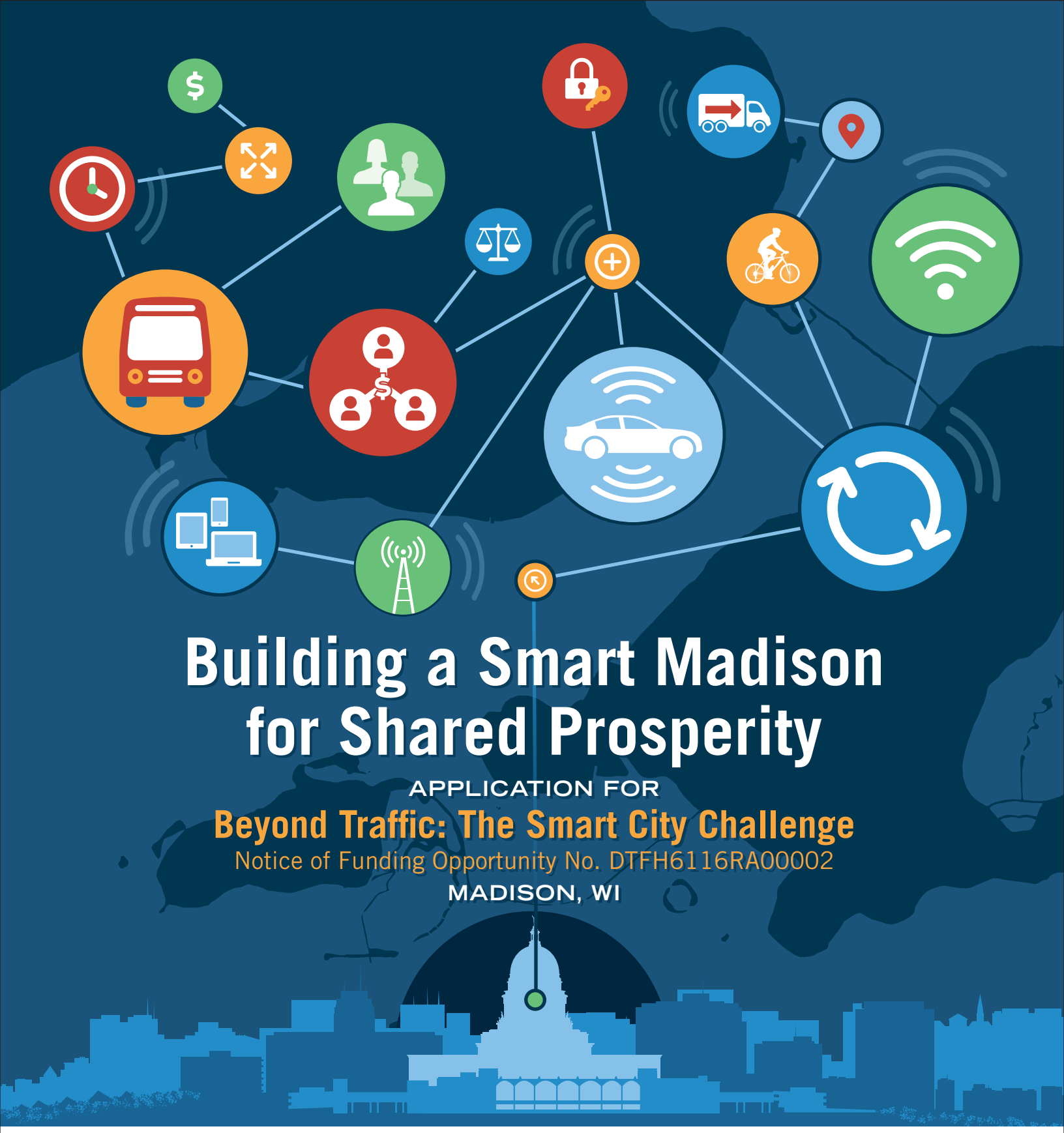

Building a Smart Madison for Shared Prosperity

APPLICATION FOR

Beyond Traffic: The Smart City Challenge

Notice of Funding Opportunity No. DTFH6116RA00002

MADISON, WI

SUBMITTED FEBRUARY 4, 2016

SUBMITTED FOR: DEPARTMENT OF TRANSPORTATION · UNITED STATES OF AMERICA

SUBMITTED BY: CITY OF MADISON · WISCONSIN

IN PARTNERSHIP WITH: WISCONSIN · UNIVERSITY OF WISCONSIN–MADISON

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February 4, 2016

The Honorable Anthony Foxx
Secretary, U.S. Department of Transportation
Washington, DC 20590

Dear Secretary Foxx:

I am pleased to submit the City of Madison's application to the Smart City Challenge. We worked collaboratively with the University of Wisconsin College of Engineering and public and private sector partners to prepare a concept paper that responds to the Department's priorities and addresses Madison's 21st Century transportation challenges. Our plan builds upon a century old regional partnership to address land use and transportation challenges. This mutual effort has developed a vibrant multi-modal transportation system in a steadily growing northern city.

Madison's growth has come with challenges for a community with limited capacity to expand roadways. Constrained by our geography and by an early, and correct, decision to reject a freeway connection through our downtown, Madison has learned to innovate. We built a robust multi-modal transportation system, including our award-winning bike path/bike share network and award-winning Metro bus system. Our franchised taxicab companies serve all our neighborhoods, senior citizens, and people with disabilities on a 24/7 basis. We provide financial support to non-profit rideshare services serving low-income second or third shift workers. We have facilitated the growth of private sector car and ride share businesses. We are an early adopter of IT and intelligent transportation applications.

As one of five Smart City semi-finalists, Madison will build upon this foundation to create a smart transportation plan that utilizes the most modern technology to link our transportation, land use and tax policies. We will manage travel and freight growth with minimally expanded road lanes. We will promote safety among all transportation modes, reduce emissions to protect public health and address climate change, and pursue equitable access and choice for all our citizens.

Thank you for initiating the Smart City Challenge. In developing our concept paper, we have strengthened partnerships and advanced our understanding of the impact that a smart transportation system will have on our community.

The Smart City Challenge will only succeed with a full, uncompromising commitment from the mayor, my staff and cabinet. As one of the five finalists, I will commit City resources to develop a comprehensive and inclusive Smart/Shared Madison plan. If we are chosen for the Grand Prize, I will assume personal responsibility for the success of the project and will appoint a Smart Madison project manager located in my office and acting with my authority. The project will be integrated into city operations, supported by an interdisciplinary staff team and guided by a citizen advisory committee. We will fully engage residents and stakeholders through workshops and social media to learn about and advise the project.

Madison is not afraid of innovation. With the Smart City award, we will approach the creation of a next generation transportation system in a holistic and powerful manner. I urge you to choose Madison's application for the second round of the Smart City Challenge.

Sincerely,

Paul R. Soglin
Mayor

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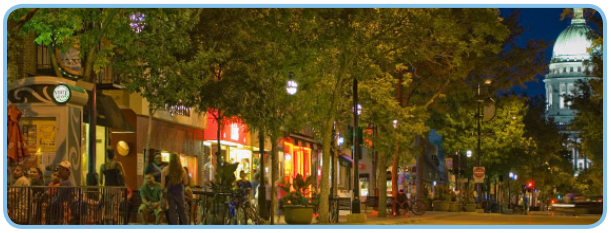
ADDITIONAL PARTNERS INCLUDE:

College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

1. Our Vision: Smart Madison for Shared Prosperity

The City of Madison, Wisconsin, in partnership with the University of Wisconsin-Madison (UW) and a consortium of public and private sector entities, envisions building a Smart Madison for Shared Prosperity. The Smart City Challenge provides Madison a unique opportunity to **deploy a next-generation transportation system encompassing all the 12 vision elements** identified in the Smart City Notice of Funding Opportunity (NOFO) to address the city's challenges and promote economic growth, equity, mobility, public health and safety, and a clean environment.

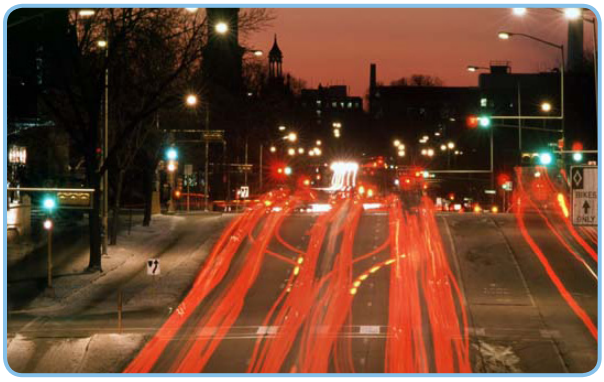


In the words of *Beyond Traffic 2045*, Madison may be "Drifting Toward Gridlock," but we reject that future. **We envision a transportation reality in which versatile, shared data empowers mobility as a service and a more equitable and responsive public transit system**. We envision a future where people have the information they need to make the best transportation choice for each trip, and connections between transportation modes are easy and intuitive. We envision buses that continue to serve main routes, while on-demand autonomous shuttles connect people to hubs and destinations across the city, day and night. A smart, shareable delivery system connects regional farmers and other producers with city vendors and buyers.

Madison offers great promise for more effectively engaging marginalized parts of the community and diverse interests in ways that restore confidence, deliver results to real people, and provide hope for the future. Madison is excited to move towards a safer, more effective, and environmentally-friendly future by providing the foundation for an innovative, equitable, and human-centered transportation system.

