In response to:

The US Department of Transportation
Federal Highway Administration’s Opportunity:

Beyond Traffic: The Smart City Challenge
Funding Opportunity Number DTFH611RA00002

City of Albuquerque, Transit Department – ABQ RIDE
Content of Application Submission
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1. Vision for our Smart City

Our vision of Albuquerque as a Smart City includes a robust public transportation system. Our citizens and visitors to the City reap the benefits of a rapid transit system that moves people throughout the City in a timely fashion. All modes of transportation are addressed, both in the services provided by public transportation as well as in the information provided to travelers. The traffic signals are responsive to the demands placed upon the infrastructure by our traffic patterns. All governmental agencies are able to communicate with each other and to the public through a low cost, reliable Wi-Fi mesh network. Residents and visitors to our City are engaged and can communicate to the City through any channel they choose.

The greatest challenge to the future economic growth of Albuquerque is how we connect our City’s two halves across the Rio Grande River. This challenge arises from the geography of our City. To the east of Albuquerque are the Sandia Mountains, which are protected open space lands and can accommodate no further development. To the north and to the south of Albuquerque are Native American pueblos, which restrict growth of the City in those directions. If the City is to expand, it will have to be to the west, or through densification. Densification, especially along transit corridors, will likely absorb some growth. But all predictions are that the west side of the City will receive the majority of the population growth expected in the next 25 years. The expectation and predictions are that the majority of the population growth will be on the west side of the river (311,000 new people by 2040), and the majority of business growth, including jobs, is anticipated to be on the east side of the river (132,000 new jobs by 2040).

The challenge is that there is a river running north and south through the City, splitting the City into two halves, east and west. There are currently four thoroughfares that span the river. It is highly unlikely that any additional bridges will be built – most properties “touching” the river are protected areas or are unsuitable for a crossing. This is exacerbated by the fact that the majority of heavy infrastructure – the airport, trans-continental railroad tracks, freeways, universities, and hospitals – are also on the east side of the river.

This imbalance of residential location and employment location across a geographical barrier challenge – how to get the large numbers of residents from the west side of the river to the east side of the river during morning peak traffic times, and back again during evening peak traffic times.

What’s needed? First, a public transportation service that is available to serve that need. Second, a system of public information that allows the travelling public to receive essential public transportation system information so that residents and visitors can use the transit system with comfort and confidence.

The City is in the process of planning a Bus Rapid Transit system, “personalized” to the City of Albuquerque by referring to it as the Albuquerque Rapid Transit system (ART). The project will
elevate our current curb-running articulated bus, the “Rapid Ride”, to a true center-running Bus Rapid Transit system. Our vision for the City of Albuquerque is that the ART system will move even large numbers of people dependably without traffic delays. Safe, consistent, timely and reliable public transportation will be available as a very attractive alternative to driving a single passenger vehicle. Such a system will reduce the number of single passenger vehicles in use at those high traffic times, increase the carrying capacity of the street infrastructure, and contribute to the reduction in the use of fossil fuels.

Additional challenges include the demographics of Albuquerque. 17.9 % of the population of Albuquerque is below the poverty level according to the 2010 census data. Persons over 65 years of age comprise more than twelve percent (12%) of the population and that percentage is growing. Twenty-four percent (24%) of the population and growing are individuals under 18 years of age, the tail end of the Millennials. Each of these population groups have a higher public transportation usage rate than the general public.

Aside from the immediate past, when unusually low gas prices have led to the first decline in bus ridership in seven years, ridership has been and is predicted to continue to rise. The current bus service offered requires riders to pay bus fare or display a bus pass previously purchased as they enter the bus through the front doors. During high ridership hours, many people purchasing bus passes causes a long boarding time that puts the bus behind schedule on its route. A bus behind schedule on its route misses connections. A bus that is behind schedule on its route and misses connections is frustrating to its passengers, at the least and can make public transportation untenable at the worst.

Our vision for the City of Albuquerque is that the ART system will serve large numbers of riders. Those riders buy their bus fare off of the bus and enter the bus through any door. As a result, the boarding time for these buses is predictable and swift. These buses have dedicated lanes and have traffic signal prioritization. These buses do not fall behind schedule and are dependable. Bus riders will be able to select which bus to take based on how crowded a bus is; it’s “vacancy rate” will be revealed on the rider’s smart phone app.

Every ABQ RIDE bus and paratransit van is equipped with a modem that broadcasts its location. As you will read below, this communication enables the dispatch function and the automated vehicle locator systems that are available to management and to the general public as traveler information systems. It also provides the means by which Paratransit van drivers are advised of their routes on any given day, and any changes due to re-routing or passenger cancellations that occur throughout the day.

Our vision for Albuquerque is to have ubiquitous Wi-Fi, called a mesh network, accessible by all government entities, including ABQ RIDE fixed route buses and Paratransit vans. That Wi-Fi channel could also be used by first responders, to include the fire department and the police department. It could provide ubiquitous access for building inspectors, permit inspectors, government construction projects, County and Federal users, the University and public school
administrators. Productivity and efficiency would be improved for all those governmental agencies that benefit from connectivity in the field.

Though self-driving vehicles have not to date been the subject of investigation, it would certainly further the vision of the City to provide for self-driving shuttles where it is feasible. The mesh network described above could provide any network connectivity required of this technology without the need for additional network infrastructure.

2. Population characteristics of our City and how they align

According to the 2010 Census data, the City of Albuquerque, NM has 545,852 residents. The City of Albuquerque is comprised of 187 square miles, with a population density of 2,907 persons per square mile. Compare that to the state’s population of 121,298 square miles for a population density of 17 persons per square mile. Albuquerque is the largest, most densely populated of all cities in the state of New Mexico. And the Central Avenue Corridor, which is to be home to the ART system, is also home to 15% of all the City’s households and over 20% of all City employment.

The City of Albuquerque has a public transportation system provided by the City’s Transit Department. The Department operates 160 fixed route buses over 40 routes. Approximately 11,795,088 trips are provided each year. In addition, the Department operates 80 paratransit vans that complete 251,648 trips annually.

