ADS FOR RURAL AMERICA

UNIVERSITY OF IOWA

IN PARTNERSHIP WITH THE IOWA DOT
AND IOWA STATE UNIVERSITY

MARCH 2019

THE UNIVERSITY OF IOWA

US Department of Transportation
Notice of Funding Opportunity #693JJ319NF00001

THE UNIVERSITY OF IOWA

COLLEGE OF ENGINEERING
National Advanced Driving Simulator
and Simulation Center
2401 Oakdale Blvd
Iowa City, Iowa 52242-5003
(319) 335-4683 Fax: (319) 335-4658
www.nads-sc.uiowa.edu

March 15, 2019

The Honorable Elaine Chao
Secretary of Transportation

RE: Automated Driving System Demonstration Grants, Funding Opportunity Number 693JJ319NF00001

Dear Madam Secretary and Members of the Selection Committee,

The USDOT has consistently prioritized improving safety on our Nation's roadways as its top strategic and organizational goal. With our decades of expertise in on-road demonstrations, commitment to producing high-quality data, and interest in improving mobility in our rural areas, ADS for Rural America is a clear choice in testing the safe integration of ADS into the Nation's on-road transportation system.

The foundational partners of the ADS for Rural America project team have led the way in preparing our state to become AV-ready. With a proven history in ADS demonstrations and on-road research, we are prepared to provide the USDOT with an innovative ADS Demonstration Grant project that provides a broad wealth of data translatable across a wider range of people and areas on our Nation's roadways. **The ADS for Rural America vision for this grant award is to demonstrate challenges to the safe integration of ADS into our Nation's rural roadways and publicly make this data available, thereby providing more significant benefits for all Americans, particularly our aging, mobility challenged populations.**

Our project team believes that all Americans will benefit from data that represents more than just the urban areas of our country. The USDOT has stated that it will prioritize policies and programs connecting all users in rural communities, especially for those who are transportation-disadvantaged, to economic opportunities and services, and we believe that ADS data should address this, too. Beyond accelerating safety and mobility, there exists a significant un-tapped economic opportunity to utilize ADSs in rural areas

We stand ready to enhance safety on all of our Nation's roadways, including those that have not yet been well-represented in demonstrations and research. With full support of our foundational partners, the University of Iowa enthusiastically submits this grant application for your review and consideration.

Daniel V. McGehee, PhD
Director, National Advanced Driving Simulator

Summary Table	
Project Name/Title	ADS for Rural America
Eligible Entity Applying to Receive Federal Funding (Prime Applicant's Legal Name and Address)	University of Iowa 2 Gilmore Hall Iowa City, Iowa 52242-1320
Point of Contact (Name/Title; Email; Phone Number)	Daniel V. McGehee Professor, University of Iowa; Director, National Advanced Driving Simulator daniel-mcgehee@uiowa.edu 319-335-6819
Proposed Location (State(s) and Municipalities) for the Demonstration	State: Iowa Municipalities: Iowa City, Hills, Riverside, Kalona
Proposed Technologies for the Demonstration (briefly list)	L3+ automation Vehicle-to-infrastructure traffic signal technologies (V2I) On-board telemetry processors (V2V)
Proposed duration of the Demonstration (period of performance)	October 2019 – April 2022
Federal Funding Amount Requested	$7,026,769.28
Non-Federal Cost Share Amount Proposed, if applicable	$822,744.09
Total Project Cost (Federal Share + Non-Federal Cost Share, if applicable)	$7,849,513.37

Table of Contents

List of Tables

List of Figures

1. EXECUTIVE SUMMARY

Iowa has a bold vision to lead the nation in improving rural roadway safety while providing significant public benefit to our communities and transportation-challenged populations like the exponentially-growing older American population segment. For decades, we've led cutting-edge national and international research in crash avoidance and ADS research. More recently, we've been collaborating with the Iowa DOT and Iowa State University to develop an automated vehicle (AV)-ready driving environment in our state through infrastructure and HD-mapping efforts.

By leveraging our previous on-road demonstrations and research, as well as financial investment through the USDOT, ADS for Rural America will develop and execute a demonstration project that gathers and generates a wealth of publicly-available data on rural roadways that can address a variety of questions among a diverse set of end users in order to safely integrate ADS into *all* of our Nation's roadways.

Our region provides an ideal location to demonstrate the safe deployment of ADS technologies in rural environments that have variance in climate, weather conditions, road surface, traffic, and much more. What is encountered in Iowa throughout ADS for Rural America will be transferrable to rural areas across the US that are not addressed by current urban-centric demonstrations. We have a proven record of experience in ADS demonstration and a wealth of expertise at one of the most world-renowned driving research centers, the National Advanced Driving Simulator, here in the heart of rural America.

KEY PARTNERS

The University of Iowa	One of the nation's premier public research universities. Home to the National Advanced Driving Simulator, the UI provides decades of expertise and some of the most experienced vehicle safety researchers in the US and internationally.
Iowa Department of Transportation	Iowa's roadway system is one of the largest in the nation, ranking as the 14th state by total number of public lane miles. The Iowa DOT is responsible for roughly 10,000 miles of the system. The Iowa DOT drives a research program that delivers targeted solutions for the state's transportation future.
Iowa State University	A leading research university that specializes in roadway infrastructure applications and data.
AutonomouStuff	A world leader in supplying R&D platforms, products, software, engineering services, and data intelligence to aid in the advancement of robotics and autonomy.
Mandli Communications, Inc.	An industry leader in specialized highway data collection and the integration of 3D pavement technology, mobile LIDAR, and geospatial data collection equipment for various state DOTs.

ISSUES AND CHALLENGES

Nationwide, rural communities and their roadways are disproportionately affected by road safety issues. While 19% of Americans live in rural areas, deaths on rural roadways account for about 50% of all traffic fatalities. Multiple, complex factors contribute to transportation-related fatalities and injuries on rural roadways, including their infrastructure—outdated designs, sharp curves, steep grades, limited sight distances, sharp pavement drop-offs—and unique environments—slow-moving vehicles, animals, high speeds, and extreme weather conditions.

While 19% of Americans live in rural areas, nearly 50% of traffic fatalities occur on rural roads

While ADS technologies bring the promise of even greater safety on our Nation's roadways, rural roads are underrepresented in ADS research today. To date, due to the complexity of rural environments, most manufacturers have focused in mapping and testing on urban, clearly-marked roads. But mobility is essential to rural America, particularly in isolated areas.

A relatively large and growing portion of rural and small-town residents are older Americans. As our Nation's population exponentially ages over the next few decades and Americans continue their desire to "age in place" (continuing to live in their own home regardless of age, income, or ability level), increased rural mobility options will be to simply maintain and, ideally, improve the safety on these roadways. Today, many of our Nation's public and private transportation options focus on getting older adults to and from medical appointments. However, healthy aging requires a holistic context of health, recognizing that factors like access to healthy food sources and social interaction also contribute to a positive quality of life.

