SCAG & City of Laguna Woods

Mobility Technology Plan

Final Report

Prepared for SCAG & City of Laguna Woods
by Arcadis IBI Group

September 2023

Document Control Page

CLIENT:	SCAG / City of Laguna Woods
PROJECT NAME:	Laguna Woods Mobility Technology Plan
REPORT TITLE:	Mobility Technology Plan
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HISTORY:	V2

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Executive Summary

The *Laguna Woods Mobility Technology Plan* represents a strategic vision to harness cutting-edge technology for the benefit of the Laguna Woods community. The Plan offers a holistic approach to enhance mobility, eliminate accessibility barriers, introduce innovative transportation options, and elevate the overall transportation quality. It not only charts a path toward Connected and Autonomous Vehicle (CAV) readiness but also envisions the potential operation of an Autonomous Vehicle (AV) pilot program within the City, with scalability for similar municipalities within the Southern California Association of Governments (SCAG) region.

The proposed solutions and strategies have been crafted based on a understanding of the community's mobility needs, technological interests, and the practical feasibility established through comprehensive public engagement and extensive industry research. Through these avenues, we identified a strong interest in autonomous vehicles within the community while noting their successful deployment in comparable cities across the United States. A recurring theme emerged, emphasizing the critical need for accessible and reliable service, especially for individuals with limited mobility, older adults, and transit-dependent riders.

With that information, the project team has designed a multifaceted approach to prepare the City of Laguna Woods for CAV adoption in the future. This approach lays the groundwork for an AV pilot program that can evolve from a proof-of-concept state into a full-fledged mobility service tailored to the community’s unique needs. This phased approach can be broadly categorized as follows:

Table 1. Summary of Phased Approach

PHASE	DESCRIPTION	INFRASTRUCTURE IMPROVEMENTS	TARGET GROUPS
Phase 1	CAV and AV preparedness and groundwork for an AV pilot program within the City of Laguna Woods in the future. Improvements in this phase provide independent value regardless of City-approved AV pilot service through improved infrastructure and other mobility improvements that would interface with AV operations.	• Mobility hubs • Roadway alterations • Mobility on demand platform • Enhanced network connectivity • Signal controllers and detectors	• General road users • Future AV owners/ operators
Phase 2	Operation of the City of Laguna Woods AV Pilot Program initiates small-scale, replicable AV services. Implementation of AV service is limited to two main arterial roadways within the City of Laguna Woods - El Toro Road and Moulton Parkway.	• Additional traffic control devices • Roadside units • High occupancy vehicle and bus-only lanes • Transit signal priority	• Existing transit riders • Local residents
Phase 3	Expands the Phase 2 pilot to additional jurisdictions and use	• Additional roadside units as needed	• Local residents

	cases, including, but not limited to, • first/last mile service within residential communities • expanded access to medical facilities • integrated trip planning		• Visitors/ tourists • Regional travelers

Across all phases, several improvements to digital and physical transportation infrastructure can prepare the City for CAV operations. These can also be seen in **Table 1.**

Understanding that Phase 2 and 3 of the Plan would require system integration and data sharing across several platforms, the project team created a detailed list of data needs and flows between systems. Should the City pursue implementation of an AV pilot service, this should be a reference for what data would be involved in system operations and planning. If AV pilot operations are established, the City can also use the performance measurement framework presented in this plan, designed to measure the program's effectiveness against several variables, including financial success, sustainability, safety, ridership, and more.

Overall, the *Mobility Technology Plan* outlines clear next steps for CAV readiness and AV pilot operations that can be implemented in Laguna Woods and replicated in similar regional municipalities.

1 Introduction

1.1 Background

The City of Laguna Woods ("The City") has created this *Mobility Technology Plan* under the project leadership of the Southern California Association of Governments (SCAG), as part of its Sustainable Communities Program (SCP). The SCP, a technical assistance program, fosters partnerships with local agencies and strategic allies responsible for making decisions about land use and transportation, all aligned with the region's collective objectives. The overarching objectives of the *Mobility Technology Plan* are as follows:

1. Facilitate lifelong mobility solutions for older adults and individuals with disabilities;
2. Eliminate accessibility barriers, preserving the dignity and independence of all community members;
3. Introduce a spectrum of mobility options that cater to current and future needs within the Laguna Woods community;
4. Enhance resilience and quality of life within the study area by curtailing vehicle miles traveled (VMT), reducing greenhouse gas emissions (GHG), and mitigating traffic congestion.