We are also home to the Sandia National Laboratories, the University of New Mexico, the Central New Mexico Community College, Innovate ABQ, Presbyterian Hospital and the Kirtland Air Force Base. The populations of these institutions are leaders in innovation and acceptance of new technologies.

3. Existing characteristics of our City and how they align

The City has shown a commitment to making open, machine-readable data accessible, discoverable and usable by the public to fuel entrepreneurship and innovation. In 2014, the City initiated an “open data” policy whereby government-generated data related to transit, as well as air quality, food establishment inspections, police incidents, City budgets, and City expenditures were made available on the Internet. The Transit information made available includes routes, schedules, bus stops, and the real time location of fixed route vehicles. The data is available at the website http://data.cabq.gov.

In order to draw attention to this newly published data and to encourage entrepreneurship and innovation, the City initiated and sponsored a contest to encourage the development of a website and smart phone applications that would access the data published, perform any required manipulation, and provide the general public with palatable presentations of the data.
in a useful manner – as information. The prize offered by the City was $30,000, and the outcome was extremely successful: there were three applications developed for presentation of the transit data alone.

Thereafter, the City continued its efforts to sponsor and encourage the use of the open data for new and innovative development by partnering with the University of New Mexico. The University continues to offer challenges to its students, making the development of applications digesting and presenting the City’s open data a core part of their coursework.
4. Annotated Preliminary Site Map

Preliminary Site Map
Infrastructure Proposed for Smart Cities Challenge
City of Albuquerque, NM

Legend
- Mesh Network
- Transit Centers
- ABQ RIDE Bus Routes
- Public or Tribal Land
- Data Facilities
- Rail Runner Stations
- All-Day
- Outside City Limits
- Traffic Signals
- Proposed ART* Stations
- Peak-Only
- City of Albuquerque
- Proposed ART* Line
- Rapid Ride
- * Albuquerque Rapid Transit (Bus Rapid Transit)
5. Our holistic, integrated approach aligns to the 12 USDOT vision elements

Vision Element #1: Urban Automation
It is expected that the technology for self-driving vehicles, shuttles, and fully automated trucks and buses will mature, making these vehicles accessible for purchase using Federal Transit Administration funds. When that occurs, it is anticipated that a slow and methodical approach to the adoption will occur, with routes on lower traffic volume streets most likely to be enabled first. The City would implement these self-driving shuttles for the Downtown circulator.

Vision element #2: Connected Vehicles
As part of the existing intelligent transportation system used by Albuquerque, each fixed route vehicle communicates its location every 12 seconds with the centralized tracking management system. That system compares the vehicle’s current location with that “estimated” to be the correct location based on the schedule for that route. In that fashion, the system “knows” when a bus is on schedule, ahead of schedule, or behind schedule. That same system is programmed with the points of connection between routes. Mesh networking would enhance the current system and provide for vehicle-to-vehicle communication, made more reliable through the mesh network, specifically to advise a vehicle on route that the connecting route with which it is soon to rendezvous will be late. Depending upon how late that connecting bus will arrive at the point of connection, pre-programmed rules of engagement within the intelligent transportation systems (ITS) can determine if the on-time bus should wait for the late bus making the connection or continue on its route on schedule. This vehicle to vehicle communication is an effort to serve the riding public and allow them to make those connections that can be “modified” based on ad hoc conditions without jeopardizing the entire system schedule.

This solution makes use of existing technology. Deployment would not involve an extensive implementation of new technology by ABQ RIDE and the City, yet would yield a measurable impact for those travelers who today may miss their connection by mere moments. New operations guidelines would be required, as would the rules of engagement regarding the time boundaries of when to “hold” the connecting bus and when to let it go.

Vision Element #4: Urban Analytics
Today, Albuquerque has in place an ITS that identifies each route and the time points along that route. In order to be “on schedule” on any given route, it is known the time that a bus should be at each time point along the route. As a result of ITS equipment aboard each bus, the current location of each bus is known (within 15 to 25 seconds). Because the ITS system has both of these pieces of information, an analysis of the data will reveal if any given bus on any given route is ahead of schedule, behind schedule, or right on time. That data is stored and available for analysis over a period of days, weeks, months, and years. Analysis of that data is used today to evaluate the viability of bus route schedules. Route schedules are adjusted based on data that reveals that a bus cannot traverse traffic at a given time of day to be on time based...
on the schedule. That same data may be used to adjust a schedule when the data reveals that a bus must consistently wait at a bus stop before it leaves, in order to maintain the schedule. That consolidated data is currently used to measure the performance of the transportation network. Given additional resources, that data could be used to predict future conditions based on trends identified, as well as permit the development of potential response plans to those conditions.

This same real time bus location information is displayed at all times in the bus Dispatch Center. Currently under development is an automated “alarm” system to notify Dispatch when routes without schedules (our Downtown Circulator, for example) have vehicles that are “bunching”. Once that information is brought to the attention of a Dispatcher, the driver of the second bus can be instructed to wait several minutes to allow a greater headway between buses. The result is better service to passengers – the circulator really will arrive every 7 minutes, as advertised. This same alarm system can be used to identify a bus leaving the garage earlier or later than scheduled, or returning earlier or later than expected.

The same real time bus location information is available to the Albuquerque Emergency Operations Center allowing a more timely response to demand occasioned by an emergency. The technology which enables this real time data has been shared with the separate transit agency operating the commuter railroad (the New Mexico Rail Runner Express) which has station connections with buses operating within the City. As the Rail Runner implements this ITS technology, ABQ RIDE Dispatchers will have the information necessary to provide drivers of connecting bus routes instructions to ensure those connections are made. In the worst case scenarios, the bus drivers will be able to advise train-bound passengers of the location of the train so the passengers will be better informed (and forewarned if they’ll have a long wait!).

ABQ RIDE is in the process of procuring a smart phone application that will allow passengers to pay their bus fare and purchase their bus passes through their smart phones. ABQ RIDE has recently learned of a technology that works in conjunction with this smart phone app to provide additional data to the agency. For those users who opt in, the app will track the user just prior to his/her boarding the bus and following his/her departure from the bus (until the traveler comes to rest for more than 15 minutes). An analysis of that data will reveal the true starting point of a trip and the true ending point of a trip. That analysis can reveal the true passenger demand of any given route.

