March 19, 2019

The Honorable Elaine Chao
Secretary of Transportation
United States Department of Transportation
1200 New Jersey Avenue, S.E.
Washington D.C. 20290

RE: San Joaquin Regional Transit District – Grant Application for U.S DOT Automated Driving System (ADS) Demonstration Grant

Dear Secretary Chao:

The San Joaquin Regional Transit District (RTD) respectfully requests grant funding through the Automated Driving System (ADS) Demonstration program for the RTD Auto Go!–Bus Transit Automation Demonstration Project. The project is consistent with the ADS Demonstration program goals of promoting safe integration of autonomous vehicles, data gathering and sharing of project outcomes, and collaboration of partners representing public agencies as well as the private sector.

Along with our local partners the City of Stockton and San Joaquin County, RTD is pleased to partner with bus manufacturer Proterra and autonomous vehicle technology company EasyMile to implement this demonstration project. The project will demonstrate the use of both electric buses and an automated driving system in order to create a catalyst for technology development and future autonomous transit bus deployments. RTD will create a Downtown Stockton "circulator" route to provide a safe and convenient mobility option for those who work and visit Downtown Stockton.

RTD brings fifty years of transit experience and has been highly successful in implementing projects that feature new technology. RTD was the first transit agency in the nation to implement an all-electric Bus Rapid Transit (BRT) route and was named the 2018 Outstanding Transit System by the American Public Transportation Association (APTA). This award recognizes RTD for its achievements in innovative business practices, environmental sustainability, and infrastructure development. Proterra is a leader in the design and manufacturing of zero-emission vehicles, having sold more than 400 vehicles across 20 states. EasyMile is one of the leading companies that specializes in autonomous vehicle technology and has a global reach with deployments in 20 countries.

SAN JOAQUIN REGIONAL TRANSIT DISTRICT
P.O. Box 201010 • Stockton, CA 95201 • (209) 943-1111 • (209) 948-8516 Fax • sjRTD.com

Thank you for consideration of our request. If you have any questions regarding the project or proposal, please feel free to contact George Lorente, our Grants Manager, at (209) 467-6674 or glorente@sjrtd.com.

Sincerely,

Donna DeMartino
Chief Executive Officer

SAN JOAQUIN REGIONAL TRANSIT DISTRICT

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RTD Auto Go!

Bus Transit Automation Demonstration Project

SAN JOAQUIN RTD

EASY MILE

PROTERRA

CITY OF STOCKTON

SAN JOAQUIN COUNTY CALIFORNIA

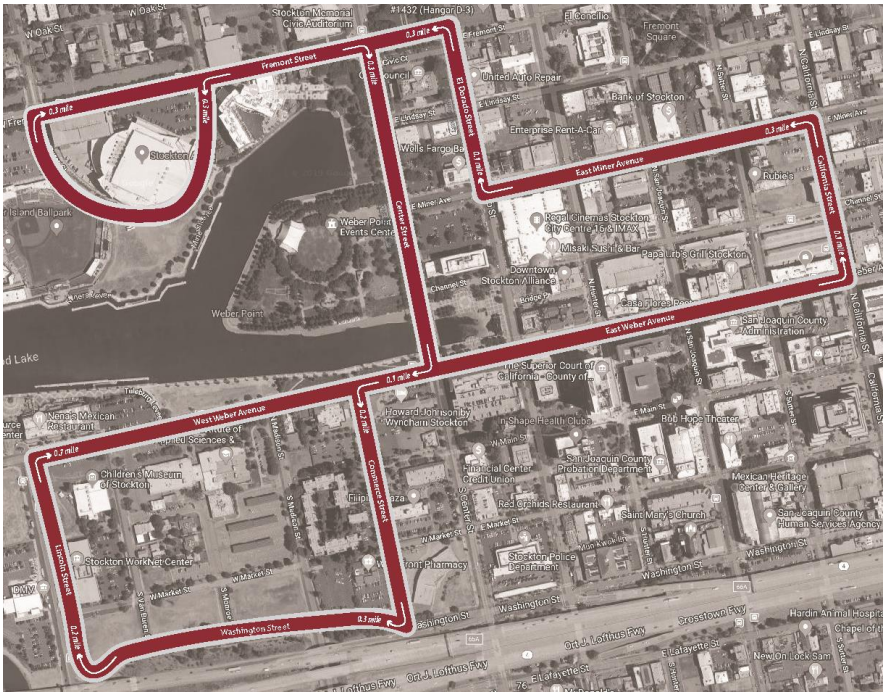
Summary Table	
Project Name/Title	RTD Auto Go!—Bus Transit Automation Demonstration Project
Eligible Entity Applying to Receive Federal Funding (Prime Applicant's Legal Name and Address)	San Joaquin Regional Transit District 421 East Weber Avenue Stockton, CA 95202
Point of Contact (Name/Title; Email; Phone Number)	George Lorente, Grants Manager glorente@sjRTD.com; 209-467-6674
Proposed Location (State(s) and Municipalities for the Demonstration)	Stockton, California
Proposed Technology for the Demonstration (briefly list)	Autonomous (SAE L3) Electric Transit Bus
Proposed duration of the Demonstration (period of performance)	June 1, 2019 – June 30, 2023
Federal Funding Amount Requested	$ 8,944,710
Non-Federal Cost Share Amount Proposed, if applicable	$ 4,159,750 (in kind)
Total Project Cost (Federal Share + Non-Federal Cost Share, if applicable)	$ 13,104,460

