
***A collaboration between***

the City of Detroit,
the Michigan Department of Transportation,
the Michigan Economic Development Corporation,
the American Center for Mobility,
Mcity,
the University of Michigan,
Wayne State University,
Ford Smart Mobility, LLC
and Deloitte LLP

March 21, 2019 |NOFO # 693JJ319NF00001

Mayor's Office

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March 21, 2019

Secretary Elaine L. Chao
United States Department of Transportation
400 7th Street S.W.
Washington, D.C. 20590

**Re: City of Detroit USDOT ADS Grant Proposal**

Dear Secretary Chao:

For over one hundred years, the brains and brawn of Detroit and Michigan have put the world on wheels, serving as the global center for the auto industry. As the industry pivots towards Automated Driving Systems (ADS), so does the talent in this city and region. The automotive, technology, and mobility research ecosystem in Detroit and Southeast Michigan does not exist in any other part of the United States. This includes the world class testing facilities located at Mcity and the American Center for Mobility, the concentration of talent, including the future Ford Motor Company in the Corktown neighborhood of Detroit, and the real world deployments of ADS the City of Detroit and the University of Michigan have implemented. On behalf of the Michigan Mobility Collaborative, a collaboration between the City of Detroit, the Michigan Department of Transportation, the Michigan Economic Development Corporation, the American Center for Mobility Mcity, the University of Michigan, Wayne State University and Ford Smart Mobility, LLC, we now want USDOT to be part of this immense value chain.

Safety is critical to the future of ADS; this proposal will create a scalable process to evaluate the safety of all future ADS deployments and share data in a way that is easy and transparent, but also protects the intellectual property of those developing the technology. We are also proposing a collaboration with the almost 90,000 seniors that call Detroit their home and the private sector to deploy ADS pilots that improve accessibility for older populations.

ADS technology can benefit millions of Americans. It is imperative the United States remains the leader in not just the automotive industry, but also innovation and the efficient movement of people. We are excited to partner with you and your team at USDOT to make this happen.

Sincerely,

Mike Duggan
Mayor, City of Detroit

| SUMMARY TABLE | |
|---|---|
| Project Name/Title | Michigan Mobility Collaborative – ADS Demonstration |
| Eligible Entity Applying to Receive Federal Funding (Prime Applicant's Legal Name and Address) | City of Detroit (on behalf of the Michigan Mobility Collaborative), 2 Woodward Avenue, Detroit, MI 48226 |
| Point of Contact (Name/Title; Email; Phone Number) | Mark de la Vergne, Chief of Mobility Innovation, dlvergnem@detroitmi.gov, 313.850.3671 |
| Proposed Location (State(s) and Municipalities) for the Demonstration | Detroit, Michigan |
| Proposed Technologies for the Demonstration (briefly list) | At a minimum, L3 ADS on test tracks and real world deployment |
| Proposed duration of the Demonstration (period of performance) | 4 years |
| Federal Funding Amount Requested | $9,926,154 |
| Non-Federal Cost Share Amount Proposed, if applicable | $7,727,284 |
| Total Project Cost (Federal Share + Non-Federal Cost Share, if applicable) | $17,653,438 |

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# PART 1 | PROJECT NARRATIVE AND TECHNICAL APPROACH

Sharon[1], a mother of two and grandmother of four, is from the west side of Detroit and has lived in the Bagley neighborhood for the past 20 years. She loves her neighborhood, is a regular at the Northwest Activities Center, and enjoys volunteering with her block club. However, as Sharon has gotten older, it has gotten more difficult for her to get to community meetings, doctors' appointments, and the grocery store. When Sharon retired two years ago, she decided to get rid of her car because car insurance rates were too expensive, and she could not afford to maintain a car with a fixed income. While Sharon has gotten used to riding the bus, she is limited in the amount of groceries she can purchase at one time, struggles using the bus in extreme weather conditions, and cannot always use the bus to get to her doctor. Sometimes Sharon's children will pick her up and drive her, but Sharon hates feeling like she's a burden on her family. She's noticed that she sees her friends and family less than she used to because she does not like burdening others for a ride, and often does not go to extra events because she hates the hassle of getting around. Two months ago, she skipped a doctor's appointment because she couldn't get a ride and stopped taking her blood pressure medicine because she couldn't get to the pharmacy. Lack of easy to use transportation has inhibited Sharon's ability to live a full and healthy life.

Autonomous driving systems (ADS) hold the promise to vastly improve Sharon's quality of life. From taking Sharon directly to the bus stop, to delivering groceries and medicine, to connecting her to friends at the Northwest Activities Center; ADS will allow Sharon to feel connected and access the basics she needs to maintain her health and happiness.

However, Sharon has concerns; Sharon heard about the ADS vehicle that crashed in Phoenix and is very skeptical of the technology. She would love to have another transportation option to help her get around, but safety is her number one priority and she needs to know that the technology is safe and easy to use.

The safety of Sharon, and the millions of other Americans who could benefit from ADS, is our priority with this proposal.

[1] Sharon is an amalgamation of interviews conducted by the City of Detroit and Ford Smart Mobility, LLC, of the transportation challenges faced in Detroit

# 1. EXECUTIVE SUMMARY

Autonomous driving system (ADS) technology can make transportation safer. And vehicles with ADS can remove transportation as a barrier to opportunity for millions of Americans. But there is still a tremendous gap between where the technology is today and where it needs to be in order to achieve these goals. This proposal will help close that gap by creating the safety, trust, and equity principles that will be necessary for the mass deployment of ADS.

Our efforts will be centered around three pillars: Safety, Data, and Collaboration.

- Creating a replicable process that evaluates the **safety** of ADS deployments today and tomorrow is the top priority of this project. This process will take advantage of the unique ecosystem that exists with Mcity, the American Center for Mobility, Detroit, and Michigan. We will execute a multi-pronged approach to that will achieve the following:
  - Demonstrate safety of ADS in a testing environment before deployment on public roads
  - Build the foundation for a voluntary safety test procedure for ADS through Mcity's ABC testing process.
  - Define data collection and monitor metrics for safe real-time operations
  - Promote faster development of "Event Data Recorder for ADS" for safety diagnosis and analytics
  - Provide and demonstrate a framework of testing and data collection for transparency of the safe operation of ADS, enabling public trust
- We are committed to sharing **data** with USDOT on our deployments and overall findings in a way that is easy and transparent through the following means:
  - Develop and deploy a near real-time data collection system that seamlessly connect the ADS fleet, the road users, and the cloud
  - Early deployment of Verizon 5G and/or edge computing infrastructure for safe and robust ADS deployment--this will first happen at the Mcity test facility and will be deployed at Detroit if appropriate.
  - Explore balanced data policy that promote public safety, privacy, and protect confidential intellectual properties
  - Explore business opportunities of the data system
- Making this technology accessible to all Americans will require a tremendous amount of **collaboration** and will be achieved in this proposal through the following methods:
  - Working with Detroit's senior and disabled populations to better understand their mobility challenges and work with private partners to build the business case for improving their accessibility Michigan cities and AV companies working on policy issues to

develop a series of case studies and "playbooks" that USDOT can use to help municipalities of all sizes across the US.

