Automated Driving System Demonstration Grant
PILOT PROJECT PROPOSAL

Creating Access to Nutrition (C.A.N.)
Through Dynamic, Point-To-Point, On-Demand ADS Systems

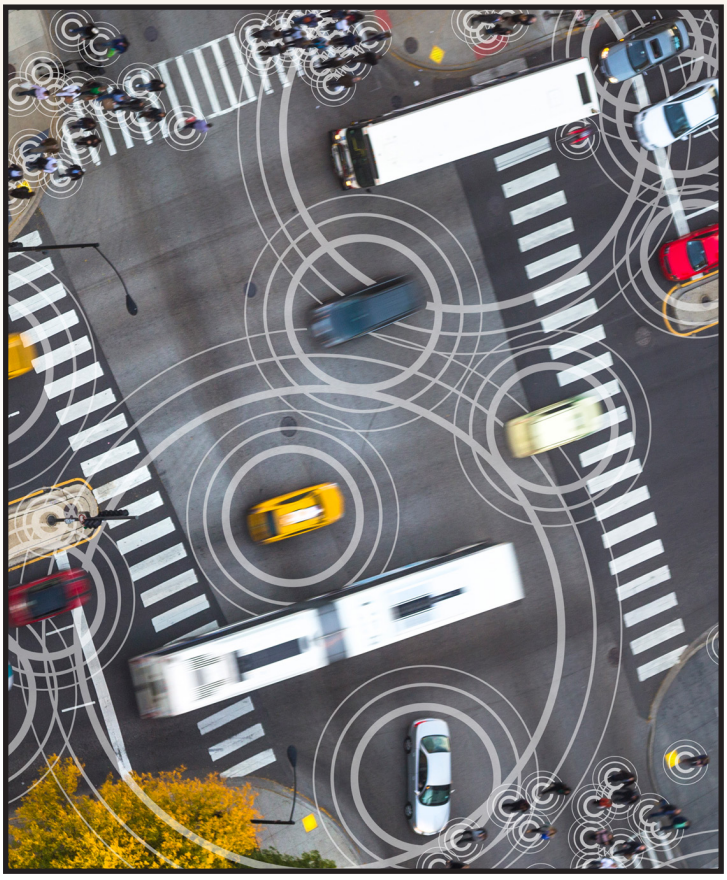
SUBMITTED TO

United States Department of Transportation (USDOT)
Federal Highway Administration (FHWA)
1200 New Jersey Ave, SE
Washington DC 20590
Attn: Sarah Tarpgaard, HCFA-32

Funding Opportunity Number: 693JJ319NF00001
CFDA Number: 20.200
Highway Research & Development

APPLICANT

Indian Nations Council of Governments (INCOG)
DUNS Number: 078662665



PROJECT PARTNERS

Public Agencies:
The City of Tulsa
Oklahoma Department of Transportation
Metropolitan Tulsa Transit Authority

Private Partners/Sub-recipients:
Optimus Ride
Xtelligent

Institutions/Sub-recipients:
The University of Oklahoma
The Oklahoma State University
The University of Tulsa

INCOG

Summary Table

Project Name	Creating Access to Nutrition (C.A.N.) Through Dynamic, Point-To-Point, On-Demand ADS Systems
Eligible Entity Applying to receive Federal Funding	Indian Nations Council of Governments (INCOG) 2 West Second Street, Suite 800, Tulsa OK 74103
Point of Contact	Adriane Jaynes Alternative Fuels and Advanced Transportation Systems Program Manager | INCOG 918-579-9494 | ajaynes@incog.org
Proposed Location	Tulsa, Oklahoma
Proposed Technologies for the Demonstration	Dynamic, On-Demand, Point-to-Point, Level 4 Automated Driving Systems with V2I and V2V integration
Proposed Duration of the Demonstration	4 years: 2020-2024
Federal Funding Amount Requested	$ 9,865,000
Cost Share Amount Proposed	$ 2,400,000
Total Project Cost	$ 12,265,000

INCOG Regional Partners — Regional Solutions
2 West Second Street Suite 800 | Tulsa, OK 74103 | 918.584.7526 | www.INCOG.org

Secretary Elaine Chao
U.S. Department of Transportation (USDOT)
Federal Highway Administration (FHWA)
1200 New Jersey Avenue, SE; Mail Drop: E62-204
Washington, D.C. 20590

Re: Automated Driving System (ADS) Demonstration Grant # 693JJ319NF00001

Dear Secretary Chao,

For more than fifty years, from the expansion of the Interstate System, through Rails to Trails projects, to planning Oklahoma's first Bus Rapid Transit line, the Indian Nations Council of Governments (INCOG) has been a convener of partners and ideas to move transformative transportation projects forward to improve Tulsa regional mobility.

According to the emerging consensus among transportation innovators, the future of mobility is electric, shared, and automated. To build this future in a way that enhances quality of life for segments of society, the safety and viability of these technologies must be demonstrate for people and places which may naturally not rise to the top of the technology and/or automotive sector priority list.

For this proposal, INCOG is committing $350,000 and convening a multidisciplinary team of national and local experts. The team will demonstrate the safe integration of Level 4 automated driving systems (ADS) into Tulsa's on-road transportation system. Given the importance of coordination with the City's traffic signal infrastructure in maximizing safety, we are complementing the ADS with V2I communication and Cooperative Intelligent Transportation System (C-ITS) technologies

We will deploy these technologies in transportation-challenged areas of Tulsa, Oklahoma to enable better access to food, medical care, other necessities, and amenities. This design improves transportation options while collecting data to provide insight into the technical and human aspects of AV operations and V2I/C-ITS capabilities in enhancing the safety of ADS deployments in the Nation's on-road transportation system. This proposal builds on years of work from technical and community development professionals from a variety of organizations.