RTD Auto Go!
Bus Transit Automation Demonstration Project

Part 1: Project Narrative and Technical Approach

Executive Summary

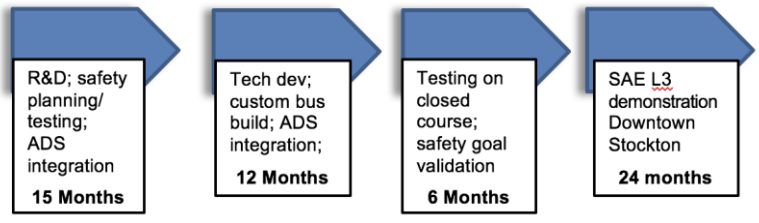
With its local partners the City of Stockton and San Joaquin County, San Joaquin Regional Transit District (RTD) is pleased to partner with Proterra and Easy Mile in a demonstration that will feature the engineering, design, development, testing, and deployment of the first public transit bus with autonomous capabilities. RTD will employ its expertise in delivering innovative and industry leading projects for this demonstration. The Proterra electric bus will use a Society of Automotive Engineers Level 3 (SAE L3) solution provided by EasyMile, developed on proprietary artificial intelligence software for autonomous vehicles using deep learning.



The project will demonstrate the use of two electric buses and an automated driving system employing a SAE L3 solution, developed with proprietary artificial intelligence software that uses deep learning.

In alignment with the primary goal of this grant opportunity, safety will be the focus in the development and operation of the autonomous driving Proterra bus. With this ambitious demonstration, a significant issue and challenge is that a transit bus is longer and heavier than an automobile. The length of the bus will require more sensors than the typical autonomous vehicle (AV). Avoiding accidents will be paramount since the weight of the bus will introduce additional risk.

The demonstration project will run for a four-year period in that will begin upon award. The anticipated timeline for the physical demonstration includes a minimum of two years of SAE L3 operations in Downtown Stockton, California.



Project Description

Autonomous vehicle functionality has been developing in this country for years with investments from the government and private sector. The potential for this technology to improve safety is great; it can reduce or eliminate vehicle collisions and reduce congestion and harmful emissions.

The local project partners—RTD, City of Stockton, and San Joaquin County are joined by Proterra and EasyMile, a leading electric bus manufacturer and a global company specializing in autonomous vehicle technology. Proterra will be developing and testing a bus using an SAE L3 solution, which was developed with proprietary artificial intelligence software for autonomous vehicles using deep learning. In this demonstration, RTD will be deploying the AV-equipped bus on a route in Downtown Stockton.

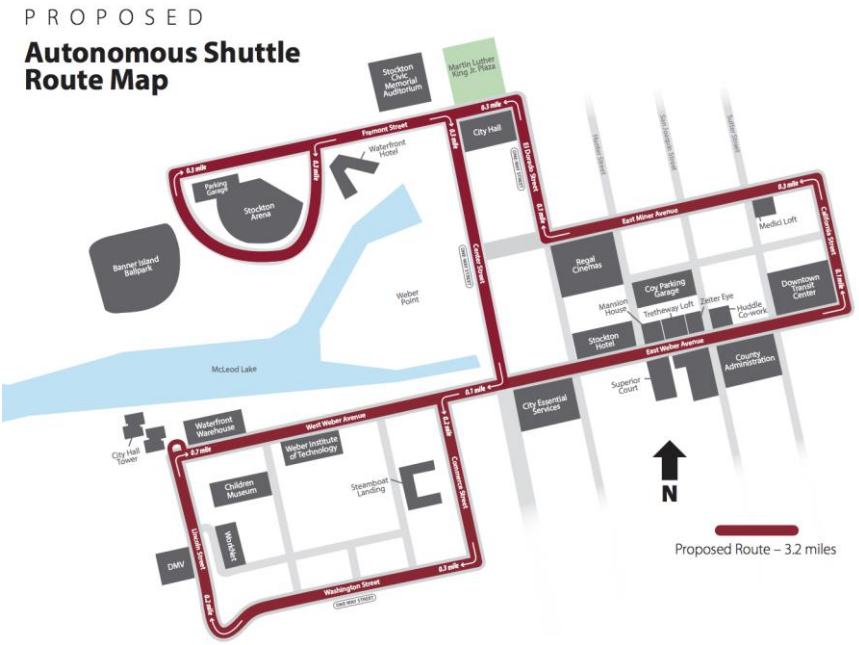
RTD's proposed autonomous bus built by Proterra and their Automated Driving System (ADS) vendor will serve to attract additional interest and investment to its region. The City of Stockton and San Joaquin County have already identified initiatives to support attracting companies to the region to test and operate autonomous vehicles. The San Joaquin Council of Governments will soon be adapting their One Voice Legislative platform to include an intent to collaborate with the local jurisdictions on the planning for autonomous vehicles.

The demonstration of the ADS Proterra bus in Downtown Stockton provides a significant public benefit to transportation-challenged Stockton residents. This new service uses an ADS vehicle that is not only safe, but also green—a zero emission all-electric bus.

RTD has experience in leading projects that demonstrate the use of advanced technologies to deliver innovative transit services. RTD was one of the first transit agencies in the state to deploy hybrid battery-electric buses, and then the first in northern California to deploy zero-emission battery-electric buses. RTD also delivered the first-in-the-nation all-electric Bus Rapid Transit (BRT) route.

