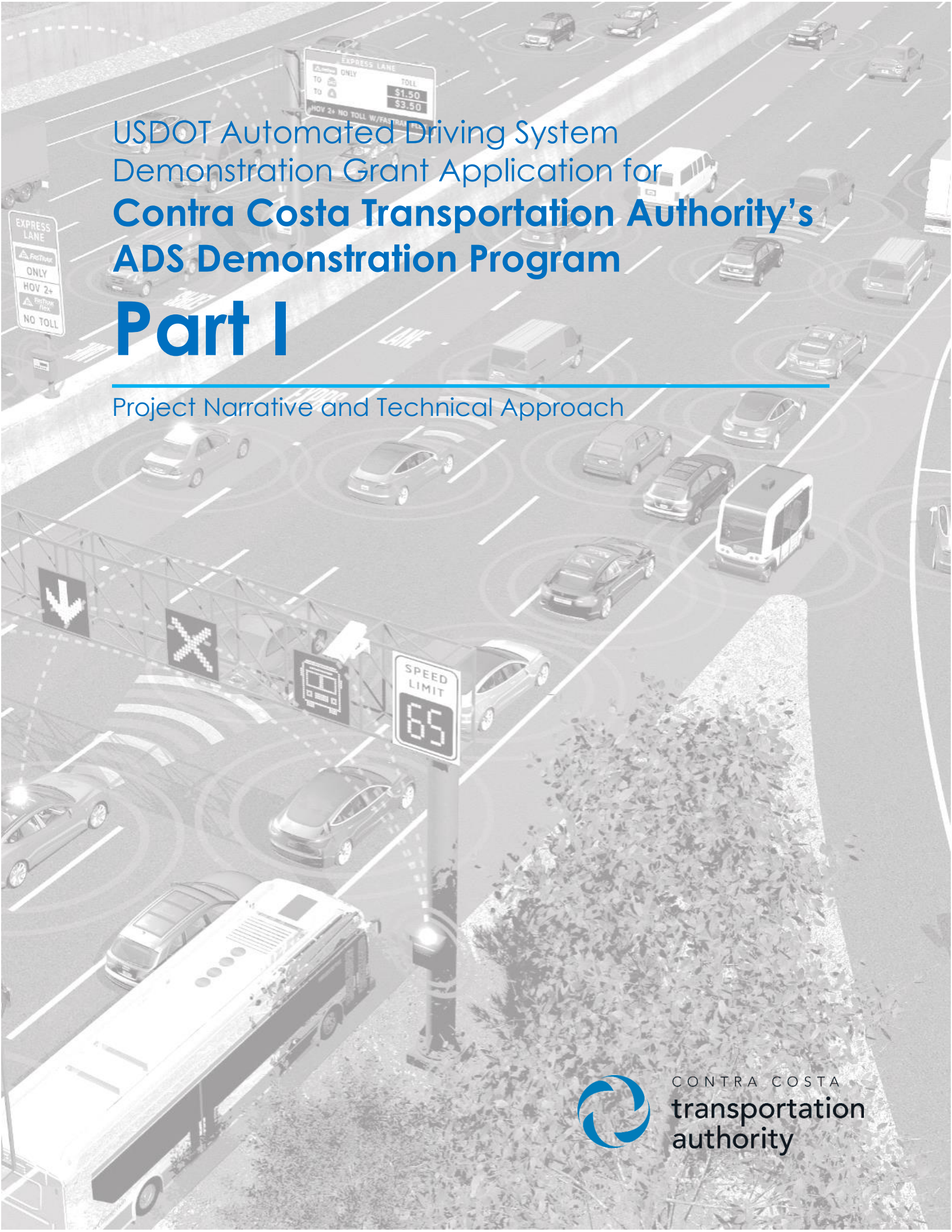


USDOT Automated Driving System Demonstration Grant Application for

Contra Costa Transportation Authority's ADS Demonstration Program

Part I

Project Narrative and Technical Approach

CONTRA COSTA transportation authority

PART I - PROJECT NARRATIVE AND TECHNICAL APPROACH

1 Executive Summary

The Contra Costa Transportation Authority (CCTA) in Contra Costa County is a public agency formed by Contra Costa voters in 1998 to manage the county's transportation sales tax program and oversee countywide transportation planning efforts. CCTA is responsible for planning, funding, and delivering critical transportation infrastructure projects and programs that connect our communities, foster a strong economy, increase sustainability, and safely and efficiently get people where they need to go. CCTA also serves as the county's designated Congestion Management Agency (CMA).

In 2014, CCTA founded GoMentum Station, which is a collaborative partnership among multiple automobile manufacturers, original equipment manufacturers (OEMs) and Tier 1 suppliers, communications suppliers, technology companies, researchers and academia, and public agencies. At GoMentum Station, technology, innovation, and commercialization are converging to define the next generation of transportation network infrastructure, including Automated Driving Systems (ADS). Underwritten through a recent investment by the American Automobile Association of Northern California, Nevada, and Utah (AAA NCNU), GoMentum Station continues to demonstrate emerging ADS technologies to solve mobility challenges occurring both today and in the future.

CCTA has taken a lead role for this grant application and has identified a team of partners outlined in Section 1.2.

Over the past five years, through our Connected and Autonomous Vehicle (CAV) program, our agency has collaborated with the California Department of Transportation (Caltrans), Metropolitan Transportation Commission (MTC), AAA NCNU, Verizon, Intel Corporation, University of California (UC) Berkeley Partners for Advanced Transportation Technology (PATH), Advanced Mobility Group (AMG), and has assembled an experienced team consisting of dozens of public and private partners. Our public and private sector partners have successfully advanced automation to improve vehicle safety and have invested in projects and initiatives to address challenges related to the safe integration of ADS. We are aware of the challenges and risks that the ADS market is currently facing, including:

Data collection and data sharing among public and private interests are still a challenge as the OEMs are protective of their intellectual property.

The need for clear rules and regulations to define safety standards for ADS that manufacturers can implement and measure.

The potential of market failure due to high risk and unpredictability of Return on Investment (ROI) for OEMs and technology companies.

Our proposal is aligned with the established goals of the U.S. Department of Transportation's (USDOT) ADS program and builds on the success of CCTA's CAV program at GoMentum Station. *CCTA's ADS Demonstration* program includes three real-world demonstration projects that take

a unique data-driven approach to finding proper solutions for key safety measures that can be used for effective rulemaking. By making useable data readily available and sharing it with the USDOT, our proposal demonstrates a commitment to deliver unprecedented mobility choices to transportation-challenged, underserved communities, while advancing automated driving systems expanding shared mobility options available to residents.

These selected demonstration projects will provide an opportunity to gather data and develop safety performance measures in alignment with the goals, focus areas, and work areas of the USDOT ADS program. The three demonstration projects will provide measurable, scalable, and replicable data to help the USDOT develop implementation standards across the nation.

PROJECT 1 | Rossmoor First Mile/Last Mile Shared Autonomous Vehicles, Walnut Creek, California

Increase transit accessibility for the elderly community using shared autonomous vehicles (SAVs). Data gathered will be used to develop safety performance measures.

PROJECT 2 | County Hospital Accessible Transportation, Martinez, California

Provide on-demand, wheelchair accessible, autonomous vehicle (AV) shuttle service to people who don't have transportation. Gather data to develop safety performance measures and to provide accessible transportation to public health facility improving quality of life and medical appointment absenteeism.

PROJECT 3 | Personal Mobility on I-680 Corridor, Contra Costa County, California

Prepare the corridor for future CAV. Install new and upgraded vehicle-to-vehicle infrastructure (V2I) and vehicle-to-vehicle (V2V) such as DSRC and 4G/5G communications, to accommodate both CAV technology and implementation of innovative operational strategies.

1.1 Vision, Goals and Objectives

VISION

Our vision is well aligned with the USDOT to advance ADS technology to address traffic safety and provide significant public benefits. Through the deployment of diverse demonstration projects, we will support the USDOT in the collection and analysis of data to improve safety, collaboration, and assist rulemaking.

With GoMentum Station, the largest CAV proving ground in the nation, serving as a facilitator between suppliers, OEMs, and public and private partners, we can conduct in-depth testing of ADS technologies and bring this vision to life. Safety during testing and implementation is our top priority. Vehicle manufacturers have been safely and effectively testing Society of Automotive Engineers (SAE) Level 3, 4, and 5 vehicles on GoMentum Station's secure roads for the past five years.

Collaboration

The GoMentum Station program was built on collaboration. This ecosystem of public and private partners will serve as a foundation for our three ADS demonstration projects. In alignment with the goals of the USDOT ADS program, we have partnered with universities, local stakeholders, private industry, law enforcement, and transportation-challenged communities.

We have engaged all the key players and have begun development of technology-driven solutions to support the advancement of ADS safety for communities in Contra Costa County, including those serving seniors, people with disabilities, and others with transportation challenges specific to accessing doctor appointments. The CCTA team, along with our public and private partners are actively committed to partnering with the USDOT and the National Highway Traffic Safety Administration (NHTSA) in support of this program, as demonstrated by the letters of support included in our proposal. We will ensure early stakeholder engagement and clear and consistent communication across our project team and the program.

Rulemaking

Rulemaking is key to ensure that ADS technologies will be deployed to meet the goals of the program and to succeed in the market. In 2016, CCTA helped pass California Assembly Bill AB 1592 to support pilot testing of Level 4 AVs on public roadways, including current testing at the Bishop Ranch Business Park.