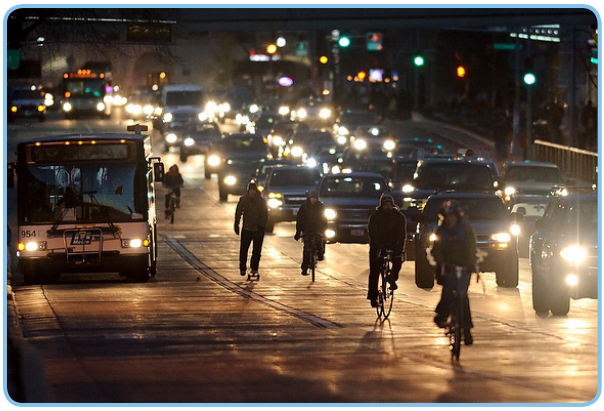
To realize this vision, Madison will leverage its existing extensive fiber communications backbone and capitalize on the synergy between the twelve NOFO elements by developing the **Shared Madison Data Platform (the Platform)**, a **cloud-based, open-source**, data platform that will become the **foundation for deploying, integrating, and enabling all the technological innovations being proposed**. The proposed innovations include **pilots of autonomous shuttles** on the UW and Epic campuses and a wide deployment of **connected vehicle technologies**, including V2I, V2X, **smart bicycle services**, and algorithms for **microtransit service and ridesharing**.

The Platform's open-source nature will allow all citizens, educational institutions, and businesses to contribute information to its catalog and to receive, digest, and design new technologies from its wealth of big data. Madison will become a **living mobility lab** that will evolve, test, and implement *smart* transportation solutions to move people, goods, and services around Madison more equitably, safely, and efficiently. The Platform, shared through the Research Data Exchange (RDE) and Open Source Application Development Portal (OSADP), will enable other cities to learn from Madison's experiences and contribute to a Smart America.



The Smart Madison project will draw for its success upon Madison's progressive leadership, a comprehensive public-private partnership, forward-thinking residents, robust start-up culture, and a world-class university that have turned the city into a hub of economic, social, healthcare, and environmental activity. Equity, opportunity, and prosperity require mobility. Madison proposes aggressively taking on climate change, safety, and public health by implementing advanced and innovative transportation technologies and services.

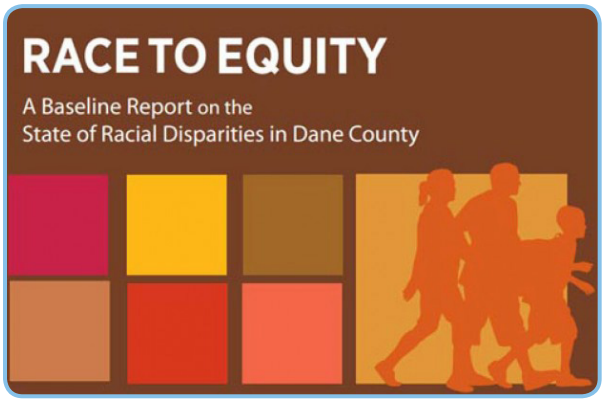
Our Challenges



Madison is a versatile, multimodal, and smart city.

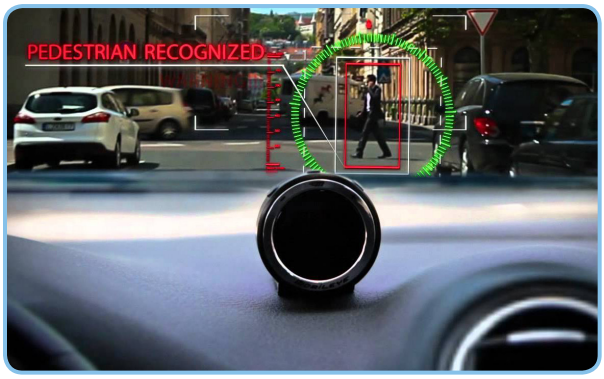
Madison is facing significant challenges in dealing with income inequality, racial disparity, mobility, safety, and the environment. Madison's thriving metro area is the fastest growing in Wisconsin and the second fastest growing region in the Midwest. According to the Wisconsin Department of Administration, Madison is projected to grow from 233,000 people in 2010 to 281,000 by 2040 (an increase of 21 percent), the largest projected increase in total persons in the state. The city faces many challenges, primarily:

Equity: The Wisconsin Council on Children and Families leads a multi-year effort known as Race to Equity, which has found that stark disparities of opportunity exist between Madison's people of color and white populations. Relevant to transportation, the WCCF found that those who live at the periphery or in low-density neighborhoods, often our lowest-income residents, transfer buses three times more often and must commute much farther distances than others. Weekday morning peak transit travel times from areas with concentrations of minority and low-income persons to the primary Madison area employment centers average 42 minutes. Similarly, our senior citizens and people with disabilities are often isolated from access to critical destinations.



Mobility: The city contains a dense, livable, compact, and walkable urban core, but a mix of outlying neighborhoods of varying densities means that a range of modal options is needed. Current transit serves this core adequately, but we seek to improve mobility for everyone more dynamically, in underserved neighborhoods, and at all times of day. Madison is located along a chain of lakes, creating four narrow pinch points. This geography constrains traffic, funneling it from the Beltline and Interstate onto limited arterials connecting to the urban core. Our roadways are challenged by our growth, numerous large-scale events, and four-season weather. The ecological and cultural character of the area combine to cause inherent mobility problems and challenges.

Safety: Madison has a multimodal focus that implemented through a strong commitment to connected and comfortable walking and biking infrastructure; its award-winning, comprehensive bus transit network; and a robust sharing economy, including Trek's B-Cycle Bike Share. In addition, Madison has a large number of pedestrians, mopeds and scooters, and growing transit ridership. As the alternative modes continue to increase, vulnerable road users (VRUs) face increasing interactions and conflicts.



Environment: Recently, Madison/Dane County air quality has approached ozone and fine particle standards. Even though the area has so far avoided non-attainment, those who live near the Beltline and other congested arterials—disproportionately low-income communities—experience a higher incidence of asthma and other respiratory diseases as a result of poor air quality.

Zero-emission Innova Dash vehicles will be utilized on UW-Madison grounds.

Our Proposed Solutions

Madison must innovate as it grows in order to address equity, mobility, safety, and environmental concerns. To handle these challenges, Madison has already implemented ITS measures, and has completed a comprehensive ITS plan for future projects. Existing transportation systems have alleviated some issues, but improvements are uneven. Smart Madison for Shared Prosperity emphasizes that **mobility = opportunity**. Mobility can lead to prosperity, but mobility must be equitable. Below is a summary of our proposed innovations to address the challenges. These are described in more detail and by vision element in Section 5.

- **Intelligent Data Collection, Analysis, and Sharing**
  - Create and host a Shared Madison Data Platform, a cloud-based, open-source, data platform with robust computing and networking, maintaining PII in a secure fashion
  - Study incoming data from all systems delivering data to the Platform to analyze the performance of the transportation network
  - Create an open-source algorithm for ridesharing and microtransit services including for first/last mile needs which will become the foundation to deploy a future driverless vehicle network
  - Create algorithms for real-time processing and sharing of data from probe vehicles, roadside vehicle detectors, Dedicated Short Range Communication (DSRC) radios, Bluetooth, and Wi-Fi detectors to share information
  - Leverage existing partnerships to encourage development and production of Platform applications, including a consortium of taxi providers currently working on sharing solutions
  - Develop smart parking algorithms to share parking occupancy and availability information
  - Support the deployment of a single fare collection system that integrates B Cycle Bike Share, Metro Transit, parking fare collection, and other user services

- Provide the data necessary to find the most efficient, time-saving, and cost-effective routes for truck deliveries into and out of the city center
- The city will incorporate data into real-time transportation system simulations for the city to make informed, relevant decisions

Autonomous, Connected, and Electric Vehicles

- Deploy pilots of EasyMile autonomous transit vehicles for shuttle services on Epic and UW campuses
- Utilize Innova Dash electric vehicles on the UW campus, one of four campuses in the country that is part of the pilot
- Develop a Mobility on Demand jitney service for a selected area to connect users to the bus system with the goal of preparing this system for autonomous microtransit
- Install DSRC Radios at all signalized intersections and railroad at-grade crossings, on all Metro Transit buses, and on select taxis
- Install electric vehicle parking spaces throughout the city with smart chargers connected to the smart grid

Smart Infrastructure

- Expand network of thermal and environmental sensors and couple with new in-situ and remote air quality sensor network to easily quantify environmental effects
- Establish four Adaptive Corridors on primary arterials
- Build a city-owned 4G network and connect all public safety, public works, and transit vehicles
- Deploy smart grid improvements with support from Madison Gas and Electric
- Accelerate the deployment of ITS devices and strategies from Madison Area Transportation Planning Board's ITS Strategic Plan
- Deploy advanced collision avoidance systems such as that provided by Mobileye

Connected Vehicle technology and smart transportation will be optimized with the Shared Madison Data Platform

Our Implementation and Demonstration Approach

The City has assembled a comprehensive public-private partnership to successfully build a Smart Madison. The City of Madison is an early adopter of IT, open data, and transportation innovation. The City will be closely supported by the faculty and staff of world class UW-Madison, experts in engineering, computer science, environmental protections, and public health. UW-Madison has a strong history of collaboration with the City of Madison and brings innovation, expertise, and creativity in cutting-edge transportation technologies, methods, and best practices.

Our partners also include the region's largest private employer (Epic Systems), businesses with roots in the area such as Trek and Propeller Health, and, nationally- and internationally-based technology companies including Leapcraft, EasyMile, Stantec, Cisco, Qualcomm, and Econolite. Public sector partners include Wisconsin Department of Transportation (WisDOT), Capital Area Regional Planning Commission (CARPC), Madison Regional Economic Partnership (MadREP), Madison Area Transportation Planning Board (MPO), and others.

2. Population and Density

Madison's density characteristics align well with USDOT's desired characteristics for a Smart City. Of the 64 cities with desired characteristics identified on the Smart City Challenge website, Madison ranks right in the sweet spot for density, a perfect exemplar of the mid-sized American city. Additionally, Madison's urban core is very dense. Madison was ranked as the #1 most compact and connected medium sized metro area in the nation out of 221 metro areas by Smart Growth America.