- Conducting public engagement around the topic of ADS and future mobility with our neighborhoods and creating a playbook around engagement for USDOT
- Ensuring collaboration between our team and all grantees

The Michigan Mobility Collaborative consists of the mobility ecosystem in Detroit and Michigan that has a depth of expertise and experience unmatched in safety testing of ADS and the deployment of innovative mobility pilots. The core team that will support USDOT's efforts in advancing ADS, include:

- **City of Detroit's Mobility Innovation Office** was established by Mayor Duggan to increase the number of mobility services available to all Detroiters. Over the last two years, the team has been lauded nationally on the number of pilots launched, the speed at which they've been accomplished, and the manner in which they've been designed around the residents.
- **American Center for Mobility (ACM)** is a uniquely purpose-built facility at Willow Run which features more than 500-acres and multiple test environments adjacent to the historic Willow Run Airport. ACM is an independent Michigan not-for-profit, public- private partnership. ACM's mission includes validation of connected and automated vehicle (CAV) technology, as well as, accelerating the development of industry standards and education to improve transportation systems.
- **Mcity** is a public-private partnership operating the world's first purpose-built test facility for connected and automated vehicles, the Mcity test facility. More than 5,000 hours of ADS testing have been conducted at Mcity by 20 industrial and academic research teams. The Mcity team also deployed the first Level-4 driverless shuttle project in the United States in June 2018.
- **University of Michigan's Transportation Research Institute (UMTRI)** was established in 1967, UMTRI has developed, piloted and field-tested dozens of driver assistance, collision warning, and crash avoidance technologies, as well as vehicle-to-vehicle and vehicle-to-infrastructure communication. More recently, it has been engaged in the development and testing of ADS of levels 2, 3 and 4. This includes the recruitment of, and extensive data collection from, thousands of participants - including millions of miles of naturalistic data collection from detailed vehicle-based and auxiliary sensor data, management of vast warehouses of both vehicle- and infrastructure-based data, human subjects protection, and protection of personally identifiable information.
- **Michigan Department of Transportation (MDOT)** has been a national leader in enabling the deployment of ADS vehicles. In 2018, they conducted an innovative program called the Michigan Mobility Challenge which awarded $8M in grants to communities and agencies to address mobility challenges among seniors and those with disabilities with new types of mobility services and technologies.

- **Michigan Economic Development Corporation (MEDC)** is the state's marketing arm and lead advocate for business development, job awareness and community development with the focus on growing Michigan's economy. In 2017, MEDC launched the nation's first state government program exclusively focused on developing autonomous vehicle and smart infrastructure investment (PlanetM). In one year, PlanetM has generated 20 new technology deployments across Michigan and attracted over $40 million in new mobility-focused investment statewide.
- **Wayne State University** is a premier University in the heart of Detroit that creates and advances knowledge, prepares a diverse student body to thrive, and positively impacts local and global communities.
- **Ford Smart Mobility LLC, City:One** uses a community-centered design approach to collaborate with community members and other stakeholders in the design, development and piloting of mobility solutions are desirable to the community they serve, technologically feasible and financially viable.
- **Deloitte Consulting** will serve as the project management office and bring their wealth of experience around autonomous vehicles, new mobility systems, and the management of data in the cloud.

We envision a four-year timeline with work plan and milestones shown in Figure 1 below.

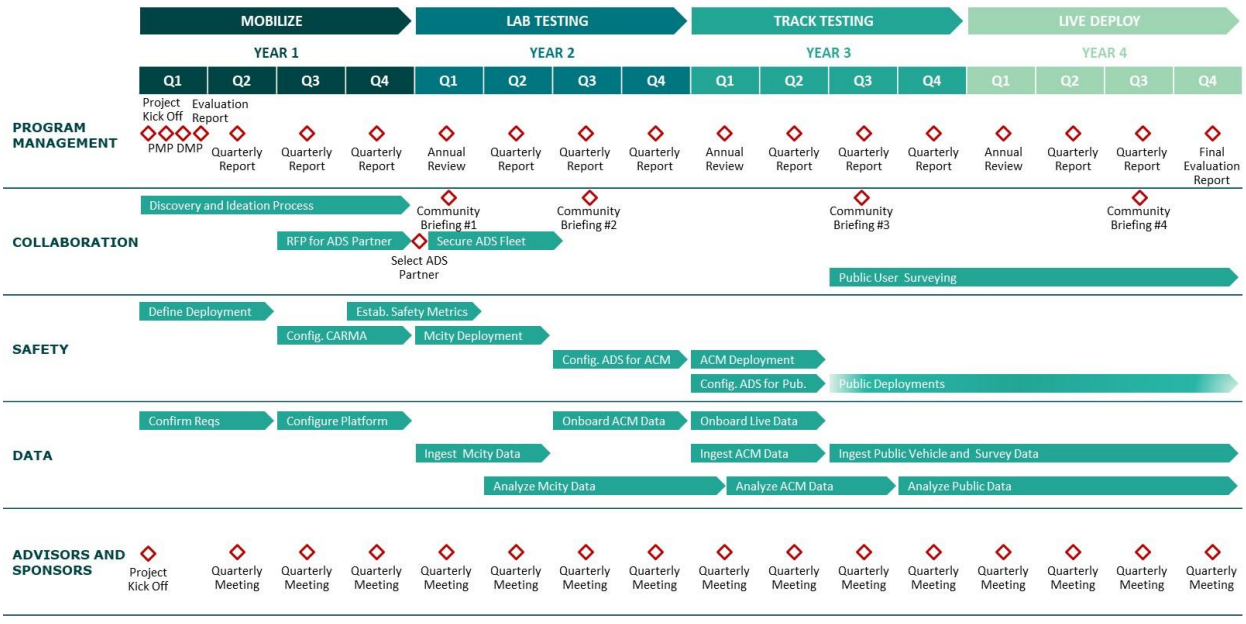


Figure 1. Michigan Mobility Collaborative Timeline

The primary challenge that this effort addresses the difficulty of evaluating the safety of ADS. Our proposed solution will be to develop a standardized process that USDOT can replicate in the future for all companies interested in deploying ADS. This process will provide USDOT with the necessary data to make decisions on ADS safety and provide companies with the security

that their intellectual property will be protected. It will be developed by the expertise at the University of Michigan, Mcity, and the American Center for Mobility.

Beyond the technology itself, our proposal will also focus on better understanding how ADS can improve the mobility of Detroit's senior and disabled populations. ADS have the potential to remove the act of driving for seniors and those with disabilities, but there are other accessibility challenges that may require either a human operator, or innovative automated systems to accommodate them. As part of this proposal, our team will conduct a discovery and ideation process to develop mobility pilots that will improve accessibility for seniors and those with disabilities in Detroit through ADS and deploy the pilot(s) on Detroit's streets using a Level-4 or higher vehicle. This process will leverage accessibility research underway at Mcity to understand the existing gaps in accessibility research as it relates to low speed shuttles and to study the human factors challenges and propose design solutions.

# 2. GOALS

The overall intent of this proposal is to accelerate the deployment of ADS and continue the country's standing as the leader in automotive and mobility technology. This will be accomplished by building the proper level of comfort, not just among those developing the technology, but those that will be regulating and using it in the future.

## 2.1 SAFETY

Building a better process for USDOT to evaluate the safety of ADS is the top priority of this project. We will be deploying vehicles with ADS both on test tracks and on the streets of Detroit to evaluate their safety. We propose a two-pronged approach to ensure safety: safety testing before deployment and safety monitoring during deployment.

### Safety Testing Before Deployment

The University of Michigan's Mcity has developed a test-track based ADS test procedure, the "Mcity ABC Test," a rigorous three-part procedure that includes:

- **Accelerated evaluation** covering the driving scenarios responsible for the most common motor vehicle crashes.
- **Behavior competence** testing to ensure the ADS vehicles possess a well-defined set of competence, and can handle the majority of driving scenarios; and
- **Corner cases**, or test situations pushing the limits of these highly advanced automated vehicles.

Following the low speed assessment at Mcity, a comprehensive assessment and pre-running will be conducted at full speeds expected in the public demonstration. ACM testing will stress the demonstration vehicle on select scenarios drawn directly from the intended demonstration missions, beyond the generic compilation previously evaluated at Mcity.

This three-part Mcity ABC test procedure has been under continuous and active development at Mcity since May 2018. The focus has been on low-speed ADS (< 25mph) operate in the urban

environment. Before deployment on public roads, the ADS fleet to be used in this project will go through the ABC test procedure at the Mcity Test Facility, followed by a mock-up deployment route replica testing at the American Center for Mobility. Test results will be used to enable fast iterations and further refinement before deployment on the public roads of Detroit.