The project will demonstrate the use of a Proterra bus with EasyMile ADS technology in Downtown Stockton for an initial deployment, with future deployments planned within San Joaquin County. Proterra will partner with EasyMile to design, engineer, build, and test the ADS bus. RTD, in partnership with the City of Stockton and San Joaquin County, will serve as the project lead for the bus that will be deployed in Downtown Stockton. The project partners seek to demonstrate the use of an ADS bus with a circulator route in Downtown Stockton that will serve the following key destinations:

- Banner Island Ballpark
- Stockton Arena
- Waterfront Hotel
- Stockton Civic Memorial Auditorium
- City Hall
- County Administration Building
- City Essential Services
- Weber Institute of Technology
- Department of Motor Vehicles
- Children's Museum
- Regal Cinemas Stockton City Centre
- City and County Administrative Buildings
- Waterfront Warehouse
- Downtown parking structures
- RTD's Downtown Transit Center (DTC)



This proposed ADS route will provide a new mobility option for travel in Downtown Stockton, create convenient access to key locations after parking in Downtown parking structures, and reduce the need for short auto trips. It will be a catalyst for future investments in Stockton and support efforts to make this region a hub for development of autonomous vehicle systems and smart city technologies. The project will also serve as a model for future ADS deployments within the City of Stockton and San Joaquin County.

Goals

The project goals include the following:

- Demonstrate the safe operation of an ADS bus.
- Support broader development of ADS technology with data for safety analysis and rulemaking
- Enable future deployments within other areas of San Joaquin County.
- Improve mobility for those working, living, and visiting Downtown Stockton.
- Promote transit ridership to reduce congestion and reduce vehicle emissions.
- Improve the environment by shifting short vehicle trips to transit use, operated with zero-emission battery-electric vehicles.
- Create jobs and economic benefits by providing a catalyst for future investment in the region with the potential to serve as an innovation hub for this technology.

Safety

In alignment with the primary goal of the grant opportunity provided by the Department of Transportation, a primary goal of this project is to demonstrate the safe operation of an ADS bus collaboratively engineered and built by Proterra and EasyMile. Significant project activities and resources will be dedicated both to ensuring the safe operation of the vehicle and to reporting the safety metrics of the project to DOT or other funding partners. The successful demonstration of the technology's safety and reliability is a key task to ensuring the widespread adoption of ADSs.

This technology solution provided by EasyMile and selected by Proterra has the potential to provide a drastic reduction in injuries and deaths caused by human error and distraction while driving. Motor vehicle crashes continue to be a major cause of injuries and death, ranking 7th in terms of the years of life lost, according to a February 2018 report from the National Highway Traffic Safety Administration (NHTSA). Nearly all crashes are due to human error and the NHSTA reports that 94% of serious crashes are linked to human error and dangerous choices people make when driving. The NHTSA "continues to promote vehicle technologies that hold the potential to reduce the number of crashes and save thousands of lives every year and may eventually help reduce or eliminate human error and the mistakes that drivers make behind the wheel."

The Proterra EasyMile bus will promote traffic safety of pedestrian and bicycles by offering proactive collision-avoidance warnings. By helping to increase safety levels for non-motorized road users, this demonstration will encourage people to consider both transit and these more active and healthy travel modes. This project will directly improve community traffic safety while reducing travel time and fuel consumption, all of which will enhance the well-being of individuals in the community. Perceptions and experiences of community residents and agencies regarding new transportation technologies will be helpful to policymakers' insights into their constituents' possible reaction to similar projects.

The bus will contain both active and passive safety features that can be activated automatically, manually by a passenger, remotely by a human operator, and mechanically to reduce the impact of a collision. The sensors will provide redundancy

and allow for decision making through deep learning based on sensor data. The bus's operational software will bring the bus to a complete stop in case of malfunction.

Economic Development and Vitality

The project will support efforts to make Stockton and San Joaquin County a hub for the development of innovative mobility options—such as autonomous vehicle technologies—attracting investments from automotive and technology companies looking to deliver smart city solutions.

Communities and states that are first to embrace this life-saving and transformational technological advancement stand to gain the most economic benefit. This is both in the short term due to the federal investment in the project and in the long term as the private sector and local government work together to enhance capabilities of the technology and to deploy it more widely across the county. With Downtown revitalization as a key mayoral priority, this initiative is particularly aligned with the Opportunity Zones tax incentive as a means to drive private investment into the city.

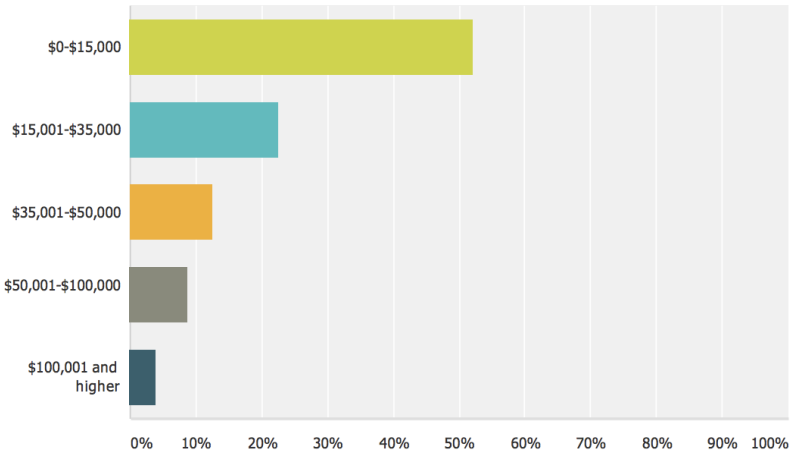
Opportunity Zones are a recent incentive designed to allow individuals and funds to invest unrealized capital gains into low-income, distressed areas—to encourage equitable economic development outcomes for cities across the country. Promoting Stockton as cutting-edge in research and development around autonomous mobility is one way to begin to take advantage of this private capital.