To achieve those goals, this plan defines strategies with actionable steps to prepare Laguna Woods for a connected and autonomous vehicle future (CAVs) while also outlining steps to establish a new autonomous mobility service for City residents, businesses, and visitors. In this way, the *Mobility Technology Plan* serves as a roadmap for autonomous vehicle (AV) readiness and potential operation of an Autonomous Vehicle (AV) pilot program within the City of Laguna Woods. The framework presented in this plan can also be applied to other municipalities in the SCAG region and offers numerous opportunities for expansion and additional AV pilot opportunities.

1.2 Area of Interest

The City of Laguna Woods occupies approximately three square miles of land that was once a part of Orange County's expansive Moulton Ranch.[1] On March 24, 1999, the City was incorporated as Orange County's 32nd city. The City of Laguna Woods is unique in that the average age of its 17,644 residents is greater than 75.[1] The City abuts the cities of Aliso Viejo, Irvine, Laguna Beach, and Laguna Hills, as well as the Laguna Coast Wilderness Park and other open space areas. Nearby state and interstate transportation corridors include Interstate 5, State Route 73, and State Route 133. Notable land uses include the private gated community of Laguna Woods Village, several senior-oriented residential communities, several commercial centers, faith institutions, and three public parks.[1] Figure 1 shows the City boundaries and relevant landmarks.

As of 2018, 86% of households in Laguna Woods owned at least one vehicle, while 14% were without a car.[2] This translates to higher-than-average transit dependency in Laguna Woods relative to the broader United States population, where an estimated 91% of households own at least one vehicle. At least 25% of City of Laguna Woods residents currently use fixed route and Dial-a-Ride buses. In addition, per the circulation element of the Laguna Woods General Plan just 54% of residents expect to have their license in the next 15 years.[3] These travel behaviors and demographics make transit services in Laguna Woods particularly critical.

[1] https://www.cityoflagunawoods.org/about-us/
[2] https://scag.ca.gov/sites/main/files/file-attachments/lagunawoods_localprofile.pdf?1606012702
[3] https://cityoflagunawoods.org/wp-content/uploads/2015/06/Circulation-Element.pdf

The transportation services currently offered in Laguna Woods include:

City Provided

- City's Senior Mobility Program (taxi bucks / non-emergency medical vouchers)

Laguna Woods Village

- Easy Rider: Nine fixed routes operating Monday through Friday from 9 a.m. to 5 p.m.
- Boost (Lyft): partnered with Lyft rideshare service to offer rides to residents within the transportation system parameter range.
- Journey (non-emergency medical transportation): Scheduled ride service for preapproved riders with medical needs.

Regional

- Age Well Senior Services non-emergency medical transportation service (to/from medical appointments).
- OCTA Fixed Route: Orange County Transportation Authority (OCTA) is the transit agency of Orange County, whose bus system comprises of 60 fixed-route bus routes throughout the county.
- Metrolink: Metrolink is the region's commuter rail line; there are two lines serving Orange County, the Orange County Line and the Inland Empire/Orange County Line.
- OC-Flex: OC-Flex is OCTA's on-demand, curb-to-curb, shared shuttle service pilot program.

Private

- Uber: Private ride-hail service
- Lyft: Private ride-hail service
- Taxi: Pertains to all private taxi services that serve Laguna Woods. Laguna Woods also offers the Senior Mobility Program, which subsidizes the cost of taxi travel for residents over 60 years of age.