The City of Madison contains 58 percent of the population of the urbanized area and the central business district (the Isthmus) contains 22 percent of the city population with a density of 11,257 people per square mile. Adding the constraint of the Isthmus and the dense one-mile corridor between the Capitol and UW, the downtown is a dense, thriving area. Density will only continue to grow as many new high-rise mixed-use buildings are currently being built or are in the works.

Although on the smaller end of the population spectrum, we believe that Madison is uniquely positioned as the city is **"large enough to matter, yet small enough to manage."** This means that the funding from the Smart City Challenge will have a more comprehensive impact in Madison than in larger cities.

Madison By the Numbers

POPULATION	DENSITY (PER SQUARE MILE)	PERCENTAGE OF THE URBANIZED AREA
233,209 people	3,037 people	58%

3. Madison's Characteristics

Madison is a smart and growing city: Madison is the capital of Wisconsin and home to the University of Wisconsin-Madison. From its incorporation in 1856, Madison's economy has focused on state government, education, and the benefits of the agricultural richness of the surrounding region. Madison's focus on research and innovation across a spectrum of industry clusters including healthcare, information technology, advanced manufacturing, and food systems contributes greatly to the community's strength and projected economic growth. During the past decade when other cities experienced significant job loss, our top 25 employers grew employment by 6.4 percent, especially within the health sector, which saw 31 percent in employment gains, accounting for nearly 8,000 new jobs.

Madison is also becoming one of the fastest growing business start-up tech towns in the nation. Nearly 58 percent of the region's population falls within the workforce age range of 20-59, which attracts and retains advanced industries, creative businesses, and a highly innovative workforce. The primary contributor to the growth in the IT sector is the presence of UW with its outstanding engineering and computer science programs. With more than $1.1 billion annually in academic research and development, UW ranks among the nation's top five in research expenditures and patent generation. Epic Systems, the world leader in the development of electronic healthcare records software, also contributes to this growth.

Epic has grown from its small offices on Madison's west side to occupy a major campus in nearby Verona where it employs 9,300 employees. This workforce has had a marked impact on Madison, where the majority of these workers live. Many Epic "spin-offs"

have helped to grow Madison's IT sector. Growth in IT entrepreneurship has also been spurred by the University Research Park, founded in 1983. Since that time, the Park has served more than 125 tenant businesses. Start-up organizations such as 100 State, gener8tor, and Capital Entrepreneurs have supported and accelerated growth of many tech businesses. A bustling makers' space, Sector 67, engages youth and adults in exploring tools and techniques and feeds beginners into the innovation environment.

Madison citizens are engaged, forward-thinking, and connected: Madison residents have always been deeply involved in civic life. Madison's curbside recycling, the first in the nation, was initiated by neighborhood volunteers working in concert with our Streets Department to pick up bundled newspapers. In each decennial census from 1980 to 2010, Madison residents have returned census forms at a higher rate than any other community.

IT and data-sharing: Madison, an early adopter of IT in City operations, began to install fiber optic cable in the 1990s, connecting its facilities, the public schools, and neighborhood centers to the Internet. In 2013, the Madison City Council adopted an Open Source Data ordinance, which allows public data to be transferred and shared among agencies, private sector businesses, and the general public. The City is committed to increasing the amount and range of data available and has solicited public requests for datasets and innovative uses for them.

The Shared Madison Data Platform, which will receive and share information from connected vehicles and individuals, is an extension of this history. As they have done with data currently made available by the City, tech innovators will create apps based on the Platform data. For example, Madison BusRadar, developed and shared by a local entrepreneur, enables Metro riders to see the location of their bus in real time.

Madison supports a multi-modal transportation system: Madison citizens are also committed to supporting our public transportation system. With a service area of 72 square miles including Madison and six adjacent communities, Metro Transit is one of the most successful bus-only transit systems in the United States. In the last 15 years, Metro ridership has increased an average of 3.4 percent annually, now exceeding 15.2 million rides annually. Metro provides 37 trips per capita and ranks 17th nationally in this metric. The system serves six neighboring communities and is set to expand to two additional communities and expand service with UW and Madison College.

Madison maintains more than 100 bicycle and walking trails that cover almost 46 miles of off-street shared use paths and 112 miles of on-street bike lanes. Bicycling mode share was at 5.3 percent as of 2013 and continuing to grow. In 2015, Madison became one of only five US cities designated with Platinum Bike Friendly Community status by the League of American Bicyclists. The city owns and operates all of its transportation systems, providing seamless management and coordination and enabling the city to make responsive changes when needed. Park & Ride can be expanded or adjusted as needed. Downtown parking can be adjusted to accommodate shifting needs of commuters as opposed to retail shoppers or large crowds for special events.

Madison is committed to improving surface transportation through ITS technology: In December 2015, area partners, including the UW, Madison Area Transportation Planning Board (the MPO) and the City of Madison, completed the Regional ITS Strategic Plan for the Madison Metropolitan Area. The goals of the plan include improving multi-agency communication, a multi-modal transportation payment system, enhancing reliability and safety, and providing real time information.

The Smart Madison partnership is long-standing and inclusive: UW faculty and students have assisted the City to develop its Sustainability Plan; have measured City GHG emissions over a decade of mitigation efforts; analyzed public health data to prevent asthma and obesity among Madison children; provided expertise to support worker co-ops; and are developing new approaches to manage urban stormwater as

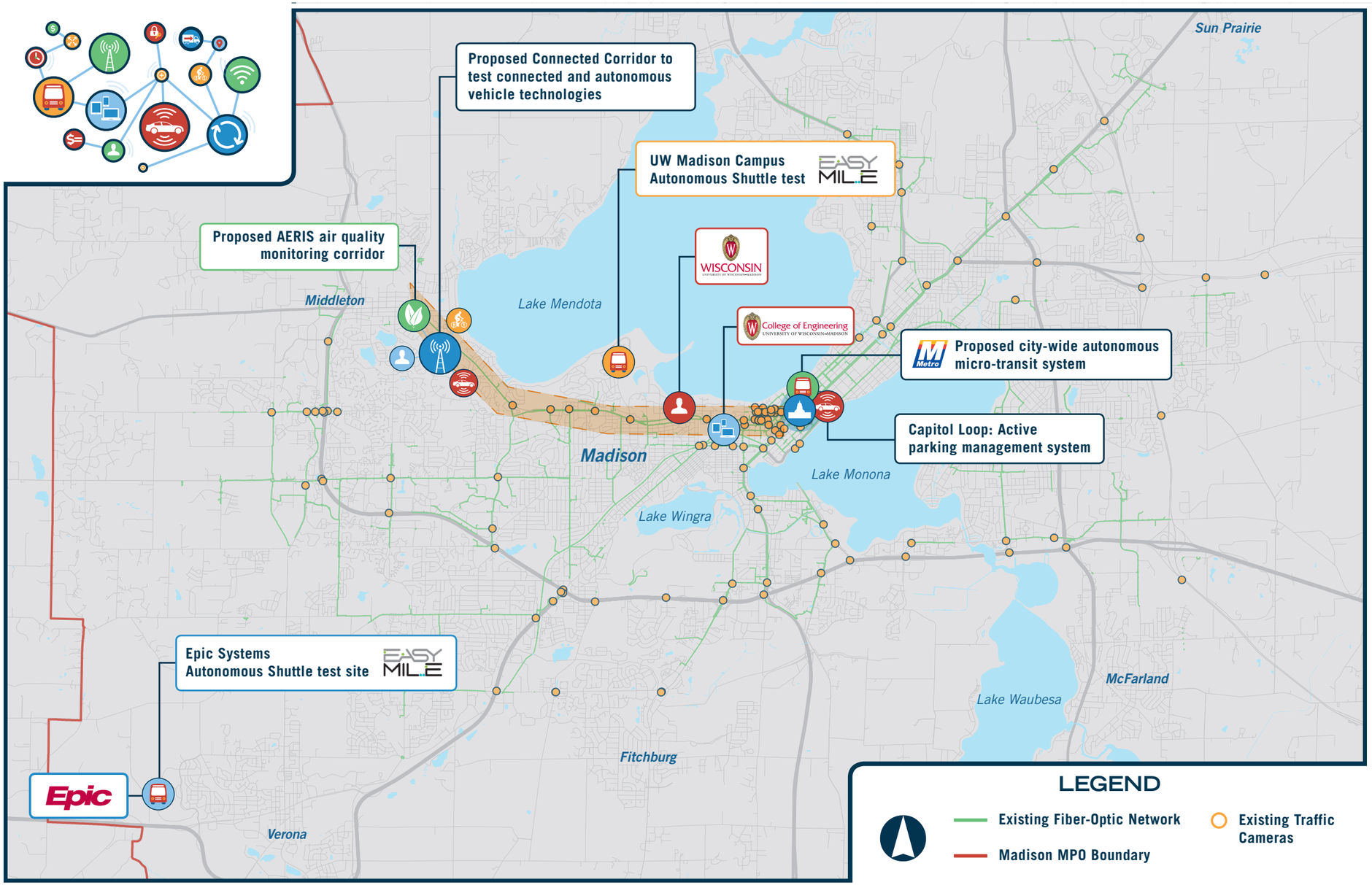
our climate changes. The City and UW are among 21 founding members of the MetroLab, a 2015 White House initiative which calls upon universities and cities to collaborate in using technology to solve urban challenges.

