

PROTERRA CATALYST® PLATFORM INTRODUCTION



Presentation to



11-21-19



OUR CUSTOMERS



PROTERRA



>800 buses sold to **>100 customers** across **41 states/provinces**

AL

ALABAMA A&M UNIVERSITY
NORMAL

AK

CAPITAL TRANSIT JUNEAU

CA

CITY OF ARVIN
CITY OF DUARTE
FCRTA FRESNO
FAST FAIRFIELD
FOOTHILL TRANSIT WEST COVINA
HUMBOLDT TRANSIT AUTHORITY EUREKA
LADOT TRANSIT LOS ANGELES
MAX MODESTO
RABA REDDING
RTD STOCKTON
SACRAMENTO INTERNATIONAL AIRPORT
SAMTRANS SAN CARLOS
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN JOSE INTERNATIONAL AIRPORT
TRI DELTA TRANSIT ANTIOCH
VTA SAN JOSE
VISALIA TRANSIT VISALIA
YOSEMITE NATIONAL PARK

CO

TOWN OF BRECKENRIDGE
SUMMIT COUNTY FRISCO
ECO TRANSIT GYPSUM

CT

GBT BRIDGEPORT

DC

DC CIRCULATOR WASHINGTON

DE

DART FIRST STATE DOVER

FL

STAR METRO TALLAHASSEE

GA

UNIV. OF GEORGIA ATHENS

HI

JTB HAWAII HONOLULU

IA

DART DES MOINES

IL

QUAD CITIES METROLINK MOLINE
JLL CHICAGO
CONNECT TRANSIT BLOOMINGTON - NORMAL
CHICAGO TRANSIT AUTHORITY

KS

WICHITA TRANSIT WICHITA

KY

TARC LOUISVILLE
LEXTRAN LEXINGTON

LA

SPORTRAN SHREVEPORT

MA

WRTA WORCESTER
PVTA SPRINGFIELD

MD

BGE BALTIMORE
MCDOT ROCKVILLE

ME

SH-ZOOM TRANSIT BIDDEFORD
GREATER PORTLAND METRO PORTLAND

MI

BLUE WATER AREA TRANSIT
PORT HURON

MN

DTA DULUTH

MT

DASH UNIV. OF MONTANA MISSOULA
MOUNTAIN LINE MISSOULA

NC

RALEIGH-DURHAM INTERNATIONAL AIRPORT
ART ASHEVILLE
GTA GREENSBORO
DUKE UNIVERSITY DURHAM
GO TRIANGLE DURHAM

NV

RTC RENO

