Andrew K. Clinger
City Manager

February 4, 2015

Anthony Foxx, Secretary
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, D.C. 20590

Re: Notice of Funding Opportunity Number DTFH6116RA00002

Dear Secretary Foxx:

It is my pleasure to submit the City of Reno's application to the U.S. Department of Transportation's "*Beyond Traffic: Smart Cities Challenge*" program. I join the Mayor of Reno and twelve of our partners and allied agencies in supporting the application.

Reno meets and exceeds all eight of USDOT's criteria to be eligible for a *Smart City* demonstration project. In addition, we believe that our unique combination of location, climate, talent, and leadership ensures a robust transportation project that could be replicated anywhere in the United States. Reno's expertise in pioneering innovative programs and our access to deep technical, industrial and academic resources positions us to design and deliver an exceptional demonstration which showcases the potential for next-generation transportation technologies to make American cities safer, cleaner, more resilient, more mobile, and more inclusive.

Thank you, in advance, for your consideration of Reno's application. Please do not hesitate to contact me if I or my office can provide additional information or answer any questions.

Yours truly,

Andrew K. Clinger
City Manager

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Reno's Smart City Vision

The City of Reno's *Beyond Traffic: Smart City Challenge* holistic vision is to overcome its challenges of urban congestion, safety, accessibility, and climate change by implementing transportation innovations in three areas: smart infrastructure, drone delivery and technology for transit. The proposed projects seek to leverage the maximum adoption of new technologies and mobility models to benefit the citizens of Reno directly as well as the nation through identification of models that can be replicated anywhere. Reno's vision integrates not only next-generation technologies focused on surface transportation, including connected and autonomous vehicles and public transit options using sharing economy models, but the potential for autonomous aerial vehicles to supplement urban logistics, playing a role in relieving first- and last-mile congestion from urban and suburban goods delivery.

Reno's goals for the *Beyond Traffic* grant flow from the City's 2015 commitment to the international Compact of Mayors[1] climate-change initiative as well as its support of the Clean Power Plan.[2] It supports the guiding principles and performance targets of the 2035 Regional Transportation Plan. The goals also flow from the will of our citizens: almost 6,000 people participated in providing input into Reno's new Comprehensive Plan during 2015 and the overwhelming majority expressed a desire for a sustainable, resilient community with effective and affordable modes of transportation.[3]

Why Reno?

At 106 square miles, encompassing an urban core with extensive suburban sprawl and a variety of diverse weather and road conditions, Reno offers the right-sized laboratory for a *Beyond Traffic* demonstration project. Both its challenges and its assets make it conducive to piloting proofs-of-concept in next-generation transportation technologies.

What are Reno's challenges?

Legacy built environment: Reno is challenged by its historic development patterns: while the city has a dense center dating from 1868, it also has numerous outlying rural and car-centric suburban areas that developed during the last 50 years. It is extremely difficult to design and provide sustainable and efficient public transit to the less-dense outlying areas. The sprawling road network strains maintenance budgets and there are bottle necks at the highway and arterial interchanges. Now, with the prospect of significant economic growth and population increase (up to 50,000 new jobs predicted within the next five years[4]), our transportation infrastructure will become even more strained. Transit constraints will be especially critical with respect to meeting the needs of lower-income citizens who frequently live in the outlying areas which provide more affordable housing as urban living becomes more desirable. In addition to housing policy actions, it will be necessary to develop new transportation models so that these citizens have equitable access to employment, healthcare and education.

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[1] Unanimous City Council approval on August 12, 2015
[2] Unanimous City Council approval of Resolution #8085 on August 26, 2015
[3] Final Summary of Phase I Public Input, 2015 www.reimaginereno.us
[4] EPIC Report, Economic Development Authority of Western Nevada, 2015

Safety: The community has become increasingly concerned with the incidence of pedestrian and bicycle crashes. A multi-jurisdictional local team formed in 2015 to examine strategies to reduce crashes and improve public safety. Several intersections were equipped with improved traffic signals, warning lights and improved crosswalks, and an aggressive public education campaign was begun. While these efforts have yielded some reductions, the issue continues to be a local priority. As our community becomes more urban, we will need to develop solutions enabling all modes of transportation to co-exist more safely.

Preservation of the environment and high quality of life: Reno currently enjoys better-than-average air quality and easy access to unparalleled natural beauty and outdoor recreation in the Truckee River system, Lake Tahoe and the Sierra Nevada Mountains. Easy access to nature and other amenities is important to the community, with residents citing Reno's 20-minutes-to-get-anywhere convenience as a key component to quality of life. The protection and preservation of this quality of life recently polled as our citizens' #1 concern. It is imperative that Reno's growth is smart, with walkable infill development projects and clean, energy-efficient transportation solutions to avoid congestion, spare the environment and allow Reno's quality of life to continue.

Fiscal constraints: As a city, Reno continues to be challenged by lingering budgetary outfalls of the Great Recession. Nevada was one of the five "hardest hit" states nationally and is still recovering from catastrophic losses to property values and personal assets. With a tax structure based primarily on property (with annual caps) and sales, Reno's revenues will not recover quickly enough to allow it to assist with large capital improvements or public investments necessary to expand or improve the conventional public transportation system. New, cost-effective, smart technologies may allow Reno to overcome this challenge.

Reno's *Beyond* Traffic demonstration project will lay the groundwork for the City and USDOT to pilot and test technology-based solutions that address these challenges. The City is interested in exploring cost-effective, environmentally-friendly approaches that meet our citizens' goals of efficient transit while also being a safe place to live, play, learn, and recreate.

Does Reno Have USDOT's Desired Characteristics?

Yes. Reno meets all eight of the defining attributes of a Smart City and has additional assets which offer unique opportunities for a robust and exceptional next-generation transportation project. The material below is numbered per the NOFO organization of eligibility questions.

1-3. Population Size, Population Density, and Population Share of Urbanized Area

Per the 2010 Census, Reno's population was 225, 221. It remains the most populous city in Northern Nevada and is the seat of Washoe County. In 2010, Reno comprised 57% of the urbanized area and its population density was approximately 2,186.4 people per square mile.

4. An Existing Transportation System

The Regional Transportation Commission of Washoe County (RTC) provides public transit services to residents and visitors of Reno, Sparks and surrounding urbanized Washoe County. RTC has a solid track record of optimizing performance of the system, with high productivity

and fare-box ratios in studies of peer analysis.[5] RTC strives to be responsive to citizen needs in soliciting input in all planning efforts and working with local non-profits to supplement the standard transit system. The current public transit services provide a range of traditional public transit services that are aligned with the size and needs of the community and available capital and operating funding levels:

- **Regular fixed route bus service** of 76 buses on 26 routes currently serving 31.6 passengers per revenue service hour on average.
- **Bus rapid transit service (BRT)** between downtown Reno and a retail/employment center five miles to the south on Virginia Street, a north-south corridor. The service currently runs 7 hybrid diesel-electric articulated buses serving 44.7 passengers per service hour on average. The BRT service on Virginia Street is expanding in 2018 to serve the University of Nevada, Reno (UNR) campus. A second BRT line will be initiated between downtown Reno and downtown Sparks on 4th Street/Prater Way, an east-west corridor in 2018.
- **Peak-hour commuter service** to Carson City runs six 69-mile round trips during commute hours serving 10.1 passengers per service hour on average.
- **Downtown circulator** runs in a loop through downtown Reno and connects to UNR seven days a week from 7 AM to 7 PM, serving 17.8 passengers per service hour on average.

Across the four fixed routes services above, fares cover approximately 24% of operating costs and the average public subsidy is about $2.50 per transit trip.

- **Demand responsive ADA paratransit service** provides mobility to people who have disabilities which prevent them from riding the bus service independently, serving 2.6 passengers per service hour on average. Fares cover 10% of operating costs. The average public subsidy is about $25 per paratransit trip. The ADA service zone includes areas within ¾ mile of existing fixed-route service.
- **Vanpool service** provides vehicle and operating subsidies to riders commuting long distances. RTC operates 76 vans that provided 210,799 trips in 2015. Vanpool participants, either as individuals, or with financial support from their employers, split the cost of the vehicle lease and gas less the public subsidy. The RTC subsidy per vanpool ranges from $400 to $600 per month depending on mileage.
- **Special Access Programs** funded by RTC aim to provide transportation support for seniors, veterans, and low income or disabled residents. The Medical Free Ride program is provided in partnership with the not-for-profit Access to Healthcare Network and can be used for medical appointments and grocery shopping. The Taxi Bucks/Washoe Senior Ride program allows qualifying residents to purchase discounted taxi voucher books that they can use to help maintain their mobility.

Reno has 696 miles of surface roads, built and maintained by a combination of RTC and Reno Public Works, and 52.19 miles of freeway, built and maintained by a combination of RTC and NDOT.

5. An Environment Conducive to Demonstrating Proposed Strategies

Several factors make Reno conducive to project demonstration. From a geographic perspective, Reno is sufficiently isolated to provide a contained test environment, allowing for stronger

[5] 2008 RTC Peer Group Analysis; http://www.rtcwashoe.com/PTreports/documents/RTC_RIDE_Peer_Comp_FY08.pdf

correlation of intervention to result. It lies next to the City of Sparks to its east, but there are no other developed neighboring jurisdictions. Reno is ringed on three sides by unimproved federal lands, deserts and forests, with its next closest neighbor, Carson City, 30 miles to the south in a different valley. And because it is one of only three jurisdictions in the greater region, including Washoe County, there are fewer bureaucratic layers of approvals involved in designing and executing demonstration projects that cross jurisdictional lines. In addition to its geographic assets, Reno's political and community leadership are open to innovation and experimentation. There is an attitude of finding a way to say yes--yes to new ideas, yes to overcoming barriers, and yes to new economic opportunities.

Reno's climate and geography lend themselves to testing under a wide range of weather conditions that could replicate those of any city in the United States. At 4,400 feet above sea level and 39.5 degrees of latitude, its high-desert climate has four true seasons, including a winter with snowy and icy road conditions. In the "shoulder" seasons, it has some of the greatest day-to-night temperature differentials in the country. Its topography includes hills, ravines and ridges surrounding a high valley. One of the drone-company executives who relocated to Reno from Australia described the city as the "perfect Petri dish" for testing. In other words, a transportation technology tested and perfected in Reno could be deployed successfully anywhere in the United States.

