CITY OF RIVERSIDE

CALIFORNIA

Application For US Department of Transportation Beyond Traffic: The Smart City Challenge Grant Application - PART 1

February 4, 2016

CITY OF RIVERSIDE

TABLE OF CONTENTS

PART 1: Vision Narrative

1.0 City of Riverside Vision for Smart City 1

2.0 City Characteristics 3

3.0 Other City Characteristics 4

4.0 Annotated Preliminary Map 5

5.0 Holistic Approach to USDOT Vison Elements 6

Vision Element #1: Urban Automation 7
Vision Element #2: Connected Vehicles 8
Vision Element #3: Intelligent, Sensor-Based Infrastructure 10
Vision Element #4: Urban Analytics 11
Vision Element #5: User-Focused Mobility Services and Choices 12
Vision Element #6: Urban Delivery and Logistics 13
Vision Element #7: Strategic Business Models and Partnering Opportunities 15
Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles 16
Vision Element #9: Connected, Involved Citizens 18
Vision Element #10: Architecture and Standards 18
Vision Element #11: Low-Cost, Efficient, Secure, and Resilient Information and Communications Technology 20
Vision Element #12: Smart Land Use 21

6.0 Risks and Mitigations 21

7.0 Partnerships and Stakeholders 22

8.0 Existing Transportation Infrastructure 22

9.0 Data and Analytics 23

10.0 Standards and Architectures 25

11.0 Measurable Goals and Objectives 26

12.0 City Capacity for Implementation 27

13.0 Opportunities to Leverage Federal Resources 28

APPENDIX: Letters of Commitment

1.0 City of Riverside Vision for Smart City

Home to deep water marine ports, a highly developed network of roadways and railways, an extensive concentration of warehousing distribution facilities, and one of the most sought-after local consumer markets, Southern California is the largest goods movement gateway to the country. Southern California provides 40% of the nation's total import traffic and about 25% of its total exports – more than any other state. The City of Riverside sits at a critical through-point in Southern California, as the City is bound by major freight corridors including: SR-60, SR-91, I-215, and I-15 and is a conduit of goods and people between the ports and the rest of the nation. Currently, the County of Riverside ranks as the fourth fastest growing county in California.

As the largest city within Riverside County, Riverside is a key component of the Inland economy for Southern California. With an estimated population of 320,000 (2014), densification of housing, four expanding universities, increases in local & regional industrial development, increased BNSF and UPRR trains, and over 400 signalized intersections, the City of Riverside is exemplary of the current transportation dilemma faced by many urban cities. As a result of the tremendous amount of economic activity and associated travel in the area, and also partly due where Riverside is situated in the Southern California air basin, Riverside has a long history of dealing with air quality issues, suffering from some of the worst air pollution in the country dating back to the 1960s. However; with aggressive air quality regulation primarily aimed at the transportation sector, pollutant emissions have been reduced by as much as 90 percent over the last half century. More recently, greenhouse gas (GHG) emissions are now being aggressively targeted in the region to deal with climate change issues. The State of California has already taken steps to restructure environmental guidelines to de-emphasize the addition of vehicular capacity as environmental mitigation- an effort in which Riverside has been an active participant. The opportunity to re-envision Riverside as a Smart City will bring relief to congested roadways, reduce emissions, encourage mode-shifts, improve safety, allow for City policy changes to parking requirements and land uses, and significantly enhance the quality of life of our City's residents and patrons.

Riverside's proposal is to develop a **Radial Open & Automated Data System (ROADS)** to build on Riverside's existing transparency and community data engagement efforts, and expand radially across boundaries, including enterprise, geopolitical, and jurisdictional boundaries. Riverside already shares millions of records, mapping data, and tabular citywide statistics through its Engage Riverside web portal – much of the shared statistics are updated every five minutes by the system and are readily integrated into third party applications. An expanded broad and encompassing approach allows a new class of solutions and is a step change in the reach and

value of the data. Information is shared with all of the key stakeholders within the community – not just the government agency that traditionally creates and manages the records. Smart Cities will require Open Data to span public and private domains, platforms and services. Moreover the scale and reach of data ROADS will need to process is far beyond anything done before and will be closely coordinated with oversight and regulating agencies.

Riverside has identified five locations, including several City-owned properties, for the construction of **Single Points of Transit (SPOTs)**, both large and small, to serve as regional, university, and neighborhood hubs for rail, automated neighborhood electric circulators, bus, bike share, electric vehicle rental, and shared economy transit services. These facilities would be linked to ROADS, and allow residents, students, and businesses within the City to capitalize on the intelligent improvements generated by the demonstration project. Riverside is also currently managing grant funded studies of a connected streetcar network, and an initiative to incentivize large-scale mixed use developments near major transit facilities.

Addressing the next generation of urban challenges does not require overhauling entire cities. In fact, Riverside's approach to smart cities improves resource management by adding connectivity and intelligence within the existing physical infrastructure and strategic-partnerships as a baseline. The proliferation of inexpensive sensors and SCADA headend systems provides significant opportunities for cities to share information and transform the transportation industry. This new sensing pattern, commonly referred to as the Industrial Internet of Things (IIoT), allows cities to begin a transformation period to integrate and develop the following elements:

- Utilize increased data availability to transform relationships between agencies, stakeholders, businesses, academia, regulators and the public.
- Enable people beyond typical SCADA/Information and Communication Technology (ICT) Engineers to utilize sensor data.
- Encourage users to ask questions, innovate, drive economic and social development, and generate data to augment SCADA/ICT engineers.
- Share local and regional real time driving information via various devices including phones, vehicles, changeable message signs, kiosks, and smart devices.
- Produce volumes of data orders of magnitude greater than what typical enterprise software handles today, and leverage this data for innovation, social and economic development, and sustainable outcomes.
- Improve commutes and decrease delays by integrating real time information to optimize traffic signal systems, automated transit, and provide users with choices on travel routes and travel modes.

The value of ROADS is the ability to integrate data from all of the critical infrastructures/services a City must provide. Riverside will integrate the transportation sector seamlessly through the following key principles:

Interoperability

True efficiency will result from the integration of city functions such as energy, water, waste, lighting, transportation and built infrastructure – enabling intelligent communication, while maintaining security protocols and data stewardship. Smart Cities are comprised of all of the critical service providers to a city, be they publicly or privately owned. Disruptive events amplify the interdependence of these critical municipal services. ROADS will be the infrastructure these critical functions use to share data, and as a result: reduce energy usage, improve situational awareness and security, and increase overall sustainability and reliability.

Cross Jurisdictional Sharing Information

Cities, Counties, State, Municipal Planning Organizations and Federal Agencies have different roles and responsibilities to perform within local jurisdictions. Local, state, and federal agencies strive to share information but often policies, security protocols, networks, and communication systems restrict data sharing. Software can now enable us to synchronize traffic signals and timing while monitoring lane level traffic patterns and emissions so that new electric and automated vehicles, bicyclists, and pedestrians can move throughout our city and respond to customer demand in real-time.

Processing at the Edge

Critical physical infrastructure including transportation networks, video detection cameras, and signal control systems produce massive amounts of real-time data. Our proposal supports adding processing power and intelligence where data is transferred and received – enabling information to be more intuitive and dynamic. ROADS will be designed with the flexibility to expand and scale.

Smart Transportation

The City of Riverside's goal is to enhance safety and convenience for the next generation of connected vehicles and infrastructure through our smart transportation solutions that leverage ROADS. ROADS will integrate real-time congestion data, direct wrong way driver alerts and accident response management, provide emergency action plans to the City's Emergency Operations Center, reduce CO2 emissions through traffic management, and process location finders for parking and electric vehicle charging stations. With this approach, our communities will be able to increase adoption of lesser used modes of transportation including commuter rail, busing, cycling, car-sharing, bike-sharing, and last mile solutions like Uber and Lyft.

2.0 City Characteristics

The City of Riverside's population characteristics fully align with the USDOT's characteristics for the Smart City Challenge Program, including:

a. Our population of 303,871 based on the 2010 Decennial Census.

b. Our Dense Urban Population was 3,731.0 people per square mile (Riverside has a total area of 81.4 square miles).
c. 15.7% of the City's population is representative of the Riverside-San Bernardino local urbanized area (1,932,666 population).

3.0 Other City Characteristics

Incorporated in 1883, Riverside is a Charter City in the State of California with a unique blend of historic charm and modern city features. While rich in history, Riverside has invested billions of dollars in infrastructure improvements to serve residents and businesses well into the future. Riverside is currently served by 20 Riverside Transit Agency routes, both Metrolink and Amtrak rail services, and a new 24 mile Metrolink extension & station expected to be completed within the next month.