TAHOE TRANSPORTATION DISTRICT
STATELINE

NY

MTA NEW YORK CITY
TOMPKINS CONSOLIDATED
AREA TRANSIT ITHACA
PORT AUTHORITY OF NY & NJ

OH

LAKETRAN PAINESVILLE

OK

THE CHEROKEE NATION

OR

SMART PORTLAND

PA

SEPTA PHILADELPHIA

RI

RIPTA PROVIDENCE

SC

CATBUS CLEMSON
CITY OF SENECA
GREENLINK GREENVILLE
CITY OF ROCK HILL
CARTA CHARLESTON

TN

MTA NASHVILLE

TX

VIA SAN ANTONIO
DART DALLAS
CITIBUS LUBBOCK
PAT PORT ARTHUR
CAPMETRO AUSTIN

UT

PARK CITY TRANSIT PARK CITY
UTA SALT LAKE CITY

VA

HAMPTON ROADS TRANSIT NORFOLK

WA

KING COUNTY METRO SEATTLE
EVERETT TRANSIT EVERETT
KITSAP TRANSIT BREMERTON
PIERCE TRANSIT LAKEWOOD

WI

METRO TRANSIT MADISON
LA CROSSE MTU LA CROSSE

WY

START JACKSON

CANADA

EDMONTON TRANSIT SERVICE

TORONTO TRANSIT COMMISSION

Only announced customer names shown. Updated May 2019

HIGH-QUALITY, ADVANCED MANUFACTURING FOR RAPID EV ADOPTION AT SCALE



Burlingame, California

Battery Manufacturing

Company HQ



Los Angeles, California

Bus Manufacturing

West Coast Operation

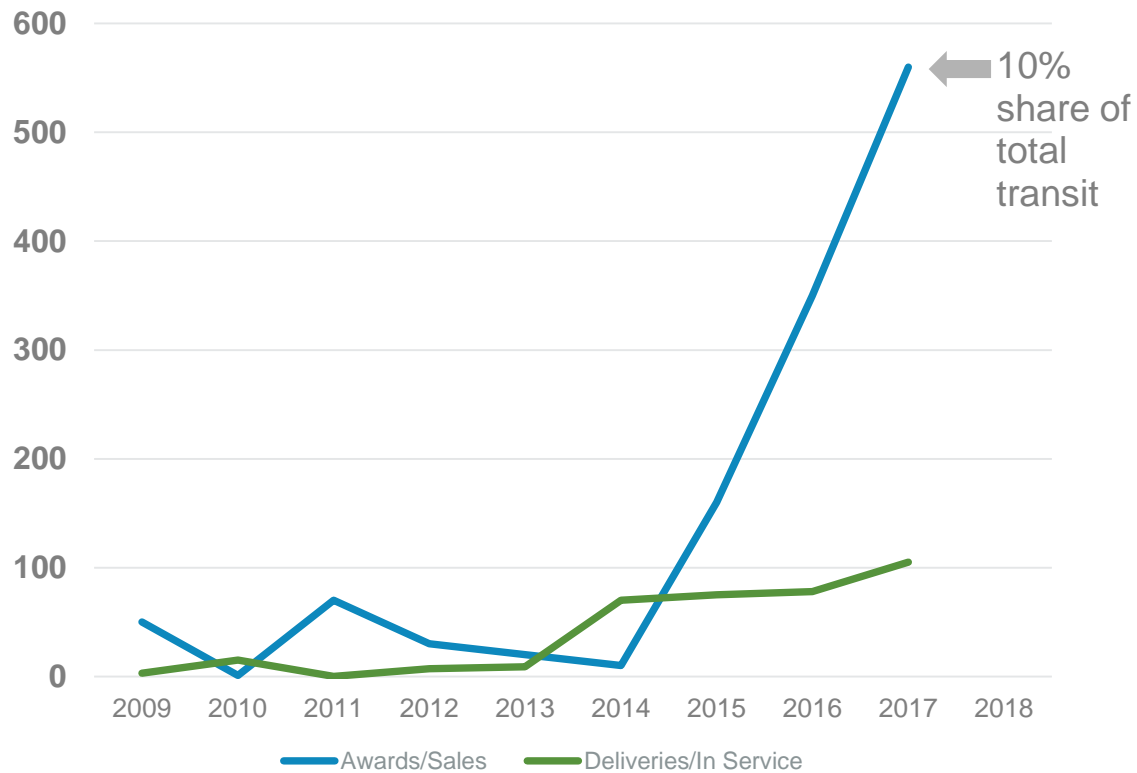


Greenville, South Carolina

Bus Manufacturing

East Coast Operation

Battery Electric Buses: North American Annual Sales and Deliveries



- Moving toward **widespread industry adoption**
- Major cities making commitments to zero-emission transportation
- **Purchase barriers eliminated** due to:
 - Improved range
 - Charging standardization
 - Sharp decline in battery costs
 - Service-proven performance