6. Continuity of Committed Leadership and Cooperation to Carry Out the Demonstration Project Throughout the Period of Performance

Reno has the appetite and the capacity to pilot a project that demonstrates how emerging technologies can make our city safer, cleaner, more sustainable, and inclusive. The Mayor and City Council are deeply committed to protecting Reno's environment and to positioning the city to be more resilient to the impacts of climate change. Starting in 2007, the City Council prioritized the goal of becoming more energy-efficient and sustainable, investing $24 million in energy retrofits, reducing the carbon footprint of City facilities by 30 percent, and piloting multiple demonstration projects for wind-based technologies.

There is high degree of intergovernmental cooperation that has enabled local and state governments to act swiftly to respond to economic opportunities. In 2013, local and state officials worked in concert with our Congressional delegation to advocate for the selection of the Reno-Stead Airport as a part of a Nevada-wide FAA test site for the commercialization of aerial vehicles, and in September of that year a special session of the Nevada Legislature was convened quickly to approve incentives facilitating the Tesla gigafactory.

The City of Reno and the State of Nevada are committed to creating the right business-friendly and low regulatory environments that foster innovation and investment, especially with respect to connected and autonomous technologies. Nevada was the first state in the nation to:

- Create new regulations enabling autonomous vehicle testing in 2011
- License testing for autonomous cars in 2012; two license classes: highway and residential allow testing state-wide
- License testing for autonomous commercial trucks in 2015

As a result of these policies, there are currently six manufacturers testing autonomous vehicle technologies in Nevada, two of them in urban areas.

7. Commitment to Integrating with the Sharing Economy

The sharing economy is a growing mindset in the Reno community. Reno's two largest-growing demographic groups are millennials and retirees. Recent sampling for Reno's Comprehensive Plan[6] confirmed that these groups have a marked preference for living in walkable urban environments, with access to an array of transportation options, including public transit, ride-sharing and ride-hailing. Many retirees and millennials, a number of whom are students and graduate students at the University, live and/or work in Reno's downtown core, a key part of our *Beyond Traffic* project demonstration area. Downtown Reno is also the home to "start-up row" and a number of entrepreneurial businesses, many of which use ride hailing.

Reno's Mayor and Council were strong advocates for integrating Uber and Lyft into the local options for transportation, despite some "pushback" from local taxi companies. Both Uber and Lyft are now in full operation. Zipcar started services at the University in 2015. Airbnb, which successfully operates in Reno, is another example of local openness to the sharing economy.

8. Commitment to Open, Machine-Readable Data That Is Accessible, Discoverable and Usable by the Public to Fuel Entrepreneurship and Innovation

The City is working with Socrata on its Open Data initiative, a rollout of numerous machine-readable data sets which provide full access to City information. Open Data officially launched on September 2, 2015 and will be fully populated by June 30, 2016. Open Data builds on earlier efforts which started in 2011, when the City began publishing its "Online Checkbook," showing expenditures and accounts receivable.

The Reno area has become an emerging leader in innovation and technology, attracting smart and talented people to a growing number of technology-focused and advanced-manufacturing companies, e.g. Tesla, Switch. As the eastern edge of the Bay Area mega-region, many of Reno's businesses and programs draw on the talent and workforce of Silicon Valley and San Francisco. The City government has itself been a change-agent in this trend, streamlining its business-license process, hosting and promoting open-source Hackathons, and piloting an innovative early-stage financing program for promising entrepreneurs.[7] In 2013, Reno's IBM Smart Cities Challenge[8] team strongly recommended building on these strengths.

Team: Capacity to Perform

The City of Reno is the lead applicant and has assembled an elite project team comprised of key staff in local, state, academic and private-sector organizations who will commit to implementing the *Beyond Traffic* project, if awarded. The proposed team may expand as we move through the application and implementation process. Together, these agencies and private-sector partners have the bandwidth, commitment, and unique combination of technical and project management expertise to perform the projects outlined in the Reno proposal.

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[6] www.reimaginereno.us, Community Survey, 2015
[7] Reno Accelerator Fund, approved by Reno City Council in FY 2014, 2015 and 2016.
[8] Reno received an IBM Smarter Cities Challenge Grant in November 2012.

The *Beyond Traffic* Implementation Team members are:
City of Reno: staff in the City Manager's Office, Public Works, Finance, City Attorney's Office, Information Technology, Community Development, and Communications and Community Engagement.

The City has a track record of successfully designing and implementing a range of complex, innovative projects. In 2010, Reno was identified by the U.S. Department of Energy as a national model for its nimble and creative approach to acting upon the Energy Efficiency Block Grant funding through the American Recovery and Reinvestment Act. In 2012, Reno was the only city in Nevada and one of only 31 nationally to receive an IBM Smarter Cities Challenge Award; it was the first city in the three-year, 100-city IBM program to expand its project to encompass 11 public and private entities in order to ensure collaboration and success. And in 2013, Reno was the first City in the United States to create a HUD-funded revolving loan program that targeted the entrepreneurial sector.

Regional Transportation Commission of Washoe County (RTC): staff in Planning, Public Transit, Engineering and Construction, and Public Information/Community Outreach.

RTC serves three roles for the Washoe County urban area, of which Reno is the County seat: it is the MPO, the transit service provider, and it builds and maintains the regional roadway network. As the MPO, RTC conducts a collaborative short and long-range multimodal transportation planning program. As the transit service provider, RTC operates the regional fixed-route bus system, electric bus program, paratransit service and vanpool service. As the agency responsible for maintenance of the regional road network, RTC is responsible for planning, designing, and constructing regional road projects. The RTC's regional Intelligent Transportation System (ITS) program maximizes the operational efficiency of the existing roadway network by coordinating traffic signals and other communications technology.

University of Nevada, Reno (UNR): faculty in the Departments of Economics, Engineering, Computer Science, the School of Business, and Administration; programs including the Nevada Center for Applied Research, the NASA-Ames NUANCE Lab, and the Nevada Advanced Autonomous Systems Innovation Center.

UNR has deep expertise in electrical, mechanical and computer engineering; computer science; Big Data analytics; autonomous systems; robotics; and information technology. The University houses and supports:

- **The Nevada Advanced Autonomous Systems Innovation Center (NAASIC)** is a leader in promoting commercial applications of civilian drone technology, conducting research and partnering with companies to realize the economic benefits of civilian drone technologies. NAASIC helps the Nevada Institute for Autonomous Systems (NAIS) conduct flights under Nevada's FAA UAS Test Site authorization, and is currently one of the partners working with NASA Ames to test the UTM system. Along with the Nevada Governor's Office of Economic Development and the Reno-Tahoe Airport Authority, NAASIC is constructing the Nevada Unmanned and NextGen Collaboration Environment (NUANCE) Lab at Reno-Stead Airport, which will open in March 2016 and will enable large-scale airspace management studies involving live and simulated aircraft. UNR is also a part of a $1.2 million cooperative research and development agreement with NASA to support UTM research, development, and testing. NAASIC is located at the UNR Innevation Center, a unique facility which co-locates a range of Research & Development

programs and faculty working in autonomous systems, advanced information technologies, and computer engineering.

- **Department of Civil and Environmental Engineering** has a respected transportation engineering program and houses the Center for Advanced Transportation Education and Research (CATER) and the SOLARIS University Transportation Center. Areas of research strength and expertise include intelligent transportation systems, advanced traffic signal optimization and operations, traffic safety analysis and improvement, and mathematical modeling of traffic and transportation systems..
- **Economics Department in the College of Business** has core strengths in public economics, economics of population and demography, political economy, growth and regional economics, transportation economics, applied microeconomics, and urban economics.
- **Nevada Center for Applied Research (NCAR)** leverages the intellectual and physical assets of UNR to enhance the success and competitiveness of industries in Nevada.

Nevada Department of Transportation: staff in Administration, Planning, Engineering, Operations, and Public Information.

Since 2002, NDOT has been installing a robust local and regional fiber network in conjunction with RTC and the City, so that state highways, regional arterials and local roads have the foundation for a strong communication backbone. The Nevada Data Exchange system (NDEX), administered by NDOT, contains data from traffic cameras, flow meters, ramp meters, and road weather sensors in the Reno region.

Reno-Tahoe Airport Authority: staff who oversee the Reno-Stead Airport, currently the site for a collaborative program between NASA-Ames Research Center, the Reno-Tahoe Airport Authority and the Nevada Governor's Office of Economic Development; the three entities are working on the Nevada Unmanned Autonomous and NextGen Collaborative Environment (NUANCE) Lab, which will research and develop the Unmanned Traffic Management (UTM) system for aerial vehicles.

Governor's Office of Economic (GOED): staff who liaise the Nevada Advanced Autonomous Systems Innovation Center (NAASIC) and Nevada Institute for Autonomous Systems (NIAS) programs. Governor Brian Sandoval is very supportive of autonomous vehicle testing in the state of Nevada, recently announcing at the CES show in January the creation of a new state-level position to liaise with automotive manufactures and coordinate testing activities in the state.

Nevada Automotive Test Center (NATC), a unique facility designed to road test connected and autonomous trucks and freight vehicles located 40 miles southeast of Reno.

Filament: Reno-based Filament, Inc. is a leader in the Internet of Things (IoT). Filament's proprietary hardware enables the construction of communication and sensor networks. Filament technology has been built with security in mind from the ground up, relying on the Telehash encrypted network protocol, private-key cryptography, and blockchain technology to create a mesh networking solution that is uniquely suited to reliability requirements of a municipal data network for connected and autonomous systems.

Flirtey: Reno-based Flirtey, Inc. is a leading company in drone delivery. Flirtey engineers have designed and built unmanned aircraft specifically to perform consumer package delivery. Flirtey tests its aircraft in the United States, Australia, and New Zealand. In the summer of 2015, Flirtey conducted the first FAA-approved drone delivery in the United States, in partnership with NASA's Langley Research Center in Virginia. In September 2015, Flirtey partnered with the University of Nevada, Reno to participate in NASA Ames's Build 1 UTM system demonstration in flights at NASA Crow's Landing Airport in central California, one of eight teams to do so in the country. Flirtey is one of the only organizations in the United States in a position to conduct city-scale drone delivery trials.