Transportation-related performance measures and evaluation will be enhanced through the use of actual data, rather than the limited information acquired through surveys. This data can provide a new depth of knowledge concerning our passengers which opens the door to a variety of analytics heretofore not possible.

Vision Element #5: User-Focused Mobility Services and Choices
Albuquerque is working to provide travelers with real-time information and tools to make travel easier, more convenient, and more comfortable. All of the fixed route buses in the Albuquerque fleet have bicycle racks to accommodate three bikes on the front of the bus. The
RFP for new buses to serve the ART system provide for bike capacity inside the buses. All of the fixed route buses and paratransit vans come equipped with ramps or chair lifts to accommodate wheel chairs. The ART system is designed to have a station floor flush with the floor of the bus, so that bicyclists and wheel chair-bound travelers can wheel directly onto the bus without the need of a ramp or a lift. Albuquerque is focused on making travel easier for all modes of transportation.

Albuquerque has miles of bicycle and hiking trails. In fact, Albuquerque was ranked #17 of all cities in the US as a Bike-Friendly City, receiving a bronze medal in 2013 from Bicycling Magazine. Adventure Cycling Association, as part of its work with the American Association of State Highway and Transportation Officials, has recently added the State of New Mexico to its National Bicycle Corridor Plan, publishing maps of that bicycle path across New Mexico, including through Albuquerque. The City is developing a 50 mile bicycle “circle” within the City that will be functional for both commuter and recreational bicyclist. The ART, in addition to accommodating bicycles aboard the buses, has incorporated consideration of existing and planned bicycle paths into the ART designs for enhancement of the existing roadway and infrastructure. Our vision is to provide for bicycles within Albuquerque to serve as commute vehicles, recreation vehicles, and sightseeing vehicles that gain much greater mobility by being able to use the ART as a means of sub-regional movement.

For those on an extended trip, the National Bicycle Corridor will provide the path. For the short, more spontaneous bicycle trips, Albuquerque offers bikes by Zagster. Zagster is an example of the public/private partnership designed to increase the options for travel throughout Albuquerque. Started in the downtown area, Zagster stations are rapidly spreading on Central Avenue to both the east and the west. Zagster provides users with a smart phone app that allows them to “check out” a bicycle any Zagster location and, once the trip is concluded, “check in” the bike at any Zagster location.

ABQ RIDE strives to provide its passengers with all of the necessary information to make the wait seem short. ABQ RIDE has enlisted the aid of a local entrepreneur to develop a smart phone application that accesses the open data published by ABQ RIDE. The app displays the real time location of all fixed route buses. That same application provides the traveler with the closest bus stops to their physical location, provides the location of vendors of bus passes, provides the schedules of any buses and notifies travelers of any delays or detours. This is the same application mentioned above that displays the bicycle paths in the City. But the most popular use of the application is to see, in real time, the location of a bus on the road. In that fashion, the user can estimate the arrival time of the bus to the bus stop where they stand waiting.

ABQ RIDE collaborated with the University of New Mexico for the benefit of both of their “customers”. UNM wanted to advise students waiting for a campus shuttle as to the location of that shuttle. Also, many of their students ride ABQ RIDE fixed route buses to get to the University from their homes. Coordinating the public system and the campus system was a critical concern. ABQ RIDE worked with UNM to outfit their parking shuttles with the same ITS
equipment aboard the ABQ RIDE buses. UNM built a website, http://wmb.unm.edu, to display real time locations of ABQ RIDE buses and UNM parking shuttles. As mentioned above, this same technology is being implemented on the Rail Runner commuter train system, and will be included in the UNM website. Through this electronic partnership, all residents of Albuquerque have an intuitive website that provides real time information necessary to make travel more comfortable and safe.

For those passengers without a smart phone (though recent studies indicate this is a shrinking minority), ABQ RIDE offers TXT2RIDE, a texting service that does not require a smart phone or data usage. At each bus stop, the bus stop number is displayed on the bus stop pole. Users enter the bus stop number and the route number onto their texting application on their regular cell phone and are instantly advised of the next scheduled departure of the bus from that bus stop on that route. ABQ RIDE is working to affix the bus stop number signs to all 3,000 bus stops in the system.

In the plan for the bus rapid transit system, each ART station is to be equipped with traveler information screens. Those screens will show a map of the area (limited to 2 miles surrounding the station) and show those buses coming toward or leaving the station. In that fashion, those waiting for a bus will be able to track its progress as it approaches. Those hoping to make a connection will be able to see instantly if the bus is arriving or departing. In addition, for those instances when the bus is further away than 2 miles, so it does not appear on the map, there will be a screen similar to those very familiar airport flight departure signs. For each route serviced by that station (or bus stop in the immediate vicinity), the next scheduled departure times will be displayed.

Informational screens to advise the traveling public of any delays or detours of the bus routes have also been incorporated into the ART design. Additional screens will be provided for museums to display upcoming events and exhibits. Non-governmental entities like the Merchant’s Associations and Main Streets could use them for advertising. Neighborhoods will be invited to describe the unique nature of their neighborhood and any upcoming events or sights to be seen. Communication with travelers and advising travelers of local events will be enhanced, both for safety and for entertainment purposes. As stated above, it is our vision to improve the experience for all travelers in Albuquerque.

The same smart phone application that will allow travelers to pay their bus fare and purchase bus passes would also allow the driver of a single passenger vehicle to review his City parking options at his intended destination. All City parking facilities will be listed, and parking spots along the street will be identified. The driver need only park in the selected spot and pay for that parking through the smart phone app. The same smart phone app is used by the parking officers to determine if a car has paid the parking fee; if not, that app, with an associated printer, can issue a parking citation. The driver can use the same app he used to find his parking spot and to pay for his parking (or not!) to pay for the parking citation.
Mesh networking and mobile applications may be the door to integrating all levels and types of transportation systems. It is our vision to enable travelers to use devices already in their possession to conduct business related to all their travel needs using just that device. Travelers will be able to get whatever travel information is required to make their travel efficient and comfortable. The application includes a tool to plan trips throughout the Albuquerque area, identifying the time and distance required if the user is walking, bicycling, or riding in a motorized vehicle. If a bus is the vehicle of choice, the nearest bus stops and schedules are identified. Bus fare can be paid using the application and the smart phone acts as the bus pass media, shown to the driver upon entry to the bus. With automated passenger counters on-line, travelers can select which bus to take based on the “vacancy” rate.