Regional partners include the Capital Area Regional Planning Commission (CARPC). CARPC promotes compact development and re-localization of the region's food system. A Fair Housing Equity Assessment found residents of low-income neighborhoods are more transit dependent, but live in low-density peripheral areas with poor transit connections to employment, school, and shopping. The Madison Region Economic Partnership (MadREP) exists to help grow the economy of Madison and eight surrounding counties. MadREP just received an Investing in Manufacturing Communities Partnership (IMCP) designation in the Agriculture, Food, and Beverage cluster from the US Dept. of Commerce. One MadREP goal is to develop a regional produce aggregation and food processing center on Madison's north side, which the improved urban freight logistics proposed here aims to benefit. Improved urban freight logistics will support this endeavor.

Madison has the capacity and political commitment to succeed: Smart City solutions will be fully integrated into the administration of the city, and the Mayor, who has identified Smart Madison as a top priority, will take personal responsibility for the management of the program. Mayor Paul Soglin has been elected mayor nine times and served three terms as a Common Council member. He was most recently elected in 2015 for another four years and will serve throughout the Smart Madison project development and implementation.

Strategic Partners: *In conjunction with UW-Madison, we have assembled a comprehensive team of public and private partners and stakeholders to develop, deploy, and manage the Platform. These partners will leverage the wealth of information available on the Platform to create equitable and efficient transportation and mobility options and solutions that benefit all people across the city.*

4. Map of Madison's Smart City Vision



5. Approach and Alignment with USDOT Vision

Madison's vision to grow as a Smart City for Shared Prosperity involves the integration of many technology applications to meet the needs of equity, mobility, safety, and environmental concerns as we grow in population. With the size of the city core constrained by the Isthmus, these technologies will allow for the expected growth and help Madison and its citizens improve on all aspects to remain at the forefront of progressive cities in the country.

The main component connecting all of these technologies is the open source Shared Madison Data Platform that will be developed with funds from the Smart City Challenge. All technologies deployed as part of this project will integrate with this powerful, versatile, and broad platform. **The Shared Madison Data Platform will provide the open source information, infrastructure, and accessibility to develop tools to foster a more efficient and equitable transportation system.**

At the core of the Platform will be the data collection from all infrastructure throughout the city and on vehicles in the city. The Platform will include algorithms to process the data in many ways. Some of these are described in this section of the proposal, while the flexibility and openness of the Platform will provide for the development of third-party applications not yet anticipated. Some of the initial applications developed on the Platform will include a ridesharing algorithm that allows members of the public to connect and share rides for mutual benefit, a live map showing current road conditions, and a single-payer system for all transportation modes.

Most importantly, the Platform provides the necessary foundation to deploy and integrate connected vehicle technologies, and will have the capability to evolve to handle driverless microtransit fleets in the future. **Truly, the Platform will be a dynamic and translatable system whose spinoff tools will help address equity, safety, mobility, and sustainability.**

Our technology deployments are listed below and categorized by the USDOT vision element with which they directly align, although many overlap with other elements. The projects are listed separately, but all are pieces to help Madison achieve our overall vision. Wherever the development of software or collection of data is mentioned, it is implied that these would be part of the Shared Madison Data Platform.

Characteristics of a Smart Madison for Shared Prosperity

- Urban automation
- Connected vehicles
- Intelligent, sensor-based infrastructure
- Urban analytics
- User-focused mobility services and choices
- Urban delivery and logistics
- Strategic business models and partnering opportunities
- Smart grid, roadway electrification, electric vehicles
- Connected, involved citizens
- Architecture and standards
- Low-cost, efficient, secure, resilient ICT
- Smart land use

Urban Automation

Using the Shared Madison Data Platform as a data-powered foundation, Madison is preparing for a future driverless vehicle network that will provide equitable transportation access to all neighborhoods. The Platform will begin by using connected vehicles (CV) and sensor data, but as levels of automation in vehicles increase rapidly, the Platform will evolve to support an autonomous fleet within the city. Madison's compact nature and concentration of businesses will allow for future AV systems to be affordable and cost-effective for all citizens.

Partnerships with Epic and UW-Madison, the two largest employers in the Madison region, will showcase pilot autonomous transit projects on their campuses' private road networks. Best practices from these projects will be applied to the future driverless vehicle network. While private autonomous vehicles will not require the Platform's data to function, they will operate more efficiently by sourcing Madison's V2I and V2X data that will provide road information, travel times, and more.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Purchase autonomous transit vehicles that will replace standard shuttle services on corporate and university campuses	Reduce carbon emissions and save people time with autonomous electric shuttles to efficiently move employees and students around large campuses	Partner with EasyMile, Epic, and UW to showcase a pilot autonomous transit project on both Epic's corporate campus south of Madison, the largest corporate campus in the Madison area, and UW's urban campus
Create an open source algorithm for ridesharing and microtransit services including for first/last mile needs which will become the foundation to deploy a future driverless vehicle network	Provide equitable and safe transportation access to all neighborhoods by providing service at all times to areas not served by Metro buses and where trips are not profitable for private microtransit	Partner with city taxi services to pilot test the microtransit algorithm and make data available to private companies such as Uber Make available the ridesharing algorithm to the public and study its usage UW computer science department will develop the algorithm

Connected Vehicles

The Shared Madison Data Platform and the city-wide fiber-optic network will provide the foundation for a CV transportation system. When built, the Platform will include data from probe vehicles, roadside vehicle detectors, Bluetooth and Wi-Fi vehicle detection technology, and environmental sensors. All connected vehicle data will be shared through the USDOT's Intelligent Transportation System Joint Program Office's (ITS JPO) Research Data Exchange (RDE). All CV algorithms and software produced by the city and UW will also be shared on the Federal Highway Administration's Open Source Application Development Portal (OSADP) and will be licensed under Apache 2.0. The goal of this data and algorithm sharing is to allow other cities and agencies to benefit from the results of the Madison study in the future.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Install DSRC Radios at all ~300 signalized intersections in the city	Prepare infrastructure for onset of DSRC radio requirements so that by 2020, we will be prepared for all V2I systems	Partner with Econolite to install DSRC radios at all intersections

Connected Vehicles *(Continued)*

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Install DSRC Radios in all ~200 Metro Transit buses as well as select taxis	Prepare transit fleet for V2V, V2I, and V2X applications and test various applications to improve safety and reliability	Partner with Econolite to install DSRC radios in vehicles Develop software for V2I applications that processes the Basic Safety Messages (BSM) and Signal Phase and Timing (SPAT)
Analyze data as more private vehicles equipped with DSRC and other technologies come online	Monitor vehicles with V2I technologies and provide CVs with I2V information to improve system mobility and safety	Store and analyze data from all CVs and develop algorithms to process and distribute useful elements of the data
Integrate an air quality sensor network into the proposed Platform to easily quantify the effects from all deployed technologies in the project	Capture air quality data to monitor and reduce emissions improving air quality for all citizens	Combine UW's proposed air quality sensor network with the AERIS applications to host a testing ground for air quality analysis

Intelligent, Sensor-Based Infrastructure

Madison is uniquely situated to host a testing ground for AERIS applications with its extensive wireless and fiber-optic network and UW's existing and proposed air quality sensor network. AERIS states that it wishes to generate and capture environmentally relevant, real-time transportation data, and use the data to create actionable, network-optimizing information. With this proposed air quality sensor network integrated into the Shared Madison Data Platform—along with safety measurements and various other inputs—the proposed Connected Corridor will provide important information to AERIS, and will be able to easily quantify the effects of a CV fleet.

The open-source Platform will receive information from constantly changing roadway conditions, will advise CVs about route conditions, and will provide users information about mode choices. With the open data environment, it is further envisioned that private developers will leverage the data to develop mobile applications that may enable mobility.

Pairing ITS infrastructure with vehicle technologies, such as Mobileye's tracking system, will enhance Madison's transportation network.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Establish four Adaptive Corridors on primary arterials by deploying Bluetooth and Wi-Fi sensors as well as adaptive traffic signals and collect data on travel times for cars, trucks, buses, bikes, and pedestrians	Heavy traffic exists on major arterials accessing the core from freeways and heavy pedestrian/bicycle traffic along with vehicular traffic exists on the main arterial passing by the UW campus Adaptive corridors allow for data collection and analysis to improve mobility for all traffic and determine best practices for managing other arterials and collectors in the city	Partnering with LeapCraft and the UW College of Engineering, big data from all corridor sources will be analyzed to measure quality and consistency of data and work directly with the city to integrate solutions

Intelligent, Sensor-Based Infrastructure *(Continued)*

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Build a city-owned 4G network and connect all public safety, public works, and transit vehicles	Improve infrastructure for connectivity so that strong and reliable service is available to all elements of the system, buses Additionally, 4G will be provided on buses and at various locations throughout the city including the Capitol square, parks, and other public gathering spaces	City will install Cisco hardware at key points in the city and the city will manage the 4G network
Add on to proposed ITS infrastructure outlined in Madison's ITS Strategic Plan	Track real-time capacity of buses, live travel times, real-time bike and traffic counts and analyze and share data to improve mobility and safety	Funding will allow for faster integration of all elements in Madison's ITS Plan Data from all elements will be integrated with the Platform

Urban Analytics

The open source platform will provide equitable mobility options to Madison residents and visitors. (Source: GovTech.com)

Data consumers adapting business intelligence practices benefit from the open source data-rich environment, which in turns benefits all end users of the inclusive transportation system. Data from the Platform will supplement existing Maintenance and Construction Management (MCM) practices to assist decision-making procedures on roadway priority improvements, transit funding changes, and non-motorized infrastructure placement.

