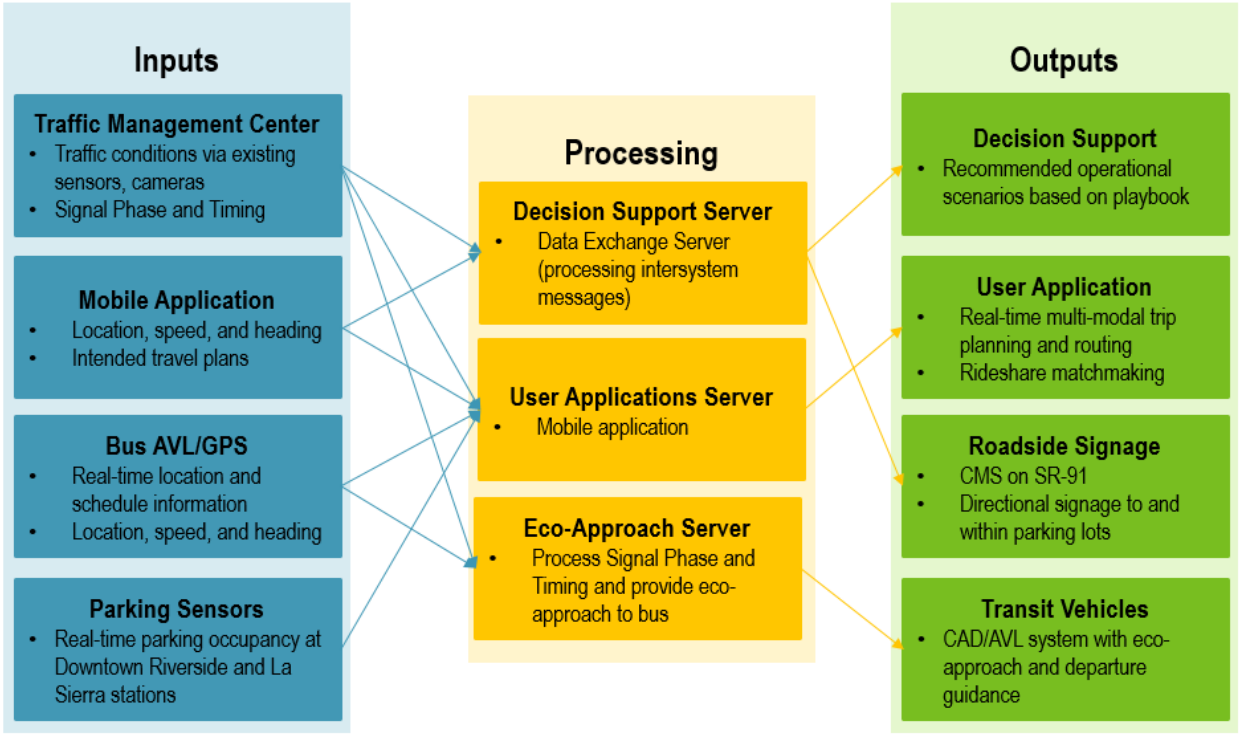


Figure 3. Functional and Operational Relationships

Multimodal Travel Application

Providing enhanced multi-modal trip planning and support is critical to the success of the State Route 91 Multimodal Corridor Management Project. This project proposes to deploy a new travel support application that will allow drivers and transit users alike to evaluate multiple options when completing a trip. Currently two services provide a number of desired functions:

- The IECommuter website and smart phone app provide information about current traffic conditions, and allow users to plan trips via bus, rail, or specialized transit.
- The IECommuter service facilitates ridesharing by matching riders and providing incentives to users. This service is not currently offered as a mobile application.

As part of this project, RCTC will develop a new application that integrates a comparison of travel times and costs on SR 91 via general purpose lanes, express lanes, and transit.

Figure 4. Sample Travel Time Comparison to be Provided by App

When congestion has developed, real-time modal diversions will be offered. Additionally, the app will also be supplemented by new changeable message signs that will provide travel time and cost comparisons to highway users who do not have the app, are not currently viewing the app, or do not have access to a smart phone.