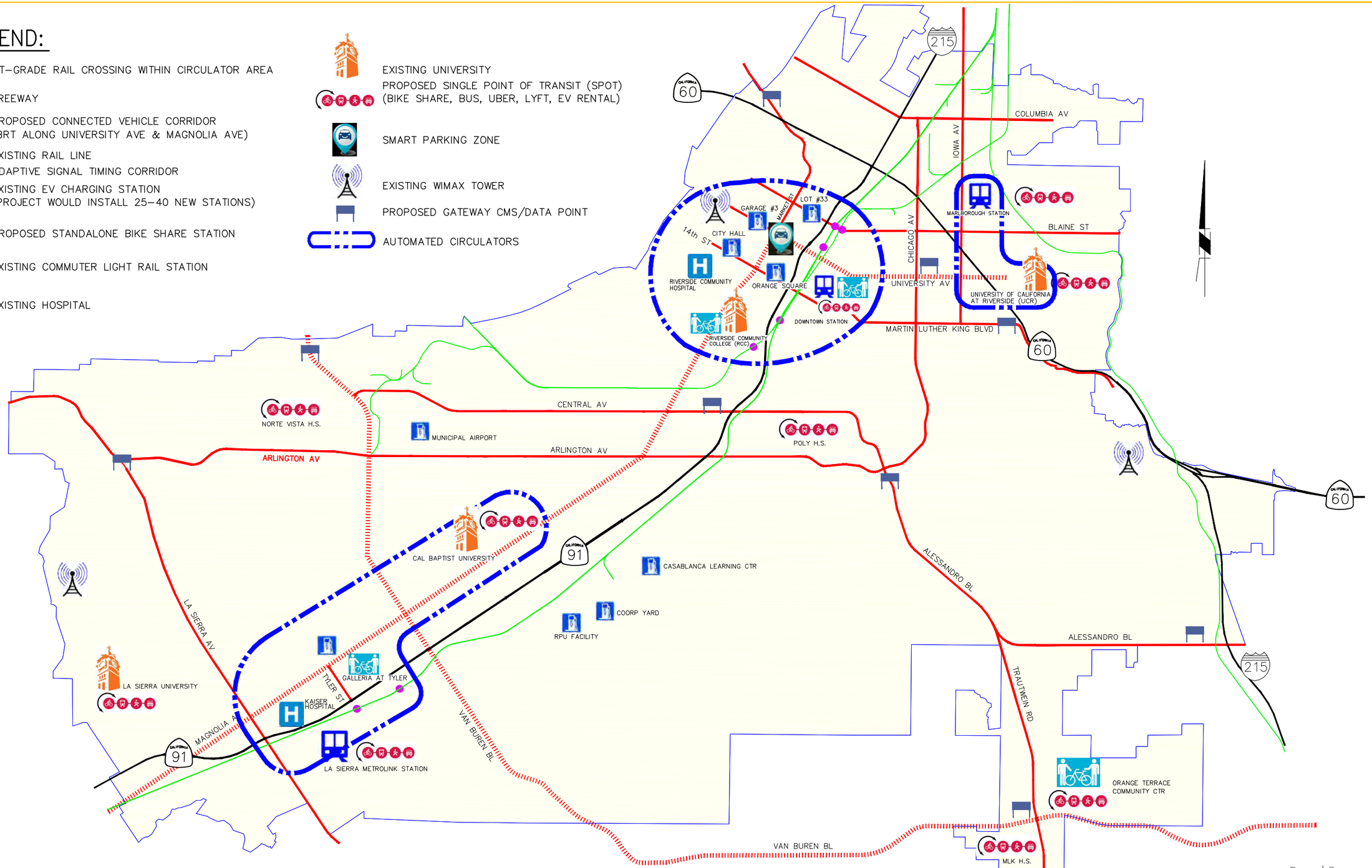
Riverside's City Management enthusiastically supports the pursuit and execution of the Smart City project, the City's success as an award-winning municipality demonstrate both the continued singular vision of its leadership, and the traits that make Riverside an ideal landscape for the Smart City project. The City is ranked #1 among all Inland Southern California cities in virtually every economic indicator; including number of jobs, number of businesses and assessed valuation. Some of the recent awards and recognitions that Riverside has received include: Number 1 City for Small Business by Inc. Magazine (2014), Number 2 Millennial Boomtown in America by Forbes (2014), Number 8 Coolest City in America by Forbes (2014), Number 1 for Job Growth in 2013 (ASU), Number 2 Spot for Tech in the United States (2013), 2012 Intelligent Community Site of the Year, 2011 Can-Do City (Newsweek), and First Emerald City (2009). Riverside is home to many legal, accounting, brokerage, architectural, engineering and technology firms as well as banking institutions. The University of California, Riverside, California Baptist University, La Sierra University, and Riverside Community College, offer specialized training, research partnerships, and a high-technology environment to support emerging and innovative companies.

The City's Single Point of Transit (SPOT) plans demonstrate a commitment to integration of the sharing economy with traditional modes of transportation. Engage Riverside, a web portal maintained by the City, provides open source data updated every five minutes that can be used by application builders. Riverside would continue its commitment to open data as part of the Smart City demonstration.

4.0 City of Riverside Annotated Site Map

LEGEND:

- AT–GRADE RAIL CROSSING WITHIN CIRCULATOR AREA
- FREEWAY
- PROPOSED CONNECTED VEHICLE CORRIDOR (BRT ALONG UNIVERSITY AVE & MAGNOLIA AVE)
- EXISTING RAIL LINE
- ADAPTIVE SIGNAL TIMING CORRIDOR
- EXISTING EV CHARGING STATION (PROJECT WOULD INSTALL 25–40 NEW STATIONS)
- PROPOSED STANDALONE BIKE SHARE STATION
- EXISTING COMMUTER LIGHT RAIL STATION
- EXISTING HOSPITAL
- EXISTING UNIVERSITY
- PROPOSED SINGLE POINT OF TRANSIT (SPOT) (BIKE SHARE, BUS, UBER, LYFT, EV RENTAL)
- SMART PARKING ZONE
- EXISTING WIMAX TOWER
- PROPOSED GATEWAY CMS/DATA POINT
- AUTOMATED CIRCULATORS



5.0 Holistic Approach to USDOT Vison Elements

The City of Riverside continually augments and updates its transportation system. The City's state-of-the art Transportation Management Center (TMC), a citywide reliable traffic signal communication network, centralized traffic management system that integrates over 200 traffic signals, and a parking management system that makes use of smart metering are just some of the enhancements that the city has incorporated to improve safety, mobility, accessibility, and the environment. The City has developed a proactive Active Transportation Program which includes 160 miles of bicycle facilities to link major transportation centers with their local universities, employment centers, downtown, and residential neighborhoods.

In order to provide a holistic approach to smart transportation, there are a number of underlying technologies to integrate:

- *Connectivity* - cost effective and persistent network-wide wireless connectivity.
- *Data Platform* - common backend data platform and format for collection, display, control and analysis.
- *Control and Automation* - the entire transportation network should be integrated with control and automation holistically.

Once data is made available through ROADS, each vision element can be wholly analyzed and operationally optimized to enhance the transportation network.

Automated electric vehicles would reduce GHG emission burdens on the network. As such, Vision Element #1 (automated vehicles) and Vision Element #8 (electrifying roadways) are highly synergistic. If the parking spaces can rapidly charge automated vehicles while they are parked, the battery size of the electric vehicles can be reduced. In addition, vehicle range is extended and the driver experience improved to make electric vehicles even more appealing.

The Electrical Grid is managed and owned by the City of Riverside. Data from each critical infrastructure element will enable the analytics and optimization in a "system" thinking approach. Automated, connected vehicles on roadways with charging capabilities (Vision Elements #1, 2 and 8) are the baseline for smart transportation. Vision Elements #5 and #6 are extensions of this approach, and give citizens mobility choices while exploiting unused capacity.

Intelligent sensors and information/ communications technology (Vision Elements #3 and #11) form the basis of data and analytics enablement. Citizens (Vision Element #9) will benefit from the information provided, while the urban analytics (Vision Element #4) will find a home to feed the information into the system.

Partnership and interoperability standards are essential for bringing innovative technology into reality. Our approach to smart transportation relies on re-imagining and re-using existing

infrastructure where possible, make them smart and multi-purpose; and providing cost-savings and efficient opportunities.

Vision Element #1: Urban Automation

City of Riverside Vision

The City of Riverside proposes opportunities to enhance mobility, accessibility, safety, and the environment by integrating automated vehicles along specific corridors and within the downtown area; it will be linked to other transportation corridors, transportation centers, universities, and commercial areas.