Existing and future private apps like RideScout and a transportation app currently proposed by the local taxi operators will gather information to provide trip recommendations to users, and the Shared Madison Data Platform will help provide data for these applications. Analytics built into the Platform will help analyze and inform modal choices, provide up-to-date transit information, spawn user-based vehicle sharing possibilities, and list parking locations and availability. In the future, these analytics would help inform CV deployments, establish optimized freight movements, and increase safety across all modes.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Create algorithms for real-time processing and sharing of data from probe vehicles, roadside vehicle detectors, DSRC radios, Bluetooth, and Wi-Fi detectors	Provide citizens, city traffic engineers, and operations centers with real-time traveler information to increase efficiency of travel, allow for smart roadway maintenance, and increased safety	UW-Madison will create algorithms to process the cloud-based data in real-time to be used in various applications
Study incoming data from all systems delivering data to the Platform to analyze the performance of the transportation network including transit systems, freight deliveries, air quality, and connected vehicles	Better understand the efficiency of the transportation network to address issues of mobility and sustainability	UW-Madison and third-party providers will process the cloud-based data from various sources and analyze quality and consistency of data as well as provide performance analytics

User-Focused Mobility Services and Choices

An objective of the open source platform is to advance equitable mobility options for all residents. Apps using platform data may provide information about money-saving trip sharing tactics, safe routes for biking or walking, or upcoming transit choices. Madison's partnership with UW and Trek also will provide bike-sharing and private parking information. In addition, Mobility on Demand services will be initially paired with ridesharing programs, but will eventually be a primary role of the city-backed autonomous microtransit system.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Encourage the development of mobile applications using platform data to provide information about on-demand and money-saving trip info	Sharing data will spur the development of many technologies that will improve safety, mobility, and equity among all modes of transportation	The Platform and the datasets that will be hosted on the Platform will be publicly available and private companies will be encouraged to develop and improve upon existing applications (such as Moovit)
Develop smart parking information sharing algorithms	Reduce the large percentage of traffic that is circulating to locate parking in downtown by providing parking availability information	Install technology in parking garages and meters to integrate with the Platform and encourage the development of a smart parking application
Develop a Mobility on Demand jitney service for a selected areas to connect users to the bus system with the goal of preparing this system for autonomous vehicles	Provide first-mile connections to the bus system to improve mobility	Mobility on Demand services will be initially paired with ridesharing programs, but will eventually be a primary role of the future city-operated autonomous vehicle system

Urban Delivery and Logistics

UW leads the Center for Freight & Infrastructure Research & Education (CFIRE) program, which has been noted as a Tier I University Transportation Center. The CFIRE consortium seeks to make multimodal freight systems to improve economic activity and increase quality of life. Through the CFIRE program and private logistics companies, the Shared Madison Data Platform will be able to receive and transmit vital information that can optimize shipments into and out of city limits. The Platform will support an industry-focused application in which logistics specialists establish shared-use delivery patterns and use smaller local routes for last-mile deliveries, pairing delivery with pick-up to minimize deadhead trips, therefore decreasing the number of larget trucks on the road and reducing greenhouse gas emissions within dense city neighborhoods. MadREP will utilize the Platform to improve food supply chain logistics by helping producers aggregate product collection, processors prepare and package appropriately, and logistics systems deliver final product efficiently to customers.

MadREP Logo

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Install DSRC radios at all rail crossings to collect and transmit train's signal preemption messages to the Platform	Process and share freight crossing data in real-time to mitigate conflict issues throughout the city making it safer for freight companies and citizens at crossings	Partner with Econolite to install DSRC radios at all rail crossings and integrate data into the Platform

Urban Delivery and Logistics *(Continued)*

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Provide the data necessary to find the most efficient, time-saving, and cost-effective routes for truck deliveries into and out of the city center	Save freight companies substantial amounts of time and money, reduce greenhouse gas emissions from large interstate trucks, and form natural "good neighbor" pairings with proximate businesses who share the smaller local trucks for delivery services	Platform will receive and transmit up-to-date transportation related information and supplement existing Maintenance and Construction Management (MCM) practices Partnering with MadREP, businesses optimize their deliveries using an industry-focused application in which logistics specialists establish shared-use delivery patterns and use smaller local routes for last mile deliveries

Strategic Business Models and Partnering Opportunities

The City of Madison will own the Shared Madison Data Platform, but the database and platform infrastructure will be managed by UW-Madison's College of Engineering. This partnership is crucial for the Smart City Challenge, and will ensure the top technology minds are helping develop, maintain, and enhance the Platform. In addition to UW, other public partnerships with Metro Transit and WisDOT will ensure that the Platform receives multimodal transportation information. Various private partnerships will further support and enhance the Shared Madison Data Platform:

- Badger Cab, Madison Taxi, Union Cab, and Green Cab: The private taxi companies throughout Madison will utilize ridesharing data as the Platform is implemented as well as developing a multi-modal transportation application
- Epic Systems: Epic will partner for a pilot project for AVs on their corporate campus before they are launched on UW's campus, then to Madison itself
- Madison Gas & Electric (MGE): This utility company will contribute information about peak energy uses throughout the day. Information about transportation-based electricity trends, such as EV charging habits and road-based sensor usage, will help MGE establish more efficient energy management practices
- Econolite: Their time-tested traffic control products will enhance the Platform's ability to receive and transmit data. Econolite will furnish ITS equipment for the program including adaptive signal systems and detection
- Qualcomm and Cisco Systems: These established technology companies will provide significant technical support, networking equipment, integration, and important analytical data to the project
- Trek: Headquartered in Wisconsin, Trek Bicycles is an important partner to establish crucial connections with their bike-sharing B-Cycle system in Madison. Trek will contribute trip information, station locations, and other data to the Platform so that users may better use the bike-sharing tool
- Leapcraft: The big data problem solvers at Denmark-based Leapcraft will partner with the City of Madison on analytics and environmentally-friendly practices in the data platform
- EasyMile: The France-based autonomous transit vehicle company has developed "last-mile" electric driverless vehicles, and will partner with the City of Madison to deploy their technology on the Epic and UW campuses
- Propeller Health: The mobile app platform company will utilize public health information from the Shared Madison Data Platform. Their mobile application pairs with a Propeller sensor which tracks the surrounding environment and its effect on personal health, asthma trends and COPD status

Strategic Business Models and Partnering Opportunities *(Continued)*

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Leverage existing partnerships to assist with development and production of the Shared Madison Data Platform and applications	Working with partners in the community and nationally to develop third-party applications harnessing data and algorithms from the Platform will create the most comprehensive systems for our citizens	Platform and the supplemental data that will be managed and administered with the technical assistance and expertise from UW Other private and public partners will be encouraged to develop applications
Create new strategic partnerships to contribute and enhance the Platform and applications	Sharing data openly will spur new partnerships that will only enhance the quality of systems provided through competition and creativity	New partnerships have already been formed as part of the Smart City Challenge initiative and partnerships will continue to be formed as the plan progresses

Smart Grid, Roadway Electrification, Electric Vehicles

Madison continues to advance its smart grid and move toward roadway electrification. A portion of the funding would go towards wireless inductive charging implementation that could be supported by existing networks within Madison. These wireless electric charging technologies could eventually be a primary way to charge a city-based electric driverless vehicle fleet. This would lead to electric vehicle charging stations throughout the city and more importantly would allow users to charge their electric vehicles while they shop using an inductive parking space. The loops that are used for inductive charging could then be used for smart parking applications doubling the benefit out of smart roadways. Users would be able to find a parking spot faster and not have to worry about where they are going to charge their vehicle. Madison's winter provides an excellent test for charging technologies because it will put a system through its paces.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Test Innova Dash electric vehicles on the UW campus, one of four campuses in the country that is part of the pilot	Last-mile connectivity causes many bottlenecks on the UW campus and the arterials going through campus. These zero-emission electric vehicles will be piloted on the campus to enhance mobility and improve emissions.	Four vehicles have already been dedicated for trial from a partnership with Innova All data from the trial will be collected and analyzed with the potential of acquiring more vehicles for the campus and other locations where first/last mile issues are present
Install electric vehicle parking spaces throughout the city with smart chargers connected to the Platform	Support the usage of electric vehicles by providing users with convenience and reduce greenhouse gas emissions Connect all charging units to the network to create a smart grid which will reduce energy usage	Expand the City's network of EV parking spaces in existing infrastructure and encourage installation requirements in all new infrastructure Partner with Madison Gas & Electric to install smart charging devices creating a smart grid
Support roadway electrification research leading to the ability to charge a city-based electric driverless vehicle fleet	Support roadway electrification and electric vehicle deployment for efficient energy use Madison consistently has about double the registrations of electric vehicles than the national average and this population of vehicles will be grown and supported	Put financial resources towards wireless inductive charging research and support pilot programs

Connected, Involved Citizens

The City of Madison's Smart City demonstration project has already been and will continue to be guided with the involvement from the public. The City of Madison features one of the most well-educated, technologically-literate, and civically-involved citizenry of any American city.

The public has already been central to the development of this application. Numerous responses were received on a public website [www.cityofmadison.com/smartmadison] created to provide citizens the opportunity to offer comments, questions, and recommendations about their vision to turn Madison into a Smart City and a Shared City. Should the city be shortlisted, it will develop and implement a detailed public outreach plan to receive ideas that will guide the development of the detailed application. The plan will include expanded online engagement, social media, in-person listening sessions, and public workshops with an emphasis on reaching underserved populations.

WiRover
Seamless high bandwidth connectivity on the move

The open-source data platform that the city will create relies fundamentally on the participation and innovation of Madison's citizens. The city will work with its partners to implement a comprehensive marketing and messaging campaign to introduce users to transportation services and mobile technologies as they are implemented.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Encourage the contribution of pertinent feedback and user information on the Platform	Proactively engage and inform citizens at the individual level to enhance overall mobility for all citizens	Develop and implement a detailed public outreach plan to receive ideas that will guide the distribution of data to citizens The city will host Saturday workshops and employ a website and social media exchange on Smart City issues and concepts
Complete the install of UW's WiRover system on all city buses, public safety, and public works vehicles	Provide free Internet service to riders on the city's public transportation system improving user experience Provide a reliable and extensive mobile network test bed for other applications	Partner with UW Computer Science department to install systems and develop software to monitor and improve system Will integrate with the city's 4G system

Architecture and Standards

The City of Madison has a comprehensive and effective ITS architecture that is part of the Wisconsin statewide architecture. By conforming to the local ITS architecture—which has been developed from the national ITS architecture guidance—the Platform and associated systems will ensure interoperability between existing and future ITS elements and system interfaces. The recently-published Madison ITS Plan spells out a systems engineering analysis and compliance checklist. All systems developed as part of this work will follow systems engineering processes and the compliance checklist.