Transportation is evolving rapidly. We appreciate USDOT's continued efforts to provide opportunities which encourage innovation through collaboration. If awarded, we look forward to safely leveraging ADS to improve the quality of life in our region and beyond, and sharing Tulsa's data and information to enhance the body of work in this field

Sincerely,

Rich Brierre
Executive Director
INCOG

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PART 1: PROJECT NARRATIVE AND TECHNICAL APPROACH

Food deserts are defined as areas lacking access to fresh fruit, vegetables, and other healthful whole foods; largely due to a lack of grocery stores, farmers' markets, and healthy food providers.

1. EXECUTIVE SUMMARY

This project will test a pilot deployment of dynamic, on-demand shared Automated Driving Systems (ADS) to demonstrate the safe integration of Level 4 ADS and V2I technologies into neighborhood and arterial streets in a nine square mile geo-fenced area, identified based on recent Federal Transit Authority funded research as a "food desert". The project is a **collaboration** of the Metropolitan Planning Organization (MPO), state and local government, public and private universities, and private companies to address transportation needs of transportation-challenged individuals while collecting significant **data** sets to enhance the **safety** of ADS.

The project team proposes a pilot deployment of Level 4 autonomous vehicles, utilizing safety drivers, to both qualitatively and quantitatively demonstrate the safe use of ADS as a safe and reliable community asset for transportation-challenged populations. The vehicles will operate as dynamic point-to-point, On-Demand Responsive Transit. Recruitment of households to utilize this service will focus on aging populations and persons with disabilities living in a defined region with limited access to transit, grocery stores, medical facilities, and other basic needs.

Figure 1. Optimus Ride vehicle on the road with no driver
Source: Optimus Ride

a. Vision, Goals and Objectives

Vision. To provide shared, electric, autonomous mobility service to expand transportation options for transportation-challenged populations to enhance quality of life, using dynamic, on-demand, point-to-point ADS technology.

Goals

1. ***Demonstrate the safe integration of ADS into the existing neighborhood and arterial network.***

    - Operate three electric, shared, Level 4 automated vehicles as a high-quality, point-to-point, on-demand demand-responsive transit service for individuals with disabilities or age-related mobility issues in a 9-square mile geo-fenced area. Document and evaluate impediments to safe operation posed by the built environment, near misses at signalized intersections using Vehicle To Infrastructure (V2I) technology, and interactions with non-autonomous vehicles, pedestrians, and bicyclists in the study area.

2. ***Collect significant data for safety analysis and rulemaking.*** The datasets made available through this project will include operational data from the vehicles and roadside infrastructure and will also include surveys and information from the human riders of the vehicles.

    - Collect data from ADS and from non-ADS infrastructure.
    - Develop a robust data management plan to work with USDOT and local partner institutions of higher learning in order to build capacity to analyze and innovate.
    - Demonstrate a model for sharing of information in near real-time with USDOT and other partners.

3. ***Facilitate collaboration*** among the public and private sectors for safe deployment in Oklahoma to advance the safe operation of ADS and associated technologies to provide more inclusive mobility options for Tulsa residents, to be replicated in other parts of the country.

    - The project and support team include an interdisciplinary group of professionals guiding the scoping, planning, and execution of the project. ADS providers,

universities, private and public sectors, transit agencies, social service organizations, software development, and local, regional, and state governments are all represented to oversee both the technical and social aspects of this project. The result will be a new transportation technology integrated into the city in a manner that enhances safety and quality of life in the project area.

- Work with private sector, local partners and USDOT to analyze data, address data gaps, ask new research questions, innovate, and build capacity to provide insight into not only the technical but also the human side of ADS operations.

Figure 2. Boston OK's autonomous Optimus cars
Source: Boston Herald

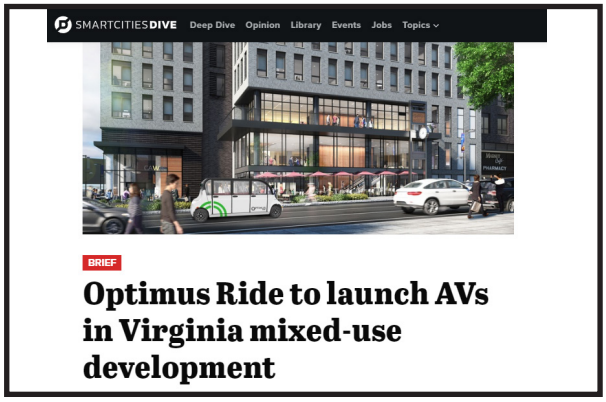


Figure 3. Optimus Ride launches AVs in Virginia
Source: SMARTCITIESDIVE

b. Key Partners, Stakeholders, Team Members

Applicant. Indian Nations Council of Governments (INCOG), the MPO for the Tulsa Transportation Management Area (TMA)

Partners

- City of Tulsa
- Oklahoma Department of Transportation (ODOT)
- University of Oklahoma
- Oklahoma State University
- University of Tulsa
- Optimus Ride, Private Entity
- Xtelligent, Private Entity
- AAA, private nonprofit
- INCOG Area Agency on Aging

c. Issues and Challenges

The challenges for the ADS pilot project are categorized into three groups to reflect the multiple domains ADS technology intersects. ADS challenges can be technological, environmental, or social in nature.

Technical

- Integration of ADS with other existing municipal platforms (such as local Traffic Management Centers and Public Transit signal priority and bus locators) to optimize traffic movements, safely and efficiently on public roads.
- ADS ability to effectively communicate with other roadway users: non-AVs, pedestrians, and bicyclists; both conveying and obtaining desired intentions of traffic movement.

