# Centralina Council of Governments

## Connected and Automated Vehicle (CAV) Roadmap Refresh



May 2023

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# 1   Introduction/ Overview

In 2018, Centralina Regional Council prepared an Automated and Connected Vehicle Roadmap that provided an overview of the potential benefits and impacts of automated and connected vehicles, presented the Fall 2017 workshop series, and introduced the Automated and Connected Vehicle Action Plan to help prepare the Greater Charlotte Region[1]. This document acts as a refresh to that Roadmap with the goals of reconvening the Connected and Autonomous Vehicle (CAV) Task Force, understanding how the CAV industry has evolved, determining if action items in the 2018 Roadmap are still relevant and whether recent efforts have been sufficient in advancing CAV action items, and identifying the handful of actions the Task Force could take on collectively.

The 2018 Roadmap outlined several Issue Areas for CAV action items. These Issue Areas included:

- Fleet Management
- Modeling and Forecasting
- Transportation Planning
- Infrastructure Costs
- Land Use Planning
- State and Policy Regulations

This Automated and Connected Vehicle Roadmap Refresh was funded by the Charlotte Regional Transportation Planning Organization (CRTPO).

# 2   Key Terminology

The following key terminology is associated with the CAV industry and used throughout this document.

AASHTO – American Association of State Highway and Transportation Officials

ADAS – Advanced Driver Assistance Systems

ADAS – Automated Driving Assistance System

ADS – Automated Driving System

AV – Autonomous Vehicle

CAV – Connected and Autonomous Vehicles

CDOT – Charlotte Department of Transportation

CRTPO – Charlotte Regional Transportation Planning Organization

CV – Connected Vehicle

DbW – Drive-by-Wire

DOE – United States Department of Energy

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[1] "Automated and Connected Vehicle (ACV) Roadmap - Actions to Prepare the Greater Charlotte Region", Fall 2017 CCOG ACV Workshop Series, Centralina COG, January 2018.

DSRC – Dedicated Short Range Communications

FHWA – Federal Highway Administration

HOT – High Occupancy Toll (lanes)

HOV – High Occupancy Vehicle (lanes)

IOO – Infrastructure Owner Operator

ITE – Institute of Transportation Engineers

ITRE – Institute for Transportation Research and Education

ITS – Intelligent Transportation Systems

MPO – Metropolitan Planning Organization

MRM – Metrolina Regional Model

MTP – Metropolitan Transportation Plan

NCDOT – North Carolina Department of Transportation

ODD – Operational Design Domain

OEM – Original Equipment Manufacturers

RITIS – Regional Integrated Transportation Information System

ROI – Return on Investment

SOV – Single Occupant Vehicle

USDOT – United States Department of Transportation

V2X – Vehicle-to-Everything

VMT – Vehicle Miles Traveled

VTO – Vehicle Technologies Office (of DOE)

# 3   Connected and Autonomous Vehicle (CAV) Task Force

On May 9, 2022, members of the Centralina Regional Council Connected and Autonomous Vehicle (CAV) Task Force reconvened in a hybrid workshop presented by Centralina and the CRTPO, with support from consultants at WSP USA Inc. The in-person portion of the CAV Workshop was held at 10735 David Taylor Drive, Charlotte, NC 28262, and the online portion held via Zoom. The purpose of the CAV Workshop was to summarize recent CAV efforts, understand how the CAV industry has evolved during and post-Covid, and to facilitate discussion on the direction and next steps the CAV Task Force should take as a committee as well as in refreshing its CAV Roadmap.

# 4   Recent National CAV Trends

At the CAV Workshop, recent trends in the CAV industry were discussed with the CAV Task Force, providing an understanding of how the industry has evolved during and after the Covid pandemic. The industry has evolved in that CAV is no longer an umbrella term to mean all vehicles are

automated. With automated driving systems still in development and testing, there are industry sectors that have been advancing use case scenarios for automated systems quicker than general market passenger vehicles.

The following are some highlights of that discussion:

- The industry is still evolving. There have been a number of mergers, acquisitions, and new start-ups that are impacting the business and development cycles of the transportation industry. A key influencer has been partnerships amongst vehicle manufacturers, mobility providers, technology and software companies, data management companies, and communications providers to develop and implement CAV mobility.
- AV software development has progressed. Over the last few years, there have been millions of miles driven by vehicles with some level of AV that has offered substantial data.
- Engagement of Infrastructure Owner Operator (IOO). IOOs plan, design, build, and manage the roadways on which CAVs operate. IOOs are generally public agencies but can sometimes be a private entity operating on behalf of a public agency. Their involvement in CAV development and deployment breaks the long-standing cycle of vehicles and roads being designed independent of each other. In this context, IOOs have direct control of and responsibility for the transportation infrastructure and its interaction with users and vehicles, similar to how a tolling or Fast Lanes vendor would operate. With CAVs, IOOs will adapt safety and mobility, roadway design, traffic controls, and education towards automated and connected driving systems through the use of technology, communication systems, and data collection/ monitoring systems.
- Confusion in public understanding. With various levels of CAV technology deployed over the last few years – automated, autonomous, driverless, self-driving, automated-driving – several industry-specific terms have emerged. This has resulted in some confusion in the public as to what is meant by 'automation'. For example, many people do not realize that a CAV is not necessarily at Level 5 Full Automation; there are interim steps and efficiencies seen with each step along the way. Many cars are now equipped with driver assistance technology, and there is momentum within the industry to try and standardize the terminology for consumers.

## 4.1 Autonomous Vehicle Deployment

Early forecasting of Autonomous Vehicle (AV) deployment was likely too aggressive and was based more on marketing hype due to the inherent lack of historical market data. In 2022, many predictions made 10 years ago have still not occurred, and the industry is still in the early stages of testing and piloting. Further, much of the forecasting for AV deployment was focused on passenger vehicles and not the sectors where AV deployment has been occurring the most (i.e., transit, freight, and fleets). While full automation may not have progressed as quickly as thought, some level of automation has come onboard in most vehicles in the last 10 years, providing a great deal of consumer-driven data through various AV software that is useful in future deployment. This includes Level 1 – Driver Assistance in most cars placed on the road since 2018 which includes adaptive cruise control, lane assist, and brake assist, but the driver must still me in control with hands on the steering wheel. Some cars, such as Tesla, have introduced Level 2 – Partial Automation which come with an autopilot function, and while the driver's hands may come off the steering wheel for short

instances, the driver must remain in control. Level 3 and beyond automation in vehicles is mostly still in testing and have not been introduced in quantities that have impacted the transportation network yet. These levels do not require a driver to take over driving with the automation features driving vehicles under various levels of circumstance, up through Level 5: Full Automation. With the onset of vehicles with some level of automation has come a technology piece that allows the vehicle to capture and relay data on current and historical driving patterns that allows consumers to understand traffic patterns and trends, peak times of day for traffic, origin/destination information, and other types of movements. This has introduced a new way for traffic engineers, retailers, freight providers, public works departments and emergency personnel, and in most cases the general public to use the data to make decisions about how they go about planning their transportation activities. In any case, this data is purely informational and must be interpreted by a driver; the larger-scale use of data for connected and autonomous driving has not emerged as quickly as originally thought. Vehicles with some level of autonomy are purely acting based on sensors within the car and are not connected to other vehicles or infrastructure.

