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A REGIONAL TRANSPORTATION PARTNERSHIP

MetroPlan Orlando CAV Readiness Study

Final Report

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Glossary of Terms

Acronym	Definition
ADA	Americans with Disabilities Act
AASHTO	American Association of State Highway and Transportation Officials
ACES	Automated, Connected, Electric, and Shared-use vehicles
ADAS	Advanced Driver Assistance System
AMPO	Association of Metropolitan Planning Organizations
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ATC	Advanced Transportation Controllers
ATMS	Advanced Traffic Management System
AV	Automated Vehicle
BSM	Basic Safety Message
CAV	Connected and Automated Vehicle
CCTV	Closed Circuit TV
CDOT	Colorado Department of Transportation
CFAVP	Central Florida Automated Vehicle Partnership
CFX	Central Florida Expressway Authority
CV	Connected Vehicle
CV2X	Cellular Vehicle-to-Everything
CVRIA	Connected Vehicle Reference Implementation Architecture
DCS	Digital Cellular Service
DMS	Dynamic Message Signs
DSRC	Dedicated Short Range Communications
D5	District 5
ESS	Environmental Sensor Stations
EV	Electric Vehicle
EVP	Emergency Vehicle Preemption
FAMU-FSU	Florida A&M University and Florida State University
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FOC	Fiber Optic Cable
FTE	Florida's Turnpike Enterprise
GOAA	Greater Orlando Aviation Authority
GPS	Global Positioning System
HAV	Highly Automated Vehicle
IMC	Intersection Movement Count
IMSA	International Municipal Signal Association
ITS	Intelligent Transportation System

Acronym	Definition
JTA	Jacksonville Transportation Authority
LiDAR	Light Detection and Ranging
LYNX	Central Florida Regional Transportation Authority
MAP	Intersection Geometry File
MDOT	Michigan Department of Transportation
MMITSS	Multi-Modal Intelligent Traffic Signal System
MnDOT	Minnesota Department of Transportation
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
MVDS	Microwave Vehicle Detection Systems
NCHRP	National Cooperative Highway Research Program
NWS	National Weather Service
NYCDOT	New York City Department of Transportation
OBE	On-Board Equipment
OBU	On-Board Unit
ODD	Operational Design Domain
PFS	Pooled Fund Study
RCID	Reedy Creek Improvement District
RSE	Roadside Equipment
RSU	Roadside Unit
RTD	Regional Transportation District
SCMS	Security Credential Management System
SOV	Single Occupancy Vehicle
SPaT	Signal Phase and Timing
THEA	Tampa Hillsborough Expressway Authority
TMC	Traffic Management Center
TRB	Transportation Research Board
TSM&O	Transportation Systems Management and Operations
TSP	Transit Signal Priority
UCF	University of Central Florida
US DOT	United States Department of Transportation
V2I	Vehicle-to-Infrastructure
V2P	Vehicle-to-Pedestrian
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
VMT	Vehicle Miles Traveled
WYDOT	Wyoming Department of Transportation

1 Project Overview

The purpose of the MetroPlan Orlando Connected and Automated Vehicle (CAV) Readiness Study is to provide area stakeholders with a thorough evaluation of the current preparedness of local counties and cities for the emergence of CAVs, as well as to recommend next steps to proactively enhance their preparation.

While the information and concepts included in this report could also be relevant for other jurisdictions, they were designed based on the unique characteristics and constraints of MetroPlan Orlando's planning area, shown in Figure 1 which includes Seminole, Orange, and Osceola Counties. This planning area is referred to as "the region" throughout this report.

Figure 1: Map of MetroPlan Orlando's Planning Area

Over a year-long period, the project team created three interim task memorandums, conducted a series of stakeholder workshops, solicited input from the MetroPlan Orlando Committees and Board, hosted a final stakeholder meeting to present draft recommendations, and summarized the results of all of this information in this final report.

The intended audience of this final report is ultimately the Central Florida region's leaders and stakeholders. While this report is complemented by a final presentation, the written report itself serves as a critical element to communicate and document results and recommendations from the study, ensuring awareness and adoption of the principles proposed and a foundation for the resulting actions to be taken in the coming years.

This final report includes the following sections:

- Section 2 provides an industry review of nationwide CAV deployments, standards, and best practices.
- Section 3 assesses the preparedness within MetroPlan Orlando's planning area for CAV technologies, including lessons learned from existing infrastructure and deployments.
- Section 4 is an overview of the stakeholder engagement that was conducted for this project, including notes from a series of stakeholder workshops.
- Section 5 proposes recommendations to spur development of projects, guide infrastructure investments, and facilitate the provision of equitable and safe urban environments for all transportation modes in anticipation of the potential impacts of CAVs in the region.
- Section 6 concludes with an overall summary of findings, conclusions, and recommended next steps for MetroPlan Orlando.

2 CAV Industry Best Practices Review

2.1 Introduction

Task 1 of the project consisted of a review of the current state of the connected and automated vehicle (CAV) industry in the MetroPlan Orlando Planning area, the state of Florida, and nationwide.

This includes an overview of current CAV planning efforts and pilot deployments to identify lessons learned and best practices, while highlighting key elements that may be relevant to the Central Florida region, organized into the following sections:

- Section 2.2 defines relevant and current definitions, terminology, and standards related to CAV
- Section 2.3 reviews the supporting infrastructure required to enable a CAV system
- Section 2.4 identifies valuable data elements that can be acquired through and/or support a CAV ecosystem
- Section 2.5 summarizes current and past CAV pilots and planning efforts nationwide
- Section 2.6 assesses national research efforts
- Section 2.7 presents a summary of CAV industry practices

Performing best practice reviews is a common component of Intelligent Transportation Systems (ITS) and CAV master planning efforts conducted by state, regional, and local planning agencies around the country. This document seeks to expand on what has been done elsewhere with a specific focus on basing findings in reality for the specific environment and constraints of the Central Florida region. Identifying best practices and their local relevance can be used to support a full assessment of the Central Florida region's readiness for CAV.

2.2 Definitions, Terminology, and Standards

This section provides an overview of CAV industry terms and standards, to support a consistent understanding throughout this project. Many terms in the CAV realm are often used interchangeably, but actually have different meanings. These distinctions and a desire for consistency have resulted in the following recommended definitions for common industry terms[1]:

- An **automated vehicle** (AV) is a vehicle with some aspect of a safety-critical function controlled by something other than direct input by a human driver. Vehicles that provide safety warnings to drivers (such as a forward collision warning), but do not perform a control function are not considered automated since there is no control implemented, even if the technology necessary to provide that warning includes a degree of automation. To be considered automated, the vehicle must use information obtained via sensors to make its own judgements and actions in a driving environment.

- A **connected vehicle** (CV) is a vehicle that is equipped with some sort of wireless communication device that allows it to share information with other vehicles and objects on the roadway. CVs can be automated, but AVs are not necessarily connected.

While automated vehicles are expected to improve vehicle safety by limiting the impact of human error, only with connectivity can the potential safety benefits of fully automated driving systems be realized, as vehicles can then gain context beyond what a regular driver would know or be able to perceive visually. Similarly, while connectivity can enable alerts and warnings to a driver-operated vehicle, deploying these messages on an automated vehicle can streamline the links between information, decision making, and action. The overlap and differences between these two technology types, as well as ITS, is presented in Figure 2. The following subsections provide additional information on the three types of technologies and other related topics.

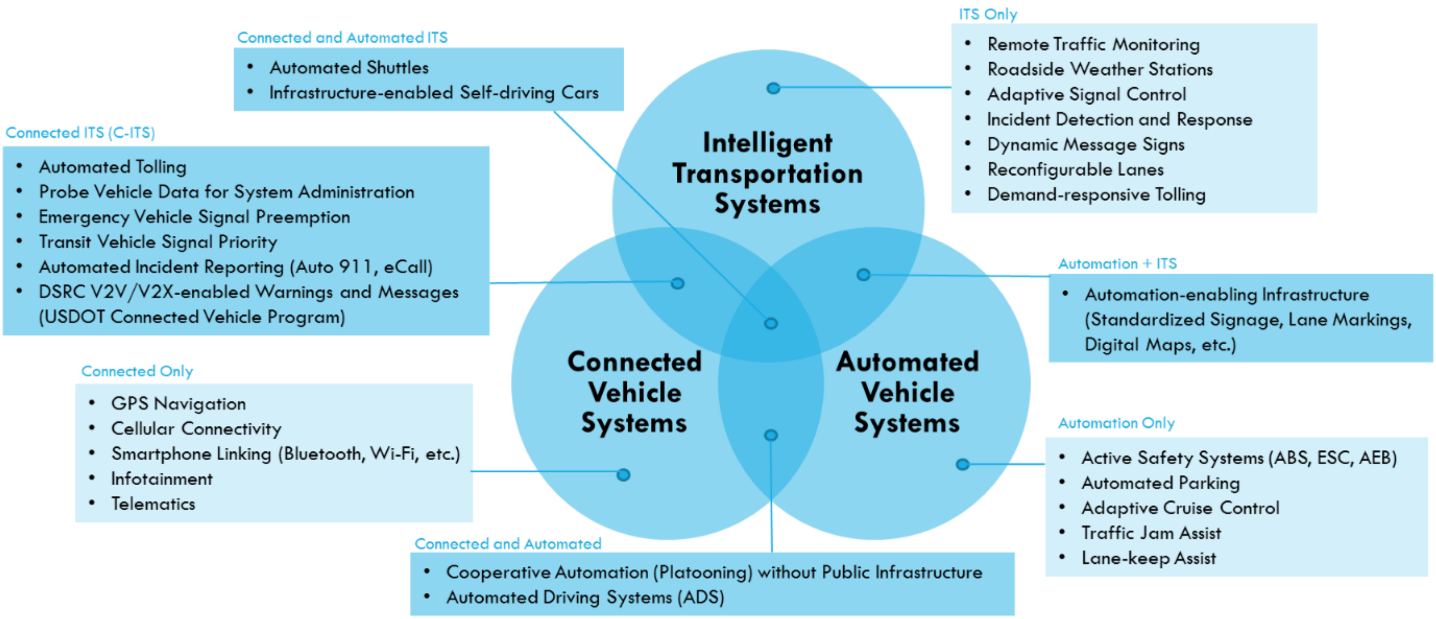


Figure 2: Categories of Advanced Transportation Technologies
Source: Public Sector Consultants and Center for Automotive Research for the Greater Ann Arbor Region Prosperity Initiative, "Planning for Connected and Automated Vehicles", March 2017, https://www.cargroup.org/wp-content/uploads/2017/03/Planning-for-Connected-and-Automated-Vehicles-Report.pdf.

2.2.1 Automated Vehicles

Automated vehicle (AV) technologies enable vehicles to detect their surroundings using a variety of on-board sensors, often using radar (radio waves), LiDAR (light pulses), cameras (images), and ultrasonic sensors (sound waves) or a combination of these multiple sensor types. By merging these information sources, as well as others such as global positioning system (GPS) data and dead-reckoning location information, an advanced control system on a vehicle is able to interpret the data to detect obstacles, identify optimal navigation paths, and interpret traffic control devices such as traffic signals, traffic control signs, and pavement markings.

Many private companies have explored varying approaches to integrating the data from these types of sensors and using this information to create decision trees for a vehicle system, However, there are still many specific operational scenarios that have yet to be fully explored, the artificial intelligence algorithms are not standard across the industry, and even some of the specific data configurations and standards have not yet been developed. For example, some companies use semantic segmentation to detect objects, as shown in the first image in Figure 3, which classifies pixels by object type. This allows the vehicle system to differentiate a sign from a person, so it can move into either determining the message the sign is trying to convey or analyzing the potential path of the pedestrian. Other companies bind the location of objects to a box, as demonstrated in the second image in Figure 3, so they can track an object as the vehicle (and possibly the object) moves.

Figure 3: How an Automated Vehicle Senses Objects
Source: Shapiro, Danny, "Eyes on the Road: How Autonomous Cars Understand What They're Seeing", January 5, 2016, https://blogs.nvidia.com/blog/2016/01/05/eyes-on-the-road-how-autonomous-cars-understand-what-theyre-seeing/.

SAE International, a standards-setting industry association of automotive experts and technologists, has developed a scale of driving automation ranging from Level 0 to Level 5 – Level 0 indicates that the vehicle uses no automation of any kind, while Levels 1-4 have varying levels of abilities that can assist drivers on very specific tasks. The highest automation level, Level 5, indicates that the vehicle can perform all tasks under all conditions (Level 5). This SAE driving automation scale is shown in Figure 4.

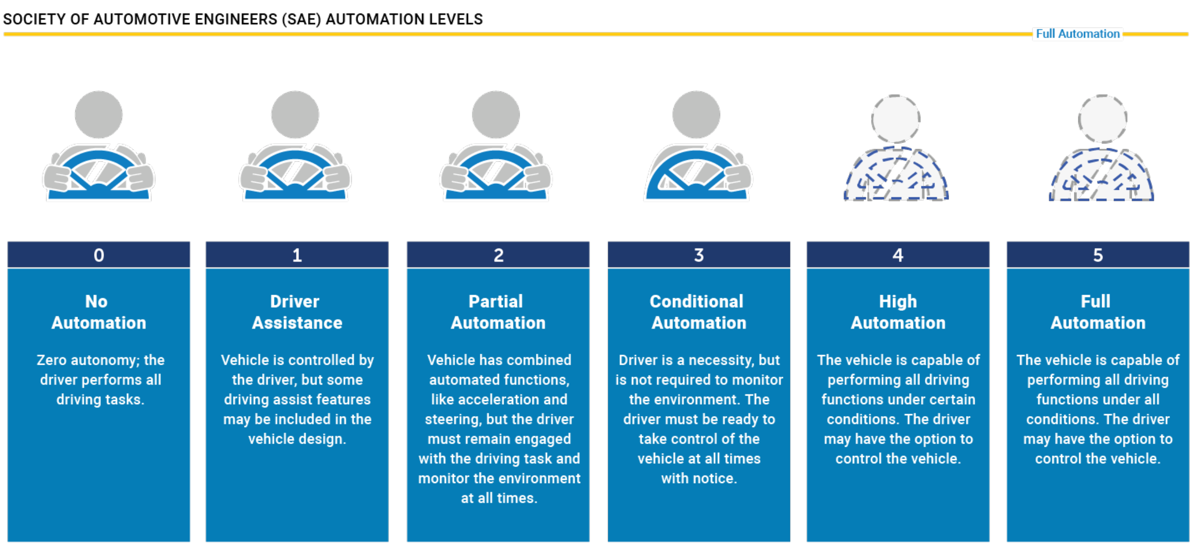


Figure 4: SAE Automation Levels
Source: US DOT, "Automated Vehicles for Safety", https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety.

Levels 1-3 describe types of AV technology that have been introduced before vehicles are entirely self-driving, and many of these types are already available today. For example, Advanced Driver Assistance System (ADAS) components such as lane keeping, parking assist, emergency braking, and adaptive cruise control have been introduced on new vehicles to assist drivers without completely taking over the driving task. Level 1-3 vehicles may be fully automated within a certain operational design domain (ODD), or defined geographic conditions, such as roadway types and weather limits.[2] A driver may be required to remain onboard the vehicle and monitor its operation, to ensure it is operating safely and is not outside its ODD. In the future, Highly Automated Vehicles (HAVs), or Levels 4 to 5, will have multiple ADAS components and on-board sensors that can analyze multiple types of sensory data to distinguish between vehicles, bicycles, pedestrians, and obstacles, and with advanced connectivity (as described below), will be able to operate a vehicle on most or all types of roadway networks.

2.2.2 Connected Vehicles

CV technologies enable various types of vehicles, roadway infrastructure, mobile devices, and other objects to communicate quickly to share vital information. CV technologies enable vehicles to communicate with infrastructure (vehicle-to-infrastructure, or V2I), between vehicles (vehicle-to-vehicle, or V2V), and with other objects on the roadway such as bicycles, pedestrians, or obstacles (vehicle-to-everything, or V2X).[3] Figure 5 provides a schematic of these communication interactions, as well as some of the systems and centers that could be used to enable them.

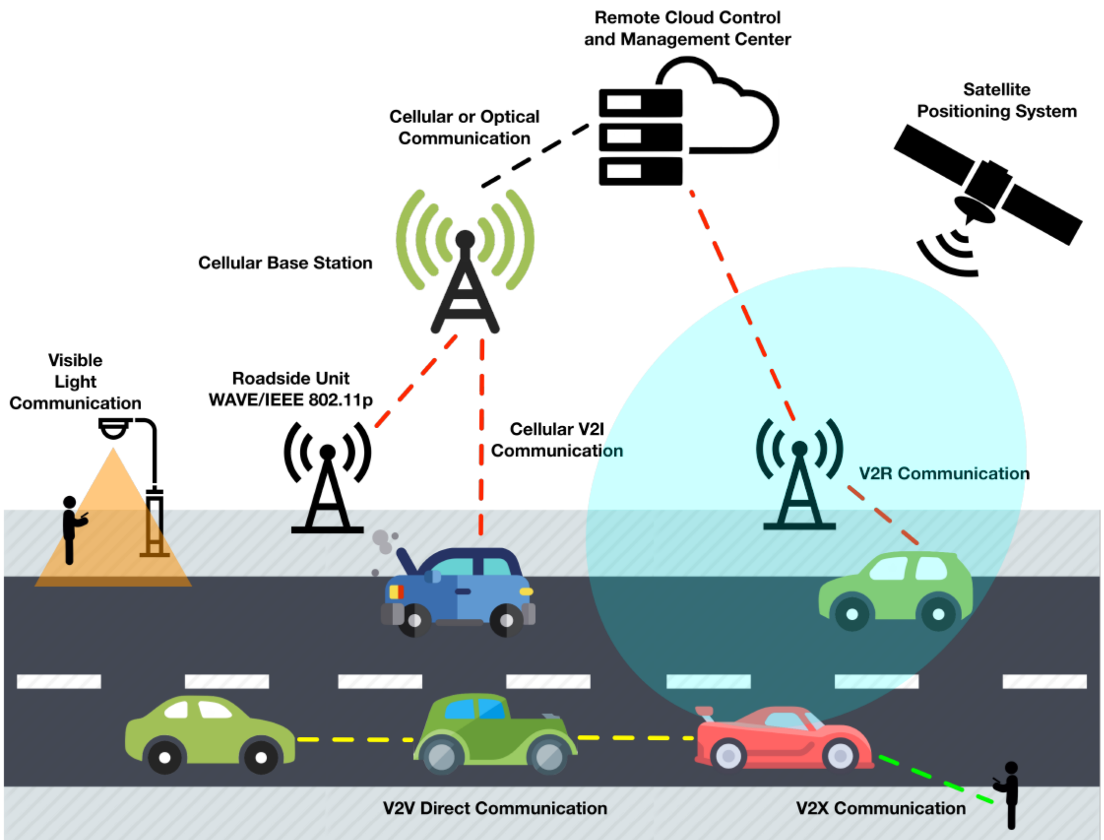


Figure 5: Drawing of V2I, V2V, and V2X Communications

Source: Fabio Arena and Giovanni Pau, An Overview of Vehicular Communications, January 24, 2019.