Environmental

- Tulsa, Oklahoma has pleasant weather throughout most of the year, but unpredictable winds, wide temperature fluctuations and extreme weather events, such as sub-zero temperatures, 100 degree heat in the summer, straight line winds in the Spring, and occasional ice and snow are common.
- Traffic signal timing, inconsistent signage heights/sizes, deteriorating pavement markings, visibility on unlighted roadways, and the ability to consistently distinguish between red and green signals.

Social

- A 2018 survey from AAA found that 73% of American drivers report they would be afraid to ride in a fully self-driving vehicle. Sixty three percent report they feel less safe sharing the road with a self-driving vehicle while walking or riding a bicycle.
- Deploying automation to improve living conditions and reduce economic disparities can help overcome social anxiety around ADS. Showcasing the technology in targeted areas will help to improve familiarity of the systems and how deployment of the technology safely benefits segments of the population in Tulsa.

d. Geographic Area or Jurisdiction

The geographic area chosen for this pilot project is nine square miles of primarily food desert just north of downtown Tulsa, Oklahoma. The nine mile area has grocery stores on the far eastern edge, a health clinic and YMCA on the southern edge, and a world class museum on the western edge. Several standard transit routes operate in the area. A new Bus Rapid Transit will operate in the area beginning in the second half of 2019.

INCOG has been working with an advisory board comprised of residents and leaders of agencies serving the area to find solutions to improve accessibility which can be replicated. These efforts place particular emphasis on the needs of elderly and disabled populations. In January of 2019 the group released the C.A.N. (Creating Access to Nutrition) Plan, which outlines the demographics, challenges, and opportunities for solutions to the food access challenges in the area. This ongoing work in engaging the targeted community, identifying need, and data collection/analysis is the basis for choosing this area for ADS deployment.

The C.A.N. region was a once booming area in the early 1900s. A portion of the region was known as Black Wall Street due to successful African American owned businesses. In 1921, the Tulsa Race Massacre occurred resulting in looting and destruction of the area. An unknown number of lives were lost. The massacre and its aftermath lead to decades of disinvestment and misguided policy aimed at the region.

Demographics for the Micro Region

Total Population	19,388
Population > 16 yrs old	14,518
People in Labor Force	8,289 (43% of Total)
People over 65 Years	2,515 (13% of Total)
People over 80 Years	621 (3.2%)
Total Households	7,022
HHs with Zero or 1 Vehicles	4,405 (63% of Total)
People with a Disability	4,240 (22% of Total)

Table 1. Demographics for the Micro Region
Source: INCOG

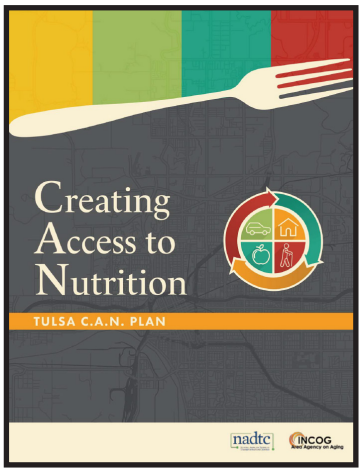
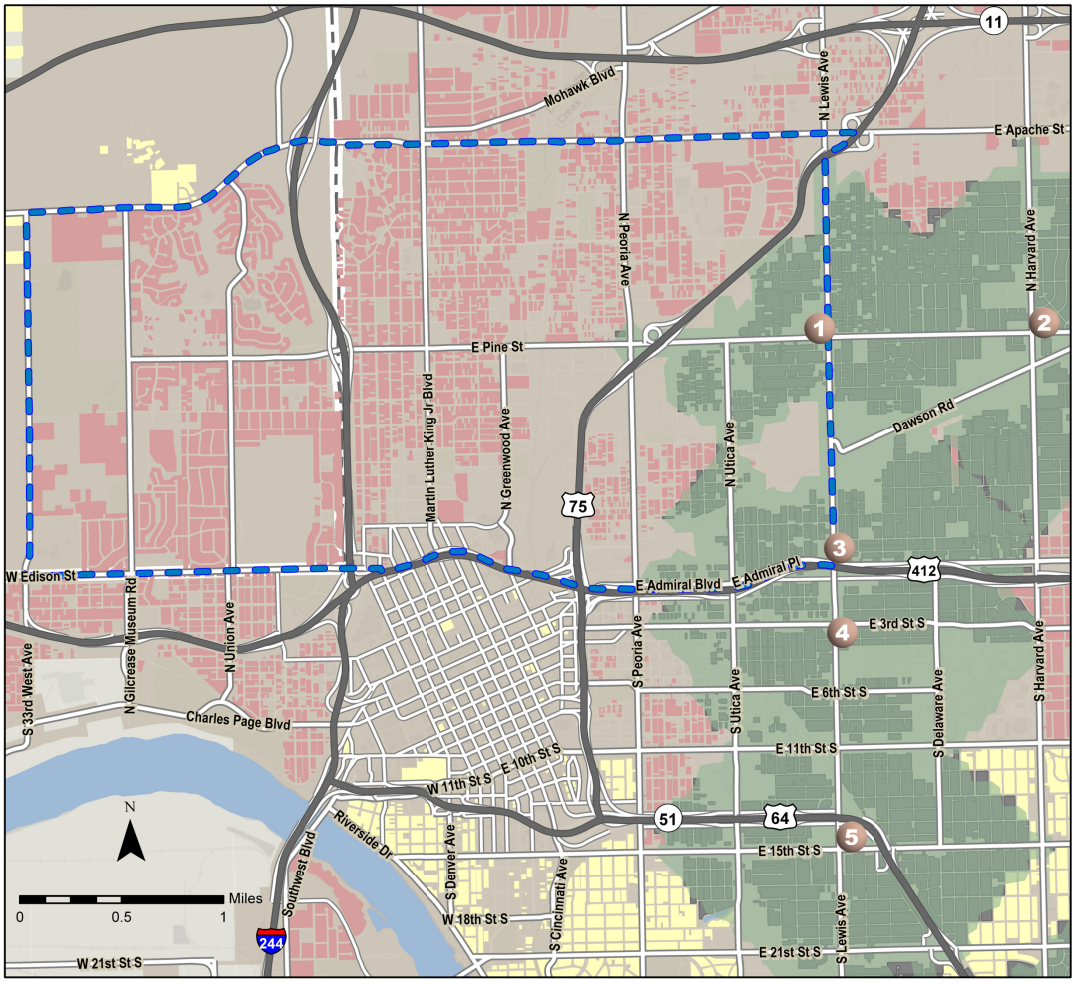