Source: CTE Center for Transportation and the Environment 2017

HIGHLY DIFFERENTIATED AND FULLY INTEGRATED HEAVY DUTY TECHNOLOGY PLATFORM



PROTERRA

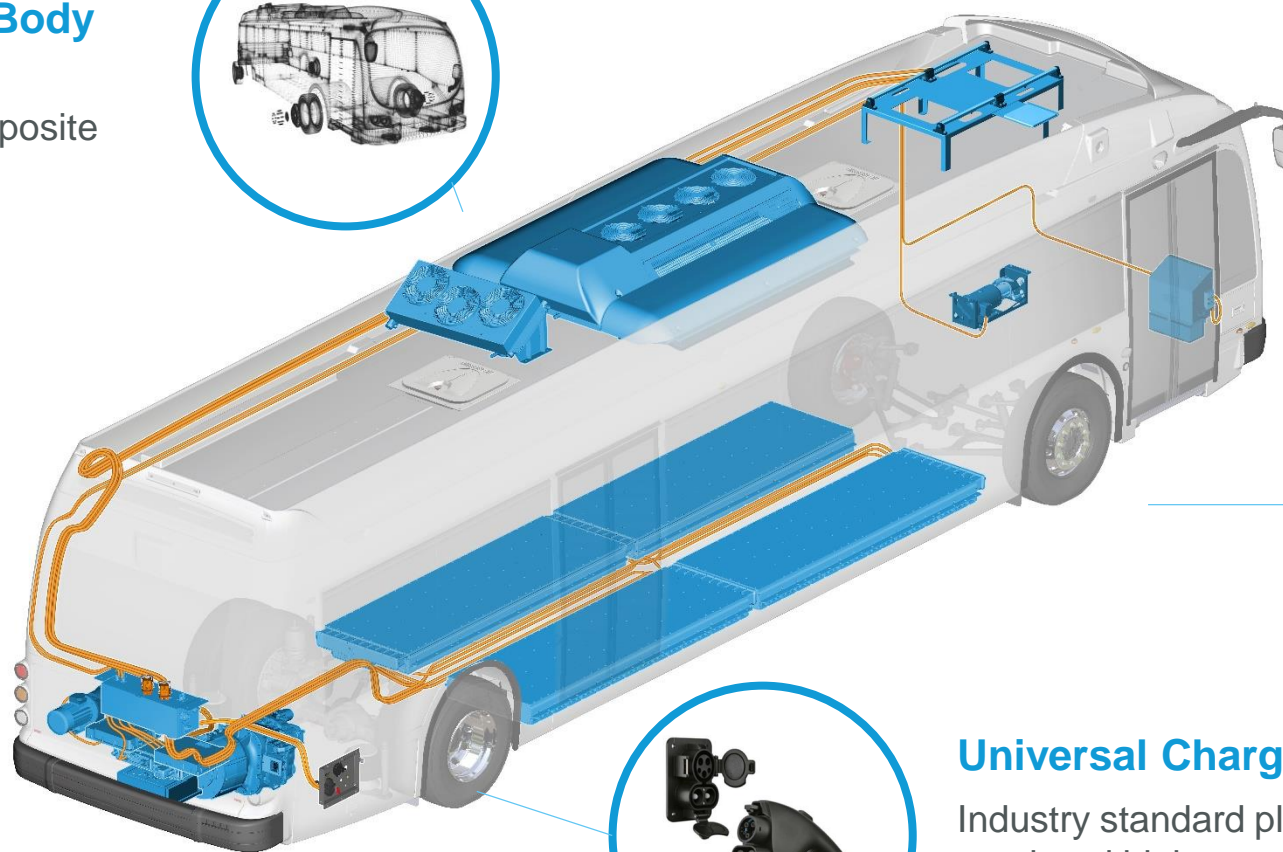
Advanced Composite Body

Lightweight and durable
carbon-fiber-reinforced composite



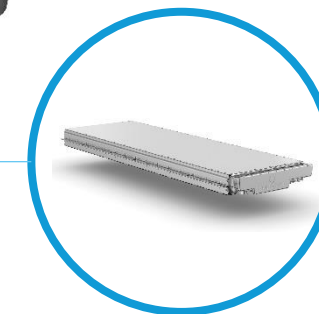
High Efficiency Drivetrain

5x efficiency of diesel
Greatest horsepower
Fastest acceleration



Heavy Duty Battery Pack

High energy density,
ruggedized battery packs
purpose built for commercial
vehicles