The Riverside Team will work closely with the California Partners for Advanced Transportation Technology (PATH) program. The Riverside team plans to apply vehicle automation, e.g. precise train-like curb parking to its transit service. For years the City of Riverside has been pursuing a connected, intelligent streetcar system on key arterials, including University and Magnolia Avenues. A partially automated bus rapid system offers improved service pursuing more advanced automation for the City's transit system, which will also include shared-use vehicle systems.

Critical Objectives: Automated City Transit Vehicles

- As part of the Smart City Program, the City would provide automated transit in the Downtown area. Downtown Riverside alone hosts over one million visitors per year. The Festival of Lights, hosted by the historic Mission Inn, attracted an estimated 78,000 visitors to the downtown on opening day, and 480,000 visitors over the course of the month long festival. The downtown hosts multiple annual events, which cumulatively attract another half million visitors. The Courts system hosts nearly 100,000 jurors each year, while the newly-remodeled convention center hosts approximately 120,000 visitors per year.
    - Fixed route automated bus services can be provided at low speed locations to reduce the complexity of purely autonomous systems.
    - Slow moving automated neighborhood electric vehicles will enhance mobility in the downtown area. It will reduce vehicle and parking demands; allowing people to hop on and off the system.
- Automated right-sized City buses can be easily integrated by:
    - Using analytics to determine ridership throughout the day to send proper size bus – full bus, van size or passenger vehicle.
    - Using sensors at bus stops to alert more real time pick-up.
    - Provide automated transit as part of the City's Single Point Of Transit initiative.
    - Trip planning including real-time traffic information and route analysis can be provided to commuters to facilitate their trip planning and modes of transportation.

- Shared-use electric vehicle systems previously developed and deployed in Riverside (see http://www.cert.ucr.edu/intellishare.html) will be expanded and integrate automated technology.
    - Riverside would allow collector roads with 7-ft or greater bike lanes to accommodate Neighborhood Electric Vehicles (NEV).
    - Riverside will deploy shared-use electric vehicles in conjunction with charging infrastructure, automated corridor(s), and smart grid energy management.
- Connectivity enablement between automated vehicles, traffic conditions, electric grid state, etc.
- Riverside will integrate Dedicated Short Range Communications (DSRC) radios along signalized intersections to transmit signal phase and timing (SPaT) and MAP messages.

Benefits

- Fuel savings and GHG emission reduction due to automated vehicles computerized route, speed and drag optimization program, as examined by Riverside partner UCR, "M. Barth and K. Boriboonsomsin "Real-World CO_2 Impacts of Traffic Congestion", *Transportation Research Record*, No. 2058, pp 163-171, Transportation Research Board, National Academy of Science, 2008."
- Commuters will be able to rely on more frequent buses or right size bus on demand.
- City will be able to increase mobility for disadvantaged disabled, under-aged and elderly riders.
- Remote monitoring to the City and RTA would facilitate immediate response to incidents and outages.
- A connected and automated vehicle population would provide the greatest safety benefits. The City of Riverside tracks collision data in the Crossroads collision database software, and the Statewide Integrated Traffic Records System (SWITTRS) and would be able to track measureable reduction in the number of and severity of collisions.
- Increased public transportation ridership.

Vision Element #2: Connected Vehicles

City of Riverside Vision

The Riverside Team has existing plans to pursue connected vehicles as part of its long-term development plans, primarily between researchers at UCR and the city's traffic operations center. Researchers at UC Riverside have been at the forefront of connected vehicle technology, particularly in the applications that are focused on the environment and mobility. For example, UCR was a major contributor to the USDOT AERIS program (Applications for the Environment: Real-Time Information Synthesis) [Barth, M., Wu, G., Xia, H., Jin, Q., and Boriboonsomsin, K. (2012). AERIS Field Study Application: Eco-Approach to Signalized Intersections. Final report to U.S. Department of Transportation, September, 37 pp.]. This effort included a major modeling effort as well as implementation via field demos at Federal's Turner-Fairbank Highway Research Center in Virginia, El Camino Real in Palo Alto, and in the City of Riverside, California. One of the key resulting applications is called

Eco-Approach and Departure, which makes use of traffic SPaT information. In-vehicle systems allow the driver to adjust the vehicle's speed to pass through the upcoming signal on green or to decelerate to a stop using the least fuel. Other applications evaluated include Connected Eco-Driving, Eco-Freight Signal Priority, Eco-Speed Harmonization and Eco-Cooperative Adaptive Cruise Control (CACC). UCR is currently working with other groups in Southern California to further develop these applications. UCR and the City are actively collaborating to implement a connected vehicle corridor to evaluate a variety of applications for improved mobility.

Critical Objectives: Expand Connected Vehicle Corridor & Mesh Hotspots

- As part of the Smart City Program, the Riverside Team would expand its connected vehicle corridor implementation, developing additional connected vehicle corridors along its major arterials. A partnership has already been formed between the city's traffic operations group, McCain traffic systems and UCR researchers.
    - Install DSRC radios on traffic signals to enable communications of traffic signal timing with motorists and cellular phones.
    - Riverside's current test installation will make use of the Python programming language and vehicles' On Board Diagnostic systems, the McCain Omni software on a 2070 ATC controller, and the ARADA LocoMate Roadside DSRC unit.
- The City will equip its fleet of over 1280 vehicles, along with fleets from UCR, the County of Riverside, RTA, and other major employers (e.g., Bourns Inc.) for a total of over 1700 equipped vehicles. These fleets will be outfitted with DSRC communication technology to take advantage of the connected vehicle corridor deployment. As the City expands and redevelops, connected vehicle technology can be conditioned on development as environmental mitigation.
- Expanding the City's existing Wi-Max network and upcoming fiber backbone on Magnolia Avenue will enable adaptive signal operations, enhanced by connected vehicles, and relay data back to City Hall for further analytics and distribution.
    - Riverside currently provides Wi-Fi hotspots, and will expand its network for use with Public Transportation.
    - The system will provide real-time traffic and vehicle data for city and shared with partnering agencies.
    - The City will enable mesh technology on a zone of city buses and selected taxis, fleets.
    - The City will provision backend cloud servers to support the traffic and vehicle data.

Benefits

- Connectivity will enhance the City's vehicle, bicyclist, and pedestrian safety program.
- Data collected from connected vehicles will provide real-time information to the City to measure performance of our intersections and roadway systems.

- The system will provide traffic signal communication with motorists to optimize their travel through a coordinated signal system.
- City's Fleet will be able to receive real-time vehicle information and route optimization.
- Determine message forwarding via mesh in manner that addresses security, and congestion control issues, thereby contributing to standards.

Vision Element #3: Intelligent, Sensor-Based Infrastructure

City of Riverside Vision

The City of Riverside aims to use existing transportation data and operations and integrate intelligent sensor-based infrastructure to enhance the operations of the City's transportation network. The infrastructure will provide an open transportation data ecosystem to improve public safety, enhance public services, enable personal mobility, and expand economic growth. Riverside will enhance mobility by integrating various networks together so partner agencies can manage the transportation corridor as a unified multi-modal system. As part of this effort, Riverside will develop policies to support, develop, integrate, and maintain systems that share travel demand data.

Critical Objectives: Responsive Transportation District

- Riverside will enable a city zone or arterial road (Magnolia Avenue and a to-be-determined intersecting arterial), to support high density sensor technologies, deploy a base connectivity infrastructure enabling integration of COTS and prototype sensors, collectively termed the "Responsive Transportation System". The City will examine its arterials and accident record data to determine the best candidate for an intersecting arterial to support high density sensor technologies.
    - Develop a comprehensive base connectivity infrastructure.
    - Integrate the City's existing communication network.
    - Enhance City's wireless network with gateway devices located throughout the district.
    - Provide low power wireless connector technologies to deploy commercially off-the-shelf (COTS) and prototype sensors.
    - Integrate Responsive Transportation System to ROADS, where data from other critical infrastructures could be combined to drive high value analytics.
    - Create real-time responsive signal and timing patterns based on current and predicted traffic patterns to ease transportation load and enhance mobility.
- Enhance multi-modal sensors.
    - Provide road and traffic conditions; and enable traffic light signals to work efficiently.
    - Provide a basis for bicyclist and pedestrian friendly road alteration.
    - Use existing Caltrans partnership to provide additional traffic data and video feeds from the Caltrans TMC and potentially traffic data from other agencies.
- Provide on-street and off-street parking sensors.

- To allow motorists to use mobile applications and reduce fuel consumption (GHG emission reduction).
- Use of a smart phone app to pay remotely & extend parking duration.

Benefits

- Increase citizens' mobility and productivity with efficient traffic signals and reserved parking facilities.
- Optimize traffic flows to minimize GHG emissions, and communicate to community users this through smart signage and mobile applications.
- Provide data and analytics for City to perform predictive and iterative analysis.
- Allow for proactive, joint, multimodal management of assets.