There are many potential mediums by which connectivity will be enabled. Satellite, cellular, Wi-Fi and other short-range communications all represent methods by which vehicles today are already connected, and the vehicles of tomorrow will become increasingly connected.

Dedicated Short Range Communications (DSRC) is one such medium, a Wi-Fi-based short range method that has been developed for high-speed low-latency situations to specifically enable safety applications. While additional cellular-based communication methods are also being developed, many pilot projects have commenced across the country to better understand the uses and impacts of connected vehicles and infrastructure in transportation networks. The primary purpose of these pilot projects is to create test beds in a real-world environment that can provide insights for future deployments. Using this approach, public agencies can be earlier adopters of CV technology, which will also allow them to experience the technology first-hand and ensure it is compatible with their needs. This approach also provides the ability for public agencies to support and test proof-of-concept solutions. For example, a Security Credential Management System (SCMS) has been tested to help ensure that CVs operate in a safe and secure manner that protects the privacy of users.[4]

2.2.3 ITS and ITS Architecture

ITS integrates advanced information and communication technologies into transportation and traffic management systems to improve safety and mobility by leveraging technology to better utilize physical infrastructure. While ITS concepts and tools are not new, they are becoming consistently more refined and powerful, and state-of-the-art deployments have demonstrated additional capabilities that were not possible even just a few years ago. Because the impact of some ITS tools is dependent on human behavioral response, their effectiveness is expected to improve as more components of the transportation system become more automated, most notably with the continued introduction of CAV technology onto roadways.

The United States Department of Transportation (US DOT) has developed a national ITS Architecture to help define a consistent framework to guide the planning and deployment of ITS, as well as CV technology.[5] This architecture is intended to be adaptable and evolutionary, allowing agencies to collaborate and identify systems that could best help meet their needs and challenges. To support this, there is a tool called the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT). The ARC-IT tool, illustrated in Figure 6, provides a common framework to agencies for planning, defining, and integrating ITS. It is an established, industry-standard product that reflects the contributions of a broad cross-section of the ITS community. ARC-IT merges, unifies, and enhances National ITS Architecture and Connected Vehicle Reference Implementation Architecture (CVRIA), as it was previously known. ARC-IT presents Service Packages, previously known as "applications" in CVRIA, which are groups of physical objects and the communications between them that are tailored to fit, separately or in combination, real world transportation problems and needs.

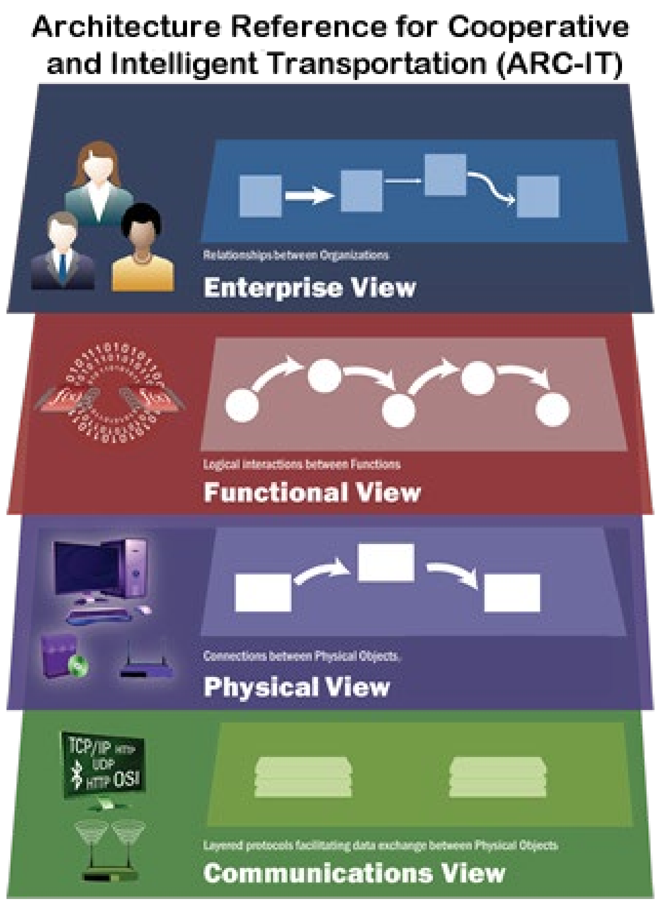


Figure 6: ARC-IT Reference Diagram
Source: US DOT, "Architecture Reference for Cooperative and Intelligent Transportation", https://local.iteris.com/arc-it/.

2.2.4 Why CAVs?

The most promising benefit of CAV technology is the potential impact on safety. With the critical reason for approximately 94 percent of vehicle crashes attributed to driver actions, there is ample opportunity to improve safety by eliminating the impact of driver error.[6] While CAVs will have their own weaknesses such as potential vulnerability to hacking, they will not drive impaired, remove their focus from the driving task, or intentionally disobey the rules of the road. However, a major safety challenge for CAVs will be interacting with vehicles that are not also automated (and connected), and there is likely to remain a combination of these vehicle types on roadways for the foreseeable future.

In addition, while it is possible that CAVs will simply replace existing vehicles one-for-one, it is likely that this paradigm shift in how vehicles are operated will come in parallel with other paradigm shifts in how transportation is provided, funded, and consumed. CAVs provide the opportunity to efficiently operate new business models and improve the movement of people and products. For example, it may become more streamlined and attractive for people to share vehicle ownership and/or individual rides in right-sized vehicles, for vehicles to be utilized at a higher rate, or for less high-value real estate to need to be made available for parking.

Shared mobility options in dense urban areas, such as transportation network companies (e.g., Uber, Lyft), microtransit (flexible on-demand service), and traditional transit, will likely be enhanced by CAVs due to improvements in vehicle balancing (of empty vehicles) and reduced costs of operation. Other CAV applications will enhance the safety of all vehicles, including transit and freight vehicles of all sizes, by transmitting additional information on roadway conditions and the behavior of other vehicles that is not easily perceptible today. While these innovations will likely be introduced by private entities, public agencies can also take advantage of their benefits. From a congestion management perspective, the traveler experience could ideally be made virtually seamless across modes, as vehicles become capable of automatically tracking connection times and coordination with first-mile/last-mile solutions, removing this inconvenience and responsibility from passengers and providing a convenient travel option for more origins and destinations. This would allow travelers to be matched to the most efficient mode for each stage of their trip, which may occasionally be a single occupancy vehicle (SOV), but could often be a shared vehicle. There are a variety of technologies that could collaborate to help enable this shared CAV future. However, improvements in shared mobility may not result in a net reduction in vehicle miles traveled (VMT), as lower travel costs provided by CAVs could have the potential to induce additional travel demand. The exact effect is unknown at this time, and could also progress through different evolutionary stages as societal changes and technology offerings impact mobility trends both positively and negatively.

Potential economic and societal benefits to agencies include enhanced data collection and information sharing that could lead to more efficient operations, both by distributing travelers across alternate routes and modes in real-time and through enhanced maintenance, such as improved deployment of road crews during inclement weather and other incidents. However, data collectors will need to consider privacy concerns. The reduced costs of collisions, including those of lost productivity, medical treatment, congestion, and property damage, are expected to provide benefits to society as a whole. Secondary impacts could impact the insurance industry, as improved road safety triggers changes to vehicle insurance policies and premiums.

As with any new technology, early adoption will likely not benefit all people equally at first. Many companies are emerging with automated rideshare and microtransit models for initial implementation, providing a service rather than the sale of these vehicles directly to drivers. This model has the potential to increase the general population's accessibility to CAV technology but, since the entities are generally still private companies, service provided may not be distributed fairly and might only be offered on corridors on which it is most profitable. Many private platforms may also not be fully accessible for people with disabilities or those without a smartphone, at least at first. This discourages use by passengers with mobility or cognitive challenges, as well as passengers who do not own a credit card or smartphone.

It will be important for public agencies to ensure CAV deployments, especially ones they are sponsoring, equitably and safely serve all their citizens. Best practices to meet this challenge are already being demonstrated with non-automated new mobility services, and include subsidizing access for qualifying users; performing outreach in key communities and using performance-based community engagement metrics to validate success; offering alternative access modes such as telephone or text booking options and physical kiosks; and switching public transit payment systems from card-based to account-based systems, which could allow users to transfer transit subsidies to other services that become available and can provide them with more mobility options on a familiar platform.[7]

2.3 Infrastructure Elements

To enable CAV applications, vehicles are outfitted with on-board equipment (OBE) that allows them to communicate wirelessly. The wireless network over which CVs communicate must be fast, reliable, secure, private, and interoperable (across applications and user types). As mentioned previously, there are several mediums that could provide the required quality of connectivity, including satellite radio, commercially available cellular, and DSRC. While these units and networks are available today, application feasibility and functionality is still limited by the low number of deployed units and concerns about interoperability between them (as the communications protocols are not yet fully standardized and certified between manufacturers).

To enable V2I communications, intersections and other roadway segments are equipped with roadside equipment (RSE) that can send and receive messages with OBEs to communicate information (illustrated in Figure 7).

For example, an intersection could provide a vehicle with information about its physical geometry (MAP message) and current signal phase and timing (SPaT message). Similarly, OBEs could communicate information on the vehicle's current location, speed, heading, acceleration, and other attributes to the RSE. These messages can help the traffic controller determine whether the combination of these conditions may result in an unsafe situation, or if interventions could be made to improve safety or mobility.

Figure 7: Drawing of Roadside Unit Communicating with Various Vehicles

Source: US DOT Intelligent Transportation Systems Joint Program Office, "Vehicle-to-Infrastructure Resources", https://www.its.dot.gov/v2i/index.htm.

V2V communications are most commonly in the form of basic safety messages (BSM) that constantly share core data elements on a vehicle's current position, heading, speed, size, acceleration, and subsystem status with other vehicles. BSMs can enable many safety and mobility applications, such as forward collision warnings and cooperative adaptive cruise control. V2X communications can help enable safety and mobility applications, in particular to warn of and help prevent collisions with vulnerable road users such as bicyclists and pedestrians. Vehicle-to-pedestrian communications, sometimes referred to as V2P, may be enhanced by connectivity with smartphones and other mobile devices.

In the long term, CAVs are intended to operate on roads without any specialized infrastructure. However, current vehicle capabilities are limited, so some infrastructure adjustments can be helpful to ensure safe operations for early tests and pilot deployments.

Most CAV providers will conduct a site visit before deployment in order to ensure an environment is suitable for their vehicle, if solicited, or to find an environment they believe would create a favorable testing environment, if unsolicited. For example, challenges operating on multi-lane roads in mixed traffic, such as changing lanes and making unprotected left turns, have not yet been fully resolved, and many vehicle vendors are not comfortable operating on roads or routes with these types of obstacles. In addition, vehicles need to be able to consistently obtain a signal for localization purposes, so obstacles such as tall grass and tree cover can also present an issue. CAV vehicles can have reduced functionality in inclement weather and are vulnerable to power failures unless an uninterruptable power source is installed with the equipment.

2.4 Data Elements

A CAV ecosystem will only be complete if key data sets are collected and distributed securely and in support of the correct applications. This section evaluates the necessary data elements essential to a CAV system and what an agency should consider when determining how to manage these large amounts of data.

2.4.1 Value of Data

Generally, drivers obtain information on the roadway primarily through sight, supplemented by familiarity with either the exact road they are currently on or with standardization among roads across the country. However, there are many conditions on the roadway that are not easily perceptible, either to a driver or to a CAV system, that could be enhanced by different types of data sharing. CV technology in particular can help improve safety by providing warnings directly to drivers and by improving the reliability of any information that can be shared on traffic and roadway conditions. For example, a CV system could send an in-vehicle message to a driver or vehicle system to warn them they are approaching an active school zone, a tight curve with a low speed limit, or a traffic backup due to a crash or other incident.

Vehicles themselves can also collect data, such as geolocated locations on the roadway with poor pavement or aggregated vehicle speed information to determine current roadway speeds (as many trip planning applications already do via smartphones). While some newer vehicle models and smartphone-based applications are already collecting and sharing this data today, many vehicles currently on the roads are not capable of sending and receiving these messages, and for the foreseeable future, the fleet is expected to remain mixed between vehicles equipped with CV features and those that are not equipped. As a result, transportation design standards focused on human drivers must remain the minimum level provided, but enhancements can be included such as providing the information via both connected capabilities and continuing more traditional means such as dynamic roadway signage. Additionally, depending on the availability of data, validation of the recommended message from a back office or traffic management center may be necessary.

Of particular importance from an infrastructure owner/driver's perspective is environmental and weather data. Approximately 22 percent of vehicle crashes on U.S. roadways are weather-related.[8] Weather such as fog and rain can reduce visibility and pavement friction, making it harder for drivers to sense and respond to roadway hazards, and affecting the safe operating parameters of a roadway. Heavy winds can have similar impacts, especially in conjunction with other weather conditions. Weather impacts can be very localized and magnified by other high-risk behaviors such as speeding, as well as other roadway conditions such as poor pavement and tight curves. However, deploying technology on both the infrastructure and vehicle sides can allow data to be matched with vehicle performance data to provide information to drivers and CAV systems on possible hazardous situations. This could potentially reduce the frequency of weather-related crashes, as well as the severity of crashes that do occur.

Many state departments of transportation already collect weather-related data, primarily to support maintenance crews. For example, the Michigan Department of Transportation (MDOT) currently has a large amount of road weather data gathered from Environmental Sensor Stations (ESS) and from a number of other fixed sources including National Weather Service (NWS) locations. In fact, ESS data is available publicly due to the proven reliability of this automatically collected data over time.

Another distribution point for roadway data is at traffic signals. Information on current signal status and time remaining until the next phase change, known as Signal Phase and Timing (SPaT) data, can open the door to critical safety applications in vehicles with the potential to significantly reduce and/or eliminate crashes at intersections. However, many traffic signals across the country use outdated technology, and may need to be updated before they can be connected to a wireless communication system.

Newer vehicle models on the road today are beginning to demonstrate the potential uses of data collected from CVs. Figure 8 shows the basic data-generating devices and flows that may be available in newer vehicles. While the data these devices generate are usually intended for a primary, safety-critical purpose, they could also be used for secondary purposes such as dynamic roadway pricing or transportation planning.

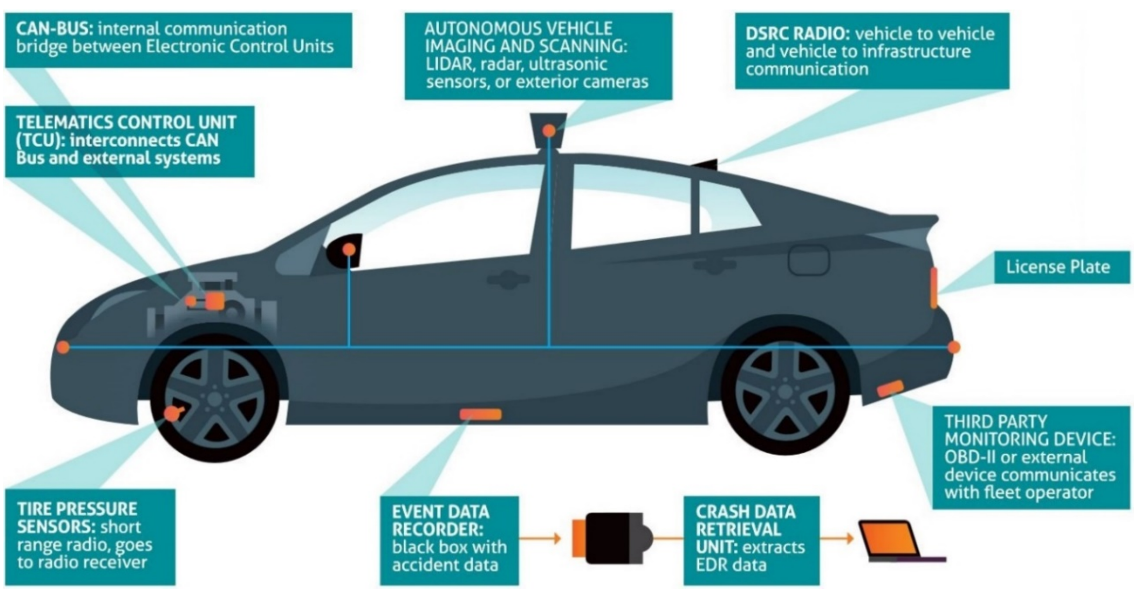


Figure 8: Schematic of Data from Connected Vehicles
Source: Future of Privacy Forum, "Data and the Connected Car", https://fpf.org/2017/06/27/future-privacy-forum-releases-infographic-mapping-data-connected-car-advance-ftc-nhtsa-workshop/.

Another type of valuable data is that collected by private mobility and CAV technology companies. Such data is used in many different forms, such as for real-time operations and in order to assess current performance and identify areas of future development. This data would be valuable to public agencies as they strive to assess the current capabilities of CAV systems and under what conditions they should be permitted to operate on public roadways. However, many of these private mobility companies are in direct competition with each other, and are therefore sensitive to sharing data they may see as proprietary in a public setting. Many vendors are more willing to share data when they are contracted to provide a service (and receiving payment or other special permissions) and under a non-disclosure agreement, but they are unlikely to share all data even under these conditions.

2.4.2 Data Management

Many state and other public agencies have existing programs to manage ITS and traffic planning data. While most are starting to discuss the benefits and challenges with integrating the wealth of CAV data that may soon be available, very few have specific plans or a timeline to add CAV data to their data management platforms. Rather, most agencies are just beginning to explore how CAV data could be used to help their agency answer questions and solve problems for both real-time operations and archived planning purposes.

During this planning process, it is recommended that agencies engage with each other to discuss similar experiences they may have gone through or currently are going through (or with vendors, to discuss whether they could offer additional capabilities or ideas). Due to the popularity of CAV research and testing, it is likely that another agency has already implemented a similar product, or even that a local university may be able to support research during the specific stage where the agency is.

Early on, agencies need to consider what data can and should be made publicly available, and what data should only be shared on an individual user basis. Because of the wealth of data that CAVs are expected to collect and be able to provide, there may be a need for agencies to redevelop their data governance, distribution, and retention policies. The Florida Department of Transportation (FDOT) has particularly stringent data retention requirements – depending on the type of data, raw data may need to be saved for many years.[9] This creates a significant data storage need which may have been feasible to meet in the past, but could become more challenging as higher volumes of data begin to be collected automatically.

2.4.3 Smart City Data

Many cities worldwide have begun exploring the possibilities to integrate technology into their transportation and infrastructure systems in an effort to become a "Smart City". These high-tech improvements allow cities to integrate both traditional service information and advanced communication technologies into their systems to improve efficiency and better manage their services and assets. A major component of a Smart City is the wealth of data that can be collected and shared with citizens and other stakeholders. Because of this, it is worth exploring the relationship between CAVs and Smart Cities in terms of data and data management.