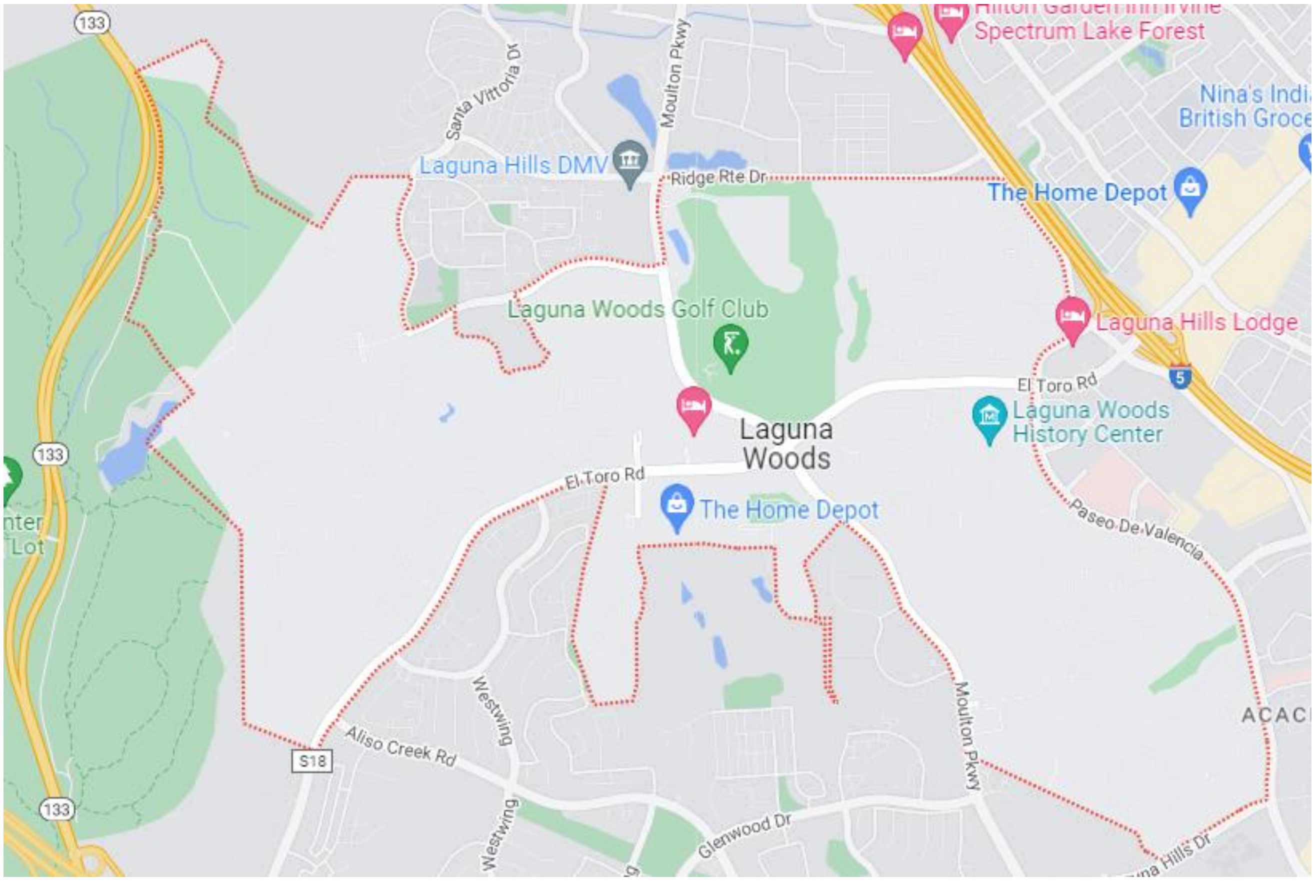

Figure 1. Map of Laguna Woods

2 Public Outreach and Engagement

To better understand the mobility needs of residents and older adults in the community, the project team hosted a series of public engagement sessions around mobility and technology. These sessions involved convening two key stakeholder constituencies:

1. **Advocacy Group**: To help ensure that mobility infrastructure and technology systems prioritize the needs of older adults and individuals with disabilities, an Advocacy Group was established, comprising nonprofit and government service providers specializing in assisting older adults and individuals with disabilities.
2. **Residents Group**: With a focus on discussions concerning mobility challenges and needs, a residents working group was formed to ensure the inclusion of older adults, individuals with low income, transit-dependent individuals, and residents with disabilities.

The Advocacy Group and Resident Group meetings were held twice during the planning process. The first round of meetings (Advocacy Group – May 23, 2023 and Residents Group – April 24, 2023) introduced the study, best practices, and gathered initial comments. The second round of meetings (Advocacy Group – July 14, 2022 and Residents Group – November 10, 2022) presented key findings and conceptual alternatives, seeking feedback to determine the preferred strategy for moving forward.

2.1 Summary of findings

Participants in both meetings expressed general support for developing *Mobility Technology Plan* with cautious optimism. Both groups acknowledged that discussions about connected and autonomous vehicles represented a forward-looking approach to addressing the mobility needs of older adults and individuals with disabilities. They also emphasized opportunities for increased collaboration among agencies and organizations to enhance mobility.