Vision Element #4: Urban Analytics

City of Riverside Vision

Building on existing strong strategic-partnership between the City of Riverside and UCR, the Riverside Smart City vision will greatly expand its Urban Analytics efforts in three key directions:

1) Traffic Monitoring: The City of Riverside has proactively set up video cameras across the city to monitor traffic, including key rail crossings. Video feeds from this camera system are currently used by City forces at Riverside's Traffic Management Center (TMC) and the City's Emergency Operations Center. These video feeds will also be analyzed using advanced computer vision tools to automatically determine traffic counts, speed, density, and flow rates throughout the city. In addition, safety applications will be developed to automatically determine potential safety hazards at key rail crossings.

2) Electric Grid Management: The City of Riverside is in a unique position in that it owns and operates its own public utilities, Riverside Public Utilities (RPU, see http://www.riversideca.gov/utilities/). RPU and UCR are working together to better monitor and manage its electric grid using advanced sensors, data collection techniques, predictive models, and energy storage. As a testbed system, RPU and UCR are using the Hunter sub-station grid to deploy various micro-PMUs (Phasor Measurement Units) across the system.

3) Real-Time Energy and Emissions Estimation: Using the City's real-time traffic data and transportation figures from other providers, UCR has developed a technique to estimate energy consumption and emissions from a variety of roadways. This technique was originally developed as part of the USDOT Sustainability Working Group in which basic safety message data from vehicles are monitored and fed into a real-time energy/emissions model. As a result, estimates of roadway link-based energy and emissions are possible. This is valuable for determining greenhouse gas emissions inventories and fuel consumption. Riverside will expand this effort as a Smart City.

Critical Objectives: Analytics for the City of Riverside

- Enable big data analytics in city backend server.

- ROADS would provide open data access to employ intelligent big data analytics cloud technology.
- Users accessing this data could be city employees, universities conducting directed Research or curricula/workforce development, and private sector participants. Each user could use their platforms of choice. ROADS would present data in a secure manner.

- Create and distribute real-time sensor data to stakeholders.
  - Provide data access to our citizens to leverage innovative ideas from the public.
  - For the purposes of the Project, UCR would be an appropriate user of the data under Directed Research Funding.
- Establish measureable metrics and performance goals to improve traffic safety and operations/enhancements.
  - Provide data mining to enable adaptive traffic signal timing/controls.
  - Provide the public optimal multi-modal traffic/travel schedule based on data.

Benefits

- Real-time traffic data provided to improve our residents' quality of life.
- Open platform application to encourage crowdsourcing and innovation.
- ROADS provides a robust security architecture providing all stakeholders access to appropriate data without compromising sensitive control and monitoring systems.

Vision Element #5: User-Focused Mobility Services and Choices

City of Riverside Vision

The City of Riverside currently interfaces with residents through the 311 mobile application – which is used to initiate service requests. The City has developed a virtual tour guide applications, a mobile application to provide residents with City News, and a separate mobile application to keep residents informed of City Council agendas and proceedings. Our partner, IE511, provides travel information to the public in Riverside and San Bernardino Counties. The City of Riverside will create strategies, initiatives, and services to increase transportation choices and options by implementing Mobility on Demand (MOD) to all users.

Critical Objectives: Mobility Services and Choices

- Riverside will promote choices in personal mobility by optimizing the transportation system and choices through Intelligent Transportation System (ITS).
  - City of Riverside partner UCR has studied the impacts of dynamic routing on the environment, "K. Boriboonsomsin, J. Dean, M. Barth (2014) "An Examination of the Attributes and Value of Eco-Friendly Route Choices", *Transportation Research Record, Journal of the Transportation Research Board*, Record No. 2427, pp. 13-25, 2014."
- Riverside will promote and utilize emerging technologies and open transportation data exchange to enable personal mobility.

- Riverside will implement multimodal connectivity and system interoperability to facilitate personal mobility.
    - Riverside will develop a MOD Program to promote a variety of mobility on demand choices, including automated vehicles, shared-use vehicles, automated Neighborhood Electric Vehicles, electric bikes, scooters and segways.
    - Riverside will implement a mobile application that ties into a networked neighborhood circulator system and links residents to employment, SPOT facilities, shopping, schools, and high quality transit routes. The City is planning to construct both large SPOT locations at high priority transit locations at Metrolink Stations, UCR, Cal-Baptist, along with small – mid size SPOTs to serve local traffic and smaller facilities.
    - The City will establish first and last mile transportation alternatives including bike sharing stations and car sharing parking facilities.
    - Data provided via mobile application can also be integrated at smart kiosks located at major transportation centers, shopping centers, and other major facilities in the City.
    - Riverside will work with stakeholders and partners to provide ride and bike sharing facilities within specific zones. Other alternatives are mixture of transportation modes, from an electric bike, sharing a vehicle, to an electric scooter.
    - Riverside will work with stakeholders and partners to fully integrate real-time apps for smart phones to indicate location of vehicle, estimated time of arrival and duration of ride.
    - The City will create and/or expand their Ride-share, and Bike-share Programs to integrate and expand mobility choices to the public.

Benefits

- The citizens of the City of Riverside can choose from a variety of transportation choices.
- GHG emission reduction by eliminating low occupancy vehicle traffic.
- Reduced traffic congestion through efficient mobility management.

Vision Element #6: Urban Delivery and Logistics

City of Riverside Vision

Southern California is the largest gateway of goods movement in our nation. It provides 40% of the nation's total import traffic and about 25% of its total exports. The City of Riverside is located at a critical through-point in Southern California, as the City is bound by major freight corridors including SR-60, SR-91, I-215, and I-15 and sits between the ports and the rest of the nation. The 2016 Sothern California Association of Governments (SCAG) Regional Transportation Plan identifies the number of trucks on key corridors within Los Angeles, Orange, San Bernardino, and Riverside Counties. Of these corridors, State Route 60 – which

passes through the City of Riverside, carries the highest number of daily trucks at 41,000 per day – a figure which is expected to expand to 68,000 by the year 2040. State route 91 – which also passes through the City of Riverside and intersects with State Route 60, is shown to carry 18,000 daily trucks and is expected to carry 32,000 by the year 2040. According to the SCAG Regional Goods Movement Plan & Implementation Strategy, Riverside County contains the highest percentage of potential warehousing space within Southern California. It is clear that the City of Riverside is a regional nexus of goods movement, and stands to benefit greatly from the automation of heavy vehicles passing through the City of Riverside. The City of Riverside seeks to use data and deployment of technologies to reduce congestion, improve safety, and protect the environment with efficient goods movement.

Critical Objectives: Urban Delivery and Logistics

- Riverside will work with public and private partners for the deployment of Goods Movement Technologies along major corridors to reduce congestion and improve air quality.
    - Riverside will develop opportunities for Dynamic Routing to enhance freight mobility.
    - Riverside will continue to promote use of Zero Emissions Trucks to all businesses, and develop an incentive program to promote further use.
    - Riverside will encourage use of Partial Automation for Truck Platooning along Freeway and Arterial Smart Corridors.
    - Work with USDOT to integrate their roadway system in the Freight Advanced Traveler Information System (FRATIS). Riverside partner UC Riverside is involved in the second phase of FRATIS deployment.
    - Riverside will expand procurement of Zero Emissions Trucks for its fleet.
- Riverside will leverage automated processes to adaptively control signal timing and traffic around distribution centers.
    - Riverside will work with public and private partners to create Arterial Smart Corridors to improve mobility from major freeways and distribution centers.
    - Riverside will work with Caltrans for the development and integration of Freeway Smart Corridors.
- The City of Riverside will integrate advanced technologies for Safety Applications including Dynamic Speed Signs, Dynamic Truck Restrictions, at Grade Rail Crossing Warning Applications, Curve Speed Warning Applications, Over-height Detection, and Roadway-Weather Applications.
    - The City will incorporate enhanced traveler information systems to address specific freight needs by working with the Port of Long Beach, Port of Los Angeles, and distribution centers. It will provide travel information including incident alerts, road closures, work zones, and routing restrictions.
    - Riverside will enable real time control and preemption of traffic signals around distribution centers to move platoons of freight vehicles around the city more effectively.

Benefits

- Reduce energy consumption, improve safety, efficiency, and mobility.
- Enhances traveler information systems to address specific freight needs.
- Leverage and maximize under-utilized vehicle capacity.
- Improves freight mobility that will benefit economic growth.
- Reduction in GHG emission.
- Reduction in City cost for transporting goods.