Smart City data can be used to understand how a city works in real-time, which can help prioritize investment, both physical and technological, in order to more efficiently identify improvements that best support the overall network and society within the city. Smart Cities also work to introduce new and emerging technologies into their systems, including integrating electric, automated, and/or connected vehicles into public vehicle fleets, as well as enhancing their operations and maintenance activities with smart sensors and smart infrastructure.

2.5 National CAV Pilots and Planning Efforts

Several CAV planning exercises and pilot deployments are underway across the nation. This section provides a few case studies of the types of CAV pilots that have been popular, highlighting relevant lessons learned and how these projects can help advance the state of the practice in Central Florida. This includes both national examples and key pilot programs that are underway within Florida.

2.5.1 Policy and Planning

The impacts of CAVs across modes will be heavily dependent on the policies that municipalities and other local maintaining agencies pursue, as well as their impacts on driver and passenger behavior. These policies include operational decisions, such as providing signal priority or preemption to certain high-occupancy (buses and trains) or high-priority (emergency vehicles) modes. Signal priority, which entails modifying normal signal operation by extending a green signal or shortening a red signal within pre-determined limits, is generally used to help transit vehicles maintain schedule adherence and to improve travel times by transit, while mitigating disruptions to other traffic. Signal preemption, an interruption/override of the normal signal operation to accommodate a vehicle regardless of the impact on other traffic, is only appropriate in more safety-critical situations, such as to improve emergency vehicle response times and the safety of emergency vehicles at intersections, or in some cases to support safer and more efficient rail operations on shared rights-of-way.

The policies agencies must consider also include regulatory decisions, such as parking requirements, vehicle occupancy minimums/maximums, and restrictions on the use of curb space by vehicle type. CAVs provide an opportunity for agencies to reassess existing transportation policies and regulations, which may be outdated, and ensure that impacts to the broader transportation network are considered and taken into account.

An emerging challenge in the new mobility space is the interaction and relationship between public government agencies and private mobility companies, as is already being seen with ridesourcing, bikeshare, and scooter providers, and varying approaches to either seek permission or ask forgiveness to operate on public roadways. Going forward, public agencies will need to find a balance between embracing CAV innovation and maintaining an acceptable level of risk to the public. They also need to ensure that the technologies they allow to be implemented are available to all and do not benefit one group at the expense of another.

Another evolving challenge in the new mobility space is the reality that new technology and rapidly changing social trends are creating complex and uncertain outcomes for planners. Within their next planning horizon, agencies need to decide how best to address the increasing deployment of automated, connected, electric and shared-use vehicles (ACES) in addition to a wide array of complementary and sometimes competing technologies. The most likely path to navigate this uncertainty is achieved through Scenario Planning.

In Scenario Planning, we pose the profound questions that force us to consider the unexpected and examine trends from a multitude of perspectives to attain clarity. Scenario Planning creates a situational framework to apply expert human thought, utilizing quantitative and qualitative analysis of potential event impact. This process enables us to predetermine which actions will endure through a wide range of possible futures. Rather than establishing actions based on historical outcomes, Scenario Planning harnesses our ability to think from a “what if” perspective. What if the trajectory of a trend deviates from what we already know and what we expect? Where will this new trend make the biggest impact? What major changes will result? Who will benefit from or be impacted by such changes? These and other key questions help us prepare today for tomorrow’s uncertainty.

2.5.2 Connected Vehicle Pilots

Many CV pilot projects have commenced throughout the country to better understand the implementation challenges and user benefits of connected vehicles and infrastructure in the transportation network. Major ongoing CV pilot projects at the national level include:

- Various initiatives by the Michigan Department of Transportation (MDOT)
  - Ann Arbor Connected Vehicle Test Environment
  - Southeast Michigan Connected Vehicle Environment
- US DOT Connected Vehicle Pilots
  - New York City (NYCDOT)
  - Tampa Hillsborough Expressway Authority (THEA)
  - Wyoming (WYDOT)
- Minnesota Department of Transportation (MnDOT) Connected Corridor
- Smart Columbus Connected Vehicle Environment

The majority of these projects are funded, at least in part, by US DOT. The primary purpose of these types of pilot projects is to create a test bed in a real-world environment that can provide insights for future deployments. While these projects are limited in their real-world benefits by nature of their pilot implementation, lessons learned can help prepare sponsoring agencies for future shifts in the industry and spur ideas on more efficient future deployment strategies and potential uses of the new types of data that can be collected. Figure 9 provides a schematic of US DOT's overall approach to the CV Pilot Deployment Program.

Figure 9: US DOT Approach to the Connected Vehicle Pilot Deployment Program
Source: US DOT Intelligent Transportation Systems Joint Program Office, Connected Vehicles: Connected Vehicle Pilot Deployment Program, https://www.its.dot.gov/pilots/pilots_overview.htm.

Having pilot projects throughout the country allows the technology and applications to be tested under a variety of conditions and environments, including in both urban and rural areas, and in response to a variety of local needs, such as signal priority for snow plows in Minnesota.

One of three US DOT sponsored CV pilots is being conducted in Tampa, Florida, under the supervision of the Tampa Hillsborough Expressway Authority (THEA). This pilot is being conducted on a tolled highway facility and within downtown Tampa, with a primary focus on improving safety and mobility by reducing congestion during the morning peak. Another major focus of this deployment is to explore agency data applications that can reinforce these benefits and provide the agency with additional data from its customers, captured from multiple sources including vehicles, mobile devices, and infrastructure.

As part of the pilot, THEA has equipped 10 buses, 10 streetcars and the cars of 1,000+ individual volunteers with CV technology to "*make downtown Tampa a safer, smarter place to walk, ride and drive*." Nearly a dozen CV applications are currently being tested on various roadways, using both V2V and V2I communication technology to improve safety and traffic conditions in downtown Tampa. The locations of these applications are shown in Figure 10. The foundation of most federally sponsored pilots is the deployment of DSRC roadside units in the desired deployment area, and OBE on the desired fleet. Other systems, such as pedestrian detection systems or smartphone applications, may be included depending on the needs of the project.

Figure 10: Downtown Tampa Deployment Plan
Source: US DOT Office of the Assistant Secretary for Research and Technology, "Connected Vehicle Pilot Deployment Program: Tampa (THEA) Pilot Update at the System Design Milestone", https://www.its.dot.gov/pilots/pdf/CVP_THEASystemDesignWebinar.pdf.

A simple way for a region or municipality to launch a CV pilot is by outfitting an agency's maintenance fleet, private partner fleets, or other publicly owned vehicles such as transit vehicles, to create a critical mass of vehicles on the roadway that enables somewhat frequent interactions between CVs to occur. This approach is being used in the NYC DOT pilot, which includes equipping transit vehicles and other large privately-owned fleets such as taxis and UPS trucks with aftermarket safety devices and OBE that converts a regular vehicle into a connected vehicle.[10]

Other pilots, such as the Smart Columbus CV Environment, include outfitting a combination of publicly and privately-owned vehicles.[11] In this case, the target is to outfit approximately 1,000 public vehicles, including transit, emergency, and other city-owned vehicles, and to recruit 2,000 additional private vehicle owners to voluntarily have their vehicles equipped. All 3,000 vehicles will be outfitted with aftermarket DSRC units and in-vehicle signage that will allow communications between vehicles in the outfitted fleet and with infrastructure in the deployment area.

Alternatively, rather than requiring vehicles to be equipped with CV technology, the first phase of the Smart 70 Project, an initiative of CDOT's RoadX program, will allow interested participants to simply install a smartphone navigation application with text-to-voice alerts about road conditions. Future phases will add additional sources of information to support this application.

The CV environments deployed in these pilot projects each contain a subset of the CV applications that have been identified by the US DOT.[12] Application types include communications between vehicles (V2V), communications between vehicles and infrastructure (V2I), methods for collecting data for internal agency use, and applications that can enhance mobility in the transportation network.

While many of these projects are funded by federal programs, some have been funded locally. MDOT has partnered with the University of Michigan and a number of local automobile and technology companies to provide support for their projects and to share input and results. For example, the Ann Arbor Connected Vehicle Test Environment, building off a project launched in 2012, uses federal, state, and university funds, however, a long-term goal of this project is to transition from government funding to a more sustainable long-term funding solution.

Smart Columbus also received many matching funds and donated equipment from local sponsors as well as national companies after winning the US DOT Smart Cities Challenge. At the state level, CDOT set aside $20 million from its 2016 operating budget to launch RoadX. This program was designed to leverage partnerships with public and private innovators; for example, the Smart 70 Project is conducted in partnership with HERE, a mapping data and GPS navigation software company.

2.5.3 Automated Shuttle Deployments

Personal automobiles available to consumers today include systems up to Level 2 that automate specific tasks such as highway driving (using adaptive cruise control and lane keeping assist) and parallel parking. Hazard warning and intervention systems such as blind spot detection and forward collision warning with automated braking have also been implemented.

However, there are also several pilot deployments focused on higher levels of automation but at low speeds that have or could be undertaken by local and regional governments, such as regional agencies or MPOs, rather than private vehicle owners. Many private companies have begun testing, marketing, and piloting low-speed automated shuttles that can operate in specific conditions but without traditional vehicle controls (such a steering wheel and foot pedals).

A sampling of vehicle vendors that have deployed in the United States to date are shown in Figure 11. Automated shuttles operate on pre-defined, fixed routes in controlled environments, thus minimizing many remaining technical and operational challenges and enabling the vehicles to operate with minimal human intervention. However, in deployments to date, a human “safety operator” has still been on board to interact with passengers and take over vehicle control if necessary.

Figure 11: Automated Shuttles from Various Vendors
Sources: https://easymile.com/, https://localmotors.com/, https://maymobility.com/, https://navya.tech/en/, https://www.optimusride.com/

Automated shuttles are generally considered Level 3 or 4 on the SAE scale, depending on the vehicle vendor and the capabilities they have demonstrated to date. These vehicles generally have a capacity of 6 to 20 passengers, operate at low speeds on surface streets rather than freeways, and most are electric, which is efficient at these speeds.

There are many opportunities for agencies to deploy automated shuttles to supplement or replace existing transit service. Generally, these vehicles are ideal for short-distance service, where they can be used to tackle the first/last-mile problem. Deployments to date have generally also been showcase opportunities, for an agency or organization to show they are innovative and supportive of AV technology.

Automated shuttles have also been opportunities for data capture to help guide future developments. For example, a one-year automated shuttle pilot in Las Vegas was sponsored by AAA, who was interested in seeing how people perceive AVs and whether their perceptions may change if they are directly exposed to the technology. This shuttle was deployed in an area of the city that attracts many tourists, and approximately half of the passengers were from outside the state of Nevada, which allowed AAA to reach a broader audience and not just the local public.

Automated shuttles can also be used for campus circulation, at a university, employment center, office park, or airport. For example, two shuttles owned by Mcity in Ann Arbor, Michigan are being used to supplement the University of Michigan's existing bus transit service that circulates students and others around campus. In another pilot by the Denver Regional Transportation District (RTD), the shuttle connects a commuter rail station to a busy employment park. Deploying these vehicles locally also provides an opportunity to educate the local public on emerging technologies. A transit agency or organization who pilots these technologies early on will be better able to adapt to future innovations, because both internal agency processes and the public will be better prepared for and accepting of AV technology. **Table 1** provides an overview of current players in the automated shuttle industry and some of their most significant current and past deployments. As of August 2018, there have been a total of 260 demonstrations and deployments of low-speed automated shuttles in North America, Europe, Asia, Oceania, and Africa.[13] While comprehensive, this list is not necessarily exhaustive, and new products could come to market and new deployments could be launched at any time.

Table 1: Current and Past Automated Shuttle Deployments

Company	Characteristics	Current and Past U.S. Deployments
EasyMile	• French company • U.S. headquarters in Denver • Vehicle capacity is 12 passengers (6 seated) • First to include a ramp for accessibility	• Arlington, Texas • Denver, Colorado • Gainesville, Florida • Jacksonville, Florida • San Ramon, California
Local Motors	• U.S. company, headquartered in San Francisco • Vehicle capacity is 12 passengers (9 seated) • Partnered with the technology group Robotic Research to improve AV technology	• National Harbor, Maryland • Greenville, South Carolina
May Mobility	• U.S. company, headquartered in Ann Arbor, Michigan • Vehicle capacity is 6 passengers (all seated) • Vehicle is a modified Polaris GEM	• Detroit, Michigan • Columbus, Ohio
Navya	• French company • U.S. headquarters in Saline, Michigan • Vehicle capacity is 15 passengers (11 seated)	• Ann Arbor, Michigan • Jacksonville, Florida • Las Vegas, Nevada • Lake Nona, Florida
Optimus Ride	• U.S. company, headquartered in Boston • Vehicle capacity is 4 or 6 passengers (all seated) • Vehicle is a modified Polaris GEM	• Boston, Massachusetts

Lessons learned from some of the early automated shuttle deployments include the need for services deployed as transit systems to comply with applicable industry regulations and standards, even in cases where due to the funding source compliance may not technically be required. For example, most automated shuttle vehicles are not ADA-accessible, though they may have some accessible features, and this has been an issue. In addition, due to the high costs of CAV-enabling technology, automated shuttles are not inexpensive. As with most investments in new technology, they require significant upfront costs, with the benefit of overall cost-savings not seen during deployment or perhaps even within the lifetime of a product. Many pilots to date have therefore been leases rather than purchases of the vehicles.

2.5.4 Efforts in Florida

Figure 12: Installation Locations for SR 434 Deployment

Source: Open Street Map

In the Spring of 2018, FDOT released its report "Guidance for Assessing Planning Impacts and Opportunities of Automated, Connected, Electric and Shared-Use Vehicles." This comprehensive report was targeted to assist Florida metropolitan planning organizations (MPOs) who are dealing with an "unprecedented amount of potential change" as they plan for their transportation needs between now and 2045. The report included guidance on the planning process, including a description on how ACES-specific scenario planning can and should be incorporated into future efforts - and examples of national scenarios that could serve as a starting point for constructing their own range of scenarios that apply the national trends to their own local economy, geography, demographics and transportation network. The report also suggested that MPOs create an "agile policy-making framework that sets in place a continual look ahead assessment."

On the deployment front, in addition to the US DOT funded THEA pilot discussed previously, there are additional local efforts to deploy connected vehicle technology within Central Florida and across the state. The CV Pilot on SR 434 in Seminole County, for example, involves upgrading six (6) signalized intersections shown in Figure 12, by installing roadside units allowing for V2I communications and the collection of automated traffic signal performance metrics. The main applications include the transmission of SPaT data to enable emergency vehicle preemption and transit signal priority (TSP). Future CV applications along SR 434 within the test corridor could include congestion warnings, approaching emergency vehicle alerts, and other traveler information.

Another local project is FDOT District Five Ped/Safe Greenway deployment at the University of Central Florida, shown in Figure 13. The first portion of this project involves the implementation of a pedestrian and bicycle collision avoidance system that uses CV technologies to reduce the occurrence of pedestrian and bicycle crashes. The second portion of the project involves increasing throughput capacity and reducing congestion by optimizing traffic signal operations with the implementation of technologies and improving the multimodal movement of people and goods. This will optimize existing traffic operations, in terms of flow rate and safety, for all multimodal traffic during peak time and special events.

On the automated shuttle side, the Florida cities of Gainesville, Babcock Ranch, Orlando (Lake Nona), and Jacksonville have all deployed shuttles on local roads or testing facilities to meet various transportation use cases. In Gainesville, a three-year pilot program is being pursued near the University of Florida campus with a fleet of four (4) automated shuttles to provide fare-free rides from campus to downtown Gainesville. Just south of Tampa, the Babcock Ranch automated shuttle pilot is part of a Smart City initiative with a longer-term goal of providing on-demand service. At Babcock Ranch, vehicles of varying sizes are planned to create a transportation ecosystem which, alongside hourly and daily car rental options, is as convenient as owning a personal vehicle. A similar initiative is underway in the Orlando suburb of Lake Nona, with Navya automated shuttles being deployed to enhance a developing network of transportation options in this planned community.

The Jacksonville Transportation Authority (JTA) vision is to transform the existing Jacksonville Skyway elevated automated people mover system into what is known as the U^2C System: an expansion of the elevated downtown network into an urban circulator system with transitions to the street level to expand the reach of the system. This transformation will require a technological solution that is able to operate on both the elevated guideway and at-grade public roadways, likely AVs supported by modifications to the guideway that provide a more similar environment to the at-grade roadways (including the removal of the monorail beam).

This full program vision is currently being supported by early deployment stages; in December 2017, the U^2C AV Test and Learn track was launched as an "outdoor classroom" to test and evaluate multiple vehicles and their associated technologies from the AV shuttle industry. This has enabled local stakeholders to gain critical information for the development of the U^2C program and for other future applications of autonomous transit vehicles as part of its overall public transportation system.

2.5.5 Summer 2019 Legislative Update

The Florida Legislature, in its 2019 session, introduced and passed legislation that further expands Florida's already "AV-friendly" statutes. CS/HB 311 provides that "a human operator is not required to operate a fully autonomous vehicle." Believed to be the first of its kind in the nation, the legislation defines that an "automated driving system is deemed operator of autonomous vehicles operating with the system engaged" and provides requirements for insurance & operation of "on-demand autonomous vehicle networks." The bill was signed into law by Governor Ron DeSantis on June 13, 2019 and took effect July 1, 2019. The bill language can be found here: http://laws.flrules.org/2019/101

Figure 13: Aerial Image of Ped/Safe Project
Source: Google Maps

2.6 National Research Efforts

At the national level, there are dozens of research projects planned or underway that identify critical issues associated with CAVs that state and local transportation agencies will face, conducting research to address those issues, and conducting related technology transfer and information-exchange activities.

A significant portion of the research is being led the National Cooperative Highway Research Program (NCHRP), run by the Transportation Research Board of the National Academies (TRB), and sponsored by the member departments of AASHTO (i.e. individual state DOTs), in cooperation with the Federal Highway

Administration (FHWA). NCHRP addresses issues integral to the state DOTs and transportation professionals at all levels of government and the private sector. Contractors conduct individual projects with oversight provided by volunteer panels of expert stakeholders.

