VSI Labs

The Importance of U.S. CAV Pilots: Programs, Resources, Technologies & Applications

By Sara Sargent & Katelyn Abel

Across the country cities and states are investing in Connected and Automated Vehicle (CAV) technologies to improve their transportation systems. Connectivity within the context of automated vehicles will serve multiple use cases including vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and infrastructure-to-vehicle (I2V) communications. This has also evolved to include vehicle-to-pedestrian (V2P) and is collectively known as V2X, where X can be anything. Connectivity is expected to be a critical enabler of automated driving to open communication between the roadway and the road users, whether they're human or machine.

There are a variety of suppliers, resources and incentive programs these local governments are leveraging to reach their CAV goals. Several cities have begun pilot programs, incorporating V2X and I2V applications, autonomous shuttles, level 4 ride hailing development, and several partnerships. The following chart summarizes the recent or ongoing pilots in a set of cities with well-developed CAV programs. This report examines connectivity applications and resources for CAV pilots, highlighting three pilots (Tampa, Columbus and Wyoming) dedicating resources to DSRC.

Pilots	Austin, TX	Dallas, TX	Arlington, TX	Boston, MA	New York, NY	Tampa, FL	Columbus, OH
AV Shuttles	• 6 Shuttles in urban environment • Airport Shuttle	Easy Mile (6 month)	Milo Pilot (2017) Easymile off-street for parking to entertainment district	Optimus Ride (2017) • Seaport District • Polaris GEM	Optimus Ride (Aug 2019) • 6 shuttles • 300-acre industrial park • 500ppl /day	Coast Pilot (2017-18) • Incomplete • Transit center to offices USF Coast Pilot (Feb 2019) • 500 students • Student hit by shuttle	Smart Circuit (2018-19) • May Mobility Shuttle • 3 mi. loop downtown • 15,000+ rides Lindin (Nov 2019) • EasyMile EZ10 • 15 passenger, ADA accessible
L4 Ride Hailing	Ford & Argo.ai (Aug 2019) • Beginning 2019 • Driverless 2021 Waymo Leaving (Nov 2019)	Uber ATG (Nov 2019) Drive.ai • July 2018 • Entertainment + Office	Drive.ai (2018-19) • 760+ trips , 440+ miles • Urban area – lg events	nuTonomy (2017) • Seaport district		Waymo (2019) • Human testing in rain • Between Tampa, Fort Myers, Orlando & Miami	
V2X	INRIX AV Road Rules • Used mostly for traffic management USDOT SPaT Challenge • Multiple locations		USDOT SPaT challenge • 4 DSRC Devices • Applied Information app • Connected signals	INRIX AV Road Rules	• 310 DSRC Signals • 8000 equipped vehicles • FCW, BSW, LCA, intersection movement, right turn – transit vehicle, compliance	• 1,600 privately owned w/ OBU • Traffic data optimization • Hard braking, FCW, intersection movement, wrong way, right turn - transit vehicle	• Launching July 2020 • V2V, V2I communication • Safety alerts • OBU installation in Dec 2019 INRIX AV Road Rules
Other	Open proposal process for private/public project ideas	Autonomous delivery	Autonomous delivery by Marble (2018)	Autonomous Delivery by Robomart (2019) Training dataset by Aptiv/nuTonomy	Ped in crosswalk • Sensor in car • Ped device • 100 users	Ped in Crosswalk • 500 app users • Alert to driver	
Programs	• Smart City Challenge Finalist • Smart Cities Readiness Challenge Grant • HGACBuy	• Smart Cities Initiative • Dallas Innovation Alliance		• 2015: Smart City Challenge- not advanced • 2016: World Economic Forum "focus city"	USDOT Connected Vehicle Pilot Deployment Program ($45M across 3 states)	USDOT Connected Vehicle Pilot Deployment Program ($45M across 3 states)	USDOT Smart City Challenge Winner (50M in funding)

Resources for CAV Pilots

There are products, incentive programs and grants available for local governments to utilize for their CAV projects. By leveraging these, they can save their time and resources to prepare and conduct their pilots.

INRIX AV Road Rules

INRIX Road Rules enables cities to digitize, store, and share local mobility information. City staff can input information like stop signs, crosswalks, bike lanes, curb designations, and sidewalk information. Additionally, vehicles can send infrastructure issues like potholes to the road authority for assessment.

Road Rules launched in 2018 with 7 cities and has become more widely adopted since then. In November 2019, the Pennsylvania DOT completed a study of INRIX and Waze data to gauge the value of monitoring real-time crowdsourced data, finding that the data is important to improve incident detection. Austin, TX also leveraged INRIX data to reduce rush-hour congestion by retiming traffic signals in high-volume areas.