Universal Charging

Industry standard plug-in and
overhead high power Level 3
charging

THE PROTERRA CATALYST MODELS



PROTERRA



CATALYST XR
220
kWh

XR

XR

220 kWh energy on board
92-118 miles operating range*
2.8 hrs charge time**

CATALYST E2
440
kWh

E2

E2

440 kWh energy on board
150-230 miles operating range*
3.2 hrs charge time**

CATALYST E2 MAX
660
kWh

E2 MAX

**E2
MAX**

660 kWh energy on board
213-328 miles operating range*
4.5 hrs charge time**

*Operating range and efficiencies approximated from simulations based on UDDS cycle Altoona testing results at SLW, and will vary with route conditions, weather, vehicle configuration and driver behavior.
**Charge time will vary depending on charger type.

Proterra's use of **advanced composite** materials makes the Proterra Catalyst not only the most efficient vehicle in its class, but extremely durable and safe as well.



Highly durable for greatest safety

- Advanced carbon-fiber-reinforced composite material
- Super strong, lightweight and impact-resistant
- Non-conductive and rust-resistant

	COMPOSITE	ALUMINUM	STEEL
LIGHTWEIGHT	●	●	●
IMPACT-RESISTANT	●	●	●
CORROSION-FREE	●	●	●

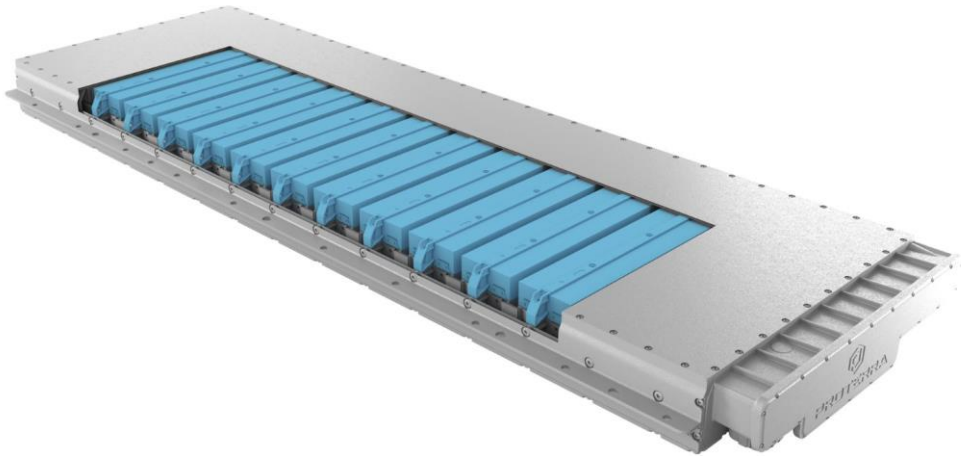


Small Format
Li-Ion Cells
(Cylindrical)

Engineered, Validated, and Manufactured by Proterra in California



Proterra battery packs are designed specifically for safe operation in heavy-duty transportation.



- Protective, **ruggedized enclosure** made with ballistic-grade materials that can withstand the toughest conditions
- Pack design ensures service technicians and operators are protected from high voltage components
- Liquid cooling for **active thermal management** to ensure optimal operation in any climate
- More than **70 sensors** throughout each pack delivers continuous monitoring and diagnostics, enabling faster service
- If a single cell within the battery fails, the pack is designed such that the defective cell will be isolated to a small region of the pack and not cause complications throughout the entire pack.
- Rigorously tested and 3rd party validated

Proterra battery packs have undergone extensive testing to meet the highest safety standards.