		Project 1: Rossmoor First Mile/Last Mile Shared Autonomous Vehicles	Project 2: County Hospital Accessible Transportation	Project 3: Personal Mobility on I-680 Corridor
GOALS	Safety	✓	✓	✓
	Data for Safety Analysis and Rule Making	✓	✓	✓
	Collaboration	✓	✓	✓
FOCUS AREAS	Significant Public Benefit	✓	✓	✓
	Addressing Market Failure and Other Compelling Public Needs	✓	✓	✓
	Economic Vitality	✓	✓	✓
	Complexity of Technology	✓	✓	✓
	Diversity of Projects	✓	✓	✓
	Transportation Challenged Population	✓	✓	✓
	Prototypes	✓	✓	✓
WORK AREAS	Technologies Associated with ADS	✓	✓	✓
	Advanced Communication Systems	✓	✓	✓
	Innovative Mobility Solutions	✓	✓	✓
	ADS that Enhance Safety and Mobility	✓	✓	✓
	Shared Interoperable Fleet	✓	✓	✓
	Demonstration and Validation	✓	✓	✓

Note: Detailed project sheets included in Part 1, Appendix A

Recently, the NHTSA implemented a temporary exemption and regulatory relief act to allow for more extensive ADS research. At CCTA, we agree that there is need for more involvement from the USDOT and NHTSA with demonstration projects to allow for the development and implementation of regulations and rules for ADS technology. At a minimum, the rules should define the basic safety requirements for ADS technology with built-in redundancy and fail-safe mechanisms.

Data and Safety Analysis

Data and safety analysis gathered from tests and demonstrations are key to identifying the minimum requirements for AVs, ADS technology, and future ADS infrastructure. In addition, the data will also need to identify detailed requirements when it comes to vehicle monitoring control capabilities of ADS such as detection, decision, and reaction, which includes acceleration, deceleration, brakes, and steering.

At GoMentum Station, we are in the process of implementing a traffic-signal lab equipped with CAV V2I communication technologies, as well as cameras, radars, sensors, and vehicle detectors. Our plan is to use such technologies to measure the capability of ADS technology to properly detect traffic signal status, such as stopping at a red light and proceeding on green. Our three demonstration projects will gather V2I and V2V data and we will equip ADS vehicles with Cloud-based/Cellular-based Vehicle-to-Everything (C-V2X) On-Board Unit (OBU) devices to gather data. We will put stand-alone data-gathering devices on the vehicles to know their exact locations and provide front and rear camera views. Data will be uploaded to cloud-based data storage servers for real-time analysis and illustration on interactive web-based maps, charts, and diagrams. Data will be available to our researchers and will be shared with the USDOT via our web-based portal during the period of demonstration as required by the Notice of Funding Opportunity (NOFO).

Data Sharing

In addition to real-time data, several key OEM partners have agreed to share their test demonstration data and logs of their ADS navigation, LiDARs, and cameras for offline analysis by UC Berkeley.

1.2 Key Partners and Stakeholders

We have a team of well-qualified partners that have spent years in planning, development, testing, and deployment of CAVs and ADS technologies. Our proposed organizational structure consists of a program management group and three demonstration projects built on the foundation of GoMentum Station's proving grounds. The complete list of our partners and stakeholders, and their involvement with each project or group, is described in *Part II, Management Approach, Staffing Approach, and Capabilities*. Some of our unique advantages and key partners and stakeholder include:

- A highly qualified program management group, consisting of CCTA, AAA NCNU, AMG, UC Berkeley PATH, UC Berkeley Transportation Sustainability Research Center (TSRC), Lawrence Berkeley National Laboratory, and Sandia Laboratory.
- AAA NCNU, as owner and operator of GoMentum Station, will provide access to a test facility and program ecosystem of partners.
- Amazon Web Services (AWS), Verizon, and Intel Corporation will provide safe driving ADS technologies, dynamic HD mapping and data collection, 5G communication, and data management.
- Stakeholders such as Caltrans District 4, MTC, local cities, transit agencies, and law enforcement who will assist with project performance and implementation.

Why Should the USDOT Partner with CCTA?

We believe our strong team of public and private partners and access to a secure test facility make our application the best fit for addressing the USDOT's objectives. Some of our unique advantages include:

1. **A Well-Established CAV Proving Ground and Test Facility**. Formerly a naval weapons station, the 2,100-acre **GoMentum Station** is now the center of cutting-edge transportation research that will advance traffic safety and bring unprecedented mobility options to the public. GoMentum Station has been fully operational for close to five years and is one of the nation's largest secure proving grounds for CAV technology.

2. **AAA NCNU Investment** - GoMentum Station is now owned and operated by AAA NCNU, a not-for-profit, mutual benefit corporation, dedicated to public safety. Backed by their substantial private investment, AAA NCNU's mission is to transform GoMentum Station into a world-class premier CAV test facility to advance CAV mobility and safety.

3. **Key Technology Partners** include industry leaders Verizon, Intel Corporation and AWS. Verizon will apply a Cloud/C-V2X application for communication exchange between vehicles and nearby users and will gather data needed for the purpose of the study. Intel Corporation's Mobileye and Intel Network Platform Group will test technologies such as Edge Computing technologies.

4. **Willing OEMs and TNCs** – Our comprehensive partner ecosystem include OEMs like Honda, Toyota, SF Motors, EasyMile, Local Motors; Transportation Network Companies (TNCs) such as Uber and Lyft; and Roadway Equipment Vendors including Telegra, Horizon Signal, TrafficCast. All of these partners are dedicated to data sharing. Our Safety Performance Measurement and Monitoring system is an effective communication channel to share real-time information through a public access-controlled website that will allow anonymized, aggregated, and summarized real-time data, as well as archived data, to be viewed by the USDOT.

5. **Diverse, Committed Stakeholders** – CCTA is the lead and sponsoring agency in this application. CCTA's team of key public and private stakeholders have a five-year history of collaboration through the GoMentum Station program. We have received a renewed letter of commitment from all our public and private partners with cash and in-kind contributions. They are committed to supporting the USDOT in the safe integration of ADS technology through collaboration on the three ADS demonstration projects for collecting, measuring, assessing, and exchanging data.

6. **Comprehensive multimodal, multi-jurisdictional and interoperable suite of use cases and demonstration projects** with significant public benefit outcomes that can be replicated anywhere in the United States. Our candidate demonstration projects and use cases are multimodal and address transit accessibility for underserved communities. This includes several transportation-challenged populations including, but not limited to, elderly, disabled, and disadvantaged communities.

7. **Well-defined CAV/ADS demonstration projects** – We will build on existing ADS project experience and use cases, such as our SAV demonstration project in Bishop Ranch, California, to deploy additional SAVs in Rossmoor and the City of Martinez. These projects would be the first major implementation of Level 4 SAVs in the United States that are focused on serving the elderly and transportation challenged persons to provide greater access to medical services and improve safety.

Commitment to USDOT Cooperative Automation Research Mobility Applications (CARMA) Initiative – The Federal Highway Administration (FHWA) has developed the innovative CARMA platform to encourage collaboration with the goal of improving transportation efficiency and safety. As an early adaptor of CARMA in our agency, we are fully committed to FHWA's commitment to advancing Transportation Systems Management and Operations (TSMO) strategies with automated driving technology focused on how infrastructure can move traffic more efficiently.

1.3 Issues and Challenges

The long-term key issues and challenges in introducing fully developed and integrated ADS technology into public roadways are institutional, operational, and technological. A lack of proper rules, regulations, and standards for ADS technology is impacting technology development, investment, operation, and acceptance. The issues and challenges we anticipate for the work related to the grant are as follows:

RULES AND REGULATIONS | Further exemptions from Federal Motor Vehicle Safety Standards (FMVSS) and similar regulatory requirements will still be needed for the testing of AVs and ADS technologies on public roads. We also anticipate the need for rules that define the roles and responsibilities of parties such as owners, operators, drivers or ADS, investors, and insurers. The data management and analytics team will specify measurable safety targets and collect data to meet these key performance indicators. Frequent analysis on the USDOT accessible web-page will explain the existence of safety features tailored for ADS vehicles and will help inform the USDOT on rulemaking and setting new safety standards.

SAFETY | We anticipate that defining safety standards will be one of the challenges involved during delivery of the demonstration projects. In partnership with USDOT, we will need to develop safety measures, safety metrics, baselines, and key safety indicators. We also understand that these measures may be different for each kind of ADS, such as light duty for personal mobility and heavy duty for commercial vehicles.

DATA GATHERING AND PROCCESING | We anticipate an enormous amount of data will need to be gathered from multiple tests. This includes data from the vehicles undergoing assessments in the three projects, the OEMs demonstrating ADS at GoMentum Station, and data from regular vehicles for comparison. This data may include live captures of cameras, LiDARS, radars, data exchange packets, communication messages, and logs.

TECHNOLOGY | We anticipate higher than normal costs because of the customization of the technology. The infrastructure equipment, roadway markings, signage, and devices will need to be customized or modified. Labor costs may also be high because most of the personnel performing the work will need to be highly skilled in this new technology.

PROCUREMENT PROCESS | While the GoMentum Station platform allows for an expedited process of procuring new technologies, it remains a challenge to meet

both the private and public sector expectations for the fast delivery of systems and the need to fully comply with the Buy America Act.