ADS FOR RURAL AMERICA GOALS

ADS for Rural America developed three major goals in addressing these issues and challenges:

- **Improve safety** on our Nation's roadways by beginning to lay the groundwork for the safe integration of ADS
- Work to **address disparities** in our Nation's roadway system by focusing demonstrations and ADS data gathering on rural roadways
- Demonstrate how ADS can be used to **enhance mobility** for transportation-challenged populations such as the aging populations in our rural communities

To begin to address these goals and the complex, multifaceted safety challenges rural roadways pose, ADS for Rural America has developed a demonstration project to gather publicly-available data for analysis that will help to identify risks, opportunities, and insights relevant for USDOT safety and rulemaking priorities. At the same time, ADS for Rural America will focus on testing ADS applications for the aging, transportation-challenged rural population. Objectives include:

- Conduct an ADS demonstration project with eight increasingly complex phases that each include ten drives of the full route to capture variability
- Collect and publicly share data in near real-time, making it available within one week after the completion of each drive

- Augment data collected with markers and other information to make the dataset most useful to those accessing it, in order to more easily identify risks, opportunities, and insights relevant to the safe integration of ADS technologies
- Provide knowledge transfer opportunities to share data and lessons learned
- Improve public open source ADS software modules (CARMA, Autoware) utilized in support of this project by identifying and correcting bugs in software as they are found and sharing software fixes in the public domain

OUR APPROACH

ADS for Rural America will take place in Eastern Iowa, a region representative of much of rural America with its variable seasons, rural roads, and roadway hazards. The project will drive in a loop from a mid-sized city (Iowa City) through rural areas and small towns, providing an example for how ADS can connect rural populations. With a focus on connecting rural transportation-challenged populations like the rapidly growing aging sector, ADS for Rural America will utilize a custom, mobility-friendly ADS built on a commercially available platform.

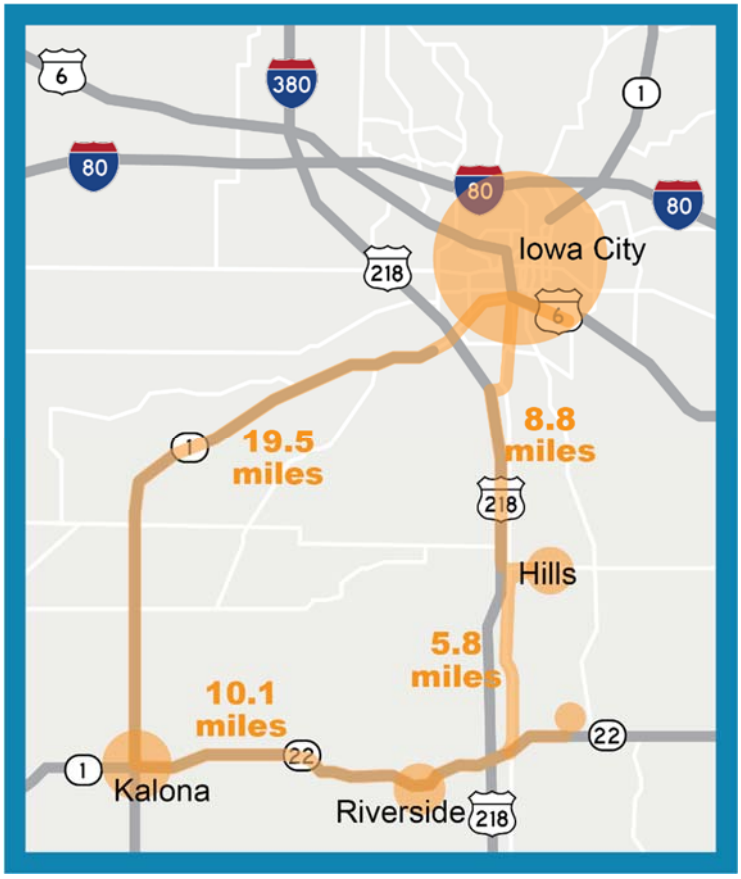

Figure 1. ADS for Rural America map

As illustrated in Figure 2, the project is comprised of eight phases, each a segment of this route that add additional automation and increase in complexity for the ADS technologies. Ten drives will take place during each phase to increase the breadth of data collected, including driving during varying lighting and weather conditions. The route will be driven in its entirety each phase. This approach will produce a dataset that provides comparative data across phases as the level of automation increases. During each new phase, the ADS for Rural America project team will assess the automation's performance and use the data collected to inform improvements in successive phases.

Figure 2. Overview of ADS for Rural America

ADS for Rural America will develop and demonstrate varying levels of automation, including L3+, and show how connected vehicle technologies can be used to support automation and provide safety-critical vehicle and infrastructure information sometimes unavailable via use of on-board sensors. We will utilize available public and open sources of connected and automated vehicle technologies, including FHWA's CARMA and Autoware, in engineering our vehicle. ADS for Rural America will also demonstrate and provide data on occupants of automated vehicles which will include information from safety drivers and passengers to gain valuable and unique insight into the occupants' perception and acceptance of being in ADS.

Within one week of a completed ADS for Rural America drive, the indexed, synchronized, point-in-time data will be uploaded to a cloud-based service and can be accessed via a publicly-available API or by request of raw per-drive data. Going further than just releasing data, ADS for Rural America strives to "tell a story," providing context by evaluating the quality of the generated data and augmenting it with markers and other information to make the dataset more useful for those using it to identify risks, opportunities, and insights relevant to safety and rulemaking priorities. Quantifiable performance improvements in the automation from one phase to the next will be part of the data collected and used to inform improvements in successive phases.

ADS for Rural America data will not only tell a story in how ADS can safely navigate our roadways, but also how these technologies can help to serve our transportation-challenged populations like the exponentially growing aging American demographic. Biometric sensors in our custom-engineered, mobility-friendly vehicle will speak to occupant comfort and emotional state during the drives. A UI-developed input/output user interface will focus on inclusive screen settings for users of varied abilities, with a goal of incorporating larger menu options and auditory cues for visually impaired, touch accommodations for those with tremors and dexterity issues, and the ability to hold the vehicle in place when there is no human driver to with which to visually communicate. Additionally, questionnaires after each drive will evaluate vehicle occupants' initial perceptions of the automation, specific comfort, feedback, and suggestions for changes to system design.

PERIOD OF PERFORMANCE

ADS for Rural America has a period of performance of 2.5 years. During the project's first six months, we will engineer the vehicle, refine plans, and establish the cloud-based storage platform. At the six-month mark, we will begin our eight data collection phases (consisting of ten drives each), with each phase taking place every quarter. Data will be released within one week after the completion of each drive and made available for five years after project completion.

2. GOALS ALIGNMENT

ADS for Rural America distinctly aligns with the USDOT's goals of safety, data for safety analysis and rulemaking, and collaboration as outlined below.

2.1.1 Safety

Like the USDOT, safety is ADS for Rural America's top priority. Safety *is* the mission of the project's lead entity, the UI National Advanced Driving Simulator: To improve safety by researching the connection between drivers, motor vehicles, and road users. It is also a pillar of the Iowa DOT's mission: Getting you there safely, effectively, and conveniently. Safety will remain our utmost priority, as evidenced through our incorporation of a Safety Management Plan, utilizing alert and trained safety drivers, and custom development of an interface that informs the safety driver of the health of the automation.

The ADS for Rural America project is a testament to the NOFO's primary goal of testing the safe integration of ADS on our Nation's on-road transportation system by focusing on rural roadways, which comprise 91% of the US' total public roadway mileage. By conducting our demonstration in rural America, highlighting the unique challenges these roadways and environments pose, we will broaden the scope of data being collected that will result in better insights and more comprehensive safety metrics for ADS nationwide.