Additional feedback related to transportation and mobility included:

- Plans should accommodate the needs of older adults and individuals with disabilities, including those with visual impairments, ensuring accessibility for all, regardless of their level of familiarity with technology or possession of smart devices
- New deployments should prioritize reliability to create a positive first impression.
- Establishing a strong rapport between drivers and passengers is crucial for current Village transportation services.
- .Discretionary travel often involves short trips for local shopping.
- Medical trips may require longer travel such as to the VA in Long Beach.
- There is a need to ensure the sustainability of existing transit and mobility services, including OCTA's Access, is essential.
- There is a need to address local traffic congestion and parking challenges is a priority.
- Transit solutions should blend on-demand and fixed-route services and consider the challenges of accessing bus stops, particularly for the first and last mile.
- Designing new mobility services should consider destinations outside the City, including medical services in Laguna Hills (Saddleback) and retail on the east side of I-5.
- Introducing a local car share program may benefit residents who no longer prefer car ownership.

- There is a need to ensure the accessibility of Apps and technology platforms, including visual cues for the deaf community, is vital.

Throughout the project, this feedback significantly shaped the proposed considerations and implementation strategies for Laguna Woods.

3 State of the Industry and Best Practices

In the endeavor to explore CAV readiness and the potential for an AV pilot program, the project team engaged in conversations with various stakeholders, including SCAG, the public, and project team members. The primary aim was to assess the state of automated vehicle technology deployments nationwide and to analyze best practices in this technology. This section delves into the pertinent regulations, vehicle types, and case studies related to AV deployments.

The regulatory landscape for AVs is evolving rapidly as policymakers adapt to technological advancements. This section provides an overview of the relevant international, national, state, and local standards applicable to the City of Laguna Woods.

3.1 International/National Standards

Multiple international standards offer guidance for agencies considering AV projects within their jurisdiction. Notably, the American Society of Civil Engineers (ASCE) and the International Organization for Standardization (ISO) have published standards relevant to these endeavors:

- ASCE's Automated People Mover Standards (number ANSI/ASCE/T&DI 21-13) establishes minimum requirements necessary to achieve an acceptable level of safety and performance for an automated people mover (APM) system. An automated people mover is a type of public transportation system that consists of driverless vehicles on a dedicated guideway, more like fixed-route transit than individual vehicles. The standards include a wide range of topics such as operating environment, safety requirements, stations and guideways, and would set the foundation for deployment of an APM in the City of Laguna Woods.

Figure 2. Example of Automated People Mover (Photo: LAWA)

- ISO's regulation 22737:2021 is titled "Intelligent transport systems — Low-speed automated driving (LSAD) systems for predefined routes" and covers similar topics as the ASCE standards such as performance and system requirements as well as test procedures. It covers level 4 automation (high automation) within specific operational design domains for systems on predefined routes.

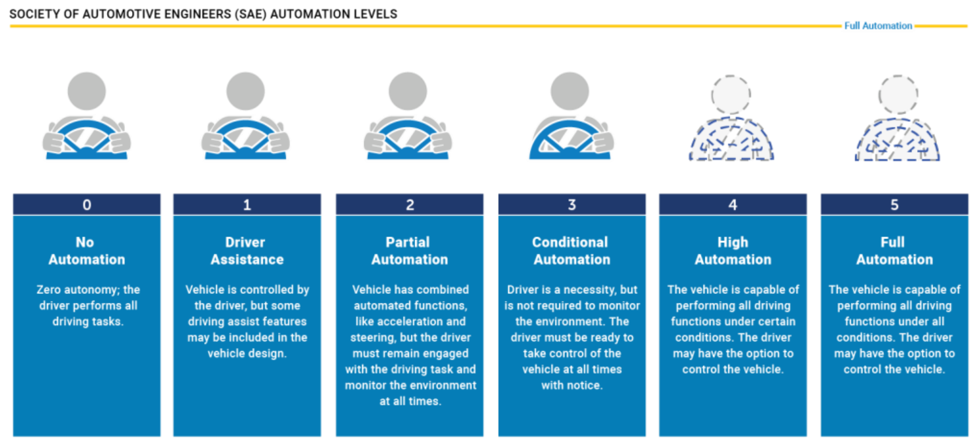

Figure 3. Levels of Automation (Photo: International Association of Fire Chiefs)

3.2 Federal Regulation

At the federal level, autonomous vehicles primarily undergo regulations concerning their design and safety equipment. The National Highway Traffic Safety Administration (NHTSA) under the U.S. Department of Transportation initially introduced the Federal Automated Vehicles Policy (FAVP) to establish safety standards and align with the Level 0-5 Society of Automotive Engineers (SAE) AV classifications.