HGACBuy

HGACBuy is a product and service procurement program led by the Houston-Galveston Area Council (H-GAC). It is a nationwide resource available to local government sectors that offers over 7,700 products and services from over 860 vendors. Local governments can use HGACBuy to find approved AV technology vendors such as Easymile, May Mobility, and Drive.ai.

SPaT & Connected Fleet Challenge

The Signal Phase and Timing (SPaT) challenge called on state and local infrastructure stakeholders to deploy DSRC infrastructure with SPaT broadcasts. The challenge propositioned each state to achieve DSRC deployment in at least one corridor or network of 20+ signalized intersections by January 2020. Thus far, 26 states have committed, and there are currently 216 signals in operation. The challenge is being led by the American Association of State Highway Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE) and ITS America.

The Connected Fleet Challenge proposes that each SPaT participant equips at least one light-duty vehicle and one heavy-duty vehicle with a DSRC on-board unit by 2021. The objective is not to equip a large number of vehicles, but rather a diverse group of vehicles like snowplows, buses, and commercial trucks. The SPaT and Connected Vehicle Challenges represent an important step on the CAV roadmap, allowing government entities and stakeholders to collaborate and learn from each other.

USDOT Funding

Smart City Challenge

The USDOT initiated a Smart City Challenge in December of 2015. They put out a call to cities to develop ideas for smart transportation systems, generating 78 proposals from cities around the United States. 7 finalists were chosen, including Austin, Columbus, Denver, Kansas City, Pittsburgh, Portland, and San Francisco. Though not considered a top technical contender, Columbus won the challenge with a proposal to increase access to jobs, connect residents and visitors to better transportation options, support sustainability in transportation, and promote smart logistics.

Connected Vehicle Pilot Deployment Program

In 2015, the USDOT granted over $45 million to three pilot sites in New York City, Wyoming, and Tampa to implement a set of connected vehicle applications designed for their region's particular transportation needs. The three sites spent one year preparing a comprehensive deployment concept, after which they embarked on a 24-month phase of design, building and testing. As of now, the sites are in the third phase of the deployment, an 18-month period during which the systems are being operated and monitored.

Connected Vehicle Applications

There are a number of connected vehicle applications used in pilots covered in this report. Here are descriptions of each application as well a short list of the types of DSRC messages being utilized.

- **The Vehicle Turning Right in Front of Bus/Transit Vehicle** application warns the bus driver when a vehicle attempts to turn right in front of the bus as the bus/streetcar pulls away from a stop.
- **The Pedestrian in Signalized Crosswalk** application warns the driver of a connected vehicle when a pedestrian is crossing the street in the projected path of the vehicle.
- **The Intersection Movement Assist** application warns the driver of a connected vehicle if it is not safe to enter an intersection—for example, if another vehicle is running a red light.
- **The Forward Collision Warning** application warns the driver of a connected vehicle when a vehicle ahead is stopped or traveling slower and there is a risk of a rear-end collision.
- **The Emergency Electronic Brake Light Warning** application alerts the driver of a connected vehicle if hard braking occurs in the traffic stream ahead.
- **The Curve Speed Warning/End of Ramp Deceleration Warning** application alerts the driver of a connected vehicle if they are going too fast for an approaching curve.
- **The Eco-Traffic Signal Priority/ Transit Signal Priority** application gives priority to buses at traffic signals to help reduce emissions and keep buses running on schedule.
- **The Intelligent Signal System** optimizes traffic signal timing based on connected vehicle data.
- **The Wrong Way Entry** application warns the driver of a vehicle that is entering a reversible express lane in the wrong direction and warns other equipped vehicles that a wrong-way driver is approaching.

Types of DSRC Messages

- Basic Safety Message (BSM)
- SPaT Message
- MapData Message
- Radio Technical Commission for Maritime Services Message

- Roadside Safety Message
- Signal Request Message
- Signal Status Message

Tampa, Florida

Tampa has several CAV Pilots operating with goals of relieving congestion and investigating technologies that will enhance transportation options for their citizens. Tampa has a great example of a V2X and I2V rollout, and Waymo is present collecting heavy rain data for L4 driving. Tampa has not had a successful deployment of a shuttle pilot, despite starting a project. The University of Southern Florida did have success rolling out a shuttle demonstration on their campus.

THEA (Tampa Hillsborough Expressway Authority) is a public agency run by a board of local citizens which develops and maintains local roads, one of which is a reversable expressway used in the pilot. This pilot project began in September 2015 when THEA was awarded $17M by the USDOT.