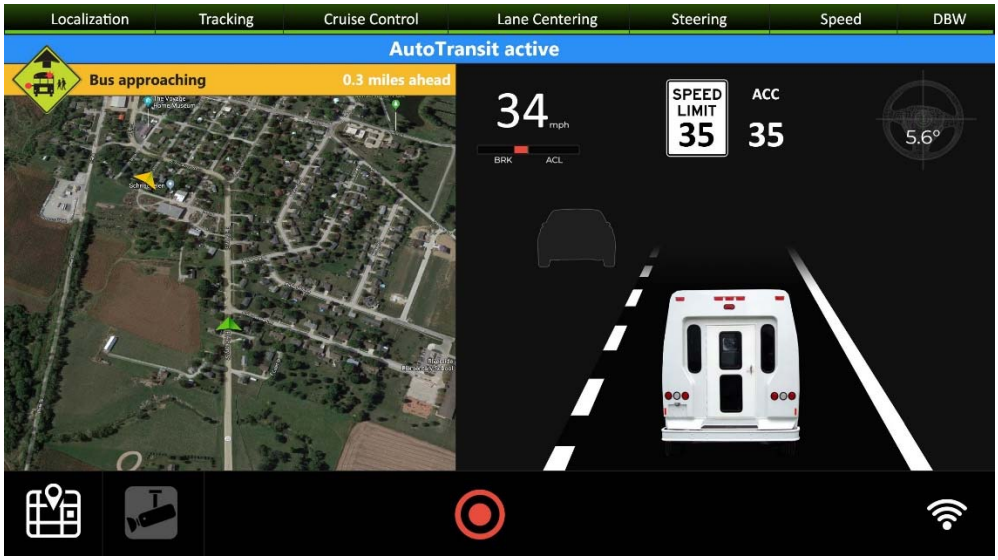

Figure 3. Custom UI-developed ADS interface for safety drivers with information on the health of the automation

2.1.2 Data for Safety Analysis and Rulemaking

ADS for Rural America is committed to ensuring significant data gathering through the eight phases of our project, with each phase comprised of ten drives each to allow for variability in conditions. While each phase will focus on a segment of this overall route that increases in complexity for the ADS technologies, the route will be driven in its entirety each drive to show how automation is increasing and to allow for comparison from one phase to the next. The data

gathered from these drives will be shared in near real time with the USDOT and the public via cloud-based service within one week of each drive's completion. This will be indexed, synchronized point-in-time data that can be accessed via a publicly-available application programming interface (API) or by request of raw per-drive data. For greater leveraging of the data, the API would allow for longitudinal searching using bounds for a given sensor.

ADS for Rural America seeks to create a framework for storing and sharing data that will prove useful to the USDOT and research community moving forward, not only supporting the needs of this project but designed to scale and adapt to the needs of future projects. We recognize the importance of this work, as the successful development and testing of ADSs will require the processing of data on a scale that will dwarf datasets created even within currently existing large-scale programs. Our cloud-based approach will support development of advanced algorithms and analytical techniques to harness these vast datasets. These new techniques have the potential to discover hidden patterns and insights that simply would not be found until we develop an organization agnostic framework for storing data from multiple research studies.

The ADS for Rural America database high-quality data will be utilized by a broad range of end users, from researchers to developers to policymakers. To expand on ADS data collected by the vehicle and provide additional opportunities to help inform insights relevant for safety and rulemaking priorities, ADS for Rural America will also gather data from:

- Vehicle-to-vehicle (V2V) technologies
- Vehicle-to-infrastructure (V2I) traffic signals
- Passenger biometrics
- Questionnaires from vehicle passengers on trust and acceptance of the ADS

2.1.3 Collaboration

The UI and Iowa DOT have a long history when it comes to developing and maintaining partnerships on projects of all sizes. Over the last few years, ADS for Rural America project team members have worked together in preparing the state of Iowa to be AV-ready by digitally mapping roadways and conducting demonstrations of ADS capabilities. Our team understands the value of collaboration that build expertise, ingenuity, and knowledge and maintains positive relationships with local, state, and national stakeholders, as well as industry experts.

As an on-road ADS project, we acknowledge that there will understandably be many questions from community residents, law enforcement, local public agencies, businesses, and others. Recognizing this, ADS for Rural America includes early and consistent stakeholder engagement to ensure safety on our roadways as well as a shared understanding of the project to conduct these demonstrations on terms that work for everyone involved.

3. FOCUS AREAS ALIGNMENT

Table 1. Focus Areas Alignment

ADS Demonstration Program Focus Area	ADS for Rural America Focus
Significant public benefits	• Improve holistic quality of life for the Nation's exponentially growing older, transportation-challenged populations • Connection of rural communities with each other and to nearby urban centers • Increase variety of ADS data (seasons, roadways, traffic) • Improve rural roadway safety
Addressing market failure and other compelling public needs	• Focus on underrepresented rural roadways • Focus on older population • Focus on enabling higher levels of automation via connected and cloud-based technologies; not purely on-board sensors • User interface will be accessible to those with varied abilities, primarily older users • Development of the user interface will include research into incorporating inclusive screen settings that increase accessibility by working to address issues like dexterity and tremors
Economic vitality	• Demonstrate ADS (autonomy and mapping) capabilities of Midwestern-based companies • Focus on connecting rural residents/communities • Highlights business opportunities in rural America for ADS-related technologies
Complexity of technology	• Focus on demonstrating L3 and greater automation • Incorporation of V2V and V2I technologies • Integration of HD map • Cloud-based connections • Cloud-based data storage and analysis
Diversity of projects	• Serves a variety of communities – small towns, rural populations, urban area • Personal mobility focus
Transportation-challenged populations	• Vehicle equipped for people with limited mobility and disabilities • Vehicle includes wheelchair restraints and lift • Vehicle provides easier entry/egress for mobility challenged
Prototypes	• Mobility-friendly vehicle custom engineered with ADS technologies • Custom input/output user interface to be designed by UI with a focus on inclusive screen settings for users of varied abilities

4. DEMONSTRATION REQUIREMENTS

Table 2. Demonstration Requirements

ADS Demonstration Program Requirements	ADS for Rural America Requirements Satisfied	
Focus on research and development of automation and ADS technology, with a preference for demonstrating L3 or greater automation technologies	✓	ADS for Rural America will utilize a commercially available, mobility-friendly vehicle engineered with ADS technology capable of demonstrating L3 and greater automation
Include a physical demonstration	✓	ADS for Rural America project is comprised of eight physical demonstrations, each with 10 drives in order to provide a significant amount and breadth of data
Gather and share all relevant and required data with the USDOT throughout the project, in near real time	✓	Data will be made available to the USDOT and public via a web-based interface within one week of each completed drive
Input/output user interfaces on the ADS and related applications that are accessible to allow users with varied abilities to input a new destination or communicate route information generated by the ADS	✓	Custom input/output user interfaces on the ADS will be designed by the UI and will allow users of varied abilities to input of a new destination. Development of this user interface will include research into incorporating inclusive screen settings that increase accessibility by working to address issues like dexterity and tremors.
Demonstration can be scaled to be applicable across the Nation to similar types of road environment	✓	As rural roads comprise 91% of total public roadway mileage, ADS for Rural America is highly applicable across the Nation. The project encompasses a variety of rural roadway types, speeds, and environments in varying weather and conditions.
Include an outreach task to share demonstration status, results, and lessons learned with other jurisdictions and the public	✓	Webinars will be held quarterly after each project phase in furtherance of technical exchange and knowledge transfer for transportation researchers and professionals. The ADS for Rural America Communications Plan includes early and consistent stakeholder engagement, as well as outreach before, during and after the project period of performance.