Transportation-challenged Populations

RTD—and public transit in general—has a proud history of serving the transportation challenged. The project will provide a new mobility option for short trips downtown. People who live, work and visit Downtown can forgo the hassle of driving and finding parking Downtown when looking to make short trips in the area. It will provide a convenient connection to bus and rail transit, enhancing available transit services and promoting transit ridership.

The project will enhance transportation options for RTD passengers, a significant portion of which are low-income, elderly, and persons with disabilities. Downtown Stockton is also surrounded by a collection of disadvantages communities.

Approximate Total Household Income—2016



Compelling Public Need—Environmental

The residents of Stockton and the San Joaquin Valley experience one of the poorest air quality conditions in the nation. This is of great concern to county residents because air pollution contributes to higher rates of cancer, asthma, and premature deaths. The San Joaquin Valley Air Basin is currently designated as nonattainment with respect to Federal air quality standards for ozone and PM 2.5 and has a maintenance plan for PM-10; The maintenance plan for CO_2 is only for the urbanized/metropolitan areas of Kern, Fresno, Stanislaus, and San Joaquin Counties. By providing a zero-emission mobility option for travel in Downtown Stockton, the project will provide environmental benefits of reduced congestion and emissions.

Requirements—Project Schedule

	2019		2020				2021				2022				2023	
Description	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Kick-off Meeting	X															
Project Management Plan	X															
Evaluation Plan	X															
Annual budget review and program plan meeting					X				X				X			
Data Collection Analysis																
(Accessible 5 years after performance period)										X	X	X	X	X	X	→
Technical Exchange and Knowledge Transfer										X	X	X	X	X	X	→
Research and Development (SAE 3)																
Award/Letter to Proceed	X															
Conception	X															
Autonomous component integration (V1)		X	X													
Catalyst By Wire Development (V1)	X	X	X													
Vehicle autonomization (V1)			X	X	X											
Internal testing					X	X										
Safety requirements	X	X														
Functional safety concept		X	X													
Technical safety concept			X	X	X											
Safety case (docs and writing)						X	X									
Safety goals tests and validation										X						
V1 conception with safety concept						X										
V1 platform modifications						X	X									
V1 internal testing								X	X							
Autonomous integration with V2							X	X								
Vehicle autonomisation (V2)								X	X							
Physical Demonstration																
Testing on closed course (V2)										X	X					
Demonstration on open road (V2)												X	X	X	X	X
Demonstration on open road (V1)													X	X	X	X

The chart above outlines the timeline of the RTD Auto Go! Demonstration and how it will satisfy the requirements contained in Section A of the NOFO (outlined below):

- The section in blue highlights about 15 months dedicated to research and development of SAE L3 automation and ADS technology.
- The section in green highlights the physical demonstration requirements of the project.
- The section highlighted in yellow highlights the relevant data gathering and sharing portion of the project. Part 3 will also discuss the data sharing portion of the project in detail. RTD will ensure the appropriate data are accessible to USDOT and/or the public for a minimum of five years after the award period of performance expires.

Technical, Risk Identification, and Risk Mitigation Approach

The technical approach for this project will begin with the integration of systems currently employed by Proterra and EasyMile. Engineering teams from the respective companies will collaborate on integrating, optimizing, and testing systems to bring advanced ADS technologies to an already cutting-edge energy efficient and performance optimized bus.

The EasyMile system that will be installed on a 40-foot Proterra bus will be adapted from the proven EasyMile Technology. EasyMile has successfully integrated their ADS technology in a vehicle designed by their company called the EZ10.

To ensure a safe demonstration and to mitigate risk, the project will involve extensive safety planning, data collection, testing, and will also incorporate risk mitigating and redundant technologies discussed further in this section.

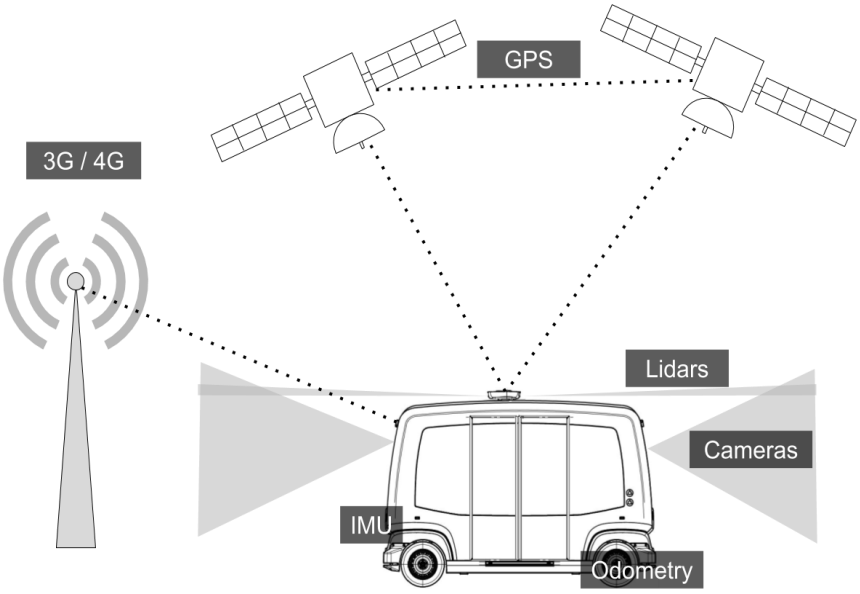
The engineering and development of the ADS bus addresses the market's inability to fund research of this size.