Subsequent documents issued by the federal government have focused on refining the government's policies. Broadly speaking, AVs must meet NHTSA standards for safety defined by the Federal Motor Vehicle Safety Standards (FMVSS). The FMVSS provides regulations specifying design, construction, performance, and durability requirements for motor vehicles and regulated automobile safety-related components, systems, and design features. However, these standards are based on traditional motor vehicle conventions, such as that the "left" side of a car is the "driver's side," and certain equipment on the vehicle must be oriented relative to that position.

Autonomous vehicles may contain the same safety equipment (such as an airbag deactivation warning light) but could be considered uncompliant if they do not have a driver position around which to orient the equipment. Until these standards are refined and finalized, many operators need to file for exemptions and receive approvals to operate on public roads.

The federal government has left the registration of vehicles, licensing of drivers, and most aspects of vehicle operations to the states to regulate as they see fit.

3.3 State Regulation

In California, the deployment of AVs is primarily governed by California Vehicle Code division 16.6, the Department of Motor Vehicles (DMV), and the California Public Utilities Commission (PUC).

DMV deployment permits are contingent upon a manufacturer's ability to satisfy the following requirements:

- Identifying the operational design domain of the vehicles, as well as describing any commonly occurring conditions within which the vehicles would not be able to operate.

- Verifying the technology is capable of detecting and responding to roadway situations in compliance with the California Vehicle Code, and a description of how the vehicle meets the definition of an SAE Level 3, 4 or 5 autonomous technologies.
- Verifying the vehicles meet FMVSS or have an exemption from the National Highway Traffic Safety Administration. For example, some autonomous vehicles do not have common equipment such as steering wheels or pedals, and therefore do not meet all of the standards of the FMVSS.
- Certifying the manufacturer has conducted test and validation methods and is satisfied that the autonomous vehicles are safe for deployment on California public roads.
- Developing a Law Enforcement Interaction Plan that provides information to law enforcement and other first responders on how to interact with autonomous vehicles.
- Providing evidence of insurance or a bond equal to $5 million.

California approved the deployment of autonomous vehicle testing without a human in the driver seat in 2018, and as of June 2022, there are seven approved companies: Apollo, Autox, Cruise, Nuro, Waymo, WeRide, and Zoox. Three firms (Cruise, Nuro, and Waymo) have been approved to deploy autonomous vehicles outside of a testing environment.

As the chief agency that regulates charter transportation of passengers in vehicles such as taxis, the PUC must also approve the operation of AV deployments where passenger service is concerned. PUC oversees two programs that were first authorized in May 2018: “Drivered AV Passenger Service” and “Driverless AV Passenger Service.” Under the Drivered service, a safety driver is still present in the vehicle, but the Driverless service allows the vehicles to operate only with a remote communication link.

In addition to meeting all DMV requirements, operators must submit a passenger safety plan, file quarterly reports with the PUC, display TCP numbers (similar to taxis and other coach vehicles) and meet insurance and other requirements. Until recently, passengers could not be charged for services offered by AV programs, but recent changes in the regulations have begun to ease that restriction.

In September 2021, the California Department of Motor Vehicles issued permits to Cruise and to Waymo to charge a fee for autonomous services offered to the general public. These services were the first to operate outside of a testing facility and on public roads within specific boundaries, but with a human operator present to take control in the case of a malfunction. Cruise (a division of General Motors) is operating a fleet of modified Chevrolet Bolts in designated areas of San Francisco between 10pm and 6am at speeds of up to 30 miles per hour. Waymo’s fleet of modified Jaguar I-PACE vehicles operate in parts of San Francisco and San Mateo counties at speeds of up to 65 miles per hour. Both types of vehicles can operate in rain and light fog.