5. TECHNICAL APPROACH

5.1 PROJECT NEED

ADS for Rural America is committed to leading the way in safely preparing our Nation for ADS technology in rural areas. **Rural roads are disproportionately dangerous**, with designs that are often outdated, presenting issues such as sharp curves and steep grades resulting in limited sight distances, sharp pavement drop-offs, missing or inaccurate signage, slow-moving vehicles or stationary obstacles, and loose surfaces or unpaved roadways. In 2017, nearly 50% of the 37,133 traffic fatalities occurred on rural roads, even though only 19% of the US population lives in rural areas and only 30% of the vehicle miles travelled occur there.

While ADS brings the promise of greater safety on our Nation's roadways, **rural areas are underrepresented in current ADS research.** Most manufacturers today have focused mapping and testing on urban, well-lit, clearly-marked roads. Although mobility is essential to rural America—transportation connects 60 million rural American residents to jobs, school, services, healthcare, and social opportunities—it's possible that rural areas could be among the last to benefit from automation.

Our population is aging quickly, particularly in rural areas. By 2035, for the first time in U.S. history, adults 65 and older will outnumber children under the age of 18, with the gap continuing to widen. By 2045, the number of drivers aged 65 and older will increase 77%.[1]

A disproportionate percentage of adults over age 65 are living in rural areas (17.2%) compared to urban areas (12.8%).[2] This trend of an aging rural America is likely to continue as many older Americans desire to "age in place," meaning they want to continue to live in their own home independently, regardless of age, income, or ability level. Public and private transportation options exist for older Americans, but many focus on getting individuals to and from medical appointments and approximately 40% of the rural US population is without public

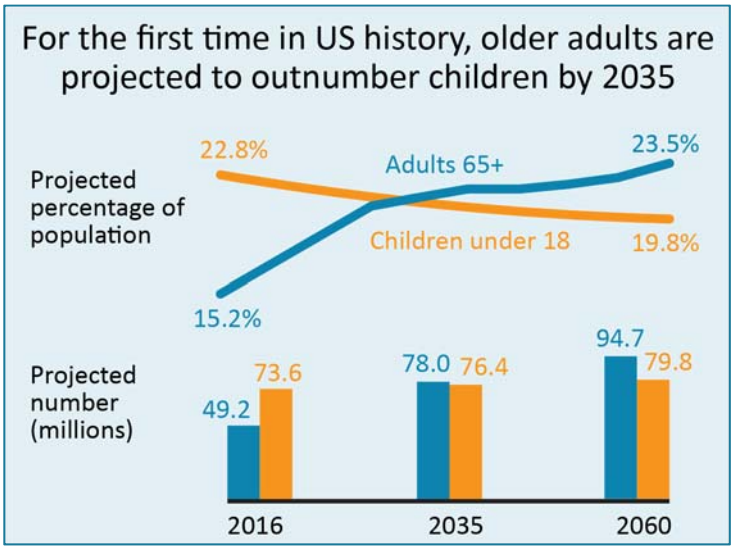

Figure 4. The US' aging population

[1] United States Department of Transportation. (2015). Beyond Traffic 2045. Available at: https://www.transportation.gov/sites/dot.gov/files/docs/BeyondTraffic_tagged_508_final.pdf

[2] US Department of Agriculture. Economic Research Service. Available at: http://www.agweb.com/article/rural-population-slips-again-in-2014-NAA-ben-potter/

transportation at all, while another 25% only has minimal service.[3] Healthy aging requires a holistic context of health, recognizing that factors like access to healthy food sources and social interaction also contribute to a positive quality of life. The safe integration of ADS into the nation's on-road transportation system, particularly in rural areas, can vastly improve overall quality of life for a rapidly growing segment of the US population that will like not be served by the private sector in the near future.

5.2 LOCATION

ADS for Rural America will take place in Eastern Iowa, traveling from Iowa City through various small communities and rural areas south of the city. These communities and rural areas were selected to highlight how ADS can provide significant public benefits to quickly growing transportation-challenged populations in the US that will likely receive insufficient private sector investment in the near future. The ADS for Rural America map can be found on page 3.

The small, rurally-located towns included on the ADS for Rural America project route, as well as the surrounding rural areas and other nearby communities, are severely lacking in amenities such as healthy food sources and opportunities for social interactions. While the majority of the population in rural America own vehicles and drive to their desired destinations, this is not such a simple task for our increasingly aging, mobility-challenged residents who desire to age in place but are unable to drive independently.

5.3 DATA SOURCES AND SENSORS

We will utilize a custom-built, mobility-friendly vehicle that demonstrates L0-L3+ automation technologies. Vehicle data will be generated by a variety of sources, as shown in Table 3.

Table 3. In-Vehicle Data Sources and Sensors on the ADS for Rural America Vehicle

Data Source	Data
VehicleCAN	Gear shifter position, steering wheel angle, vehicle speed, odometer, outside temperature, seatbelt status, accelerator pedal position, brake pedal position, low/high beam status, brake light status, fog lamp status, wheel speed, airbag status, anti-lock brake system status, cruise control status
UserCAN	By-wire system commands, software commands, status faults, ROS topic subscriptions, etc.
LIDAR	LIDAR localization, point cloud data of roadway, scenery and objects near the vehicle
Radar	Adaptive cruise control, tracks (ESR), and detections (SRR)
GPS system	GPS time, position latitude, longitude, elevation, quality, receive TRK corrections
High resolution camera x 2	Object detection with sensor fusion and deep neural net algorithms
Cohda MKS OBU	On-board unit receiving smart infrastructure V2X data
Mobileye	Collision avoidance warning, pavement marking, signing, and pothole roadway condition
Webcam video	Forward view, rear view, passenger face and torso, safety driver face, hands, torso and feet
Millimeter wave sensor	Passenger biometrics such as heartbeat and respiration rate

[3] National Council on Disability. (2005). *The Current State of Transportation for People with Disabilities in the United States.* Washington, DC: National Council on Disabilities.

To gather additional data, ADS for Rural America will deploy a number of technologies and components throughout our route, on stationary objects and moving vehicles. These connected vehicle and infrastructure technologies are needed to support higher levels of automation on rural roadways. Some of these technologies (tractors and school buses) are already being deployed and studied through other ADS for Rural America project team work (see Cost Sharing section for more information). Other technologies, such as connected traffic signals, are being incorporated to support automation along the route. Our plan is to log data from these external technologies and index it against data from the ADS.

5.4 DATA TO BE COLLECTED

Today, many vehicle developers use the primary metrics of miles accumulated on public roads and number of times a safety driver has to intervene. While these metrics are important, they provide a limited view of ADS testing since they don't offer a way to measure the diversity of situations encountered. No single measure at any stage or setting can tell the entire story. "**Roadmanship**" is a new, not yet entirely defined, integrated leading measure of driving abilities that goes beyond these basic safety metrics to suggest that an ADS behaves similar to human drivers. Data collected throughout the ADS for Rural America project would be a significant way to begin to build roadmanship metrics.

Rural roads are incredibly complex, which makes the safe integration of ADS onto these roadways an immensely challenging endeavor. There is a need for automated vehicles to be tested under challenging, as well as more common conditions. It's also widely understood that there's a need to develop rich databases with more comprehensive geospatial roadway data to improve ADS' safe navigation and operation.[4] Similar to much of the Nation, ADS for Rural America provides these more challenging conditions in which to demonstrate and record data in the operational design domains (ODD) in which ADSs are designed to operate.

ADS for Rural America consists of eight phases, with 10 drives each on the project route as shown in Figure 5.