INSTITUTIONAL | Bringing together different agencies to share and execute a common vision in addressing the region's transportation and mobility challenges can have its own trials and tribulations. While we have a long history of successful partnerships with other public agencies, it will be a new challenge to work with various private sector entities on a larger scale with different goals and objectives.

OPERATIONAL | Supporting institutional integration with a well-organized and open flow of information and processes throughout the development of the ADS technology is our priority. Interoperability will be key in addressing the operational challenges of Human Machine Interface (HMI) for people with disabilities.

PUBLIC AWARENESS, EDUCATION AND OUTREACH | Acknowledging the importance of public awareness and education, we will work closely with our public sector partners during the planning and implementation phases of the demonstration process to keep the public informed on all aspects of ADS technology.

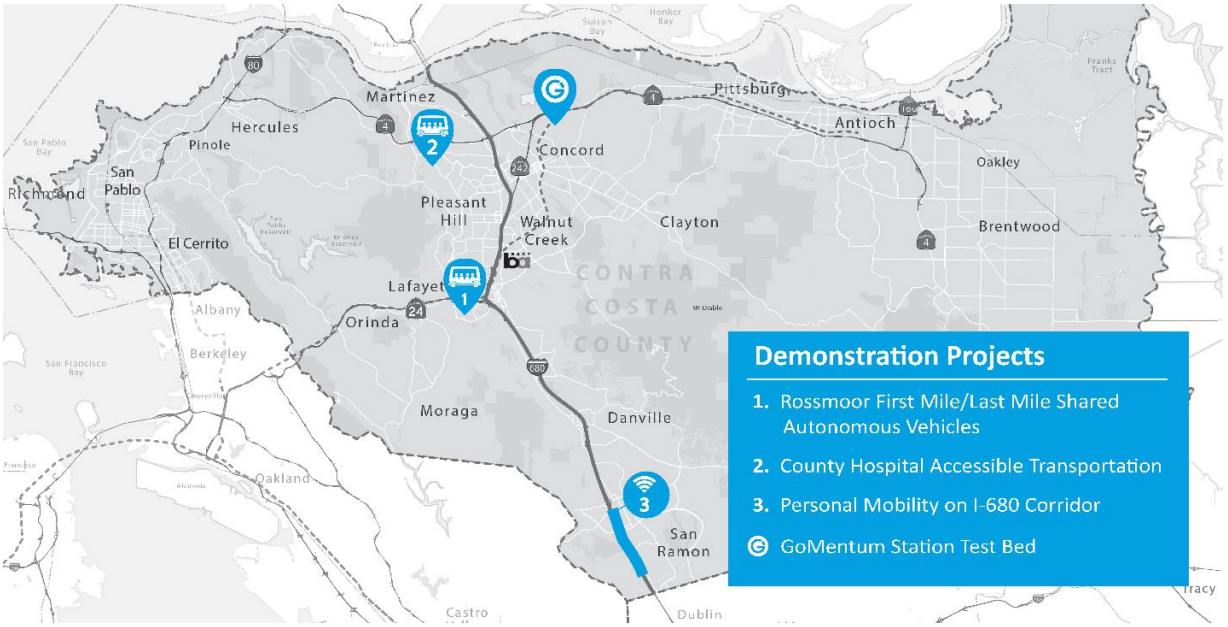
1.4 Geographical Area

All the work will be performed in Contra Costa County near San Francisco, California. The three project locations are illustrated on the map below. The first project will test a slow-moving (up to 30mph) AV shuttle in a gated community for senior residents (over age 55) living in a transportation-challenged community. Implementations of SAVs in the area will help connect them to transit and mobility hubs.

The location of the second project is near the Contra Costa Regional Medical Center, also known as the County Hospital, in the City of Martinez. The hospital is in a suburban community and is visited by patients from throughout Contra Costa County. While bus transit service is available to the hospital, there are a high level of medical appointment cancellations due to lack of transportation to the facility. We will deploy an on-demand wheelchair accessible vehicle with speeds up to 55mph to provide greater access to preventative medical care.

The third project will be along freeway, arterials and local streets within a two-mile radius of the City of San Ramon and Bishop Ranch Business Park. For the past three years, the area has been involved in multiple demonstrations of ADS technology and some of the infrastructure on local roadways may be re-used for these demonstration purposes. We are planning to test and validate many personal mobility vehicles with speeds up to 65mph for demonstration purposes in this area.

We expect all the vehicles for the three demonstration projects to be first tested at the GoMentum Station. Upon verification at GoMentum Station, the vehicle will be deployed for testing at the demonstration project site where they will continue to undergo testing and verification. Only when the vehicle is verified to meet specified safety requirements and validated to meet user needs will that vehicle be deployed to scale.

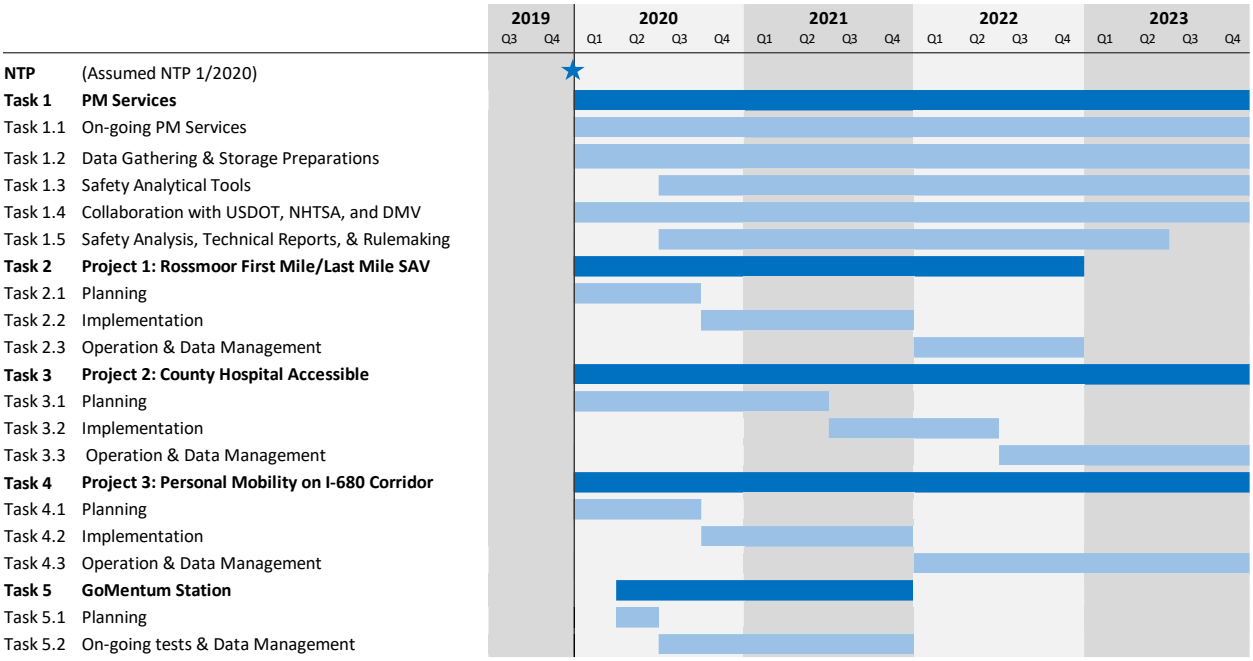


1.5 Implementation Schedule

As soon as the Notice to Proceed (NTP) is granted, the duration of the work related to the grant will be a total of four years. The three projects will start simultaneously, and the projects will go through a preparation phase that includes planning, procurement, and preparation of the infrastructure for testing and demonstration. This will also involve keeping the stakeholders informed and reaching out to the public to inform them that these demonstrations will be conducted in their area. Preparing the data-gathering infrastructure, data storage, analytic tools, and the data illustration website will commence with the NTP in a collaborative effort between the CCTA, AAA NCNU, USDOT, AMG, UC Berkeley PATH, Lawrence Berkeley National Laboratory (the Berkeley Lab), Verizon, Intel Corporation, Telegra, and AWS. The data management environment will be in place prior to the start of the demonstrations. The procured or provided ADS technologies will be tested at GoMentum Station in a safe and secure environment for a duration necessary to reach verification and validation levels required prior to deployment.

Once the ADS technology for each vehicle is verified and the project sites are ready for deployment, the implementation phase will begin. Project mobilization activities will include site surveys, risk assessments, obtaining the necessary permits, installation of roadway markings, signage and charging stations, infrastructure preparation, and will culminate with the deployment of vehicles with ADS technology. Once deployed and ready for demonstration, the data-gathering methods will be re-tested to ensure that the proper techniques for gathering real-time data from deployments on public and private roadways are in place.

The data storage services, archived data, technical reports, websites, and analytical tools will remain accessible for five years after the completion of the work per the requirements identified in the Data Management Plan.



2 Goals

2.1 Safety

As part of the work for this grant, our team will take a multi-step approach toward testing and verifying the safety of ADS integration into on-road transportation systems.

The first step is to perform a safety assessment of the AVs and their ADS technology in the secure, controlled, and safe testing environment of GoMentum Station. AAA NCNU will oversee the initial deployment of the vehicles at GoMentum Station and perform a AAA-AV Safety Assessment for different scenarios. The scenarios will be designed to assess vehicle performance across the four main categories of the pre-existing Advanced Driver Assistance System (ADAS) standards tests, which are the basic AV core competencies, edge cases, and fault injections. The test methodology is aligned with the International Organization for Standardization (ISO) Safety of Intended Functionality (SOTIF) framework and uses the most commonly accepted closed-course practices.