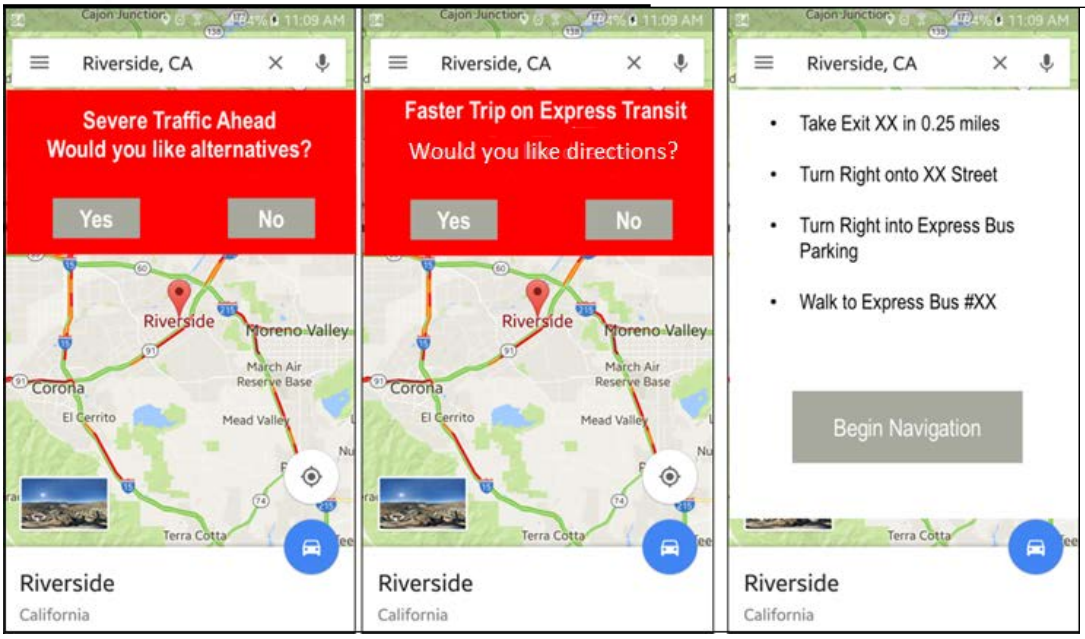


Figure 5. Sample App Notification and Route Guidance to Modal Option

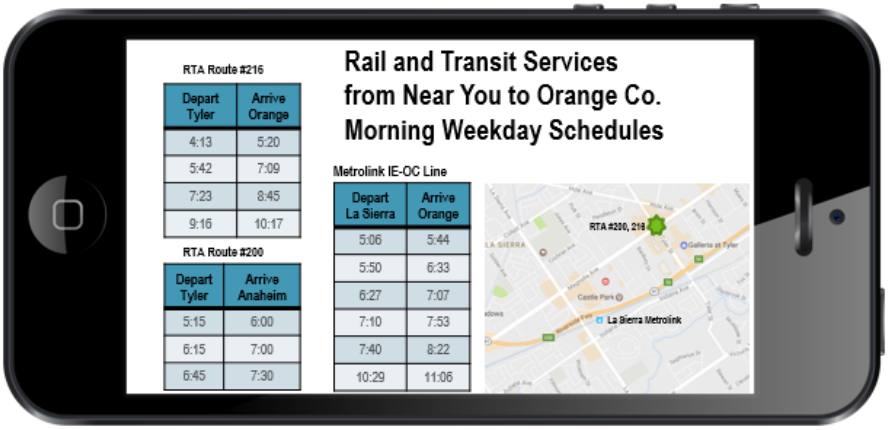


Figure 6. Sample App Schedule Information

Once a user selects a desired trip, the app will be capable of providing step-by-step instructions. Parking is often a challenge at the Downtown Riverside and La Sierra transit stations. As part of the initiation of the RTA 200 bus line service, 50 new parking paces will be leased next to the Downtown Riverside station; additionally a 450-space park-and-ride lot is currently under construction at the La Sierra station. To facilitate

ease of travel and provide peace of mind, parking availability will be indicated within the multi-modal travel app.

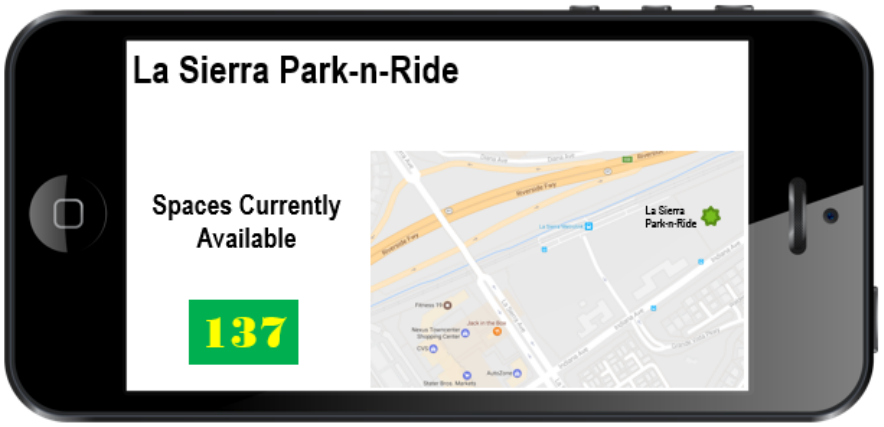


Figure 7. Sample App Real-Time Parking Availability

Decision Support System

The SR 91 corridor has seen considerable investment in ITS infrastructure. The Inland Empire Traffic Management Center (IETMC) supports incident clearance, motorist assistance, traffic control, demand management, and traveler information capabilities using a combination of vehicle detection stations, changeable message signs, cameras, ramp meters, and data from HERE and the operations center in the City of Riverside.

The State Route 91 Multimodal Corridor Management Project will integrate all of these inputs in order to develop a decision support system capable of evaluating current and predicted conditions and providing operational recommendations. While the multi-modal trip planning application and changeable message signs will form the user-facing elements of this project, the decision support system will provide the back office capabilities that allow RCTC to provide comprehensive travel information to travelers.

The decision support system will be based upon playbooks that are developed between project stakeholders to describe response plans. Using a combination of expert knowledge, current conditions, and pre-defined plans, the decision support system will include plans that support daily operations, freeway incident management, transit incident response, planned events and closures, and disaster response.

The decision support system will also support the ability to provide future capabilities. Existing roadway sensors, cameras, and data from HERE will allow for segment-specific

and lane-specific messages including queue warnings and speed harmonization recommendations via the multi-modal travel application.