The current EasyMile shuttle is not that different from a human being in the way it navigates to its destination. It requires the same information to reach its destination:

- Where is it located?
- Where is it going and how can it get there?
- What are the environmental conditions and how should it adapt its behavior?

To do so, all current EasyMile vehicles, including the EZ10 are Level 4 according to the SAE definition of Driving Automation Systems for On-Road Motor Vehicles - J3016_201806. A Level 4 system is an Automated Driving System (ADS) that can itself perform all driving tasks and monitor the driving environment – essentially, do all the driving – in certain circumstances. The human need not pay attention in those circumstances.

The EZ10 is preprogrammed by EasyMile engineers or certified partners to run on predefined routes or network of routes, under certain circumstances.



EasyMile Sensor Stack

The software has been designed to know the vehicle's exact position with centimeter-level precision, at all times. By merging the types of data below, the software can obtain this level of precision: Software for the ADS demonstration will be developed to the same standard as the EZ10. These safety technologies are described in more detail below.

Environmental Laser Scanning - LiDARs

The current EZ10 shuttle is equipped with several different LiDARs to ensure redundancy in information collection. The Proterra bus built for this demonstration will be built to the same standards whenever possible.

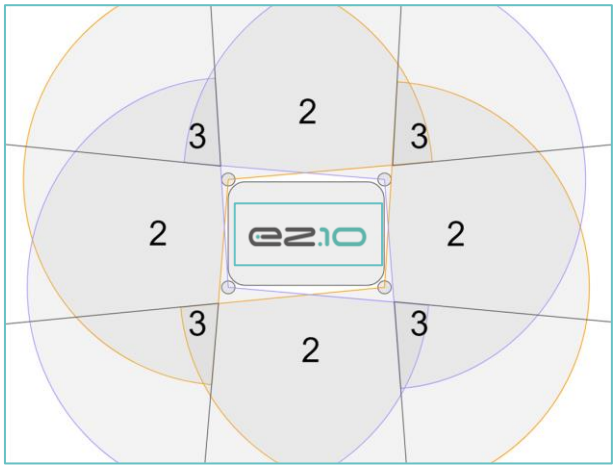
- 4 LMS, also called Safety LiDARs on the EZ10
  - One at each corner of the vehicle
  - Strategically positioned 12 inches above the ground
  - Single layer LiDAR
  - Range of 130 feet
  - 270° horizontal scanning
  - Used for obstacle detection by high-level software
  - Used for obstacle detection by the Safety Chain
  - Used for navigation by high-level software

There is currently no certified LiDAR on the market, which is why EasyMile has chosen to include redundant sensor coverage sourced from different suppliers. This

architecture mitigates any risk of failure of a single sensor.

The four LiDARs, each scanning 270°, located at each corner of the vehicle, offer a 360° redundant perception of the environment. Any obstacle within 130 feet of the EZ10 will be detected by at least two LiDARs.

- Two of the LiDARs are LDRMS, also called Localization LiDARs on the EZ10. Strategically positioned on the roof of the EZ10 to detect fixed elements in the environment (buildings, statues, tree trunks, signs, streetlights, etc.) without being disturbed by moving elements in the environment that are usually smaller and not in the sensor's field of view (pedestrians, cars, bicycles, etc.)
  - 4 layers
  - Range of 720 feet
  - 110° horizontal scanning
  - 3.2° vertical opening
  - Used for navigation by the high-level software



- Two of the LiDARs are VLP16, also called 3D LiDARs on the EZ10. One is at the front and one is at the rear of the vehicle (bi-directional vehicle).
  - LiDARs 16 layers
  - Range of 260 feet
  - 180° horizontal scanning
  - 32° vertical opening
  - Used for navigation by the high-level software
  - Used for obstacle detection by high-level software

GNSS corrections are received via the 3/4G network, and are determined using a set of SmartNet reference bases. They do not require the installation of an additional reference base dedicated to this project, which are often problematic and vulnerable to cyber-attacks.

Inertial Measurement Unit (IMU)

The EZ10 is equipped with an inertial unit capable of integrating the vehicle's movements (acceleration and angular velocity) to estimate its orientation (roll, pitch, and heading angles), linear velocity, and position.

Odometric Estimation

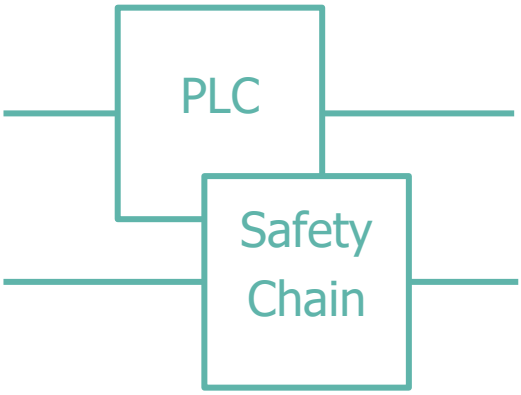
The EZ10 has sensors on the wheels to measure the vehicle's movement. Odometry is based on the measurement of wheel movements to reconstruct the overall movement of

the vehicle. Starting from a known initial position and integrating the measured displacements, the current position of the vehicle can be calculated at any time.