The THEA Pilot stands out because of a large population of the general public (1000+) is actively taking part, having their own vehicles outfitted with on-board units (OBU). Participants were incentivized with a discount on the tollway fees. It also has an outstanding public outreach initiative, providing resources to inform the public about the technologies being deployed. The THEA Pilot's interactive map breaks the pilot into sections with details on each application and why they are being deployed in each area.

Interoperability with New York, NY and Wyoming pilots was a requirement for the THEA pilot, which was a key consideration from the beginning. Hillsborough Community College was leveraged to install the OBUs for the privately-owned vehicles.

Connectivity Applications

- Vehicle Turning Right in Front of Bus
- Pedestrian in Signalized Crosswalk
- Intersection Movement Assist
- Forward Collision Warning
- Emergency Electronic Brake Light Warning

- End of Ramp Deceleration Warning
- Transit Signal Priority
- Wrong Way Entry
- Over the air Updates
- Intelligent Signal System

Wyoming

The Wyoming pilot is unique because it focuses on commercial vehicles and their operators. They are developing applications that use V2I and V2V connectivity to support services like roadside alerts and dynamic travel guidance on the highway.

The Wyoming pilot is concentrated on a 400+ mile stretch of I-80. During the winter, crash rates on I-80 have been found to be 3-5x higher than in the summer, likely due to winds of 65+mph. This results in hundreds of truck blowovers every year, which often leads to road closures and delays. The pilot is expected to improve road safety and reduce incident-related delays by decreasing the number of blowovers and weather-related accidents in the corridor.

Connectivity Applications

- Forward Collision Warning
- I2V Situational Awareness
- Work Zone Warnings
- Spot Weather Impact Warning
- Distress Notification

Columbus, OH

Columbus was the winner of the Smart Cities Challenge and is expected to be a leader in in CAV development for cities. They will use INRIX to for traffic and V2X applications and have already completed a 9-month shuttle pilot with plans for more underway.

Launching in July 2020, the Connected Vehicle Environment will allow public and private connected vehicles to communicate with other vehicles, traffic signals and other infrastructure to enable safety alerts to drivers. Installation of OBUs is slated to start in December of 2019 at no cost to users.

Connectivity Applications

- Blind spot warning
- Red light violation warning
- Rear end collision warning
- Intersection Movement Assist
- Forward Collision Warning
- Emergency Electronic Brake Light Warning
- Vehicle data for traffic ops
- Reduced speed school zone
- Transit Signal Priority
- Snowplow and emergency vehicle priority
- Over the air updates

Conclusion

There are dozens of cities participating in CAV pilots in the US, this report only covers a handful of the initiatives being developed. Having so many CAV pilots deploying means there will be a lot of opportunities to learn, discover new challenges and find solutions for using connectivity as a resource for improving transportation and automated vehicles.

Being open about the problems that arise during the pilots is critically important. Additionally, resources like the HGACBuy database can save cities' a lot of time. Connectivity has become increasingly important for automated driving when it becomes commercialized. The vehicle itself becomes a resource to the roadway owners as a tool for collecting maintenance and traffic data. For these reasons it is important to see a continued trend of the automated vehicle industry working with the infrastructure operator owners on pilots like these.

About VSI Labs

Established in 2014 by Phil Magney, VSI Labs is one of the industry's top advisors on AV technologies, supporting major automotive companies and suppliers worldwide. VSI's research and lab activities have fostered a comprehensive breakdown of the AV ecosystem through hands-on development of its own automated vehicle platform. VSI also conducts functional validation of critical enablers including sensors, domain controllers, and AV software development kits. Learn more about VSI Labs at https://vsi-labs.com/.

How to Engage with VSI

VSI Labs offers subscription research packages to meet your needs:

- VSI Insights – High level technical analysis of CAV technologies and the future of automated driving.

- VSI CAV Technology Databases – Deep insights on the products and technologies that make up automated driving.

- VSI Pro – Decomposition of an AV's functional domains and time saving instructions on how to build an AV.

Learn more about our portal services or contact us to get started!

Conditions of this Report

In no event shall VSI Labs (a.k.a. Vision Systems Intelligence, LLC.) be liable to you or any other party for any damages, losses, expenses or costs whatsoever (including without limitation, any direct, indirect, special, incidental or consequential damages, loss of profits or loss opportunity) arising in connection with your use of this material. The information in this report is assembled on a best-efforts basis and VSI Labs shall not be responsible for errors or omissions and any claims arising from this.