The current metrics that are most widely used to benchmark AV safety are limited and need further development as the industry advances. The current lack of objective and meaningful AV safety metrics undermines public confidence in the implementation of AVs on our roadways and is delaying research and deployment. Our demonstration projects will provide the data needed to develop more effective metrics. Demonstration project SAVs will be tested and compared to human-driven vehicles on a closed track at GoMentum Station which, at a minimum, can ultimately advance the safety potential of AVs.

The next step will be monitoring and gathering data from the vehicles deployed at GoMentum Station on roadways for long distances. After performing the safety analysis at the test facility,

the vehicles that have met all the safety requirements will be deployed on private and public roadways, as described in the three demonstration projects we are proposing.

Multi-Step Approach to Safety

Step 1 | Deployment of vehicles at GoMentum Station for initial safety assessment of ADS technology in a secure and controlled environment.

Step 2 | Monitoring and gathering data and testing capabilities of ADS technology through standardized and effective safety-performance metrics. Once vehicles have successfully passed the initial testing phase, they will be eligible for deployment on predetermined roadways in the project areas.

Step 3 | Deployment of vehicles on private and public roadways. Vehicles will be equipped with on-board data gathering devices to collect and analyze data to study the metrics, performance measures, and identify key safety indicators.

Our team will work together with the OEMs and public agencies during the deployment process on roadways to ensure and maintain safety. Verizon, Telegra, AWS, and AMG will work closely to gather safety data from the AVs and ADS technologies in cooperation with UC Berkeley PATH, UC Berkeley TSRC, and the Berkeley Lab, in close collaboration with Intel Corporation and AAA NCNU. The vehicles will be equipped with data-gathering devices that will provide real-time location of the vehicles, the speed, acceleration rate, deceleration rate, turning angles, target/nearby object classifications, safety envelope violations, safe distance data, infractions, responsibility sensitive safety measures, roadman-ship metrics and models. In addition, information from the infrastructure will be gathered, such as the real-time status of traffic signals, phasing, and timing, data from radars/detectors/ cameras, V2V, V2I, and V2X data packets such as Signal Phasing and Timing (SPaT) messages, Map, Basic Safety Messages (BSM), and Pedestrian/Personal Safety Messages (PSM). The purpose of this data gathering is to illustrate the exact path that was taken by each AV on an interactive map. With that data, the researchers will be able to use analytical tools to process the data, study the metrics, performance measures, and identify key safety indicators.

2.2 Data Sharing

Data sharing is one of the key goals for CCTA, not only because public acceptance requires confidence in the technology and its safety, but also because data sharing enables our large team of partners to work collaboratively with each other toward achieving the goals of the program. Our academic partners will analyze the data to measure the safety metrics and provide study results that will inform rulemaking and safety metrics.

Commitment to Data Sharing

We are asking OEMs to commit to sharing their data for an effective safety study to enable a comprehensive and collaborative approach toward achieving program goals.

1. **Data Sharing/Data Dump |** OEMs will provide data from of their AVs that at a minimum includes; recording of the radars, LiDARS, and cameras, and logs of their ADS and Navigation System (dynamic mapping logs).
2. **On-board Data-Gathering Device |** OEMs will allow placement/installation of a device on the AV for gathering real-time data. It is assumed that this will be a stand-alone device with a camera and LiDAR on the front and rear side of the vehicle.
3. **Data Gathering from Connected Vehicles and Infrastructure Detections |** OEMs will collect real-time data from CAVs equipped with Dedicated Short-Range Communication (DSRC)-based or cellular-based On-Board Unit (OBU) that communicates with traffic signals through V2I and other nearby vehicles through V2V and/or V2X for detection of other moving objects.
4. **Safe Driving Data |** This will include accident reports and other data, such as Forward Collision Warning (FCW), Headway Monitoring Warning (HMW), hazardous geolocations, and alerts heatmaps-braking.
5. **Mobility Data |** Data will include pedestrian crowds and their location, location of cyclists, number of rides per day and frequency of passengers, and the quality of rides.
6. **Traffic Conditions Data |** Data will include ease of highway insertion/exit (wait time in highway entrance/exit), traffic density per highway lane (e.g., carpool lanes versus ordinary lanes and at different times of the day/days of the week), available parking spots in streets, and average time for red traffic lights.
7. **Road Environment Data |** Data will include potholes on the roads, highway signs and lanes status, and any road hazards (e.g., construction areas, closed lanes).

We will also look for gathering data related to the OEM's miles traveled on public roads and events such as near misses, disengagements, crashes, serious injuries, and other possible major safety measures. We will gather similar data from regular/manual cars and compare the typical capabilities (detection, reaction, steering, braking, accelerating) to develop a recommended safety range for rulemaking.

Approach to Data Sharing for Development of Safety Measures and Key Performance Indicators

Data Sharing/Data Dump | The team will prepare the necessary Non-Disclosure Agreements (NDA) to receive the data and other information necessary to understand, process, and analyze the data included by a third party evaluator for anonymization, assessment of safety measures, and preparation of graphs, diagrams, and reports which will then be provided to the USDOT. Data will be provided in accordance with the Data Management Plan.

Web-based portal to display data | The data collected by the on-board data gathering device will be processed in real-time by a Safety Performance Measurement and Monitoring System and will be posted to a secured website with specific access control/hierarchy for the public, USDOT, and OEMs.

Data Mapping | Each test vehicle and its route will be shown on a multi-layered map in real-time through both live and historical plotting. Clicking on the vehicle icon will enable access to live and historical data gathered from the test vehicle including acceleration and deceleration graphs, turn angles, target classifications, and safety measures.

Data Gathering from Connected Vehicles and Infrastructure Detections will be provided to the same web-site that gathers data through the device detailed in item number two on the previous page. Additional information from V2I, V2X, and V2V will be added to the website, such as the status of the traffic signal and target classification (type of vehicles) moving objects around/near them.

2.3 Collaboration

It is evident that the automotive industry needs to collaboratively establish a methodology and the standards for safety validation in partnership with global standards, bodies and regulators. Our proposed demonstration projects will establish a collaborative environment and will form a relationship between private partners, universities, and local government, including engagement from the USDOT and NHTSA.

3 Focus Areas

3.1 Significant Public Benefits

Public Benefits

Collectively, our three proposed demonstration projects will benefit the public by improving safety on our roads, reducing traffic congestion and accidents, reducing carbon dioxide (CO2) emissions, and lowering fuel consumption. Our projects will greatly improve transportation accessibility for transportation challenged communities, reduce travel time and transportation costs, and promote better health.

The Rossmoor First Mile/Last Mile (FM/LM) SAV demonstration project will provide an electric AV shuttle service for senior residents who live in a transportation-challenged community. This project will increase the ease of accessibility for all residents, regardless of ability. We will collaborate with the community of Rossmoor to empower and enable access to community facilities for residents that have transportation challenges and the goal of providing transportation comparable to the convenience of travel by personal vehicles.

The County Hospital Accessible Transportation Shuttle demonstration project will increase for transportation challenged individuals in the City of Martinez through the deployment of wheelchair accessible vehicles with on-demand capabilities. This project aims to improve better access to healthcare by lowering the occurrence of missed medical appoints. Patrons that have transportation challenges could use Level 4 AVs to more easily access preventative healthcare. This will reduce the need for emergency medical transport to the emergency room.

Our third demonstration project, Personal Mobility on I-680 Corridor, will test ADS at higher speeds on freeways and local streets. The data gathered from these tests will serve to help develop data for safety performance measures and will prepare our vital transportation corridors for CAVs. All data gathered will be stored in the CCTA Safety Performance Measurement and Monitoring System in real-time. The data will be aggregated and anonymized to be shared on the CCTA website with separate access portals for the public, the USDOT contractors and consultants, and the OEMs sharing their data.

3.2 Addressing Market Failure and Other Public Needs

To date, the lack of clear standards, rules and regulations to define safety for ADS have prevented manufacturers from building vehicles that meet specific safety targets. Furthermore, the lack of rulemaking and the uncertainty of the direction that federal standards will specify, also hinder the development of safety features tailored for ADS vehicles. To avoid failure, additional research involving NHTSA needs to continue to identify standard performance metrics that AV manufacturers need to achieve.

Rulemaking

With its involvement in the nation's existing demonstration programs, the NHTSA will be paramount in the successful development and implementation of standards, and verification processes that could result in more investment, increased involvement of manufacturers and ultimately, reaching the goals of fully-tested, safe, and functional Level 4 and Level 5 vehicles.

Although there have been significant investments in a few models of ADS vehicles, there is still a notable market failure in terms of investments in ADS vehicles that cater to the needs of disabled access persons, and necessary smart infrastructure to achieve V2I/V2X to safely integrate CAVs into our existing transportation networks. We have learned in our extensive experience working with private partners that further investments in ADS systems and necessary infrastructure is considered high risk. Furthermore, we have learned that a lack of interest to invest in ADS results from an unclear target date for a return on investment.

We believe that in addition to the FMVSS certification and verification processes, state agencies should be involved to monitor Level 4 and Level 5 vehicle testing, verification, and validation on public roadways in concert with NHTSA and third-party test facilities. Our demonstration projects will follow these same processes to put the burden of self-certification testing on fleet management companies.

3.3 Economic Vitality

Economic Growth in the United States

Once the demonstration and proof of concept is completed, the resulting technologies for adoption and mass deployment will be certified Buy America if federal funds are used.