Currently, safety is assessed by two indexes: mileage driven, and mileage between disengagements/interventions. Both are measured while driving on public roads. The main criticism toward these indexes are: (i) mileage driven does not tell the full story: e.g., a mile on an empty highway is very different from a mile on a busy downtown street during rush hour; (ii) disengagement is a human action and is not well defined nor uniformly reported. We also believe that "it takes two to tango" in many motor vehicle crashes, especially those involving pedestrians, bicycles, left turn and rear-end crashes. Objective and repeatable safety assessment can be more easily completed in a control experiment in places like Mcity and ACM, instead of uncontrolled experiments on public roads. Safety will be assessed using the basic kinematic variables such as relative position and velocity between the road users. These data will be collected using onboard cameras and Real Time Kinematic (RTK)/Inertial Navigation Systems (INS) sensors, as well as cameras/lidars installed on the road-side (e.g., on a light pole). In addition, time of initial action, and time to full action (marked by time-to-collision, instead of absolute time) indicate the responsiveness of the ADS and will form the basis for our safety analysis. These variables will come from the vehicle Controller Area Network (CAN) bus if available, and if not, will need to be obtained by differentiating vehicle motion measurement.

### Safety Monitoring During Deployment

For the on-street deployments, critical vehicle motion data will be collected using an on-board data acquisition system to monitor the safety performance of the vehicles in near real-time. The data will be used to monitor sensing and perception degradation (e.g., due to rain and dust), control accuracy and latency, and most importantly, the overall safety performance interacting with other road users.

The data during the on-road deployment will be used to monitor the safety of the ADS vehicle operation, should unexpected problems arise, as well as to support a larger goal of understanding whether and how surrogates for safety can be identify and applied for this type of ADS operation. To that end, the deployment data intends to capture any incidents of safety concern, as well as the conditions and circumstances of operations. In order to compare the ADS vehicle's effect on safety, a baseline set of data from infrastructure-based sensors at key locations will be used to compare the inter-vehicular kinematics near the ADS vehicle in the "baseline" condition (without the vehicle nearby) and with the active ADS vehicle. Because crashes in traffic are rare, the exposure of the system on public roads will likely not provide a statistically significant result, in terms of crash rates with or without the ADS present. However, the data can be used to investigate and possibly eliminate certain surrogate measures from consideration, by comparing their predictive behavior with incidents or near crashes. At the time of on-road deployment, 5G and edge-computing should be mature and the team will fully explore the new technologies for near real-time data download and analysis.

## 2.2 DATA FOR SAFETY ANALYSIS AND RULEMAKING

The development of a data process – and a data archive – that can be used in this project will serve as a template for future ADS deployments. Data will be collected both during closed-course verification testing and during an on-road deployment, addressing both the efficacy and acceptance of the mobility application as well as the safety and engineering performance of the ADS vehicle. Within the project, these data are used for verifying basic competencies of the ADS before deployment, and for monitoring safety during the deployment to ensure that incident rates are not statistically higher than baseline incident rates within the deployment zone.

But, as with many ADS deployments, crashes and other incidents are rare enough that the deployment would need to accumulate perhaps several hundred vehicle years of data, if safety is based only on crash rates. We will build up archives that can be used to identify surrogate measures of safety for ADS systems in mixed traffic (ADS and non-ADS vehicles sharing the road), when the archives are combined. Therefore, in addition to this project's specific findings, the effort will contribute to a community-wide data set that will help the USDOT in its efforts to facilitate safety analyses. Whether rulemaking or industry consensus is the goal, this project will help create a process for additional ADS deployments and contribute to the wider effort of leveraging data for future efforts.

## 2.3 COLLABORATION

The principle of collaboration is foundation upon which this entire proposal is built upon. We envision a number of unique collaborations, including:

### With Detroit's Senior and Disabled Communities and Private Sector

For many, including seniors and those with disabilities, getting around can be a challenge. The ability to drive can make a tremendous difference in a residents' quality of life. As part of this effort, the team will work with Detroit's seniors and those with disabilities to better understand their transportation challenges and work with private partners, including a local health system, a medical insurance provider, a grocery/pharmacy, and a national senior advocacy group, to build the business case for improving accessibility for these two populations.

### With Michigan Cities

ADS is going to change cities, and cities will have to make changes along with the deployment of vehicles with ADS - from how space alongside the curb is managed to how police pull over a vehicle. Deloitte Consulting, in partnership with Detroit, Ann Arbor, Grand Rapids and State of Michigan, will hold quarterly discussions between cities and ADS companies to work through policy issues among practitioners. The outcome of this collaboration will be a series of case studies and "playbooks" that USDOT can use to help municipalities of all sizes across the US.

### With the General Public

Talking about ADS and the future of transportation with the public is difficult; most folks just want to see their immediate issues addressed, like making sure the bus arrives on time and the pothole on their street gets filled. Our engagement process is another "playbook" that will be

able to be scaled for use across USDOT's work. In addition, through its research with Mcity, JDPower will explore consumer sentiments on the ADS ecosystem for insurance, safety frameworks and data sharing.

#### With Other Awardees

This team is eager to work with USDOT and other award winners. It is imperative that we share our learning experience and address the challenges we face as a group to maximize the impact of the technologies and the investment from the USDOT. We propose to host an annual convening in Detroit during the North American International Auto Show every June. This will facilitate an opportunity for awardees to get together to share experiences, as well as for the USDOT to demonstrate progress to industry--possibly including Mcity/ACM tests as part of the annual program.

# 3. FOCUS AREAS

While this proposal has a tight focus around safety and equity, these two topics have a much more expansive view.

## 3.1 SIGNIFICANT PUBLIC BENEFIT

Too many people needlessly die in traffic crashes; 37,133 in 2017 to be precise. Addressing vehicle design, driver behavior, and roadway design has significantly reduced this number from its peak in the 1970's and 80's, yet that does not comfort a family who loses a loved one from what supposed to be just a short trip to the grocery store.

In Detroit, this issue is even more acute**.** In 2016, Detroit had the highest traffic fatality rate and pedestrian fatality rate of any of the 23 cities with a population over 670,000 residents. While this number decreased in 2017 and Mayor Duggan has outlined a target of reducing fatalities by 21% in the next four years, there is still much to do. ADS offer a new opportunity to provide safer mobility to the residents of Detroit.

## 3.2 ADDRESSING MARKET FAILURE

For many Detroiters, transportation is the barrier to accessing opportunity or improving one's health or quality of life. This is due to a number of factors, including the housing/jobs mismatch in which 70% of Detroiters work outside of the City, the cost of owning a vehicle in Detroit being higher than any other City in the US, and the historical lack of investment in public transit. All of these contribute to transportation being the critical factor in determining one's ability to succeed.

The City of Detroit has made improving transportation for its residents a priority. The list of accomplishments over the last few years including adding 24 hour bus routes to eleven routes in the City, establishing the Office for Mobility Innovation to help launch and integrate new types of mobility services and technologies, launching a pilot in collaboration with Lyft to address first/last mile challenges during the overnight hours, enabling the deployment of an autonomous vehicle fleet (May Mobility) to serve Downtown Detroit's largest employer, and successfully overseeing the deployment of 1,200 scooters, including 25% of the fleet outside of

the greater downtown area, by working with the private companies as opposed to fighting with them and working on a national level on data sharing with the companies and other cities. Advancing ADS to make it easier for the residents of Detroit to get around will have tremendous benefits.

## 3.3 ECONOMIC VITALITY

Detroit put the world on wheels and the Detroit region is still the densest cluster of automotive design, engineering, R&D and manufacturing on the planet. Detroit and Michigan continue to be the center of the North American industry, with 17 automakers, 11 assembly plants, 23% of U.S. auto production, 96 of the 100 top suppliers to North America (1,772 total suppliers), and 76% of U.S. auto R&D investment ($10 Billion annually) all existing within this area.

The City and State have made a number of investments to ensure the infrastructure, assets, and legislation are all in place to support the future of the mobility industry. This includes Mcity and the American Center of Mobility, both of which are best in class testing facilities. The mobility ecosystem for ADS deployments in Southeast Michigan cannot be replicated anywhere else in the United States.

Detroit is now a larger part of this ecosystem, with Ford Motor Company creating a $740M campus in the Corktown neighborhood around the rehabilitation of Michigan Central Station, which will bring the 5,000 jobs, FCA and the City working on plan to bring 5,000 new manufacturing jobs to the east side of the City, and the MEDC establishing the Landing Zone, a co-working space for start-ups and corporations in the automotive and mobility industries, in Downtown Detroit.