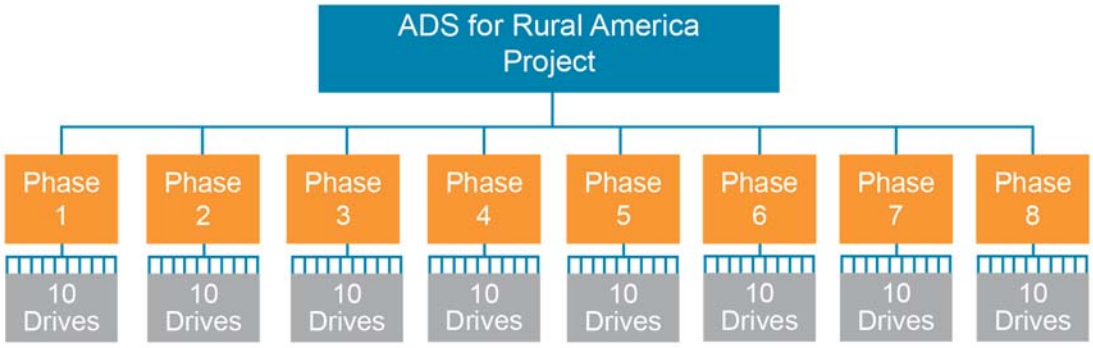

Figure 5. Project phases and drives

[4] USDOT Roundtable on Data for Automated Vehicle Safety: Summary Report. (January 2018). Available at: https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/304471/roundtable-data-automated-vehicle-safety-report.pdf

More automation will be introduced with each project phase to address different types of roads, intersections, driving conditions, and more that will be encountered. The defined route will be driven in its entirety for each of the project's eight phases to show how automation is increasing and to allow for comparison from one phase to the next. During each new phase, the ADS for Rural America project team will also be assessing the automation's performance and using the data collected to inform improvements in successive project phases.

During all drives, a **trained, alert** safety driver will be ready to take control from the automation if needed, with an additional project team member always present in the vehicle.

Each drive will be scheduled to capture different lighting, weather, and roadway conditions to develop a dataset that will offer unique insights into the effects of these on ADS performance. Data anticipated to be collected for all phases and drives from the vehicle:

- Automation and vehicle performance along entire route
- Automation and vehicle performance in varying weather and lighting conditions
- Automation and vehicle performance on varying road surfaces
- Safety driver and occupant physiological, emotional and postural state
- Indexed data from sensors, video cameras (internal & external), LIDAR

The next several pages explain the various phases and drives, including unique data anticipated to be collected.

5.4.1 Phase 1 – Controlled Access Divided Highway/Interstate

April – June 2020
Route Technologies: L3+ automation

Phase 1 Unique Data Anticipated:

- Maintaining lane position
- Maintaining following distance
- Responding to slower moving vehicles
- Responding to merging vehicles or cut-ins
- Reaction to unexpected events

April – June 2020
Route Technologies: L3+ automation

Phase 1 Unique Data Anticipated:

- Maintaining lane position
- Maintaining following distance

Controlled access highways and interstates are considered to be the easiest candidates for implementing automation, as all undivided lanes travel in the same direction, vehicles are only able to enter and leave the roadway at on and off ramps, and most vehicles travel around the same speed.

This initial phase will navigate along controlled-access highways in L3 automation or above, traveling at normal highway speeds in mixed traffic which will include heavy trucks, wide loads, and slow-moving vehicles. The vehicle will maintain lateral and longitudinal position via automation that utilizes on-board sensors and a high-definition map of the route. All other parts of the route will be driven under L2 automation or manual control via the safety driver.

5.4.2 Phase 2 – Two-lane Undivided Highway

July – September 2020
Route Technologies: L2-L3 automation

Phase 2 Unique Data Anticipated:
Everything in Phase 1, plus:

- Oncoming vehicles encroaching in lane
- Vehicles on the shoulder encroaching in lane (bicycles or slow-moving road users like horse and buggies)
- Roads with a wider variety and conditions of lane markings
- Roads with a wider variety of vehicle types, speeds, and shapes
- Unexpected events (animals on roadway)
- Traffic entering the roadway from driveways or intersections

Two-lane undivided highways present traffic that travels in opposite directions, more variable vehicle speeds, and vehicles may pass in oncoming traffic lanes. Crash data shows that traffic incidents on rural highways result in higher injuries to people and more damage to vehicles.

This phase will build upon the previous phase, adding higher levels of automation to navigate in L2-L3 automation, maintaining lateral and longitudinal position via automation that utilizes on-board sensors and a high-definition map of the route. The safety driver will assume control over parts of the route where the vehicle doesn't have protected right of way (such as intersections).

5.4.3 Phase 3 – Connected Vehicles on Two-lane Highways

October – December 2020
Route Technologies: On-board telemetry processors (V2V)

Phase 3 Unique Data Anticipated:
Everything in Phases 1-2, plus:

- Interactions with tractors and agricultural equipment at unexpected locations (V2V)
- Interactions with slow/stopped school buses (V2V)
- Varying roads surface conditions due to rain, leaves, and snow
- Varying lane widths due to snow drifts
- Unpredictable behavior of other drivers due to inclement weather
- Exposure to significant traffic on Big Ten college football game days

Slow-moving and stopped vehicles pose hazards across our Nation's rural roads, particularly on steep grades and around curves.

Phase 3 will outfit two school buses and two tractors/slow-moving vehicles with on-board telemetry processors. Multiple interactions with these vehicles will be orchestrated throughout each drive. During the drives, on-board telemetry processors will provide location and speed information to our vehicle, enabling it to slow down and/or stop even without direct line of sight. This phase will build upon the previous phases and augment the automation with connected vehicle data and our experience in instrumenting rural school buses with connected vehicle technology for demonstrations.

5.4.4 Phase 4 – Roads through Cities and Towns

January – March 2021
Route Technologies: L2-L3 automation, V2I traffic signals

Phase 4 Unique Data Anticipated:
Everything in Phases 1-3, plus:

- Higher traffic densities across multiple lanes of traffic
- Controlled intersections with traffic signals with and without connected infrastructure capability
- Interactions at uncontrolled intersections
- Snow and ice-covered roadways
- Higher exposure to poor lane markings and potholes due to worsening road pavement conditions over winter
- Speed limit variations
- Fewer, faded, and hidden traffic signs
- Limited sight distance

Urban areas have a wide variety of intersections and higher traffic densities. This phase adds higher levels of automation to navigate roadways and these intersections under L2-L3 automation. We will instrument four intersections with transmitters to provide more accurate information about the traffic signal state to the vehicle.

We anticipate collecting data in challenging driving conditions for the vehicle's on-board sensors due to winter weather, including snow and ice-covered roads. Phase 4 will present a unique opportunity to explore how well the HD map will help make up for any potential loss in on-board sensor functionality. Even when roads have been cleared, we anticipate lane markings to fade over the winter months due to continuous salting plowing. Additionally, lane markings will likely be difficult to distinguish from white lines created by anti-icing treatments.

5.4.5 Phase 5 – On- and Off-Ramps

April – June 2021
Route Technologies: L2-L3 automation

Phase 5 Unique Data Anticipated:
Everything in Phases 1-4, plus:

- Vehicles merging onto or exiting highways at varying speeds
- Vehicles displaying varying lane positions and spacing from other vehicles

Off-ramps (and, even more so, on-ramps) are uniquely challenging due to varied geometries and vast differences in speeds of vehicles entering and leaving highways. Driver behavior in these locations can be highly unpredictable.

Phase 5 will add higher levels of automation on highway on and off-ramps along the project route, with a goal of navigating these under L2 and L3 automation.