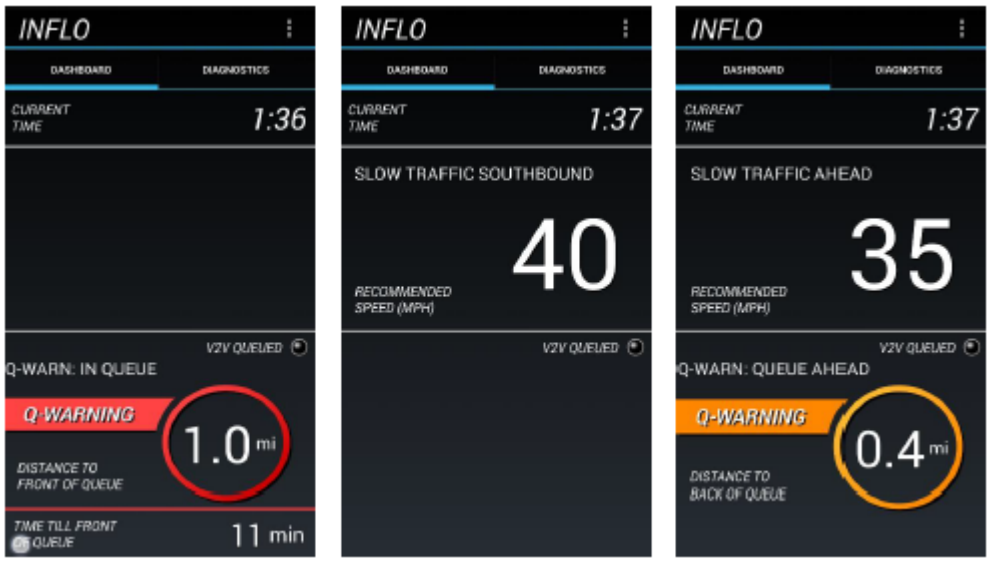


Figure 8. Sample App Speed Information and Queue Warnings

Transit Eco-Drive

In an effort to curb emissions RTA has invested considerably in the fleetwide replacement of motor coaches with new state of the art CNG buses. 100 percent fleet replacement occurred in FY2015 with 6 additional buses procured specifically to support express bus service on the new 91 Express Lanes facility. All buses are equipped with transit ITS technology that allows such capabilities as GPS positioning, computer aided dispatch and automatic vehicle location, mobile data terminals for drivers, automatic passenger counts, and capability to support transit signal priority.

This technology will form the basis for a Transit Eco-Drive application. The proposed system integrates recent advances in transit ITS technology and connected eco-driving applications. On the infrastructure side, signal data from traffic controllers and traffic data from roadside sensors are transmitted to the traffic management center (TMC). The Eco-Drive server developed by University of California – Riverside then pulls key signal and traffic information from the TMC, such as real time Signal Phase and Timing (SPaT) message, green band information, transit signal priority status and queue length. On the vehicle side, the buses are equipped with transit ITS technology to enable AVL/GPS positioning, on-board diagnostics (OBD) and automatic passenger counts. Once Eco-Drive services are requested by the transit bus, the location and vehicle activity data of

the bus will be sent to the Eco-Drive server and feed into the Transit Eco-Drive planner to develop safe, fast and eco-friendly strategies that are adaptive to given signal, traffic and geographic conditions.

The proposed transit Eco-Drive applications include the following:

- **Eco-Approach and Departure.** SPaT information calculates the most energy-efficient vehicle speed profile for passing through intersections while considering surrounding traffic;
- **Eco-Bus-Stop** determines the most energy-efficient acceleration/deceleration operations when approaching and departing bus stops;
- **Eco-Drive in Green Band** keeps the vehicle in the green band of the coordinated signalized corridor to minimize the number of stops and fuel consumption; and,
- **Communication Delay Compensator** measures and compensate the time delay caused by wireless communications.

In the Driver-Vehicle-Interface of the bus, speed recommendations and the vehicle's position in the green band will be displayed to provide drivers accurate and timely eco-drive guidance. The diagram below characterizes the components of the Transit Eco-Drive system.

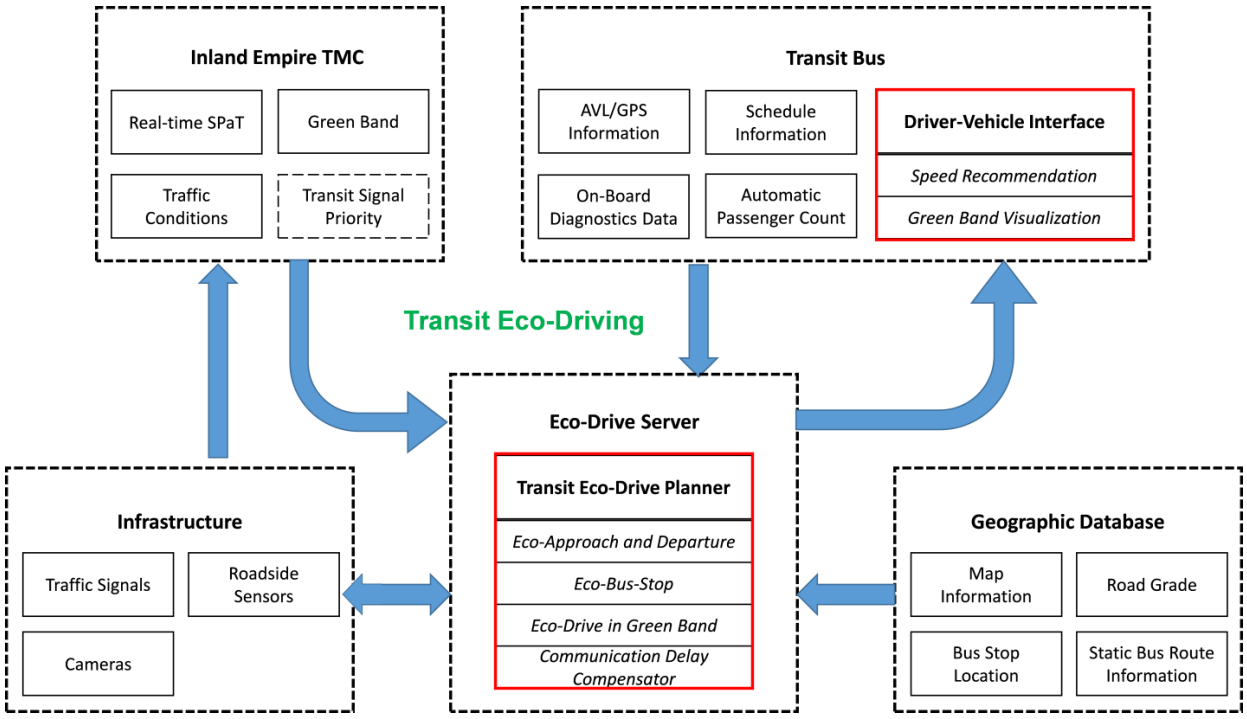


Figure 9. Transit Eco-Drive System

The Eco-Drive system, in addition to using the green wave to enable buses to stay on schedule, will investigate and implement passive signal priority where appropriate.