Continuing to innovate around ADS in Southeast Michigan is important not just to the region, but to the entire country.

## 3.4 COMPLEXITY OF TECHNOLOGY

The ADS fleet to be used in this project include (1) one of the Mcity test vehicles (see Figure 2 below) that will be converted to run the FHWA CARMA open source system. This vehicle will be used during the first two years to further refine the Mcity ABC test procedure; and (2) a fleet of up to 5 ADS vehicles will be identified and acquired through an open call-for-application process.

## 3.5 DIVERSITY OF PROJECTS

While Detroit has challenges with respect to access to transportation, it is the same issue that cities across the country are facing. Identifying solutions that can work in Detroit will also improve the transportation opportunities for other cities leading to better access to opportunity.

## 3.6 TRANSPORTATION-CHALLENGED POPULATIONS

Our work will be focused on developing ADS solutions that improve the accessibility for Detroit's senior and disabled populations. There are a number of external factors that make it difficult for this segment of population to access what they need. The collaborative discovery

and ideation process will focus on creating ADS pilot deployments to improve transportation in Detroit for seniors and those with disabilities and the business models necessary to ensure sustainability.

### 3.7 PROTOTYPES

The Michigan Department of Transportation (MDOT) and the Michigan Economic Development Corporation (MEDC) will help to oversee an RFP process to secure the ADS fleet, targeted for delivery during the second year of this project. The research team has first-hand experience with ADS deployment, including the NAVYA shuttles deployed by Mcity at the University of Michigan campus, and May Mobility vehicles in downtown Detroit. We have identified a number of companies who support the approach we are taking and are interested in pursuing in the ultimate deployment.

## 4. REQUIREMENTS

The deployments as part of this project will meet all the requirements set forth in the NOFO.

### 4.1 L3 OR GREATER AUTOMATION TECHNOLOGIES

The ADS fleet to be used in this project includes two groups for different purposes. (1) One of the Mcity test vehicles (see Figure 2 below) will be converted to run the FHWA CARMA open source system. This is based on the assumption that the CARMA planned release in mid-2019 is mature enough to perform the planned Level-3 driving function. If this turns out not to be the case, we plan to use either one of our three NAVYA shuttles or the Autoware open source library as a backup plan. This vehicle will be used during the first two years to further refine the Mcity ABC test procedure; and (2) a fleet of up to 5 ADS vehicles will be identified and acquired through an open call-for-application process. The MEDC and MDOT will oversee this process. The ADS deployment fleet vehicles will be specified to travel at a speed up to 25mph, to operate safely in urban environments interacting with pedestrians, cyclists, and other vehicles, including at intersections. There will be a safety conductor onboard at all time, both to monitor the operations of the vehicles, and to “be there” to provide help and comfort to the riders.


Figure 2. Mcity Test Fleet

### 4.2 PHYSICAL DEMONSTRATION

This project includes three stages of physical demonstration.

In the first year of this project, we will implement the Cooperative Automation Research Mobility Applications (CARMA) software platform on a Mcity test vehicle (Lincoln MKZ or Kia

Soul). This vehicle will be used as a reference platform, mainly for the purpose of further refining the safety test procedure at Mcity and ACM. There are two reasons why CARMA is selected: it is open source, perfect for a reference system, and it enables testing of both self-contained automated vehicles and cooperative automated vehicles. CARMA is projected to release another update in mid-2019 to have adequate Level-3 cooperative driving features for our safety test development. If it turns out to be not suitable or not ready in time, we plan to use one of our three NAVYA shuttles, or use other self-driving features available from Autoware or Mcity's own test vehicle as the back-up plan.

By the end of the second year of the project, we will demonstrate the safety testing of the CARMA vehicles at the Mcity Test Facility using the Mcity ABC test procedure, to demonstrate the vehicles' ability to handle common daily driving scenarios, a set of "behavior competence" scenarios, as well as selected corner cases. The Mcity ABC tests are described in detail in Section 5.1.

After successful testing at Mcity, the CARMA vehicle will be tested at the American Center for Mobility (ACM). In the urban testing environment of ACM, the team will design a mock-up route, as a close replica of the deployment route in Detroit. The vehicle will be put through an endurance test, to understand its performance under different lighting, weather and traffic conditions.

When the ADS deployment fleet vehicles become available, they will also be put through the Mcity ABC test and ACM mockup route test. The test procedure and results will be communicated with the USDOT team regularly.

During the third year of this project, we will conduct a few week-long demonstrations using the ADS fleet on the identified routes in Detroit. In these pilot runs, vehicles may take on selected riders when it is safe to do so, to collect their feedback. The ability of the vehicles to operate safely on public roads, as well as collecting critical data in near real-time, and perform analytics to ensure safety-critical events will be examined. Selected events will be reviewed and analyzed further by the research team frequently for fast iteration and improvement. The human-machine interface for users with varied abilities (vision and physical mobility challenged) is also an important element of this demonstration.

In the last year of this project, the ADS vehicles will have an iterative 6-month deployment cycle to gather long-term, continuous service to the senior mobility-challenged community in Detroit. Engineering (safety) data, non-engineering (mobility) data, and subjective data from riders and the general public will be collected and analyzed. A near real-time data sharing system with USDOT will be fully validated and data will be shared throughout this 6-month period.

## 4.3 DATA COLLECTION AND SHARING

This project team believes that one of the most important outcomes of this grant is the data collected and how it will be shared with the USDOT. The data will provide important insights to the safety of these vehicles, how they are similar or different from manually-driven vehicles, in the way they interact with other road users and the roadway environment. Equally important is whether people trust and use vehicles with ADS, and how the vehicles with ADS become part of

a much larger integrated mobility system. Collecting, analyzing, and sharing these data will greatly improve everyone's understanding of these vehicles, and lead to better design and use of the next generation AVs.

The engineering (safety) data we will collect from the fleet vehicles includes stereo cameras, and on-board real-time kinematic (RTK) GPS data—details are discussed later in Section 5.2. These data will capture the motion (position and velocity) of the vehicles with ADS, as well as the distance to other road users. Important metrics to compute include time-to-collision (time gap), minimum-distance, acceleration, and yaw rate. Other metrics will be developed as kinematic safety surrogate measures, as an output of the project.

The non-engineering data will include ridership, origin/destination of trips, and connection to/from other mobility modes. Survey data will also be collected to understand user trust, need, and feedback.

The data we collect, both raw and analyzed data, will be shared with USDOT as part of the deliverables of this project. The raw data will be shared near real-time, through the data system that we will build in close consultation with USDOT. Data sharing will allow researchers from the public to have access to the data, to accelerate the further development of AV technologies. The specifics of the date sets are discussed in the Data for Safety Analysis and Rulemaking Approach of this proposal.

## 4.4 USER ACCESSIBILITY

All vehicles of our demonstration project will have designed input/output user interfaces and apps that allow users with varied abilities (vision and physical mobility challenged) to input a new destination or communicate route information and to access trip information. At Mcity, accessibility has been identified as an important research thrust. Mcity has supported two accessibility projects (supported by the Mcity industrial membership). The findings will be shared with the ADS provider to design interfaces and apps to ensure these vehicles are accessible for the vision and physical mobility challenged population.

## 4.5 SCALABILITY

The team members of the Michigan Mobility Collaborative have a long history of developing and deploying advanced mobility concepts, including connected and automated vehicles. Mcity operates the first Level-4 driverless shuttle deployment project in the US to focus on consumer acceptance of ADS. The year-long process of acquisition, equipping, testing, training and operation was fully documented, and the white paper was available freely from the Mcity web site, https://mcity.umich.edu/wp-content/uploads/2018/09/mcity-driverless-shuttle-case-study.pdf.

This project leverages the strong prior knowledge of the best Michigan researchers. The team will continue the open and shared learning approach and will work with USDOT and other grantees funded by this program, to accelerate the learning and scaling-up of highly automated vehicles.