ABQ RIDE has provided these same benefits to travelers utilizing our Paratransit system as well. Once the trip is scheduled, the interactive voice response (IVR) portion of the ITS monitors all rides. For those travelers who have opted in, the IVR system calls the traveler’s phone and describes the trips planned for the next day. This is called a day-ahead reminder call. The traveler has the option to cancel any trips scheduled for the next day during that phone call. The following day, after the completion of all trips scheduled before the traveler’s trip, an imminent arrival call is made to the traveler approximately eight minutes before the van arrives for pickup. If for any reason the van is going to be delayed more than 20 minutes beyond the scheduled time of pickup, a phone call is placed to the traveler to notify him or her of that fact, and to offer to reschedule the trip. In that fashion, each paratransit van traveler is advised the day before and eight minutes before the arrival of the scheduled pickup. The traveler is empowered to cancel the trip during any of those calls, to make it more convenient for the traveler and more efficient for ABQ RIDE.

The same goals of keeping the traveler informed of the progress of the vehicle he’s waiting for is universal – regardless of what provider is operating the vehicle. The vision of ABQ RIDE is to consolidate information from multiple service providers and expand dissemination of traveler information to accommodate those travelers in any part of the state, and on any mode. Any traveler seeking to pass through the state should be able to plan a trip, regardless of the entity providing the actual service. The payment of fares should be simple for the traveler and apportioned to the providers through the back end of a system that is programmed to perform that task totally out of the view of the traveler. Where appropriate, the information could be relayed by screens at the bus/rail station or at other public hubs like convention centers and airports. That same information could be available to travelers on their smart phones or on their cell phones. *Ad hoc* notices could be distributed immediately through those same communication channels, allowing the traveler to rely on only one device to get all of his/her traveling information. To implement this vision, ABQ RIDE must offer the use of the existing technology to more transit agencies in the state. This may require an expansion of the currently implanted technology combined with more universal access to data currently produced by those agencies and not yet publicly available.
Vision Element #6: Urban Delivery and Logistics
The ART has been described above; one of the goals of that system is to reduce single passenger vehicles usage on the main east west thoroughfare through the City. Where a dedicated lane is used by the buses in that corridor, the City is installing protected left turns to cross traffic as well as protected U-turns for access to businesses.

Vision Element #7: Strategic Business Models and Partnering Opportunities
ABQ RIDE has extended an invitation to partner with transit agencies in the State. With federal funding, ABQ RIDE has implemented a system by which buses are tracked real time. That data is published at a publicly available website (http://data.cabq.gov/transit). The intent is to leverage the federally funded resources to benefit transit agencies in the state and the University of New Mexico, which consume the data and publish it to the public, including university students and other travelers. ABQ RIDE has worked with the State’s commuter train system, the Rail Runner, managed by the Rio Metro Regional Transit District, to deploy the same technology on trains and employ the City’s backend system to gather the data and publish it for the same type of real-time reporting as is currently available for the City buses.

ABQ RIDE’s vehicle scheduling system is shared with the Albuquerque Department of Senior Affairs to plan the deliveries of their Meal on Wheels for senior citizens. This application devises the most efficient use of resources for each trip, reducing the time and fuel required to accomplish the goals.

Additional partnering opportunities have arisen between ABQ RIDE and organizations throughout our community. Any Rail Runner (the commuter train, operated by the Rio Metro Regional Transit District) passenger needs only present his/her receipt from that day’s trip on the Rail Runner in order to ride the fixed route ABQ RIDE bus free of charge. ABQ RIDE has partnered with the University of New Mexico and Central New Mexico Community College to make riding the bus more convenient for their students. Both educational institutions apply stickers to the student’s ID badge to indicate that the traveler is a current student at either of those institutions, and the students can enter the bus and show the driver the sticker, and they ride the bus for no charge. Any military veteran who has a Veterans Affairs Healthcare System identification card can ride the bus for free, and qualified veterans with the identification card can ride the paratransit system for free.

Those benefitted are:
- University of New Mexico and their students – fully implemented
- Albuquerque Department of Senior Affairs and the recipients of their Meals on Wheels – fully implemented
- Rio Metro Regional Transit District and their demand response travelers – fully implemented
- Rio Metro Regional Transit District the Rail Runner, and their passengers (for riding the bus for free with a Rail runner receipt) – fully implemented
- UNM and CNM and their students (who ride for free) – fully implemented
• Veterans carrying their U.S. Department of Veterans Affairs Health System Identification card ride for free – fully implemented
• Rio Metro Regional Transit District, the Rail Runner, and their passengers (for tracking the Rail Runner Commuter train) – in development

ABQ RIDE has implemented the Smart Business Partnership to promote the use of alternative transportation (other than single passenger vehicles) among employees of local businesses. This public/private partnership provides discounted bus passes to those individuals who are encouraged by their employer to use the ABQ RIDE bus as their vehicle for the commute to work each day. ABQ RIDE also recognizes those business who distribute pamphlets and informational pieces that describe the use of alternative modes of transportation to improve air quality and decrease traffic congestion in the Albuquerque area. These activities also have the effect of reducing employee use of parking in retail districts.

It is the vision of the City to expand these partnerships and these efforts. As citizens, employers, businesses, and educational institutions make their needs known, Albuquerque stands ready to expand the use of discounted bus passes to encourage use of the bus. The data gathered by the current ITS system is available today at our open data website. Albuquerque would encourage and assist other agencies involved in the movement of people to use the same ITS equipment or compatible formats to enlarge the data store for analysis purposes as well as for distribution to the public and for designing responses to current conditions and trends.

Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles
The City of Albuquerque has created two parking spots, free of charge for electric vehicles, to park and recharge their cars at no cost. This is an effort to encourage and incentivize citizens to adopt electric vehicles and to allow the City to measure the interest in those vehicles. Further, the City has a program that allows for free parking for all zero emissions cars. One needs only provide the City’s Parking Division with proof of ownership of a zero emission car, and the City will provide a decal to be affixed to the car that entitles the driver to park free of charge in any on-street parking spot owned by the City. In this fashion, again, the City is encouraging the use of zero emission vehicles.

The City is currently seeking expertise to advise the City in its evaluation of existing fixed route service for conversion to a battery powered fleet. That evaluation will include: modification of the bus maintenance shop locations currently in use to maintain and store the vehicles; adding the infrastructure for recharging the vehicles; and adding photovoltaic solar panels at the facilities to supplement the electrical requirements attributable to the recharging needs of the battery powered fleet. This same expertise can assist with the discussions with the local power company to examine the opportunity to create a smart grid to service the infrastructure required to properly service road electrification.

The vision of the City is to encourage the adoption of electric and hybrid vehicles. The benefits include the reduction of carbon emissions, but also improvements to the electrical grid system that will have even farther reaching benefits. The increased use of photovoltaic solar arrays
benefits not only the transportation needs, but the electrical needs of the entire City. Wireless inductive charging technologies will benefit not only the ABQ RIDE vehicles, but could be made available to private vehicles equipped to utilize them.

Vision Element #9: Connected, Involved Citizens
The City of Albuquerque is engaged with its citizens and encourages their involvement is many circumstances. The 3-1-1 Citizen Contact Center, initiated in 2006, created involved citizens. All manner of City communication is now initiated through a single, short phone number. That system was expanded to include Internet-based access to the same feedback process with the launch of See, Click, Fix and ABQ311, a website and a smart phone application. Citizens are enabled 24 hours per day with a self-help channel to stay connected and involved, communicating with their City.

The City sponsored a competition among its citizens to develop applications, including mobile applications, which use open data for the benefit of its citizens. The competition was highly publicized and the winners were rewarded. Those applications rely on the open data published by a variety of City departments and now benefit the citizens by providing that data in easy to consume applications. ABQ RIDE champions the use of the open data showing the real time location of the buses and has provided the data for several applications benefitting its riders. Those applications provide riders with route schedules, location of bus stops closest to them, and the real time location of buses on the routes that interest them.

The wide variety of data now published by the City has given rise to other applications which benefit the citizens of Albuquerque. Pollen count data is published, as is annual vehicle emission measurements dating back to 2004. Building permits, business registration, food and swimming pool inspections are all available on-line. Albuquerque is a popular place to film movies and TV shows. The locations of those filming events are published. Some folks want to travel to those locations; others want to avoid those locations. By publishing the data and making it available to the public, the citizens can successfully fulfill their desires.

Our citizenry is connected with the Transit Department through those smart phone applications, the website developed by the University of New Mexico showing the real time location of the buses, our own website which provides schedules, notices of detour, holiday hours of operation, and a plan-your-ride tool. In addition, ABQ RIDE has 1,457 followers on its Facebook account and 1,024 followers on its Twitter account.

Vision element #10: Architecture and Standards
Google has created the standards for publishing transit information in a format that will allow them to import the data and display it in their wildly popular Google Transit application. ABQ RIDE has been publishing its routes, schedules, bus stops, and route trace maps in accordance with those standards for years. That data is available to Google, but also to the public at the Albuquerque Open Data website (http://data.cabq.gov). For all data published at that open data site, Albuquerque includes in each category subdirectory the documentation required to know the source and format of the data contained therein. In this fashion, any consumer of the
data is apprised of the history and source of the data, the frequency with which the data is refreshed, the “owner” or producer of the data, and many other facts concerning the data that may be relevant for the application developer or analyst using that data.

In addition to compliance with the Google fixed route transit standards, ABQ RIDE has published real-time reporting location of the vehicles. As with all data stores at the open data site, this data includes the documentation of the format and standards of the data. This documentation has been used by other agencies in the area to publish their data for dissemination and display to the public just as the ABQ RIDE data is displayed. More agencies are planning to use those standards for publishing their data.

Albuquerque’s vision is to continue to leverage the ITS equipment and expand the network of agencies publishing their data. This data is available for use by any app developer and the apps developed are not limited by geography. The real-time data available to the traveling public could easily cover the entire state and the process could be replicated across the nation.

Vision Element #11: Low-cost, Efficient, Secure and Resilient Information and Communications Technology (ICT)

Those computers upon which the real-time data is dependent are duplicated with a fail-over system so that if one computer or set of computers fail, the failover computer or set of computers will begin to operate to prevent a prolonged outage. Our riding public has become reliant upon the information we provide. That data is consumed by the public through the UNM web page (http://wmb.unm.edu) or through our smart phone applications or through our texting application (TXT2RIDE). When that data is not available, we are quickly advised of its absence. Because of that reliance, we are loathe to have that data not available. We have implemented a variety of monitoring systems that notify the ABQ RIDE IT staff immediately if ever the system stops updating. This fail over and backup and disaster recovery system protects the computers which process the raw data transmitted by the buses and vans, and publishes it to the data store at the open data site.

The data store at the open data site is also backed up and stored; it is replicated within the Transit computer domain and again within the City’s computer domain. Any outage is rectified using either of those sources. This methodology complies with IT standards and is affordable, adaptable, efficient, secure, and resilient. Rather than distribute the data to all those interested, the data is stored in an accessible location so that there is no need to consume bandwidth or person power for that distribution. This “pull” process is far more efficient and timely than a “push” process.

ABQ RIDE protects the privacy and security of drivers by protecting their identities from widespread publication. The driver’s identity is not published with the real-time bus location as delivered to the public in the smart phone app or the website. Those identities are displayed on the internal presentation of the information for the sole purpose of management.
Personal Identifiable Information (PII) is collected for purposes of qualification for the on-demand transit services with the paratransit vans. That PII is accessible and used only for those legitimate purposes of documenting the passenger’s qualification for the service.