Tests performed to account for possible incidents such as:

- Vehicle crash
- Road debris striking the battery pack
- Street manhole cover explosion
- Defective or failed cell within pack
- Overcharge of high voltage system
- Coolant flood internal to battery pack
- Fuel fire external to the vehicle (collision with a combustion engine vehicle)

SMARTER CHARGING

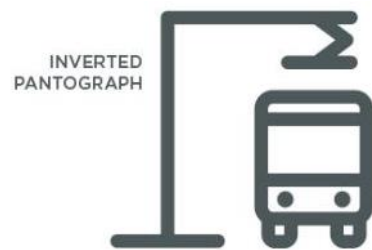
COMPATIBLE WITH INDUSTRY-STANDARD CHARGING SYSTEMS



OVERHEAD CHARGING

Keep your Catalyst buses rolling with easy depot or on-the-road charging, made simple by industry-standard SAE J3105 overhead systems.

- Charge on the road for longer routes or enable 24/7 circulator operations
- Low maintenance costs and high availability
- Compatible with roof-mounted pantographs as well as inverted pantograph systems, offered by Schunk and other suppliers



ADOPTED BY MAJOR OEMS



PLUG IN CHARGING

Regardless of your fleet size, powering up your Proterra buses at the depot is as easy as plugging in a standard J1772-CCS Type 1 charger.

- Universal chargers are offered by Proterra and other suppliers
- Catalyst vehicles can be configured with two charge ports for flexibility at the depot
- Electric buses, utility vehicles and cars can share the same standardized chargers



ADOPTED BY MAJOR OEMS



SMARTER CHARGING PROTERRA POWER CONTROL SYSTEMS



60KW
For fleets with longer
available charge times.

Catalyst charge time:
~6 hours



125KW
For fleets with high
uptime requirements

Catalyst charge time:
~3 hours



500KW
For fleets with extended operating
hours and high mileage requirements

Catalyst charge time:
~30 miles per 10 minutes



Open source
communications
protocol



Bi-directional
V2G capability



Smart grid ready



Telematics-
enabled

INTELLIGENT

Automated and rules-based
vehicle charging

UNIVERSAL

Standards-based, OCPP 1.6 open
communications protocol-compatible

REMOTE

Can be located up to 500 feet
from dispenser

SCALABLE

Can be installed side-to-side and back-to-
back for high-density charger banks

COMPATIBLE CONNECTIONS



PANTOGRAPH



INVERTED PANTOGRAPH



UNIVERSAL PLUG IN



125 kW PCS

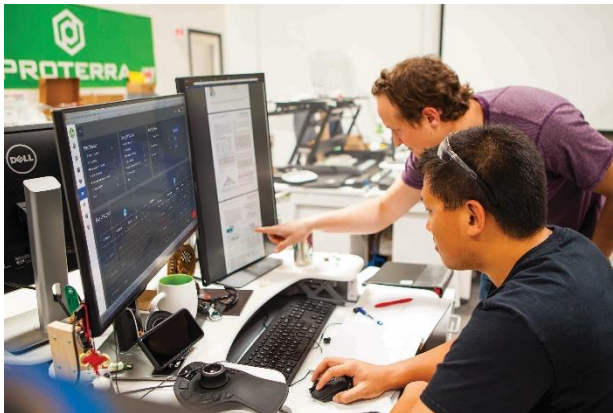
CHARGING DISPENSERS

- **Proterra charging systems can have multiple dispensers paired with a single Power Control System (PCS)**
 - Available for the 60 kW and 125 kW systems
 - Enables automated **sequential** charging
- **Lowers cost of infrastructure**
 - Less hardware to purchase
 - Less major equipment to install
- **Reduces space needed for charging systems**
 - Optimal for space-constrained depots



INTRODUCING PROTERRA ENERGY FLEET SOLUTIONS

TURNKEY ENERGY DELIVERY FOR ELECTRIC FLEETS



By providing a full suite of Proterra products and services in-house, we offer **a comprehensive solution** to help you meet your electrification goals.