5.4.6 Phase 6 – Unmarked Road

July – September 2021
Route Technologies: L2-L3 automation

Phase 6 Unique Data Anticipated:
Everything in Phases 1-5, plus:

- Roads without lane markings
- Exposure to oncoming vehicles that seem directly in path
- Adopting a line of travel not informed by lane markings and changes depending on if there is any oncoming traffic
- Interaction with oncoming vehicles
- Narrow lanes
- Soft shoulders
- No centerline
- No lighting

The lack of any lane marking presents a unique challenge as there is no well-defined lane for either direction of travel. This challenge becomes more daunting on unpaved roads. While travel is allowed in both directions, drivers often to choose to drive in the center of the road for safety reasons, due to a lack of shoulder. As an oncoming vehicle approaches, drivers then move closer to edge of the roadway.

In Phase 6, our goal will be to have the vehicle drive these roads under L2-L3 automation.

5.4.7 Phase 7 – Navigating Parking Areas

October – December 2021
Route Technologies: L2-L3 automation

Phase 7 Unique Data Anticipated:
Everything in Phases 1-6, plus:

- Slow speed maneuvering in tight spaces
- Interactions with pedestrians crossing in unanticipated places
- Interactions with other vehicles

October – December 2021

Parking areas present unique challenges, as streets and lots each have their own structure and lanes of travel. Parking areas expose ADSs to other vehicles and pedestrian in tight spaces.

In this phase, we will look at higher levels of automation in two on-street parking areas and in two parking lots where we will pick up and drop off passengers. We anticipate that some of the enhancements will be parking area specific, while other automation enhancements could be more generally applicable to navigating all parking areas.

5.4.8 Phase 8 – Full Loop

January – March 2022
Route Technologies: L2-L3 automation

Phase 8 Unique Data Anticipated:
Everything in Phases 1-7, plus:

- Winter weather
- Slow-moving road users

The previous phase represented the last new element of automation for this project. This phase offers an opportunity to address some of those challenges in the previous phase and collect more data on a highly automated vehicle across the entire route. This phase also exposes the more refined vehicle to a second Iowa winter.

5.5 EVALUATION OF DEMONSTRATION AND DATA

ADS for Rural America will generate a wealth of publicly-available data that can address a variety of questions among a diverse set of end users. These data, generated from a number of sources, will be utilized in important ways during and after the project. At each phase, the team will evaluate the quality of the generated data and augment the data with markers and other information to make the dataset most useful to those accessing it. This complete dataset from each phase will be used in two valuable ways. First, the project team will use a combination of available data to evaluate the drives and provide key outcome measures of the phases. The publicly-available dataset generated will also be a valuable tool for other researchers and practitioners following project completion. The following sections describe the approach to ensuring data quality, how the data will be used to evaluate the project, and how the available dataset might be utilized by a number of unique end users. Our Part 3 – Draft Data Management Plan provides more details on how we will securely and reliably manage the data and provide access to the data to users inside and outside our organization.

5.5.1 Evaluation of Demonstration and Data Quality

Evaluation Strategy – Upon project award, the project team will develop an Evaluation Strategy that identifies the expected data use cases. Using this strategy as a guide, the team will develop a set of testable scripts/algorithms to run on the data at each phase to ensure that the data collected is relevant and appropriately accessible to end users outside the research team.

Evaluation Plan – Working with the USDOT, our Evaluation Plan will be used as a guide for data collection and potentially for analysis, which will require refinement as more details on opportunities to collect data become available. In consultation with the USDOT, development and continual refinement of this Evaluation Plan will be a validation exercise that will examine how a user need might be met or improved as further drives are conducted and data is collected.

The goal of this step, which will be conducted at minimum after each phase, will be to provide usable data to a wide set of end users. The Evaluation Plan will include items such as:

- Evaluation of the completeness and quality of the different data sources. This is a critical first step in ensuring the usability of the resulting data set and will be achieved through a series of processes that include visualizing the data streams, removing extreme and spurious values, and performing routine checks and validation of the different data elements.
- A method for inserting markers into the data to identify certain events or portions of the roadway. For instance, having markers to indicate where voluntary takeovers by the control driver occurred or interesting interactions with other road users.
- Specific procedures and documentation for end users to access and manipulate the available data, including a dictionary defining data elements and how they were collected
- Base level data reduction algorithms to easily provide summary measures for specific drives and phases of the demonstration. For example, this might provide the average speed over a particular stretch of road for different phases of the project.

The Evaluation Plan, with Evaluation Criteria, description of data collection procedures tailored to these criteria, outline of an Evaluation Report (draft list of topics to be addressed), and a description of the data system, will be provided within 90 days after project award.

5.5.2 Demonstration Evaluation

Evaluation of the drives, performed following each phase, will be a critical piece of ADS for Rural America, as they will provide insight into the safety, effectiveness, and development of ADS capabilities during each phase. Demonstration evaluation will encompass a number of criteria and approaches:

- **Evaluating Progress.** By collecting data along the entire route during each drive, we will be able to assess the expanding capabilities and effectiveness of the automation over the course of the project. Using this approach, we will also be able to evaluate the L3+ automated capabilities against both lower level automation and manual vehicle control along the same segments of the route.
- **Evaluating Sensor and Automation Performance.** To evaluate the capability of the automation, it is critical to understand the performance of the sensors used for the automated capabilities. Using the metrics that drive the health of the system indicators, this analysis will evaluate how often the sensors failed or provided degraded signals, how often sensor failure led to voluntary or forced takeovers, and how well the automation was able to perform if and when particular signals were lost.
- **Evaluating Occupant Trust, Acceptance, and Health.** The final piece of automation capability evaluated will be the interaction and feedback with the occupants and safety driver. Participants will be involved in each of the drives. Questionnaires will be completed by occupants and safety drivers at the start and end of each drive in each phase. These questionnaires will evaluate initial perceptions of automation, specific comfort and feedback about the completed drive, and suggestions for changes to system design. Additionally, biometric sensor data will be used to speak to occupant comfort and emotional state during the demonstration.

5.5.3 Ongoing Database Utilization

In addition to these initial evaluations, ADS for Rural America will generate an immense database of useful, high-quality data. We envision that our publicly-accessible database will be utilized by a broad range of end users, from researchers to developers to policymakers. While these myriad of potential use cases cannot be described in full (and will continue to evolve well after the project), Table 4 provides examples of potential applications:

Table 4. End Users and Examples of Potential Applications

End User	Example Use Case Question	Relevant Available Data
Roadway Engineer	What roadway factors (lane markings, pavement types) limit the capabilities of automation?	Sensor Quality Data
Policy Maker	What level of vehicle-to-vehicle communication is necessary to support rural AV deployment?	Vehicle Interaction and Safety Data
Automated Vehicle Developers	What AV control behaviors make occupants and drivers less accepting of vehicle technology?	Takeover Information
Human-Machine Interface Designers	What information is important to provide to occupants and safety drivers?	User Preference/Acceptance Surveys
Human Factors Engineers	How comfortable are drivers and occupants in certain situations with rural AVs?	Occupant and driver biometric and survey data

5.6 COMMUNICATIONS AND OUTREACH PLAN

Collaboration and open communication are essential for any project. ADS for Rural America has developed an initial Communications and Outreach Plan, which will be further refined and expanded upon project award after review with partners and the USDOT. At that time, our Communications and Outreach Plan schedule will be finalized and we will proceed with implementation. All outreach activities will be documents and details will be provided in quarterly, annual, and final progress reports.