2.6.1 Impacts of CAVs on State and Local Transportation Agencies

One research program of great importance to this study is *NCHRP 20-102 – Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies.* The objectives of this research program include identifying critical issues associated with CVs and AVs that state and local transportation agencies and AASHTO will face; conducting research to address those issues; and conducting related technology transfer and information exchange activities. There are four "teams" of consultants and academics working on the following tasks under this program:

Completed Tasks

- 20-102(01) Policy & Planning to Internalize Societal Impacts of CV/AV Systems into Market Decisions
- 20-102(02) Impacts of Regulations and Policies on CV/AV Technology in Transit Operations
- 20-102(03) Challenges to CV and AV Application in Truck Freight Operations
- 20-102(06) Road Markings for Machine Vision
- 20-102(07) Implications of Automation for Motor Vehicle Codes
- 20-102(08) Dedicating Lanes for Priority or Exclusive Use by CVs and AVs
- 20-102(09) Introduction of CV/AV Impacts into Regional Transportation Planning and Modeling

Tasks in Progress

- 20-102(10) Cybersecurity Implications of CV/AV Technologies
- 20-102(11) Mobility-on-Demand and ADS: A Framework for Public-Sector Assessment
- 20-102(12) Business Models to Facilitate Deployment of CV Infrastructure
- 20-102(15) Understanding the Impacts of the Physical Highway Infrastructure Caused By the Increased Prevalence of Advanced Vehicle Technologies
- 20-102(18) Data for Planning Analysis of the Mobility and Reliability Impacts of CAVs
- 20-102(19) Update AASHTO's CAV Research Roadmap

Future Tasks

- 20-102(05) Strategic Communications Plan for NCHRP Project 20-102
- 20-102(13) Planning Data Needs and Collection Techniques for CV/AV Applications
- 20-102(14) Data Management Strategies for CV/AV Applications for Operations
- 20-102(16) Preparing TIM Responders for Connected Vehicles and Automated Vehicles
- 20-102(17) Deployment Guidance for CV Applications in the OSADP
- 20-102(20) Workforce Capability Strategies for State and Local Agencies
- 20-102(21) Infrastructure Modifications to improve the Operational Domain of AVs
- 20-102(23) Potential Impacts of HAV/SM on Traveler Behavior
- 20-102(24) Infrastructure Enablers for CAVs and Shared Mobility
- 20-102(28) Preparing Transportation Agencies for CAVs in Work Zones

Additional tasks are being formulated at TRB conferences and committees throughout the year, providing the 20-102 organizing panel with updated input to constantly changing research needs. The results of these tasks will provide fundamental guidance and input to state and local DOT's as they continue operating in this fast-evolving space.

Beyond the NCHRP 20-102 program, a project under the NCHRP 20-24 program (Administration of Highway and Transportation Agencies) was recently completed to help infrastructure owner/operators understand the level to which they intend to equip their roadways for the impending rollout of CAVs. NCHRP 20-24(112) focuses on developing a consensus Connected Road Classification System that will be useful to state and local DOTs and MPOs that are planning or implementing CAV-compatible infrastructure. The project is based on the premise that an important decision facing each infrastructure owner/operator is the level to which they intend to equip their roadways for the impending rollout of CAVs. Recognizing this, the Colorado Department of Transportation (CDOT) has proposed a road classification system with six levels that relate to the roadway's ability to support CAVs. The intent of this NCHRP research project is to build on CDOT's efforts to develop a uniform classification system. This will help agencies designate their roadways based on the degree and level of readiness to accommodate CAVs and plan their deployment of needed infrastructure.

2.6.2 Other National Research

US DOT has been working on important deployment-oriented research through their CV Pilot program for several years now. The CV pilot deployment programs are expected to integrate CV research concepts into practical and effective elements, enhancing existing operational capabilities. On September 1, 2015, US DOT awarded three cooperative agreements—collectively worth more than $45 million—to initiate a design/build/test phase in three sites: with New York City DOT in New York City, THEA in Tampa, and Wyoming DOT in Wyoming. All three pilot programs have progressed through development and are currently in varying states of operation and evaluation.

Other critical US DOT-sponsored research on cooperative automated transportation includes projects that evaluate enabling technologies, emphasize safety assurance, address need in transportation operational performance, and focus on policy and planning needs created as a result of this rapidly evolving space.

While automakers and device manufacturers will dictate availability of vehicular equipment, transportation agencies will deploy and operate roadside infrastructure and incorporate CV technologies into infrastructure applications (e.g., traffic signal control). In response to this environment, a group of state and local transportation agencies and FHWA created a pooled fund study (PFS) - the Program to Support the Development and Deployment of Connected Vehicle Applications - to conduct the work necessary for infrastructure providers to play a leading role in advancing CV systems.

The CV PFS has completed projects ranging from technical and economic research to ground-breaking design and development of a software and hardware system that services multiple modes of transportation, including general vehicles, transit, emergency vehicles, freight fleets and pedestrians. This multimodal intelligent traffic signal system (MMITSS) is the next generation of traffic signal systems that provide a comprehensive traffic information framework to service all modes of transportation, including general vehicles, transit, emergency vehicles, freight fleets, and pedestrians and bicyclists in a CV environment.

2.6.3 AMPO CAV Working Group

In early 2017, the Association of Metropolitan Planning Organizations (AMPO) assembled a Connected and Autonomous Vehicles Technical Working Group to "identify how to best leverage the benefits of CAV development and deployment." The effort began with four national meetings over a year and a national symposium in March 2018, and recently concluded with the release of a national framework.

White Paper #1 – April 2017

In April 2017, the AMPO CAV Working Group held their first meeting in Arlington, Texas, to kick-off the Working Group by identifying current policy, practice, and activities at MPOs related to CAV, as well as challenges, needs, opportunities, and next steps. The Working Group identified several challenges that

MetroPlan Orlando has identified in other locations, including deployment timeline, safety/security implications, capacity/congestion implications, and impacts on mobility and mode options. Other challenges identified by this meeting included:

- Data management;
- Implications to funding and the operation, structures, roles, and responsibilities of transportation agencies;
- Stakeholder coordination;
- Information sharing; and
- The role of the MPO in building technical, institutional, and policy capacity.

As a result of the discussion, the Working Group developed three primary recommendations for MPOs centered on training and technical assistance, information exchange, and regulations and guidance. At the conclusion of the first meeting, the group focused their efforts on developing recommendations on an information sharing template which other regional agencies could use to share information.

White Paper #2 – July 2017

In July 2017, the AMPO CAV Working Group held their second meeting in Cincinnati, Ohio, focusing on coordination with other regional transportation agencies and risk management in their metropolitan areas. This meeting strongly highlighted the need for early and frequent coordination between State DOTs, MPOs, and other transportation agencies, to increase awareness of CAV related activities, build synergy, reduce redundancy, and efficiently use and leverage limited resources for CAV projects. Coordination between MPOs and the freight industry was also highlighted since the application of CAV in freight industry has several applications to increase freight capacity and reduce congestion. The Working Group identified several questions/identified risks (safety, environmental justice/equity, stakeholder expectations, data sharing, and incorporation into the current planning process and decision making) for further exploration, and a desire to learn more about societal adaption to past technologies and the factors that led to their widespread implementation. The Working Group concluded with the identification of actions that transportation agencies can take now to prepare for CAV technologies, many focused on self-assessments to identify their strengths, weaknesses, and areas that need focus within agencies.

White Paper #3 – November 2017

In November 2017, the AMPO CAV Working Group held their third meeting in Washington, D.C., focusing on the federal perspective and coordination/collaboration with transportation stakeholders, associations, and organizations. Several topics discussed overlapped with topics identified at the previous meetings, but several discussions were new, including a significant discussion about CAV deployment on infrastructure stresses and loadings, particularly on bridges or ramps, and the potential need for design practice modification to adjust for additional reinforcement. Another significant discussion focused on considering the full range of emerging technologies (Smart Cities, electrification, shared carpooling, and crowdsourcing) while discouraging the bundling of CAV technologies for discussion, since their needs, benefits, impacts, and deployment scenarios/timelines are likely to be quite different. The Working Group also discussed the impacts of CAV deployment on the MAP-21/FAST Act performance measure requirements for MPOs and identified the need for federal support, potentially including new policies/regulations, guidance for planning/investment decisions, and guidance on the effective use of funding/investment. Ultimately, the Working Group identified three strategies to address the uncertainty in deployment and implementation:

- Make investment decisions that support the future transportation system with or without CAV deployment.
- Make investment decisions that support and guide the transportation system to the desired future.

- Identify specific elements to help guide incorporation of CAV deployment into transportation processes and stakeholder involvement.

White Paper #4 – March 2018

In March 2018, the AMPO CAV Working Group held their fourth and final meeting in Orlando, Florida, to focus on next steps in planning for CAV deployment and how to establish effective partnerships (between public and private sectors) and coordination practices between them. The meeting focused primarily on examples of CAV research and deployment in the Central Florida region, namely the City of Orlando Smart Cities, the Central Florida AV Proving Ground, the AV Mobility Initiative with FDOT, MetroPlan Orlando, and LYNX, the SR 434 AV Pilot Project, the I-75 FRAME project, the SunTrax AV Test Bed, and Florida Turnpike Enterprise test/pilot projects currently underway. The meeting also focused heavily on the roles of MPOs as innovators in C/AV technology and transportation planning, since over 75 percent of the nation's population lives within the boundaries of an MPO. Some of the strategies identified as part of this Working Group meeting include:

- Do not prematurely select a preferred technology
- Expand MPO staff skills in emerging technologies
- Explore the future in incremental transitions

The meeting also focused on the relationships between the public/private sectors, and the ways to establish effective partnerships and coordination practices between them, citing regular coordination meetings as a strong way to keep everyone informed on the status of CAVs in the region and best practices nationwide. As critical questions and theories on the impacts of CAV are discussed, it is essential for MPOs, transit agencies, and the private sector to continue to meet to discuss evolving trends surrounding and affecting the deployment of CAV technologies. The meeting concluded by identifying partnerships between transportation agencies and the private sector, namely, some essential needs related to data sharing, data quality and security, and privacy concerns that could be aggregated in a national repository.

National Framework – April 2019

The most recent publication from the AMPO CAV Working Group was their National Framework for Regional Vehicle Connectivity and Automation Planning document, unveiled during a public webinar in late April 2019. The framework "is intended to assist MPOs as they explore the implications of vehicle connectivity and automation for the transportation system, its users, and the concept of mobility." Recognizing this will be a "working document," there are many recommendations that can be viewed as initial steps, in response to what is a fast-evolving issue.

The framework is a culmination of the previous four white papers, bringing together two years' worth of dialogue and doing its best to capture in an easy-to-digest format the many impact areas, opportunities, challenges, and considerations for the planning process. The document is presented by key impact area, including the following issues of importance to MPOs:

- Safety
- Security
- Operations
- Mobility & Mode Choice
- Freight
- Transportation Demand
- Infrastructure Requirements
- Funding & Financing
- New Service Markets
- Equity
- Data Collection & Housing
- Public Acceptance
- Land Use
- Air Quality/Conformity
- Engagement
- Employment

A number of additional resources are being made available in parallel to the release of the national framework, to provide support for MPOs as they wrestle with institutional readiness, policies, and investment decisions that are often long-term in vision against a backdrop of rapidly changing technology.

2.6.4 Bringing Research to Florida

As noted, one of the three US DOT sponsored CV Pilots is being conducted in Tampa, under the supervision of THEA. The Central Florida region is also home to SunTrax, a soon-to-be-operational 475-acre state-of-the-art facility dedicated to the research, development and testing of emerging transportation technologies in a safe and controlled environment, owned and operated by Florida's Turnpike Enterprise (FTE). When fully operational, SunTrax will provide numerous testing spaces to aid in the study of tolling technology, lane marking, intelligent transportation systems and CAVs. The SunTrax facility is located adjacent to Florida Polytechnic University, a long-standing partner to Florida's Turnpike. Other key academic partners in the partnership include the University of Central Florida (UCF), and FAMU-FSU College of Engineering.

SunTrax is part of the larger Central Florida Automated Vehicle Partnership (CFAVP). The partnership offers a comprehensive approach to the research, development and deployment of emerging mobility solutions across Central Florida by providing the three necessary components — simulation at the University partners, closed testing at SunTrax, and eventually open-road deployments on public roads. FDOT, also a member of CFAVP, has several CV pilot deployments underway throughout the state, to help them justify proposals or amendments to policy, design and engineering standards. Data that illustrates the use of AVs on public roadways is extremely important because these type of data sets for real-world conditions are scarce.

2.7 Summary of CAV Best Practices

Nationwide, there is growing interest and excitement in CAVs, as there is when any new technology is emerging, but it is important to understand that there are still many challenges that must be overcome before CAVs can have widespread use on shared public roadways. While the technology is improving rapidly, the timeline for CAV introduction and adoption is still to be determined, and will be impacted not just by the readiness of the technology but also by the readiness of the regulatory environment and the receptiveness of overall public sentiment. MetroPlan Orlando has the opportunity to learn from and teach other regions and agencies during this transitional era, building planning expertise that goes beyond technology development and assessment.

Based on lessons learned, it is clear that one challenge with early CAV deployments and other projects is the need to balance projects that are feasible, projects that respond to a local need, and projects that demonstrate that an agency or region is innovative. In reflecting on the current needs at MetroPlan Orlando, as well as on the wide range of existing and emerging technologies with applications to the region, there are several short- and longer-term opportunities to introduce CAV technologies into future investments. Both the short- and longer-term opportunities are ripe for discussion now, so that MetroPlan Orlando can remain on the forefront of innovation as a more connected and automated future approaches. Based on the Central Florida region's specific areas of interest, these opportunities can be further explored and detailed to inform the decision-making process and match local needs and capabilities with emerging industry trends.

3 Evaluation of Existing Local Capabilities

3.1 Introduction

Task 2 of the project provided a review of existing connected vehicle (CV) and automated vehicle (AV) infrastructure and practices in the Central Florida area, with a special focus on building an inventory of existing connected and automated vehicle (CAV) efforts and projects within Orange, Seminole, and Osceola counties. This section is organized into the following subsections:

- Section 3.2 identifies CAV-enabling roadway infrastructure
- Section 3.3 identifies staffing proficiency at each of the interviewed agencies
- Section 3.4 identifies system and network capabilities
- Section 3.5 identifies potential locations for CAV testing within the MetroPlan Orlando area
- Section 3.6 identifies agency-wide training plans for CAV awareness
- Section 3.7 identifies potential equity challenges in CAV testing and implementation
- Section 3.8 presents recommended next steps

A list of the interviewed maintaining jurisdictions is identified in **Table 2** – interviews were conducted either via phone or in person during May and June 2019.

Table 2: Maintaining Jurisdictions Interviewed

Jurisdiction/Agency	Primary Contact	
Orange County	Hazem El-Assar	Chief Engineer
City of Apopka	Pamela Richmond	Senior Planner
City of Maitland	Alyssa Eide	Public Works Director
City of Orlando	Benton Bonney	Transportation Systems Manager
City of Winter Garden	Jon Williams	Assistant City Manager, Public Services
City of Winter Park	Don Marcotte	Assistant Director, Public Works
Seminole County	Frank Consoli	Deputy Public Works Director
City of Altamonte Springs	Brett Blackadar	Director of Growth Management
City of Casselberry	Chris Bowley	Community Development Director
City of Lake Mary	Krystal Clem	City Planner
City of Longwood	Shad Smith	City Engineer
City of Oviedo	Anoch Whitfield	Public Works Director
City of Sanford	Michael Cash	Planning Engineer
City of Winter Springs	Bryant Smith	City Engineer
Osceola County	Tawny Olore	Transportation & Transit Executive Director
City of Kissimmee	Nabil Muhaisen	Traffic & Projects Engineer
City of St. Cloud	Kevin Felbringer	Engineering Manager
FDOT District Five (D5)	Jeremy Dilmore	District TSM&O Engineer
Greater Orlando Aviation Authority (GOAA)	Brad Friel	Transportation Planning Manager
Central Florida Expressway Authority (CFX)	Bryan Homayouni	Manager of Traffic Operations
Florida's Turnpike Enterprise (FTE)	John Easterling	District Traffic Operations Engineer
Central Florida Regional Transportation Authority (LYNX)	Doug Jamison	Senior ITS Developer
Reedy Creek Improvement District (RCID)	Lee Pulham	Planner

3.2 Roadway Infrastructure

This section identifies existing technology and roadway infrastructure within each of the three counties – Orange, Seminole, and Osceola counties – in terms of readiness for CAV. The analysis considers deployed roadway infrastructure, ITS devices, and planned ITS/CV deployments, and concludes with a high-level discussion regarding what modifications would improve the CAV-readiness of the MetroPlan Orlando planning area.

3.2.1 Roadway Infrastructure

There is a wide variety of development across the region in terms of roadway infrastructure to accommodate CAVs. By far, the majority of agencies are taking a measured approach to CAV infrastructure, due to the rapid (and sometimes unpredictable) evolution of devices and technologies. Most are focusing on infrastructure improvements that serve dual purposes - not just readiness for CAV, but for immediate needs such as roadway safety deployments (wrong way detection, curve warning systems, etc.) and improvements in operational capacity and monitoring (CCTV, Bluetooth readers, etc.).

In general, the larger agencies in the MetroPlan Orlando planning area (FDOT D5, LYNX, CFX, FTE, Orange, Seminole, and Osceola Counties, and the City of Orlando) have more advanced and robust levels of investment in roadway infrastructure with deployed ITS and CAV-ready devices, and many continue to maintain signals on behalf of their local jurisdictions.

As described in Section 2, pavement markings and adequate signal systems are critical infrastructure components to CAV operations. To prepare for AV implementation on roadways, the majority of agencies indicated their pavement markings should be more than suitable for AV deployments in terms of lane control and automated steering, due to FDOT design guidelines being comprehensive and state-of-the-practice. However, several agencies indicated the need for improved maintenance programs to keep pavement markings in a well-maintained state.

Agency-specific initiatives are summarized below:

- FDOT D5 is very well positioned in leading the region towards CAV. FDOT D5 is taking on the bulk of the costs for technical overhead, data management/storage, and pilot projects to allow local jurisdictions to focus on maintaining existing systems. FDOT D5 is working to ensure interoperability between CAV devices, security standards, and safety. FDOT D5 is providing equipment and working with local agencies to upgrade equipment to allow for CAV, such as advanced transportation controllers (ATCs). FDOT D5 has recently transitioned to a new traffic management center (TMC), which has additional functionality and systems which it believes will better position it for future CAV operations and data management.
- CFX is well prepared to accommodate CAV technologies in terms of fiber-optic network capacity and redundancy, with backbone fiber cable located along each side of their facilities. CFX has an extensive deployment of ITS devices including vehicle detection, Closed Circuit TV (CCTV) cameras, dynamic message signs (DMS), and digital cellular service (DCS) antennas. CFX maintains some of the interchange traffic signals and has a mixture of equipment based on the adjacent agencies' preference.
- LYNX does not deploy traffic signal equipment, but has enabled their buses with Opticom 2101 TSP equipment using 4G communications in the field. LYNX does not use DSRC or 5G communications. LYNX also plans to use SPaT information at stops along LYMMO (Bus Rapid Transit) routes, potentially in partnership with AV transit vehicles. LYNX is also planning to define a roadway "ecosystem" certification that reviews land use, roadway design, signaling, etc. to identify roadway segments that are "ready for CAV."
- Orange County is in the process of moving from Siemens traffic signal controllers to Intelight traffic signal controllers, which have the capability to broadcast CV-ready J2735 formatted signal phase and timing (SPaT) messages directly from the controller. And as a result of the County's actions, many partner agencies are also considering a change (CFX, local jurisdictions, etc.). CV roadside devices are planned for deployment in Orange County in the coming year as part of a FDOT D5 pilot project. The County has numerous ITS devices deployed including CCTV cameras, Bluetooth/Wi-Fi readers, passive pedestrian detection, and microwave vehicle detection systems (MVDS). The County also has a TMC and advanced traffic management system (ATMS) for both Siemens (TACTICS) and Intelight (MaxView). The County has also deployed adaptive signal system operation on numerous roadways.