In June 2022, California regulators approved Cruise to begin fully operating AVs as taxis in the San Francisco area without a human operator present. Cruise is currently permitted to operate 150 vehicles at night (10pm-6am), and 50 vehicles during the day. The emphasis on nighttime operations is partially because the vehicles are unable to drop passengers at the curb, and instead must block a traffic lane while loading/unloading.

3.4 Local Jurisdictions

At the local level, cities and counties may impose additional restrictions or accommodations for autonomous vehicles, such as special signage, dedicated pick-up and drop-off areas, partnerships with local businesses, or operational area restrictions.

3.5 Vehicles

A range of autonomous and human-operated vehicles offered by different industry providers was analyzed to provide a holistic view of operations. Some of the vehicles are custom designs manufactured and operated or sold by the company. Others are standard passenger vehicles manufactured by a legacy auto manufacturer and modified with additional equipment to make them autonomous. A selection of the companies and the vehicles used is presented below.

Autonomous shuttles are vehicles that navigate autonomously at sub-20 to 25 mph speeds along predetermined, learned paths. Because of these characteristics, the shuttle segment is less regulated than the automotive market. Hence, trial deployments are anticipated to ramp up quickly.

Autonomous shuttles may provide an attractive, flexible solution to move people around industrial campuses, city centers or suburban neighborhoods, connecting such areas with main mass transit systems, greatly improving public transportation.

3.5.1 Human-Operated Shuttles

Given the dynamic nature of the AV industry, the team also assessed the capabilities of existing human-operated shuttles for potential phased deployment in the City of Laguna Woods. These shuttles may be less costly and faster to implement than an AV, while helping to familiarize residents, visitors, and key stakeholders with a new type of local service. In Southern California, Anaheim Regional Transit currently operates FRAN (Free Rides Around the Neighborhood) using electric Polaris vehicles that are manufactured nearby and that operate in a defined service area. Farther south, the City of San Diego operates FRED (Free Rides Everywhere Downtown) using similar vehicles, and the City of Oceanside recently began service on a similar pilot program of its own.

Figure 4: Polaris GEM deployment (photo: FRAN)

3.5.2 Local Motors

Local Motors, founded in 2007,introduced Olli, a small electric shuttle designed to operate at speeds of up to 30 mph. Olli was deployed in approximately two dozen locations over the past several years, and a new version of the vehicle designed for ADA compliance was expected to operate in Palo Alto, CA (see case study below) before the company went out of business in January 2022.

Figure 5: Local Motors Olli (photo: VTA)

3.5.3 GreenPower

GreenPower manufactures purpose-built electric vehicles focused on heavy duty applications, such as cargo delivery, public transit, and school buses. Based on its EV Star platform, the company claims that the AV Star is the first zero-missions, Buy America, ADA compliant vehicle that is fully autonomous. It is capable of operating at speeds appropriate for arterial roads (40-45mph) with up to a capacity of 21 passengers. The first AV Star is currently undergoing testing on public roads in Youngstown, OH, with expected deployment in San Jose, CA at a later date.

Figure 6: AV Star (photo: GreenPower)

3.5.4 Waymo

Waymo, a subsidiary of Alphabet (Google’s parent company) has been testing its AV technology using converted passenger vehicles such as Chrysler Pacifica minivans. Waymo’s vehicles are capable of operating on major streets, and the company has been permitted to provide ride-hailing/taxi-like service in both Arizona and California. Its current deployment in California uses converted all electric Jaguar I-PACE SUVs.

Figure 7: Waymo Chrysler Pacifica (photo: Valley Metro)

3.5.5 May Mobility

With funding from Toyota, BMW, Bridgestone, and a number of venture capital funds, May Mobility has incorporated its AV technology into Lexus SUVs and Toyota minivans. To provide ADA service, the company has also converted small shuttles (similar in appearance to a large golf cart) that some jurisdictions are using for local shuttle service with a human operator. Their converted SUVS/minivans are capable of operating on major streets, while the smaller shuttles are limited to 25-30mph.

Figure 8: May Mobility Lexus RX

3.5.6 EasyMile

EasyMile manufactures small purpose-built electric Avs deployed worldwide, often in more controlled areas or private sites such as business parks, airports, factories, and universities. Based in France, many of the company’s deployments have been in Europe and Asia, but the company has also operated in Salt Lake City, UT, and Boulder, CO (see case study below). Its EZ10 is capable of carrying up to twelve passengers, has a built-in automated electric ramp, and travels at speeds up to 25 mph.