Enterprises that may invest in the AV industry are drawn to the revenue potential derived from this consumer-driven data, and thus the industry has seen a greater diversity of interest and investment. Communities are drawn to the improved mobility and safety benefits of AV, including the ability for all users to more safely use the transportation network, more efficient commutes and better access to travel options, and the potential for less pavement to be dedicated to roadways due to efficiencies in traffic movements.

## 4.2    Connected Vehicle Deployment

While AV deployment has evolved over the last few years, Connected Vehicle (CV) deployment is not as advanced. According to the website Statista, in 2021 there were approximately 84 million vehicles in the U.S. that were considered Connected in some fashion[2]. This number is expected to increase to approximately 150 million by 2025. Many AVs are not connected to their surroundings, meaning they are not communicating with other vehicles, infrastructure, or devices. Several nearby states (GA, FL, TN, and VA) continue to roll-out comprehensive roadside infrastructure enhancements in preparation for future connected vehicle services. Immediate benefits of CV technology will primarily be seen by the transit, freight, and fleet vehicle industries, with passenger vehicles lagging behind – similar to the AV forecast expectations. Technology choice for CV is evolving from Dedicated Short Range Communications (DSRC) toward Cellular-based Vehicle-to-Everything (V2X) communication. The use of Cellular-based communications is more cost-effectively deployed and their use has already been successfully demonstrated in technologies such as traffic signal priority.

## 4.3    IOO Advancement

CAV concepts are emerging so quickly that in 2019, the American Association of State Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE), and the Intelligent Transportation Society of America (ITS America) formed a joint Task Force to develop guiding principles for IOOs in supporting CAV. This resulted in the preparation of an Infrastructure Owner Operators Guiding Principles for Connected Infrastructure Supporting Cooperative Automated

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[2] https://www.statista.com/statistics/1155517/global-connected-car-fleet-by-market/#:~:text=In%202021%2C%20there%20were%20about,biggest%20market%20for%20connected%20vehicles

Transportation report in 2020[3]. That report addresses 5 dimensions of IOO development of Connected and Automated transportation systems in order to begin to develop some consistency across CAV infrastructure projects.

GP1 – Automation of vehicles and the infrastructure that vehicles share with other users.

GP2 – Data that enables the automation.

GP3 – Telecommunications that enable the data interactions between the vehicles, infrastructure, and users.

GP4 – Operations that use standardized messaging and communication and other operational capabilities that can improve efficiency and/or cost-effectiveness.

GP5 – Collaboration creates an environment that values and incorporates the needs and objectives of all participants.

There are several investments that IOOs involved with CAV deployment are making as part of construction and regular rehabilitation projects that will provide benefits and enhance the readiness of our infrastructure for CAV deployment in the future. It should be understood that newer technology has a short shelf-life; what IOOs install today will likely need updating in a short timeframe regardless of Federal Communications Commission (FCC), the market, or state or local government policies. Because of this, IOOs typically benefit most from looking into specific infrastructure projects that support CAV development use cases or pilot projects, rather than investing in larger, top-down infrastructure projects that may adapt to CAV later or that would require integration into a larger CAV system. The most common application of an IOO project involves retrofitting an existing roadway for automation. This would entail using ITS developed alongside the enabling computing and communications technologies to inform and support operational decision-making of the roadway, providing IOOs an opportunity to influence traffic conditions beyond the actual deployment of the automated roadway.

## 4.4   CAV Economic and Societal Benefits and Concerns

There are several economic and social benefits of CAVs to transportation providers, municipal and state agencies, and communities. The deployment of CAVs also comes with some concerns or questions that still need to be answered before fully understanding the potential impact. The potential economic and societal benefits of CAV's 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.

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[3] Infrastructure Owner Operator Guiding Principles for Connected Infrastructure Supportive Cooperative Automated Transportation, AASHTO, ITE, ITS America, February 2020.

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.

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.

## 5   Assessment of 2018 Roadmap & CAV Task Force's Interim Progress

The 2017 workshop series led to the development of key issues that are highlighted in the 2018 ACV Roadmap Action Plan.  These key actions are prioritized to advance change within those areas, and key steps needed to achieve those actions are detailed. The key Issue Areas identified in the 2018

Roadmap Action Plan are still relevant and should continue to be used as Issue Areas in the Refresh. The Issue Areas are as follows:

- Fleet management
- Modeling and forecasting
- Transportation planning
- Infrastructure costs
- Land use planning
- State policy and regulations

Flowing from the third and last workshop were poll results that overwhelmingly indicated the desire to continue support of regional coordination on this effort. The workshop participants resolved to keep the momentum going around the topic of CAV. To do this, Centralina Regional Council developed a CAV Task Force. The CAV Task Force was meant to serve for a limited time during this period of technology advancement, and function as the primary custodian of this 2018 Roadmap Action Plan to coordinate partners and to prioritize and advance strategies. Its initial task was to clarify and formalize its charge based on the workshops' outcomes, time availability among those involved, and resources that can be accessed over the long term. The CAV Task Force made some advancement in this direction, including ensuring the region is regularly involved with activities at the state level, but progress was slowed, primarily due to the uncertainties caused by the pandemic in the way we travel, and also due to the slowing advancement in the development and adoption of CAV technologies.

## 5.1   CAV Roadmap Refresh

The goals, recommendations, and action items outlined in the 2018 Roadmap remain largely relevant and fundamentally sound. The themes identified in the 2018 Roadmap should continue to guide action items, and include:

- Convene regional stakeholders to identify organizations and partnerships that can implement key local actions that capitalize on the emergence of CAVs while ensuring the integrity and long-term visions of the region's growing communities.
- Incorporate CAV in planning studies and documents.
- Update tools to be able to evaluate CAV impacts.
- Consider possible implications of CAV on capital investment needs (e.g., road widenings, parking structures).
- Continue to seek opportunities to educate and inform regional political leaders, agency leadership, and staff.
- Provide the voice of the regional perspective on CAV issues.
- Identify opportunities to be partners in pilot tests for new technologies.

## 5.2   Assessment of 2018 Roadmap Action Items

This section is meant to provide an assessment of the 2018 Roadmap, indicating progress the CAV Task Force has made on each action item and offering WSP's opinion on which action items are still relevant and should be continued, which action items are still relevant but should come with some modified action, and which action items are no longer relevant and should no longer pursued.