The data platform also will integrate the USDOT Connected Vehicle Reference Implementation (CVRIA) from the National Architecture. Open source data will be used to supplement the CVRIA outputs as CV technologies evolve. The College of Engineering, proposed to manage the data platform, also hosts the Wisconsin Statewide ITS Architecture, and as the Platform is established it will be able to transfer its data and technology to systems elsewhere.

Architecture and Standards *(Continued)*

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Ensure that all projects with federal appropriations follow specific guidance to conform to the regional and national ITS architecture	Create model architectures that are uniform in order to align with a nationwide or broader deployment	Platform will follow data movement practices from regional and national architecture and integrate with the USDOT Connected Vehicle Reference Implementation (CVRIA) from the National Architecture

Low-Cost, Efficient, Secure, Resilient ICT

Security and resiliency are critical to Shared Madison Data Platform. By establishing a city-wide fiber-optic network and eventual 4G wireless network, the city has already taken the first step to develop a low-cost and efficient communications platform. These communication networks will be the secure conduits for data to be communicated to the Shared Madison Data Platform. The platform will be the ideal host for USDOT's prototype Security Certificate Management System (SCMS) technology to maintain cohesiveness between ITS infrastructure and to ensure security for all data inputs. Through partnerships with UW, Cisco, Qualcomm, Epic and others, physical platform security will be established during deployment to ensure resiliency. The concepts proposed here minimize the need for personally identifiable information (PII), but to the extent it exists, the open source platform will maintain PII-related information in an extremely secure fashion. Information will be collected and processed using all USDOT standards including the CV SCMS and other relevant standards.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Robust computing and networking, maintaining PII-related information in a secure fashion	Create practices that advance information and communications technology that is affordable, adaptable, efficient, secure, and resilient	Through partnerships with UW, Cisco, Qualcomm, Epic and others, physical platform and network security will be established during deployment to ensure privacy

Smart Land Use

In conjunction with this effort, Madison continues to pursue smart land use strategies, complete corridor policies, and compact, efficient, and walkable development with its zoning and land use regulations. Data collected from Madison's platform will better inform land use decisions. The State Smart Transportation Initiative (SSTI), housed at UW, will leverage the open source data platform to further their evaluation of the connection between land use and transportation. Land use planning partners include the Capital Area Regional Planning Commission (CARPC), the regional planning and water quality management planning entity for Dane County. CARPC, which in 2011 received a HUD Sustainable Communities Grant, has been instrumental in promoting equality of opportunity as the guiding value of all growth plans.

MADISON'S VISION OBJECTIVE	HOW IT WORKS TO SOLVE CITY CHALLENGES	IMPLEMENTATION
Collect and use data to improve zoning and land use regulations that promote compact, efficient, and walkable development	Create a more connected community by concentrating growth in a compact, walkable and bicycle-friendly way	Data collected from the Platform will be used by the CARPC and MPO to evaluate travel trends, health, and other outcomes, and to guide ongoing land use and comprehensive planning

6. Risks

We anticipate three types of risks that may arise: technical, policy, and institutional. An overarching risk will be ensuring coordination between multiple deployments and stakeholders. To mitigate this risk, the city will appoint an overall program manager whose responsibility will be to coordinate activities and manage risks to program schedule and project delivery.

Technical Risks

Technical risk is inherent with the experimental nature of many of the proposed elements. Security and interoperability between devices, vehicles, and the backend control systems will be one of the biggest technical risks and challenges for the various deployments. Having the right integrators on board at the onset is critical to ensuring interoperability. Using existing standardization in transportation communication protocols will mitigate some of the technical risks, and it is essential that devices deployed in the network be compatible with the latest standards, e.g., National Transportation Communications for ITS Protocol (NTCIP).

All the proposed devices for deployment require a reliable and extensive communication network to transmit data between the field and the Shared Data Platform. To mitigate this risk, the city has already installed a redundant fiber-optic network and is planning to install a wireless 4G network to further connect devices and provide another mode of communication.

RISK	RANKING	MITIGATION/PLAN
Winter conditions	Low	Maintain requirements for field equipment to be hardened to the prevailing environment. To the degree possible, ensure that any construction/ deployment/test is scheduled to not conflict with the winter season.
Unreliable communications	Medium	Install a physically redundant communication system using multiple modes of communication (fiber and wireless). The city has already established an ITS plan which lays out a plan for further redundant communications.
Device interoperability	High	Require ITS devices to use standard communication protocols. The city will monitor USDOT research initiatives into CV standards to ensure that they are using the latest standards as they are released.
Data security and integrity	High	Given that data collected by the system will be made publicly available, architecture and firewalls must minimize intrusion. The data of the CV and AV components will be highly secured and any CV deployment shall be required to have failsafe mechanisms in the event that roadside infrastructure is compromised.

Policy Risks

Madison's commitment to apply for the Smart City Challenge also is a commitment to creating an amenable policy environment for Smart City applications. A pertinent example is Section 3.72 of the Madison Code of Ordinances, which makes explicit the city's commitment to open data.

To ensure that risks are minimized with respect to policy changes that may adversely impact any deployments, the project staff and city senior leaders will engage with WisDOT and other state legal entities to make them aware of the city's plans and the project itself. Current state statutes do not specifically prohibit autonomous vehicles, and the team is working with the Legislature to clarify this next session. Wisconsin has already been exposed to proposed legislation in support of autonomous vehicles and held a public hearing in September 2015. In parallel, testing of autonomous vehicles on certain roads can be done without statute modification, e.g., on the UW or Epic campuses.

RISK	RANKING	MITIGATION/PLAN
Lack of clarifying AV legislation	Low	Pursue clarifying legislation next session. Establish a test corridor for connected and autonomous vehicles. Engage local and state decisions makers to educate them on the Smart City Challenge and the city's plan.

Institutional Risks

With multiple stakeholders in both the public and private sectors pledging support to this initiative, it is inevitable that there will be competing ideas and challenges from an institutional standpoint. It will be the responsibility of the City and program manager to ensure continuity and that each stakeholder and their institution consent to a successful deployment.

RISK	RANKING	MITIGATION/PLAN
Lack of and competing institutional support	Medium	Partner with multiple public and private institutions to limit exposure to the backing out of an entity. Employ a program manager to communicate with and coordinate stakeholders.

7. Partners, Stakeholders, and Governance

A key strength in Madison's Smart City demonstration is the team of entrepreneurs, staff personnel, citizens, advocates, and experts from across the university, private, and public spectrum. The core internal project team consists of the City of Madison, UW College of Engineering, and key stakeholders.

City of Madison

The City of Madison is leading the Smart City initiative to create the Shared Madison Data Platform and implement the supplementary ITS technologies and communications networks in the city. Guidance and governance will be provided by:

- **City Traffic Engineering**, which will be the central coordinator for the development and deployment of the Platform
- **The Mayor**, who will appoint an overall program manager, located in the Mayor's Office, to manage the day-to-day operations of the project
- **The Smart Madison Oversight Committee,** which will oversee the project's full integration into city government and participate in collaborative processes that guide transportation, land use, tax policy, and equity. The Smart Madison project will be guided by a cross-functional staff group, appointed by the Mayor, from the Public Works Improvement Committee, the Plan Team Group, and the Human Services Group. As with all projects, the Smart Madison project will be examined through an equity lens
- **A Citizens Advisory Committee** representing diverse residential and stakeholder interests to advise the project. Members will be appointed from City of Madison Planning, Transportation, and Public Works commissions; Madison MPO; Dane County; CARPC; MadREP; area employers; IT specialists; and citizens-at-large

UW-Madison College of Engineering

UW-COE will take a leading role in technical development of the Platform. Primary agencies will be:

- The **Department of Civil and Environmental Engineering,** including the **Wisconsin TOPS Lab**, holding an advisory role, and providing expertise on transportation systems and technologies
- The **Department of Electrical and Computer Engineering**, providing data and networking design and management
- The **Center for Freight & Infrastructure Research & Education (CFIRE)**—this UTC is a partner on the urban freight and logistics element

Other Key Stakeholders

- **Metro Transit:** Some of the proposed ITS technologies, including Mobileye, will be implemented on Metro Transit's fleet for safety and data collection
- **The Madison Area Transportation Planning Board (Madison's MPO)** will provide coordination with the implementation of this proposal and with the ITS strategies outlined in Sections 8 and 10
- **The Wisconsin Department of Transportation (WisDOT)** will provide support aspects of this proposal that fall under WisDOT's jurisdiction or interface with their systems
- **UW Computer Sciences Department** will provide institutional knowledge and expertise to advise and assist with development of the data platform and communications systems, e.g., WiRover
- **Madison Citizens** will provide input that will be crucial to establishing Madison as a Smart City. To better engage all Madison citizens in this discussion, Madison will hold a series of Saturday morning workshops and will conduct special outreach to underrepresented populations. These will be facilitated learning events during which the Smart

Madison partners will share information about the project and hear from residents and stakeholders about their ideas and concerns for the project. Outreach and learning methods will also include webinars and social media

- **MetroLabs Network**, of which UW is a founding member, is committed to regular knowledge sharing with similar City-University partnerships around the country
- **The UniverCity Alliance** brings together multiple, non-transportation stakeholders to work with Madison on public health impacts and addressing disparities from the Smart City Challenge
- The **Wisconsin Energy Institute**, a nationally-recognized, interdisciplinary research institute is a key resource for the electric grid and energy benefits from the Smart City Challenge
- **Madison Region Economic Partnership (MadREP)**, the lead economic development agency for the eight-county Madison Region will bring together local businesses in support of improving freight and urban logistics
- **Group Health Cooperative**, **Dean Healthcare**, **UW Health**, and other local providers: Facilitated by Madison's Shared Data Platform, improved collection of personal transportation behaviors, including minutes and intensity of active travel and user-specific boarding data from transit, local healthcare companies will be able to provide incentives—in the form of reduced premiums and wellness benefits—which will reinforce transit, biking, and walking

Private Partners

Please see **Section 5** of this application for descriptions of each stakeholder and their partnership role with Madison in the Smart City Challenge.Private partners will include:

- Badger Cab, Madison Taxi, Union Cab, Green Cab
- Madison Gas & Electric (MGE)
- Econolite
- Qualcomm
- Cisco Systems
- Trek
- Epic Systems
- Leapcraft
- EasyMile
- Propeller Health
- Innova EV
- Stantec

We will deploy EasyMile autonomous shuttle vehicles on the UW-Madison and Epic campuses to offer mobility solutions for students and employees.