The City has installed three ticket vending machines, which are available twenty four hours each day at our park and ride locations. For the convenience of our passengers and as part of the ART project, the City will install an additional 50 ticket vending machines, two at each of the ART stations. The credit card transactions processed through the ticket vending machines are 100% PCI compliant, with the City storing no credit card information.

The City is in the process of instituting a new smart phone application that will allow riders to purchase their bus fares on-line, using a credit card and their smart phone. That same smart phone application will allow travelers to pay for their parking at City owned parking garages and on street parking with a credit card. This application, also, will be 100% PCI compliant. The phone application will store no personal information for the sake of security for the user.

Albuquerque’s vision is to enable its citizens to conduct business with the City through devices the user already has in his/her pocket, without fear of identity theft or credit mishap. For those individuals without use of a smart phone, the same confidence should apply to purchases made at City-owned vending machines selling bus passes. Any account associated with the smart phone application will be stored “in the cloud” by the smart phone application developer under strict security measures. It is resilient and guaranteed to be available 99.9% of the time. It is PCI compliant, which requires tokenization and encrypted servers. The vendor is PCI-DSS Level 1 PCI compliant.

Vision Element #12: Smart Land Use

The Central Avenue corridor is the City of Albuquerque’s primary east-west corridor serving sub-regional transit needs on either side of the Rio Grande River. It is the oldest and best developed transit corridor in the state. 15% of all households in the City are within about 1/2 mile of either side of Central Avenue as are 23% of all jobs in the City. The three routes serving Central Avenue carry about 42% of all transit ridership. Thirty-two of the 38 other fixed routes serving the City intersect with Central Avenue.

Along this corridor are the University of New Mexico and the Presbyterian Medical Center. It is a short distance from the corridor to additional medical facilities and the Central New Mexico Community College. Old Town, the BioPark, Nob Hill, Downtown, City Hall, our Convention Center, and many other popular destinations are within easy reach of this corridor.

The ART system is planned to cover the central nine miles of the Corridor with fully-developed Bus Rapid Transit facilities. The same buses would then leave the constructed corridor and continue to a major transit park and Ride by a major commercial and shopping district to the north of Central Avenue and with Tramway Boulevard, the major thoroughfare on the furthest point to the east of the City, and to the major thoroughfare and park and ride facility at the
western end of the City. ABQ RIDE is working with neighborhood and merchant associations, other City Departments (including traffic control, street design and maintenance, Planning and Economic Development), utility companies, the University and individual businesses along the corridor. The goal is to improve the pedestrian experience, the bicyclists’ experience, and the motorists’ experience all while enhancing dependability for users of public transit. Those improvements include landscaping, widening of sidewalks, improved safety of roads and crossings, and a more appealing living and business environment in the immediate vicinity of the corridor. ABQ RIDE has sponsored meetings between business owners, land owners, commercial and residential real estate associations, and business opportunity consultants to explore the potential for improvements along the corridor. Many opportunities are already blossoming through the planning process.

The ART system will bring a variety of traveling improvements along the corridor. Stations will be well – lit and provide shelter from our weather. The buses will, like all BRT systems, provide off-board fare purchase and level-floor loading of the buses. Each station will provide cultural and artistic havens, unique to their location along the route. Traveler information will be available at each station, providing the real time location of the ART buses as well as connecting routes. A Transit App will be available to advise passengers of any last minute detours and delays.

Making Our City Smarter

The City of Albuquerque would install a ubiquitous wireless mesh network for the benefit of transportation, construction, and public safety. Like the network installed in Oklahoma City by the Tropos company (see http://muniwireless.com/2008/06/03/oklahoma-city-deploys-largest-muni-wifi-mesh-network/ and https://www.okc.gov/news/2008_06/Oklahoma_City_Wi_Fi_mesh_network.html), the network is to provide network service (currently weak in some places, non-existent in others) to police and fire personnel. It also provides access to the City network for building and food inspectors; for municipal development personnel, and for Transit vehicles. The mesh network provides a wireless connection to the City’s internal broadband network through a series of wireless access points mounted on buildings, light poles, traffic signal poles, and in vehicles themselves. These wireless access points communicate with one another and are connected through wires at different points to the fiber optic cable that currently rings the City and that will be installed down the Central Avenue Corridor as part of the ART system. The architecture is such that failure of any one or several of the wireless access points will not disrupt the flow of data from the furthest points of the network – the data simply finds a different path. It is resilient.

The benefit of this system is that officers will have better access to crime databases and can connect to the video systems installed by any City Department for surveillance and safety. Fire fighters will have access to the most recent information about locations before or during a fire or accident. Field personnel will have access to the same information they can access in their
offices. Broadcasting of real time transit information for travelers will be greatly enhanced – the data will be available not only at all of the bus stations but on-board the buses as well.

How Service Would Be Improved

Currently, the buses broadcast their GPS coordinates to the management server through a cellular connection. Those cellular connections may drop, or the communication may experience lag as a result of poor coverage in parts of town, or in the downtown area as a result of buildings. City-issued smart phones would function using the mesh Wi-Fi network for all data communications, such as e-mail and calendar functions.

The video cameras currently on-board buses or at park and ride locations could be monitored more effectively if the Transit Security Division wasn’t limited by bandwidth restrictions, either on the vehicles or at the park and ride locations. In addition, as stated above, the Police Department can easily access the same video, both at the Real Time Crime Center and in route to the incident if they have continuous access to the broadband network.

This same mesh network would improve the vehicle-to-vehicle communication necessary to coordinate route connections in the event of a delay of a bus. As all buses will be connected to the City’s network wirelessly, and no longer dependent upon a cellular connection, there will be no lag time in the communications nor would there be lost signals. That mesh network would also provide uninterrupted communication for the vehicles to report their GPS coordinates, for the benefit of all of the passenger information systems. Those ticket vending machines currently reliant upon cellular service or poor wired service would also benefit by the constant availability of the mesh network.

ABQ RIDE’s current plan is to provide passenger information at all of the ART stations down the Central corridor. This is made possible because the planned optic fiber will be laid in the Central Corridor next to, and connecting, each station. However, with the advent of a mesh network, any bus stop at any location could have access to the data necessary to provide travelers with the same level of information: show the buses as they approach or depart each bus stop; provide the scheduled departure times of the next two buses at that bus stop for each route; or show any connecting route’s buses as they approach or depart the point of intersection.