Ride Report by Knock: Ride Report is a free app for cyclists that runs continuously in the background of users' smart phones and collects data that allow riders to have safer and more stress-free rides, as well as allows transportation planners to better understand improvements that will make streets safer for cyclists and pedestrians.

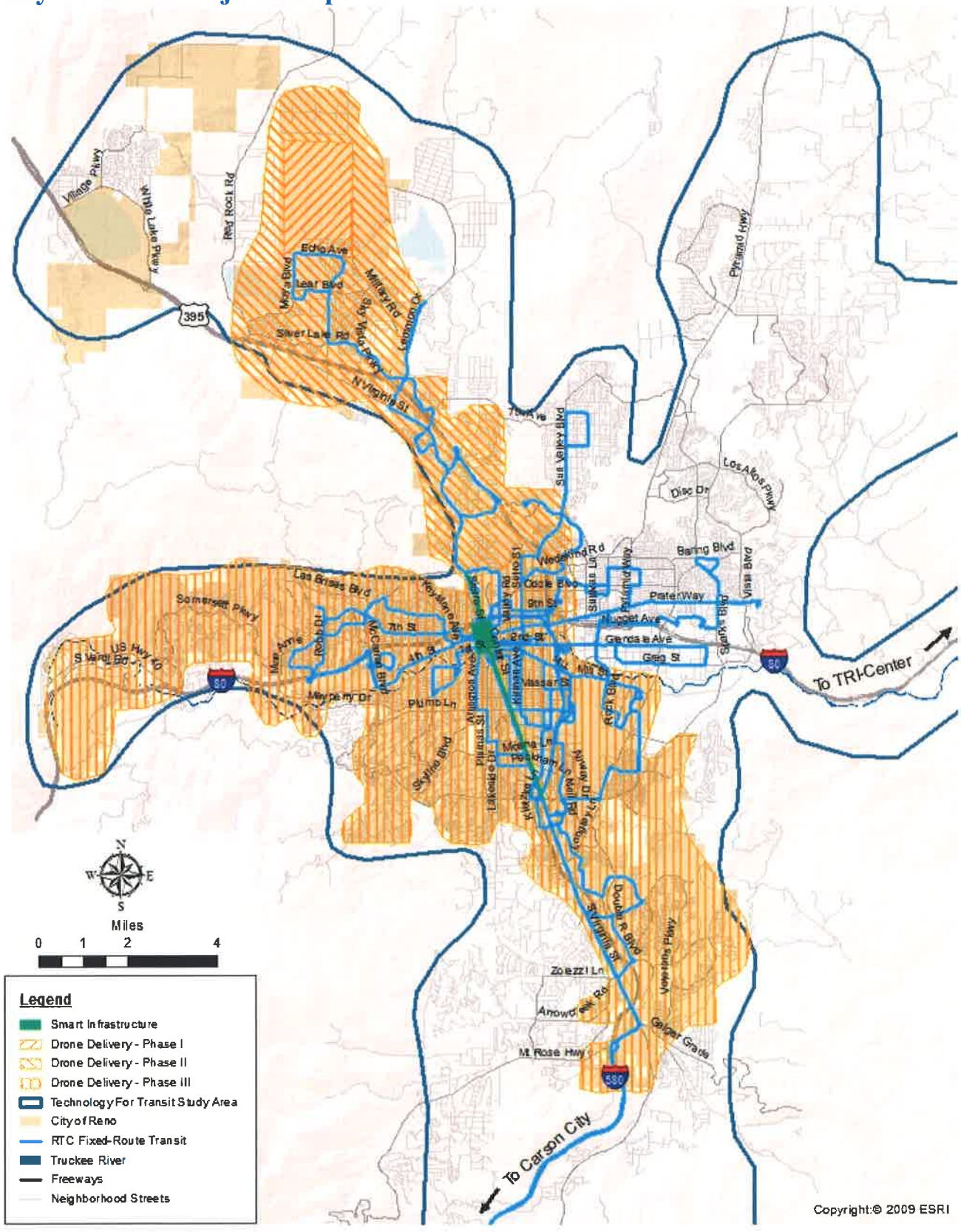
HERE: HERE provides high-definition camera/lidar mapping and real-time collection, processing and communication of map-based data powering vehicle navigation. HERE's ability to gather, validate and distribute dynamic information from fixed and mobile sensors can be used by connected vehicles and government agencies to manage traffic and measure performance. HERE is working with every major automotive company. HERE has created the HD Live Map for all highways in North America to support AV navigation, and has committed to adding resolution to local road maps should Reno be selected as the *Beyond Traffic Smart City*.

Introduction to City of Reno's *Beyond Traffic* Proposal

Reno's proposal is organized into three complementary sections: Smart Infrastructure, Drone Delivery and Technology for Transit. A quick summary is below and details follow.

1. **Smart Infrastructure**: Reno is proposing to create a demonstration project encompassing a 20-square-block "Smart Downtown" and a "Smart Corridor" along a six-mile stretch of Virginia Street. The project area will be equipped with an array of communication technology and sensors, allowing for connected and autonomous vehicles to optimize flow and respond to road conditions, including construction, special events, pedestrians, and cyclists. The *Beyond Traffic* deployment will also include real-time parking management technology and electric vehicle charging stations to support public and private adoption.
2. **Drone Delivery**: Working with private and academic partners, Reno will deploy first-of-their-kind trials to evaluate how package delivery by drone can relieve traffic congestion from current ground-based solutions. These trials will build on the region's expertise in unmanned aerial systems, and will provide a blueprint for other cities to integrate drone delivery into their logistics networks.
3. **Technology for Transit**: The project will assess opportunities and release an RFP to solicit solutions to public transit challenges that leverage new mobility technologies and operating models. There is also a pedestrian and cycling component leveraging smartphone apps to improve safety and mobility.

City of Reno Project Map



Smart Infrastructure

Improve safety and efficiency of traffic management and explore interaction and benefits of CVs/AVs in an urban environment

Smart Roadways

In brief

Reno will install Smart Roadway infrastructure to test uses, benefits and cost savings of connected and autonomous vehicles. The Smart Infrastructure will allow various advanced sensor technologies, communication technologies, adaptive traffic operation, and more. The infrastructure will accommodate the data and communication requirements of connected vehicles. An autonomous-vehicle-friendly traffic environment will be investigated and tested.

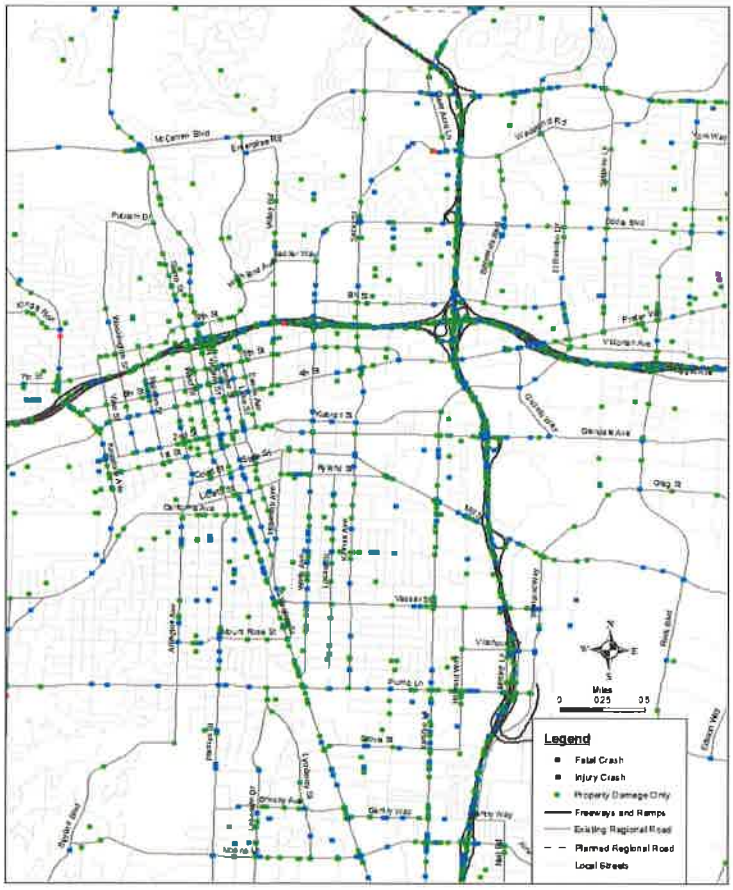
Background

The Reno *Beyond Traffic* project team conducted extensive interviews with manufacturers of connected and autonomous vehicles to understand what would be most useful for technology implementation in an urban environment over the next three years. Traffic signal data and pedestrian/cyclist detection were identified by private industry as particularly valuable.

Scope

The Smart Roadway infrastructure deployment will focus on a 20-square block area representing Reno's downtown business district as well as a six-mile stretch of Reno's main commercial thoroughfare, Virginia Street/Business-395, from the north to the south intersections of the McCarran Boulevard ring road. This area will include two freeway on- and off-ramps: the Virginia Street intersection with I-80 and the Virginia street intersection with I-580.