    - The **City of Apopka** uses Siemens traffic signal controllers and maintains their signals in-house. They have limited ITS facilities within the City.
    - The **City of Winter Garden** uses Siemens traffic signal controllers, which are maintained by Control Specialists. They have limited ITS facilities within the City.
    - The **City of Maitland** uses Siemens traffic signal controllers, maintained by Control Specialists. Within the City, there is some fiber-optic and wireless communications infrastructure. There are Bluetooth readers and MVDS deployed within the City along the state road corridors.
    - The **City of Winter Park** uses Siemens traffic signal controllers and maintains their signals in-house. They are moving towards adding fiber-optic connections to all of their signals. FDOT D5 is working with the City on the SR 426 adaptive signal system from Phelps Avenue to Balfour Drive as an extension of an Orange County adaptive system to the east.
    - The **City of Orlando** has a mixture of Trafficware controllers including ATCs. The City has a TMC and Trafficware ATMS platform. The City has purchased the CV module for the ATMS platform which allows for the transmission of traffic signal data from the central system. The City has numerous ITS devices deployed including CCTV cameras, Bluetooth/Wi-Fi readers, intersection movement count (IMC), and microwave vehicle detection systems (MVDS).
- **Seminole County** recently transitioned all of their traffic signal controllers to ATCs and uses the Trafficware ATMS platform. Seminole County uses CCTV cameras, Bluetooth/Wi-Fi readers, and adaptive signal control across the county. As part of the SR 434 CV pilot project with FDOT D5, Seminole County will deploy roadside units (RSU) with Dedicated Short Range Communications (DSRC) at six intersections. Seminole County is also working on centralized CV applications and is planning to deploy additional BlueToad combination BlueTooth/DSRC radios within the county.
    - The **City of Altamonte Springs**' traffic signals are maintained by Seminole County. The City has remote read-only access to the County's ATMS platform and CCTV cameras. The City is working with the County to deploy additional equipment as new signals are installed or rebuilt.
    - The **City of Longwood's** and the **City of Winter Springs'** traffic signals are maintained by Seminole County. The **City of Winter Springs** has remote read-only access to the County's ATMS platform and CCTV cameras, and the **City of Longwood** is working to setup similar access.
    - The **City of Casselberry's**, **City of Lake Mary's**, **City of Oviedo's**, and **City of Sanford's** traffic signals are maintained by Seminole County.
- **Osceola County** uses Econolite traffic signal controllers and is currently working to deploy real-time data collection using video detection at signalized intersections. The Osceola County TMC uses Econolite's Centracs ATMS platform, and uses CCTV cameras and Bluetooth/Wi-Fi readers to monitor traffic.
    - The **City of Kissimmee's** and **City of St. Cloud's** traffic signals will be maintained by Osceola County as the agencies transition responsibility over the coming months.
- **RCID** uses Siemens traffic signal controllers, video detection, dynamic message signs (DMS), Blincsy travel time readers, and is looking to upgrade all of their controllers from Siemens M50 to M60 so RCID can output SPaT data (13 of their intersections already have the M60 controllers). RCID is looking to add Blincsy DSRC at each of their intersections.
- **GOAA** has ten signalized intersections, all of which are maintained by the City of Orlando. They have CCTV cameras on a closed system and their signal controllers are not connected to an ATMS platform for security reasons.

- **FTE** does not have signalized intersections as part of their system. They have extensive ITS deployments including CCTV cameras, MVDS, tolling systems, and dynamic message signs. FTE has two TMCs: one in Orlando and one in Pompano Beach.

3.2.2 Planned ITS/CV Deployments

Several agencies in the MetroPlan Orlando region have begun or are planning ITS/CV deployments in the next few years, and many are preparing for future deployments by upgrading their existing roadway, system, or network infrastructure. Agency-specific initiatives related to CAV deployments are summarized below:

- **FDOT D5** and **Seminole County** are participating in the **SR 434 CV Pilot**, which uses DSRC RSUs to broadcast SPaT data, and will explore Transit Signal Priority (TSP) and Emergency Vehicle Preemption (EVP) applications along the corridor.
- **LYNX** has several planned ITS/CAV deployments - most notably, a planned one-year AV Concept of Operations study in partnership with the City of Orlando and MetroPlan Orlando that will examine incorporating AV into transit service, specifically on one of their LYMMO (Bus Rapid Transit) routes.
- **Seminole County** is looking to install BlueToad combination Bluetooth/DSRC RSUs along Lake Mary Boulevard.
- **FDOT D5** and **Orange County** are participating in the **PedSafe/Greenway CV Pilot Project** at the University of Central Florida and along SR 50. This project will deploy 33 RSUs to provide SPaT, TSP, EVP and pedestrian/bicycle collision avoidance applications utilizing CV technologies. This project will also work to upgrade equipment at signalized intersections in Volusia, Brevard, Orange, Seminole, and Osceola Counties so that they are CV ready.
- The **City of Orlando** is planning to deploy one to two RSUs as part of a Beep AV shuttle deployment.
- **FTE** is planning a CV pilot in South Florida to test both on-board units (OBUs) and RSUs.
- **RCID** is planning to install Blincsy DSRC at each of their intersections.
- The **City of Altamonte Springs** is pursuing a CAV pilot project this year, after being selected as a “City Possible” by the *MasterCard Smart Cities* competition.

3.2.3 Improvements Needed for CAV Readiness

The agencies within the MetroPlan Orlando region are at various states of CAV readiness, and each agency will need different improvements to move forward with the implementation of CAV technologies. A review of each agency’s existing equipment indicates the following general improvements are needed for broad based CAV readiness.

- Traffic signal controllers need to be upgraded to ATC models that can enable CAV applications (data output in standard SAE J2735 formats).
- Signal controller cabinets need to be upgraded to provide additional space within the cabinet for new equipment and improved interfaces.
- CV communications interfaces will be needed to allow vehicles to communicate with roadway infrastructure. There are multiple manufacturers and technologies competing to gain market share in this area, and agencies will need guidance on what systems should be deployed for long term benefit and interoperability.
- Improved maintenance programs for pavement markings should be implemented to maintain visibility.

3.3 Staffing Proficiency

This section identifies staffing proficiency at each of the maintaining agencies within the MetroPlan Orlando planning area. The maintenance and operation of CAV infrastructure will require several new skills for both the signal maintenance personnel and the maintaining agencies. This section concludes with an evaluation of existing and future resources each agency needs to create a "CAV-ready workforce".

3.3.1 Staffing Proficiency

In general, the majority of the agencies interviewed indicated their staff (or contractors) had established proficiency in signal installation, maintenance, and repair; however, they lacked specific training in CV applications, since much of the software, equipment, and technologies are new and evolving rapidly. Agency-specific initiatives are summarized below:

- **FDOT D5** staff is very confident in their CAV/ITS related group - the entire department is supportive of CAV and its benefits. FDOT D5 is planning to take charge of developing CAV training modules, since many local jurisdictions have expressed a need for additional technical training. FDOT D5 believes working with vendors is critical to provide hands-on training and create how-to video tutorials for others to view.
- **CFX** staff has a focus on maintaining their existing ITS systems (through staff and contractors), and staff receives training on new and innovative technologies through Team Florida, the Florida AV Summit, FDOT D5's Transportation System Management and Operations (TSM&O) Consortium Meetings, and vendor presentations. CFX would be open to and encourages CV-specific training offered by a regional entity.
- **LYNX** staff focus on the vehicle side of the system, particularly the installation, configuration, maintenance, and debugging of TSP equipment on buses. Training is provided to LYNX operations staff on a project-by-project basis, in a "train the trainer" format, but LYNX would like to provide consistent training to operators and supervisors on working with a partially or fully implemented AV system. In addition, LYNX recognizes the importance of ongoing training for any new system or technology – from "generation to generation."
- **FTE** staff is focused on maintaining existing systems, and is typically trained at FDOT D5, ITE, or ITS Florida trainings – occasionally, vendors will provide trainings. There is an agency-wide need for additional training on CAV technologies, software, and equipment as the industry evolves.
- **Orange County's** signal maintenance group is IMSA-certified, and is hopeful for additional training opportunities through FDOT D5 or a regional entity on CAV.
    - The **City of Apopka** is focused on maintenance of existing signals and has limited staff training opportunities, but would welcome basic training on CAV practices and CV applications.
    - The **City of Winter Garden** has contracted out signal maintenance but believes that a top-down approach on staff education would be best.
    - The **City of Winter Park** signal maintenance group is IMSA-certified and is hoping that IMSA provides CAV training.
    - The **City of Maitland** has contracted out signal maintenance to Control Specialists.
    - The **City of Orlando** signal maintenance group receives IMSA and vendor training, and believes in training all staff to the same level so that all personnel can perform the same functions. Sstaff needs additional training on network management, and would like to receive formal training on CAV and believes that regional training is needed.
- **Seminole County** has signal maintenance responsibility for all jurisdictions within the County. The majority of existing staff training comes from IMSA seminars, vendor training, or in-house staff training. Seminole County is currently working to improve computer-based staff training and is working with FDOT D5 on vocational training programs at local technical schools. The County would like to see FDOT D5 or regional training offered on new/emerging technologies.
- **Osceola County** has signal maintenance responsibility for the entire County and all jurisdictions within the County. The majority of existing staff training comes from vendors or demonstrations, but the County would welcome regional hands-on training on CAV.

- **RCID** handles minor maintenance items in-house and has contracted out larger maintenance tasks and aerial work but is interested in CAV-specific training and best practices from other agencies.

3.3.2 Staff Training Needed for CAV Readiness

Through interviews with the agencies within the MetroPlan Orlando planning area, it was widely noted that a regional training effort is needed to support CAV deployment. Most agencies are familiar with CAV concepts, but lack awareness and training on specific technologies or applications. The following initiatives should be considered:

- Regional CAV awareness & training with local agencies and FDOT D5.
- Device specific training to assist with operations and maintenance of CAV equipment.
- Technical training on systems and networks related to both CAV and non-CAV equipment and applications.
- Additional staff to support CV/AV deployment throughout the region. Each agency that employs traffic signal technicians noted they need additional staff to meet current needs, and as there is an increase in CAV deployments, additional staff will be needed.

3.4 System & Network Capabilities

This section identifies existing communications and network infrastructure for each of the maintaining agencies, to help determine where CAV can be prioritized and where additional network enhancements might be required. CAV infrastructure is heavily reliant on high-speed and low-latency data exchange and will require a robust and stable backhaul communications network. Much of the new equipment also relies on new standards and protocols (e.g., IPv6), introducing potential changes to the entire network architecture.

3.4.1 Communications/Network Infrastructure

Overall, the majority of jurisdictions in the MetroPlan Orlando region have fully implemented or are moving towards the use of fiber-optic cable (FOC) networks within their jurisdiction. While the implementation of communications is often straight-forward, anticipating data storage and server needs for agencies is a bit trickier, as many Central Florida jurisdictions have partnered with vendors to store data on cloud servers instead of in-house. Agency-specific initiatives are summarized below:

- **FDOT D5** uses a ring topology for its FOC network, with all existing equipment IPv4 and IPv6 compatible. To prepare for data/system requirements from local jurisdictions, FDOT D5 built a new Regional TMC with a 100-amp circuit, 2 new air handlers, 15 petabyte storage, and 3 sources of power. From a data perspective, FDOT D5 is more concerned about ease of use/viewability rather than adequate storage and is taking on the technical side and data management of CAV for the region so that local jurisdictions can focus on staffing.
- **CFX** has a FOC network (currently being upgraded with Layer 3 switches), with a redundant FOC backbone located along each side of their facilities, and they have sufficient server/data storage capacity at their TMC. CFX feels that in the near-medium term, minimum upgrades to their infrastructure are required; however, as CAV applications mature, their network will need to be reevaluated for data storage, archival, and extent of analytics required.
- **LYNX** will be focusing their AV/CV efforts on transit vehicle preparedness, relying upon jurisdictions for infrastructure and non-vehicle network connectivity.
- **FTE** uses an extensive FOC network, with shared fiber between FDOT D5 and CFX to connect across highway segments, and their goal is to attain 10 Gbps across the network.
- **Orange County** uses an extensive FOC network with connection to 95 percent of the signalized intersections within the County.
    - The **City of Apopka** have no existing network infrastructure.

    - The **City of Winter Garden** has limited network infrastructure, primarily along SR 50 which is maintained by the County.
    - The **City of Maitland** and the **City of Winter Park** have a mixture of FOC and wireless communications, which provide a connection to the Orange County TMC.
    - **The City of Orlando** has an extensive FOC network with some point-to-point wireless communications. They are working to replace old FOC incrementally as part of new projects. Overall, approximately 95 percent of their signalized intersections are connected to the network. The City needs to improve redundancy within the network and better manage their network. The City would like to have a network engineer. Improvements are needed to the network infrastructure, such as upgrading switches.
- **Seminole County** uses an extensive FOC network, with all of their intersections connected to the network; however, they have a limited amount of server/data storage. As a result, the County recently transitioned their Bluetooth data to the cloud, to increase storage capacity and reduce the server load. The County also has a limited number of spare FOC pairs on their existing cables, which limits expansion of the network bandwidth.
    - The remaining jurisdictions in Seminole County have limited network infrastructure related to transportation. Most have connections between agency buildings and police/fire stations.
- **Osceola County** has an extensive FOC network and is working to further expand their network through on-going projects. The County is working with FDOT D5 to integrate their existing systems into SunGuide.
    - The remaining jurisdictions in Osceola County have limited network infrastructure related to transportation. Most have connections between agency buildings and police/fire stations.
- **RCID** uses a FOC communications network and stores intersection data on the cloud through a vendor.
- **GOAA** uses a FOC ring topology and is currently working to upgrade network capacity. They have a closed network for security reasons.

3.4.2 Improvements Needed for CAV Readiness

A review of each agency's existing communications/network indicates the following improvements are needed for CAV readiness:

- Local agencies and FDOT D5 should continue to work together to establish communications at all signalized intersections within the MetroPlan Orlando area. This will be required to maximize the effectiveness of CAV technologies.
- FOC cables with limited or no spare pairs should be replaced to allow for additional capacity within the network.
- Agencies with existing FOC communications should work to establish redundancy in their networks.
- Network infrastructure, such as switches, should be upgraded to improve network capacity and provide additional ports for connection of CAV equipment.

3.5 Potential Locations for CAV Testing

This section identifies potential locations for CAV testing within the MetroPlan Orlando planning area where minimal infrastructure improvements might be needed so that momentum can be built by achieving early success in CAV deployment. While there are two primary locations in the MetroPlan Orlando planning area where existing CAV testing is currently underway, there are several other potential locations that agencies have identified for near-term, mid-term, and long-term improvement testing timelines. The locations are shown in Figure 14, and the agency-specific initiatives are summarized below:

- **FDOT D5** is working on three current pilot projects: the SR 434 CV Pilot (Seminole County) (**Location #1** in Figure 14), PedSafe/Greenway (Orange County), and the I-75 FRAME project (Marion & Sumter Counties – not shown in Figure 14). FDOT believes that investments in infrastructure readiness and staff training for CAV should take financial precedence over CAV testing/pilot projects.
- **CFX** is targeting their highest-congestion corridors as potential locations for mid- and long-term CV testing, most notably: SR 408, SR 417, and SR 528. CFX is also examining smaller-scale deployments for more near-term testing.
- **LYNX** is targeting the use of exclusive LYMMO lanes in downtown Orlando for CAV testing and revenue service and is targeting non-revenue service testing at the SunTrax CAV Test Bed in Polk County.
- **FTE** is currently working on a CV pilot in South Florida and is leading the development of the SunTrax CAV Test Bed in Polk County. For future CV testing, FTE would likely target parking lots or interchanges close to existing FTE facilities.
- **Orange County** is targeting locations for CAV testing where pedestrian safety has been a major issue, most notably the UCF area (**Location #1** in **Figure 14**), International Drive (**Location #2** in **Figure 14**), and Pine Hills (**Location #3** in **Figure 14**).
  - The **City of Apopka** does not yet have any targeted locations for future CAV testing.
  - The **City of Winter Garden** is targeting SR 50 (**Location #4** in **Figure 14**), Daniels Road in front of Winter Garden Village (**Location #5** in **Figure 14**), and along Plant Street in downtown Winter Garden (**Location #6** in **Figure 14**) as potential long-term locations for future CAV testing locations; however, these locations would need significant infrastructure investments.
  - The **City of Winter Park** and **the City of Maitland** are targeting US 17/92 for CAV testing (**Location #7** in Figure 14).
  - The **City of Orlando** will be broadcasting signal data city-wide through 2 third party vendors in the coming months. They are also participating in a near-term AV shuttle pilot in Lake Nona (**Location #8** in Figure 14). The City is targeting International Drive (**Location #2** in Figure 14), the Universal resort area (**Location #9** in Figure 14), and Baldwin Park (**Location #10** in Figure 14) as potential opportunities for both CV and AV deployments in the mid- and long-term.
- **Seminole County** is targeting near-term CV deployment along Lake Mary Boulevard and long-term testing at SunRail crossings, along US 17/92 (pedestrian safety), along SR 436, and at the Park Side development. They are also examining placing AV shuttles on the County's trail system.
  - The **City of Altamonte Springs** is targeting a near-term AV deployment between the Advent Health campus, Uptown Altamonte, and Crane's Roost (**Location #11** in Figure 14). They have identified the SR 436 corridor adjacent to the Altamonte Mall as a potential location to test CV-based pedestrian safety applications (**Location #12** in Figure 14).
  - The **City of Casselberry** is targeting the US 17/92 and SR 436 corridors within the City, particularly intersections with pedestrian safety issues (**Location #13** in Figure 14).
  - The **City of Lake Mary** is targeting International Parkway and Lake Emma Road due to their proximity to commercial and office uses and high numbers of pedestrian activity (**Location #14** in Figure 14).
  - The **City of Longwood** is targeting SR 434 at Ronald Reagan Boulevard as a potential location to address issues at the railroad crossings (**Location #15** in Figure 14).
  - The **City of Oviedo** is targeting Mitchell Hammock Road for testing in the long-term (**Location #16** in Figure 14).
  - The **City of Winter Springs** is targeting the intersection of SR 434 and Tuskawilla Road to improve safety and operations (**Location #17** in Figure 14).