An important theme in the proposed work is to establish, demonstrate, and validate a process of stepwise assessing the usefulness and readiness of an ADS deployment, in order to assure there is an unmet need and a safe solution. This includes:

- the careful investigation and identification of user needs in a community;
- the exercising of a vehicle with ADS by a "third party" team in the safe confines of a closed area, with a specific and rigorous set of tests that progress in realism, derived from the current state of the art on the topic;
- a deployment that includes specific data gathering and monitoring activities with statistical components; and
- an assessment of whether the deployment is serving the mobility needs initially addressed.

The project will further create a data repository, with tools, so that others can investigate our work, or pull data to help with their own pre- or post-launch assessments. These data will be as complete as possible, with real safety content, without unduly exposing provides of vehicles with ADS to business risks that could result in a delay in mobility benefits. These elements of the proposal stem from the team belief that deployments do not need to occur in isolation but should leverage past and current deployments for quantitative and qualitative findings. Lessons should not need to be re-learned in each city. For both the safety and the mobility of all populations, an open and sharing approach is needed to accelerate the safe deployments of vehicles across the country.

# 5. APPROACH

## 5.1 TECHNICAL APPROACH

Our overall approach to this effort is to work collaboratively with USDOT to create a process than can easily evaluate the safety of ADS, work with Detroiters to develop potential ADS deployments that address real transportation challenges, and then select a provider to deploy ADS mobility services on Detroit's streets in a way that follows the safety process created by UMTRI, Mcity, and ACM.

### Task 1: Safety Approach

The primary hypothesis of this proposal is that a replicable process to evaluate the safety of ADS can be created through safety testing before real-world deployment and safety monitoring during deployment. This will be accomplished through a two-stage approach.

1. Safety testing before deployment

The University of Michigan's Mcity has developed a test-track based ADS test procedure, the "Mcity ABC Test," a rigorous three-part procedure that includes:

- An accelerated evaluation process that covers the three most common driving scenarios (car following, lane change, and left-turns) that are responsible for seven of the top ten crash situations identified by the National Highway Transportation Safety Administration (NHTSA), see Figure 3, below.

| No | Pre-Crash Scenario | Group | Cost |
|---|---|---|---|
| 1 | SCP @ non signal | Junction Crossing | **20.4%** |
| 2 | LTAP/OD | LTAP/OD | **15.1%** |
| 3 | Rear-end/LVS | Rear-End | **14.8%** |
| 4 | Opposite direction/no maneuver | Opposite Direct ion | **14.7%** |
| 5 | Rear-end/LVD | Rear-End | **6.1%** |
| 6 | Rear-end/LVM | Rear-End | **5.1%** |
| 7 | Changing lanes/same direction | Lane Change | **4.2%** |
| 8 | Turning/same direction | Lane Change | **3.1%** |
| 9 | Opposite direction/maneuver | Opposite Direction | **1.7%** |
| 10 | Drifting/same direction | Lane Change | **1.7%** |
| | **Total** | | **86.9%** |

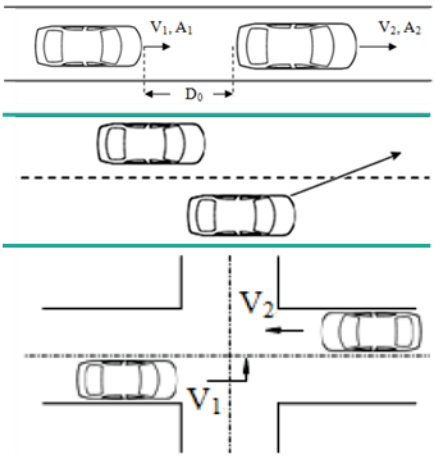


Figure 3. Three common scenarios covered in accelerated evaluation testing

The accelerated evaluation process, which is currently in development by Mcity, is based on the importance sampling concept, a methodology used in financial institute stress tests, communication systems failure and other applications with rare failures. In this process, the first step is to collect naturalistic driving data that reflects what the test vehicles will face on public roads in normal conditions. The behavior of the human drivers is then "skewed" (based on the importance sampling theory) to boost aggressive/risky behaviors and focus on difficult miles. The importance sampling theory ensures that the skewed probability can be skewed back to remap the real-world risk. This process is possible because the University of Michigan has 20 years of experience leading field operational tests to collect tens of millions of miles of driving data. This approach was developed by an Mcity research project in 2017.

- A behavior competence testing process will be designed to ensure that the ADS have a known level of competence for common daily driving tasks. The ADS vehicles will be put through a set of scenarios to demonstrate their safety performance. Based on our literature review, including from California PATH, Waymo, Torc robotics, Voyage, China Ministry of Industry and Information Technology, Beijing, Shanghai, Guangzhouwe created a list of 50 scenarios. All 50 scenarios can be tested by using Mcity and the American Center for Mobility.

  Based on the operational environment of the Detroit's deployment, 16 test scenarios will be used as a starting point. These scenarios are shown in Figure 4, below.

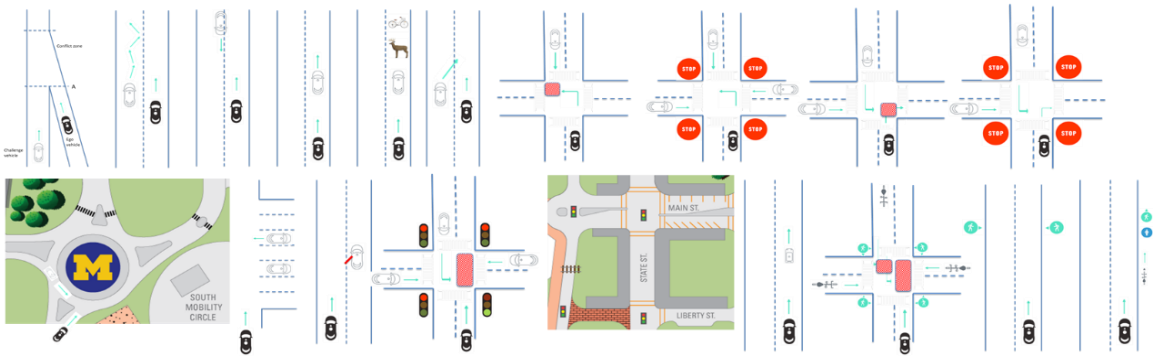


Figure 4. Example behavior competence test scenarios

- Corner cases or test situations push the limits of these ADS vehicles. There is no official definition of corner cases, other than the fact many agree these cases should be deterministic and should be at the very edges of the operational design domain of the ADS. For example, an ADS traveling at its highest speed with the most obstructed view and facing a pedestrian dashing at the highest speed wearing black clothes, and so on. Corner cases also can be designed to explore the known weakness of the sub-systems of the vehicle, such as testing a vehicle relying on cameras to recognize a black car on a raining dark night. Once we have the ADS fleet, we will create a corner-case library based on the operational design domain of the vehicle and known challenges of the sensing and perception algorithms.

Currently, safety is assessed by two indexes: mileage driven, and mileage between disengagements/interventions. Both are measured while driving on public roads. We believe that "it takes two to tango" in many motor vehicle crashes, including those involving pedestrians, bicycles, left turn and rear-end crashes. Objective safety assessment can be more easily done in a control experiment in places like Mcity and ACM, instead of uncontrolled experiments on public roads.

During the tests at Mcity and ACM, we will record camera images from both the vehicle side and the roadside. In addition, RTK units will be installed on all involved road users, to obtain accurate measurement of relative position and velocity, to compute derived variables such as minimum gap and time-to-collision. While these kinematic variables are the basis of measure safety, they alone are not enough. We will also track two important variables: time of initial action, and time to full action. These two variables measure how responsive the ADS is. Based on human driving data, we will establish acceptable bounds of the ADS behavior, so that the way we measure safety does not encourage exceedingly conservative driving style. This is because driving too slowly/conservatively is also not safe. Good roadmanship need to be built into the way we test and measure safety behavior of the ADS vehicles.

2. *Safety monitoring during deployment*

As detailed later in the proposal, our team will work closely with USDOT to select an ADS provider for Detroit's senior and disabled populations. By waiting to select a provider, we will

be able to build awareness among providers of the safety and data requirements that will be included in the project to ensure we move this project forward.