Vision Element #7: Strategic Business Models and Partnering Opportunities

City of Riverside Vision

The City of Riverside continues to partner with local, county, state, and national agencies to reduce congestion, improve safety, protect the environment, and enhance the quality of life in the region. The City of Riverside has partnered with UCR / CE-CERT to further research of: EV charging stations, smart grids, emissions, and now connected vehicles. The City has also partnered with Caltrans and Riverside County Transportation Commission (RCTC) to improve mobility along SR-60, SR-91, I-215, and I-15, including the upcoming installation of over 20-miles of managed lanes along SR-91 and I-15. The Smart City program brings opportunities to leverage creative strategic partnerships to plan and implement advanced smart city solutions in the City of Riverside. The City of Riverside is excited to partner with a comprehensive project team of experts and stakeholders to the Smart City Challenge Program, including: local government agencies, local businesses, transit agencies, planning organizations, technology companies, vehicle manufacturers, freight industry, ride-sharing companies, academia, and professional associations.

Critical Objectives: Strategic Business Models and Partnering Opportunities

- Riverside will build on their current strategic partnerships with local agencies to promote data sharing, systems interoperability, and deployment of emerging technologies to enhance mobility in the City and region.
    - Riverside will build on relationships with Caltrans, Riverside County Transportation Commission (RCTC), County of Riverside and other local and state agencies to integrate the City of Riverside smart city solutions with other transportation systems in the county including upcoming applications from the SR-91 and I-15 managed lanes, Caltrans' Integrated Corridor Management Program, and other emerging technologies that are planned along major corridors in the County of Riverside.
- Riverside will build on their current strategic-partnership with UCR / CE-CERT to further research of EV charging stations, emissions, and connected vehicles.
- Riverside will leverage the private sector partners to implement multi-modal transportation options focused on smart mobility services and choices.

- Riverside will partner with local business, neighborhoods, freight, to promote and implement smart city solutions throughout the City.
- Riverside will leverage technology partners to implement the City's vision to implement smart emerging transportation technologies, open data, cyber security, and mobility solutions and applications.
- Riverside will partner with vehicle manufacturers to test and implement emerging and innovative CV and AV solutions.
- Riverside will leverage the freight industry to promote the use of Zero Emissions Trucks and integrate Partial Automation for Truck Platooning.
- Riverside will partner with professional associations to support smart city solutions.

Benefits

- A robust and strategic public-private partnership will facilitate deployments of advanced smart city solutions.
- The City of Riverside's partnerships with Caltrans and the County of Riverside will enhance mobility throughout the county and southern California.
- Partnering with globally recognized private technology firms, including Qualcomm, IBM, Cisco, BOSCH, ORACLE, Zipcar, Philips, and others will bring worldwide expertise on the rapidly changing technologies, standards, and applications.
- Partnering with the auto industry will enhance the Riverside Team to facilitate the vision elements that will incorporate connected vehicle/automated vehicle solutions and applications.
- The Riverside Team will be partnering with local, state, and national universities, including University of California, Riverside (UCR), University of California, Berkeley – California PATH, California Polytechnic State University, San Luis Obispo, and California Polytechnic State University, Pomona. In addition, The Ohio State University will serve as a collaborator to our academia team. Our academia team will bring expertise on research, development, standards, and applications, of smart city solutions; including UCR's existing smart city programs with the City of Riverside.
- Partnering with professional associations, including the Society of Automotive Engineers (SAE), Institute of Transportation Engineers (ITE), and Smart Cities Council.

Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles

City of Riverside Vision

The City of Riverside has accomplished a long list of green goals, from hydrogen fueling stations to solar installations. The City of Riverside offers incentives for purchase of all-electric vehicles, and the City has 25 public EV charging stations. The most recent fast charging station installed can provide up to an 80% charge within 30 minutes. This station uses the "Greenlots" mobile application – which directs users to additional charging stations and allows them to manage payments. The City of Riverside Public Utilities (RPU - owned by the City) is sponsoring a project

to convert all City street lights to LEDs including the potential integration of smart street lighting control and energy management system features. The City conducts a citywide GHG inventory (includes: local government operations, and for the community as a whole) every five years, the first was in 2007 and the second was 2010. We are now finalizing the 2015 GHG inventory. The City's 2007 inventory is included in the City's Climate Action Plan as the baseline for future reductions. In addition, the City of Riverside residents participate on the City's Sustainability Coalition Group, a group of city community members who provide feedback on the city's sustainability efforts (http://www.greenriverside.com/about-green-riverside/gap-committee). The City of Riverside has several existing partnerships with UCR / CE-CERT to manage EV charging stations in coordination with power distribution status, vehicle needs, and smart grid energy management system as part of their joint Sustainable Integrated Grid Initiative (SIGI, http://www.cert.ucr.edu/sigi). The City of Riverside vision is to continue leading urban sustainability by promoting and implementing smart city solutions that will enhance mobility, improve safety, and protect the environment.

Critical Objectives: Expand City of Riverside Green Action Plan

- Integrate wireless and smart charging with city parking spaces.
- Strategically place wireless charging along EV based transit routes.
- Automatic wireless inductive charging of for automated passenger vehicles.
- Implementation of Vehicle to Grid (V2G) and smart charging technology.
- Advanced energy management of EV charging to minimize peak energy demand on the utility and distribution network.
- Integration of distributed energy generation (Solar PV) coupled with EV charging to reduce fossil fuel consumption.
- Provide EV owners with price based charging options as function of power availability.
- The citywide LED conversion project will have the potential to be integrated, networked, and feed or relay data as part of the Smart City Program. The street lights provide easy locations for installation of DSRC radios, midblock detection, and data collection technologies. The street lights can potentially be used as connection points to broadcast information (e.g. link to Changeable Message Signs, smart kiosks, etc.).
- Provide expanded electrified transit and/or light rail routes.
- Retrofit a number electrical vehicles with wireless charging receptors.

Benefits

- Cable free, supports both driver and automated vehicles.
- Leveraging the light rail power for less complex installation and extend range of charging.
- Smart grid integration charging – time of day charging, low cost electricity charging.
- Electrical vehicles can be less expensive due to smaller battery requirement.
- Reduce GHG emission – fear of range anxiety has been reduced, more electrical vehicles will be sold.

- The quality of life for drivers improves significantly as battery charging time decreases.

Vision Element #9: Connected, Involved Citizens

City of Riverside Vision

The City of Riverside interfaces with residents through the 311 mobile application, which is used to initiate service requests. The City also has virtual tour guide applications, a mobile application to provide residents with City News, and a mobile application to keep residents informed of City Council agendas and proceedings. Engage Riverside is a website focused on transparency (http://riversideca.gov/transparency/) which contains 4.1 million pages of public records, along with freely available datasets for use by the public. Datasets available include 311 calls for service, fire responses, permit activity reports, crime reports, neighborhood mapping data, recreational location mapping data, fire stations, police stations, libraries, city council data, and the financial data transparency portal. City of Riverside vision consists of strategies, local campaigns, and processes to proactively engage and inform citizens at the individual level by deploying hardware, software, and open data platforms in an effort to increase personal mobility. Advanced technologies would be used to enhance overall mobility for all citizens including people with disabilities, elderly, and Millennials.

Critical Objectives: Connected Riverside Program

- Riverside will create a Connected Riverside Program, linked to ROADS, to promote smart mobility and sustainability, and enable citizens to participate in the Smart City Program.
- The program will expand open access to City data using City servers.
- Riverside will leverage the use of crowdsourcing and provide communication conduits through mobile technologies to connect citizens with city operators about a myriad of topics.
- The City will install smart kiosks at major transportation centers, government buildings, and shopping malls to promote smart mobility solutions and transportation choices to the public.

Benefits

- Real-time mobility solutions and transportation choices to the public.
- Intuitive and transparent data for user access.
- Create support from residents and businesses.
- Provide economic growth in the City of Riverside and the region.

Vision Element #10: Architecture and Standards

City of Riverside Vision

The City of Riverside has deployed a state-of-the-art transportation system that includes copper/fiber optic/wireless communication transportation network that links the City's signalized intersections, including controller, sensors, and closed circuit television (CCTV) cameras, to the City's Traffic Management Center (TMC). The City of Riverside transportation communication network is also linked with Caltrans and adjacent agencies to enhance mobility along local roads and freeways. The City's transportation communication network is based on state and National ITS Architectures. As part the Smart City Program, the City of Riverside understands each vision element emphasizes architectures, governed by rules, documentation, and standards and that may be extended to a nationwide or broader deployment. The City of Riverside is committed to develop a framework for innovative emerging interoperability technologies, solutions, and applications using the National ITS Architecture and the Connected Vehicle Reference Implementation (CVRIA) and associated SET-IT software tool, and published and under-development ITS standards to demonstrate interoperable ITS capabilities.