Our demonstration projects are structured to be scalable and replicable nationwide. Through our research and development, our demonstrations will incorporate the best and the latest technologies. The demonstration ecosystem will reflect companies with American employees with local offices in the United States. If there is a knowledge transfer or need for a product from outside the United States, that product or service will be provided as an in-kind contribution.

3.4 Complexity of Technology

All three projects are testing SAE Level 3 and Level 4 vehicles involving highly complex technological standards. We have received the commitment of our partners for real-time data sharing. We will have AVs equipped with DSRC-based or Cellular-based OBUs that will collect and share real-time data from V2I, V2V and/or data gathered from V2X with USDOT.

3.5 Diversity of Projects

We have systematically selected our three demonstration projects for both their unique benefits and challenges. The Rossmoor FM/LM SAV demonstration project will be implemented in a senior residential community located near shopping areas and public transportation. The demonstration project will utilize local roads that have both stop sign and signal-controlled intersections. The new autonomous service will provide safe and reliable mobility for the aging community.

The County Hospital Accessible Transportation Project will be implemented in a residential suburban area with shopping areas and public transportation close to the County Hospital. The on-demand autonomous shuttle is intended to improve community health and safety by providing on-demand, reliable transportation and wheelchair accessible services to support sick, elderly, and disabled patients that lack adequate transportation to the County Hospital.

The Personal Mobility on I-680 Corridor demonstration project will be implemented on a congested freeway mainline and will test high-speed AVs for future public transportation, carpool, and freight movement applications. The project will deploy integrated corridor management strategies and CAV technologies to increase the movement of people and cars

throughout the corridor. These strategies hold the promise of balancing demand on the freeway system to enhance mobility, safety, sustainability, and to meet existing demands and future population growth.

3.6 Transportation-Challenged Populations

The Rossmoor FM/LM SAV project intends to solve FM/LM challenges by using Level 3 and 4 vehicles to empower seniors by connecting the residents of Rossmoor to the greater Walnut Creek community and beyond through improved access to transit service providers. Rossmoor is an active senior living community with the average age of residents being 77 years old. While most residents are retired, some are still of pre-retirement age. About 12 percent are 64 years old or younger, and about 29 percent are 65 to 74 years old. The SAVs will enhance mobility within the Rossmoor community and between the city and everyday destinations throughout the region and solve transit accessibility and connectivity.

The County Hospital Accessible Transportation project will provide on-demand transportation services for people who are transportation challenged (i.e. cannot drive, do not have access to a car, do not live near a transit stop) and need to access the County's medical facility in Martinez. The Contra Costa Regional Medical Center (County Hospital) is a vital resource for many who are low-income and or lack medical insurance. The hospital conducts over 30,000 outpatient visits per month and experiences a high level of appointment absenteeism resulting in an increase of emergency medical visits to the emergency room.

3.7 Prototypes

The team has experience with testing, validating, and deploying prototype technology. The Bishop Ranch SAV project is one example of how we tested and evaluated on-road deployment of the ADS. The SAV was able to demonstrate crossing a four-way signalized intersection on a public road adjacent to Bishop Ranch. We will prototype the Q'STRAINT automated securement and restraint systems in the AVs used for the Rossmoor and County Hospital demonstration projects. All three of the ADS demonstration projects have technology prototypes suitable to support safe demonstrations. The GoMentum Station test bed has the capability and the infrastructure needed to test V2V and V2I technologies.

4 Requirements

Our proposed test demonstration projects meet all the criteria required by the USDOT NOFO and the minimum safety, functionality, and operational requirements for the USDOT ADS program. We are committed to data collection and sharing, collaboration, physical demonstration, and meeting the minimum technical requirements such as dynamic mapping, ADS technology, physical demonstration, cybersecurity, secure data, accessible data to all partners, scalable across the county and region, and safety expectations, all of which are described in the following sub-sections. As a requirement for award, CCTA will negotiate and sign a mutually agreeable data sharing agreement with the USDOT for at least the minimum defined period.

4.1 Research and Development (Advancing ADS Technology)

Part of our research may include gathering data from a few standard "control" vehicles that are SAE Level 1 or Level 2 for comparison with our test vehicles that have ADS technological capabilities of Level 3, Level 4 or greater. We expect that our demonstration projects will foster additional research and development opportunities during planning, testing, integration, deployment, and operations to further enable manufacturers to advance their ADS technologies. The demonstration projects will establish safety standards and rulemaking necessary for deployment. Our team has identified the following areas that will be explored during the research and development process including, Americans with Disabilities Act (ADA) compatibility, interoperability between CAVs and V2X, V2I, and V2V technologies, dynamic High Definition (HD) mapping, and transitioning to 5G communication.

CARMA

We support the USDOT CARMA architecture and are confident that V2X, V2I, and V2V can play a major role in improving the safety capabilities of AVs.

4.2 Physical Demonstration

All three demonstration projects we are proposing involve the use of Level 3 or greater ADS technology. Our projects will test low speed (up to 25mph), medium speed (up to 50mph), and high speed (up to 65mph) fully automated AVs that will be equipped with a user interface or HMI that allows a user to call for a ride and/or to identify the desired destination.

Our top priority is safety during the testing and demonstration of each project. We will follow best practices from previous demonstrations of AVs. Planning and preparing for these demonstration tests may include application for permits prior to the test, field surveys, risk assessments, infrastructure improvements, roadway markings and signage, detours, traffic maintenance, and public outreach.

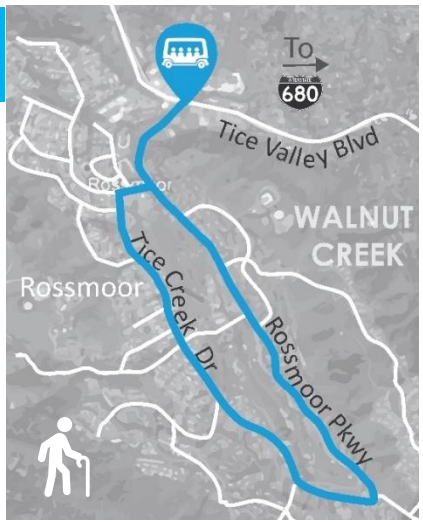
1 Rossmoor First Mile/Last Mile SAVs, Walnut Creek, California

Level 4 low-speed shuttles (up to 25mph)

Fixed route SAV shuttle service that will provide increased transit accessibility for the elderly and people with disabilities and will gather data to develop safety performance measures.

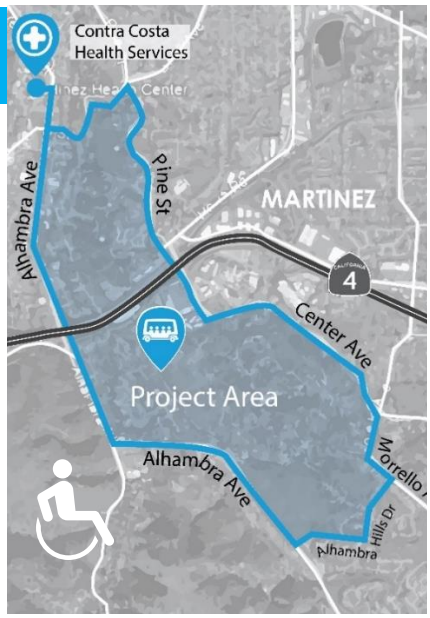
Demo Type: Fixed route SAV service with multiple stop locations along a predetermined path to load and unload passengers.

HMI: User interface is able to identify desired stop, Q'STRAINT automated securement and restraint systems.



2 County Hospital Accessible Transportation, Martinez, California

Level 3, Level 4 medium speed shuttles (up to 50mph)



On-demand wheelchair accessible AV shuttle service designed to support people who are transportation challenged and provide increased access to the County Hospital. The project will gather data to develop safety performance measures.

Demo Type: On-demand AV wheelchair accessible transportation services for Martinez residents. Following the demonstration period, the plan is to expand the service area to include on-demand services to the adjacent cities of Concord, Pleasant Hill, and Walnut Creek.

HMI: Smartphone app and dial-a-ride service, Q'STRAINT automated securement and restraint systems, and optional wearable device such as a bracelet especially designed for seniors and minimally ambulatory individuals.

3 Personal Mobility on I-680 Corridor, Contra Costa County, California

Level 3, Level 4 high-speed AVs (up to 65mph)

This project will prepare a portion of the I-680 Corridor for future CAVs. We will install new and upgraded V2I and V2V 4G/5G communications to accommodate CAV technology, along with the implementation of innovative operational strategies. ADS technologies such as HD dynamic mapping and dynamic data describing high risk areas will assist in paving the way for AV solutions in the corridor.

Demo Type: Integrate and operate highly-automated Level 3-Level 4 vehicles on a two-mile segment of the I-680 freeway and adjacent arterials.

HMI: Touch screens with maps which will enable the user to identify a destination and preferred route.

The purpose of testing and demonstrating a combination of modes is to provide data to assist ADS manufacturers to furthur develop HMI. This could lead to the eventual integration of more complex, interoperable HMI into vehicles.

4.3 Data and Collaboration

The three proposed demonstration projects will use different techniques for real-time data gathering, reporting, storage, and analysis as described in Section 2.2 of this document and is further described in *Part III – Data Management Plan*.

Collection of Real-time Data

Reports and studies generated using the real-time and historical analytical tools and ADS data and logs provided by the manufacturers will be uploaded daily to the project's cloud-based website in near real-time for all partners to review.