The operations of the ADS fleet will be monitored continuously to evaluate safety. The on-board data acquisition system will be designed by UMTRI in close coordination with the ADS provider to sure it does not interfere with the safe operations of the ADS, nor does it reveal any confidential information of the ADS design. The data system will be discussed in detail in the next section.

### Task 2: Data for Safety Analysis and Rulemaking

This effort will continuously deliver a large set of shareable data to support the USDOT's needs for understanding the performance of the ADS, developing methods and processes for ensuring safety of future ADS deployments, and to enable researchers to develop innovative methods to understanding ADS performance and safety. Our approach focuses on how data would be collected, how it would be shared with USDOT and qualified researchers and stakeholders, and how we will analyze the data.

*1. Data Collection*

The project data will include both "ADS operational and performance data "and "mobility application data." The operational and performance data includes data from the project's pre-launch verification tests, as well as data on vehicle usage and performance during ADS operations on the streets of Detroit. The mobility application data will document the use of the ADS in the service of the use cases described in this proposal. Figure 5 shows the types of data considered to be project data. Each type of data is now described.

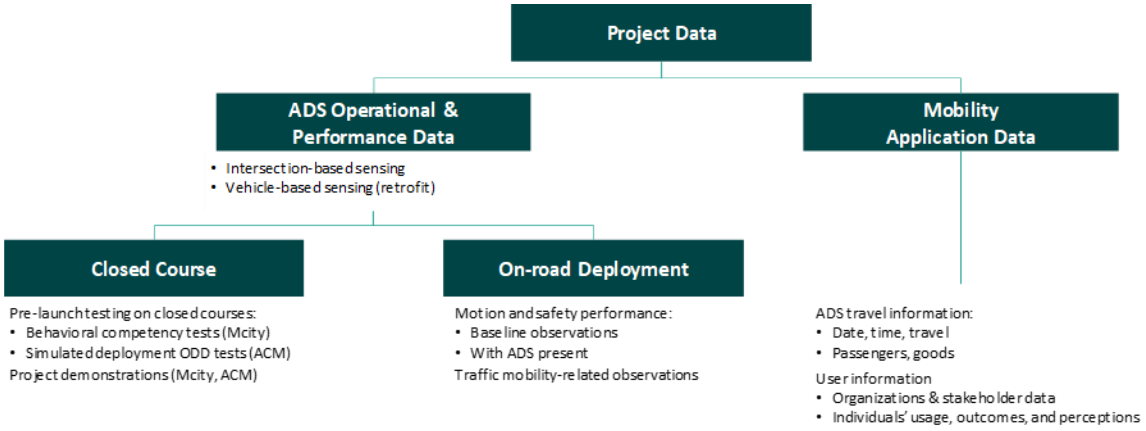


Figure 5. Categories of Project Data

Figure 5 shows that operational and performance data will be generated and collected during two phases of work: closed-course testing before the on-road deployment phases, and on-road "deployment" data from the streets of Detroit with the ADS vehicles in either pilot operation or deployment. These data are "engineering" in nature, and will come from the vehicles with the ADS, as well as from infrastructure-based sensing systems that will support the vehicle ADS by broadcasting the location and motions of nearby road users. At least three infrastructure-based sensing systems ("smart intersections") will provide an additional and unique view of selected

locations on the ADS vehicle's path because sensors are mounted high above the roadway, so that they are able to observe more than a vehicle-based system. The smart intersections also allow the team to observe changes in other vehicles' and other road users' behaviors and interactions at the location, so that changes in those behaviors or interactions that occur when ADS vehicles appear can be detected. These data include traffic signal phase and timing, traffic counts, and remote sensing of the location and motions of vehicles and vulnerable road users (VRUs) near the intersection.

In both pre-launch and deployment phases, the team's data from the ADS vehicles will come from retrofit instrumentation systems that will consist of at least the following:

- High precision location and velocity of the ADS vehicle
- Retrofit remote sensors to locate nearby targets, their type, and their relative motion
- Passengers and goods metadata per trip (number, type)
- Safety-critical ADS vehicle switches (safety driver intervention, crash)
- Weather and lighting
- Video external of the vehicle for scenario understanding

Although final data lists have not been finalized, the draft data management plan provides a likely list of data that would be shared from the ADS vehicles. Note that data that is native to the ADS vehicle (e.g., data on OEM data buses) is not intended at this time to be part of the project data. This allows the team to provide a full set of data to USDOT with less conflict between commercially sensitive information and the need for USDOT to have a full set of data. In addition, the retrofitting allows a separation of duties between organizations which will allow the project to be more efficient and more timely. Samples of the native data from the ADS vehicle itself, including "original" sensing, can be shared in briefings with the USDOT as part of the pre-launch review of closed-course testing, to help USDOT understand the ADS technology.

The instrumentation on the ADS vehicle will be captured by an UMTRI data acquisition system (DAS) is an update version with more capabilities than the successful Safety Pilot Model Deployment version. The system uses a unique approach that synchronizes signals onboard and will also capture critical ADS vehicle operations signals (e.g., any intervention). This system is well known to USDOT (including Volpe), given UMTRI's participation in Safety Pilot Model Deployment and several other large field operational tests. UMTRI has expanded the ability to send substantial data over the air for remote monitoring, providing a rich set of data for monitoring ADS and DAS health, vehicle location and motion, kinematic signatures and video of triggered safety-relevant events, and continuous periodic sampling of context and host/target kinematics. UMTRI has developed an approach – which has been leveraged by GM as demonstrated in NHTSA/UMTRI/GM projects tracking thousands of vehicles – that uses modest wireless bandwidth to capture much of the key data. Meanwhile, at day's end, the rest of the DAS data set is offloaded at day's end to complete the full video and sensor records. This therefore combines UMTRI experience with the ongoing data collection with a Navya shuttle

being operated by Mcity and many years of onboard data acquisition, data handling, and analytics experience known to USDOT.

The on-street deployment data will provide a description of the trips made by the ADS vehicles, including their position, velocity, date and time, number of occupants (if appropriate), goods carried, providers and recipients, and more. Also shared will be survey data from beneficiaries of this travel, whether they are individuals or organizations.

In addition to the UMTRI retrofit instrumentation system on the ADS vehicle, data will be collected from at least three smart infrastructure sensing platforms that observe the site and report target types, locations, and motion, and capture signal phase and timing (SpaT); and user travel data. This captures comprehensive data at three levels:

- Roadway and traffic environment
- ADS vehicle and its surroundings
- End user of the ADS vehicle

The smart intersections locations will be connected to the Detroit Traffic Management Center network, and then VPN'd back to the UMTRI servers to capture the streaming data of SpaT and target data from the intersection. (UMTRI currently receives streams from several intersections in Ann Arbor, so this is another proven approach.) The statistics of the observed interactions at each location will be used to calibrate triggers for observed events – whether in baseline data collection (without the ADS vehicle nearby) or during data collection with the ADS vehicle – for remote monitoring of the intersection, as well. The user traveler data will be collected from participants, under an IRB informed consent, and that data can be synched with the ADS vehicle location and time.

The data from both the vehicle-based and smart infrastructure data will initially reside on UMTRI servers. After brief data filtering operations, the data will be migrated to the cloud data sharing platform. The data filtering is done for many reasons, including quality control of specific signals (e.g., loss of signal from a sensor or camera blockage), any de-identification or fuzzing of video that is necessary for sharing the data, and ensuring that the data does not contain non-natural data elements, such as when project engineers are testing the vehicle manually.

The infrastructure data will be analyzed to observe any large differences in traffic behaviors when the ADS is and is not present, including key performance indicators (KPIs) of mobility and safety. An ongoing automatic process will use the ADS vehicle DAS data to determine whether there are statistical suggestions of a potential safety impact when the ADS is present. Given the short deployment and the likely sensing uncertainties, the team does not expect either crash rate or potential injury impacts to reach statistical significance, so during the project's deployment, these data will be useful for advisory purposes for the project's monitoring activity. The data and the analytics used to consider the safety with and without the ADS present, however, could support future hypothetical studies in which these data might be used to seed simulations of hypothetical conditions or hypothetical vehicles.