Audiences critical to the ADS for Rural America project include: local participants, including residents, businesses, and community leaders; the state of Iowa; USDOT, partners, and vendors, who will help fund and implement; transportation and technology industries, research community, US cities, and others who will monitor and utilize our lessons learned, including international audiences; media, including print, digital, and broadcast (local, state, national, and international); policymakers, including elected local, state, and federal officials.

5.6.1 Community Outreach

Through our previous on-road research studies, we have found that communication with local participants, residents, our community, and partners is of vital importance. ADS for Rural America will include early and consistent stakeholder engagement, including early coordination with law enforcement local public agencies, industry, transportation-challenged populations, the public, and other relevant stakeholders as applicable to conduct the project on terms that work for all parties. Communications outreach will take place before, during, and after the demonstration period to ensure that everyone is on the same page.

Key community outreach activities include:

- Regular briefings to local, state, and elected officials on demonstration details
- Utilize the Iowa Advisory Council on Automated Transportation and its subcommittees to disseminate information to communities and partners statewide
- Develop a presentation and pursue opportunities to present to conferences and organizations

5.6.2 Knowledge Transfer

The ADS for Rural America Communications and Outreach Plan will share demonstration status, results, and lessons learned with other jurisdictions, the public, and professionals through quarterly webinars that coincide with the demonstrations. We will ensure technical exchange and knowledge transfer to as many people as possible by working with the USDOT and our partners to distribute invitations to the webinar. During the webinar, we will share images, videos, and information that will effectively communicate lessons learned during and after data collection so that our experiences can be replicated across the US. Additionally, we will post the webinars online so individuals who are not able to attend can watch the recordings later and contact us with questions. Stakeholders may be invited to attend in person, if possible.

5.7 OUR PRIMARY FOCUS: TRANSPORTATION-CHALLENGED POPULATIONS

While ADS for Rural America addresses all of the ADS Demonstration Grant focus areas, our primary focus is to collaboratively demonstrate challenges to the safe integration of ADS on our Nation's rural roadways by conducting drives that gather a significant amount of data in near real time, while simultaneously addressing how we can provide significant public benefits to transportation-challenged populations like the rural elderly.

By 2030, 22% of Iowa's population will be over age 64.

The safe integration of ADS into the nation's on-road transportation system, particularly in rural areas, can vastly improve overall quality of life for the rapidly growing older segment of the US population that will likely not be served by the private sector soon. Our custom-engineered, mobility-friendly vehicle will be handicap accessible and outfitted with a wheelchair lift and restraints. We will install biometric sensors, which will speak to occupant comfort and emotional state, as well as interfaces with inclusive screen settings for users of varied abilities. As mentioned in Section 5.5.2, we will also be distributing questionnaires after each drive to evaluate vehicle occupants' initial perceptions of the automation, specific comfort, feedback, and suggestions for changes to system design. All of this will provide new insights into how ADS technologies can better serve older Americans.

5.7.1 Vehicle

The ADS for Rural America will utilize a custom-built, mobility-friendly Ford Starlite Transit vehicle. This accessible vehicle will be outfitted with a wheelchair lift and restraints in order to better serve transportation-challenged populations like older Americans, which are the focus of our project. Engineered by AutonomouStuff, this vehicle will have all the necessary hardware and software to support the needs of ADS for Rural America.

To the extent possible, the AutonomouStuff software suite will utilize publicly-available software platforms including Autoware and CARMA. While these platforms contain limited capability that does encompass the broad needs of this project, we feel that it's important to utilize these modules and report on our findings on how they can be improved. In the event that our team finds problems and introduces bug fixes in Autoware and CARMA, we will share those with the larger community of users.

More Information regarding the vehicle, sensors and concept drawings is provided in Part 3 – Draft Data Management Plan.

5.7.2 Safety Driver User Interface

Eight critical modules are necessary for the vehicle to drive autonomously: Localization, Tracking, Cruise Control, Lane Centering, Lane Change Assist, Steering, Speed, and Drive-by-wire (DBW). The UI will develop a user interface for the safety driver that will help to identify the states of each of these modules. A potential method for presenting this information is included in Part 3 – Draft Data Management Plan. Using this interface, the safety driver will be more informed regarding the health and status of each module and therefore the level of automation available at different points along the drive. This data will also be recorded and provided as part of the project phases.

5.7.3 Accessible User Interface

The ADS for Rural America demonstration vehicle will have an input-output user interface with applications that will be developed by the UI to allow users with varied abilities to input a new destination and communicate route information. Development of the user interface will include research into incorporating more inclusive screen settings that increase accessibility for all. This work will investigate and potentially incorporate:

- Larger menu options for older/visually-impaired populations
- Touch accommodations to make the interface easier to use for individuals with tremors and dexterity difficulties
- Audio cues to provide riders, particularly those who might be visually impaired, with details on next stops and other information
- Ability for users to hold the vehicle at the destination for a certain amount of time to accommodate individuals that may have difficulties moving quickly and do not have a human driver to communicate with visually

6. SCHEDULE

The ADS for Rural America project schedule is our roadmap to success. Table 5 provides a summary version of our project schedule, which will be expanded and refined prior to and during the kick-off meeting with the USDOT. To develop this ambitious yet realistic schedule, our team utilized our previous experience in conducting on-road ADS demonstrations. This schedule anticipates a start date of October 1, 2019.

Table 5. Schedule

2019	2020				2021				2022
Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Program Management									
Communications Outreach									
Procurement									
Tech development									
Plan development									
		Data Reduction / Analysis / Sharing							
				Evaluations					
				Webinars and Knowledge Transfer Activities					
		Phases							
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8

We will meet all milestones and produce deliverables as listed in the NOFO. Additional deliverables are listed below.

Initial planning and development tasks and deliverables:

- Communications and Outreach Plan
- Evaluation Strategy and Evaluation Plan
- Safety Management Plan
- Risk Mitigation Plan and Crisis Communications Plan
- Procurement of mobility-friendly vehicle
- Technology installation – ADS engineering of vehicle
- Procurement and installation of V2V/V2I
- Establish access to cloud-based storage platform; develop method for users to create accounts and request access to data

Tasks and deliverables during and after each phase:

- Data accessible one week after each drive
- Evaluation of phase and data collected
- Evaluation of safety outcomes
- Webinars/knowledge transfers

7. POTENTIAL OBSTACLES AND RISK MITIGATION

Our key ADS for Rural America partners enjoy productive and close cooperative relationships with state and local jurisdictions that will be included in this project. We do not anticipate many legal, regulatory, environmental and/or other obstacles that cannot be addressed within the context of this project.

7.1 FEDERAL REQUIREMENTS

We do not anticipate requiring any exemptions from the Federal Motor Vehicle Safety Standards (FMVSS), Federal Motor Carrier Safety Regulations (FMCSR), or any other regulation. We will not be modifying any of the safety features on our chosen vehicle, a Starlite Transit. The selection of a Starlite Transit abides by the Buy American Act and we do not anticipate requesting an exception under the Buy American Act or an exception to the NOFO Clause at Section F, Paragraph 2.J Buy American and Domestic Vehicle Preferences.

7.2 STATE LEVEL

Currently, there are no regulations on vehicle automation within the state of Iowa other than legislation that limits following distance for any class of vehicle. State legislators have recently introduced a bill that attempts to outline regulations for automated vehicles on Iowa roadways. While legislators are supportive of our work and believe this bill will further the safe integration of automated vehicles on our roadways, we recognize that even well-intended legislation can often have unintended consequences. Since the bill's introduction, UI and Iowa DOT staff have communicated with legislators and staff on details for this bill and are working to ensure any adoption would not hinder ADS research taking place.