The assessment of action items from the 2018 Roadmap and those developed as part of this Refresh were derived from the CAV Task Force Workshop in May 2022 and expanded upon by CAV industry experts at WSP. The CAV Refresh Action outlines the action items that the CAV Task Force should focus on in the near-term. Action items are identified as:

- Continue as Short-Term Action Item: this is something that the CAV Task Force should look to as a short-term action item in the next few years.
- Continue as Long-Term Action Item: this is something that is beneficial for the CAV Task Force to keep in their action item list, but is not something immediate that should be taken on.
- Continue to Monitor: this is something that is not a direct action item of the CAV Task Force and is to be led by others with coordination with/ or participation in the CAV Task Force.
- Do Not Continue as an Action Item: This is something that is no longer relevant or does not achieve one of the key goals of the CAV Task Force and should no longer be pursued.

Further, following the assessment of action items under each Issue Area are new action items identified through the CAV Workshop that should be added as part of the Roadmap Refresh.

### 5.2.1   Issue Area: Fleet Management

*Issue Area Question 1 – What actions should be taken to promote universal standards across all Original Equipment Manufacturers (OEMs) and roads?*

Action Items
- Establish standards for new technologies, promote collaboration and cooperation between the public, government, and business environments.
- Establish a federal/universal framework (guidance) for software and hardware.

CAV Task Force Progress
These action items were identified to be led by the Federal government with support from NCDOT and regional organizations. At the CAV Task Force Workshop in May 2022, the participants indicated a desire to focus on action items that they could directly control. While some traction has been made at the federal and state level on standardizing CAV and developing a universal framework for software and hardware, the CAV Task Force has been coordinating with NCDOT and communicating progress to various regional stakeholders, but is not directly involved in establishing standards or establishing a universal framework for software and hardware.

CAV Refresh Action – Continue to Monitor
The CAV Task Force should continue to coordinate with NCDOT and federal agencies on establishing CAV standards and establishing a universal framework for software and hardware, but leading these efforts is not a direct action item that the CAV Task Force should pursue.

*Issue Area Question 2 – How to ensure there are short- and long-term requirements and potential retrofits in a mixed fleet environment?*

Action Items
- Establish a staging and transition plan for baby boomers and others that might be skeptical of new automotive technologies.
- Need to have proven safety first; public roads are not testing grounds.

CAV Task Force Progress
These action items were identified to be led by the CAV Task Force and partners. The CAV Task Force has not advanced any staging or transition plans specific to baby boomers and others that might be skeptical of new automotive technologies and has not advanced any proving grounds for CAV testing/ pilots.

CAV Refresh Action – Continue as Long-Term Action Item
The CAV Task Force can participate in a larger educational campaign on CAVs. This is likely a longer-term strategy and would require partnering with NCDOT and others on a standardized campaign when greater CAV implementation is ready.

The federal government has programs to offer funding for piloting CAV technologies on select corridors. The CAV Task Force should coordinate with NCDOT, universities, and potential CAV partners on identifying CAV testing grounds or pilot corridors and applying for funding to pilot CAV on these corridors/ campuses.

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*Issue Area Question 3 – What actions can be taken in the short- or long-term to transition into mixed fleet use and operation?*

Action Items
- Don't over-regulate the testing of ideas.
- Promote training and education for the driving workforce.

CAV Task Force Progress
These action items were identified to be led by the CAV Task Force and partners. The CAV Task Force has not taken on any regulation of CAV technologies or ideas. While the Centralina Regional Council has programs for workforce training and development and emerging transportation technologies, they have not been directly pointed at training and/or educating workers for CAV implementation or usage.

CAV Refresh Action – Continue as Long-Term Action Item
The CAV Task Force does not directly have the authority to regulate the testing of CAVs. This is an action that can be coordinated with NCDOT and federal agencies. Further, as CAV technologies become more prevalent, the CAV Task Force can work to develop specific workforce training and education that can be useful to workers or those seeking employment in the driving industry to utilize in order to become more comfortable with CAV technologies. As an example, with a Spring 2022 update of the Driver's Education Manual, Maryland is the first state to have any substantial information on Advanced Driver Assistance Systems (ADAS) for novice drivers and have had workshops to teach an understanding of ADAS for driver education instructors and law enforcement liaisons.

The U.S. Department of Energy's (DOE) Clean Cities program looks to develop partnerships through its Vehicle Technologies Office (VTO) to provide technical assistance and analysis, information resources, and online tools that local coalitions (like the CAV Task Force) can leverage to provide assistance to fleets implementing alternative and renewable fuels, idle-reduction measures, fuel economy improvements, and emerging transportation technologies. The CAV Task Force should monitor open funding opportunities on the DOE Clean Cities website and develop applications as desired.

## 5.2.2   Issue Area: Modeling and Forecasting

*Issue Area Question 1 – What actions should be taken to address modeling needs for these new technologies? What steps can be taken now and in the long-term to adapt assumptions, surveys, and other standard tools for trend analysis?*

Action Items
- The model is not ready for major changes, but the state can now start developing a plan for it.
- Need for scenario testing and tracking potential impacts of CAV environment.

CAV Task Force Progress
The majority of the modeling and forecasting tasks occur outside of the CAV Task Force. The Metrolina Regional Model (MRM) custodian, which is currently Charlotte Department of Transportation (CDOT) is responsible for development and maintenance of the travel demand model. The MRM Project Manager is a member of the CAV Task Force and provides updates as needed.

CAV Refresh Action – Continue as Short-Term Action Plan
Based upon input from the CAV Task Force at the May 2022 workshop, the original 2018 Roadmap action item is updated and described in Section 5.

*Issue Area Question 2 – What actions can be taken to adapt the approach to model capacity? Short-term capacity will include a mix of traditional vehicles, CAV, and electric vehicles. Long-term capacity might include vehicles sized quite differently from today (such as vehicles designed with capacity to transport only one person).*

Action Items
- Wait and watch (use existing real-time data resources such as Regional Integrated Transportation Information System (RITIS))
- Develop microsimulations to connect land use and transportation.

CAV Task Force Progress
The majority of the modeling and forecasting tasks occur outside of the CAV Task Force. The MRM custodian, which is currently Charlotte Department of Transportation (CDOT) is responsible for development and maintenance of the travel demand model. The MRM Project Manager is a member of the CAV Task Force and provides updates as needed. The MRP

Project Manager also sits on the Steering and Implementation Committee for the NCDOT Research and Development sponsored project, Guidance on Considering CAVs in Travel Demand Models (led by ITRE).

CAV Refresh Action – Continue as Short-Term Action Plan
The CAV Task Force should continue to work with agencies and organizations focusing on CAV modeling and scenario planning (i.e., NCDOT, UNC Charlotte, and ITRE) to coordinate the availability and use of real-time data resources. *Additional action items regarding scenario planning are outlined in Section 5.*

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*Issue Area Question 3 – How can the state evaluate and predict possible mode shift shares changes? For example, attitudes might change toward transit and other options/ more complex multimodal trips.*

Action Items
- Conduct attitudinal surveys, conduct data analysis on past data, and monitor results. Focus should be on building out scenarios with current models.