6. Risk analysis

There is the risk that the computer systems will fail or contract a virus or be “hacked”. Industry standards dictate the use of a firewall and anti-virus software and anti-malware software. All computer installations have security experts who must be constantly vigilant to ensure the latest updates are applied to those software “guardians” and the latest security standards are met. Albuquerque is so equipped and will continue to manage that risk at a heightened level as
more and more people become more reliant upon the data underlying their applications and the functions to which those applications apply.

The mesh network is installed. All of the buses and the Albuquerque Police Department and the Albuquerque Fire Department and the Federal Agencies and the School district and the Sheriff’s Department rely on the mesh network for all network connectivity. The risk is now greatly increased that if the mesh network fails for any reason, none of these entities will have communication channels.

The mitigation for such a risk is that all of the buses are still equipped with radios, as are most of the vehicles and staff of the other agencies mentioned above. Though not communicating the same degree of data as was accomplished by the mesh network, the radio communications prevent anyone from being inaccessible.

The City of Albuquerque has a robust data center, with physical security as well as the software security outlined above. ABQ RIDE also has data centers at which transit-specific equipment is stored. Both use an off-site backup/disaster recovery site and follow industry standards to equip it and test it. All servers are described and documented in “runbooks” to allow for a speedy recovery in the event of the loss of any server or group of servers. The City’s network was designed with redundancy and the fiber optic cable circling the City provides alternate paths for data in the event of a break in the line.

7. Partners, stakeholders, and demonstration governance processes

- ABQ RIDE has historically partnered with the University of New Mexico and the Central New Mexico Community College. That partnership continues for the benefit of all parties. The institutions get to offer to their students, as a benefit of their enrollment, the opportunity to ride ABQ RIDE buses as their commute vehicle at no additional charge. The students benefit by using the bus rather than incurring the cost and the risk of driving a single passenger vehicle. ABQ RIDE benefits by increased ridership and the “training” of a large pool of citizens to ride the bus as the best alternative to single passenger vehicles. The community benefits by a reduction in the number of single passenger vehicles on the road and a reduction of the attendant congestion and carbon footprint.
- ABQ RIDE is further working in close concert with the University of New Mexico in the City’s effort to install optic fiber cable down the Central Avenue corridor as part of the ART project.
- The City is seeking an expert consultant to guide it in its effort to develop a smart grid and photovoltaic solar installation to accommodate the needs of electric vehicles as that fleet grows in ABQ RIDE and in the community at large.
- ABQ RIDE is partnering with the Parking Division of the City to design and acquire a smart phone application that will allow travelers to use the City’s parking spaces and the public transportation system through a single application. Travelers benefit from the use
of a single application with a single payment event. The Parking Division benefits through the installation of a convenient, useful parking fee collection system, integrated with an enforcement system. ABQ RIDE benefits from the additional convenience granted to its passengers, allowing off-bus fare purchase and quicker boarding times.

- ABQ RIDE is working to bring together vendors to integrate that bus pass purchase application with the passenger tracking application described earlier in this response. The additional data will provide ABQ RIDE with actual trip start and finish points to suggest and justify route changes. These changes benefit the travelers.
- ABQ RIDE currently partners with the Albuquerque Department of Senior Affairs, the Rio Metro Regional Transit District, and the University of New Mexico by making its CAD/AVL and route scheduling software available to them. The benefits include making the real time location of buses available to students and all other travelers, making the delivery of meals to seniors more efficient, saving time and resources, and putting in place the pieces necessary to ensure bus to bus and bus to rail connections are met, despite occasional delays by one vehicle or another.
- ABQ RIDE will continue to work with the vendor of equipment used to provide transit signal prioritization to the ART buses. Currently offered by vendors of this type of equipment are all of the pieces necessary to determine the geographic location of the bus at any given moment in order to determine when to trigger the prioritization request. ABQ RIDE will work with the vendor to develop a system that uses the real time geographic location of the bus already documented to trigger the request for signal prioritization. The goal of such an effort is to reduce the footprint of the required equipment aboard the bus, reduce the complexity of the calculations required of that equipment, and to leverage the data that is already available for so many other uses.

## 8. Existing transportation infrastructure

The Albuquerque region has a broad range of existing transportation infrastructure, with several recent additions of shared-use mobility services. The area has 547 lane-miles of interstate highway and 1,920 lane-miles of arterials; with local streets the total network includes about 4,200 lane-miles of roads. As described previously, the City of Albuquerque operates fixed-route bus service (40 routes) carrying about 12.5 million passenger trips per year, as well as paratransit service providing over 200,000 trips annually for people unable to use the fixed-route service. The region’s 96.5-mile commuter rail line, operated by Rio Metro, provides over one million passenger trips per year between Albuquerque, Belen to the south, and Santa Fe to the north, with average passenger trip lengths of about 45 miles.

Shared-use mobility services have broadened considerably in recent years. Two car-sharing companies, Zipcar and Enterprise Carshare, have provided services for several years. Likewise, ABQ RIDE has provided ridematching services for over 15 years. In two major additions to shared-use mobility in Albuquerque, Uber began providing its ride-sharing service in 2014, and a public-private partnership organized by Downtown ABQ MainStreet introduced a bike-share program in the downtown area in 2015.
A variety of ITS services are provided in the Albuquerque region, supported by a diverse and growing infrastructure. Currently underway is a major project to build a new Transportation Management Center (TMC) that will be the first in the region to house multiple-agency transportation operations in a single co-located facility. The Center will consolidate monitoring and transportation management activities across jurisdictional boundaries, including reporting of speeds and travel times during peaks, adaptive traffic signal control and flow enhancement systems, coordination of emergency response for traffic incidents or other hazards, and reporting of hazardous travel conditions such as inclement weather, crashes, or construction-ahead notifications. Already in place are dynamic message signs and video surveillance cameras on major roadways. The region has begun use of adaptive signal control, with an initial installation on one of the corridors leading to one of Albuquerque’s bridge crossings. ABQ RIDE has implemented ITS technologies most visibly with publicly accessible, real-time vehicle information and alerts for service disruptions, as outlined above.