Critical Objectives: Architecture and Standards

- The Riverside Team will develop a Smart City Architecture and Standards Framework for each of the Vision Elements that includes using ITS National Architecture and the Connected Vehicle Reference Implementation (CVRIA), and supporting standards, policies, and guidelines.
- Riverside project architecture will be conformable to enterprise, physical and communications architecture defined in CVRIA.
- Riverside will leverage our academia and private sector partners for their extensive knowledge and participation of over-the-air standards and technologies in all relevant sectors – transportation, automotive, telecommunications – to bring high performing interface solutions pertinent to into the project and the CVRIA architecture.
- The City of Riverside will define and demonstrate integration and interoperability of ITS systems with other systems which comprise a smart city.
    - As part of this effort, the nature of required interfaces to other systems should be defined to utilize existing networking or other standards when available.
    - Where new standards are needed, the needs will be fully documented by the Riverside Team.
    - To the extent viable, these interfaces will be documented using the CVRIA system architecture tools and feedback will be provided to the USDOT to facilitate expansion of CVRIA to accommodate these additional interfaces.
- The City will employ SET-IT tool to develop concepts and architectures, then rigorously use it for configuration control.
- The City will participate and contribute to SDOs where standards lessons learned from the Smart Cities work in progress can inform and improve standards, [e.g., IEEE 1609

WG and SAE DSRC TC for message dissemination (use of IPv6 and mesh networks), enhanced SAE J2735 Traveler Information Message to fit Smart Cities applications].

Benefits

- Provide National Architecture-compliant implementation.
- Provide advances to CVRIA and enhancement of standards.
- Facilitate field deployment of variety of applications-appropriate and standardized air interfaces.
- Riverside's implementation will be a leap forwards in complete, interoperable V2X standards, extensible to all US deployments.

Vision Element #11: Low-Cost, Efficient, Secure, and Resilient Information and Communications Technology

City of Riverside Vision

In addition to standards and practices facilitated through USDOT assistance, the City of Riverside will continue to maintain a widespread and secure communications network. The City's technology is currently protected by a network that makes use of the NIST cybersecurity framework. Outside data connections are firewalled, and devices on the network are maintained rigorously to ensure compliance with security policies. The addition of hundreds and potentially thousands of additional ITS components to the Riverside network will force Riverside's security policies and practices to scale alongside the Smart City program.

Critical Objectives: Information and Communication Technology – ROADS

- Implement secured information and communications technology across a responsive transportation system, connecting all of the critical infrastructures in the district into a common platform, ROADS (Radial Open & Automated Data System).
- Leverage cloud based services for elastic scalability and cost efficiency.
- Open data without providing access to secure process control networks or PII data.
- DSRC secured authentication for trusted devices.
- Assess current IT infrastructure and Systems in Responsive Transportation System. Specifically surveying and identifying APIs to connect to existing control systems such as Traffic Control System, Adaptive Lighting Control System, Stormwater/Wastewater System, Electric Grid/SCADA, Building/BMS etc. and upgrade necessary interface/APIs to allow secure real-time data acquisition from existing systems.
- Deploy wireless connectivity layer in the Responsive Transportation System to enable deployment of gateways and wide variety of sensor types and locations.

Benefits

- Users enjoy resilient data access without fear of personal information compromised.
- Vehicles can communicate with trusted devices.
- Wi-Fi hotspot and informational center allows on demand access.

- Cities save money with shared cloud based services.

Vision Element #12: Smart Land Use

City of Riverside Vision

The City of Riverside is currently in the process of revamping the Downtown Specific plan, which is expected to be completed during 2016. The revitalized plan will more readily adapt to a changing development landscape; the Economic and Community Development Department expects both housing and employment to increase dramatically following the implementation of the new Specific Plan. Riverside's current Streetcar assessment study requires that the City closely study the relationship of economics and land use within the proximity of a streetcar alignment. The City is also investigating the use of City owned property for the implementation of small to mid-sized Single Point of Transit facilities. Riverside is also in the process of developing a Framework Plan to encourage the development of large-scale mixed use development near transit hubs.

Critical Objectives: Smart Land Use

- Implement eco-friendly last mile solution: electric bikes, scooters and segways.
- Enable developers to construct.
- Bicycle safe lanes for encouraging more bike use.
- Re-using existing transportation for multi-purpose such as:
    - Electrifying wireless charging parking space.
    - Installing sensors for ridership analytics and pick up.
    - Enabling access to city data for all citizens.
- Eco friendly approach to smart transportation allowing a greener community with less GHG emission.
- Right sizing transportation for more cost effective, customized service.
- Allowing data to drive management of decision support systems to optimize the system and gain increased efficiencies.

Benefits

- Re-claim and re-use existing space and infrastructure without overhaul.
- Cost savings for cities and citizens in right sized pollution free transportation.
- Framework for business/resident in future smart land use.
- Leverage existing infrastructure in new ways to optimize capacity and flow of transportation system.

6.0 Risks and Mitigations

The City of Riverside is fully committed to all the requirements that will be defined under the Smart City Challenge Program. If selected, one of the first tasks of the program is to develop a Risk Management Plan that will address risks and mitigations for each vision element including additional tasks associated with the program. It is anticipated that the Smart City Program will face risks associated with integrating existing legacy technologies with emerging technologies, sharing of Open Data and protocols, institutional policies, and environmental policies. Further changes to local, state, and national requirements due to integration of connected, automated, and automated vehicles, also pose risk to the project. A Risk Management Team will be created from our public-private partners that will be responsible to identify, rate, and develop alternative mitigations and solutions that will be presented to the City of Riverside and the USDOT Team. As part of the Risk Management Plan, the Riverside Risk Management Team will develop a framework for each vision element that will include the type of risk and associated mitigation and/or solution. The Risk Management Plan will be a dynamic element, and will continually address risks and mitigations throughout the entire program. In addition, the City of Riverside will provide a Quality Assurance/Quality Control Team that will develop Quality Assurance/Quality Control Plan and Processes as necessary for each proposed mobility solution. It will provide check and balances to the Smart City Program, and it will minimized the number of risks to the Program.

7.0 Partnerships and Stakeholders

For the Smart City Program, the City of Riverside is prepared with robust strategic-partnerships with city departments, local government agencies, local businesses, transit agencies, planning organizations, technology companies, vehicle manufacturers, freight industry, ride-sharing companies, bike-sharing companies, academia, and professional associations, to support development of advanced and innovative smart city solutions. Partnering with globally recognized academia, auto industry, and private sector firms will bring worldwide expertise on the rapidly changing technologies, standards, and applications. The City of Riverside has a long, strong, and extensive strategic-partnership program with the University of California, Riverside. The Smart City Program will enhanced our partnership and will allow us to work together on all aspects of the program. In addition, the City of Riverside Team is partnering with other local, state, and national universities to provide additional support and collaboration, including University of California, Berkeley – California PATH, California Polytechnic State University, San Luis Obispo, and California Polytechnic State University, Pomona. In addition, The Ohio State University will serve as a collaborator to our academia team. The City of Riverside has reached-out to public and private sectors, including globally recognized companies that can bring smart city business portfolios for each vision element. We have over 20 private-partners in the Riverside Team - including Qualcomm, BOSCH, Microsoft, Volvo, INRIX, AirSage, and others. We have invited other technology companies and automakers, including Mercedes Benz and Toyota, and

they have agreed to explore teaming opportunities with the City of Riverside upon a final award has been made by USDOT. A complete list of our strategic public-private partners and their anticipated support on the vision elements are highlighted in the Appendix.

8.0 Existing Transportation Infrastructure

The City of Riverside maintains 870 miles of urban roadways, 155 of which are considered arterial routes. Alessandro Boulevard, a major East/West route within Riverside, carries approximately 65,000 vehicles-per-day (VPD). Van Buren Boulevard – which runs parallel to Alessandro Boulevard, carries an additional 60,000 VPD. Magnolia Avenue, which runs parallel to State Route 91, carries over 30,000 VPD on its busiest segments. State Route 91, State Route 60, and Interstate 215 all pass through the City of Riverside, totaling 21 miles of freeway facilities. These freeway facilities are major goods movement corridors serving the Port of Long Beach and Port of Los Angeles. The City of Riverside is served by two commuter rail-lines (Metrolink), one Amtrak route, and is nearing completion of a new Metrolink Station to serve the Perris Valley Line extension, a 24-mile route that will establish Riverside as a hub between neighboring cities to the east and lines that extend to other inland and coastal cities. Riverside is also served by the Riverside Transit Agency (RTA), the Riverside Downtown Terminal is a hub for 15 major routes and 2 inter-county routes. In addition to its published routes, RTA offers dial-a-ride services. Both the University of California, Riverside and California Baptist University's campuses offer ZipCar services to provide students with on-demand vehicles. The City is currently in receipt of grant funding to implement a Bike-Share Program that will link downtown businesses and attractions to a full-service location located at the Downtown Metrolink Station. The Bike-Share Program is already planned for expansion following the successful implementation of the first project phase. The City's ambitions for construction of large Single Point of Transit (SPoT) locations as major transit hubs would integrate shared services such as Uber and Lyft and be configured to for continual adaptation to the changing transportation landscape.