A passive priority strategy seeks to favor roads with significant transit use in the area-wide traffic signal timing scheme. One strategy under consideration is to give priority only to late RTA buses based on the GPS location information provided by the RTA system. This strategy will optimize schedule adherence and provide more reliable travel times. The City of Riverside and Caltrans Traffic Operations have jointly committed to provide priority where necessary during system development.

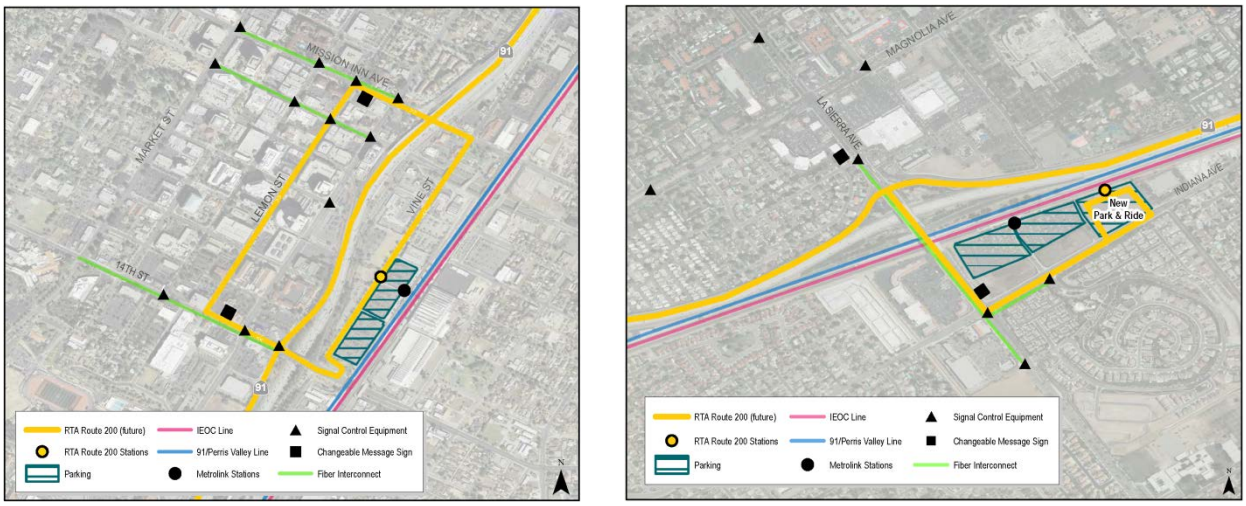


Figure 10. Equipment, CMS, and Fiber Installation Locations: Downtown and La Sierra

Changeable Message Signs and Parking Occupancy Signs

In addition to the multi-modal travel application, changeable message signs will be deployed to reach travelers who do not have the app, are not currently viewing the app, or do not have access to a smart phone. Highway signage along SR 91 will provide information about travel options that might include timing or cost comparisons for general purpose lanes, tolled express lanes, and transit options, and to indicate parking capacity. Static signage will also be provided along the route to help direct drivers to parking lots.

Changeable Message Signs
Source: *FHWA, Research and Innovative Technology Administration (RITA)*

Once drivers reach the Downtown Riverside or La Sierra parking lots, signage will direct them towards available spaces. At the new La Sierra Parking garage, occupancy sensors will be embedded in individual spaces, while the Downtown Riverside leased parking lot will utilize a camera-based detection system. Occupancy data can be presented to travelers via app and signage along SR 91.

Roadside changeable message signs along SR 91 and city streets, static directional signage on streets within the City of Riverside, and parking occupancy signage will create a seamless experience for travelers who opt for transit mid-trip. While the travel

planning app will be more focused on pre-trip diversions, signage will cater to mid-trip diversions where viewing a mobile device may be difficult or unsafe.

Summary of Deployments

The State Route 91 Multimodal Corridor Management Project will integrate data inputs from the Inland Empire and City of Riverside TMCs, a multi-modal travel application, RTA buses, and occupancy sensors in park-and-ride lots. The fusion of these data sources will provide meaningful information to travelers via app and roadside signage; to owners and operators through a decision support system; and to bus drivers using existing RTA mobile data terminals.

The technology components of this project align with the desired elements of the ATCMTD program. Table 2 below summarizes how the project achieves outcomes sought by USDOT.

	Multi-modal Travel Application	Decision Support System	Transit Eco Drive	Changeable Message Signs and Parking Capacity
Advanced traveler information systems	●			●
Advanced transportation management technologies	●	●	●	●
Infrastructure maintenance, monitoring, and condition assessment		●		
Advanced public transportation systems	●		●	●
Transportation system performance collection, analysis, dissemination		●		
Advanced mobility and access technologies	●			●

Table 2. Project Outcome

VI. Deployment Plan

The technology being deployed as part of this grant will be incorporated into ongoing operations among the team members, overseen by a RCTC and the City of Riverside. RCTC and Caltrans will provide a single point-of-contact for future operations, maintenance, and updates. Ongoing maintenance and operations of the equipment in vehicles will become the responsibilities of the vehicle owner following the initial technology deployment period. All organizations have committed to, and are providing, in-kind labor and resources to maintain the hardware indefinitely as part of their

operations. The City of Riverside and Caltrans will monitor, collect, and make available the information and will monitor the equipment to determine if repairs or upgrades need to be made. The schedule section in this grant application provides a detailed work plan for deployment of this project.