    - The **City of Sanford** is targeting SR 46 and SR 46A adjacent to the Seminole Town Center and also Downtown Sanford and the Riverwalk (**Location #18** in Figure 14).
- **Osceola County** is targeting the Neptune Road corridor (**Location #19** in Figure 14) and the NeoCity development (**Location #20** in Figure 14) as potential locations for future CAV testing, since both are technology corridors. In addition, smaller-scale safety deployments could target school zones and SunRail crossings within the County.
    - The **City of Kissimmee** is targeting the use of Main Street (**Location #21** in Figure 14) and Neptune Road as potential locations for future testing. They also see the Kissimmee Circulator as a potential option for conversion to an AV shuttle operation.
    - The **City of St. Cloud** is targeting US 192 to test CAV technologies (**Location #22** in Figure 14).
- **RCID** is planning to deploy Blincsy DSRC radios at all of their intersections within Walt Disney World and looks to make long-term improvements to their system to prepare for potential CAV testing in the future. They believe that route guidance is an area of opportunity (**Location #23** in Figure 14).
- **GOAA** believes there is an opportunity to partner with rental car agencies located at the airport to assist in route guidance to and from their facilities. They also see the opportunity to implement AV shuttles between the terminals and parking lots.

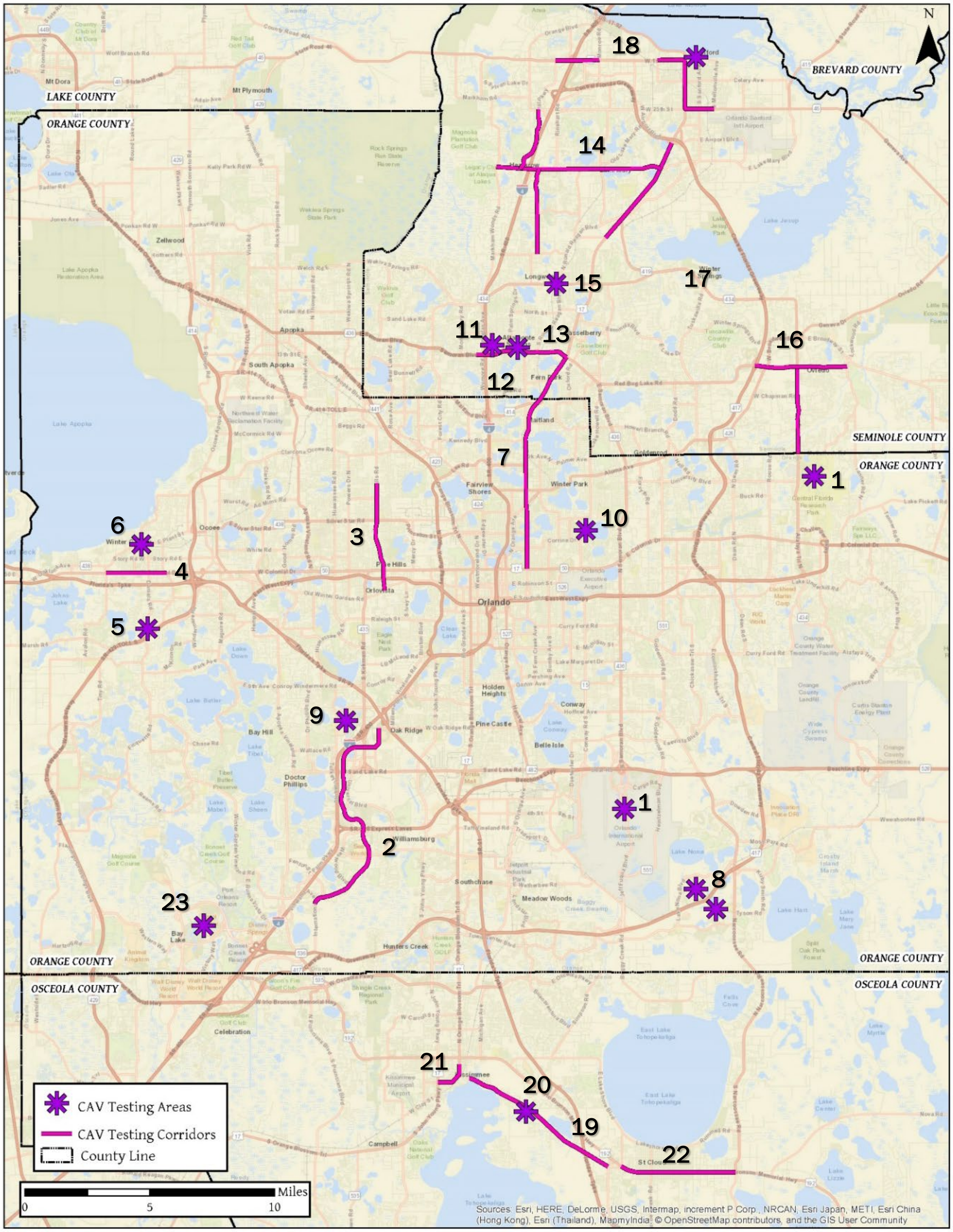


Figure 14: Potential Locations for CAV Testing

3.6 Training Plans

This section identifies existing training plans in place within the MetroPlan Orlando planning area which have been or are being developed to train agencies on how to configure and operate CAV systems. In addition to operations and maintenance, training in place (or planned) to learn the benefits of the system and how data can be leveraged to improve road users experience will be identified. Agency-specific initiatives are summarized below:

- **FDOT D5** believes that around 25 percent of existing D5 staff know how to work with CAV technologies, and FDOT D5 plans to use the staff knowledgeable with CAV to share knowledge amongst other control groups. There is broad support for CAV technologies from the top down, but agencies need to understand that CAV is a long-term solution that will take time to mature. FDOT D5 is working to develop training materials that other agencies can use.
- **CFX** is allowing CAV technologies to mature so that a roadmap can be established for training in the future.
- **LYNX** is evaluating what training is needed to further CAV knowledge for operators and supervisors, as well as maintenance staff for TSP and CAV technologies on transit vehicles.
- **FTE** utilizes a large consultant work force to maintain and operate their systems. These consultants also provide training to FTE staff on new and emerging technology. Overall there is an agency-wide need for training on CAV technologies and equipment, in addition to training on new software. FTE is working to determine what types of training should be used to enhance CAV knowledge, and if a specific role is needed for CAV operations.
- **Orange County** is evaluating what training is needed to further CAV knowledge. In the future, the County believes that additional specialists will be required to maintain the CAV infrastructure.
    - The **City of Apopka** needs some basic training on CAV practices. This training should focus on the City's needs across various agencies within the City to prioritize CV applications. Further, the City feels that the Information Technology, Planning, Engineering, and Public Safety departments could be interested in some form of basic training.
    - The **City of Winter Garden** believes that a top-down approach would be beneficial to expanding the understanding of CAV. It is important to gain the support of the Mayor and City Manager.
    - The **City of Winter Park** needs an overview of CAV technologies to expand their working knowledge. They are looking for industry associations such as IMSA to provide training.
    - The **City of Maitland** does not currently have in-house traffic staff, but the expansion of CAV systems may require the City to bring someone in. The City would like additional training specifically targeted at interacting with the public on CAV technologies and issues.
    - The **City of Orlando** has a directive from the Mayor to incorporate CAV into the City's comprehensive plan in the coming years. The City needs formal CAV training and additional staff and consultant support. They are looking for regional training opportunities and want to leverage the D5 Transportation Systems Management and Operations (TSM&O) Consortium.
- **Seminole County** would like regional training opportunities on CAV technologies and additional training resources from FDOT D5. On a higher level, the County believes it is important to establish champions on the County Commission to further CAV deployments.
    - The **City of Altamonte Springs** embraces new technologies and innovation at all levels. They are actively working to further CAV within the City. They plan to rely on the private sector for AV shuttle operations. The City also sees the opportunity to expose students to CAV through their Altamonte Springs Science Incubator (AS2I) program.[14]

- The **City of Casselberry** needs an overview of CAV technologies to expand their working knowledge. They also need to review City policy to determine the impacts on CAV deployment.
    - The **City of Lake Mary** would like to participate in regional conferences/workshops to further their understanding of CAV technologies.
    - The **City of Longwood** needs an overview of CAV technologies to expand their working knowledge. Their primary sources for information on CAV are MetroPlan Orlando's TSM&O and TAC committees.
    - The **City of Oviedo** is not familiar with CAV technologies and needs additional training. One of their main concerns is with the impacts to land uses and planning.
    - The **City of Winter Springs** staff is excited at the opportunities presented by CAV; however, they need additional training.
    - The **City of Sanford** has had limited discussion on CAV but would like to increase discussions with City Council. The City would like training, webinars, and conferences to improve CAV knowledge, not just status updates. Internal training should start with public works group then branch out.
- **Osceola County** would like regional training opportunities on CAV technologies and believes that hands on training is needed.
    - The **City of Kissimmee** believes there is a need for regional training and to define goals and timeframes for implementation. Currently most of their CAV knowledge has come from MetroPlan Orlando and conferences.
    - The **City of St. Cloud** is not familiar with CAV technologies and needs additional training.
- **RCID** supports CAV technologies throughout the agency but is trying to determine a path forward with a quickly changing marketplace. A regional focus is needed, specifically in regard to RCID which is surrounded by larger agencies that have an impact on how traffic enters the agency.
- **GOAA** obtains CAV training through their consultants, and this training includes senior level staff. GOAA also participates in FDOT D5 training efforts.

3.7 Equity Challenges

This section identifies potential equity challenges in CAV testing and implementation and documents how other peer agencies have balanced equity issues in approaching CAV pilot testing and eventual deployment. Maintaining equity is necessary to ensure the broadest possible cross-section of Central Floridians have an opportunity to see, touch, and experience the positive benefits CAV can bring to the future transportation environment. The analysis also assesses potential shortcomings for equitable deployment between jurisdictions and impacts on under-served communities, i.e. low-income, minorities, and disabled communities.

In terms of equity, several of the agencies indicated they anticipate equity challenges as they implement CAV applications, particularly equity within the transportation sector in a vertical sense. Agency-specific initiatives are summarized below:

- **FDOT D5** anticipates there will be some equity challenges in CAV implementation, namely a further stratification of existing trip types, and sees potential in balancing trip chaining using subsidies to balance out the benefits of CAV for those who cannot afford a new vehicle with CAV technologies. FDOT D5 believes that policy changes are needed to improve equity between users in the region.
- **CFX** anticipates the vehicle penetration of OBUs could be a potential equity issue, but proper outreach could minimize disparities in the region.
- **FTE** roadways pass through multiple FDOT Districts, counties, and local jurisdictions, and as a result, they anticipate equity challenges between regions in terms of CAV implementation, equipment, and preferred vendors/software.

- **LYNX** provides transit service to the entire Central Florida region, and as such, is committed to ensuring that CAV benefits would be equally distributed by all users, including meeting Title VI and ADA requirements. CAV deployments need to consider fleet-wide deployments and system-wide applications so the benefits of CAV are "marketable" to boards and funding partners, and so CAV is quickly integrated into Central Florida's transportation system holistically, not just as an "add-on."
- **Orange County** has a diverse population and anticipates some equity challenges, particularly in the low-income and rural areas of the County. In addition, the County anticipates potential equity challenges if their local jurisdictions do not use the same signal equipment as the County (Intelight).
    - The **City of Apopka's** main challenge is funding for infrastructure improvements. They see the opportunity to partner with Orange County on CAV efforts, with the City playing a supporting role.
    - The **City of Winter Garden's** main challenge is funding for infrastructure improvements. They also see the potential for challenges due to generational gaps in the City, which has a median age of 45/46.
    - The **City of Maitland** is separated by the physical barrier of I-4. This may lead to challenges unifying the City's efforts in CAV implementation.
- **Seminole County** has a diverse population and anticipates that residents may demand CAV technology before the County and local jurisdictions are ready. The County has concerns about how end users will deal with multiple applications and interfaces based on the CAV equipment and manufacturer's requirements, and associated equity challenges.
    - The **City of Altamonte Springs** understands that Americans with Disabilities Act (ADA) compliance will be an issue with AV shuttles. They plan to deploy CAV technologies based on population density to maximize use and reach as many people as possible.
    - The **City of Lake Mary** would need to analyze the population in the City now to see how low-income areas would benefit from CAV. The City sees its partnership with the County as helpful to the City from a budgetary perspective.
    - The **City of Longwood** is open to working with adjacent jurisdictions and has done so in the past on other projects. The City has small areas of lower income.
    - The **City of Oviedo** has challenges with the limited number of east/west corridors within the City. In addition, lower income residents within the City have limited mobility choices.
    - The **City of Winter Springs** sees the potential for equity issues if CAV technologies are only deployed in certain areas and would like to see the technology spread throughout the City.
    - The **City of Sanford** sees the potential for equity challenges created by access to CAV technologies. The City will need to balance maintaining existing systems versus installing new technologies. The City is on the outer area of the MetroPlan Orlando region.
- **Osceola County** has a diverse population and anticipates some equity challenges, particularly in the low-income and rural areas of the County. The County understands that all road users should benefit from CAV.
    - The **City of Kissimmee** believes there will be numerous equity challenges. They are trying to set aside money each year to improve ITS within the City. The City is also concerned with how CAV will impact land use codes.
    - The **City of St. Cloud** believes the US 192 corridor will have no equity challenges. The City has not had many major challenges.
- **RCID** doesn't anticipate the same type of equity challenges as other adjacent jurisdictions, because they serve tourist populations rather than residents. They are primarily concerned with how changes to adjacent jurisdictions will impact traffic entering their jurisdiction.

- GOAA serves a leisure market which creates pressure to keep user fees low. AV may reduce parking revenue and lead to user fees for access to the facilities. They are concerned with how different modes will interact and keeping balance amongst all modes.

3.8 Summary of Existing Local Capabilities

This section provides conclusions from the exploration of local capabilities, and summarizes what was considered while developing the recommendations for MetroPlan Orlando and its partner agencies.

3.8.1 Roadway Infrastructure

In general, the MetroPlan Orlando region and its partner agencies have shown a demonstrated interest in CAV technology with the implementation of the two major pilot projects; the SR 434 CV Pilot and the PedSafe/Greenway Deployment. However, there seems to be a lack of consistency between the large jurisdictions on roadway infrastructure needs, even within counties and their local city jurisdictions. These findings indicate the need for a region-wide body for the purposes of providing a central group for each jurisdiction to send their related operations/signal staff to receive region-wide training, network with other jurisdictions, and collaborate on best practices in terms of equipment, software, and other testing/implementation issues.

3.8.2 Staffing Proficiency

The majority of the local jurisdictions in the MetroPlan Orlando area indicated their staff (or contractors) had established proficiency in signal or TSP device installation, maintenance, and repair; however, they lacked specific training in CAV applications, since much of the next generation software, equipment, and technologies are new and evolving rapidly. However, since there is no CAV-specific training being currently offered at the regional or state level, many agencies are training their existing operations and signal maintenance staff to different training levels, leading to a lack of consistency amongst jurisdictions.

Many of the jurisdictions requested that a region-wide training program on CAV be developed, to promote consistency between counties and city jurisdictions on CAV testing, equipment, software, and deployment. In addition to serving as a common training, the collaboration of the region's operations and signal staff could provide an open forum for discussion and collaboration between jurisdictions on CAV-related issues that will arise as testing and deployment begins.

3.8.3 System & Network Capabilities

Overall, the majority of jurisdictions in the MetroPlan Orlando region have fully implemented or are moving towards the use of FOC networks within their jurisdiction. The use of FOC networks within the next five (5) years has the potential to enable consistent communication and testing grounds for region-wide CAV deployment.

While the implementation of communications networks are often straight-forward, anticipating data storage and server needs for agencies is a bit trickier, as many Central Florida agencies have partnered with vendors to store data on cloud servers instead of in-house.

3.8.4 Potential Locations for CAV Testing

While there are two primary locations in the MetroPlan Orlando planning area where existing CAV testing is currently underway, there are several other potential locations that jurisdictions have identified for near-term, mid-term, and long-term improvement timelines. To facilitate partnerships and the advancement of near and mid-term CAV testing locations, a region-wide CAV consortium could be created, with the purposes of providing a forum for jurisdictions involved in CAV to collaborate and share best practices. As part of the consortium, it would be ideal for agencies to provide feedback on other jurisdiction's testing projects and learn from best practices. In addition, the LYNX AV Concept of Operations study will provide key insights into integrating AV with transit service in the region.

3.8.5 Training Plans

Consensus between agencies within the MetroPlan Orlando planning area is to identify necessary training, to expand their working knowledge of CAV systems. The jurisdictions believe that regional training is needed to ensure interoperability and consistency when deploying CAV systems, and LYNX is planning to define a roadway "ecosystem" certification to identify roadway segments that are CAV-ready. Plans are being developed by FDOT D5 to train jurisdictions on how to configure and operate CAV systems. In addition to operations and maintenance, training in place (or planned) to learn the benefits of the system and how data can be leveraged to improve road users experience will be identified.

3.8.6 Equity Challenges

In terms of equity, several of the jurisdictions indicated they anticipate challenges as they implement CAV technologies, particularly equity within the transportation sector in a vertical sense (agency-to-agency). Going forward, ensuring equity for each agency's and jurisdiction's residents and visitors will be critical to the success of CAV implementation and deployment across the MetroPlan Orlando planning area. Agencies must collaborate and work together to ensure that all members of Central Florida's communities have equal access to the benefits of CAV technology or demonstrations, and that all sectors of their community have equal access to CAV implementations, going above and beyond Title VI and ADA requirements. FDOT D5 anticipates CAV implementation could lead to further stratification of existing trip types and sees potential in balancing trip chaining and directing subsidies to balance out the benefits of CAV.

In addition, for statewide jurisdictions like FDOT D5 and FTE, cross-regional collaboration will be imperative to ensure that CAV testing and implementation is most effective and duplicative efforts are not required, not only within the metropolitan areas of Orlando, but the more rural jurisdictions and roadway segments in between.

4 Public Workshop Summary

4.1 Workshop Overview

The third task for this project was a critical step in the overall effort, and focused on both educating local stakeholders as well as gathering their feedback. This section provides an overview of the public involvement and stakeholder engagement process, which consisted primarily of three public workshops held in the three counties that comprise the MetroPlan Orlando planning area – Orange, Osceola and Seminole.

The following public involvement goals for informing stakeholders about CAVs were met.

- Increase awareness of MetroPlan Orlando's role to prepare Central Florida for the arrival of CAVs on public roads
- Communicate how CAVs will impact local and regional transportation planning efforts
- Convey current and projected status of applicable legislation, policies and regulation
- Identify opportunities for public and private sector relationship building

During the workshops, findings from the first two technical memorandums were presented, highlighting best practices and the current state of the CAV industry in the MetroPlan Orlando Planning area, the State of Florida and nationwide, and providing an overview of existing CAV capabilities within local governments and agencies across Orange, Osceola and Seminole counties. The workshops provided opportunities for collecting public comments to gain a better understanding of how and where stakeholders want to see local CAV testing and project deployments.