The City of Riverside has an extensive Ethernet fiber-optic communications network deployed by the Riverside Public Utility (RPU), and additional infrastructure managed and installed by the Public Works department dedicated solely to the Traffic network. The City's Traffic network is comprised of over 20-miles of copper hardwire cabling, spread-spectrum radio installations, a Citywide Wi-Max 5ghz range radio deployment with three major access points, fiber-optic cable installations, and a planned 10.5 mile fiber-optic cable backbone. This major fiber-optic route will be used as a conversion point for existing serial lines, and will be fitted with access points to enable radio communications in locations previously deemed to have poor reception on the City's Wi-Max network. The major fiber-optic installation will also tie in to the fiber optic cabling on Caltrans' State Route 91, to enable direct communication with the Caltrans Traffic Management Center (TMC). The City's state-of-the-art TMC currently displays video feeds of major intersections, at-grade rail crossings, and Caltrans web feeds. The City has deployed over 30 dedicated CCTV installations for traffic management, and additional CCTV deployments for law enforcement, building services, and parks & recreation. Riverside maintains over 400 traffic

signals. The City of Riverside's Public Utility has made use of Smart Metering features since 2010. 25 Electric Vehicle charging stations have been deployed within the City of Riverside, the most recent of which is a pilot installation to test next-generation charging technology. This new deployment uses the mobile application, "Greenlots" which allows users to access additional chargers in the area and coordinate payments for charging. Both the City and UCR monitor charging station use as part of a collaborative effort.

9.0 Data and Analytics

The City of Riverside manages a wide array of data relevant to transportation, including: accident records, service requests, greenhouse gas (GHG) emissions, vehicular count and speed data, and video camera recordings. The City collects and publishes millions of public records, fire responses, permit activity, crime reports, and neighborhood and services mapping data. The City's Public Works Department retains records pursuant to City Council resolution 21774 and CA Code 34090. Transportation data collected can be correlated with the remainder of the City's databases to improve emergency response times, automatically develop detour routes for new street opening permit applications, manage the flow and queueing of goods movement vehicles, inform placement of new land uses, and monitor business trends related to traffic flow within Riverside. Video data collected through CCTV traffic cameras is also used to facilitate law enforcement investigations, and has a positive impact on public safety; enhanced video capabilities would further the efficacy of traffic cameras which can double as safety tools. Conversely, data collected regarding the use of City facilities, emergency services, and development can be used to shape the expansion of the City's ITS network and inform the strategic placement and routing of automated / high quality transit services. As part of the Smart City Program, the City of Riverside would significantly increase its transportation data collection efforts, and endeavor to build on existing data sharing relationships with regional partners to bring in outside sources of data to enhance travel within the City and region. The City recently installed a GridSmart camera unit – which has the capability to tie in to V2I hardware, record signal phasing information concurrently with video data, and generate unique models for each entity passing through the video stream. Under the Smart City Program, the City would pursue widespread installation of enhanced video technology for data collection purposes and sharing additional information with our partnered agencies to improve mobility in the City and the region.

The City has existing strategic-partnerships and memorandums of understanding (MOUs) in place with our local transportation agencies, including the County of Riverside, Caltrans District 8, and the University of California, Riverside to facilitate the sharing of transportation information, including: As part of the State Route 91 HOV project, the City is completing a physical connection to the Caltrans District 8 fiber optic communication network – which will provide the City with access to State Closed Circuit Television (CCTV) cameras and output data from the State highway system. Currently, the City also hosts six District 8 interchanges on the City's central traffic management signal system – QuicNet, and has an existing MOU to add an additional interchange.

Data output from State highway facilities can be used to augment signal timing and operations along key corridors within the City of Riverside and it allows our partner, Caltrans, to manage operations of their freeway facilities. The City's existing agreements with Caltrans District 8 place restrictions on the modification of traffic signal data, and existing options within Riverside's central traffic management system make the restriction of such data simple. The City is also working with Caltrans District 8 to establish an inventory and map of deployed ITS technologies within Riverside and surrounding agencies in an effort to create smart inter-agency corridors that will bring relief to the congested state highway system, improve safety and mobility.

The City of Riverside's agreement with the County of Riverside allows for sharing of video feeds at shared intersections through use of a VPN connection. The City of Riverside has a committed strategic-partnership with the University of California, Riverside (UCR). The City's partnership allows UCR to collect data related to DSRC V2I communications installed at City's intersections via remote vehicular access, and direct supervised physical access to the traffic signal controllers. Aspects of UCR's Science Perimeter Network can be integrated into ROADS – which allows for high-volume data transfer, remote experiment control, and data visualization. The City of Riverside has separate partnership agreements with UCR through the Public Utility to share information regarding its Electric Vehicle charging stations. Currently, the City has partnered with Riverside Transit Agency (RTA) as part of the Bus Rapid Transit Pilot Program along Magnolia and University Avenues, and traffic signal data collected by the City has been used to update traffic signal priority timing and technologies. Each existing strategic-partnership with our local transportation agencies and UCR allows the sharing of transportation data and technologies. In addition, our strong strategic partnerships and MOUs allows for future expansion of data sharing.

In addition to the City's existing strategic-partners, the City will team with major transit service providers such as Amtrak and Metrolink to provide ridership information to travelers at transportation centers, including transportation information and choices. In addition, the City will request and assist with the development of real-time data from rail services, along with Riverside Transit Agency, to provide travelers with up-to-date transit options. The City has further plans to share traffic data with emerging transportation data providers such as Waze and Apple; along with shared transportation companies, including Uber and Lyft.

By serving as the central point for such key public-private partnerships, the City of Riverside can coordinate the collection and distribution of real-time open data for all modes of transportation, providing a significant benefit to the users of each potential travel mode. As with its existing partnerships, the City of Riverside will be mindful of the safety and cyber security implications of any data shared, and ensure that relevant security measures are taken to prohibit malicious or unintentional harmful impact on the operations of any City facility and the users. The Smart City Program will be used to fund technologies that maximize open data input and sharing, and used in the full extent possible to enhance existing public-private partnerships while fostering new

public-private relationships to improve mobility, improve safety, reduce congestion, protect the environment, and provide economic growth in the City and region.

10.0 Standards and Architectures

The City of Riverside Smart City Program and initiatives shall conform to the National ITS Architecture, the Connected Vehicle Reference Implementation (CVRIA) and associated SET-IT software tool, and published and under-development ITS standards and processes to demonstrate interoperable ITS capabilities. As part of the City of Riverside Smart City Program, the City will develop a Smart City Strategic Plan describing the City's goals and visions and specific framework for each vision element. At a minimum, it will identify applicable standards and architectures, public-private strategic-partners, applicable policies, users' needs, strategic opportunities, strategic initiatives, safety, security, implementation, operations requirements, performance measures, risks and mitigations, innovative features, emerging interoperability technologies, solutions, applications, quality assurance and quality control procedures, etc. to maximize the overall benefits of the Smart City Program. A Smart City Strategic Team will be created from our public-private partners and they will be responsible to develop and maintain the City's Vision Element Strategic Plan and will work with technology developers to improve the quality of products based on lesson learned deployments.

11.0 Measurable Goals and Objectives

The City of Riverside proposes to develop measurable goals and objectives for each element of the City's vision. As part of the City's Smart City Challenge Program, the City will develop an overall Concept-Of-Operations (ConOps) and System Engineering Plan that incorporates each Vision Element. The plan's measurable goals and objectives for each vision also will be integrated as a systematic City approach to monitor the impact of the demonstration on mobility, safety, efficiency, sustainability, and climate change. The plan will identify a set of targeted performance measures related to the each component of the proposed deployment. Several standard tools are available for evaluation as performance measures at intersections and corridors in the City of Riverside. In addition, our partners at UC Riverside have developed unique performance measures and tools that can be applied for key mobility and environmental applications. By providing real-time feedback, these tools will improve the efficiency, mobility, and safety throughout the City.