Figure 4. The Tulsa C.A.N. Plan
Source: INCOG

This map highlights the region's food assets and needs. The map and the recent community engagement and planning work by INCOG in this area, are funded through the Federal Transit Administration's National Aging and Disability Transportation Center to create a plan to connect elderly and disabled populations in the targeted area to better nutrition. This proposal builds on these previous efforts, known as the Tulsa C.A.N. Plan.



Tulsa C.A.N. Plan Target Area

Legend

Full Service Grocery Stores

1. Save-A-Lot Food Stores
2. Supermercados Morelos
3. Las Americas
4. Warehouse Market
5. Reasor's

Grocery Store Service Areas

Areas within a 1-mile walk

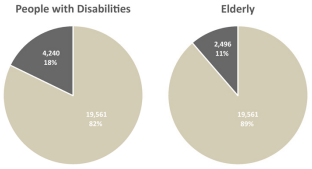
Residential Parcels

Not in a low-income area
In a low-income area
Served by a Grocery Store

Tulsa C.A.N. Plan Target Area

Nine square-mile area

Demographics	NADTC Area	Total Served by a Grocery Store	Total NOT Served by a Grocery Store
Total Population:	19,561	2,940	16,621
With a disability	4,240	591	3,649
No disability	15,321	5,349	12,972
65 + years:	2,496	188	2,308
With a disability	1,257	90	1,167
No disability	1,239	99	1,140



e. Period of Performance

Year 1. Define Scope, Engineering and Refinement to Approach/Research

- Engage with key stakeholders to refine scope and secure buy-in on approaches
- Determine cybersecurity approach for the project team given existing architecture
- Bench test technology with relevant ADS vendors and city/state Intelligent Transportation Systems (ITS) departments
- Secure connectivity via Virtual Private Networks (VPN), etc.
- Deploy the interface hardware devices within the selected area
- Begin collecting baseline data for future evaluation purposes
- Set up a data exchange on cloud platform for near real-time access to USDOT and other relevant partners, including emergency first responders

Year 2. Deploy for Testing and Use

- Integrate ADS into City-ITS (C-ITS) system, test reliability
- Set up data fusion platform to integrate ADS vehicle movement data
- Conduct safety protocol testing to ensure sound technical integration between ADS/C-ITS
- Deploy decentralized algorithm to start testing control, optimization, safety in C-ITS standalone environment
- Integrate ADS movement data with C-ITS to being testing impact on transportation system
- Deploy pilot vehicles and recruit users
- Test framework for voluntary data exchange vs defined requirements for data by USDOT/Local Public Agency (City of Tulsa)

Year 3. Collect and Analyze to Inform Public Policy

- Refine the technology / algorithms based on testing results
- Collect time series data across months / seasons to understand cyclicality
- Conduct full evaluation of the efficacy of the technology
- Build out UI/UX for government to help visualize data, analytics, prediction

Year 4. Analyze Data and Preserve to Continue

- The project is expected to conclude in three years. The fourth year is listed here as a contingency in the event certain components take longer than anticipated

Introduction and Background

The emerging consensus among transportation thought leaders is that future transportation systems will be autonomous, electric, and shared. The challenge for both public and private partners is how to facilitate and encourage the development of safer transportation systems to serve all segments of society, and ensuring that marginalized constituencies are not left behind as society progresses. This research and development proposal will address these challenges directly.

Two-thirds of U.S. adults report they would feel less safe sharing the road with a self-driving vehicle while walking or riding a bicycle[1]. Exposure of the general public to these technologies, along with demonstrated **Safety, Reliability, and Performance are key factors in demonstrating the ability of ADS to meet the daily transportation needs of the general public.** Of these components, SAFETY is the foundation on which the other components must be built.

This project will demonstrate the safe integration of ADS and V2I technologies into neighborhood and arterial streets in a nine-square mile area, identified as a food desert in Tulsa. Level 4 ADS, utilizing safety drivers, will demonstrate on-demand, point–to-point, dynamic, demand-responsive transit as a safe and reliable community asset for transportation-challenged populations.

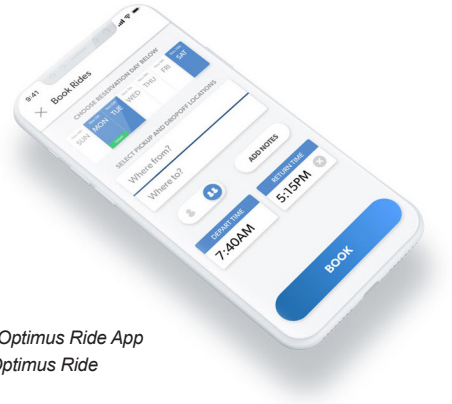


Figure 5. Optimus Ride App
Source: Optimus Ride

Recruitment of households to utilize this service will focus on aging populations and persons with disabilities living in the defined region with limited access to transit, grocery stores, medical facilities, and other basic needs.This design will provide targeted individuals with improved transportation options while collecting significant data to provide insight into not only the technical, but also the human side of ADS operations. A team of national and local experts are collaborating for this proposal.