9. Albuquerque’s data stores

- Fixed route transit data, in the Google-prescribed format (gtfs)
- Real time fixed route bus locations of all ABQ RIDE buses
- Real time bus locations for all UNM parking shuttles
- Real time Rail Runner train locations (currently limited to 1 locomotive)
- Daily air quality index, vehicle emission levels and pollen counts
- Building permit applications, the location of filming crews, the results of food inspections and pool inspections
- The contact information for police area command centers and crime statistics
- Locations and information regarding bike paths, public swimming pools, golf courses, parks, open spaces, recycling drop off locations, and many other public services

10. Existing standards, architectures and certification processes for ITS

The City of Albuquerque and ABQ RIDE maintain their IT infrastructures pursuant to best practices for the industry. The equipment is housed in environmentally controlled environments with physical access restrictions. Networking and software security are also constantly monitored, pursuant to industry standards. Backup and recovery are in place, as is a disaster recovery site, including all of the run-books and procedures required to restore outages in a timely fashion.

Data storage is properly secured, including all Personal Identifying Information. The data published to the City’s open data site meets the general transit format standards. All data pools within than open data website include documentation to describe the source and content of each data set.
11. Goals and objectives

Ridership is the historical approach to measuring the success of the transit system, however ridership is typically impacted by the cost of alternative transportation. Historically, ridership tends to increase as the cost of gasoline increases, and decrease if there is ever a drop in the cost of gasoline. But ridership may also increase as a result of better, more convenient service offerings. Albuquerque would measure ridership to indicate a relationship of improved satisfaction with the ART system and the bus fare purchasing app.

If route changes are suggested by the data collected to the smart phone app regarding real trip initiation point and real trip destination, ridership data would also be indicative of a system more responsive to the needs of the travelers.

The Parking Division will measure the use of the smart phone app as it applies to paying for parking spots. The Parking Division will also measure the use of the smart phone app as it applies to paying for parking citations.

ABQ RIDE passengers have historically called the 3-1-1 Citizen Contact Center to get information regarding the scheduled time of arrival of a bus at a specific bus stop. Albuquerque has measured the impact of the current smart phone application, the UNM WMB website, and the TXT2RIDE application by the reduction in calls to the 3-1-1 Contact Center. There is a correlation between the increased “hit rate” to the UNM WMB website and the use of the TXT2RIDE application and the number of calls placed to the 3-1-1 Contact Center for Transit information. The smart phone application provides us with the number of downloads of the app from the application distribution sites, but does not provide us the number of uses of the application. A new smart phone application would provide that information. ABQ RIDE will continue to monitor the use of traveler information systems to determine the correlation between their use and the use of the 3-1-1 Contact Center. In addition, the number of bus passes sold by the smart phone application will be measured; its impact on the sale of bus passes from other sources will be evaluated.

12. Evidence of capacity to perform

There are few impediments to the City’s ability to perform as described herein. With the introduction of each new technology, the City has embraced the opportunity to utilize it for the benefit of its citizens. Dating back to the implementation of the 3-1-1 Contact Center to engage our citizens, and continuing through the implementation of the smart phone application, the development of the websites (both for Transit information and for additional channels for the 3-1-1 contact center) and now to the intended implementation of the bus rapid transit system specifically geared for Albuquerque, the City has been at the forefront of innovation and adoption. Those visions identified herein require only available funding and willing partners to see them through to fruition. Many of the projects are either underway or in the planning stages, awaiting available funding.
Except for the driverless bus technology, none of the technologies associated with the visions identified herein are theory only and merely on the drawing board. In each instance, the technology required to fulfill the vision is tried and true and available in the market place today. In most cases, ABQ RIDE has consulted with vendors in the industry and determined that they are available to compete for the opportunities presented by these goals. Additionally, ABQ RIDE has experience in leading vendors to developments, enhancements, and innovation with their products not foreseen at the moment of implementation. As a result, the technology that is today could bring these visions to fruition could be enhanced to further the goals of the Smart City Challenge beyond even what is foreseeable today.

13. Opportunities to leverage Federal resources

ABQ RIDE implemented an ITS system to improve the management of buses on fixed routes. The implementation was made by possible through Federal resources. Since that time, ABQ RIDE has leveraged that implementation for the benefit of far more than the management of buses. It is from the data pool generated by that system that ABQ RIDE has been able to extract the data to publish its General Transit Feed Specification data (gtfs), used to power the Traveler Information Systems currently in use. The same equipment aboard the buses allows for the publishing of the real time location of buses, also used in the Traveler Information Systems currently in use.

The ITS technology used by ABQ RIDE is being leveraged to accommodate those travelers in adjoining counties (Rio Metro’s Demand Response vans) and those using the Rail Runner commuter train and students at the University of New Mexico and seniors receiving Meals on Wheels. As described above, ABQ RIDE has assisted those agencies in installing the equipment and configuring it to communicate with the consolidation and publishing servers within the ABQ RIDE system. The result is that those agencies are able to utilize the services of those federally-funded systems to display the real time location of their vehicles or to plan the most efficient routes for their deliveries.

The mesh network described above would provide network access to all governmental entities within the geography of the City, which include City, County, State and Federal entities. Further, educational institution staff and administrators could benefit by that access. Within the City alone that would include those Departments that issue permits and inspections, business registrations, public safety, traffic control, and infrastructure maintenance.

Within the City and County and State traffic control systems, leveraging the equipment and expertise occasioned by this award would lead to the improvement of the traffic control management capabilities, occasioned by the connectedness of each traffic signal and the application of new standards and rules.
The Smart City Challenge presents a number of opportunities for leveraging funds and capitalizing on synergies between projects. Albuquerque is one of nine cities chosen to participate in Living Cities’ initiative to foster innovation in cities. That designation makes Albuquerque potentially eligible for future private grant money to help make innovative projects possible. With Living Cities’ emphasis on the well-being of low-income people, Albuquerque’s proposal to use Smart City Challenge funding for improving public transportation could help the City qualify for and receive private funding for complementary improvements.