Our Data Management Team, consisting of the Berkeley Lab, UC Berkeley PATH, AMG, Verizon, Telegra, and AWS will review the data to ensure that only the appropriate data is accessible to the public for the duration of the grant and a minimum of five years after the completion of the period of performance. The letters of commitment from the ADS technology developers, AV manufacturers, and OEMs are included in *Part IV, Letters of Commitment*. Partner collaboration will be key in developing rulemaking and will help in improving public confidence. Nondisclosure agreements could be executed to prevent confidential business intellectual property from being accessible to the general public or industry competitors. Our Data Management Plan describes how we will implement multi-level access control to secure, anonymize, and aggregate the data in technical reports per the expectations of the USDOT.

Secure Data Sharing System

- **Cloud-based access for sharing technical reports and data**
- **Real-time cloud-based Data Storage (Mirror #1 by Verizon and AWS)**
- **Real-time Local Data Storage (Mirror #2 by Telegra)**

Some data gathered may be used in simulations and modeling software to use the analytical tools available for the development of the technical reports and studies.

Comprehensive Data Collection

Data will be gathered in a comprehensive manner and made available to the USDOT in order to support rulemaking and demonstrate the safety performance of ADS technology.

1 Collection of conventional data regarding safety including near misses, incidents, accidents, operation (vehicle and ecosystem), exposure measures, and innovative measures of safety-relevant vehicle behaviors that may indicate potential safety issues. Data on safe driving is further expanded in *Part II Management Approach, Staffing Approach, and Capabilities*, *Section 1 Management Approach*.

2 Vehicle monitoring control capabilities of ADS such as detection, decision, and reaction, which includes acceleration, deceleration, braking, and steering.

3 V2I communication technologies, as well as cameras, radars, sensors, and vehicle detectors.

4 ADS technology capability for properly detecting traffic signal status and responding appropriately to the signal system.

For the purpose of this grant, we are planning to take our three demonstration projects into a deep, data-driven approach to not only gather similar data from CV technologies such as V2I and V2V where available, but we are also planning to equip ADS vehicles with a cloud-based C-V2X OBU device to gather data from a wider range. The following quantitative and qualitative metrics that will be used in the AV Safety Assessment includes:

1 **Road Law Compliance |** All vehicles that drive on public roads shall meet the laws established for the jurisdiction. Each scenario is evaluated against the jurisdictions specified in the operational design domain and judged whether it was compliant with the road laws. The outcome is either Yes or No.

2 **Severity Score |** A severity score is used to determine the safety state of the AV to another moving object. The representation of the severity score is a number greater than or equal to zero. A severity score of less than one means that the vehicle can remain safe by decelerating at an allowable rate. A severity score of greater than one means that the AV cannot avoid all possible unsafe situations on its own, but it does have the opportunity to mitigate potential impact.

3 **Minimum Distance |** The distance between the AV and all other objects is not only an input to the severity score and is a useful metric to define risk. As part of the testing, the minimum distance will be collected and reported.

4 **Subjective Assessment |** The addition of a subjective evaluation is meant to supplement the objective criteria mentioned above. Judgments made by the safety driver will represent the safety measures that are not captured by earlier criteria.

Data Mapping | Each test vehicle will be illustrated on a map in real-time through both live and historical plotting. The map will be multi-layered and will provide information such as signage, traffic signals, and the status of the traffic signals. It will include a history bar in the corner of the map that will illustrate the path the vehicle traveled. Clicking on the vehicle icon will enable live access and historical data gathered from the test vehicle, including acceleration and deceleration graphs, turn angles, target classifications, and safety measures.

4.4 Dynamic Mapping and Destination

One of the key requirements of the demonstration projects is that ADS technology manufacturers use dynamic HD mapping and share the associated data and logs. Additionally, we propose that certain AVs that use the same dynamic HD mapping technologies share the data via cloud-based storage over a 4G or 5G network to enable the broadcasting of the

information to other AV fleets. An example of this type of data exchange and benefits from this feature is the ability of a vehicle to report back to other vehicles that a change in roadway infrastructure has occurred, such as a change of an environmental condition or temporary construction zone. Once the team has verified that the ADS technology developer can demonstrate the basic features of dynamic mapping, the next step is to ensure the interoperability between the ADS technologies developed by multiple manufacturers and dynamic HD mapping.

4.5 Scalability

Our three proposed demonstration projects are scalable to other locations in Contra Costa County and the nation. We are planning for Project 1 to become a model demonstration project for FM/LM solutions to transit accessibility challenges across the country.

CCTA has worked closely with Bay Area Rapid Transit (BART), the Bay Area Air Quality Management District (BAAQMD) and County Connection, a local transit service provider, to develop a long-term and sustainable partnership that will result in the county-wide deployment of FM/LM SAVs.

The vehicles verified in Project 2 will be ready for commercialization as soon as the demonstration is complete. The County Hospital Accessible Transportation SAVs would first be deployed in the cities of Martinez, Concord, Pleasant Hill, and Walnut Creek and eventually expand to other cities in the county, and beyond.

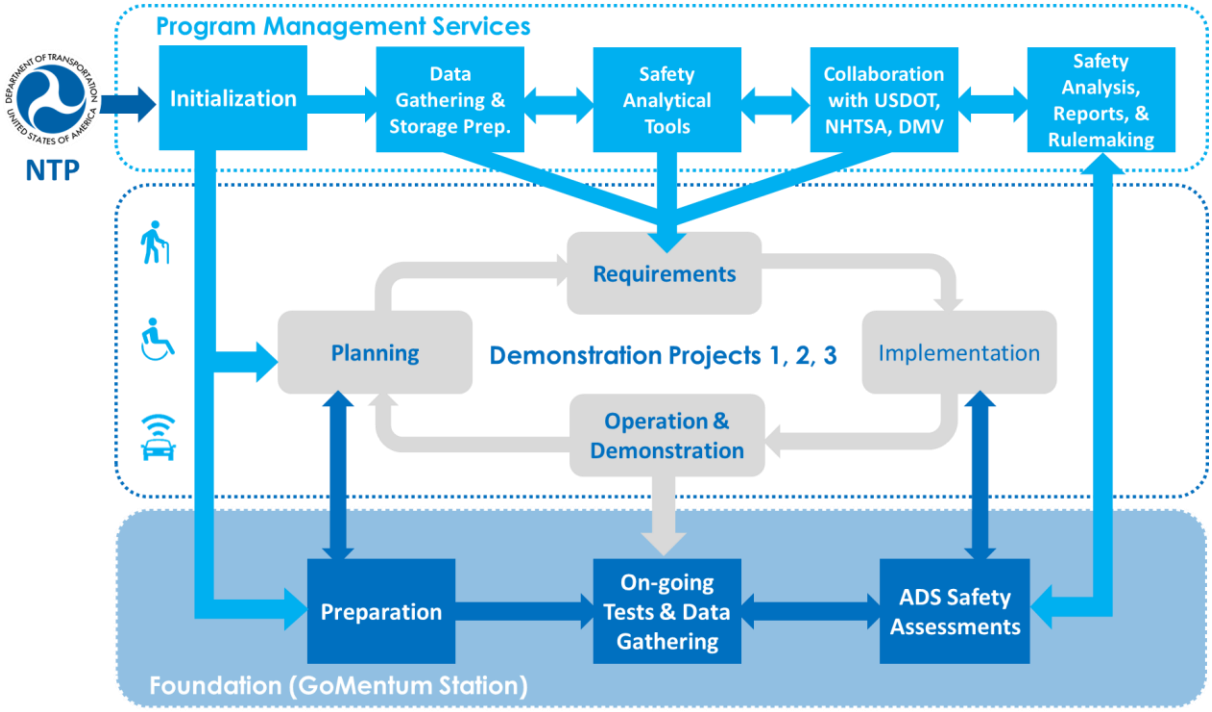
Project 3 is focused on harnessing ADS technology for personal mobility use on private or public roadways, and eventually, across the nation. These personal mobility vehicles can also be used for carpooling and carsharing, which can increase people throughput on our roadways, reduce vehicle miles traveled along I-680, and enable other communities to do the same across the greater Bay Area and beyond. To take advantage of the current momentum and the advancement in ADS technology, the team will install new and upgraded V2I and V2V communication capabilities and prepare the I-680 Corridor for future CAVs.

GoMentum Station's AV testing grounds will provide critical insights into best practices of big data usage through AV testing and will serve as a foundation for building a community around AV research.

5 Approach

5.1 Demonstration Evaluation

We are taking a data-driven approach toward the implementation, demonstration, and evaluation of our three demonstration projects to integrate ADS technology and AVs on public roadways. We will be utilizing the Scrum and Agile (USDOT *Applying Scrum Methods to ITS Projects* August 2017) systems engineering workflow methodologies to constantly test, prioritize and deploy physical demonstration projects.



In following the USDOT guidelines, *Automated Vehicles 3.0.* dated October 2018, we will be using Agile (technical approach for systems engineering where we prioritize needs of prototypes to determine deployment, using the Scrum method for project development. The Scrum method is a software development technical approach for testing prototypes in and iterative incremental approach that furthers development as the physical demonstration progresses. It will be combined with a systems engineering approach to evaluate the demonstration projects. The Scrum methods will be applied based on the USDOT's Guidebook of Applying Scrum Methods to Intelligent Transportation Systems (ITS) projects, dated August 2017 for ITS and Connected Vehicles[1].