2. *Data Analytics*

Data analytics will be performed throughout the project, using engineering data collected from the ADS vehicles, the smart infrastructure, and other vehicles or surrogate targets used during testing. Using the data that was described in the previous section, vehicle performance measures will be computed. These include, of course, simple measures such as time to collision, required decelerations to avoid collisions, and proximity measures. But a key objective in the analytics will be to further the science in the difficult area of surrogate measures of safety. Because the field deployment will be in urban Detroit, the lower-speed environment that includes complexity such as vulnerable road users, intersections, mixed vehicle traffic, and street parking means that traditional kinematic measures that are meaningful at higher speeds, in vehicle-only contexts, such as freeways, are not as predictive and not adequate. At lower speeds, vehicle action changes time to collision much faster than at higher speeds, for instance, so that surrogate measures for safety will likely be driven more by proximity and accurate prediction of target motions that by the "host" vehicle maneuverability that drives higher-speed surrogates.

The analytics in this project will dive deeply into these lower-speed predictors, and wrestle with scenario-specific factors that can influence their effectiveness. Therefore, there will be an emphasis on accurate data, and the capture of contextual data and scenario classification. The data set for deployment will include both raw data (after quality control filtering), as well as scenario and maneuver "tags" to support the project's (and data users') ability to study events, the context and scenarios, and the sensor-based conflict data. The outcome of this work will be to help USDOT and the community move toward understanding how surrogate measures can be used in monitoring and assessing real-world deployments.

### Task 3: Collaboration Approach

The public, private, and non-profit sectors in Detroit and Michigan have extensive history collaborating to support investments around the automotive and mobility industry and to address mobility challenges. We will be leveraging this previous work to provide USDOT with an unprecedented level of collaboration around a deployment of technology grant.

We envision collaborations between cities (Detroit/Ann Arbor/Detroit), with the private sector (Ford Smart Mobility, LLC, Henry Ford Health System, HAP, a grocery store) and nonprofits (AARP, philanthropy) and leading knowledge sharing with the other grantees. There are three focus areas of our collaborative efforts:

1. *Discovery and Ideation Process with Detroit's Senior and Disabled Communities Leading to ADS Deployments in Detroit*

While ADS have great potential to improve the safety and quality of life for American citizens, much work still needs to be done to understand how this potential can be realized. We will undertake a collaborative planning process to focus on opportunities to deeply understand the needs of Detroit's senior and disabled populations and co-design ADS solutions hand-in-hand with that community. Too many "innovations" in mobility technology and services are designed for the users instead of with the users. Our approach is designed to integrate and leverage all

types of stakeholders and perspectives throughout the process, ensuring we develop ADS solutions for seniors in Detroit that are desirable, feasible and financially viable.

This five-stage process will be led by the Ford Smart Mobility, LLC team, who has successfully completed similar innovate human centered design work as part of their City:One Challenges in Pittsburgh, Miami, and Grand Rapids. Partners will include the Cities of Detroit, Ann Arbor and Grand Rapids, the State of Michigan, Henry Ford Health System, AARP, HAP, a grocery store, and local advocates for transit and people with disabilities. The final stage being the deployment of ADS for seniors and those with disabilities in Detroit. This will be crafted similarly to the successful Michigan Mobility Challenge that was launched in 2018 by MDOT and the MEDC; these two partners will own this stage of the process as well.

Stage One: Framing & Alignment

The initial phase of the project will focus on identifying and energizing the relevant stakeholders, senior communities, and residents with disabilities in Detroit, solidifying their support and engagement throughout the research, design and development process. The project team will review and clarify the stated problem-to-be-solved, ensuring all stakeholders have a clear understanding of what the team is trying to achieve. We will also explore, discuss and align on the various constraints that will need to be considered in the design and ideation process.

Stage Two: Exploring & Identifying Needs

The second stage of the process would utilize a combination of deep community engagement and analytics to identify senior and disabled community mobility challenges. Qualitative insights would be identified about existing and potential barriers to senior and disabled access to key services in the area including grocery stores, health services, public spaces, and social and civic engagement opportunities. This process will provide opportunities for a diverse group of community members and project stakeholders to have an open, honest discussion about the realities of seniors and those with disabilities living with mobility barriers in Detroit.

A quantitative data analysis will be conducted using Ford's data analytics platform. This will identify the habits, patterns and barriers related to the mobility needs of Detroit's senior and disabled populations. A community focused qualitative synthesis will also support this work, through a blend of exploratory and evaluative research approaches with senior, those with disabilities, and community members to identify why the habits, patterns and barriers exist (identified in the quantitative analysis) and begin to explore how solutions might positively impact them.

Stage Three: Crafting & Testing Ideas

After the initial analysis and discussions, a series of facilitated ideation and co-design sessions will be held with seniors and those with disabilities, community members and key deployment stakeholders including potential pilot partners (i.e. Henry Ford Health Services, local grocers, e.g. Whole Foods, Honey Bee or Meijer), mobility providers (i.e. Detroit Department of Transportation, SE Michigan Regional Transit Authority, paratransit companies, private sector shuttle and ride hailing companies), policy makers and funders (i.e. City of Detroit, State of

Michigan, HAPs) and investors in public space (i.e. Downtown Detroit Partnership, Riverfront Conservancy, Roosevelt Park Partnership).

The team will translate learnings from community research into design recommendations that give clear direction and guidance to the types of solutions that would be most impactful. This will include community ideation and co-creation, pressure testing the ideas with the community, then validating the feasibility of ideas and the viability of business models with the partners.

The outcome of Stage Three would be pilot designs and ideas for new ADS mobility service and space designs in a specific neighborhood that can better support living, mobility and accessibility for seniors and those with disabilities, such as more and better travel options using ADS vehicles to key services including health, grocery stores, and opportunity for social and civic engagement and the ability to mitigate and/or replace trips to these locations through the use of ADS delivery services

Stage Four: Preparing ADS Solutions for Pilots

Apart from the community engagement activities, senior mobility insights, and solution set, the City:One team will focus on helping bridge the two most difficult stage of innovation: solution design and pilot implementation. To that end, success for the team includes creating the right ecosystem conditions to bring solutions to pilot, even if Ford Smart Mobility, LLC is not directly involved in the pilot and development stages. This will include identifying barriers to implementation, developing go/no go processes, pilot partner engagement, and an ecosystem acceleration.

Stage Five: Deploying ADS Pilots

The final step of the process will be to deploy the pilots. Deployment of the ADS will leverage the experiences of multiple members of the team.

The ADS fleet will be procured by MDOT, in partnership with MEDC. An initial Request for Information will begin conversations with potential providers on what the team and USDOT are looking for and what the providers are able to provide. A Request for Proposal will then clearly describe what data they need to provide and in what manner.

A wide variety of factors and stakeholder requirements and opinions will be taken into consideration of the deployment, including the following:

- **Operational Environment:** The project will balance the capabilities and safety of the available ADS fleet with sufficient interactions to produce valuable and relevant data, as well as to provide useful solution identified as part of the pilot.
- **Speed:** Because safety is our top priority, the maximum operating speed of the ADS fleet will be 25 mph. The prevailing travel speed of the selected route will be monitored to ensure that the ADS fleet will not cause congestions or safety concerns.

- **Signage:** It is critical to make sure all other road users in the area understand they will be interacting with the ADS vehicles, we will leverage lessons learned from the previous Mcity deployment.
- **Conductor Training:** A robust training program is necessary to prepare them to take on this role. Training will include demonstration of proficiency in a closed facility of a tiered skill set. Following closed facility training, conductors will also be trained on the final intended deployment route.
- **Incident Response Plan:** Engaging a wide variety of stakeholders in an emergency response plan is essential. A series of mock crash scenarios will involve stakeholders from public safety, etc. to develop and refine an emergency response plan

2. *Policy, Operational, and Engagement Impacts from ADS*

The impact of ADS will change more than just who is behind the wheel. It will drive changes around all aspects of how municipalities function.