Performance measures will include: wait time, percent arrival on green, vehicle delays, V/C ratios, turning movement counts, red light violations, Purdue Coordination Diagrams (PCDs), traffic energy consumption per mile, and total traffic GHG and pollutant emissions per mile. In addition, The Riverside Team will also provide Automatic Traffic Signal Performance Measures (SPMs). These SPMs metrics will show real-time and historical functionality at signalized intersections, allowing the City to measure what they previously could only model. Accurate real-time decision-making on signal performance and timing will help signal management personnel identify malfunctions in vehicle and pedestrian detectors. This cost effective solution will also measure

vehicle delay and the volume, speeds and travel time of vehicles. The City can use these metrics to identify operational deficiencies, optimize mobility, and help manage traffic signal timing and maintenance.

Evaluating traffic signals helps reduce congestion, save fuel costs and improve safety. SPM's are based on high-resolution data recorded on a 24 hour/7 day, cycle-by-cycle basis using an embedded controller data logger. To develop the performance measures, high-resolution data are necessary. The City's communication infrastructure is foundational to the SPM system followed by traffic signal detection. The SPM system is vendor neutral and uses open-source software. The City of Riverside welcomes and supports any USDOT independent evaluation of system performance with respect to the targeted measures, to collect or infer contextual data that allows for the isolation and mitigation of confounding factors, and to provide supplementary evaluation with respect to a broader set of safety, environmental, mobility and public agency efficiency measures of interest to USDOT. The City will allow access to the project locations, project team, and to conduct evaluation-related experiments, interviews, and surveys.

12.0 City Capacity for Implementation

The City of Riverside is very proud to have strong collaborative partnerships among civic, cultural, educational, and business leaders; and our City Leaders are committed to provide top quality transportation services to residents, businesses, and visitors. Our City Mayor Mr. Rusty Bailey, Council Members, City Manager, Managing Directors from Public Works, IT, and Public Utilities Departments are very familiar of the magnitude of the Smart City Program and have pledge full commitment to take the Smart City Program as the top priority for the City of Riverside. Our existing strategic partnerships with UCR, Caltrans and local agencies will bring resources with different expertise to the Smart City Challenge Program. In addition, UCR and Advantec Consulting Engineers are contributing partners on the grant's application and UCR has pledged support to implement and manage the project's data, milestones, and grant performance. Riverside is located in Southern California and the City envisions working with local government agencies, local businesses, transit agencies, planning organizations, technology companies, vehicle manufacturers, freight industry, ride-sharing companies, bike-sharing companies, academia, professional associations, and various other stakeholders to incubate and deploy advanced technological applications to meet evolving transportation challenges.

If selected, the City will develop a Program Management Plan describing our public-private partners, management teams, specific work plan/task associated with each element and team, anticipated project schedules, and additional management tools that will be necessary for this Program. The City of Riverside has the capacity, planning, engineering and support personnel, and experience to take on large projects. In recent years, the City has successfully managed, designed, and/or constructed over 15 large transportation projects that collectively have exceeded $580 million. In addition, the City has successfully worked with federal, state, and local agencies in grant delivery, management, and performance reports. Many of the City's grants have required partnerships and collaboration with local agencies, stakeholders, and neighborhood

groups. The City employs planners, surveying, and transportation, traffic, and wastewater engineers. In addition, the City owns the electrical and water public utilities in the City and employs electrical and clean water engineers to support those services and would be available to assist with this project. Most of the engineers employed by the City have engineering design experience and are familiar with local, state, and federal guidelines. The Public Works Department is actively working with the Public Utilities and IT Departments to share fiber optic communication facilities to share bandwidth and make traffic signal communications more robust and reliable. The City, Inland Region, and Educational Institutions recognize the unique and landmark opportunity being offered by the Department of Transportation with the Smart City Challenge Program and have pledged full commitment at the executive level to ensure its success. The City has an infrastructure that would facilitate deployment of technological advanced applications and programs including:

1. A robust IT Network that was recognized when City was named "World's Most Intelligent Community, which includes copper, radio, and fiber optic lines of communication.
2. Riverside owns its own water and electrical public utilities which would facilitate specialized communication applications.
3. Riverside employs a strong Traffic Engineering and Signal Maintenance Division that is equipped to work ITS Technologies and communications.
4. Fiber-optic communication backbone. The City is working with Caltrans, to provide communication redundancy through use of the Caltrans network.
5. State of the Art Traffic Management Center.
6. Three Freeway Systems that traverse the City and the State would support the Smart City Challenge Program.
7. BNSF and Union Pacific Railroad traverse the City and have numerous at-grade and grade separated intersections that could test railroad safety applications as part of a safety monitoring program.
8. City will have the longest Railroad Quiet Zone project.
9. Three major universities reside in Riverside, including UCR which employs scientists and engineers at the Bourns College of Engineering Center for Environmental Research and Technology (CE-CERT).

13.0 Opportunities to Leverage Federal Resources

Riverside is actively managing and in pursuit of several grant-funded projects totaling over $25M that would directly augment the efficacy of the Smart City Program. Riverside was recently awarded Highway Safety Improvement Program (HSIP) funds – which will provide, in addition to pavement friction improvements at several locations citywide, the installation of new pedestrian HAWK signals, and the re-coordination of Central Business District traffic signals along with the purchase of new CCTV equipment. Procurement of ITS technologies from this grant will be forward-thinking; CCTV cameras purchased for the downtown will have the potential to integrate with V2I and data collection technologies. The City will also be installing several additional HAWK

signals as part of two rounds of Active Transportation Program (ATP). The ATP's primary use is the installation of citywide pedestrian and bicycle improvements to enable and foster an active lifestyle for Riverside residents within disadvantaged neighborhoods through the installation of bike lanes, Bicycle-Share Programs, and HAWK signals. The HAWK signals as part of both ATP and HSIP funding are strategically located at locations with high volumes of pedestrian travel. These locations are ideal for smart kiosks to provide transportation information and options to residents, in addition to their intended crossing safety benefits. The new HAWK signals will be tied to Riverside's ITS network, and have the potential to be augmented through Smart City funding.

Riverside is currently deploying the first stage of the BNSF and UPRR Quiet Zone project – which will provide advanced pre-emption services for many at-grade crossings within the City. Rail pre-emption and data recording equipment installed as part of Quiet Zone installations is significantly more sophisticated than a traditional railroad pre-emption, and could be relayed to the Smart City's network to alert motorists and automated transit services of potential delay at crossings.

The Riverside Planning Division has several efforts underway to better integrate land use development and transportation, many of which use or plan to use grant funding. The City is currently fulfilling a State grant to study the feasibility and potential benefits of a Streetcar System. The study considers alignments, ridership, physical constraints, along with the land use economics analysis required to identify full streetcar costs and funding sources. The streetcar feasibility study is expected to be completed summer of 2016, and will include detailed analysis of value capture and property assessments strategies. Implementation of a streetcar alignment within Riverside would promote alternative transportation, and would readily tie in to Smart City Program. Riverside Planning also received a grant from the Western Riverside Council of Governments (WRCOG) to prepare a Transit Oriented Development Framework Plan for properties near the Downtown Metrolink station. The Framework Plan will coordinate the objectives of the City, County, transit agencies, and private property owners, and create a development vision that coordinates transit infrastructure, vehicle circulation, pedestrian and bicycle corridors, parking resources, and land development constraints. Implementation of this framework by developers will attract residents who are inclined towards the use of alternative transportation, and are likely to be participants in the Smart City infrastructure. The City is also working to create a land use & transportation initiative that would encourage private development projects to incorporate multi-modal hubs, known as Single Points of Transit (SPOTs). The SPOT program is currently identifying high priority sites within Riverside that are of a size to accommodate private development of a complementary retail, office or residential uses. Outside of the SPOT program, Riverside can maximize new development's participation in the Smart City Program.

The Governor's Office of Planning and Research is currently in the process of retooling the California Environmental Quality Act guidelines to shift from the improvement of vehicle Levels of Service (LOS) as environmental mitigation metric to the reduction of vehicle miles traveled (VMT) – which provides the City an opportunity to enhance the Smart City Program, including performance measures. For example: in order to mitigate a development's VMT impact, Riverside could require the development's integration of V2I technology in to a company rideshare program, or pay towards the addition of ITS equipment at impacted locations. Riverside will maximize the potential from our extensive strategic partnerships with the public and private sectors, including - city departments, local government agencies, local businesses, transit agencies, planning organizations, technology companies, vehicle manufacturers, freight industry, ride-sharing companies, car-sharing companies, bike-sharing companies, academia, and professional associations. Our academia and private partners have a rich history of successfully conducting large scale technical demonstrations, evaluations, and real-world implementation of transportation technologies and smart city solutions. Our strategic public-private partners have pledged resources, including staff expertise, in support of the City of Riverside Smart City Program.