AUTO CRASHES 2014
(Not Including Bike or Pedestrian Crashes)

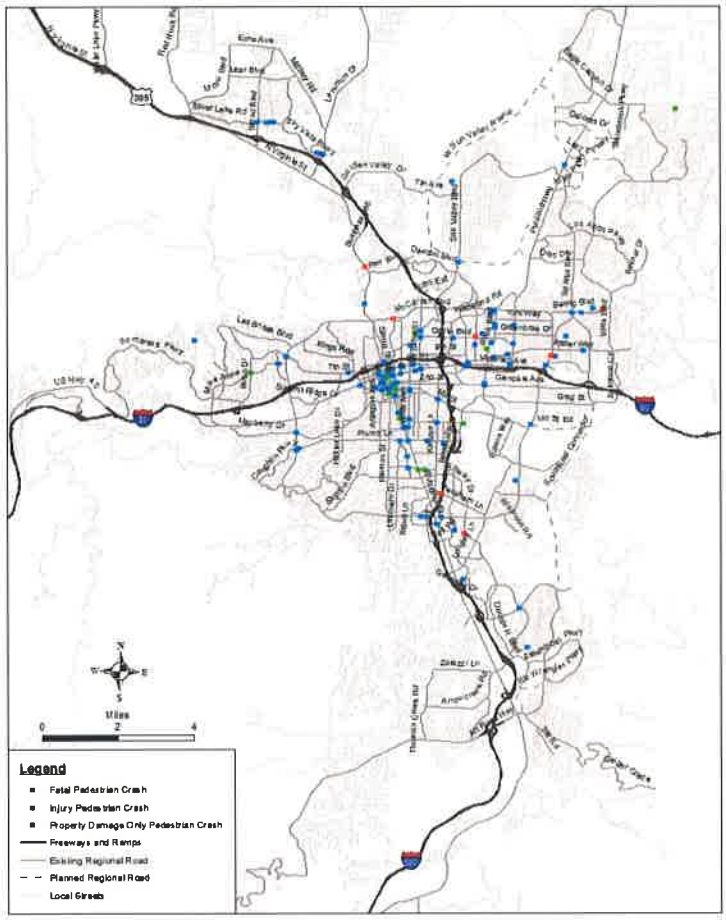


The geography was chosen because it provides a wide variety of use-cases and challenges:

- **Opportunity to improve safety**: Downtown and Virginia Street have the highest concentration of non-highway auto crashes in the region. Downtown and Virginia Street

have the highest concentration of pedestrian- and cyclist-involved crashes.[9]

PEDESTRIAN CRASHES 2014



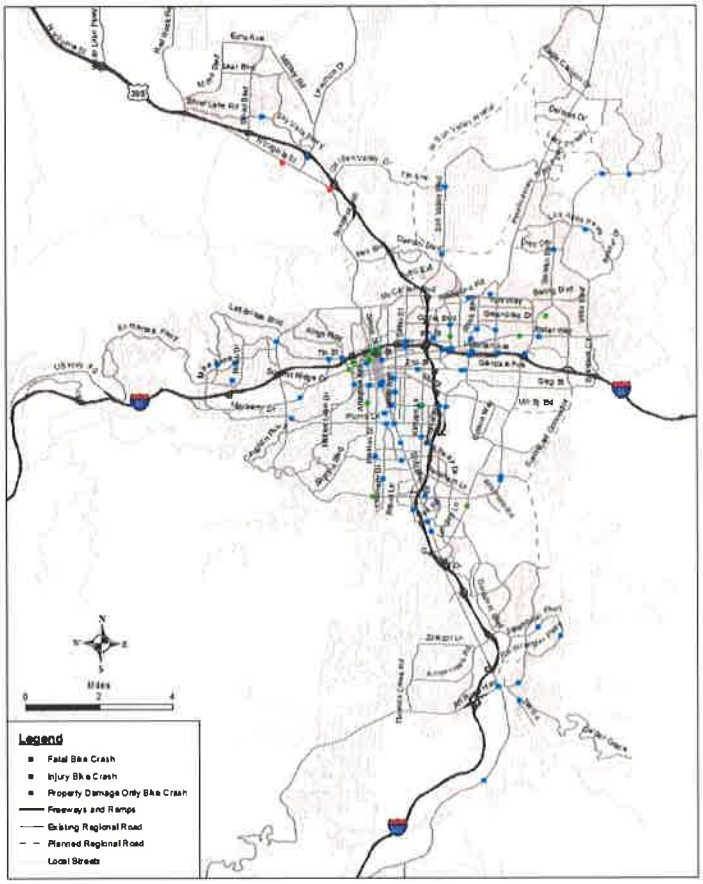
- **Opportunity to address congestion**: Several areas of Virginia Street experience significant traffic congestion. Because this is a Transit-Oriented Development (TOD) corridor with high pedestrian activity, traditional solutions like adding more lanes for cars are not appropriate. Alternative operational solutions are required to improve mobility. Congestion is exacerbated during sports and graduation events at the University and during the 32 special events held annually in the downtown core, most involving significant road closures and traffic rerouting.
- **Opportunity to improve public transit**: Downtown contains the main public transit terminal (4th Street Station) and Virginia Street has several important bus routes, including a Bus Rapid Transit (BRT) line. The planned 2019 extension of the BRT service on Virginia Street includes conversion of a general purpose lane to a bus-only lane. An additional BRT line, the 4th Street/Prater Way BRT Project, will extend premier transit serve east from downtown Reno to downtown Sparks.
- **Opportunity to improve emergency services**: Downtown contains the most active police precinct and fire station, as well as a large regional hospital.
- **Opportunity to test in different built environments**: Virginia Street at the north end of the study area serves as the western boundary of the University of Nevada, Reno (UNR) campus, then travels south passing over I-80, through the downtown entertainment district of high-rise casinos and hotels, the commercial/office area known as the Liberty District, the mixed-use restaurant/boutique/residential district known as Midtown, and finally through a mix of strip-malls and big-box developments at the south end of the study area.
- **Opportunity to better serve disadvantaged populations**: Low-income households and minority populations make up more than 12.9 and 34.5 percent respectively of the census tracts in downtown and along the east side of the Virginia Street Corridor.[10] Improved

[9] RTC Transportation Safety Report, January 15, 2016: http://bit.ly/1KQAeUb
[10] *2035 Regional Transportation Plan*, http://rtcwashoe.com/metropolitan-planning-7

efficiency of the existing transportation network will provide ladders of opportunity to these residents.

- **Opportunity to address environmental concerns**: Air quality could become a serious concern for the Reno region. The region is a "maintenance area" for particulate matter (PM10) as well as Carbon Monoxide. The region does not meet the new Ozone standards published by the EPA in 2015. The proposed study area is in the low spine of the Washoe Valley, and experiences the eye of pollution during inversion events.

BICYCLE CRASHES 2014



Components

Dedicated short-range communications (DSRC), dynamic traffic control signals, and vehicle, pedestrian, and cyclist sensor technology will be installed throughout the geographic scope. A variety of pedestrian and cyclist sensor technologies will be deployed to test performance of different technologies (video, radar, thermal/infrared, laser scanners, microwave). Effective performance is crucial to migrating technology to the real world, not only to provide actionable data but also to minimize wasting the scarce sources of mid-sized cities in solving equipment failures. Sensors and DSRC devices will be connected by the existing fiber network. Dynamic signal optimization and real-time information dissemination will be implemented based on the connected system and real-time data input. Police, emergency and transit vehicles operating in the geographic area will be retrofitted with DSRC and display technology, if not already existing.

An innovation-focused traffic management center (iTMC) will be established to support the Smart Roadway deployment. The iTMC will aid in bringing the new technologies online then, as operations mature, transition management to the virtual traffic management center (vTMC) where authorized users will be able to access and operate the traffic system devices remotely. The iTMC will be located at the Applied Research Facility on the UNR main campus and connected to the sensors and DSRC devices and traffic operations across the region (Reno, Sparks, Washoe County, NDOT, UNR, RTC) via the existing fiber network.

The new iTMC will also house a data center designed and implemented for real-time traffic data communication and operation to support the Smart Roadway deployment. All data collected will be open, machine readable and accessible, using national standards and protocols for public data.

The iTMC data center will be connected to the Nevada Data Exchange system (NDEX) administered by NDOT for sharing the Smart Roadway data and obtaining data from other sources. NDEX already contains data from traffic cameras, flow meters, ramp meters, and road weather sensors in the region.

The project will promote awareness of Smart Infrastructure and adoption of connected vehicle technologies to the public. Vehicles increasingly have connected technologies built into the dash displays, but many people will have to use smartphone or other peripheral devices mounted on the dash to take advantage of new information. We will work with auto manufactures, device vendors and data/app providers to help consumers understand, adopt and safely use new data.

The Smart Roadway project team will consist of a partnership between the *Beyond Traffic* Implementation Team, RTC ITS/Traffic Operations Section and Transit Department, and the CATER center at UNR. The team will work with a vendor partner, e.g., HERE/Econolite, to complete the installation and configuration of the system, as well as provide ongoing support. The deployment will be sequenced in manageable phases, allowing incremental learning and alignment with the planned major capital projects taking place in the project area.

Primary objectives

The combination of the smart infrastructure technologies in the Smart Roadway proposal were chosen because they provide the clearest benefit to the most users:

- **Safety**: There are several safety benefits: V2V and V2I communication allows drivers to know traffic, weather and road conditions in advance (e.g., location of ice from ABS or electronic stability control sensors); pedestrian and cyclist sensors disseminate information to alert vehicle drivers and AVs of their presence; and, the dynamic traffic signal system allows traffic flow optimization (e.g., prolonging yellow light timing during storms).
- **Opportunity to improve public transit and emergency services**: The dynamic traffic signal system will reduce bus delays and provide the ability to clear the path of lights for emergency vehicles. With one lane on Virginia Street converted to a bus-only lane in 2019 to support the expanded BRT service, ITS and other operational improvements will be critical in maintaining flow for auto traffic as well as the BRT. Technology that improves traffic operations will improve mobility for personal, transit and emergency vehicles in this important TOD corridor.
- **Alleviate traffic congestion and improve user experience**: Traditional signal coordination can handle peak hours and adaptive signals can handle off-peak, but highly fluctuating volumes resulting from the numerous special events and emergency-response incidents in the proposed Smart Roadway project area need real-time management. Dynamic traffic signal control will accommodate these fluctuated traffic demands to best serve signal coordination and reduce vehicle stops and delays. The real-time traffic condition information will offer drivers of CVs or smartphone app users early opportunities of re-routing during road closures. Signal timing countdown allows drivers or AVs to adjust approach trajectory accordingly and provides information on signal operation to improve driver satisfaction. There is also the opportunity to provide better real-time travel time estimates to drivers by providing intersection-level delay data to complement the GPS travel/speed estimates used currently.