The diagram above illustrates the specific roles and activities of the Program Management (PM) group, the demonstration projects, and GoMentum Station. The main role of the PM group is to define the requirements for data gathering, safety analysis, collaboration, and data sharing while overseeing the project's implementation toward successful demonstration. The GoMentum Station test bed foundation will be working closely with all three demonstration project partners and the OEMs to gather data, perform safety assessments and oversee implementation to ensure safe and sound operation. The three demonstration projects will follow Scrum principles and practices and the demonstration area will be expanded with verification scenarios defined by the requirements, which will become more advanced after each successful demonstration and evaluation.

We will follow the USDOT AV guidelines and will implement the five core strategies to effectively accelerate the integration of AVs onto our roadways. These strategies include sharing our voluntary safety self-assessments with the public to increase transparency and

[1] FHWA-JPO-17-508

confidence, engaging the stakeholders and the public, using best practices, supporting voluntary technical standards and approaches to advance the integration of technologies, conducting targeted technical research, and modernizing transportation regulations.

The AVs and ADS technology that will be deployed as part of the demonstration projects will first be assessed at the GoMentum Station secure test bed, prior to deployment on private or public roadways. The ADS technologies will be categorized as one of the following:

A	**Ready for full ADS deployment -** AVs that can be commercially deployed and operated in mass for validation and fine-tuning opportunities.
B	**Ready for limited ADS deployment -** AVs that can move toward limited commercialized operation for gathering user/public feedback and verifying underlying safety assumptions.
C	**Ready for ADS Road Testing Challenge/Expansion -** AVs that have reached build confidence in the technology within specific Operational Design Domain (ODD) and are ready for expansion into more challenged environments fail-safe testing.
D	**Developed Prototype** - AVs that are ready for Early Stage Road Testing - requires an assessment of safety risks and implementation of mitigation strategies.
E	**Under Development Prototype -** AVs that need improvement prior to implementation.

Using our systems engineering approach, CCTA will oversee the verification, validation, and safety assurance processes at each stage of testing, which will result in gaining statistical confidence in the system's ability to handle use cases. Our team will verify ODDs, risk assessments and mitigation, conformance with requirements, the stability of the system, the monitoring of safety and key performance indicators, safety items, and the capability of the system to function as expected. The stakeholders, partners, USDOT, NHTSA, and the Department of Motor Vehicles (DMV) will all be involved and engaged in each step of the process, as was the case with our Bishop Ranch SAV pilot project.

5.2 Institutional Issues

Existing federal transportation regulations and standards generally assume that there is a human driver, which normally requires a steering wheel, accelerator pedal, brakes, mirrors, visible instrument displays, status indicators, and windshield wipers. With the emerging AV ADS technologies, these regulations need to adapt, and we are aware that the USDOT is in the process of identifying and modifying regulations for AVs and ADS technologies as it pertains to testing, sales, and operation of these vehicles.

CCTA and GoMentum Station have been working to advance legislation for innovative technology since 2016. At that time, California's AV regulations did not allow the operation of shuttles without provisions for a steering wheel, gas or brake pedals, accelerator or operator. CCTA has worked on the legislative and regulatory fronts and has been successful in working with former Assemblywoman Susan Bonilla, in passing California Assembly Bill No. 1592 which allows for the operation of low-speed, electric, multi-passenger AVs.

The SAV shuttles require extensive technical, legislative, regulatory, certification, and market acceptance processes prior to full operational deployment in Contra Costa County. Acknowledging this, CCTA has been working to address these requirements with great progress, including the development and testing of SAV shuttle operations at GoMentum Station. Additional regulations and legislation to support provisions for SAV shuttles to travel through communities to transit hubs, such as BART, may still be needed.

Working with the manufacturers, our experienced team will be able to identify areas where the ADS vehicles may or may not be meeting the FMVSS, Federal Motor Carrier Safety Regulations (FMCSR), Federal Transit Administration (FTA) regulations, ADA act standards, Environmental Protection Agency (EPA) regulations, and other applicable local regulations and standards.

We acknowledge that the standards for the safe testing of ADS technologies exist for good reason, but some standards may be outdated, which make some exemptions a necessity. We will implement the necessary training and policies within the program to ensure the appropriate attainment and use of such temporary test permits and exemptions are handled appropriately.

For the purposes of inspecting the vehicle, its surroundings, and data in the event of a roadway accident or incident involved with an AV, we will work with law enforcement and ADS manufacturers to implement technologies that will record critical safety-oriented vehicle data that can be shared with law enforcement, our project partners, DMV, and USDOT.

5.3 Commitment on Data Sharing and Measurement of Effectiveness

Our partners support the ADS NOFO goals and we have attained signed letters of commitment from them to provide the data necessary for measuring safety. In addition, our key partners are committed to data sharing standards that will enable interoperability between vehicles and infrastructure which will provide uniform data exchanges between AVs, law enforcement, and first responders. This infrastructure includes traffic signals, other vehicles, bicycles, and pedestrians. The real-time data gathering system put in place for the purposes of this program will gather as much real-time data from the vehicles, infrastructure, and OBUs as possible to enable effective research and development to identify and record key safety indicators to support future rulemaking.

Besides safety measures, the data gathered will serve many purposes. We also plan to use the data collected to measure and compare the effectiveness of the ADS technology on the roadway's traffic conditions, vehicle miles traveled, mobility, environmental conditions, person throughput increase, and the increase in transit ridership. Some of this will be possible by sharing the vehicle locations via Basic Safety Messaging (BSM), Cooperative Adaptive Cruise Control (CACC), and ADS technologies.

5.4 Risk Management Plan

A Risk Management Plan will be developed for each demonstration project with actionable risk mitigation strategies and monitoring metrics to ensure successful project and program completion. We will collaborate with our partners at GoMentum Station and conduct risk

reviews and analyze metrics to determine the ongoing risk status and identify serious risks to the project. A Risk Log containing a comprehensive list of identified and assessed risks for the successful completion of the project will be maintained for the duration of the project.

Our systems engineering approach along with our management approach will identify mitigation strategies and monitoring metrics, to ensure the successful deployment of the vehicle on public roadways. The best practices, safety procedures, testing protocols, and functional safety processes may be put in place depending on the condition of the ADS technology, complexity of the scenarios, use cases, and safety assessment.

Besides the risks related to operation and deployment, we will review the specification and architecture of the AVs and their associated ADS technologies to analyze if the design takes in redundancy or fail-safe system considerations. We will assess other technology-related risks such as technology limitations, cybersecurity threats, and hardware failures.

We will then assess and identify risks related to driving with ADS technology, such as line-of-sight limitations, detection limitations, decision making limitations, reaction time and capabilities. This will include identifying the risks of the behavior of other drivers, pedestrians, and road users. Other risk mitigation strategies will include signage on roadways, roadway markings, traffic maintenance, detours and/or infrastructure improvements. Keeping the public aware of testing on the roadways through public outreach will also be key in minimizing the risks associated with testing vehicles on roadways.

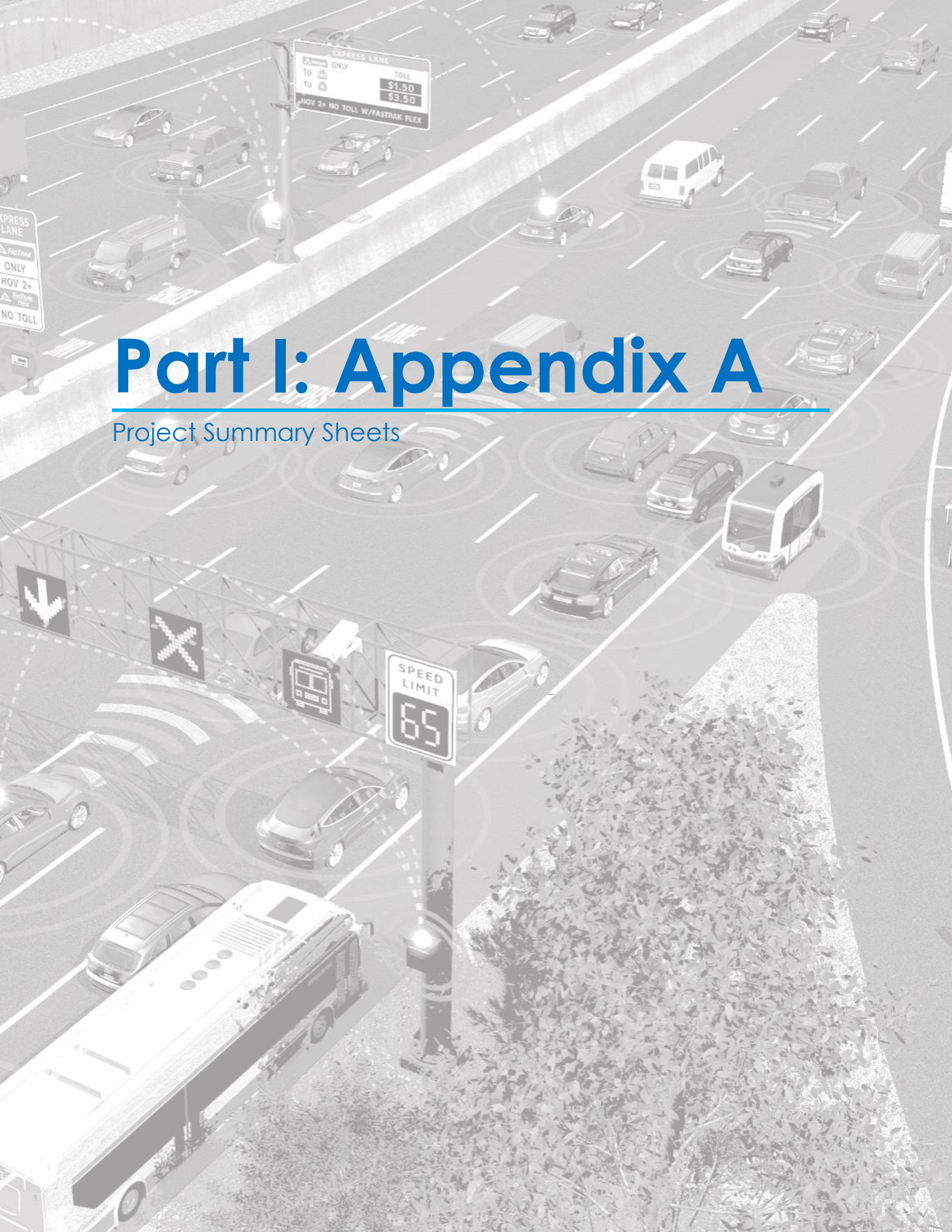
In collaboration with our partners we will consider integrating multiple technologies to reduce risk. These technologies could be the use of cooperative automation, and connectivity such as V2V, V2X, V2I, or USDOT's CARMA architecture.