VII. Regulatory, Legislative, and Institutional Challenges

California has long been a leader in ICM deployments. In 2010, the I-15 corridor in the San Diego metropolitan area was selected as one of ICM two pilot sites by U.S. DOT. The system went live in 2013 and has been in operation ever since. There are no regulatory barriers to any of the proposed deployments in California, and Caltrans has actively pursued ICM as an important component of its congestion relief toolbox. One challenge is the need to be able to initiate signal pre-emption without having to install any additional hardware on the RTA buses serving Route 200. This will be addressed by sending the bus location information provided by RTA's AVL/GPS system to the traffic signal controllers through the Eco-Drive Server to pre-empt signals when the bus is running behind schedule.

Multi-modal trip planning applications, changeable message signs, smart parking technology, and decision support systems each have strong precedent in California. The constrained information capacity of changeable message signs will present a challenge because of the multiple modal options available for travelers in this corridor. Messaging protocols for display on the CMS will be developed when the detailed concept of operations is prepared, so appropriate information on travel options is conveyed clearly to travelers.

The State has also aggressively pursued emissions reductions. This, coupled with UCR's body of research on transit eco-approach and departure, presents a strong case for other deployments to take advantage of the Transit Eco-Drive suite of applications in the future.

VIII. System Performance Improvements

RCTC has developed a robust monitoring plan to measure the system performance improvements attributable to the proposed project, both to enable refinement of the technology deployments during the two-year demonstration period and to document successes and challenges for knowledge-sharing and transfer purposes.

Relative to the project goals enumerated below in Section X, RCTC has identified the following metrics to benchmark system performance both before and after the project

launch. RCTC will be closely coordinating with the City of Riverside, Caltrans District 8, Metrolink, the California Highway Patrol, and RTA in the collection and evaluation of relevant data.

Table 3. Project Goals and Performance Metrics

GOAL	PERFORMANCE METRIC	DATA SOURCE(S)
1: Educate commuters about available transit options	• Number of downloads for IECommuter app before/after project launch • App usage activity during morning AM peak before/after project launch • Number of in-app user responses to queue warnings	Monthly app usage reports provided to RCTC
	• Number of visual impressions associated with new CMS locations	Caltrans IETMC traffic counts at CMS locations SR 91 Express Lanes customer survey responses
2: Alleviate congestion	• Number of new transit customers on Route 200 or Metrolink services who diverted mid-trip from SR 91 in response to queue warnings • Average length of diverted trip	Rider intercept surveys for Route 200 Rider intercept surveys for Metrolink customers on IEOC and 91/PVL lines
	• Mode shift, measured by increase in the number of planned transit trips/commutes registered in IECommuter app, segmented by origin zip code, before/after project launch	Monthly app usage reports provided to RCTC
	• Travel times for auto commuters on SR 91 between key diversion points before/after project launch • Average travel speeds on westbound SR 91 before/after project launch • Onset of morning AM rush hour on westbound SR 91 before/after project launch	Caltrans IETMC traffic data

GOAL	PERFORMANCE METRIC	DATA SOURCE(S)
	• Number of traffic incidents requiring CHP involvement before/after project launch	
3: Promote social equity	• Travel times for Route 200 transit customers before/after project launch • Percentage of transit customers diverted from SR 91 who are also low income	RTA operations data Rider intercept surveys
4: Leverage investments	• Park-and-ride lot occupancy during morning AM peak before/after project launch	Monthly facility usage data collected by embedded parking sensors and provided to the City of Riverside
	• Metrolink ridership on IEOC and 91/PVL lines before/after project launch	Monthly station boardings by Metrolink train number
	• Average RTA operating cost per revenue service hour before/after project launch	RTA operations data

Much of the data can be collected from existing sources. More targeted data collection efforts may be required to monitor goal performance in certain areas. For example, RTA may need to conduct rider intercept surveys specific to Route 200 in addition to its annual customer surveys to assess exactly how many passengers diverted as a result of the proposed CMS or in-app notifications and their average diverted trip length. Specific questions may also needed to be added to SR 91 Express Lanes customer surveys to gauge the extent to which facility users demonstrate meaningful awareness of the project.

IX. Safety, Mobility, and Environmental Benefit Projections

The proposed project is expected to result in modest levels of diversion from SR 91 to parallel transit corridors. The number of auto commuters who choose to re-route their trip will drive the project's safety, environmental, and mobility benefits, principally in the form of reduced vehicle miles traveled (VMT).

The table below provides a preliminary estimate of commuters with a high propensity to take advantage of multimodal travel options in the SR 91 corridor and use the technology features offered through the proposed project. This subset of commuters is

identified through the following screening factors: those who 1) are traveling westbound in peak direction travel during the morning rush hour, 2) already have the IECommuter app (or compatible third-party apps) installed on their smartphones, 3) are single-occupant drivers, and 4) are likely to be receptive to transit alternatives (based on the results of the employee e-survey covering Inland Empire residents).

Table 4. Preliminary Calculation of Project Benefits

PRELIMINARY CALCULATION OF PROJECT BENEFITS	
12,740	Average Daily Traffic WB During AM Peak
87	% Single-Occupant Vehicles (SOVs)
11,084	Number of SOVs
33%	Willingness to Use Transit
3,694	Addressable Market for Multimodal Management Project
25%	Market Penetration for IECommuter App Users or Third-Party Opt-In users (as % of Total Commuters)
923	High Propensity Project Users
2%	Diversion Rate
18	Number of Vehicles/Daily Commuters Diverting to Transit
250	Number of SR 91 Congestion Incidents Per Year (Delays of 30 mins or more)
4,500	Annual Number of Additional Transit Trips on Metrolink or RTA Buses
64	Average Diverted Trip Length (miles roundtrip)**
288,000	Annual Reduction in VMT Attributable to Project

*** Assumes roundtrip between La Sierra Metrolink station and Anaheim Convention Center. 70% of home-based work trips on SR 91 are intercounty.*

RCTC estimates that the proposed project will generate approximately 4,500 new transit trips in the first year of deployment, with an average diverted trip length of 64 miles roundtrip, for a total annual reduction of 288,000 VMT attributable directly to the project. The VMT reduction will in turn result in safety and environmental benefits for project non-users in the form of reduced accident rates and auto emissions.