- **Improve maintenance**: The communication backbone will collect road condition data from vehicles that can be used to prioritize maintenance (e.g., identify potholes that create safety and flow the most problems from data generated by on-board accelerometer/gyro data).
- **Leverage federal/state/local dollars**: There is synergy with RTC's federally-funded Complete Streets and BRT work on the 4th/Prater and Virginia Street corridors. The 4th/Prater Project is funded through a $16 million TIGER grant and $6.4 million Small Starts grant, as well as other federal sources such as the Surface Transportation Program and Congestion Mitigation Air Quality programs. The Virginia Street project has been accepted into the Small Starts project development pipeline, as well. There is also synergy with NDOT's in-progress DSRC pilot on I-580 between Reno and Cason City. And finally, the City of Reno is committing funds to a variety of planning projects in the study area, including the Reno Master Plan update ($600,000), Urban Land Institute Study of Virginia Street Corridor ($125,000), and the Downtown Reno Action Plan ($100,000).
- **Environment**: Less stopping and idling means reduced fuel consumption and reduced greenhouse gas emissions. Further, increased safety and better integration of pedestrian and cycling mobility could lead to increased adoption, decreasing vehicle emissions.

Smart Roadway Project Metrics
- Reduction in pedestrian/cyclist related accidents
- Reduction in accidents during inclement weather
- Reduction in transit delays/improved on-time performance and reduced variability in trip time
- Reduction in average travel time, delay, and stops on various road segments
- Increase in road and transit data pulled into consumer-facing apps
- Increase in vehicle throughput per green light by reducing headways and/or startup delay (reaction time)
- Increase in driver satisfaction/comfort level with the utility of the transportation system
- Reduced fuel consumption and GHG emissions

Secondary objectives

In addition to the expected benefits listed above, the Smart Roadway investments will also provide a testing environment to further our understanding in several key areas:

- **Match communication technology to use cases**: The sensor- and communication technology-rich Smart Roadway deployment will allow testing of many combinations of sensor data, vehicle data and communication paths. The project team will develop and publish a framework to discover the minimum viable communication technology for each V2I and V2V communication use case. We will analyze and recommend matches between types of data and communication technology considering the latency, reliability and security needs of the various use cases.
- **Match sensor technology to use cases**: Explore and recommend approaches to sensor deployment depending on environmental conditions and use cases. We will seek to answer questions such as: which types of intersections need which types of sensors (e.g., does a mid-block crossing warrant cameras and flashers, while intersections only need cameras)?; how is sensor performance affected by different weather conditions?; and, what is the best combination for sensing pedestrians since all sensors have strengths and weaknesses? The

goal is to contribute to the knowledge base and prioritize future investments for project expansion.

- **Operation protocols**: Explore the need to create operation protocols to ensure vehicles can achieve benefits that rely on coordination regardless of manufacturer (e.g. should all AVs be able to draft off one another, not just ones of the same manufacture?). In addition to promoting the USDOT standards for data architecture, explore if common protocols are needed for how the data is processed/acted upon between different map/auto companies (e.g., are there safety concerns if one car is programmed to react differently to incoming data than another?).
- **Target information**: Determine how to send only relevant data to targeted vehicles, potentially in collaboration with cloud-processing data and a mapping company, e.g. HERE. In parallel, explore which data points are safety- and time-critical and need to be communicated directly to a vehicle/driver versus which data points can first go through processing in the cloud.
- **Discover new uses/models**: Provide open communication infrastructure and allow the market to innovate uses. Some ideas that could result:
    - Encourage the private sector to expand use of BLE-connected devices plugged in the OBD-II diagnostics port in cars to cost-effectively retrofit non-connected vehicles and allow them to communicate data from the car's computer (e.g., when wheels lose traction over ice). Test if Filament Patch can be a low-cost way to retrofit non-CV vehicles to receive alerts.
    - Make DSRC and Filament mesh network available for vehicles to send information into system and see what evolves (note: some auto manufactures have experienced jurisdictions that only allow DSRC communications out to vehicles). Depending on interest/response from the private sector, add additional DSRC boxes where fiber already exists outside the study area to expand the communication network component of demonstration. The Filament network will already cover the entire City by the end of 2016.
    - Because we heard from AV manufacturers that communication technologies that provide multiple GPS confirmations are especially useful in urban environments, we will explore how to best provide differential GPS correction data in the Smart Roadways project area.
- **Support development of autonomous vehicles (AVs)**: It is expected that autonomous driver mode will become increasingly available to the public for highway driving over the three-year *Beyond Traffic* study period. As such, the current focus of AV testing is on highways, but the focus will soon transition to more urban environments as cities become the remaining frontier to full autonomy. Reno's Smart Roadway will provide an excellent urban test environment for AVs. While AVs are being designed to operate without external inputs, safety problems arise when pedestrians/cyclists are obscured by parked cars, vegetation, etc. and when traffic lights are not uniform across a city, much less between cities, states and countries. To further improve the AV testing environment, land detection sensors embedded into the pavement will be deployed and tested along road- and turning-lanes at select intersections to improve accuracy of AV location information. The connected traffic signals, pedestrian/cyclists sensors provide redundancy that increases safety in intersections for AVs.

Reno will also add cameras along the study area that independently assess vehicle performance ("ground truthing") to support AV testing. Instruments outside the car give a different perspective and provide an independent comparable measure of performance. The intention is not to rank or even publish results while AVs are in testing conditions, but this information could be a useful tool for evaluating and monitoring safety once AVs are commercially deployed. The AV testing will sequence the deployment in manageable phases that allow incremental learning and alignment with the planned major capital projects taking place in the project area.

Risks

Project risks are technical, regulatory and social in nature. The primary technical risk is alignment between the project deployment timeline and the R&D testing timeline for autonomous manufactures in urban areas. Potential mitigating factors include that we already have several manufactures testing in Nevada, the Tesla factory is in our region, and we are close to the Bay Area where much R&D is already occurring. Regulatory uncertainty is also a risk. While Nevada has a supportive regulatory environment, lessons learned in Nevada might not immediately translate nation-wide due to lagging policy in other jurisdictions and in the insurance market. Social risk is the potential for slow consumer adoption of connected and autonomous vehicle technologies due to concerns for privacy and skepticism of autonomous systems. We will mitigate this risk through public engagement efforts.

Supporting projects

Smart Parking and EV Fleet Upgrades are two proposed projects that support the improved road management and environmental benefits of the Smart Roadway project.

Smart Parking

The Reno community sees parking as a major mobility issue, particularly in downtown, Midtown and around the UNR campus. The Smart Parking project will focus on on-street and garage parking in these three areas that have limited street-parking and experience periods of high parking demand. The street parking in downtown and Midtown is a mix of metered and unmetered, while the street parking around UNR is managed through a parking permit system. Downtown has a mix of paid public lots and free lots connected to the casino properties. Both on-street and garage parking space utilization will be monitored with sensors and available spaces will be displayed via a free parking app. The data will be open and available to other parking and mapping apps. During special events, on-street signs will be spaced on main roads entering town directing the public to available lots.

Additionally, an array of electric vehicle charging stations will be deployed in the Smart Roadway project area and in other commercial hubs throughout the city. Currently there are 31 EV charging locations in the Reno area, each offering one to eight plugs. There are no quick-charge stations in Reno. The Smart Parking project will deploy a combination of quick and long-charge stations depending on the characteristic of the charging location (e.g. if a car is typically visiting for one hour or eight hours). EV charging locations will be displayed via the same app as parking and the app will notify drivers when the vehicles are fully charged. EV charging data will also be made open and available to pull into other apps, such as PlugShare. A

public awareness campaign will promote the program and solicit feedback on how to improve both parking and EV charging infrastructure communications and capacity.

The primary objectives of the Smart Parking component are to aid in day-to-day parking management, aid in management of large events and provide enough charging infrastructure to address "range fear," increasing private sector adoption of electric vehicles. Deployment of the parking sensors and EV charging stations will be by private vendors and in partnership with local stakeholders, such as UNR parking services, the casino properties and NV Energy.

Metrics will include: the number of active users of the parking data/app; improved public perception of parking availability; reduction of parking-related congestion during events; utilization of charging stations; and, increase in local EV ownership

We will work with vendors to finalize the details of the Smart Parking deployment if selected as one of the five cities for the final round of the *Beyond Traffic: Smart City Challenge*.

EV Fleet Upgrades

The EV Fleet Upgrade component will increase the share of electric vehicles in Reno's municipal fleet, in RTC's bus fleet, and incentivize use by private mobility service providers, like taxis.

The City of Reno has begun to green its fleet of vehicles that can be provided in hybrid or fully electric models. The City faces limitations in adoption due to the need for many city functions to perform in 4-wheel drive storm environments. Of the City's fleet of 85 non-patrol sedan vehicles, the City currently has 3 hybrid vehicles. The EV Fleet Upgrade proposes to add 15 fully electric vehicles to Reno's fleet: six unmarked police cars, three business license vehicles, two for an employee motor pool program, three for parking enforcement and one for meter collection.

RTC launched the Electric Bus Initiative in April 2014 with four all-electric, zero-emission Proterra buses. These buses are popular with the public and have saved over 25,000 gallons of fuel so far. As with many transit systems, RTC is struggling to maintain existing service levels in the face of ever increasing costs for fuel and maintenance of its aging diesel fleet. Using electric bus technology that reduces fuel and maintenance costs helps support long-term, sustainable transit operations. The RTC will expand its EV fleet in 2017 through the purchase of four Proterra electric buses for the 4th/Prater project. Tesla Motors, which will employ an estimated 6,500 workers by 2017, has indicated an interest in an electric bus commuter service. An additional three Proterra electric buses and one additional charging station as part of the EV Fleet Upgrade could be allocated to this or other service areas.

We would like to begin a new program to provide incentives for private mobility service vehicles to go electric. Incentive levels and mechanisms will need to be explored in greater detail.

The primary objective of the EV Fleet Upgrade project is to increase electric vehicles on the road, reduce maintenance costs, and reduce emissions. Metrics include reduction in fuel and maintenance costs due to EV fleet, increase in EVs in fleet, and reduction in GHG emissions.