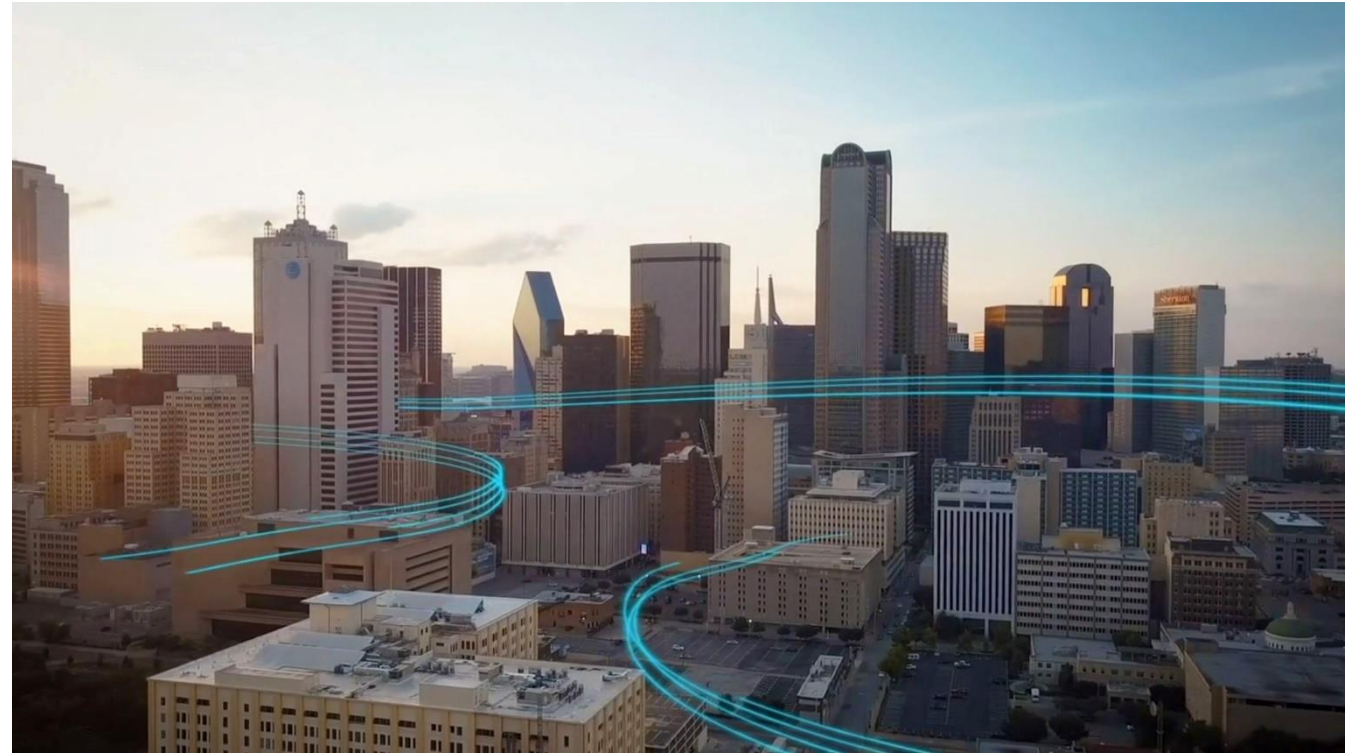
- **SOPHISTICATED PLANNING**
- **TURNKEY INFRASTRUCTURE INSTALLATION**
- **SMART ENERGY MANAGEMENT**
- **ADVANCED ENERGY STORAGE**
- **PAY-AS-YOU-GO**

Proterra has helped **more than 45** fleet operators throughout North America install high-power charging systems.

SOPHISTICATED PLANNING FOR SUCCESSFUL ELECTRIC BUS IMPLEMENTATION

Beginning with a high-fidelity route simulation, fleet modeling and detailed TCO analysis, Proterra helps you choose the right vehicle, battery and charging configurations to meet your route requirements now and as you scale.