Figure 6. Article on Optimus Ride and its effort to test self-driving vehicles in Boston. Source: Bostinno

2. GOALS

Level 4 electric, ADS vehicles will be the most visible project element, offering dynamic, on-demand, point-to-point demand-responsive transit service. The geo fenced targeted area consists of arterial and neighborhood streets, at-grade rail crossings, planned roadway construction elements, as well as highway interchanges. These vehicles and mobile ride hailing application will be the public face of project efforts, providing transportation-challenged populations with new mobility solutions to enhance their quality of life, as well as the data needed to make this project a success.

Equally important, though less visible is the Vehicle-to-Infrastructure (V2I) and Cooperative Intelligent Transportation System (C-ITS) element. Project partner Xtelligent's work with Argonne National Laboratory demonstrates that ADS and non-ADS vehicles integrated into a studied distributed V2I/C-ITS network benefit from safety-enhancing adaptability and information from public infrastructure. This project will further advance system integration research that will make it possible for such ADS/C-ITS system integration to take hold more broadly, which would have significant transportation safety impacts on city street infrastructure across various municipalities.

In many regions, ADS and road infrastructure technologies are evolving separately without significant cooperation between the industries. This project will attempt to enable a collaborative data sharing environment to unlock the full safety and data benefits these technologies can offer, while protecting data privacy and mitigating industry concerns. The following goals and objectives, all related to safety, data, and collaboration will expand upon this concept.

Figure 7. Optimus Ride Autonomous Vehicles
Source: Optimus Ride

a. Safety

Demonstrate the safe integration of ADS into the existing transportation network of neighborhood and arterial streets.

1) Operate three electric, shared, Level 4 automated electric vehicles as a dynamic, door-to-door, on-demand, demand-responsive transit service for individuals with disabilities or age related mobility issues, within a nine-square mile geo-fenced area defined as the Tulsa C.A.N Region.

- Document challenges posed by the built environment of the geo-fenced region to the safe operation of ADS.
- Demonstrate safe operations of on-demand service, measure, and analyze service utilization and downtime.
- Measure and document interactions with non-autonomous vehicles, pedestrians, and bicyclists in the study area.

2) Incorporate V2I technologies in the targeted area.

- Measure and document near misses at signalized intersections using V2I technology.
- Document costs and technologies used to incorporate V2I.
- Document agency regulatory and/or administrative paths to deploy V2I on public roads.

3) Utilize surveys and ADS vehicle captured data to evaluate the adoption and usage of users and interactions with non-users, such as drivers, pedestrians, or delivery drivers.

- Expand on Optimus Ride collaboration with Perkins School for the Blind to develop their technologies and ensure user interfaces are designed and tested employing ADA compliance and implementing Universal Design elements.
- Convene multidisciplinary research teams to include faculty from University of Oklahoma Schools of Social Work, Community Medicine, and Physical Therapy to more deeply understand needs of various subgroups.

b. Data collection for safety analysis and rulemaking

Significant amounts of data will be appropriately collected and made available through this project, including operational and anonymized user data from the vehicles and surveys.

1) Develop a robust data management plan to work with USDOT and local partner institutions of higher learning in order to thoroughly analyze data and innovate.

- Determine data gaps and investigate additional data needs and/or redundancies to eliminate, which are not pertinent to the service.
- Evaluate and develop policy guidance for distributed network control vs centralized command in connected ADS systems.
- Evaluate the dashboard user interface used for ADS technologies and its integration with City of Tulsa operating system for the Traffic Management Center (TMC) as well as the real-time bus tracking system for the Metropolitan Tulsa Transit Authority. The usage of cooperative data platforms will benefit all parties involved.

2) Properly investigate data integrity and cybersecurity issues for both operations of the ADS and address privacy concerns of users.

- Identify data requirements of public interest for a City to enable the deployment. Inform governing bodies on how to best integrate ADS systems into city/DOT ITS infrastructure while minimizing cyber vulnerabilities.

3) Identify data exchange needs for USDOT rulemaking and determine ways to collect data from multiple perspectives, including public infrastructure (such as roadside infrastructure and other private non-ADS vehicles interacting with ADS).

4) Develop research questions that will generate insight into human perceptions, specifically from the perspective of disadvantaged populations and their interactions with ADS.

c. Collaboration

Facilitate collaboration among public and private sectors for research and deployment, advancing the safety of ADS technologies. This research will build replicable, governmental capacity to safely provide more inclusive mobility options for residents.

1) Build interdisciplinary research team with social and engineering scientists involved in the scoping, planning, and implementation of the project.

- This project facilitates collaboration among universities, public entities- including the City of Tulsa, Oklahoma Department of Transportation, and the MPO- and private companies in Optimus Ride and Xtelligent, to integrate new transportation technologies into the city in ways that enhance quality of life for all citizens ultimately furthering the research and development of safe ADS technologies.

2) Recruit potential riders through local partners currently serving these populations & document the process.

- The development of the C.A.N. Plan in partnership with the INCOG Area Agency for Aging has completed public involvement, outreach, and needs assessment. This work and previously established relationships will be the foundation of the project's outreach efforts.

3) Demonstrate local coordination with private sector ADS technologies through integration with City of Tulsa Traffic Management Center and coordination with public transit technologies, the new Bus Rapid Transit line running through the test area, and legacy transit routes.