We will work with vendors to finalize the details of the EV Fleet Upgrade deployment if selected as one of the five cities for the final round of the *Beyond Traffic: Smart City Challenge*.

Drone Delivery

Drone delivery trials to relieve first- and last-mile surface congestion

In brief

Reno will work with its academic and commercial partners to conduct drone package delivery trials in suburban and urban areas. These trials will test use cases for drone-based package delivery to consumers, will estimate the extent to which drone delivery can relieve surface congestion, and will explore technical and policy strategies to ensure that delivery drones operate safely and responsibly in the presence of manned aircraft, suburban and urban activity and privacy-conscious citizens.

Background

In recent years, interest in unmanned aircraft systems (known colloquially as "drones") has skyrocketed across the United States. During the 2015 Christmas Season, the Federal Aviation Administration estimated that over 700,000 small consumer drones would be purchased as gifts for hobbyists with a wide array of interests and flying skills. Concurrent with the explosive growth in drone hobbyists, commercial interest in unmanned aircraft has increased dramatically across a number of industries, ranging from agriculture and mining to real estate and sport photography. Among all of these commercial applications of drone technology, one seems to stand out in the public's imagination: drone package delivery. Encouraged in part by efforts from tech companies such as Google and Amazon, many people expect drone delivery to become a reality in the immediate future.

In spite of this interest, there are a number of challenges standing in the way of wide-scale deployment of drone delivery systems. The FAA has been slower than anticipated to implement Congress's 2012 mandate to integrate civil drones into the U.S. National Airspace System. Beyond the regulatory challenges, a key technical hurdle to overcome is the traffic management problem: how to coordinate a large number of unmanned aircraft with each other, with manned aircraft and with air traffic control to ensure safety and minimize congestion in the skies. Within cities, this challenge is compounded by the difficulty of ensuring reliable communications between drones and infrastructure. Solutions in manned aviation, such as Automatic Dependent Surveillance-Broadcast (ADS-B), have not been tested in urban conditions, and have power and weight requirements that are prohibitive for small unmanned aircraft.

Interest in drone delivery remains high in the face of these challenges because of the potential of drone delivery to enhance the efficiency of first- and last-mile logistics. The vast majority of packages delivered to consumers weigh less than 5 pounds, and have shapes and sizes that are well-suited to delivery by drone. Delivering such packages by drone has the potential to relieve much of the surface congestion caused by ground-based last-mile delivery systems, leading to improved traffic efficiency, better optimized logistics and greener transportation, as electric unmanned aircraft supplant ground transport powered by carbon-based fuels.

To address the technical challenges of coordinating a large number of low-altitude unmanned aircraft operations, NASA Ames Research Center has been working with partners on a project *Unmanned Aircraft System (UAS) Traffic Management (UTM): Enabling Civilian Low-Altitude Airspace and Unmanned Aircraft System Operations*, known colloquially as UTM. Relying on distributed infrastructure, UTM promises to enable a large number of unmanned aircraft to conduct safe operations in the national airspace. UNR has been working on components of UTM with NASA Ames since fall 2014.

One of the key trends driving growth in the civilian drone industry is the continuing miniaturization of electronics for drone control and communication. This same trend is pushing forward the nascent Internet of Things (IoT) in which physical devices are enhanced with wireless networking hardware to enable device-to-device communication. Although IoT technology has seen the most use in industrial settings to date, there is significant potential for cities to leverage this technology to create decentralized municipal data networks. Combining such networks with emerging drone technologies holds significant potential in the near future.

Components

The City of Reno will deploy phased drone delivery trials to determine the effectiveness of aerial package delivery in reducing surface congestion. These trials will be conducted in partnership with the University of Nevada, Reno and Reno-based companies Flirtey and Filament. The trials will focus first on safe flight in a variety of real-world settings, and will move quickly to test package delivery to real customers in suburban and then urban settings.

Phase 1: The first phase of the trials will ensure that drone delivery systems can operate safely beyond the line of sight of the drones' operators. This capability is essential for city-scale drone delivery to become a reality, and will coincide with work that the University of Nevada, Reno and Flirtey are already performing to assist NASA and the State of Nevada in testing UTM and related drone air traffic management systems. This work will be well underway before the close of 2016, and will leverage the capabilities that UNR and Flirtey have already been developing to enable deployment of a large number of drones. This phase will allow the city to establish requirements for safe drone delivery operations, and will involve creating a safety case to present to federal aviation officials to allow safe beyond line of sight operations of Flirtey aircraft.

Concurrently, Reno will work with Filament to begin deploying a mesh network that will enable drones to communicate more efficiently with each other and with city infrastructure. Flirtey vehicles will be equipped with Filament's communication devices that will allow the drones to broadcast their position in real time, using less power than conventional aviation approaches such as ADS-B.

Phase 2: Building on the safety case established in phase 1, the second phase will test the viability of small-scale drone delivery in a sparsely-populated suburban area. Once safe beyond line of sight operations are better understood, the next task is determine how to deliver packages to customers in sparsely populated suburban areas. Flirtey already has the technological capability to do this. In this phase, Reno's goal will be to determine how to enable delivery drones to fly safely over people. Flirtey has developed redundancies and safety features on its delivery platform, which will guide the development of standards for safe suburban operations.

This phase will also enable testing the Filament network on a larger scale.

Phase 3: As both the mechanisms for delivery and networking are successful in increasingly challenging settings, Reno will expand the availability of drone delivery towards denser suburban areas, with the eventual goal of performing drone deliveries in urban areas.

Three components will enable successful drone delivery trials in Reno:

- **A drone delivery system**: Reno-based Flirtey is a drone-delivery company with extensive experience building and deploying drones for package delivery. Flirtey drones have been used to deliver packages in the United States, Asia, and the Middle East. Flirtey's systems are some of the only systems in the world that have been used for real drone deliveries.
- **A mesh networking system**: To enable secure, decentralized communication between Flirtey's aircraft and Reno's infrastructure, the project will rely on a mesh network deployed in Reno by Filament. The network operates in the sub-GHz range and uses very secure and private encoding of data transmissions. This network will allow drones to communicate with each other and with city infrastructure.
- **A traffic coordination system linking the first two components**: Linking the first two components, UNR will develop the software necessary for vehicle coordination through a decentralized municipal network.

Scope

In phase one, trials will be centered around the Reno-Stead Airport. This airport is in a sparsely populated area, and is one of the airports at which drone activities can take place under Nevada's FAA Test Site Certification of Authorization. This is also where UNR and Nevada will be conducting test flights to support NASA's UTM research efforts, making it an ideal location for drone testing of all kinds. During this phase, airspace management research will be supported by the NUANCE Lab.

In phase two, trials will move south, into suburban areas surrounding Reno-Stead Airport. The population density in this area remains low, ensuring a strong safety case for delivery trials, and is well within the operational range of all aircraft Reno plans to use for the trials.

In phase three, trials will continue to move south, with operations being conducted in urban areas near the Reno core. These trials will incorporate lessons learned from phases one and two, and will demonstrate the ability of aircraft to operate safely in urban centers.

All three phases are supported by Reno's position as a major logistics and distribution hub for the West Coast. In particular in the initial trial area surrounding the Reno-Stead Airport is home to many companies who are target users of aerial delivery services.

Primary objectives

The overarching objective of this project is to determine how drones can realistically conduct package deliveries in cities. Realizing this objective will require that the following goals be achieved:

- **The safety case**. Although hobbyist drones have become common, it is still unclear how best to integrate drones into urban settings. Companies that are working on drone delivery

have begun developing reliable, redundant aircraft systems, but the role that cities can play in ensuring safe drone operations at low altitudes remains unclear. The proposed drone delivery trials will help clarify the safety case for drone delivery, and could become a model for every city wrestling with the question of how (or even whether) to integrate drones into urban life.

- **Reducing traffic from ground-based delivery**. The real promise of drone delivery is more efficient ways to get goods to consumers. Because drones can perform deliveries much faster, it stands to reason that, at scale, drone delivery could significantly reduce the need for last-mile delivery via ground vehicles. The proposed trials would quantify the extent to which this intuition is well-founded.
- **Exploring municipal data networks for drones**. Using a Filament mesh network to enable drone-to-drone and drone-to-infrastructure communications is expected to reduce power requirements for drones and increase operations' safety, but because no city has yet created such a network, both the exact nature and extent of the benefits of such a network are uncertain. The proposed trials will clarify and quantify how beneficial municipal data networks can be for unmanned systems, aerial and otherwise.
- **Leveraging existing federal funding**. UNR currently has funding from NASA to support the UTM project through a five-year, $1.2 million research and development agreement in partnership with the State of Nevada and the Reno-Tahoe Airport Authority. The university also has an additional $400,000 from NASA to perform UTM-related research and development under Nevada's FAA Test Site construct. Some of that money has been dedicated to maintaining the NUANCE Lab, which is explicitly designed to support research and development of airspace management technologies. The work that UNR and Flirtey are doing in air traffic management directly supports the proposed trials. Filament is deploying the city-wide mesh network at no cost to the City.

Drone Delivery Project Metrics

- Number of packages delivered by drone
- Increasing scope of FAA approval for beyond visual line of sight operations and operations in suburban and urban settings
- Positive safety record
- Delivery efficiency
- Ground traffic reduction
- Carbon footprint reduction
- Economic development

Secondary objectives

The proposed trials will create opportunities to conduct other research that would be useful for cities. We will explore the following secondary objectives:

- **Discover socially optimal drone routing (skyways vs. direct flights)**: Although a large number of recreational drones operate in the United States, their operations are limited and uncoordinated. As commercial interests begin to conduct operations in and around urban areas, it will be critical for cities to discover the best way to route these vehicles through the skies. Beyond science fiction and a few speculative analyses, almost no work has been done on this problem that can be used for the practical applications that will become available as federal airspace restrictions loosen. This project can be used to provide data that cities can use to develop municipal airspace management principles.
- **Other uses for drones**: While the primary focus of the proposed trials is to explore the possibilities surrounding drone delivery, the research partners in this proposal understand

the other potential benefits of drone technology. UNR researchers are currently focused on understanding how drones can be used to assist search and rescue teams, and support first responders. Reno researchers are also developing techniques that will allow drones to perform infrastructure inspection and monitoring. As delivery trials proceed, the team will look for opportunities to use trials to explore other socially-beneficial applications of drones in urban settings.