The ADS for Rural America project team has organized and coordinates the Iowa Advisory Council on Automated Technology and is working with this state-level organization for guidance and communications outreach. The Council meets once each quarter and is available upon request for assistance in communicating with policymakers.

7.3 LOCAL LEVEL

The ADS for Rural America demonstration vehicle will need access to cellular service to operate on an HD map. Poor quality cellular service is not anticipated along the majority of this route. If cellular service is experienced, the project team will identify the location and work with service providers, as well as develop alternative solutions.

We are proposing installation of V2I communications at a number of intersections. From our previous on-road demonstration experience, we understand that technology deployments can pose delays, and we are building this into our schedule. Iowa State University is experienced in installing these technologies and is coordinating the deployment of SPaT technologies in four intersections within the ADS for Rural America project route.

7.4 RISK IDENTIFICATION, MITIGATION, AND MANAGEMENT

Safety is the top strategic and organizational goal of the USDOT and ADS for Rural America. It is also a critical component of any technology demonstration. The ADS for Rural America team's risk management approach follows industry best practices for mitigating factors that are likely to jeopardize the ability to achieve project or task objectives within budget and schedule constraints. To manage risk, we will draft a Safety Management Plan and establish a risk log to track project risks. We will apply risk assessment criteria to ensure consistent risk assessment practices. We will review these risks with the USDOT management on a quarterly basis and offer technically sound and achievable mitigation approaches. We will utilize our prior experience with on-road demonstrations and involve the UI's Risk Management and Strategic Communications offices as neccesary and according to our protocols.

7.4.1 Safety Management Plan

With safety as our top priority, ADS for Rural America will develop a detailed Safety Management Plan as part of the planning process and closely monitor safety aspects as we further design, test, conduct demonstrations, and evaluate the systems. This document will be critical to the project's success and we will seek out inputs from key partners and the USDOT on lessons learned from similar projects and demonstrations as it is developed. Upon project award, ADS for Rural America will prepare and submit a draft Safety Management Plan to the USDOT for review.

7.4.2 Crisis Communications Plan

Clear lines of communications are essential in managing our risk response. Upon project award, the ADS for Rural America project team will develop a detailed crisis communications plan and emergency response protocol to include: a chain of command and staff designated to respond to emergencies; communications approaches/draft messages; actions to be taken to mitigate crises; procedures for notifying USDOT, the public, and others impacted; a process for identifying corrective procedures; staff crisis communication training; contact information cards for each team member and the vehicle; and annual review and updating of the plan.

7.4.3 Preliminary Risk Identification

The ADS for Rural America project team has worked to initially identify risks and intends to take strict measures to mitigate safety concerns and protect the traveling public on our roadways. For instance, in some cases, duplicative technologies or backup systems will be installed in our vehicle to guarantee as safe a demonstration as possible. Top possible risks for the project, including those preliminary risks outlined in Table 6, will be presented at the kick-off meeting with the USDOT. This preliminary identification of risks will offer an early opportunity to discuss collaborative ways to mitigate such risks. A detailed plan with mitigation actions based on potential impact will then be developed. During the project, the project team will maintain a risk log.

Table 6. Potential Risks and Mitigation Measures

Potential Risk	Likelihood	Impact	Mitigation Measures
Automated vehicle not properly calibrated and is involved in incident/crash	Low	High	Vehicle will undergo a strict testing process at the AutonomouStuff facility and then on-site along the route. Engineers from AutonomouStuff will drive the route prior to each phase. During all project drives, a trained safety driver and researcher will be present in the vehicle during all drives. The vehicle will be designed to enable manual driver override at any point during automation.
Addressing data quality and integrity issues	Medium	Medium	Establish data quality standards, with an assigned team member checking data quality before, during, and after drives. We will develop scripts that perform data bounds and continuity check to flag any problems at the end of each drive.
Cost overruns	Low	Medium	Budget has been developed based on prior experience with on-road demonstrations and subcontractors. In the unlikely event of a cost overrun, this can be mitigated by adjusting scope. ADS for Rural America's project manager, with experience on many other large government-funded projects, will track finances on a monthly basis and progress on a weekly basis to ensure alignment with the project scope of work.
Lack of (or reductions in) stakeholder and/or community support	Low	Medium	Reinforce stakeholder support prior to project kick-off and maintain positive working relationships and open communications.
Environmental conditions (fog, rain, snow, ice) impact operation of vehicles	Medium	High	One of our goals is collect data during inclement weather. However, we will develop procedures to ensure operation only when it's safe to do so.
Communications failures with DSRC, modems, sensors, or other devices	Low	Medium	One of our goals is test and study the impact of communication failures. The vehicle will be designed to continue functioning to the extent possible while informing the safety driver of any reductions in capability. A UI-developed driver interface displaying the health of the automation will continuously inform the safety drivers of ADS status. In the event of a more significant failure, the vehicle will issue a takeover request to the safety driver to assume manual control of the vehicle.
Fixed obstacles in pre-planned routes	Medium	Medium	The safety driver will assume manual control if ADS is unable or incapable of re-routing around obstacle automatically.

8. COST SHARING AND PARTNERING

To successfully accomplish our vision, ADS for Rural America will leverage experience from projects completed through our longstanding public and private partnerships. We will also leverage the following state and industry-funded projects in order to implement a more robust ADS project.

8.1 IOWA DOT RURAL HAZARD ALERTING DATA FEED DEMONSTRATION

Slow moving or stopped vehicles on rural highways pose a huge safety issue and this project is meant to explore how connected vehicle technologies can enhance safety by providing information about these vehicles before line of sight is established. ADS for Rural America will utilize funding and lessons learned from this project for the demonstration.

8.2 IOWA ADVISORY COUNCIL ON AUTOMATED TRANSPORTATION

The Iowa Advisory Council on Automated Transportation provides guidance, recommendations, and strategic oversight of automated transportation activities in the state. Members include Iowa DOT staff, state departments, technology, motor truck, and insurance associations, organizations representing cities and counties, regional federal transportation representatives, state legislators, and more. For the ADS for Rural America project, the Council would be utilized as an advisory board to provide independent review on evaluation strategies and other tasks. ADS for Rural America will benefit from the Council's collaboration and guidance, as well as members' access to stakeholders.

8.3 ADS FOR RURAL AMERICA DATA REDUCTION

The UI has proposed to the Iowa DOT a project for preliminary analysis of the ADS for Rural America data collection. This data reduction project, which will build off of ADS for Rural America, would provide in-depth analysis of data collected through the ADS for Rural America project to begin to identify risks, opportunities, and insights. For example, the analysis might address the extent to which additional markings are necessary to enable ADS technologies on certain types of rural roads or potential guidelines for data requirements for ADS testing in rural areas. Through this project, we will work to identify and better define roadmanship metrics to characterize safety risks. This project, estimated at $400,000, is pending award of the ADS for Rural America grant.

8.4 RURAL TRANSPORTATION AND MOBILITY

The goal of this industry-sponsored project is to identify the needs and challenges faced by older adults living in rural areas in Iowa and examine their attitudes associated with more advanced transportation options that may be available in the future. A high-level data analysis will be conducted to summarize the information regarding specific challenges/needs based on things such as age, health, and lifestyle. This project is scheduled for completion in September 2019, with results helping to inform the ADS for Rural America project and its vehicle occupant questionnaire.