Independent Obstacle Detection Function

The processing power needed to run an autonomous vehicle is huge. There is no certified processing unit with enough computing power to enable obstacle detection functions. Our approach is based on adding an independent safety layer: **Safety Chain.** This architecture mitigates the risk of processing unit failure (due to hardware or operating system fault). By design, the EZ10 is composed of two main levels:

- An industrial-grade computer with a tailor-made version of Linux enabling better control of processing and cyber-security than commercial OS (Operating Systems). Complex filtering algorithms are embedded on this computer to monitor obstacles around the shuttle, calculate collision probabilities, and adapt its behavior accordingly.
- A **Safety Chain** based on a certified PLC (Programmable Logic Controller) is independent from the main computer. It uses very simple algorithms and can perform emergency stops should the main computer fail to anticipate the potential collision.



Programmable Logic Controller (PLC)

The PLC used in our Safety Chain is SIL3 certified (according to IEC 61508 Functional Safety standard) and PLC certified (according to ISO 13849 “Safety of machinery - Safety-related parts of control systems” standard).

The PLC performs the following tasks with a high safety level inherent to its certification:

- Continuous monitoring of critical components (such as steering and traction controllers, braking systems, LiDAR sensors, emergency buttons, main computer, etc.)
- Triggering of an emergency stop, in case of Safety Chain, emergency button activation or detected failure of monitored components. This will enable to ensure that vehicle and its passengers are safe.
- Safe Door and Automatic Ramp management (opening and closing) - one of the most critical functions in transportation systems because of potential injuries, failures, and unavailability.

The PLC outputs are always considered with the highest level of priority over the other robotics, electronic, or computer systems. In case the PLC encounters a failure, its

certification level ensures that it will reach its fail-safe state. In this state, a fail-safe brake will be automatically activated to enable vehicle to stop.

Supervision—System Brain

EasyMile has developed EZ Fleet, its own Fleet Management system able to handle a fleet of any type of autonomous vehicles based on real field data from the ongoing projects around the world. The EZ Fleet is the electronic brain of the whole system. It is designed to be flexible and modular, so as to enable different operating scenarios and adapt to the various customer needs.

Known Environment and Pre-Programmed Paths

To move autonomously, the vehicle runs along a pre-programmed route designed by a deployment engineer. Thanks to localization techniques, the vehicle knows its position on the route and moves from one station to another following its trajectory.

During deployment, the engineer makes an acquisition by driving in manual mode with the vehicle (trajectory, environment, GPS position, etc.). This acquisition is then cleaned, the trajectories reworked to be comfortable for passengers, and serves as a reference map for the vehicle during operations. This map contains the programmed speed for each road section, the activation of the indicators or bell if necessary, the presence of red lights, traffic signs (Stop, Yield, etc), stations, etc.

Data Fusion and Interpretation

The high-level software collects, fuses, and interprets data from the above-mentioned sensors.

In particular, a technique called S.L.A.M. (Simultaneous Localisation And Mapping) laser consists in measuring, using laser beams (LiDARs) and the distance from surrounding objects (e.g., buildings, trees) and thus makes it possible to create a mapping of its environment. This system requires sufficient "hang points" for the laser detectors that are used to locate the vehicle in its environment. The environment

around the road planned for the EZ10 in Reno is very rich in "hang points" for LiDAR localization.

The fusion of data from the various sensors ensures redundancy and robustness in the vehicle's localization, with the weak points of one system being compensated by the strong points of the others.

The presence of trees on the route or indoor traffic are excellent examples of situations where GNSS coverage will be very low or non-existent. The system is then able to detect that the uncertainty related to GNSS information is too high (0 or very few satellites detected when the vehicles normally detect between 10 and 15) and to reject the information from this sensor. The fusion of data from the other sensors is good enough, so the vehicle will continue to run without any problems.

Intersection Management—Connected traffic lights

The proposed demonstration will be run on the UNR Living Lab's Virginia Street in Reno. Several types of intersections can be programmed along the EZ10 route, where the vehicle slows down or stops depending on the situation, in order to scan the environment and decide to continue. In all circumstances, the obstacle detection functions described above remain valid.

Intersections with Signage

At a Stop or Yield intersection, EZ10s are able to scan the environment and make the decision to cross the intersection when the area is free.

Pedestrian Crossing

Like Yield intersections, EZ10s are designed to scan a pedestrian crossing and make sure there is no pedestrian crossing or about to cross before going through.

Intersections with Traffic Lights—DSRC

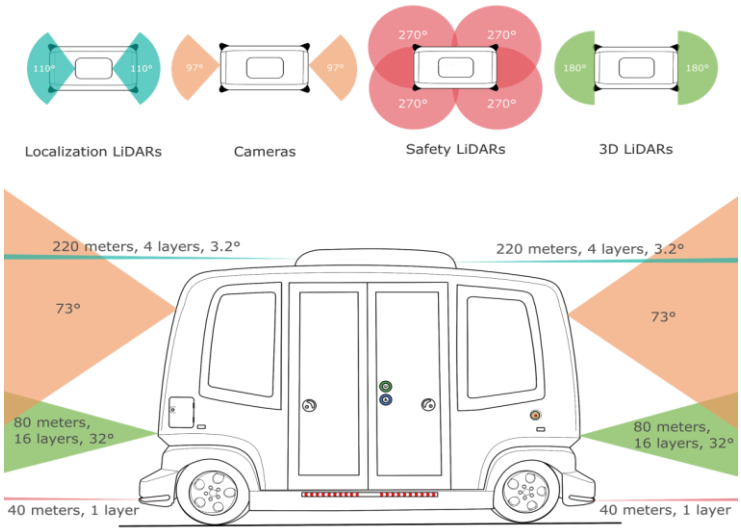
Vehicle to infrastructure (V2I) communication is a key component of EasyMile's technology. As shown in the graphic below, the EZ10 can communicate with traffic signals via a communication network (DSRC, ITS-G5, 3G, 4G, or 5G networks) and with other infrastructure (e.g., railroad crossings), as needed. The ultimate goal is to leverage these technologies in order to introduce more complex traffic situations without human intervention.