- **Privacy protections**: One of the chief concerns surrounding drones is the risk that sensor-equipped aerial platforms pose a risk to individual privacy. At the same time, it is unlikely that drones will be able to function on a large scale without cameras and other sensors that will allow them to operate safely in city airspace. This tension may be impossible to resolve completely, but the proposed trials will explore how competing concerns between privacy and vehicle effectiveness can be balanced to ensure that society can enjoy the benefits of delivery drones without sacrificing their important privacy rights.

Risks

Risks to the project take three forms: operational/technical risk, regulatory risk, and social risk. Because Flirtey's vehicles contain redundancies to enable safe flight over populated areas, the primary technical risk is that integrating Filament's hardware with Flirtey's aircraft may be harder than anticipated. Flirtey and UNR have rigorous processes for integrating hardware onto unmanned aircraft, which should largely mitigate this risk. Filament's expertise will also minimize the impact that this risk holds for the project. A more significant risk comes from the current regulatory environment. The FAA currently prohibits non-recreational UAV flight over people not involved in flight operations, which makes suburban and urban operations very difficult. Our phased approach mitigates this risk: UNR has experience working with the Nevada FAA UAS Test Site to conduct flights under the state's authorization, and will use this experience to help make the case for drone delivery to the FAA. The regulatory environment is also expected to shift towards greater airspace openness through the duration of the challenge. Using lessons learned from earlier phases, the regulatory risk can be controlled. The third category of risk, social risk, stems from the potential that people may reject drone delivery as unsafe, or may fear that drones will invade their privacy. Although consumer hobbyist drones have led some to mistrust drones in general, research conducted at UNR indicates that people generally take into account the application of a drone before deciding on its acceptability: people tend to hold favorable views of drones that are used for purposes that hold widely-recognized social benefits. Knowing this, the trials will focus on emphasizing the positive role that commercial drones can play in cities so that social risks are minimized.

New Technology for Transit

Bring sharing economy models to public transit and non-motorized transport

Technology for Public Transit

In brief

Reno will leverage the innovation of the private sector in select public transit use cases to enhance mobility for residents and provide more cost-effective service by adapting new mobility technologies and models.

Background

For select cases, we believe mobility-as-a-service options that leverage new technology and sharing economy models have the potential to be less expensive compared to the full cost (fare plus subsidy) of providing the corresponding public transit option and offer more direct and customized service. These services also offer the flexibility to serve outlying, lower density developments that are challenging to serve with traditional transit service.

Scope

The project will consider the existing public transit system as well as unfunded needs identified in the *2035 Regional Transportation Plan* (adopted in 2013) and the *Short Range Transit Plan* currently under development, with the ultimate scope determined as a result of the analysis proposed in the first component, below. Unfunded needs include transit services to low-density development in outlying areas. Because land is less expensive in these parts of the community compared to the urban core, low-income residents who purchase more affordable homes often later find that their transportation costs are more expensive.

Components

The first project task will analyze and draw conclusions towards identifying new transportation service types and public-private partnerships that may offer potential savings and service improvements achieved by adopting new mobility technologies and operating models for specific transit use-cases. This work will be lead by the UNR Economics Department and will focus on three areas:

- **Transit opportunities**: The UNR team will review and build on the RTC's Short Range Transit Plan, which includes existing transit operating data and analysis to evaluate the effectiveness of the current system and identify areas for potential improvement. Unfunded transit needs will also be considered as new service types of public-private partnership models may allow cost-effective service to underserved areas. Opportunities to be evaluated include:
    - Capture more of the approximately 20,000 people who commute between Reno and Carson City per day.
    - New regional service to the Tahoe-Reno Industrial Center (TRI-Center)--the largest industrial park in the nation and a rapidly growing employment center--located 20 miles east of Reno is needed.
    - Opportunity to use new technologies to supplement paratransit services
    - Characterize opportunities for new service models to serve outlying suburban areas that are not currently served with existing transit options due to fiscal limitations
    - Technology to improve the efficiency of dial-a-ride service for seniors and individuals with disabilities
    - Characterize the service needs of low-income households to improve accessibility to employment, education and healthcare
- **Financing and business models**: The UNR team will evaluate financing options and implications for various business models for provision of public transit. Questions to be explored include:
    - For various trip scenarios, compare the costs, time, convenience between the different mobility options, including personal driving, new private mobility services, e.g., Uber and Lyft, and public transit. Include an evaluation of social equity in the analysis.

- What is the right business model for using new mobility technologies and service models for public transit? How can various structures, like public-private partnerships, be used to supplement and extend mobility?
- What are the opportunities and best-practices for multi-jurisdictional revenue-sharing to fund transit when benefits of transit spill across jurisdictional lines? In particular, the analysis will consider the transit needs and benefits of serving the TRI-Center.
- What are the best methods to utilize mobile technologies for fare payments to reduce transit operating costs and improve customer convenience? With electronic payments making it possible to change fares in real-time and create a user-profile for each rider, analysis will consider the implications of the potential for public transit to charge variable rates depending on real-time demand or income of the rider. Specifically, are there scenarios where ridership levels of less-subsidized passengers would allow for revenue-neutral public transit? What are the policy, equity, and security implications?
- What regulations should local and national governments anticipate as the private mobility-as-a-service market matures? For instance: what consumer protections should be considered (e.g. when does demand pricing become price gouging?), what are the social equity considerations, and in the future, should mobility companies directly contribute to road maintenance costs instead of individual taxpayers such that contributions more accurately reflect benefit received?
- For various passenger/household profiles, identify the balance/threshold of public transit and private mobility-as-a-service options that become cost-comparative to personal car ownership, and/or allows multi-car households to downsize to one car. Develop recommendations for levels of subsidy to accelerate the transition.

- **Technology options**: Many of the new mobility models are finding innovative ways to achieve higher utilizations of shared resources. Powerful analytics allow the identification of patterns in many individual trip requests, which in turn allow combining trip segments of passengers in ways that achieve the economies of scale underlying traditional mass-transit models. Some services offer this on the fly in real time (as in uberPOOL and Lyft Line) while others only offer on planned routes (uberHOP[11] and Bridj[12]), during certain times (uberCOMMUTE), or for certain populations, like seniors (Lyft Concierge[13]). The UNR team will review existing technologies to determine key minimum viable scales for different operating models.

The UNR Economics team will assess the topic areas above; develop scenarios combining different parameters of service areas, financing/business models, and technology options; and, recommend a short-list of public transit opportunities for the second project task.

The second project task is to draft and release RFPs soliciting technology-based service solutions for a selection of the use cases identified in the first task that meet criteria around potential impact and applicability outside of Reno. The intention is to offer financial support for the development of the service and underlying technology, as well as an operating subsidy over the project period that is in line with the long-term goal level of public contribution to transit. The

[11] https://newsroom.uber.com/us-washington/more-people-in-fewer-cars/
[12] http://www.bridj.com/
[13] http://blog.lyft.com/posts/nationalmedtrans-concierge

work of drafting, publicizing, reviewing, selecting, and managing implementation will be lead by the *Beyond Traffic* Implementation Team.

The RFPs will specify that any vehicles proposed by private companies be electric, hybrid or use an alternative fuel source to the greatest extent possible. We will also explore requiring the winning company(s) to commit to measuring public benefit impact (through a platform like B-Analytics) on an annual basis as a model for good practice when contracting with a public agency to provide a direct public service.

Public Transit Project Metrics

- Reduction in travel times and traffic congestion
- Reduction in per passenger mile cost of transit
- Increase in ridership and productivity (passengers per service hour)
- Increase in transit options for disadvantaged populations
- Increase in electric, hybrid and alternative fuel vehicles
- Reduction in fossil fuel use and GHG emissions
- Reduction of cars per household

The *Beyond Traffic* Implementation Team will also develop a public engagement program to build awareness of the new services and solicit input to aid in the iterative improvement of the services. Each of the agencies participating in the project has highly effective and proven public information and communications capability. Working together, they will design and implement public awareness and engagement campaigns to ensure robust citizen engagement.

Primary objectives

The knowledge gained during the first task, and the on-the-ground impact during the second task of the Technology for Public Transit component of the Reno proposal serve many objectives specific to the Reno community:

- **Improve public transit**: we expect the use of new transportation technology and models for certain use-cases will provide more cost-effective service and allow expansion of public transit service within the same level of funding.
- **Provide more user-focused mobility options**: many new mobility-as-a-service technologies bring information and choice directly to users smartphones, often allowing more customized service (e.g. closer to door-to-door, fewer transfers, etc.)
- **Improve access for disadvantaged communities**: the project will identify lower-cost approaches to improving mobility for seniors and other disadvantaged populations who live in areas difficult to serve with conventional public transit.
- **Reduce congestion**: reducing single occupant driving will improve traffic operations for transit and ride-sharing vehicles.
- **Reduce environmental impact**: additional mobility-as-a-service options will reduce fuel consumption and GHG emissions by shifting single-passenger trips to multi-passenger, and having those trips in electric, hybrid or alternative-fuel vehicles.

Secondary objectives

The Technology for Public Transit component of the Reno proposal also serves broader goals in understanding and shaping the future of public transit nationally:

- Provide a low-risk environment for a start-up or new division of an existing company to develop products for the public transit market. Ideally, the new company or division would be structured as a benefit-corporation.

- Beta-test new transit services that can be expanded to other cities.
- Evaluate and recommend appropriate public-funding options for various types of new transit services.
- Evaluate impacts of private mobility as a service model and explore potential public-sector responses. A recent report from the National League of Cities finds only 3 percent of cities have studied the impact of ride-hailing services like Uber and Lyft[14]; this is an opportunity to complete analysis in a context that can serve many cities.

The *Beyond Traffic* Implementation Team will coordinate between the UNR Economics Team and RTC Teams for the first task and will manage the second task--from drafting the RFPs, evaluating the responses to managing the implementation by the selected company(s)--in close coordination with RTC.