5.5 Cost Sharing

Although a dollar match is not a requirement of this particular USDOT ADS grant application, we have identified greater than a 2 to 1 funding match commitment from public and private partners to advance the development of ADS technologies. Significant cost sharing commitments are outlined below:

Committed Cost Sharing

$18M	CCTA's committed funding match to the SAV pilot projects and preparing the I-680 Corridor for future CAV operations.
$50M	AAA NCNU's commitment to build a premier world class CAV proving ground at GoMentum Station ($50M over ten years).
$5M	MTC's commitment to advancing CAV in the San Francisco Bay Area.
$15M	Collective contributions by our private partners AWS, Intel Corporation, and Verizon and the OEMs ($15M+ over five years).



Part I: Appendix A

Project Summary Sheets

Project 1	**Rossmoor First Mile, Last Mile Shared Autonomous Vehicles (SAV), Walnut Creek, CA**	
Increase transit accessibility for the elderly and people with disabilities through the use of shared autonomous vehicles and gather data to develop safety performance measures. The shuttles are Level 4 (L4) and low speed (up to 25mph).		
Goals	Safety	Testing L4 Slow Moving Vehicle in Suburban Areas
	Data for Safety Analysis & Rule Making	Moving and frequent stops, detecting obstacles and objects
	Collaboration	County, cities, transit agencies, law enforcement, private industries
Focus Areas	a) Significant Public Benefit	First Mile/Last Mile, accessibility, new travel options, transit ridership, safety, societal, better health, less traffic
	b) Addressing Market Failure and Other Compelling Public Needs	Legislation and regulation, risk management, FMVSS testing, cybersecurity, investment, V2X, safety of testing, data collection
	c) Economic Vitality	Buy America and Hire America, economic growth, expandability to the rest of the county and region
	d) Complexity of Technology	L4, challenges of operation in urban areas, high cost, object and obstacle detection, V2X
	e) Diversity of Projects	Residential suburban, senior community center, shopping areas, public transportation.
	f) Transportation-challenged Population	Elderly (<55) travelers, individuals with disabilities, senior community
	g) Prototypes	Existing prototype
Work Areas	a) Technologies associated with ADS	L4
	b) Advanced Communication Systems	V2I, V2X, NRTK, 4G/5G
	c) Innovative Mobility Solutions	FM/LM
	d) ADS that Enhance Safety and Mobility	ADA compatible vehicle to elderlies
	e) Shared Interoperable Fleet	SAV is a shared AV and has room for 6-10 people or 6 people and a wheelchair
	f) Demonstration and Validation	Passenger movement, validating interoperable integration of SAV into the on-road transportation, safe operation, data exchange, cybersecurity, dynamic mapping, detection of obstacles/objects, and detection of roadways and signage. Validation of safety, security, interoperability, functionality, performance, scalability and expandability
Operational Design Domain (ODD)	Low speed (>25mph) operation on two-lane roadways consisting of intersections with stop or signal, parking lots, health care, residential suburban area, senior community, during daytime and in normal weather conditions.	

Project 2	**County Hospital Accessible Transportation, Martinez, CA**	
Provide accessible on-demand autonomous vehicle shuttle to the Contra Costa Regional Medical Center (County Hospital) in Martinez and gather data to develop safety performance measures. The shuttles are expected to be Level 4 and with medium speed (up to 50mph).		
Goals	Safety	Testing L3 and L4 medium speed moving vehicle in suburban areas
	Data for Safety Analysis & Rule Making	Moving and frequent stops, detecting obstacles and objects
	Collaboration	County, cities, transit agencies, law enforcement, private industries, County Hospital
Focus Areas	a) Significant Public Benefit	On demand transportation access to medical appointments results in fewer appointment cancellations and medical issues resulting from unaddressed health issues and additional 911 emergency room visits. Increase in accessibility, convenience, affordability, new travel options, safety, better health, and less traffic.
	b) Addressing Market Failure and Other Compelling Public Needs	Legislation and regulation, risk management, **FMVSS testing,** cybersecurity, investment, V2X, safety of testing, data collection
	c) Economic Vitality	Buy America and Hire America, economic growth, expandability to the rest of the county and region
	d) Complexity of Technology	L4, challenges of operation in urban areas, cost, object and obstacle detection, V2X
	e) Diversity of Projects	Plain, residential urban, shopping areas, public transportation, health center
	f) Transportation-challenged Population	Individuals with disabilities, patient sitter, and caregivers, and transportation challenged individuals
	g) Prototypes	Existing prototype
Work Areas	a) Technologies associated with ADS	L3 and L4
	b) Advanced Communication Systems	V2I, V2X, NRTK, 4G/5G
	c) Innovative Mobility Solutions	FM/LM, on-demand transportation
	d) ADS that Enhance Safety and Mobility	ADS compatible vehicle for people needing to access the County Hospital
	e) Shared Interoperable Fleet	Room for 4 passengers and 1 wheelchair
	f) Demonstration and Validation	Successful demonstration would validate taking passengers to and from different points and interoperable integration of SAV into the on-road transportation, safe operation, data exchange, cybersecurity, dynamic mapping, detection of obstacles/objects, and detection of roadways and signage. Validation of Safety, Security, Interoperability, Functionality, Performance, Scalability, and Expandability
	Normal speed (<55mph) operation on local roadway with intersections with stop or signal, parking lots, health centers, mixed residential suburban arterials during daytime and in normal weather conditions.	

Project 3	**Personal Mobility on Innovate 680 Corridor, Contra Costa County, CA**	
Prepare the corridor for future connected autonomous vehicles. Install new and upgraded vehicle-to-vehicle infrastructure and vehicle-to-vehicle such as 4G/5G communications, to accommodate connected and autonomous vehicle technology along with implementation of innovative operational strategies. Integrate and demonstrate operation of a large number of highly automated high speed (up to 65mph) AVs Level 3-Level 4 on a 2-mile segment of I-680 and parallel arterials.		
Goals	Safety	Testing high-speed moving vehicles in urban freeway
	Data for Safety Analysis & Rule Making	Detecting speed measurements, traffic volume counts, and traffic density
	Collaboration	Collaboration between public sector and private sector
Focus Areas	a) Significant Public Benefit	Safety, improved air quality, greater personal productivity, less congestion, FM/LM connections, enhanced TDM strategies, efficiency of bus services, cool corridor 'Hot Spots', HOV/Express lanes, reliability, sustainability and accessibility
	b) Addressing Market Failure / Public Needs	Legislation and Regulation, Risk Management, FMVSS Testing, Cybersecurity, Investment, V2X, Safety of Testing, Data collection
	c) Economic Vitality	Buy America and Hire America, economic growth, expandability to the rest of the county and region
	d) Complexity of Technology	Detection system, V2X
	e) Diversity of Projects	Highway I-680, urban, public transportation, carpools, freight, high-speed movement
	f) Transportation-challenged Population	Commuters, students, low-income, transit deserts, elderly
	g) Prototypes	Existing prototype
Work Areas	a) Technologies associated with ADS	L3 and L4
	b) Advanced Communication Systems	Changeable message signs, arterial traffic signal system, traveler information systems and mobile apps, V2I, V2X, NRTK, 4G/5G, DSRC, ICM, ATM
	c) Innovative Mobility Solutions	FM/LM, shared on demand
	d) ADS that Enhance Safety and Mobility	ADS compatible vehicle to people with disabilities
	e) Shared Interoperable Fleet	CAV with 4 people
	f) Demonstration and Validation	Successful demonstration would validate safe operation among other high-speed vehicles on the corridor, lane merging on-ramp and off-ramp, passenger movement and interoperable integration of SAVs including on-road transportation, safe operation, data exchange, cybersecurity, dynamic mapping, detection of obstacles/objects, and detection of roadways and signage. Validation of safety, security, interoperability, functionality, performance, scalability, and expandability
High-speed (<65mph) operation on smooth and wide freeway with multiple lanes, express lanes, BRTs 24h a day and in normal weather conditions including rain, wind and hail.		