Cameras

The EZ10 is equipped with indoor and outdoor cameras. EasyMile completes the development and validation of the use of these cameras for navigation and environmental detection.

Differential GPS

The EZ10 is equipped with a GNSS antenna from the Canadian manufacturer Novatel. This antenna allows the EZ10 to find its way through space thanks to the constellations of GPS, Glonass, and Galileo satellites. EasyMile also uses the services of a GNSS—Real Time Kinematic correction provider referred to as "SmartNet" to refine the vehicle's position, with centimeter accuracy.



Proterra's Zero-Emission Buses

Proterra's electric buses are unique when compared to other zero-emission battery-electric transit buses. The Proterra Catalyst family of battery-electric buses was specifically designed from the ground up to be heavy-duty electric vehicles, thus resulting in the market's best performing and most efficient buses available. Other OEMs are forced to work within the constraints of an existing metal framed body, often using high voltage battery packs that are not uniform in form factor and placed at suboptimal locations both inside and outside of the passenger cabin.

The 40' Proterra Catalyst completed its testing at the Pennsylvania Transportation Institute Bus Testing and Research Center (Altoona) in April 2015. As noted in the Altoona Test Report, the Proterra Catalyst received a best-in-class average energy efficiency of 1.70 kWh/mi which is the equivalent of 22.14 MPGe (Miles per Diesel Gallon equivalent). In addition to energy efficiency, the Proterra Catalyst broke records at Altoona for gradeability, weight (lightest electric bus), and acceleration. The Altoona Test Report is available at: http://altoonabustest.psu.edu/buses/454.

Having the foresight to design the vehicle purely as an electric vehicle, Proterra began with a light-weight, durable composite monocoque body structure manufactured from high strength fiberglass, carbon fiber, and resin with a balsa wood core. The benefits of using the composite body include: a lighter total vehicle weight (reducing the impact to local roads / infrastructure), improved vehicle efficiency / fuel economy, improved thermal and noise reducing properties, exceptional torsional stiffness (resulting in an excellent ride and handling), increased durability (LA Metro has reported that their composite bus bodies are expected to last up to 20 years), corrosion resistance, and best-in-class safety (better impact resistance). For reference, most electric buses that have traditional metal framed bodies weigh an average of 5,000 lbs more than Proterra's Catalyst electric buses.

Additionally, the Catalyst battery-electric buses have a recessed cavity under the bus body, between the axles, for the high-voltage battery packs. Much like purpose-built light-duty electric vehicles, placing the high voltage battery packs under the body increases vehicle safety (located outside of the passenger cabin and below the side impact zone), improves the ride and handling (centering mass between the axles and low to the ground), and optimizes the use of space around the vehicle (allowing for a rear window and a clean, simple powertrain design).

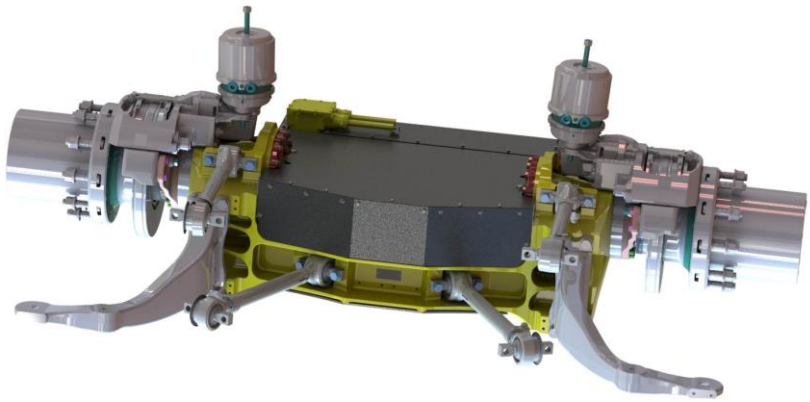
Underbody View of 40-foot Catalyst E2 Battery Packs

The Proterra Catalyst comes standard with all wheel air-disc brakes, a more robust ZF independent front suspension, all-electric components and accessories, a state-of-the-art vehicle multiplex system, a proven all-electric HVAC, state-of-the art high voltage battery pack components manufactured by Proterra in the United States (which meet Buy America requirements for components), and an ergonomically designed driver's station.