CAV Task Force Progress
None to report

CAV Refresh Action – Continue as Short-Term Action Plan
The CAV Task Force should work with CRTPO on the Metropolitan Transportation Plan update and subsequent Regional Travel Demand Model update to identify surveys and data analytics that would be useful in understanding potential CAV impacts on the transportation system. The CAV Task Force also should work with agencies and organizations focusing on CAV modeling and scenario planning (i.e., NCDOT, UNC Charlotte, and ITRE) to understand how various scenarios can be modeled to better understand the potential implications of CAVs. *Additional action items regarding scenario planning are outlined in Section 5.*

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### 5.2.3    Issue Area: Transportation Planning

*Issue Area Question 1 – What ordinances will need to be looked at to prevent unintended consequences?*

Action Items
- Consider potential for HOT/HOV lanes to be converted into CAV lanes.
- Address zoning ordinances, land use, parking requirements, and setbacks.

CAV Task Force Progress
Consideration for converting HOT/HOV lanes to CAV lanes was identified to be led by the FHWA with support from NCDOT and CRTPO. The CAV Task Force has not discussed to date any conversion of HOT/HOV lanes to CAV lanes. Additionally, the CRTPO just conducted a Fast Lanes Reassessment to identify whether there are additional corridors throughout the Charlotte region that could be considered for HOT/ HOV lanes.

CAV Refresh Action – Continue to Monitor
The CAV Task Force should continue to coordinate with NCDOT, federal agencies, and CRTPO on the potential for conversion of HOT/ HOV lanes to CAV lanes, which could become part of CAV corridor pilot testing plans. The immediate need is for congestion management, with longer-term strategies possibly looking at conversion to CAV lanes.

Since there is still great uncertainty surrounding the deployment of large-scale CAV's, communities have focused much of their transportation and land use planning on being "CAV ready" so that codes and ordinances can help facilitate emerging mobility with the idea that they would continuously be updated to reflect changes in CAV technology. *Additional action items regarding transportation and land use planning are outlined in Section 5.*

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*I*ssue Area Question 2 – What actions can be taken to address assumptions and collect data regarding future capacity needs? What can be done to analyze when changes will take place, how they will impact planning? How can the state start capturing data that will provide better real-time and reduced time/ cost planning processes?

Action Items
- Develop "a plan for the plan" and identify needs such as data needs and engage in scenario planning.
- Equity needs to be addressed in the long-term in advancing CAV technology. Need to proactively determine how all communities can take advantage of CAV technology.

CAV Task Force Progress
None to report.

CAV Refresh Action – Continue as Short-Term Action Item
The CAV Task Force should work with CRTPO and surrounding MPOs on their Metropolitan Transportation Plan updates and subsequent MRM update to identify surveys and data needs that would be useful in understanding potential CAV impacts on the transportation system. The CAV Task Force also should work with agencies and organizations focusing on CAV modeling and scenario planning (i.e., NCDOT, UNC Charlotte, and ITRE) as well as communications and technology vendors to understand how data can be collected from existing CAV's in use and analyzed.

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*Issue Area Question 3 – What actions can be taken to challenge our assumptions on which planning is reliant?*

Action Items
- Conduct political and education outreach so that politicians and the public can understand the changes that are coming.

CAV Task Force Progress

This action item was identified to be led by the CAV Task Force. The Centralina Regional Council has undertaken outreach campaigns surrounding the CONNECT Beyond project, which incorporates some similar mobility objectives, but not a campaign directly solely on CAV deployment.

CAV Refresh Action – Continue as Short-Term Action Item
The CAV Task Force should work with various regional partners to develop a CAV outreach and engagement strategy. This can begin as a strategy to engage with regional partners to participate in continued CAV Task Force type workshops and to gather input into the action items outline in the 2018 Roadmap and this Refresh. As the Centralina Regional Council begins an action plan for implementing CONNECT Beyond strategies, an emerging mobility political and educational outreach campaign can be included.

### 5.2.4    Issue Area: Infrastructure Costs

*Issue Area Question 1 – What steps can be taken to transition institutional structures focused on capital planning to future focus on life-cycle cost planning and asset management/ operations?*

Action Items
- Agencies need to inventory what they have so they can know how to leverage it.
- Agencies need to educate officials so everyone is on the same level of understanding.
- Demonstrate the costs versus the benefits of technology to demonstrate why it is worth the investment.
- Tie benefit/ cost analysis into the comprehensive plan.
- Study driver behavior in the context of evolving technology.

CAV Task Force Progress
There has been little involvement from the CAV Task Force to date on these action items.

CAV Refresh Action – Continue to Monitor
The CAV Task Force at the May 2022 Workshop indicated a desire to better understand the overall cost/ benefit of investing in CAV and emerging mobility technology, what impacts it may have on infrastructure and asset management, and to educate partners on the cost/ benefit of investing in technology. They also indicated a need to answer the question "what is CAV infrastructure and what are the costs associated with its deployment" to better understand how CAV technologies might be deployed regionally and what the life-cycle cost comparison to traditional transportation infrastructure is.

Regarding studying driver behavior in the context of evolving technology, a much larger-scale deployment of CAV technologies throughout the transportation network is needed before a considerable effort can be made to study driver behavior in the context of CAV and evolving technology. The use of ITS can improve operational efficiency and ultimately make transportation networks more cost-beneficial in terms of life-cycle costs. A transition to improving operational efficiency of the transportation network should be coordinated with, and could become a component of the Centralina update of the regional Intelligent Transportation System Plan.

*Issue Area Question 2 – What can be done to integrate CAV and local agency planning (and/or funding) of transit/ pedestrian/bicycles?*

Action Items
- Consider safety first, then capacity in terms of deployment of CAV technology.
- Keep the public involved in the discussion.
- Secure funding for software technology to interact between modal groups.

CAV Task Force Progress
Federal agencies have made some safety related data around CAV technology available, but the CAV Task Force has not advanced any action items around this.

CAV Refresh Action – Continue as Short-Term Action Item
As CAV technology deployment continues and additional data is collected from federal agencies and universities, the CAV Task Force can collect, analyze, and share this information with regional partners. There has been a lot of recent research activity on the interaction of different transportation modes and the impact from technology to improve safety.

As the CAV Task Force advances CAV strategies, keep the public aware through campaigns and high visibility pilot projects that can help build awareness and support for CAV programs. The CAV Task Force should also collaborate on and support implementation of CONNECT Beyond recommendations, many of which reflect the use of technology to expand mobility choices.