- Demonstrate a model for sharing of information in near real-time with public and decision makers.

4) Develop a collaborative framework to inform local policies regarding the safe integration of ADS technologies. Share the findings of the project through public relations strategies, publication of scholarly or peer-reviewed articles, presentations from the project partners, media events and news releases, and presentations at various national conferences by project leadership and in coordination with USDOT.

3. FOCUS AREAS

a. Significant Public Benefits

Public benefits stemming from this proposal include a focus on shared mobility solutions and coordination with public transit. As mentioned in the introduction, AVs must be shared to truly unlock their potential to bring down transportation costs and reduce congestion. Yet, there is a real risk that ADS technologies will simply enable more single occupancy vehicle travel. Early demonstration projects should focus on shared mobility and work collaboratively with public transit to show the viability of these options to the public, automakers, and transit agencies.

Further, as ADS and V2I technologies become more prevalent, cities and MPOs will need to expand their capacities to fully understand how to deploy these technologies. The management approach outlined in this proposal will serve as a platform to show how existing local government capacities can be grown and leveraged into these new areas.

Regarding V2I and ITS technology, although there have been significant advancements in the ADS itself, there have been fewer developments of road infrastructure technologies to support ADS deployment. Specifically, enabling data sharing from the vehicle to the traffic management infrastructure and vice-versa can cooperate with, adapt to, and enable ADS. This has resulted in limited one-sided V2I communication where signal phase and timing (SPaT) from traffic signals to the vehicles are being enabled, but the inverse has not happened in any meaningful sense. Yet there are significant public benefits where certain vehicle data is shared with city infrastructure including safety, efficiency, and environmental benefits as articulated in other sections. In addition, significant benefits are expected from additional infrastructure information to the ADS such as more accurate SPaT data.

Furthermore, one of the key challenges of integrating ADS with city infrastructure has been concerns regarding cybersecurity. By enabling an opportunity to fund, deploy, and test the real-life integration and communication between ADS and city infrastructure, the project team will help identify best practices for future integration methods that can help mitigate concerns regarding security in other locations throughout the nation.

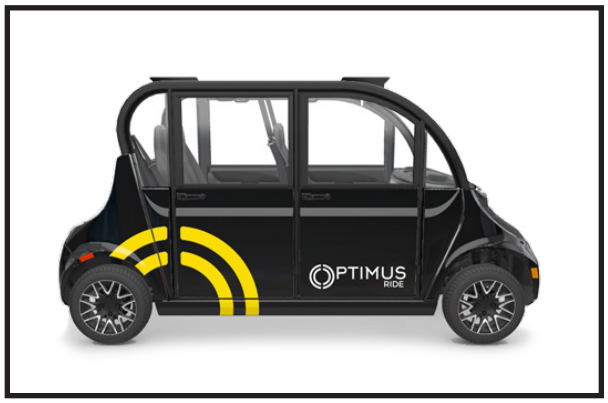


Figure 8. Optimus Ride Autonomous ADS
Source: Optimus Ride

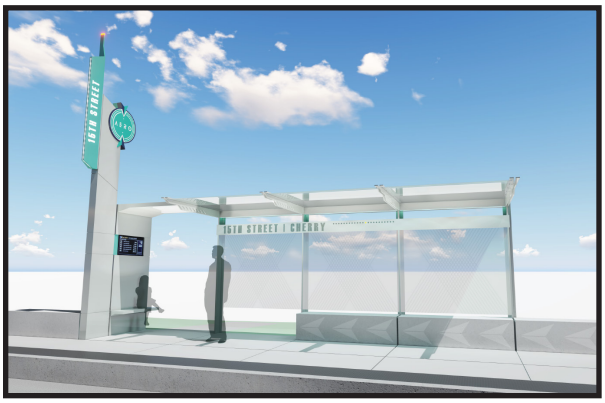


Figure 9. Peoria Bus Rapid Transit Station
Source: INCOG

b. Market Failure and Other Compelling Public Needs

This project will provide a framework for deeper understanding of several components of planning for ADS which are fairly widely discussed among planners and thought leaders in the ADS space, but which have not yet been put into practice, partially due to lack of market incentives. These include:

1. ***Social equity in ADS deployment.*** A real risk with increased use of ADS is exacerbation of existing transportation inequity. Without intervention or possible regulation, it is likely that ADS may be purchased and utilized only by wealthier populations, limiting their benefits to a relative few. In shared ADS applications, it is also likely that without additional incentive or requirement, we may see AV fleets fail to meet the needs of certain neighborhoods where operations may be deemed less financially viable.

2. ***Ability equity in ADS deployment.*** As with social equity, we must demonstrate the viability of accessible ADS deployment. ADS have the power to allow older people to remain mobile, active members of their communities long after they lose the ability to drive. For individuals of all ages with disabilities which may not allow them to drive, ADS offer a new opportunity for freedom which many have never experienced. Thus, it is imperative that ADS are designed for people of varied cognitive and physical ability.

3. ***Public-Private Partnerships in ADS deployment.*** Public investment in this cutting edge technology is envisioned to parallel private enterprise investment to enable City of Tulsa, USDOT and universities to capture necessary and sufficient data for public safety.