8. Existing Transportation Infrastructure and System Features

Madison currently has a very robust transportation system. Roadways, sidewalks, and award-winning bicycle infrastructure provide a multimodal network throughout the city. Metro Transit provides numerous options for fixed-route transit, while B-Cycle and Zipcar provide bicycle-sharing and car-sharing options, and Uber and Lyft provide ridesharing opportunities. Madison has the groundwork for Information and Communication Technology (ICT), ITS, and Smart Grid Infrastructure and plans to expand upon this infrastructure.

Existing Transportation and Mobility Options

- Madison has 127 miles of arterials and 21 miles of freeway, including I-39, I-90, and I-94
- Metro Transit has an expansive bus system throughout Madison and surrounding communities, with 62 different bus routes and service on UW's campus. Metro Transit's bus network is largely focused on service to downtown Madison, with transfer points at four different locations throughout the city
- Madison has five park-and-rides with free parking at which passengers can arrive by vehicle and commute on the bus to downtown Madison and the University of Wisconsin
- Metro Transit provides paratransit service for qualifying individuals.
- Shared-use mobility services in Madison include:
  - B-Cycle, with a fleet of 39 bicycle-sharing stations and 350 bicycles throughout Madison. B-Cycle uses GPS and radio-frequency identification (RFID) technologies to track all of members' trips, logging distance, duration, and carbon offset for each trip
  - Zipcar car-sharing service, with vehicles located on the UW campus and in downtown
  - Uber, connecting drivers with passengers seeking transportation. Uber X, for individuals or small groups, is the primary service available in Madison
  - Lyft also connects drivers with passengers. In Madison, Lyft and Lyft Plus are available, which provide two different size vehicles depending on the passenger need
  - There are several taxi and limousine companies in Madison that provide transportation for those living in or visiting the city. These companies are especially important for low-income populations as a supplement to the transit system, bicycling, and walking

Existing Information and Communication Technology (ICT)

Madison's existing fiber network, described earlier, is a central feature of ICT providing the backbone for communications to field infrastructure. In addition to this, here are three examples to help illustrate Madison's ICT strengths:

- Madison is part of Wisconsin's 511 traveler information system, providing travel and road weather conditions on all major highways and key arterials. It includes data interfaces to share information with other systems and can alert registered users about adverse conditions on their route
- Metro Transit provides open data for app developers to identify bus stops, read schedules, and real-time arrival status. Links to known live arrival information phone apps and websites are available on Metro Transit's website
- UW uses a text message alert system to inform students and staff of any incidents on campus. Incidents include weather warnings, campus closures, and safety-related incidents

Current Intelligent Transportation Systems

EXISTING ITS TECHNOLOGY	PROPOSED ITS STRATEGIES TO SUPPORT THE DATA PLATFORM
Field-Based ITS Elements ■ Traffic cameras (83 cameras) ■ Arterial roadway and transit DMS ■ Ramp meters ■ Traffic signal systems ■ Emergency signal preemption ■ Adaptive signal control technology ■ Pedestrian and bicyclist hybrid beacons and detection ■ Speed display signs ■ Road weather information systems ■ Parking management systems ■ System detector stations ■ Bike counters ■ Electric vehicle charging stations	+ Expansion of adaptive signals on 6 corridors + Air quality sensors along highly congested corridors (AERIS applications) + Add about 4 to 5 traffic monitoring cameras a year depending on construction projects + Bluetooth and Wi-Fi detection sensor improvements for evaluating signal timing, Destination/Origin studies and identifying unanticipated delays + Real-time availability of bike racks on buses + Electric vehicle parking spots + Smart parking applications + Dedicated short range communications (DSRC) radios at all intersections and into a subset of Metro Transit bus fleet (buses on major routes) + Install ATC-compliant signal controllers

Vehicle-Based ITS Elements
■ APCs (currently 65 out of 214 buses have APC)
■ Automatic transit vehicle location systems
■ Mobile data terminals/mobile data computers
■ Transit on-board fareboxes
■ Transit on-board video camera system
■ Transit external announcement system
■ Freeway service team vehicles/equipment
■ Electric vehicle charging infrastructure
	+ Add APC to all buses
	+ Add Mobileye's Shield +TM driver assistance safety technology to all buses
	+ Collect data on:
	  ■ Real-time capacity of buses
	  ■ Live travel times
	  ■ Real-time bike and traffic counts

Centers and Center-Based ITS Elements ■ Statewide Transportation Operations Center (STOC) ■ City of Madison Traffic Operations Center ■ Dane County Public Safety Communications Center ■ UW Communications Center ■ Metro Transit Computer Aided Dispatch System ■ Dane County Emergency Management Systems	+ The College of Engineering will manage the open source data platform + City of Madison has budgeted for a new expanded Traffic Operations Center within the smart cities project timeframe + Apply centralized signal priority system for Metro Transit + Incident management communications system to connect agencies

Current Intelligent Transportation Systems *(Continued)*

EXISTING ITS TECHNOLOGY	PROPOSED ITS STRATEGIES TO SUPPORT THE DATA PLATFORM
Centers and Center-Based ITS Elements ■ Wisconsin 511 (phone and website) ■ Metro Transit online bus tracking and real-time schedule information ■ University of Wisconsin emergency notification system (WiscAlerts) ■ Social media (various) ■ Subscription-based services (various)	+ Smartphone applications to support distributing data to the public
Centers and Center-Based ITS Elements ■ Metropolitan Unifed Fiber Network (MUFN) ■ ITSNet	+ Build a city-owned 4G wireless radio system utilizing existing backbone fiber + Complete lateral fiber connections to traffic signals

Smart Grid Infrastructure

MGE is already developing their smart grid infrastructure further and has teamed with the City of Madison to create and expand the EV charging stations available to the public. Currently, there are 27 charging stations around the Madison Metro area. Each charging station is available to use once users download and sign up with the Greenlots application.

9. Data Collection and Data Sharing

By collecting, housing, and making available large amounts of data, the Platform will improve consumer information about transportation options while removing some of the initial expensive step of data collection for entities seeking to innovate or agencies performing transportation projects.

Current Data Collected

The City of Madison collects speed, travel times, and volumes from the extensive loop detector and automatic traffic recorder (ATR) network surrounding the city on state roadways. Traffic and pedestrian counts are regularly done for projects and research studies. These studies are then used to update signal timing and inform investment decisions.

Metro Transit collects automatic passenger counting (APC) data on approximately one third of the agency's buses. This data provides the agency with the capability to analyze ridership and travel patterns at a stop level. Metro Transit also collects automatic vehicle location (AVL) data using a radio data channel. Metro Transit uses this data to analyze the route performance and to provide real-time location information.

The City of Madison has tracked bicycle usage for many years, including using using digital loop detectors, and Madison has recently installed visual bicycle counters. These collect real-time information on the number of bicycles that pass it.

These are just some examples, as the Platform is expected to grow and evolve as sources are added to the catalog. These include data from the existing and proposed environmental sensor network, collecting thermal and air quality data; the city's Bluetooth and Wi-Fi traffic detectors; third party GPS-based

vehicle probe data; and mobility data from emerging strategies to better understand pedestrian and bicycle movements, e.g., cellular signal processing and signal sources already mentioned.

A New Data Frontier: The Shared Madison Data Platform

The city has had a strong commitment to sharing open source data with private and public entities. Section 3.72 of the Madison Code of Ordinances details the city's commitment to open data to "streamline intra-governmental and inter-governmental communication and interoperability, promote efficient solutions for government, advance innovative strategies for social progress, and create economic opportunities." Through this Smart City Challenge, more data and new data types will increase the accuracy and coverage of the current data. Madison's partnership with UW will ensure a completely open source platform of data. If the market demands a new data-driven product or app, data will be ready for a developer to use without access or use limitations.

The City of Madison will use the real-time data to update DMS and inform travelers of congestion along their routes. Non-motorized users will have indications of congestion or problematic biking conditions, e.g., construction or ice. Transit users will also be able to plan their trip and make decisions based on real-time travel information, busloads, and data regarding bicycle loads on buses. This data also benefits Metro Transit operations and service planning, including autonomous microtransit service. Included in this initiative is parking availability at meters and in structures.

In addition to existing environmental sensors is a higher resolution sensor network of digitally connected 'smart' sensor packages, equipped to collect measurements of temperature, relative humidity, wind speed and direction, ozone, carbon monoxide, carbon dioxide, nitric oxide, nitrogen dioxide and particulate mass. Data from the sensor network at scales of tens of meters will be relayed to the data platform in real time, and integrated with vehicle flow and transportation data.