This estimate is based on high-level planning assumptions and could vary considerably according to the severity of future congestion in the SR 91 corridor, service frequencies

on the planned RTA Route 200, and time-of-day capacity constraints at transit station park-and-ride lots. It should be noted that RCTC intends to leverage its nationally-known commuter assistance program to aid in the marketing and promotion of this potential service. Operation of a robust commuter incentive program combined with direct ownership of ridematching software and a Search Engine Optimized, geo-fenced online marketing program, will enable RCTC to broaden constituent awareness of the proposed technology deployments and achieve the diversion goals and associated estimate of VMT reduction benefits.

In addition to generating near-term operational and mobility benefits, the project is anticipated to be an effective outreach and educational tool, with CMS and in-app notifications serving as a frequent on-the-road reminder of multimodal travel options in Riverside County. RCTC believes it has the potential over time to convert some of the occasional project users into more regular transit customers. To the extent possible, RCTC will be collecting data and tracking user responses to assess the project's performance and better quantify improvements in safety, mobility, and environmental outcomes.

Travel time improvements are also anticipated specifically for transit users as a result of the project's eco-approach and departure guidance to drivers. Information about Signal Phase and Timing provided by the Inland Empire and City of Riverside TMCs combined with an algorithm and vehicle data from the existing AVL/GPS system will determine an appropriate "glide-path" allowing transit drivers to encounter all green lights on their route. Not only will this curb bus emissions, it will reduce maintenance costs for RTA by eliminating a portion of the wear and tear associated with starting and stopping.

While the eco-approach and departure guidance is expected to result in mobility benefits for transit-only users, RCTC does not necessarily expect significant travel time savings to accrue to users who undertake a multimodal trip, due to the additional time required for diversion to a park-and-ride lot, transfer to a bus or rail service, and the first/last mile connection to the final destination. That said, the multimodal trips facilitated and supported by the proposed project are likely to be time-competitive with auto travel, as commuters can generally be assumed to base travel decisions on known and rational factors including cost, travel time reliability, and comfort/convenience.

X. Vision, Goals, and Objectives

The guiding vision for the State Route 91 Multimodal Corridor Management Project is to promote quality of life in the Inland Empire by improving access to transportation options that meet the needs of all residents, employees, and students.

Goal 1: Educate commuters about the availability of increasingly robust transit options in the SR 91 Corridor and break down both logistical and attitudinal barriers to transit use through the innovative use of technology, with the ultimate objective of inducing persuadable drivers to become occasional transit users and then regular customers.

Goal 2: Alleviate congestion by facilitating discretionary mode shift to RTA Route 200 and Metrolink services, thereby reducing the number of SOVs on SR 91, especially during peak periods.

Goal 3: Promote social equity by improving travel times for transit riders through enhanced signal priority and offering the same level of service afforded to SOVs traveling in SR 91 Express Lanes, but at a lower price point.

Goal 4: Leverage regional investments along the SR 91 corridor including expanded highway capacity, new bus and rail routes, enhanced station amenities, multi-modal traveler apps, and ITS.

Goal 5: Serve as a platform for future transportation deployments and a resource for other metropolitan regions targeting similar societal issues.

XI. Partnership Plan

Implementation of the SR 91 Multimodal Corridor Management Project will be accomplished through an innovative collaboration and partnership among multiple public agencies, institutional stakeholders, and academic research entities located at the University of California, Riverside.

The list of partner agencies includes:

- The City of Riverside Department of Public Works facilitates the safe and efficient movement of traffic within the city. As part of this project, 17 city traffic signals will be upgraded to facilitate signal priority for the RTA Route 200 bus line. The City of Riverside will be responsible for managing traffic signal maintenance at city intersections and ensuring a reliable feed of signal phase and timing data is maintained between its centralized signal control system and the Transit Eco-Drive server. Additionally, arterial CMS will be required within the city's right of way.
- The Riverside Transit Agency (RTA) provides transit services throughout a 2,500 square mile service area in western Riverside County. RTA will soon launch the new Route 200 bus service, which this project will supplement with the Eco-Transit suite of applications. RTA will be responsible for facilitating coordination between Clever Devices and the University of California, Riverside (UCR) to ensure that the Eco-Transit suite is appropriately integrated into their existing AVL/GPS system.

Additionally, it will continue to push real-time bus location and schedule information to the IETMC for inclusion in the IECommuter application.

- The Center for Environmental Research and Technology at UCR is distinguished by more than 50 years of high-impact environmental, energy, and transportation research, including the field of connected vehicle technology. CE-CERT will develop the Eco-Transit suite of applications for bus drivers. Activities to accomplish this will include developing and hosting the Eco-Transit application on a UCR server, coordination with the Inland Empire and City of Riverside TMCs to pull signal phase and timing information, and integration with the existing RTA Clever Devices AVL/GPS system to provide eco-driving guidance to bus drivers.
- Metrolink provides commuter rail service in Southern California with seven lines, 55 stations, and nearly 390 miles of rail network. Metrolink will continue to push real-time train location and schedule information to the IETMC so the IECommuter application can show real-time information for the Inland Empire-Orange County Line and the 91/Perris Valley Line operating in the SR 91 Corridor.
- The California Highway Patrol (CHP) is responsible for enforcing traffic laws and responding to incidents on California highways including SR 91. As part of this project, a decision support system (DSS) will be deployed to assist TMC operators in responding to varying traffic conditions based upon pre-defined scenarios. Once the DSS is developed, CHP will have responsibilities as it relates to informing the TMC about incidents and implementing action plans based on the DSS playbook.

XII. Plan to Leverage Existing Assets

The proposed project will not only maximize use of existing transportation assets and create new synergies between highway and transit networks, but also build upon significant regional investments in both completed and future projects and services intended to increase mobility, reduce emissions, and support sustainable patterns of development in Riverside County.