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*Issue Area Question 3 – What can be done now, and in the long-term, to assess how CAV might impact roadway design, parking requirements, and other infrastructure investments?*

Action Items
- Continuing education with stakeholders.
- Continue collaborating to learn from peers' experiences.
- Continue to work on standard designs, which are important in the long run.

CAV Task Force Progress
The CAV Task Force began collaboration with stakeholders and peers; however, this exercise was disrupted by the Covid pandemic.

CAV Refresh Action – Continue as Short-Term Action Item
Discussion of land use linkage, right-of-way, and curbside policies are further outlined in Section 5.

### 5.2.5 Issue Area: Land Use Planning

*Issue Area Question 1 – As potential impacts of CAV on land use and population growth are considered, what strategies or actions can be employed to mitigate possible negative impacts as isolation or disconnected communities?*

Action Items
- Identify the potentially isolated and disconnected communities.
- Allow more mixed-use development in suburban areas.
- Stay aware of how communities evolve and how regulations change.

CAV Task Force Progress
The CAV Task Force collaboration includes state and local representatives. Although the CAV Task Force doesn't have direct control over land use, the Task Force members, along with Centralina and CRTPO staff, have coordinated and supported several regional initiatives for transit-supportive development and regional mobility. Local governments have reached out to the CAV Task Force for input on and support with local policies that they should be considering to ready themselves for CAV.

CAV Refresh Action – Continue as Short-Term Action Item
Through the CAV Task Force and update of the region's MPO MTPs, provide member jurisdictions with support in land use scenario planning to help them understand how various build scenarios, including those related to CAV, might shape their community.

The CAV Task Force should also collaborate on and support implementation of CONNECT Beyond recommendations, many of which reflect the use of technology to expand mobility choices.

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*Issue Area Question 2 – In what ways can land use planning and CAV be better coordinated to open up more right-of-way for other modes or to create additional choices for users?*

Action Items
- Require flexible transportation in site plans (walk and drop off locations could be beneficial for CAV's)
- Preserve right-of-way for innovative ideas.

CAV Task Force Progress
The Task Force members, along with Centralina and CRTPO staff have coordinated and supported several regional initiatives for transit-supportive development and regional multi-modal mobility. Local governments have reached out to the CAV Task Force for input on and support with local policies that they should be considering to ready themselves for CAV.

CAV Refresh Action – Continue as Short-Term Action Item
Discussion of land use linkage, right-of-way, and curbside policies are further outlined in Section 5. Further, the CAV Task Force should also collaborate on and support implementation of CONNECT Beyond recommendations, many of which reflect the use of technology to expand mobility choices.

*Issue Area Question 3 – What steps can be taken to increase flexibility in regulatory environments, especially parking, and how can it be transitioned to supportive land use planning in sync with how the fleet evolves.*

Action Items
- Connect modes (related to drop-off areas), support existing modes, and prepare for the future.
- Reduce or eliminate parking.

CAV Task Force Progress
Local governments have reached out to the CAV Task Force for input on and support with local policies that they should be considering to ready themselves for CAV, such as parking, curbside management, and transit-supportive land use.

CAV Refresh Action – Continue as Short-Term Action Item
Discussion of land use linkage, right-of-way, and curbside policies, including parking, drop-off, and storage of vehicles, are further outlined in Section 5. Further, the CAV Task Force should also collaborate on and support implementation of CONNECT Beyond recommendations, many of which reflect the use of technology to expand mobility choices.

### 5.2.6   Issue Area: Policy

*Issue Area Question 1 – What actions should the state take to ensure state and local agencies are well informed about CAV?*

Action Items
- Develop statewide vision and goals, with goals in place so that a website can be set up where a consistent message can be sent to the public.
- Host regional workshops and presentations.
- Identify a central contact group in order to keep the message consistent.

CAV Task Force Progress
The CAV Task Force collaboration includes state and local representatives, with constant updates on state and local actions related to CAV and regional involvement in Fully AV Committee at state level.

CAV Refresh Action – Continue as Short-Term Action Item
Through the CAV Task Force, maintain membership and participation by state agency representatives to provide information to local and regional representatives on CAV activities being undertaken at the state level. With regards to the NC Fully Autonomous Committee, Centralina and CRTPO staff, on behalf of the CAV Task Force, should be in communication with the support staff of the NC Fully Autonomous Committee and the various working groups (Business, Infrastructure, Legislative, Research, and Operations) in order to relay the latest discussion to the CAV Task Force. This will keep the CAV Task Force apprised of the ongoings at the state level and help prevent the CAV Task Force from duplicating efforts. The

NC Fully Autonomous Committee has not met on a consistent basis recently, so an early action item would be to connect with staff on the next steps for the NC Fully Autonomous Committee and to also relay what progress the CAV Task Force has made and what their next steps are.

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*Issue Area Question 2 – What regulations, if any, should the state have to ensure CAV improves safety and mobility? Consistency between local and state policy and federal policy; Different private sector profit and public sector acceptance of risk; Unclear roles re: implementing policy – what level of government is responsible?; Cyber security issues.*

Action Items
- Need to implement state statutes and recommendations, and make sure that North Carolina is adapting as uncertainties become clear.

CAV Task Force Progress
The CAV Task Force collaboration includes state and local representatives, with constant updates on state and local actions related to CAV.

CAV Refresh Action – Continue to Monitor
The CAV Task Force indicated a desire to focus on those local and regional action items that they could control and leave statewide issues to NCDOT and other state agencies, with the CAV Task Force monitoring these actions. The CAV Task Force should continue to coordinate with NCDOT and federal agencies on any universal CAV frameworks.

With regards to the NC Fully Autonomous Committee, Centralina and CRTPO staff, on behalf of the CAV Task Force, should be in communication with the support staff of the NC Fully Autonomous Committee and the various working groups (Business, Infrastructure, Legislative, Research, and Operations) in order to relay the latest discussion to the CAV Task Force. This will keep the CAV Task Force apprised of the ongoings at the state level and help prevent the CAV Task Force from duplicating efforts.

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*Issue Area Question 3 – What actions should the state take to ensure a coordinated approach to CAV planning and implementation? Are there actions, events, tools, or other resources that the state could provide? Consistency between local and state policy and federal policy; Unclear roles re: implementation policy – what level of government is responsible?*

Action Items
- Need a statewide and national standard.
- Need to dedicate funding to specific projects for planning and implementation.

CAV Task Force Progress
The state has already implemented ordinances and needs to ensure that there is coordination down to the local jurisdictions.

CAV Refresh Action – Active Coordination with State Representation

The CAV Task Force indicated a desire to focus on those local and regional action items that they could control and leave statewide issues to NCDOT and other state agencies, with the CAV Task Force monitoring these actions. The CAV Task Force should continue to coordinate with NCDOT and federal agencies on any universal CAV ordinances and the coordination from federal and state down to local jurisdictions that needs to occur. This can occur through regular communication of the Centralina and CRTPO staff with the NC Fully Autonomous Committee and the various working groups (Business, Infrastructure, Legislative, Research, and Operations) in order to relay the latest discussion to the CAV Task Force.