Locally, the conditions found in the C.A.N. Plan region are the epitome of private enterprise failing to meet the needs of residents. Smaller businesses experience difficulty with success in the region because they lack the purchasing power to offer the variety and lower prices that big box stores provide. The large commercial grocery store that once served the region closed and its profits left the region.

c. Economic Vitality

This project will seek to first utilize solutions from companies based in the United States with domestic manufacturing operations. All project partners to date are domestic, with manufacturing operations and facilities located in the United States. Further, to promote Oklahoma within this emerging industry, we will work with our local university partners, to ensure the pipeline of talent into these industries includes Oklahomans by giving students hands on involvement with these technologies and research.

d. Complexity of Technology

This project will deploy Level 4 (L4) autonomous vehicles and aim to address V2I connectivity and bi-directional data sharing for L4 ADS on roadways. Integration of existing roadside infrastructure and its interaction with the vehicle will be captured in order to determine the safe deployment and benefits & costs for public domains, in terms of both hardware and software. This project will extend and enable data from the vehicle to the infrastructure, enabling intelligent cooperation and integration between ADS and transportation infrastructure which yields significant safety, efficiency, and environmental benefits for all parties.

e. Diversity of Projects

To date, most ADS deployment has naturally gravitated toward new developments, technology rich campus environments, or large cities. ADS is often perceived as experimental and inaccessible or unfeasible in middle America. This project tests that perception by deploying Level 4 ADS vehicles, coupled with V2I elements in a geo-fenced 9-square mile food desert, encompassing neighborhood and arterial streets and highway interchanges to serve older adults and people with disabilities in Oklahoma.

f. Transportation-challenged Populations

Twenty-one percent of the C.A.N. region's total population is disabled and fifteen percent are age 65 or older. There are 61 visually impaired people living in the C.A.N. region. In 2018, 17,000 rides were provided to residents in the C.A.N. region by the Lift, Tulsa Transit door-to-door paratransit service.

This project will explore adapting an existing mobile application interface for people with varied cognitive and physical abilities, and upfitting an ADS vehicle with wheelchair restraints and ramps to ease entry/egress. With accessible ADS technology in place, many older adults and people with disabilities will have access to life sustaining needs such as medical appointments and nutrition. Other quality of life opportunities could also emerge from the availability of ADS technology through the offering of transportation to social and community events, places of worship, recreational opportunities, and personal errands.

g. Prototypes

Optimus Ride's first generation product currently offers point-to-point service in Boston's Union Point and Seaport District. Optimus is preparing for their next deployment in Reston, Virginia in a new real estate development featuring housing, retail, offices and public spaces. Currently, their primary vehicle platform is a Polaris GEM, in either a 4-seat or 6-seat configuration. The vehicles are well-suited to the short trips in the proposed operating area. These are low-speed vehicles (as defined under FMVSS) designed to operate at speeds below 25 miles per hour in accordance with Vision Zero objectives. No

safety waivers or exemptions are needed as these are built on an existing vehicle platform conforming to Federal Motor Vehicle Safety Standards (FMVSS). Optimus Ride's ADS platform consists of hardware and software and offers dynamic point-to-point service via a mobile application. The sensors, computer, and controls suites can be integrated into existing vehicle systems. Optimus Ride outfits the vehicles with the necessary hardware for ADS in-house. The software technology stack consists primarily of the perception stack and the robotics stack. The perception stack is what lets the vehicle identify where it is in the world and what else is around it, while the robotics stack is what defines what route the vehicle will take, and more specifically exactly when and how it should apply the acceleration, brakes, etc. in order to get to its destination.

This project proposes to integrate V2I technology. The Xtelligent team has been developing an early prototype of the V2I/C-ITS technology since 2013 in the research laboratories as with National Science Foundation, Department of Transportation, and the California Department of Transportation funding. Since 2016, the first real-world prototypes focusing on distributed algorithms have been tested in research, bench, and real-life environments across multiple metropolitan areas and in partnership with major ITS and vehicle companies.

4. REQUIREMENTS

The project partners have worked diligently to ensure compliance of this project with all requirements listed in the Notice of Funding Opportunity (NOFO).

1. As previously outlined, this project will focus on Level 4 autonomous technologies with V2I integration.
2. Level 4 autonomous, electric vehicles will be physically deployed in a dynamic point-to-point, on-demand demand-responsive transit service for older adults and individuals with varied physical and cognitive abilities via a mobile application in which users can request rides. Additionally, V2I elements will be installed in City infrastructure.
3. Partners commit to gathering and sharing all relevant and required data with USDOT throughout the project, in near real time, and making that data available for at least five years after the project concludes. INCOG will work with USDOT and project partners to ensure data compliance and refine a detailed data management

plan within the first sixty days of announcement of award.

4. Project partners are committed to ensuring ADS user interfaces are accessible to people with varied cognitive and physical abilities. Given the population this project proposes to serve, accessibility of the ADS is of utmost importance. Our vehicle partner, Optimus Ride, has worked previously with the Perkins School for the Blind to understand how to better design their vehicles and UX for individuals with visual impairment. INCOG and our partners look forward to working collaboratively with Optimus Ride to ensure this service meets the needs of individuals with varied physical and cognitive abilities due to age or other factors.
5. INCOG and Partners are additionally committed to outreach efforts to share the work we are doing here in Tulsa, and demonstrating this project's scalability. The findings of this project will be highly relevant to many cities with similar challenges, and the project team is committed to sharing the results widely through scholarly articles, press releases, whitepapers, hosting tours of the C.A.N. region and ADS deployment, and speaking engagements at national and regional conferences.

5. APPROACH

a. Technical Approach

The approach for this research and development project is divided into four segments: (i) Defining the micro-regional roadways and developing protocols for operations (ii) Deployment of AVs, (iii) Data collection and analysis, and (iv) Data curation and information sharing.

Segment (i): Define the Micro-Regional Roadways and Develop Operational Protocols. Define scope and parameters for public roadways, charging, parking within the micro-region for deployment the ADS will serve.