4.2 Workshop Approach and Materials

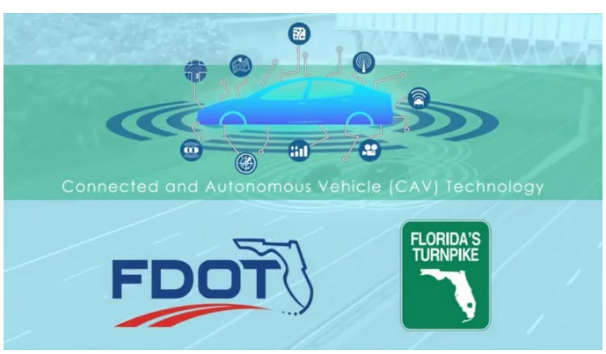
This section provides a summary of the approach and materials used at each of the three public workshops, including brief descriptions of each aspect and images from the workshops.

Sign-In Forms – At each of the three workshop entrances, attendees were asked to voluntarily sign in. The sign in form stated that all information provided is public record and may be viewed by the public and media.

Informative Display Boards – As attendees entered workshop locations in Orlando, Lake Mary and Kissimmee, display boards told the story of why the CAV Readiness Study is needed; defined differentiators between connected vehicles (CV), automated vehicles (AV) and CAVs; presented study findings; and showed anticipated CAV impacts on future urban development.


eSurvey – To gather stakeholder input, a 10-question eSurvey asked attendees their opinions about riding in CAVs, safety concerns, policy concerns and how they think CAVs could impact their surroundings. In addition to the English version on the tablet, paper survey questionnaires in Spanish were available upon request.


CAV Video – A video titled "Connected + Autonomous Vehicle CAV Technology", produced by FDOT and Florida's Turnpike Enterprise, was included at the beginning of the formal presentation. The video provided an overview of CV, AV and CAV technologies; and how these technologies will aim to solve transportation problems and improve mobility and safety on roads in Florida in the future.

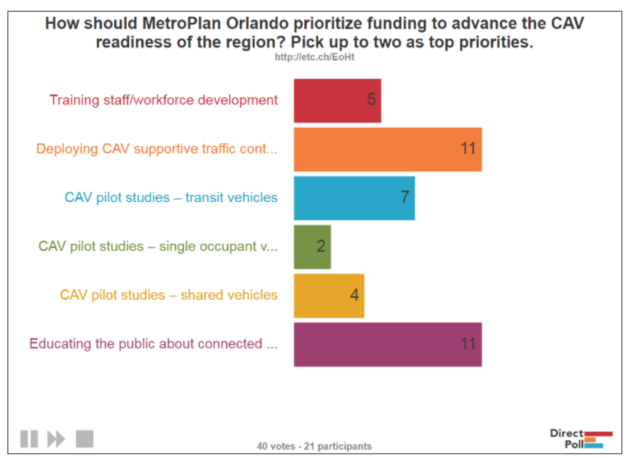


Formal Presentation – Eric Hill, MetroPlan Orlando Director of Transportation System Management & Operations, delivered an overview presentation that highlighted the purpose of the study, findings of the current state of the CAV industry review and the evaluation of existing local CAV capabilities. At the conclusion, attendees were asked to comment and ask questions.

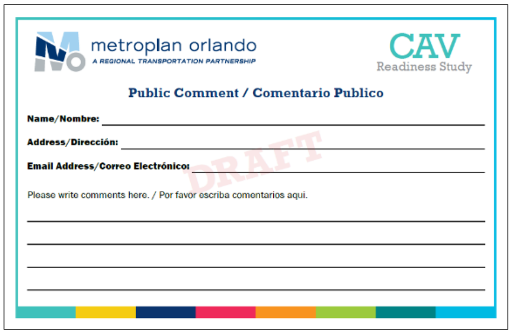




Live Polling – At the conclusion of the formal presentation, attendees were provided a QR code and website URL to enter into their smart phones for accessing the Direct Poll website and participating in live polling. The four questions asked their opinions about the CAV readiness information presented during the workshop.



Public Comment Forms – A table with bilingual English/Spanish public comment cards provided stakeholders with the ability to leave written comments for voicing their opinions and concerns about future CAV impacts.



metroplan orlando
A REGIONAL TRANSPORTATION PARTNERSHIP
CAV
Readiness Study

Public Comment / Comentario Publico

Name/Nombre: ______

Address/Dirección: ______

Email Address/Correo Electrónico: ______

DRAFT

Please write comments here. / Por favor escriba comentarios aqui.

Media Coverage – Local Orlando television station WKMG Channel 6 covered the Orange County (downtown Orlando) event and aired a short segment during the station's 11 p.m. news program on November 19, 2019, that included an interview with Eric Hill of MetroPlan Orlando.

The segment can be viewed at the following link: MetroPlan Orlando CAV Readiness Study News Story – WKMG Channel 6 https://youtu.be/64b-B9FyQuY

4.3 Workshop Attendance

The overall dates, locations, and approximate attendance for each of the three public workshops are shown below in Table 3.

Table 3: Workshop Dates, Locations, and Attendance

Date	Oct 29, 2019	Nov 12, 2019	Nov 19, 2019
Location	Kissimmee Civic Center Kissimmee, Florida	Lake Mary Events Center Lake Mary, Florida	First United Methodist Church Orlando, Florida
Attendance	12	20	20

4.4 Workshop Findings

As shown in Figure 15, 75 percent of attendees at the combined 3 workshops understood the difference between CV and AV before the presentation even began (according to data from the eSurveys conducted before the presentation).

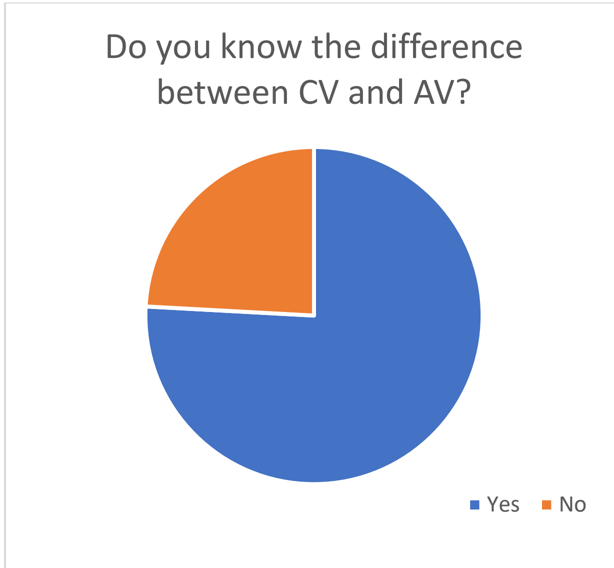


Figure 15: eSurvey Data - Difference between CV and AV

Attendees at all three workshops also consistently showed a favorable opinion of CAV concepts. As shown in Table 4, live polling during the presentation demonstrated a significant majority of workshop participants were somewhat or very enthusiastic about CAVs.

Table 4: Live Polling Data from Workshops - Enthusiasm Toward CAVs

	Osceola	Seminole	Orange	Total	Average
Very enthusiastic	9	4	6	**19**	6.3
Somewhat enthusiastic	3	8	9	**20**	6.7
Neutral	1	1	0	**2**	0.7
Somewhat worried	0	3	2	**5**	1.7
Very worried	1	1	1	**3**	1.0

While they were enthusiastic, attendees had safety, privacy and data security concerns, along with believing that vehicle technology development, workforce training and data storage will be the biggest challenges in the region as CAVs emerge on public roads. Table 5 shows results from live polling for the question "Based on what you've heard today or knew in advance, where will the greatest challenges lie in preparing the region for connected and automated vehicles?"

Table 5: Live Polling Data from Workshops - Greatest Challenges for CAVs

	Osceola	Seminole	Orange	Total	Average
Dev/testing/debugging of vehicle tech	1	5	8	**14**	4.7
Funding/install of traffic control devices	2	4	5	**11**	3.7
Training and educating staff	3	1	3	**7**	2.3
Data storage/management	3	1	1	**5**	1.7
Updating existing policies and regulations	1	1	2	**4**	1.3
Public acceptance	0	5	2	**7**	2.3

Attendees agreed that future planning opportunities need to include prioritizing funding in the region to educate the public and form a cross-agency consortium to share knowledge and make recommendations to ensure that CAV testing and pilot programs are deployed equally in urban and rural areas. Live polling data is shown in Table 6, responding to the question "How should MetroPlan Orlando prioritize funding to advance the CAV readiness of the region? Pick up to two as top priorities."

Table 6: Live Polling Data from Workshops - Spending Priorities for Region

	Osceola	Seminole	Orange	**Total**	Average
Training staff/workforce development	4	4	5	**13**	4.3
Deploying supportive traffic control devices	7	6	11	**24**	8.0
CAV pilot studies – transit vehicles	5	5	7	**17**	5.7
CAV pilot studies – single occupant vehicles	4	1	2	**7**	2.3
CAV pilot studies – shared vehicles	1	3	4	**8**	2.7
Educating the public about CAVs	4	10	11	**25**	8.3

For the longer-term outlook, workshop participants were less certain on how CAVs might impact various transportation priorities. Table 7 shows results from the pre-workshop eSurvey, responding to the question "Once a majority of vehicles feature some level of advanced CAV systems, up to and including self-driving capability, do you believe this will change any of the following? (Check all that apply.)"

Table 7: eSurvey Data - Predicting Longer Term Impacts

	Osceola	Seminole	Orange	**Total**	Average
More willing to live farther from work	2	2	5	**9**	3.0
More willing to take solo trips	2	2	3	**7**	2.3
Businesses won't need as much parking	1	9	9	**19**	6.3
More willing to share a ride with someone	2	5	5	**12**	4.0
Less willing to share a ride with someone	1	2	1	**4**	1.3

5 Recommendations for CAV Preparedness

This final step of the project built on the lessons learned during the prior tasks and stakeholder engagement to develop and document recommendations for leaders to evaluate in terms of developing short-term to mid-term concepts and plans for CAV preparedness. While these concepts and plans could also be relevant for other jurisdictions, they were designed based on the unique characteristics and constraints of MetroPlan Orlando's planning area.

5.1 Recommendations: Planning & Policy

5.1.1 Executive Guidance

Awareness and periodic engagement from senior leadership representing all of the stakeholder agencies is necessary to maintain momentum. While each agency will undoubtedly have their own priorities and unique challenges, there will be many common themes and opportunities that are best achieved through executive leadership. There will also be decisions made concerning funding, partnering, and overall engagement that will be served best if leaders in the region are aware, involved, and committed to advancing CAV. MetroPlan Orlando is ready, willing, and able to be a facilitator and conduit for information flow – but a willingness on the part of agency executives to establish a vision for the region that is inclusive of CAV, and take steps necessary to achieve that vision will be the ultimate measure of success.

- Ensure that leadership is on board with promoting CAV at the highest level, and that all actions taken are in line with this high-level vision. This leadership could include any state, regional, and local leaders, with MetroPlan Orlando acting as the regional convener.
- Identify specific elements to help guide incorporation of CAV deployment into transportation processes and stakeholder involvement.
- Establish a clear delineation of state, local, and agency-specific regulatory, deployment, and legislative roles in order to foster uniform collaboration and achieve policy objectives at all levels.
- Engage in national multi-agency initiatives and industry groups to build a national profile and facilitate knowledge exchange.

5.1.2 Long-Range Transportation Planning

CAV applications will be continually evolving with new technologies emerging and local jurisdictions becoming more familiar and addressing infrastructure and communication improvements to foster CAV. As the CAV Readiness Study was regional in its scope, the integration of its recommendations into long-range transportation planning in Central Florida will be important. This includes the planning activities being undertaken by MetroPlan Orlando, as well as other regional partners such as LYNX, the Florida Department of Transportation (FDOT), Central Florida Expressway Authority (CFX) and local counties and cities.

- Make planning and readiness for CAV technology an important element in the MetroPlan 2045 Metropolitan Transportation Plan (MTP). This should include how CAV fits into the future scenario planning to be undertaken as a cornerstone to the MTP. The CAV Readiness Study will be completed in time for its recommendations to be integrated into the 2045 MTP.
- Note within the 2045 MTP the need to identify and prioritize a set of CAV demonstration projects. These will include signal system and overall communication improvements to integrate CAV, and specific connected vehicle (CV) and automated vehicle (AV) pilot projects at the local level. Work with regional partners to identify potential funding needs to support these projects.

- CAV development should also be reflected in other adjacent jurisdiction and local jurisdiction comprehensive transportation plans, including those for city and county governments.
- Develop and promote educational programming for key stakeholders and community partners on the trends, opportunities, and challenges related to CAV technology. MetroPlan Orlando and FDOT can be leaders in providing overall information as well as specific training at local colleges, universities, technical schools, and other community resource centers.
- Align CAV activities with existing committees or partnerships where possible. This would particularly include integration into the MetroPlan Orlando Transportation Systems Management and Operations (TSM&O) Committee and the FDOT District 5 TSM&O Consortium.

5.1.3 Site Development

CAVs bring great opportunities to transform the built environment in ways that, where appropriate, can refocus communities towards the needs of humans instead of the movement of automobiles. CAVs will change the way users access their vehicles, bring reductions in demand and space needed for parking, yield opportunities for road diets and complete streets, and require major redesigns to transportation corridors and development sites to accommodate passenger drop-offs and pick-ups. As CAVs become the majority share of the vehicle fleet, transformative redevelopment opportunities will arise in those communities that have anticipated this technology and reframed their traditional land use and development regulatory structure. Taken as a whole, the coming of CAVs can help the region promote multi-modal, mixed-use districts and corridors that see this technology as a means of promoting placemaking and human-centered design.

To advance the region's transportation and land use agenda, MetroPlan Orlando should support and work with its partners to pursue strategies and undertake updates to Land Development Codes that 1) develop and implement district-level and/or corridor-level land use plans to promote multi-modal, mixed-use areas that enable the full use of CAV technology, 2) track parking trends and shape new parking regulations, 3) monitor best practices and implement new designs for drop-off/pick-up zones, and 4) partner with local governments, private entities, and community groups to develop inter-jurisdictionally compatible land use plans, development strategies, and land development regulations (including design standards) that use CAV-generated transportation changes as a catalyst to the region's urbanization.

- Building upon existing visions and policies within local and regional comprehensive plans, identify districts and corridors that can be transitioned to become successful multi-modal, mixed-use, and CAV-friendly areas. These may include nodes around existing major transit centers (e.g. LYNX Central Station, SunRail stations), corridors connecting major nodes within the region, and districts around existing airports.
- Develop guidelines and promulgate best practices for landscaping maintenance to ensure CAVs can receive accurate data from signage, signals, and other important generators of information that will influence the operation of the vehicle.
- Drawing upon best practices and pilot projects, develop drop-off zone and CAV holding zone strategies and plans for key urban districts and corridors in the region. CAVs will bring a sharp increase in passenger drop-offs and pick-ups and district-level approaches will be needed to ensure efficient transportation networks and safety for passengers as they enter and exit vehicles.
- Develop design guidelines and promulgate best practices for drop-off zones for a variety of land use types. Site-level considerations for drop-off zones are also paramount, especially within suburban and rural areas of the region. This will require working with developers, land

owners, and design experts to develop example drop-off zone designs across a range of typical land use types.

- Working with its partners, MetroPlan Orlando should identify strategic opportunities for creating drop-off zones, such as on-street parking areas, retrofitted parking garages, and underutilized surface parking lots. This could include placement of drop-off zones in locations that easily serve multiple properties and/or land uses.

- Monitor parking trends to assess the impact of CAVs on parking demand. Updates to parking minimum standards will likely need to occur, as increased adoption of CAVs could result in the need for fewer on-site parking spaces and reduced demand for handicapped parking spaces. It is also possible that local jurisdictions will identify needs for remote CAV holding or waiting areas, which is another strategy for accommodating CAVs.

- As demand for parking is expected to decrease over time, MetroPlan Orlando and its partners should develop updated recommendations for parking best practices as CAVs grow in market share. These efforts should include the design guidelines for surface parking lots and parking garages that factor in CAV technology. Guidelines may also be required to successfully bring Smart City technology to parking lots and metered parking, in the form of signage or sensors that transmit parking information to CAVs.

- Be prepared for unusual circumstances that might necessitate temporary or medium-term adjustments, as witnessed during the 2020 pandemic of COVID-19. Some cities around the US (and globally) utilized AVs for unique use case scenarios - such as in Jacksonville (FL) where a low-speed AV shuttle is moving between a testing site and a laboratory to transport test kits. In this example, special/temporary curb-side design may need to be considered.

- Assess and update signage standards and regulations as CAVs grow in market share. The coming of CAVs will also impact the need for informational signage and commercial signage, which will allow for less cluttered and pedestrian-oriented signage, especially within the multi-modal, mixed-use districts within the region.

5.1.4 Equity

Just as public agencies intervened to ensure electricity was supplied to rural areas and phones are affordable to more individuals, we can weave strategies into our planning efforts that explore ways to ensure that the promise of CAVs will improve the lives of those who now face the most serious transportation barriers. This focus on “vertical equity” means that the broadest possible cross-section of Floridians experience CAV benefits, demonstrations, and challenges – giving them an opportunity to see, touch, and experience the positive benefits of CAV while giving planners insight into diverse needs and key equity measures such as cost, geographic access, and personal mobility.

It can also be helpful if we understand that equity can take on multiple meanings. Sometimes viewed as “horizontal equity,” each agency within the MetroPlan Orlando region is at a different level when it comes to system capabilities, and each agency has different challenges that they are facing in terms of providing predictable and reliable multi-modal options. This is a natural condition, and these differences should be viewed as strengths that agencies can lean on to leverage each other’s investments in infrastructure, workforce development, and policy evolution.

- Support CAV application development in all geographic areas of the region, taking care to ensure that it includes those that might have seen limited deployment opportunities.

- Continue outreach to all types of communities to better understand needs, gaps, and opportunities to expand CAV access and protect equity.

- Play a greater role in workforce development initiatives as a tool for workforce retraining, economic development, and workforce readiness for CAV.
- Ensure CAV pilot projects are accessible to users with varying abilities, including those with physical or cognitive disabilities (consistent with Americans with Disability Act [ADA] guidelines), users of varying ages, socioeconomics, and demographics, and travelers across different modes, including pedestrians and bicyclists.

5.2 Recommendations: Infrastructure Guidelines

5.2.1 Roadway Technology

Roadway infrastructure requirements and guidelines are a key component to successfully deploying CAV technologies and ensuring interoperability throughout the MetroPlan Orlando planning area. This includes updated signing and pavement markings, as well as traffic signal hardware, such as the example cabinet shown in Figure 16.

It also includes connected vehicle roadside equipment [i.e. dedicated short range communications (DSRC) radios or cellular vehicle to everything (CV2X) and other connected vehicle support infrastructure (in-cabinet processors, Light Detection and Ranging [LiDAR] sensors, etc.)].