- **CUSTOMIZED ROUTE SIMULATION**
- **INFORMED VEHICLE SELECTION**
- **FLEET MODELING**
- **COST OF OWNERSHIP EVALUATION**



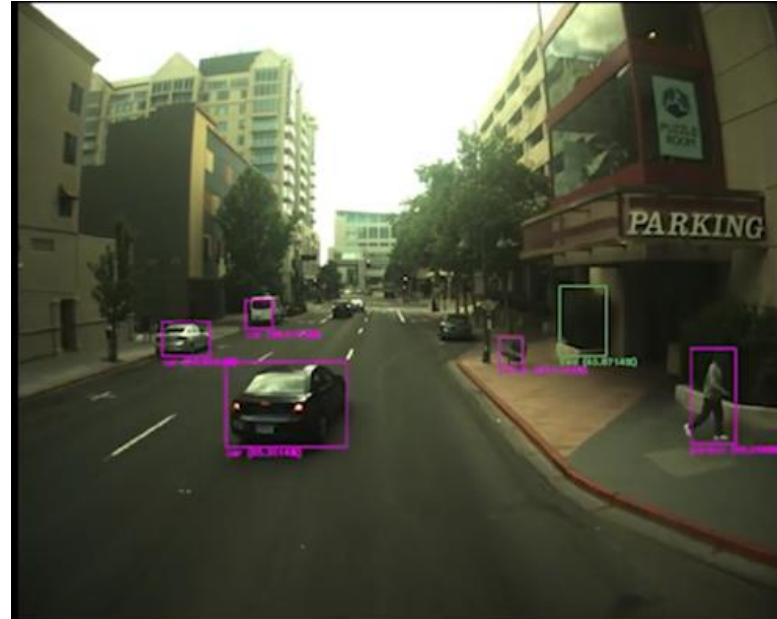


- From crash avoidance and driver response enhancement to smart city integration, Proterra is enabling transit agencies to adapt to a complex and changing transportation environment.
- Increased automation for buses promises to improve safety, operations and efficiency, while also addressing congestion in cities. Automation will also help with parking and charging buses, maximizing depot space and enabling smart charging as a cost-effective measure.
- Robust, connected vehicle technology enables safer, more efficient movement through complex and dynamic urban environments.

- **Advanced Driver Assistance** –Automation can provide support when it comes to detecting and reacting to potential safety concerns. Automatic emergency braking for collision avoidance, precision movement for narrow lanes, and smooth acceleration and deceleration.
- **In-depot Automation** – Automation will power precision movement for electric buses to provide an automated assist with parking and recall, charging, maintenance and washing. This will lead to maximizing parking space in the depot and minimize charging hardware and infrastructure investment.
- **Platooning** – Led by a lead bus with an operator at the wheel, automation will enable several buses to follow behind in close proximity, creating a “platoon.” With platooning, transit agencies could flexibly increase rider capacity during peak hours by connecting two or more standard transit buses, reducing aerodynamic drag and improving fuel efficiency of the vehicle.
- **Fully Autonomous Bus** –The autonomous bus of the future will need to accomplish both driving and non-driving tasks, including many tasks that autonomous passenger vehicles do not need to incorporate such as assistance for older adults and people with disabilities, fare collection, and help with passenger navigation.

THE LIVING LAB PROJECT

- Proterra has been developing and testing connected vehicle technology that will form the basis for increased automation.
- Proterra vehicles are designed with driver assist features to help with charger docking.
- Nearly two years ago, Proterra initiated the industry's first autonomous bus program with the University of Nevada, Reno and its Living Lab Coalition partners including the Regional Transportation Commission of Washoe County (RTC).



GPS-ENHANCED VISUAL-INERTIAL ODOMETRY

The images here show a ROS wrapping a deep neural network with trained weights that represent living beings, vehicles and traffic signs.

THANK YOU.



PROTERRA