To better understand these impacts, Deloitte Consulting will lead quarterly discussions between a number of stakeholders and select experts around a number of topics, including, curbside management, policing, emergency response, fleet management and operations, infrastructure, and accessibility. These discussions will be held in partnership with the Cities of Detroit, Ann Arbor, and Grand Rapids, the State of Michigan, and other impacted stakeholders. We will also invite the other awardees to participate in these discussions.

In addition, the City of Detroit is in final negotiations with the Knight Foundation around a $1.1M grant to conduct innovative public engagement around ADS. Our proposal is to hire 1 to 2 community managers in a neighborhood to lead conversations around ADS. The community managers would be residents of the neighborhood. We envision this scaling across the city after the initial pilot phase.

Deloitte will create a white paper summarizing each of the discussions and identify topics for further research. We envision this being able to be shared with other municipalities and states, so they can learn and participate in further research.

3. *Knowledge Sharing with Other Grantees*

The team proposes to host an annual convening of the awardees in Detroit. We envision doing this the week of the Auto Show in June. In addition to convening all of the awardees to have discussions about their efforts, it also provides an opportunity for private industry to be part of the conversation and for USDOT to build awareness of the groundbreaking work to industry and media.

## 5.2 APPROACH TO LEGAL, REGULATORY, ENVIRONMENTAL, OTHER OBSTACLES

In December 2016, Michigan's Governor Rick Snyder signed into law automated vehicle legislation that permits the operation of automated vehicles on Michigan roads. Prior to this legislation, the State of Michigan permitted the testing of automated vehicles by manufacturers on public roads. The new law took the form of an amendment to the Michigan Vehicle Code.

The Michigan Vehicle Code now permits the operation of automated vehicles on public roads, provided they comply with the applicable Michigan Vehicle Code requirements. Additionally, the Michigan Vehicle Code requires that the person "operating the vehicle" be able to take control of the vehicle's movements in case of an emergency. Alternatively, if the person "operating the vehicle" cannot take control, then the vehicle must "be capable of achieving a minimal risk condition."

With the passage of the amendment, the operator is no longer required to be inside the vehicle. The State of Michigan was among the first states to remove such a requirement, which will pave the way for the deployment of fully automated vehicles. As safety is of the utmost importance to the project, the team will require that an operator (a safety conductor) be present in the ADS at all times with the ability to take control of the vehicle if necessary. Moreover, as required by the Michigan Vehicle Code, each safety conductor is licensed to operate a motor vehicle in the State of Michigan.

While legislation regarding the operation of motor vehicles is traditionally under the purview of the states, regulation regarding the design, manufacture, and safety of motor vehicles is within the federal government's scope of authority. Prior to the recent adoption of automated vehicle legislation by certain states, virtually all U.S. laws governing the design and operation of motor vehicles were written for motor vehicles operated by a human driver. Prior to the enactment of ADS legislation by Congress, we will seek applicable federal exemptions if the ADS deployed does not conform to FMVSS. We do not anticipate requiring an exception under the Buy American Act.

## 5.3 COMMITMENT TO PROVIDE DATA

This project team believes that one of the most important outcomes of this grant is data to be shared with the USDOT. The data will provide important insights to the safety of these vehicles, how they are similar or different from manually-driven vehicles, in the way they interact with other road users and the roadway environment. Equally important is whether people trust and use these AVs, and how the AVs become part of a much larger integrated mobility system. Collecting, analyzing, and sharing these data will greatly improve everyone's understanding of these vehicles, and lead to better design and use of the next generation AVs.

The engineering (safety) data we will collect from the fleet vehicles includes stereo cameras, and on-board real-time kinematic (RTK) GPS data—details are discussed later in Section 5.2. These data will capture the motion (position and velocity) of the AVs, as well as the distance to other road users. Important metrics to compute include time-to-collision (time gap), minimum-distance, acceleration, and yaw rate. Other metrics will be developed as kinematic safety surrogate measures, as an output of the project.

The non-engineering data will include ridership, origin/destination of trips, and connection to/from other mobility modes. Survey data will also be collected to understand user trust, need, and feedback.

The data we collect, both raw and analyzed data, will be shared with USDOT as part of the deliverables of this project. The raw data will be shared near real-time, through the data system

that we will build in close consultation with USDOT. Data sharing will allow researchers from the public to have access to the data, to accelerate the further development of AV technologies. Our team is committed to evaluating the data in partnership with USDOT and the other selected awardees of the grant.

## 5.4 APPROACH TO RISK IDENTIFICATION, MITIGATION, AND MANAGEMENT

As detailed in the collaboration section, Ford Smart Mobility, LLC City: One team will conduct a human-centered design thinking process with Detroit's senior and disabled communities and private sector and non-profit partners, including AARP, Henry Ford Health Systems, a grocery store, and HAP, to develop a series of ADS pilots that will improve accessibility and quality life and have innovative business models that the private sector partners are willing to explore. During this process, we will put out a Request for Information (RFI) from ADS vehicle providers that explains what the future deployments will likely be centered around (moving people/goods, geography, time of day, etc.) as well as include data requirements that are agreed upon by the team and USDOT in order to meet the necessary requirements to evaluate safety. The RFI will open a dialogue with the providers that will inform an ultimate Request for Proposal (RFP) that will come from MDOT and the MEDC.

Our decision to conduct an RFP process during the project as opposed to selecting a provider from the outset was based on our conversations with providers over the last few months. We discussed potential partnerships with two OEMs and one ADS shuttle company and all three had the same concerns on the potential unknowns of the project at this time, particularly around data sharing. There was concern that even if we reached an agreement at this time, future changes, whether it was on our side or the provider's, would impact the ability to provide the services promised in this proposal.

The major risk in this proposal is that no provider actually responds to the RFP and we are not able to complete this portion of the project. We are mitigating this risk through two means:

- We will meet the requirements of "each demonstration must include a physical demonstration" and "demonstrations may occur on proving grounds, test tracks, port terminals, campuses, or on public roads" through the proposed demonstrations at both Mcity and the American Center for Mobility.
- By collaboratively working with providers and the USDOT on the RFI and RFP closer to when the actual deployments are going to occur, we will be able to provide the reliability to the providers to bid on the project that they do not feel exists today.

While there is risk in this approach, we believe it is significantly less risky than bringing on a provider today and hoping that they will be able to meet the requirements that we set two to three years from now. We have letters of support from a number of ADS providers that agree with this approach and are interested in participating in the future procurement process.

## 5.5 APPROACH TO CONTRIBUTE AND MANAGE NON-FEDERAL RESOURCES

In order to expand the work that can be completed by Michigan Mobility Collaborative as part of this proposal, we have identified the following cost share allocations:

- The City of Detroit will provide $2,250,000 in infrastructure support over three years around traffic signals, resurfacing, restriping, and signage to support the deployment of ADS vehicles on city streets.
- The City of Detroit will contribute $278,710 in in-kind staff time to this project
- Mcity will contribute approximately $1,754,368 in existing research work and testing infrastructure that will be dedicated to this effort
- Mcity will contribute $550,800 in imputed test track usage fees
- Mcity will contribute approximately $706,356 in in-kind staff time to this project
- ACM will contribute $1,146,050 in test track usage fees

The City of Detroit is currently in the final approval stage of a $1,041,000 grant from the Knight Foundation around public engagement for autonomous vehicles. Assuming that grant is approved, it would be used to support this project.

This is a total of $7,727,284 in potential cost share to this project.

A number of the partners, including Henry Ford Health Systems, AARP, Verizon, were not able to commit financial participation to the project in the timeframe allowed, but have committed a willingness to share staff time as well as identify additional funding opportunities. Henry Ford Health Systems has funded a number of innovative mobility projects in Detroit, including sponsoring MoGo, and Verizon currently has equipment at Mcity.

In addition to the commitments listed above, the City of Detroit's Office of Development and Grants (ODG) will be dedicated to raising additional funds to support further research and pilots. This office is one of the largest dedicated municipal fundraising teams nationally and raised over $325 million dollars for city programs and initiatives in 2018 alone. ODG will manage the relationships with the non-federal funders and work closely with the foundations that provided letters of support to raise money.