# 6  CAV Roadmap Refresh

The purpose of the May 9, 2022 CAV Task Force Workshop was to understand how the CAV industry has evolved, determine if action items in the 2018 Roadmap were still relevant and whether recent efforts have been sufficient in advancing CAV action items, and conduct a refresh of the Roadmap to identify the handful of actions the Task Force could take on collectively that individual agencies/ organizations might not take on alone.

The following action items reflect input from the 2022 Workshop. Participants specifically emphasized that action items should be tailored to local municipalities and agencies in the region, and to let larger more statewide efforts be coordinated or led by NCDOT and other state agencies.

## 6.1  CAV Task Force

As noted throughout the 2022 workshop, Task Force members have unique needs that often differ from the statewide or regional needs. While the statewide and regional needs would tend to focus more on network infrastructure and broad policy making, the local needs would tend to focus more on managing the impacts of CAV on land use and curb utilization. These unique challenges often preclude local agencies from large-scale investments or high-risk initiatives. However, that doesn't mean that local agencies shouldn't endeavor to remain part of the conversation.

The regional landscape of CAV in the Charlotte region includes several regional initiatives that have begun that will help guide the implementation of multimodal strategies, many of which incorporate CAV technology and other smart mobility elements. Beyond the various MTPs developed by MPOs, CONNECT Beyond and Beyond 77 are two guiding documents that the CAV Task Force should be involved with implementing. Centralina has begun the next steps of implementing the strategies of CONNECT Beyond over the next few years. Several strategies from these efforts have been pulled into the CAV Roadmap Refresh, outlined in this section.

A key benefit of the CAV Task Force is the opportunity to get together regularly and use the gathering as a means to stay updated on industry activities, state-of-the-practice changes, and opportunities for partnerships in testing and deployment. While COVID was a large reason behind a gap in activity between the actions taken following the original Roadmap until the impacts of the pandemic took hold and the 2022 Workshop, the CAV Task Force members now have an opportunity to more frequently meet and not only respond to needs or project ideas but be proactive in planning for them going forward. Regular meetings will also be a great mechanism for staying abreast of other peripheral yet related issues such as federal grant opportunities, evolving

telecommunications and broadband opportunities, the mass-introduction of electric vehicle fleets, and ongoing technical issues such as cybersecurity or standards evolution.

*Action Item:*
*Continue to meet regularly as a CAV Task Force and use the meetings as a vehicle to remain updated on policy, technology, and institutional changes in the CAV industry. Engage the private sector in this Task Force that are currently piloting CAV technologies or wish to soon deploy or test CAV technologies. Include feature speakers on various topics at each meeting, discuss project concepts for future federal grant opportunities, and engage more actively with state and regional activities in the CAV space. As a starting point, Centralina and CRTPO staff, on behalf of the CAV Task Force, should be in communication with the support staff of the NC Fully Autonomous Committee and the various working groups (Business, Infrastructure, Legislative, Research, and Operations) in order to relay the latest discussion to the CAV Task Force. The NC Fully Autonomous Committee has not met on a consistent basis recently, so an early action item would help to understand the next steps for the NC Fully Autonomous Committee and to also relay what progress the CAV Task Force has made and what their next steps are.*

*The Centralina and CRTPO staff should reach out to agencies and organizations focusing on CAV modeling and scenario planning (i.e., NCDOT, UNC Charlotte, and ITRE) to understand how planning efforts across Centralina can evolve to better account for CAV deployment in future modeling analyses. This includes discovering new and emerging data sources that utilize probe data and preparing for the onset of future CAV data that will ultimately be beneficial to traffic modeling.*

*Further, with the conversation around CAV evolving to more of a conversation around Emerging or Future Mobility, the CAV Task Force should consider evolving into an Emerging Mobility Task Force. This would allow the Task Force to not be limited to CAV and to better align itself with the recommendations stemming from CONNECT Beyond and Beyond 77. This would enable the Task Force to stay engaged in specific CONNECT Beyond efforts such as:*

- *Developing and adopting policies related to integrated land use and transit planning.*
- *Convene a Regional Transportation Demand Management (TDM) Advisory Committee.*
- *Establish a regional technology for identifying commute solution options.*
- *Establish an Emerging Mobility Working Group.*
- *Complete an Emerging Mobility Suitability Assessment.*
- *Integrate emerging mobility service options in the Regional TDM Plan*
- *Regional mobility services should be included in the Regional Fare Integration and Implementation Study.*
- *Incorporate guidance on emerging mobility services into regional transit standards and performance measures.*
- *Perform a suitability analysis for electric infrastructure in the region.*

*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.*

## 6.2   CAV Framework

For a regional CAV system to function as it is meant to be, the communication and data management framework must be in place, essentially acting as the CAV system backbone. Without a regional framework and governance structure in place, CAV elements will act independently of each other, thus not providing the full benefit of a connected region.

*Action Item:*
*The Task Force should begin to work with appropriate stakeholders at USDOT, NCDOT, City of Charlotte, surrounding MPOs, as well as other jurisdictions and transportation providers, to begin to develop a regional communication and data management framework. This was identified in the Beyond 77 recommendations as well. Beyond those traditional transportation and municipal agencies, the Task Force could pull in other potential partners to develop this framework, such as members from:*

- *Consulting firms associated with CAV*
- *Technology-based companies and equipment providers*
- *Cellular, computing, and communications firms*
- *Autonomous vehicle and micro-mobility pilot firms*
- *Freight and delivery industry*
- *Academic and institutional stakeholders*
- *Utility providers*
- *Not-for-profit, community-based organizations, and/or philanthropic organizations*
- *Health care providers and facilities*
- *Banks and financial providers*

*This would ultimately lead to the development an official Data Management and Governance Plan that identifies roles, responsibilities, policies, and other guidance for agencies and municipalities to follow, along with regional agreements that allow for planning, instruction, data sharing, software applications, and management of a truly regional system. Further, the Task Force can lead a conversation with stakeholders on a centralized data operating and management system. This Data Management and Governance Plan should be coordinated with, and could become a component of the Centralina update of the regional Intelligent Transportation System Plan.*

## 6.3    Fleet Management

The term "fleet management" refers to the various degrees of mixed traffic flow that will be experienced when fleet-based CAVs (owned and operated by transit agencies, freight companies, ride-hauling services, etc.) are mixed into the traffic stream with regular human-driven vehicles. Initially, the CAV penetration rate will be very low (as could be argued is the case today), but this penetration rate will gradually increase over time to where eventually CAVs will be the predominate vehicle type. What we do know is that elements of automation and connectivity will be introduced to the real-life traffic stream in stages, in what can be considered use cases.