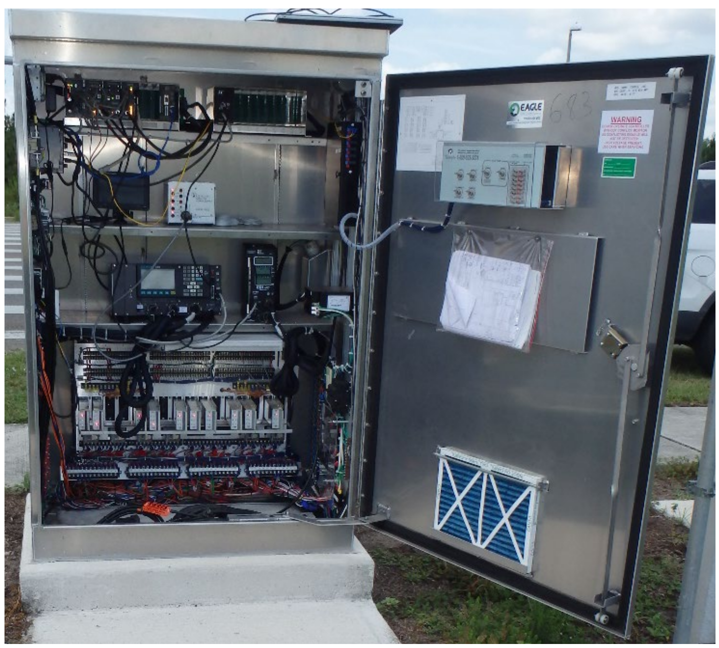


Figure 16: Example TS2 Signal Cabinet

A comprehensive review of the CAV industry should be performed to develop these requirements and guidelines. These requirements and guidelines should be revisited each year since this is a quickly evolving marketplace, and a detailed review should be performed every three to five years as part of broader agency Master Planning updates.

- A set of guidelines should be developed which can be applied at signalized intersections across the MetroPlan Orlando planning area to allow for ease of CAV deployment and interoperability.

  Following is a list of hardware/equipment guidelines that should be considered:

    - Traffic Signal Cabinet – Type 6 cabinet, recommended minimum
    - Traffic Signal Cabinet Type – TS2, recommended
    - Controller Type – ATC, required
    - Communications – Required, fiber optic recommended
    - Managed Field Ethernet Switch – Required

  The guidelines should also establish mounting recommendations for the roadside equipment to maximize transmission distances and reduce interference.

  For locations where CAV deployment will not be accompanied by full replacement of the existing hardware/equipment, space and power requirements for signal control cabinets and other infrastructure should be developed to support CAV technologies.

  A field inventory should be completed to determine which traffic signals require full replacement of the existing hardware/equipment to meet the recommended guidelines and which locations only require upgrades. A checklist should be developed to document the inventories and prioritize upgrades.

- Minimum acceptable CAV signing and pavement marking guidelines, in compliance with current and new standards set by FDOT, the Federal Highway Administration (FHWA), and the MUTCD, should be developed and applied across the MetroPlan Orlando planning area. This will aid in the interoperability of CAV technologies between jurisdictions within the MetroPlan Orlando planning area.

  In addition, recommended maintenance standards and schedules should be developed, along with service life guidelines. Adhering to maintenance standards and guidelines for signing and pavement marking is crucial in the development and operation of applications for CAV technologies.

- Perform an assessment to determine if the current design and maintenance of pavement markings and signage are compatible with the needs of CAVs. This should include recommendations from CAV technology manufacturers and consideration of regional and national practices to allow for interoperability.

- Perform a review of new and evolving national infrastructure guidelines related to CAV to determine if they are sufficient for everyday needs as well as for special cases (such as inclement weather, especially for evacuation route applications).

- Perform an assessment of the deployment and infrastructure requirements related to electric vehicle (EV) charging stations. This should include an evaluation of the current and future demand for EV charging stations, including locations, ownership, and maintenance.

5.2.2 TSM&O/ITS Guidelines

CAV technologies are part of the larger TSM&O and Intelligent Transportation System (ITS) framework, which supports the safe and efficient movement of people and goods throughout the MetroPlan Orlando planning area. As CAV technologies are further developed, guidelines that define CAV's role within this framework will be needed.

- As CAV technology and infrastructure continues to grow, communication guidelines with private industries such as Google Maps, Apple Maps, and Bing Maps should be developed. Updates regarding construction and situational developments should be provided to these industries and would help to ensure current information is incorporated into their systems and is consistent with guidance provided at the local level.

- The wireless network over which CAVs communicate must be fast, reliable, secure, private, and interoperable (across applications and user types). This includes newly adopted technologies such as next generation DSRC or 5G, as deployments continue to rise.

- For network protocols and routing, standardize IP assignments and ensure sufficient IP addresses are available to each agency and promote the sharing of fiber optic cable where feasible.

- Security is an important factor in public acceptance and safety. Use cyber locks and password protection at field locations to protect hardware. Develop data sharing requirements between agencies and vendors/manufacturers. Use a security credential management system (SCMS) to validate authorized users and verify the authenticity of messages transmitted between vehicles and roadside equipment.

- Leverage FDOT's efforts to develop state and regional ITS architecture related to connected vehicles.

- For roadside units (RSUs), develop guidelines for equipment deployed within the region to ensure interoperability between jurisdictions within the MetroPlan Orlando planning area.

- Develop guidelines on a basic set of applications, such as signal phasing and timing (SPaT), that each RSU within the region should operate to allow for a seamless experience for road users. For example, a regional deployment of CV based emergency vehicle preemption (EVP) would allow for fire/rescue vehicles from different jurisdictions to receive priority throughout the MetroPlan Orlando planning area. Similarly, the same infrastructure used for EVP could be used for regional transit signal priority (TSP). Also, identify a central location for agencies to access proven applications that are RSU manufacturer agnostic.

5.2.3 Maintenance

The deployment of CAV technologies will bring additional maintenance responsibilities for local jurisdictions, the state, and private industry partners. Clear guidance is needed to define who will maintain this equipment, and training will be required for those performing maintenance on newly deployed CAV technologies.

- Define maintenance responsibilities between local jurisdictions, the state, and private partners. This should include identifying who will require access to the equipment for maintenance both on-site and/or remotely, how equipment will be accessed for maintenance, and who is responsible for replacement in the event of damage or loss.

- As equipment is deployed, maintaining agencies and/or contractors should ensure procurement of replacement equipment. FDOT has already established maintenance fees for CV technologies deployed at state intersections. Local agencies will need to identify additional funding sources for maintenance of CV technologies deployed on local roadways.

- CAV technologies will be used for safety applications in the future. As such, they will become critical roadway infrastructure. A review should be performed to establish the acceptable roadside equipment downtimes. In addition, the need for redundant systems should be reviewed to provide a backup in the event that the CAV technology in place fails.

- Develop guidelines for CAV equipment monitoring, which can be used by local agencies operating CV equipment. These guidelines should define protocols to identify equipment failures, including communication failures, and establish standard operating procedures for maintenance/trouble calls.

- Develop standardized maintenance procedures for roadside equipment, including firmware upgrades, routine maintenance, trouble calls, and public concerns (intended operation vs actual operation).
- RSUs broadcast a static message, called the MAP message, that defines the roadway geometry and characteristics. This message identifies what information each end user receives based on their location within the roadway. Changes to the roadway such as lane closures (temporary) or newly added lanes (permanent) will impact the integrity of the MAP message. As such, guidelines for changes to the MAP message will be needed.
  - Develop a standardized process for construction activities, specifically for temporary lane closures (MAP message) and project closeout (MAP message).
  - Develop standardized processes for changes/modifications to the MAP messages.

5.3 Recommendations: Data Collection & Management

5.3.1 Data Governance

Data governance includes the systems for managing data as well as the decision-making authority on data policies and data stewardship. The ultimate responsibility for data governance for the region should be at the state level, with FDOT setting clear and consistent guidance that can be implemented in all regions across the state, including the MetroPlan Orlando planning area. Based on regional stakeholder guidance, the following recommendations should contribute to this overall state-wide strategy.

- Establish better data sharing regulations for CAV to understand how data could be used to evaluate trends and system/modal performance, while protecting information that may be proprietary or personally identifiable.
- Update data retention policies for CAV to reflect the value of new types of data as well as a cost-benefit analysis on the storage needs for saving the vast amounts of raw data that may become available.
- Establish consistent and efficient methods to filter large data sets for usability, in order to enable future evaluation of changes to safety and efficiency due to CAVs, as well as to seamlessly supplement datasets that are already being collected.
- Begin to explore how and whether CAV data could be used as a strategy to price roadway usage or otherwise change how the transportation system is funded, understanding the role of data, today and in the future, and how to translate data into value.
- Develop an official CAV Data Governance Plan, led by FDOT, that identifies roles, responsibilities, policies, and other guidance.
- Learn from CAV pilot project experience what types of vendor data is most useful, and use these lessons to inform better data sharing agreements for future projects.

5.3.2 Data Collection/Storage

As vehicles, infrastructure, and other objects in the transportation system become increasingly more connected, there will be ample opportunities to collect data via information that is transmitted for other purposes. While this additional collected data may be used to enhance transportation planning and other processes, it will also lead to additional challenges, most notably in making sure that storage needs for collected data will continue to be met. As is the case for data governance, FDOT should also be the lead agency for data storage at the policy-setting level, though it will likely be the ultimate responsibility of each entity collecting data to ensure it can be stored properly.

- Assess anticipated CAV data storage requirements, including the types of data that will need to be stored and for how long. Potential types of data include but are not limited to CAV data (both from vehicles and from infrastructure), travel time data, traffic count data, crash data, and data to support performance measures (such as for evaluating CAV pilot projects).

- Begin to establish data sharing agreements with vehicle vendors and other private entities, that allow MetroPlan Orlando and other public agencies to collect information on the use of their infrastructure without requiring the sharing of too much information that may be proprietary, personally identifiable, or superfluous to meeting a public agency's needs.

- Ensure servers are capable of storing higher volumes of data and plan for extra contingency space for future data needs.

- Develop back-end systems capable of accepting and managing the CAV data that can be collected.

5.3.3 Data Sharing

The primary users of transportation data at this time are researchers, both universities and private entities. Greater use by transportation professionals, as well as other entities such as insurance companies and application developers, could be enabled by the enhanced amount of detailed data made available by CAVs. Policies on whether and how to share data with entities other than the agency collecting and storing the data will need to be determined in order to support novel uses of CAV data while protecting data value, privacy, and security.

- Develop open-source platforms to promote cross-collaboration and data sharing.

- Early on, implement policies to anonymize available CAV data prior to sharing. Decide how and whether raw, personally identifiable, proprietary, or otherwise sensitive data should be retained, stored, and/or shared on an individual user basis.

- Establish memorandums of understanding (MOUs) between agencies on how to share CAV data and data resources (such as experienced staff or analysis tools) between agencies.

- Partner on data sharing with jurisdictions to promote Smart City connections.

5.3.4 Data Security

Collecting, storing, and sharing CAV data brings with it the responsibility to ensure this information is protected. Learning from best practices elsewhere, including in other industries, agencies within the region will need to implement strong systems to maintain data security.

- Ensure security protocols are designed to keep CAV data safe during acquisition, analysis, use, or storage within each jurisdiction by studying and implementing best practices from other industries and regions.

- Protect personally identifiable information using separation and other techniques.

- As described in Section 5.2.2, ensure security at field locations and for messages transmitted between vehicles and roadside equipment.

5.4 Recommendations: Pilot Projects

5.4.1 CV Pilot Projects

With the advent of new CV technology, new opportunities to test these technologies through pilot projects should be undertaken. This would build on initial efforts led by FDOT along the SR 434 corridor in Seminole County, and on the University of Central Florida (UCF) campus.

- Promote CV pilot projects and partner with local agencies to support pilot projects in the region. Identify corridors for potential application through the MetroPlan Orlando and FDOT TSM&O forums. Guiding principles for CV projects should be developed through these forums. Equity should also be a consideration to assure that CV systems are available to different user groups and in different geographic areas around the region.

- Build an interoperable CV system between pilot projects within the region and elsewhere in the state and nation. This will ensure consistency of CV application as travelers move from one geographic location to another, particularly with respect to interaction with signal systems.

5.4.2 AV Pilot Projects

Promote specific applications to test new AVs and technology within the MetroPlan Orlando planning area. This would build on initial pilots being considered on the downtown Orlando LYMMO system, at UCF and in Altamonte Springs, as well as an operational pilot at Lake Nona shown in Figure 17.

Figure 17: Operational AV Shuttle in Lake Nona

- Establish use cases for AV pilot projects that further the state of the practice and support these projects when feasible. Consider an equitable distribution of AV pilot projects within the region to the extent possible.

- Partner with local interest groups to gain insight into user input on AV testing. Involve the creation of user focus groups and meeting forums.

- Partner with private automakers to learn more about AV technologies and to further pilot activities.

5.4.3 CAV Testing

As CAV technologies evolve, continual testing will be required to assess the impact of new technologies on roadway operations and safety. Accomplish this through CV and AV pilot projects, and through use of the new SunTrax testing facility. Guidance also will be obtained from the USDOT AV 4.0 documentation, related to federal involvement in the testing and implementation of CAV.

- Promote CAV testing to expose the local public to emerging technologies and demonstrate benefits today.
- Incorporate feedback/evaluation into CAV tests that engage the general public.
- Evaluate pilot projects (existing and new) to assess whether they have adequately met local needs and whether there have been any unexpected or unintended consequences.
- Further analyze CAV testing activities to achieve a better understanding of maintenance and staffing needs for infrastructure used by CAVs.
- Establish guidance on permitting that allows pilots and deployments to proceed under reasonable and safe conditions.
- Maintain awareness of federal grant and other external funding opportunities for pilots and projects.
- Support federal and state lobbying efforts and statutes that promote CAV innovation.
- Educate internal and external stakeholders (the public, agency staff, potential partner agencies, etc.) to increase awareness of CAV technology, better understand their needs that could be met by CAV and leverage public engagement to inform technology development and outcomes.

5.5 Recommendations: Staffing & Training

5.5.1 Recruitment/Retention

The widespread adoption of CAVs is expected to have varying impacts on workforce needs, including the already emerging challenge of finding, attracting, and retaining employees with the right skillsets needed to operate, maintain, manage, and plan the transportation network. Meeting this challenge will require incorporating lessons learned from other regions and parts of the country, including investing in local training programs and technical schools, promoting staff engagement and growth, and exploring new ways to hire qualified applicants.

- Look for opportunities to hire from technology fields and local technical schools and promote the application of emerging technologies for transportation applications.
- Offer existing staff new opportunities to work on CAV projects or testing.
- Support needs for signal and other emerging technology capability recruitment (for example, to help with a lack of qualified signal technicians) through Central Florida community colleges, by encouraging investment in educational programs that will help the region meet these needs.
- Address recruitment challenges for attracting and retaining qualified data scientists and other high-salary positions by reviewing existing limitations and exploring the possibility for joint hires between jurisdictions.

5.5.2 Training

While one potential solution to supporting the recruitment and retention of qualified applicants would be to enhance training of existing and potential staff, training in some new types of skillsets is not yet widely available. Much of this training can be built up within the region as experience in these emerging fields begins to grow, but it will also be important, particularly in the shorter-term, to look elsewhere for training opportunities and knowledge sharing of lessons learned.

- Identify regional training efforts with lessons learned from early deployments, and site visits to deployed systems. This would include experience with installation/maintenance of on-board units (OBUs), and MAP message deployment. Regional training efforts may include reaching out to technical schools and local universities and colleges.
- Identify training that covers device setup, best practices for maintenance, standard operating procedures (SOPs) for troubleshooting, and device software interfaces.
- Coordinate with FHWA and others about available CAV certification programs (similar to International Municipal Signal Association [IMSA]) and communications/networking training.
- Seek out external training opportunities, such as webinars led by other states, to train staff and to inform training programs that could be led by MetroPlan Orlando regional partners in the longer term.

6 Overall Findings, Conclusions, and Next Steps

The Central Florida region has experienced strong population growth over the past decade. With this type of growth come challenges in managing traffic congestion, delays, collisions and resulting negative environmental impacts. CAVs offer a future ripe with opportunities to significantly improve safety, enhance mobility options, and positively impact the environment in Central Florida. But to reach that plateau, the MetroPlan Orlando planning area needs to continue its exploration of CAV impacts and readiness, while also preparing its businesses and residents for how to best take advantage of the potential safety, mobility, and environmental benefits of CAVs.

As next generation mobility applications and technologies continue to evolve and improve, the timeline for CAV introduction and adoption will be impacted by the readiness of the technology – but also by the readiness of the regulatory environment.

These trends were part of what motivated MetroPlan Orlando to commission the CAV Readiness Study. The information provided through this study, whether via the memorandums, stakeholder meetings, or this final report, are intended to provide a useful jumping off point for continued CAV activities in the Central Florida region, to help prepare residents and governments for the emergence of new technologies such as CAVs in their transportation system.

It is worth noting that the recommendations presented in Section 5 may not be implemented in the same way or on the same timeline by all agencies in the MetroPlan planning area. Each organization is currently at a different level of capability and maturity with CAV and may have different priorities for the types of outcomes they would like to see first. While some agencies are already conducting real-world pilot tests, others are still in the early stages of understanding foundational terminology. Therefore, an action item that might be longer term for one agency, could be nearer term for another agency.

The importance of these recommendations, however, is to put the full menu in front of all regional agencies, and stakeholders more broadly, so they can pick and choose what suits their current capacity and status – and for the region to coordinate on a common set of actions, recognizing they won't all be accomplished at the same pace across every agency or jurisdiction. The implementation of these recommendations will also depend on funding availability, as well as integration with other ongoing equipment and infrastructure upgrades and how they could be modified in a cost-effective way, to best pursue the overall investment while enabling future trends in transportation like CAV.

Whether through existing or new committee structures, MetroPlan Orlando can facilitate dialogue in pursuit of building policies and procedures to help guide agencies as they begin, continue, or enhance their efforts in CAV.

MetroPlan Orlando also has an opportunity to act as a convener to foster collaboration and as an information conduit to help share best practices from other regions and agencies, ultimately building a planning expertise that goes beyond technology development and assessment by implementing the recommendations presented herein.

Going forward, there is an important role for any committee that takes on the responsibility for "owning" a regional recommendation. Some of the recommended actions – specifically those that pertain to collaborative recommendations across jurisdictions and agencies – can be pursued jointly, either through small groups of agencies getting together, or by the region as a whole. This will likely include discussion, debate, and eventual agreement within the committee structure, and may result in actions that will supplement the recommendations and findings of this project.

In order to maximize the value of this report, the responsible committee(s) should revisit these recommendations on a periodic basis, to ensure they are up to date with any emerging trends and updated to reflect significant changes to either the region or the CAV technology landscape. The lessons of 2020 and an unexpected pandemic virus have taught us, if nothing else, that the transportation environment is not static, and will always need to be adaptable to change.

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