Proven Electric Propulsion Systems: DuoPower

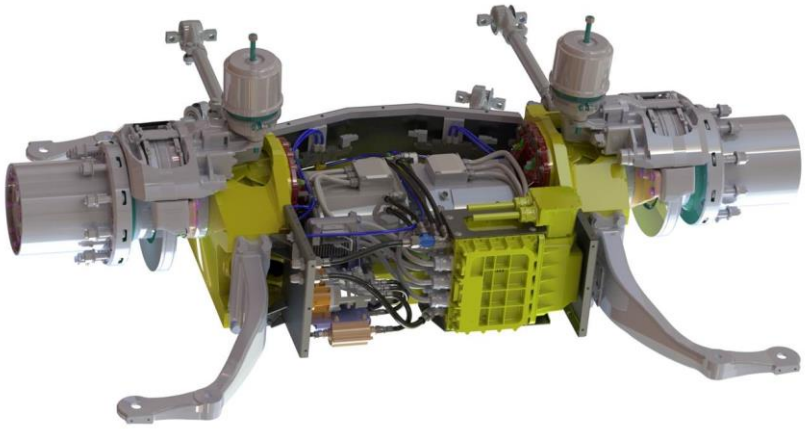
To unlock even more route opportunities, Proterra has introduced the new DuoPower™ drivetrain. This new drivetrain delivers twice the horsepower and acceleration and five times the efficiency of a standard diesel engine. By combining the DuoPower drivetrain with Proterra's market-leading battery technology and lightweight composite bus body, the Catalyst vehicle provides unparalleled performance.

The DuoPower drivetrain features two electric motors that deliver an impressive 510 horsepower, accelerating a Catalyst bus from 0-20 mph in 4.5 seconds, while also achieving an industry-leading 26.1 MPGe. In addition, it can propel a bus up a 26 percent grade, which is more than twice the performance of the average 35- or 40-foot diesel bus, and 100% better than the average competing electric transit vehicle, making it an ideal option for transit agencies with steep hills.



DuoPower Drivetrain

The new “DuoPower” Proterra Catalyst drivetrain system employs state-of-the-art electric vehicle technology that is conveniently integrated into the rear axle of the bus. Proterra uses two 190 kW permanent magnet synchronous motors, each directly coupled to a multi-speed gearbox that independently drives its respective wheel. The system is capable of up to 510 peak horsepower and is controlled via an inverter which receives direct current from the high voltage battery system. The drivetrain system uses a liquid cooling circuit to reject heat through the bus heat exchanger. The Proterra multi-speed gearbox is purpose designed and built for heavy duty electric vehicle operation. The gear ratios were selected to maximize fuel economy for transit bus operation while ensuring best in class performance. The gearbox contains a pneumatically actuated shift mechanism to seamlessly shift between low and high gear. An external electric pump is used to circulate oil for lubrication and heat rejection. The output of the gearbox is coupled to a planetary gear reduction unit housed within the wheel hub. All actuators and sensors for the gearbox are connected to the Proterra powertrain controller which is responsible for shift actuation and motor torque commands. The controls have been optimized for transit bus service to balance drive feel while maximizing efficiency. The vehicle control system was designed using Proterra’s state-of-the-art computer simulation model and calibrated with real-world data from customer vehicles, engineering testing utilizing proprietary drive cycles and standard FTA drive cycles (CBD, Arterial, Commuter).



The DuoPower drivetrain allows Proterra customers with more challenging routes to select a more powerful and more efficient drivetrain solution for their electric buses.

Operating Profile

As the below chart indicates, the energy storage system of the Proterra Catalyst vehicles provides customers with electric bus options for most of their fixed transit routes. Proterra provides detailed route simulations to its customers to specifically predict product performance on any given route.

- **Proterra Vehicles**: 40' Catalyst E2
- **Energy Storage** (kWh): 440
- **Charging Strategy**: In-Depot (Overhead or Plug-in)
- **Design Operating Profile** (hours): Up to 24

Recharging/Refueling Requirements

Proterra offers two primary means of charging the Catalyst battery-electric buses, plug-in depot-based charging and overhead fast-charging. Both the Catalyst fast-charge vehicles and the Catalyst extended-range vehicles are designed to charge from either charging option, although operational demands typically make one or the other better suited for specific deployments. In any and all cases, the Proterra team works with its customers on developing operational plans that optimize the types, quantities, and locations of the charging equipment.

Plug-In/Depot Charging

All Proterra vehicles can charge the high voltage batteries using any SAE J1772 CCS Type 1 commercially available plug-in charger. The SAE J1772 CCS standard is the North American plug-in charging standard that many automotive OEMs have adopted, including GM, Ford, Chrysler, BMW, Porsche, Audi, and Volkswagen. Leveraging the automotive standard allows Proterra's customers to piggyback on the strong demand in the automotive sector for SAE J1772 CCS chargers, resulting in lower prices that are driven by open competition and market forces.

For the 2019 US DOT Program, Proterra is offering SAE J1772 CCS chargers at power levels of 60 kW and 125 kW. These chargers consist of a remote Power Control System (PCS) charger and a local dispenser which can be wall-mounted, mounted overhead, or mounted on a small pedestal.

Legal, Regulatory, and Environmental Approach

For the purposes of the proposed demonstration, automating a Proterra bus does not require any exemption from Federal Motor Vehicle Safety Standards (FMVSS) or Federal Motor Carrier Safety Regulations (FMCSR). Proterra and EasyMile anticipate no federal exemptions being required based on the regulations in place today. The proposed EasyMile hardware and software systems have been deployed in other jurisdictions in the United States without the need for federal exemptions.

Buy America Act

Well in advance of the new Buy America requirements in the FAST Act, Proterra's buses already contain greater than 70% domestic content. And since their vehicles are proudly built in South Carolina and Los Angeles, partnering with Proterra provides transit agencies with the confidence of knowing that the FY 2020 Buy America requirements have already been demonstrated. The Proterra ADS bus will not require exemption from either the Buy America Act or the domestic vehicle preference established in the NOFO clause at Section F, Paragraph 2.J. The proposed automated bus system will be manufactured in the United States.