The requested FHWA grant of $4 million will leverage over $2.09 billion in related investments. A summary of these regional investments is presented below in Table 5.

Table 5. Summary of Leveraged Investments

MODE	INVESTMENTS	COST (IN MILLIONS)
Highway capacity	Major reconstruction of the SR 91 corridor including the addition of two general purpose lanes, tolled express lanes and connectors, and improved interchanges, bridges, and local streets.	$1,400
Highway technology	• Regional ITS investments including the Inland Empire Transportation Management Center (IETMC).	$30
Transit capacity	• Full bus fleet replacement and expansion to create transit bus service on the SR 91 corridor to provide hourly weekday service in each direction on the tolled express lanes	$365
	• Extension of the Metrolink commuter rail from Riverside into the Perris Valley, the first major expansion of the Metrolink system in over 20 years	$240
	• New bus terminal and other enhancements at La Sierra Metrolink Station, North Corona Main Metrolink and RTA Corona Transit Stations	$4
	• New limited stop RapidLink express bus service serving Magnolia Avenue	$5
Transit technology	• Bus GPS positioning, computer aided dispatch and automatic vehicle location, mobile data terminals for drivers, automatic passenger counts, and the capability to support transit signal priority.	$1
Multimodal travel amenities	• Establishment of the Inland Empire 511 (IECommuter) Traveler Information System, which provides real time trip planning, alternative commute information, and park-and-ride lot capacity	$1
First/last mile connectivity	• Planned investment in 450 parking spaces at La Sierra Metrolink Station with embedded occupancy sensors in individual spaces • Additional spaces at Downtown Riverside Metrolink Station • Parking enhancements at the North Corona Main Metrolink and RTA Corona Transit Stations.	$45
Total Investments		$2,091

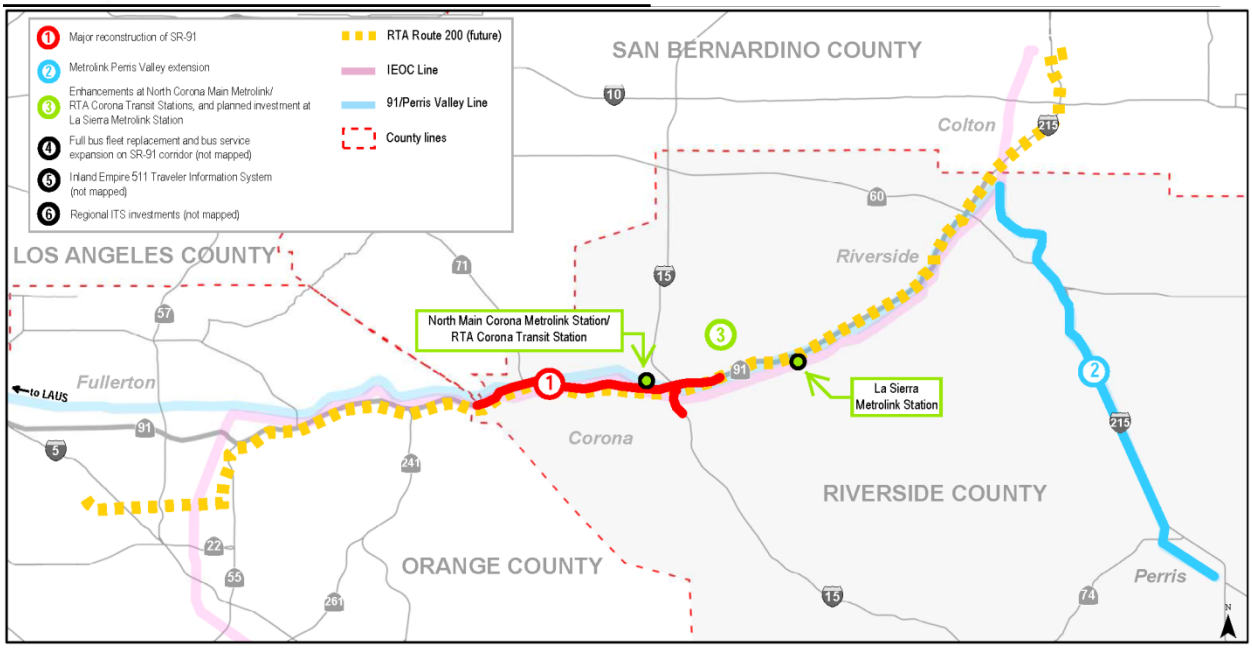


Figure 10. *Figure 10 identifies the location of these investments in relation to the SR 91 Corridor, with additional discussion below on some of the key operational interfaces between these investments and the proposed project.*

(3) Enhancements at Metrolink/RTA Transit Stations. Transit service along a corridor like SR 91 is ineffective without adequate provision of parking, as many trips to and from transit stations will originate in SOVs. The project will provide parking occupancy information to commuters prior to and during trips. The new La Sierra Parking lot will embed occupancy sensors in individual spaces, while the Downtown Riverside leased parking lot will utilize a camera-based detection system. Occupancy data can be presented to travelers via app and signage along SR 91, with parking lot signage to direct them towards available spaces.

(4) Bus Fleet Replacement. RTA has invested in a fleet expansion which will include 6 new buses for new transit service on the SR 91 tolled express lanes. This new service will allow transit users to benefit from the same travel time benefits as SOVs utilizing the tolled express lanes.

Additionally, a new limited stop RapidLink express bus service will serve Magnolia Avenue, the primary arterial along the corridor, with 15-minute headways between the Corona Transit Center and UCR. RapidLink stops will see exclusive use by this line and will include modern shelters, lighting, and signage.

(5) Multimodal Travel Applications. RCTC developed the IECommuter website and smartphone app, both of which display information about current traffic conditions, and allow users to plan trips via bus, rail, or specialized transit.