- Freight. Both long haul and short haul freight providers are exploring automated driving systems as a way to combat driver shortages, reduce fuel consumption, enhance safety, and increase efficiencies. Long haul providers are typically piloting on Interstate highways, either as stand-alone or in platooning with two or more trucks. The increased development of tiered-warehousing across the country, regional distribution to local warehouses, along with the desire for same-day or next-day delivery has put pressure on the freight industry. Short haul providers are piloting urban freight delivery as a last-mile option for personal parcel delivery. Some are using sidewalks, but larger models are designed for roadway use. Short haul last-mile delivery has been rapidly expanding in more controlled environments like campuses and business parks. Overall, the lack of policies directing automated-freight has impacted larger-scale deployment.
- Fleet Vehicles. Privately operated fleets used for passenger travel, such as ridesharing, ride-hailing, carsharing, transit, passenger and school bus, etc. are testing automated driving systems.  There are numerous tests underway in major cities from coast-to-coast focused on improving the driving systems for "robotaxi" services and other rideshare services. Paid passenger services Fleet vehicles owned by IOOs and other large organizations and governments are also targets for CAV early-deployment. Examples such as transit and emergency vehicle signal priority, collision avoidance in rental fleets, and automated parking systems in government and private fleets are being piloted in several locations.

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*Action Item:*
*The Task Force should collaborate with public and private fleet companies engaged in freight platooning and freight automation to begin outlining policies that are beneficial to municipalities as well as the provider. Through these discussions, the Task Force can identify freight companies interested in testing and deployment of various technologies in the region, first looking for campus or business-park use cases for personal delivery device deployment opportunities and collaborating with stakeholders to bring such services to deployment.*

Discussion
- Truck platooning allows trucks to follow each other closely, thereby reducing air drag and improving fuel economy. Platooning also has the potential to increase vehicle capacity on our highways, particularly along freight corridors. A combination of production safety systems and CV technology allows trucks to closely follow each other in a safe manner by enabling the trucks to continuously communicate and coordinate travel with other trucks in close proximity. Truck platooning deployed across the country is expected to improve national freight movement and the national economy. Vehicle connectivity enables

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> smoother and closer following-truck movement and could lead to increased off-peak trucking.
>
> - Additionally, many freight fleets are looking at how to more efficiently deal with package delivery and last-mile delivery. Pilots are underway in many urban areas and campus-settings to implement automated food delivery and on-demand package delivery using small uncrewed vehicles that can operate on sidewalks or private roadways. These services not only usher in a culture of innovation to the city they are deployed in but provide visible benefits to everyday consumers and help increase future adoption of CAVs.

As supply chains continue to evolve, new delivery techniques will continue to emerge in the form of autonomous delivery vehicles and micro-delivery vehicles, or delivery bots. The changing supply chains will mean an increase in delivery vehicles in urban areas and, in particular, on neighborhood streets. This brings to light the importance of curbside management that both allows businesses to load delivery vehicles to ship their products directly to consumers and to allow delivery vehicles to access consumer homes. Below are strategies that the CAV Task Force could be involved with to ready the region for such technologies and advancements in the freight and logistics industry.

*Action Item:*
*The Task Force should collaborate with freight, distribution, and delivery stakeholders, transportation agencies, and municipal stakeholders to develop an Autonomous Delivery and Micro-Delivery Best Practice Guidebook and Sample Policy.*

Discussion
The development of an Autonomous Delivery and Micro-Delivery Best Practice Guidebook and Sample Policy would be led by Centralina and/or CRTPO staff, with the assistance of an industry consultant expert if desired, with input from freight, distribution, and delivery stakeholders, as well as federal and state transportation agencies. This memo/ policy would be for local governments to use to help develop policy geared towards autonomous and micro-delivery and to ready municipalities and their departments for such technology.
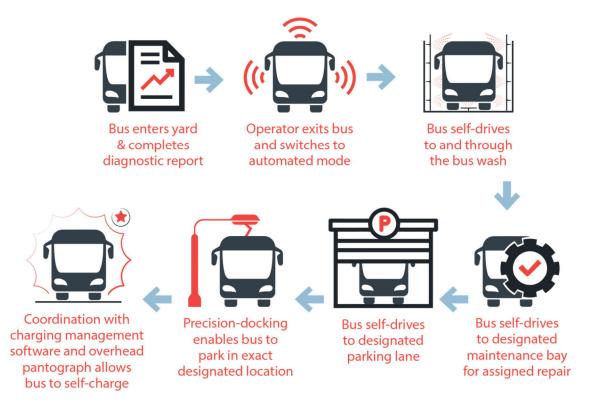
Autonomous delivery vehicles are driver-less vehicles that pick-up products from source locations (businesses, warehouses, manufactures, etc.) and deliver them to consumers. Micro-delivery techniques reflect the use of non-traditional delivery devices, such as delivery robots and drones that make deliveries directly to consumers and could be used in connection with a larger delivery vehicle that arrives in a neighborhood and then sets a smaller bot or drone to make the final product delivery to the consumer's door. These technologies may also necessitate the need for communal neighborhood drop-off/ pick-up zones that residents can use, like a mini P.O. box. This would allow delivery vehicles, robots, and drones to make one stop at a communal location rather than multiple trips throughout a neighborhood. Policies on how these vehicles/ devices may operate on and across streets and sidewalks and where they may "park" will need development. Policies on the operation of package drones similarly need development; for example, should they be restricted to flight paths over existing rights of way, where can they land, and what protections are needed should packages come loose and fall from overhead.

While much of the autonomous and micro-delivery policies and regulations would come from federal agencies or NCDOT, the Task Force should lead collaboration amongst freight, warehouse &

distribution, and delivery stakeholders, transportation agencies, and local jurisdictions to understand how the freight, logistics, and delivery industry is evolving to use CAV and work towards identifying best practices and developing a guidebook to ready municipalities for evolving freight, logistics, and delivery. It will be beneficial to the freight and logistics industry to have consistency across jurisdictional boundaries.

## 6.4 Transit

Transit providers are exploring automated driving systems with AV shuttles that operate in fixed environments (i.e., campuses, resorts, airports, vehicle fleet yards). An expanding use of CAV in transit has been deployment in automated bus yards, which can yield a significant return on investment. Bus yard CAV benefits include enhanced safety, liability cost savings, charging infrastructure cost savings, facility cost savings, and operations and maintenance reductions.