1. A detailed task-based cost and schedule will be adapted by the joint partnership with the Sponsor (INCOG) and all the cooperating agencies based on the Systems and Value Engineering.
2. Identify the network of streets to include neighborhood streets, collectors, minor arterials and specific destinations along with people to serve within the region.
3. Develop detailed project timelines for integrating ADS technology into municipal infrastructure. All roadside assets and infrastructure (such as stop signs and

signals along with the BRT stations and existing transit routes) will be used in order to develop a successful deployment schedule, requiring testing to ensure compliance between municipal ITS infrastructure and ADS technologies.
4. LiDAR and detailed engineering and design for the streets network to be used for testing in real time will be utilized for the deployment within the geo-fenced zone.
5. A LiDAR-enabled test vehicle with Level 4 capability will traverse the network as planned and ascertain or modify the network based on results. Collect data related to conflict points, pertaining to the physical interaction of transportation modes or technology ITS interactions. Isolate and analyze conflict point variables such as nature of collisions, engagement of automatic braking, ADS response to BRT traffic signal preemption and other user based interfaces.
6. Vehicle data capture and integrity of data and security for users (specifically the elderly and disabled) will be tested.
7. A user base of volunteers to use the service as passengers in the test period will be generated with the information from the Tulsa C.A.N. Plan. This work is facilitated by the INCOG Area Agency on Aging in order to better address the needs of the population that has been studied.
8. One vehicle with Level 4 capability will be deployed and tested
9. Document user interface and vehicle behavior.

Segment (ii): Test and Document. Deploy three Level 4 ADS enabled vehicles on the public streets

1. In Year Two of the grant, a fleet of three Level 4 vehicles will be deployed.
2. The deployment will be coordinated by a national team of technical experts as proposed, with local universities and the City of Tulsa assisting these efforts.
3. Deployment will include extensive data collection as agreed upon in the Data Management Plan.
4. Collaborate to identify data, technology, and communications needs at all infrastructure locations, primarily intersections.
5. Test the competence of V2I and V2V communication protocols with limited additional public infrastructure.
6. Troubleshooting, testing and managing of the information will be delegated to technical partners and academic institutions, based on expertise and project roles.
7. Test cybersecurity issues by testing data integrity of V2V communication with integrated systems monitoring.
8. User benefits and adoption will be measured by INCOG Transportation Department and INCOG Area Agency on Aging.

Segment (iii): Data Analysis and Policy Recommendations

1. Utilize pilot project demonstration and project findings for development of benchmarks for ADS technology safety statistics.
2. Suggest safety guidance related to targeted population, user interface, vehicles.
3. Develop an ADS adaptability rating to jointly go with the street rating for speed, capacity, multi-modal use, and land use with data analysis and research.

Segment (iv): Data Curation and Information Sharing

1. Work with project partners and USDOT to ensure all needed data collected throughout the project is stored in a manner consistent with mutually agreed upon data management policy, industry best practices, and USDOT standards.
2. Share data analysis, project findings, and results with interested parties through the publication of peer-reviewed articles, presentations from the project partners, media events, news releases, and presentations at various national conferences by project leadership and in coordination with USDOT.

b. Legal and Regulatory Approach

In late 2019/early 2020, as a part of a separately funded initiative, INCOG and the City of Tulsa, with the support of ODOT, will undertake a review of state and local traffic law with an eye toward understanding possible necessary updates to the language for the safe accommodation of ADS, new mobility technologies, and other transportation innovations. This review is slated for completion prior to deployment of ADS in this project. Thus, with supportive MPO, city, and state executives, along with a plan for a clear understanding of impediments our laws may pose to wider ADS deployment, we are confident we can work with our partners to overcome any legal or regulatory barriers, either through temporary waivers or regulatory change. Our partners have assured us that they are in compliance with FMVSS and no waivers are needed for this project. Further, we do not currently anticipate needing Buy America waivers as our partners have domestic manufacturing operations.

c. Commitment to Provide Data

INCOG and the other project partners commit to providing the data gathered in this project, and to participating in and facilitating the evaluation of safety outcomes of proposed activities, and noting measures of effectiveness in other areas.

d. Risk Mitigations Approach

INCOG is aware of the cultural and technological complexities of this effort and is committed to collaborate and work with our partners and stakeholders to solve each of these to work towards the path of an inclusive and livable city and region.

e. Non-Federal Resource Management Approach

INCOG has a proven history of financial management of federal and non-federal resources. Many of our current projects require cost share with non-federal resources. Our accounting staff has significant experience and expertise in managing such projects. INCOG and project partners are committed to providing data and participating in the evaluation of the safety outcomes of proposed activities. This will be further explained in Part 3, Data Management Plan.

Risk Domain	Potential Risks	Mitigation	Responsible Party
Community	Public opinion may not support technology and city streets to be used for deployment.	Develop Community Engagement Plan, work with project partners with existing community relationships.	INCOG, AAA, City of Tulsa, Agency on Aging
Community	Target population may confidence in ADS and be hesitant to participate.	Establish continuing, collaborative, and authentic community engagement and dialogue with our stakeholders.	INCOG, AAA, City of Tulsa, Agency on Aging
Community	Target population may lack smartphone access and ability to schedule rides.	Build on existing platforms of phone based ride scheduling for target population; train caregivers in ride scheduling via their smartphone.	INCOG, Agency on Aging
Policy	State or local law may pose barriers to ADS deployment.	Prior to deployment, conduct a review of state and local law, work with policy makers to obtain needed waivers.	INCOG, City of Tulsa, ODOT
Institutional	Intergovernmental coordination to fully integrate technology at a local and then regional scale.	Continue building upon working relationships with local & regional partners.	All Partners
Technical	Integration of data sources	Work with all technical partners and USDOT to ensure compliance with USDOT data.	INCOG, Optimus Ride, Xtelligent, OU, OSU, TU