A standalone IECommuter service also facilitates ridesharing by matching riders and providing incentives to users. This service as a mobile app is currently under construction for the purposes of ridematching, incentive management and implementation of a commute log or diary. This app is expected to be deployed by the fall of 2017 and is being proposed as the starting point for the public facing diversion element of this proposal.

The project will build upon the functionality currently under construction and through the development of a new multi-modal trip planning application, which allows people to see viable transit alternatives in real time. Enhancements to the Downtown Riverside and La Sierra station parking lots will also allow for parking occupancy and wayfinding to be provided within the app.

(6) Regional ITS Investments. Caltrans, in partnership with RCTC and other regional agencies, recently completed the construction of the IETMC. This facility utilizes embedded roadway sensors, radar, and HERE data to gather real-time traffic information from the roadway. Extensive coordination occurs with nearby TMCs including those in the Cities of Riverside and Corona. From this central command center traffic management strategies can be developed and implemented to address current traffic conditions.

The proposed project will rely upon a decision support system using data inputs from the IETMC and other facilities throughout the region. Response plans will utilize the changeable message signs and/or the multi-modal travel application to disseminate information to travelers. Future enhancements may also allow for such applications as queue warning and speed harmonization within the decision support system.

ITS investments in the region have not been limited to roadways. RTA has deployed in-bus technology including GPS positioning, computer aided dispatch and automatic vehicle location, mobile data terminals for drivers, automatic passenger counts, and the capability to support transit signal priority. The project will utilize this data to provide better information to travelers.

XIII. Schedule

This grant is expected to be executed in a relatively quick fashion with installation of all equipment and software to be completed within a **two-year period**, with another two years for operation, maintenance, and evaluation of the system. After this initial project

phase, the technologies will be incorporated into the ongoing traffic operations system on SR 91. Because the roadside technology is fairly well understood and available commercially, it should require minimal time to become fully operational. The development and testing of the software applications by UCR will be the long lead item in deployment of this project.

Table 6 summarizes the proposed schedule for the project with the major Work Breakdown Structure elements identified. Importantly, some of the technology components associated with this project, particularly the software, typically requires a long development and testing time. However, the project team along with UCR has already initiated these processes and will be able to accelerate deployment along this focused test corridor. For the purposes of scheduling, we have assumed a start date for the grant of January 2, 2018.

Table 6. Proposed Schedule

TASK	START	FINISH
Task 1 - Program Management		
1.1 - Contracting and Administration	1/2/18	12/31/21
1.2 - Program Management Plan Development and Update	1/2/18	12/31/21
1.3 - Schedule Management/Monitoring	1/2/18	12/31/21
1.4 - Meetings and Communications	1/2/18	12/31/21
1.5 - Public Outreach	1/2/18	12/31/21
1.6 - Performance Measurement and Assessment	1/2/20	12/31/21
1.7 - Reporting	1/2/18	12/31/21
Task 2 - Planning and Systems Engineering		
2.1 - Concept of Operations	1/2/18	4/2/19
2.2 - System Requirements	4/3/18	10/3/18
2.3 - System Design and Architecture	9/1/18	2/1/19
Task 3 - IECommuter Mobile Application Development and Testing		
3.1 - Update and Test Enhanced Software Application	10/3/18	4/3/19
Task 4 - Decision Support System Development, Testing and Integration		
4 .1 - System Development	8/3/18	2/3/19
4 .2 - System Integration	12/3/18	5/3/19
4.3 - System Testing	2/3/19	8/3/19
Task 5 - Changeable Message Sign Installation		
5.1 - City of Riverside and Caltrans	8/3/18	8/3/19
5.2 - RCTC (Transit Station Smart Parking)	2/3/19	8/3/19

Task 6 - Operations and Maintenance		
6.1 - Infrastructure Health Monitoring	8/3/19	12/31/21
6.2 - Data Management and Monitoring	8/3/19	12/31/21
6.3 - IECommuter Application Update and Maintenance	8/3/19	12/31/21
6:4 - Infrastructure Equipment Maintenance	8/3/19	12/31/21
Task 7 - Local Agency Integration		
7.1 - Infrastructure Implementation and Integration	2/3/19	8/3/19
7.2 - Traffic Signal Timing Plan Development	2/3/19	8/3/19
7.3 - Traffic Signal Timing Deployment / Monitoring	6/3/19	8/3/19
7.4 - Connect Communications to Signals	2/3/19	6/3/19

XIV. Supporting DOT ITS Programs

The Project will seek to leverage and support USDOT ITS programs, including the Integrated Corridor Management (ICM) and Connected Vehicle Programs. The ICM Program establishes a vision of utilizing proactive integration and management of major transportation corridors to move people and goods more efficiently. The Department selected two corridors (I-15 in San Diego and US-75 in Dallas) to demonstrate this approach as part of this program. Both sites developed a decision support system as part of their efforts to coordinate regionally. The proposed Project will account for lessons learned in these pilot sites, including[1]:

- Regular communication with partner agencies throughout the project lifecycle.
- Adherence to a systems engineering "V" process to build a robust design.
- Prioritization of performance measures throughout the planning, design, and implementation processes.
- Accountability of post-deployment operations and maintenance

RCTC will also leverage the Connected Vehicle Reference Implementation Architecture (CVRIA) in developing the Eco-Transit suite of applications. UCR has contributed to this program through its research and deployment efforts related to Eco-Approach and Departure at Signalized Intersections for Transit Vehicles. While this project will not use DSRC to transmit information to vehicles, it will utilize an adapted version of basic architecture set forth in the CVRIA.

RCTC also intends for technologies deployed in the proposed project to be easily replicable in other regions and states. In support of this goal, the project team will support knowledge exchanges with USDOT and other agencies though ongoing engagement with the ATCMTD evaluation team and participation in industry events.

[1] https://www.its.dot.gov/factsheets/pdf/ICM_DemoSites_V7.pdf

ii. Staffing Description

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