*Action Item:*
*The Task Force should work with regional transit agencies to identify opportunities for Automated Bus Yard deployment. This would initially include development of a Feasibility Study to determine if automated bus yard deployment is feasible from a cost and infrastructure sense. If determined feasible, this would evolve into an Automated Bus Yard Pilot Program at select locations.*

Discussion
An Automated Bus Yard involves the deployment of buses equipped with Automated Driving System (ADS) equipment programmed to safely operate within the Operational Design Domain (ODD) of the

bus yard. This use case offers solutions to advance the evolving capabilities of the technology, increase safety within the yard, and explore the many ways to increase operational efficiency by testing ADS-equipped buses on private property. There are five potential operating scenarios for the automated yard that provide a competitive return-on-investment (ROI):

- Parking & Recall
- Bus Wash
- Bus Maintenance/Service Bays
- Vaulting
- Precision Docking in Service Bays

Most transit agencies will realize safety and service benefits from adopting automated bus yard technology; however, transit agencies with the following attributes may see increased benefits:

- Buses with Drive-by-Wire (DbW) throttle control
- Existing or future plans to transition to a battery electric fleet
- Capacity-constrained bus yard(s)
- Interest in or experience managing innovative pilot programs
- State policy and/or CAV working groups that support and provide insight throughout pilot deployments

The Federal Transit Administration offers funding opportunities, such as through its Advanced Driver Assistance Systems (ADAS) for Transit Buses Demonstration and Automated Transit Bus Maintenance and Yard Operations Demonstration Program.

## 6.5   Modeling and Forecasting

CAV technologies offer potentially transformative societal impacts—including significant mobility, safety, and environmental benefits. The Task Force indicated a desire to understand real-time traffic data when automation is used and when automation is not used.

Current traffic analysis and planning tools, however, are not well suited for evaluating CAV applications because of their inability to incorporate vehicle connectivity/ communication and automated features. There is a need to be able to mimic CAV features in a model for evaluation and assessment of impacts and benefits on the transportation system. Until more and better data is available to improve the accuracy of these models, scenario planning is a viable option. The way this request could be realized in the model is through scenario planning which could help understand the range of outcomes based on their uncertainties. The logic behind regional travel demand model development doesn't render itself well to determine individual vehicular behavior, which is better suited for microsimulation software such as TransModeler or Vissim.

Scenario planning is making assumptions on what the future is going to be and how a given scenario will change overtime in light of that future. It is a flexible means for exploring open-ended challenges, and as a way of thinking that can be applied to a variety of functions, including:

- Policy Development and Strategy
- Investment Decision Support
- Land Use Policy
- Operations Planning

- Design

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*Action Item:*
*The Task Force* should work with agencies and organizations focusing on CAV modeling and scenario planning (i.e., NCDOT, UNC Charlotte, and ITRE) to understand how planning efforts across Centralina can evolve to better account for CAV deployment in future modeling analyses. This includes discovering new and emerging data sources that utilize probe data and preparing for the onset of future CAV data that will ultimately be beneficial to traffic modeling.

Discussion
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.

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## 6.6   Transportation/ Land Use Planning

There was discussion from the Task Force that further deployment of CAV could lead to increased demand for lane usage, curbside use, and/or sidewalk use in the form of automated freight delivery vehicles, on-demand automated ride-hailing services, and automated transit vehicles/ shuttles. This necessitates a need to rethink how the right-of-way is used with respect to both vehicles and vulnerable road users such as bicyclists and pedestrians.

This also necessitates thought on curbside management and how various uses will compete for the curbside. Curbside management policies would be aimed at removing static use of roadway curbsides and transitioning to dynamic use that reflects the demand for curbside space during different times of the day, week, and/or year, recognizing the need to share curbside space with all users. The ideal curbside management strategy would involve the use of smart mobility technology that could work in a connected environment with vehicles to relay real-time information about what curbside usage is permitted and where.

Without policy direction, the private sector will continue to deploy CAV using "their own rules". Government agencies should get in front of these deployments with policies to provide direction in the best interest of citizens - but doing so cooperatively so as to not discourage private investment and innovation.

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*Action Item:*
*The Task Force should collaborate with stakeholders from across the transportation realm (i.e., freight, distribution, and delivery stakeholders, transportation and transit agencies, bicycle and pedestrian advocacy groups, and municipal officials) to develop a memo and/or policy direction involving discussion on trends, issues, and best practices for right-of-way sharing and curbside management.*

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The CAV Task Force identified a need to better link land use with automated mobility. Centralina and CRTPO have developed the CONNECT Beyond plan which identifies strategies to better link land use and future mobility and have issued guidance on mobility hubs in the region. CONNECT Beyond is a regional transit vision and plan that provides real mobility solutions and opportunities for residents and visitors across the Centralina region. A key recommendation of this plan is for regional partners to work with local governments to update their development codes to allow for mobility-supportive development in their communities. This could potentially be expanded to include automated mobility.

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*Action Item:*
*Using CONNECT Beyond as guidance, the Task Force should work with municipalities, developers, and agencies to identify best practices and develop plans and policies that enhance the linkage between land use and CAV/ Emerging Mobility. This could lead to sample unified development code language on how to address CAV's, associated parking, drop-off, and storage, usage of rights-of-way, etc.*

*In Fiscal Year 2024, Centralina was awarded funding through the CRTPO Discretionary Funds Program for a project titled "Linking Transit and Resources." This is a four-part training session series supporting the CONNECT Beyond goal of "Supporting local governments in adopting transit-supportive development policies." This session could help support this action item.*

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*Action Item:*
*The Task Force should work with the MPOs in the region as part of the update of their MTPs to make* planning and readiness for CAV technology an important element. This should include how CAV fits into the future scenario planning to be undertaken as a cornerstone to the MTP.

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## 6.7   CAV Infrastructure

The CAV Task Force recognized a need to better define what CAV infrastructure is and whether this differentiates from traditional transportation infrastructure. This would assist in understand what infrastructure updates are needed to make the region more CAV-ready. The CAV Task Force also discussed opportunities to identify efficiencies in procurement if IOOs are introduced as part of the CAV infrastructure deployment.

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*Action Item:*
*Understanding the true CAV readiness of the region's infrastructure is a large task. As short-term action item, the Task Force could work with partners to scope and secure funding for a study that would provide an overview of each municipality's and agency's existing traffic signal controller equipment and its readiness for CAV. This could also be incorporated into the Centralina ITS Plan update rather than as a stand-alone study. This would lead to identification of key areas where traffic signal controllers and controller cabinets need to be upgraded to models that enable CAV application, communications interfaces are needed to allow vehicles and other infrastructure equipment to communicate with traffic signal equipment, outline maintenance programs for pavement markings and equipment upkeep, develop guidelines for the placement of CAV equipment at intersections and within the right-of-way. A prioritized list of key locations to focus on should be identified (such as Uptown, along key commuting corridors, etc.).*

Discussion
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 to allow for CAV capabilities. The Beyond 77 Plan identified an action item related to conducting a comprehensive inventory of traffic signals and other infrastructure to determine which are CAV ready, and which should be upgraded to be CAV ready. This could be the first step towards preparing an ITS/CAV/Mobility Infrastructure Asset Management Program.