Risks

Project risks are technical, regulatory and social in nature. On the technical side, the primary risk is that there are no qualified respondents to the RFPs. The *Beyond Traffic* Implementation Team will mitigate this risk through effective outreach in advance to ensure interest from qualified potential applicants. Regulatory risk will depend on what services ultimately go to contract and will have to be explored/mitigated at that time. In terms of social risk, new forms of public transit may not be embraced by users. We will mitigate this through ensuring that the developed new services offer high value and utility, as well as a good marketing campaign.

Supporting Project

As a complement to the Technology for Public Transit component, the Reno proposal also includes technology aimed towards improving the pedestrian and cyclist experience.

Technology for pedestrians and cyclists

Reno's topography and climate make it ideal for non-motorized transit: Reno is located primarily on the flat bottom of a valley and experiences over 300 days of sun a year. Data developed in the course of ReImagine Reno confirm that the majority of Reno residents desire walkable neighborhoods and value access to outdoor recreation. Residents are also very concerned about their safety as they walk or cycle through the city; this finding confirms an earlier survey in March 2015 by ETC Institute in which pedestrian and bicycle safety ranked in Reno citizens' top three concerns. Investing in bicycle and pedestrian infrastructure, three guiding principles of the RTC, are to support safe and healthy communities, sustainability, and to increase travel choices.

RTC integrates Complete Streets design principles into all regional roadway projects. RTC has adopted a Bicycle and Pedestrian Master Plan and is currently developing a Complete Streets Master Plan. This groundwork ensures that safe multi-modal transportation options are incorporated into roadway design. Since 2004, more than 160 miles of bike lanes have been added, and the City has paralleled RTC's work by using wider sidewalks as the design standard in downtown and along Virginia Street.

[14] "City of the Future" report, 2015; http://bit.ly/20KWpVZ

Despite these efforts, data show that there is a cluster of pedestrian and bicycle incidents in downtown and along Virginia Street. It will be necessary to have a better understanding of the factors behind the statistics in order to create safe roadways that can accommodate additional transportation technologies.

The Technology for Pedestrians and Cyclists component of Reno's proposal aims to build on RTC's existing bicycle and pedestrian count program and other investments in Complete Streets with user-focused apps that help identify stressful walking and cycling environments and use the data to prioritize investments in safety improvements and improve route planning. Additional data and safety measures will come from the pedestrian/cyclist camera sensors that are part of the Smart Roadway component of the proposal and the MobilEye technology that will be deployed on all RTC buses in the performance period.

Ride Report is a new, free, user-friendly application that runs in the background of users' smartphones. The City is including this technology in our *Beyond Traffic* proposal because it will be an effective tool to gather much-needed information. Unlike other ride-tracking apps, e.g. Strava, Ride Report runs in the background and collects data whether users are actively engaged or not. It tracks the personal ride experience of users' routes and can be used to create customized routes which optimize time, safety, etc. Users can choose to add extra information about the stress of a ride with a simple left or right swipe on a notification that pops up after a ride. Ride Report aggregates the user data anonymously, and provides analytics for mapping and visualization. The map and analytics dashboard will pull in additional data points, e.g., collisions and congestion, and will be accessible to the public as well as to city and RTC planners. Reno and RTC will publicize the app through existing and new public outreach programs

Ride Report plans to develop the same services and benefits for pedestrians in 2016. We will also contract with Ride Report to use the pedestrian format of the app when it is available.

The objectives of working with Ride Report are to improve the pedestrian and cycling experience in Reno, encourage healthy, pollution- and emission-free alternatives to auto trips, and gather localized data on the pedestrian/cycling experience to help illustrate policy and design choices in the Master Plan update, code revision work, day-to-day building permit review, and Regional Transportation Plan, with the goal of continually raising the bar.

Metrics include number of app users, reduction in rides rated as stressful, increase in bike trips, and increase in pedestrian trips.

Primary risks are technical and social. Technical risks are around development timelines: Ride Report is currently for iPhone users; an app for the Android platform and the pedestrian component of the service are still in development. Ride Report is aiming for 2016 release for both, but could be delayed. We believe the risk is low, as Ride Report is already under contract with Portland, Atlanta and Raleigh. The social risk is generating an adequate base of users in Reno to support useful insights. We will mitigate this through marketing and public outreach.

Alignment with USDOT Beyond Traffic vision

The City of Reno's proposal steers the city towards a better path that aligns with the *Beyond Traffic 2045* vision of moving from a future of potential gridlock and to one that takes advantage of rapid technology advances to solve mobility capacity constraints and improve the experience and safety for all users. The following lists summarize how the Reno proposal addresses each of the 12 USDOT vision elements towards transforming urban transportation.

Technology Elements

Urban Automation

1. The Smart Roadway project includes a testing environment for autonomous vehicles; the large and varied urban testing environment includes features specific to AVs, e.g., "ground truthing" cameras, extra sensors at intersections and on-ramps--two cases that need the greatest study--and, Reno offers a four-season climate for replicability anywhere.
2. The Drone Delivery project develops the safety and regulatory case for commercial unmanned aerial vehicles to relieve first/last-mile goods logistics in urban environments.
3. The Technology for Public Transit project seeks private sector solutions for first/last mile travel to access fixed-route public transit: these solutions could leverage low-speed self-driving shuttle technology.
4. The Smart Parking project allows vehicles operating in autonomous mode to locate spots via an app and self-park after dropping passengers off in the commercial centers of Reno.

Connected Vehicles

1. The Smart Roadway project provides a communication and sensor-rich environment for connected vehicles: both private and public buses and emergency vehicles can benefit from optimized signals and more advanced road condition data.
2. The city-wide Filament network that supports the Drone Delivery component can also be used by surface connected vehicles for select low-bandwidth data traffic uses.
3. Emphasis on open data allows for smartphone users to receive data inputs in a similar fashion to connected vehicles.

Sensor-Based Intelligent Infrastructure

1. The Smart Roadway project will deploy DSRC, dynamic traffic signals, and extensive sensors in a 20-block section of Reno's downtown core and along a 6-mile stretch of the main surface corridor, connecting a diverse range of built environments and users, and improve road management in a key congested corridor in the region.
2. Sensors include pedestrian and cyclist detection technologies to improve safety in the test area, an area with a high concentration of pedestrian- and cyclist-involved accidents.
3. The Smart Parking component will outfit street and garage parking spaces in high-demand areas to communicate parking availability to the public and improve parking management during the numerous special events where parking-related congestion is high.
4. The sensor- and communication technology-rich Smart Roadway deployment will allow testing of many combinations of sensor data, vehicle data and communication paths. The project team will develop and publish a framework to identify the minimum viable communication technology for each V2I and V2V communication use-case.

Innovative Approaches to Urban Transportation Elements

User-Focused Mobility Services and Choices

1. The Public Transit component will bring mobility technologies and models that offer more customized service, such as on-demand routing and scheduling, to public transit users.
2. Both the Smart Roadway and Smart Parking components feed advanced traveler information data to apps and open platforms, allowing citizens to make smarter choices based on real-time traffic, transit and parking information.

Urban Analytics

1. The iTMC and data center of the Smart Roadway component provide the analytical capacities to process all the roadway data into actionable information for real-time road management, CVs and AVs, as well as historical analysis to support future modeling and planning efforts. All iTMC data will also be shared with the NDOT NDEX system to ensure a fully connected ITS backbone.
2. Drone delivery flight data will be stored at NUANCE and iTMC and used for route optimization based on public preferences and environmental performance measures.
3. Use of the Ride Report application for pedestrian and bicycle data will be fed into the iTMC datacenter to enable analytics by the city, RTC and third parties.

Urban Delivery and Logistics

1. The Drone Delivery component is a unique opportunity to progress the potential for unmanned aerial vehicles to relieve surface congestion related to first/last-mile goods delivery in urban areas.

Strategic Business Models

1. Smart Roadway component involves the UTC and leverages significant federal resources already committed to roadway and transit improvement projects in the study area.
2. The Drone Delivery component leverages expertise and investments by public sector (NASA, RTAA), academia (UNR, NAASIC) and the private sector (Flirtey, Filament).
3. The Public Transit component will analyze potential business models for the provision of public transit in the new-technology-and-sharing-economy era, and use the RFP process to solicit private sector response.

Smart Grid, Roadway Electrification and EV's

1. The Smart Parking and EV Fleet Upgrade components support increased private adoption of electric vehicles by addressing range concern and leading by example.

Connected, Involved Citizens

1. Community preference input from the recent ReImagine Reno survey (~6000 participants) informed the overall proposal, particularly the desire for Reno to be an innovative technology center, as well as improving the range and desirability of public transit and increasing parking.
2. The metrics in the proposal will be reported in Reno's Open Data initiative with Socrata.
3. All proposal components are supported and will be influenced by public engagement efforts.

Smart City Elements

Architecture and Standards

1. The data collected and stored from all proposal components will conform with the CVRIA, National ITS Architecture and any published and under-development ITS standards.

Low-Cost, Efficient, Secure and Resilient ICT

1. The Smart Roadway component will use the SCMS for all DSRC communication.
2. The Drone Delivery component will use the secure and private encoding of data transmissions offered by Filament; Filament itself is a low-cost communication network.
3. Each element of the proposal seeks to identify the minimum viable service level and alternative options to ensure safety and security while lowering costs.

Smart Land Use

1. There are a number of Reno planning efforts that support all project components. These include: the update to City Master Plan (June 2017) that responds to citizen desire for policies that support walkable, bikeable and sustainable neighborhoods; continued Reno support of the Complete Street sprogram with RTC; and, integrate citizen desire for policies that support walkability, bikeability and sustainability into the update of the Regional Transportation Plan and the Truckee Meadows Regional Plan (2017).

The City of Reno's *Beyond Traffic: Smart City Challenge* is an invitation to envision a transportation system that makes American cities safer, cleaner, more resilient, more mobile and more inclusive. The City and its project partners believe our unique combination of location, climate, talent, and leadership ensures a robust *Beyond Traffic* project generating practical lessons and knowledge that can be applied anywhere in the United States.