Integration of Transportation Data

As Madison collects additional transportation data, it will be integrated with other functions and services. Public works will be more informed regarding maintenance as they have a greater understanding people's travel patterns. Emergency services will know about crashes more quickly and will be able to respond accordingly. Collected data will be aggregated and managed by the UW College of Engineering on the Shared Madison Data Platform, and will be shared with third-party users via a variety of API formats, e.g., xml feeds. The data exchange interfaces will be standards-based, including the following examples:

- ITSA ATIS Data Quality Guidelines
- SAE J2354 ATIS Message Set Standard
- AASHTO-ITE Traffic Management Data Dictionary (TMDD)
- IEEE Incident Management 1512 Standards
- Applicable State of Wisconsin and WisDOT IT standards
- Location Referencing Message Specification (LRMS)
- The National Transportation Communications for ITS Protocol (NTCIP)

This will allow the data to be easily transferred to anyone who wishes to use it. For public use the data will be more refined in a usable platform with select options for filtering and viewing the data. The majority of the data that is being used will be generated from third-party users creating and distributing applications that are built around a specific task, such as real-time congestion based directions. The City of Madison will also share their open-source data application on the Open Source Application Development Portal and on the Research Data Exchange.

Terms and Conditions for Data Sharing

Madison will maintain its current legal policy regarding the sharing of open data.

10. Systems Engineering for ITS and CV

The proposed ITS and CV strategies will support and supplement the Shared Madison Data Platform and will build off the existing ITS investments in Madison. Once implemented, these technologies will be routinely monitored to improve the quality of the products over time and can be used as lessons learned for other cities to use in future projects and deployments.

Strategic Goals:

- Optimize multimodal transportation systems and services
- Provide and share relevant, timely, and actionable information via the open-source data platform
- Promote safe and efficient emergency/incident response to the public and agencies
- Enhance transportation operational data/ information, communication, and coordination between agencies
- Enable routine, consistent system performance measuring, monitoring, and reporting to improve the quality of the product
- Ensure all new ITS investments conform to the regional and national ITS architecture

Existing Infrastructure

The recently-published Madison ITS Plan describes the existing ITS infrastructure in Madison and spells out a systems engineering analysis and compliance checklist that will ensure that projects adhere to the systems engineering development process and conform to the regional and national ITS architectures. The College of Engineering's wealth of experience and expertise in developing complex systems will be critical to the success of the Smart Madison for Shared Prosperity vision.

The Platform will integrate the USDOT Connected Vehicle Reference Implementation (CVRIA) from the national architecture to establish a powerful foundation for future connected transportation deployments. Open source data from the public, private partners, and the Madison city government will be used to supplement the CVRIA outputs as CV technologies evolve.

A major existing asset to be leveraged by the Shared Madison Data Platform is the city-owned high-speed (1-10 Gbps) fiber optic connections to more than 80 facilities throughout the City of Madison. This includes most of the water towers and radio towers. This fiber-optic network to backhaul data, with the proposed city-owned 4G wireless radio system, would service the entire Madison Metropolitan area.

Determining and Communicating Lessons Learned

Lessons learned in deployment of the proposed strategies will be described through progress reports and can be used as a model for other cities facing similar transportation challenges. The Oversight Committee will lead all internal progress reviews of system performance. Performance measurement during initial deployment of the open source data platform and ITS strategies will accomplish the following:

- Assess the Platform's performance: How well is the Platform collecting and aggregating data to serve agencies, the public, and the private sector?
- Measure and maximize operational efficiency: What can be done to enhance system reliability, and improve data collection and transfer?

11. Performance Measures

The team will monitor the impacts of all aspects of the Smart Madison for Shared Prosperity elements as they are developed and running. The UW-Madison Department of Civil and Environmental Engineering in particular will bring their expertise with mobility and environmental performance management to bear on this. Utilizing the partnerships from the project, several initial impacts will be monitored through the following performance measures:

- Number of transportation-related applications developed from platform data
- Analytical assessment of application usage by companies, members of the public, and the City of Madison
- Geographical usage analysis to identify where applications are being most utilized
- Bandwidth usage of fiber-backed 4G network to assess utilization increases and reach of service
- Before-and-after travel times on Metro Transit bus routes after upgraded and DSRC radios are implemented into major intersection signal systems
- Transit ridership increases and on-time accuracy
- Number of vehicles utilizing connected vehicle technology
- Vehicle counts near high parking demand areas to observe reduction of "circle time" spent finding a parking spot
- Pedestrian and bicycle mobility patterns, with support from our LeapCraft partner
- Air quality assessment in high emission areas to note the positive impacts from transportation network optimization, which includes leveraging the baseline data being collected already by a network of thermal and environmental sensors managed by UW
- Road user mobility metrics including delay and reliability, by auto, transit, and freight, furnished in part by Madison's own detectors and third party GPS probe data providers

Identified Program Goals to Measure

GOALS	OBJECTIVES	IMPACTS MONITORED
Providing affordable, reliable transportation system to all modes	■ Establish framework to deploy CV technology ■ Build framework to deploy driverless technology to CV fleet ■ Execute demographic analysis to identify impoverished & low accessibility neighborhoods ■ Create frequent, affordable microtransit system to reach all communities	✔ Identify number of vehicles utilizing connectivity technology ✔ Note transit ridership increases from on-time accuracy ✔ Analyze accessibility increases from future microtransit deployments
Drastically reduce the number of transportation-related deaths and injuries across all modes, and increasing safety and comfort for all users	■ Rapidly deploy safety-enhancing technologies using platform data to decrease crash rates	✔ Assess decrease rates of traffic-related injuries and deaths ✔ Solicit feedback on transportation system comfort for non-motorized users ✔ Analyze problem points and address issues

Identified Program Goals to Measure *(Continued)*

GOALS	OBJECTIVES	IMPACTS MONITORED
Reduce transportation-based carbon emissions and halting the effects of climate change	■ Optimize signal systems, freight delivery routes and transit systems to reduce systemwide travel time averages ■ Encourage deployment of electric vehicles for CV and future driverless fleets ■ Use environmental information to encourage users to utilize alternative modes, such as walking or bicycling	✔ Using partner expertise, monitor air quality from transportation sources and note decreases ✔ Encourage shared-use freight systems to optimize delivery patterns ✔ Note vehicle counts near high parking demand areas to observe reduction of "circle time" spent finding a parking spot ✔ Assess travel times and stall times at intersections to note decrease in idle-based emissions
Engage citizens, private companies, and stakeholders to help grow the future transportation system	■ Advertise platform to prospective app developers and end users ■ Increase usage of platform-based applications ■ Solicit feedback on app performance, user-friendliness and functionality ■ Encourage companies to market platform technology to benefit the public good	✔ Note the number of platform-based applications developed ✔ Assess the amount that the applications are being used ✔ Analyze bandwidth performance of fiber-backed wireless 4G system ✔ Observe user behavior and opinions towards applications

12. Demonstration of Capacity

Executive Commitment

The Mayor's Office is the leader and initiator of the Smart City Challenge proposal. The Mayor is supportive and committed to implementing the Smart Madison project. Mayor Soglin was recently re-elected in 2015 to a four-year term and will provide sustained leadership throughout the project period.

Infrastructure Readiness and Data Capabilities

The City of Madison, together with UW, has the existing infrastructure and data capabilities to implement the proposed elements, leveraging existing and planned ITS technologies and Madison's expansive existing Metropolitan Unified Fiber Network, a network of 110 miles of fiber-optic connection locations across the city and beyond. This existing network will be used to collect, aggregate, and share data.

Existing ITS Technologies as a Foundation

The ITS field and vehicle elements that will be integral for both disseminating information to travelers and collecting information from the field and vehicles for the Platform include those shown in the table in Section 8, which lists a column of planned and proposed expansions.

UW College of Engineering Data Platform and Sharing

The platform and the supplemental data that will be acquired for the Platform will be managed and administered with the technical assistance and expertise from the College of Engineering, others at UW-Madison, and the private and public partners. These entities commit personnel and resources to the ongoing management of the Platform, including the potential hiring of a full-time platform coordinator.

Workforce Capacity

City staff have been preparing the implementation of managing technology. The City and our partners are prepared with the capacity for ongoing coordination of the demonstration project and maintenance of the Platform. City staff in Engineering and Planning will lead coordination, and the Department of Public Works will manage and maintain field infrastructure deployed for collecting transportation data to be made available on the Platform.

13. Funding Leverage Opportunities

The Smart City grant will build upon and reinforce relevant federal awards to the City. These include TIGER II and TIGER VI Planning Grants, both still open. The first TIGER project, nearing completion, plans a multimodal transit hub to be located within a mixed use Downtown Block. The second TIGER planning project focuses on planning TOD corridors and bus rapid transit (BRT) routes along four Madison arterials. In addition, in 2016, Madison will submit a TIGER project application to support development of a bus garage needed to expand the bus fleet and add articulated buses to expand service to underserved areas and create an efficient BRT system. In 2015, the US Dept. of Commerce designated the Madison region a "Investing in Manufacturing Communities Partnership" area in the Agriculture, Food, and Beverage focus. The IMCP, in place for the next two years, will provide Madison a concierge service in navigating grant opportunities relevant to the designation.

The Smart Cities project will intersect with MadREP to optimize freight logistics between rural producers and the Madison urbanized area. The Smart Cities award will also build upon existing funding for CV and AV research and development underway at UW, and funding from NSF's Global Innovation for Network Innovation that lays critical groundwork for adaptive communication infrastructure to be applied to the elements proposed.

Furthermore, Madison has secured the commitment from various private stakeholder entities. The role of these partners is discussed in more detail in Items 5 and 7 of this application. Letters of commitment are included in our application following this narrative. At this time, partners have pledged to review making financial and in-kind commitments, with details on these to be outlined in our shortlist application during Phase 2.