Figure 9: EasyMile EZ 10 (photo: Colorado Smart Cities Coalition)

3.5.7 Navya

The Navya Autonom Shuttle (previously known as Navya ARMA) is an autonomous, low-floor, battery-electric mini-bus built by French firm Navya.

Navya Autonom Shuttles have been deployed in cities around the world, with a notable presence in Europe, North America and Australia.

A Navya driverless shuttle operated in downtown Las Vegas. The City of Las Vegas and Keolis initially partnered on a short-term deployment in January 2017, which was then followed by a year-long pilot sponsored by AAA of Northern California, Nevada & Utah for a 0.6-mile loop involving eight intersections and connected infrastructure.

Figure 10. Navya (photo: Las Vegas Downtown Circulator)

3.6 Deployment Cost Estimates

Deployment costs for automated low-speed shuttle demonstrations vary the number of shuttles, vehicle miles traveled, lease duration, and the need for onboard operators.

Based on current industry experience, the following presents order-of-magnitude cost estimates for automated shuttle deployment.

Table 2. Deployment Cost Estimates

ITEM	COST
Shuttle Lease (includes regular maintenance of shuttle vehicle)	Annual: $110,000 - $130,000
Shuttle Purchase	$230,000 - $300,000
Operational Costs	Annual: $180,000 - $220,000 • $80,000 - $100,000: maintenance, insurance & software license • $100,000 - $120,000: fixed labor costs (could be spread over two to five shuttles)
Operational Costs – Energy (to charge shuttle batteries**)**	Annual: $1,500 - $2,000
Signage and Miscellaneous Charges	Annual: $15,000 - $25,000

While these purchases would need to be made by the City for any AV pilot, FTA grants may be pursued to assist with these costs. IDEA grants and AIM grants in particular have been awarded in the past for such purchases and operational costs. It is also important to note the uncertainty of true cost estimates as some of the vendors in the AV space are underwritten by venture capitalists that may be willing to take a long view on profitability.

3.7 Case Studies

The project team reviewed existing documentation of autonomous vehicle deployments around the United States and updated it based on publicly available information found on the websites of public agencies and news sources. A summary of the AV deployments information compiled through the web is listed in Appendix B at the end of this report.

3.8 Key Takeaways for Laguna Woods

The case studies exercise revealed many key takeaways for potential deployment of an autonomous vehicle/shared people mover concept in the City of Laguna Woods. They are organized into three primary categories and detailed below.

Technical Takeaways are related to the vehicles and the environments in which they operate. These include:

1. Vehicle Selection: Choosing a vehicle that aligns with the specific operating environment is paramount. While smaller driverless shuttles like Olli, designed for lower speeds, may not be suited for main thoroughfares in Laguna Woods, they could be appropriate for smaller neighborhood streets.
2. Data Collection and Mapping: Deploying more advanced vehicles, similar to those in use in Chandler, AZ, or Arlington, TX, necessitates an extensive effort in data collection and mapping to ensure safe operations at higher speeds and in larger areas. This may require advanced partnerships with private operators.
3. Maintenance Facility: The availability and location of a maintenance facility represent a significant constraint in AV deployments. This factor can greatly influence the range and service area of AV operations.

Governance Takeaways are related to the planning, implementation, and funding of the potential project. These include:

1. Cost Considerations: Implementing an AV program can be costly. The City of Laguna Woods may be able to add or improve traditional mobility options at a lower cost. Additional funding through grants might be possible but may not cover the entire expense of the AV program.
2. Procurement Processes: The City should evaluate its own procurement processes to identify any potential restrictions or hurdles that could complicate the purchasing and contracting processes with potential vendors.
3. Workload and Resources: Even with "turnkey" AV solutions largely planned and operated by private firms, implementing an AV program can demand significant resources from the City. To effectively oversee the program, the City should appoint a dedicated project manager with the capacity and time to manage the initiative. Establishing strong relationships with partner agencies and departments is also essential.
4. Regulatory Framework: The City of Laguna Woods may need to develop AV-specific regulations to clarify roles and responsibilities in operating the AV system.
5. Insurance and Liability: Dealing with insurance and liability matters in AV systems can be complicated. Therefore, the City's legal department should be engaged early in addressing these complexities.

Acceptability and Social Perceptions Takeaways are related to expectations and community engagement/buy-in. These include:

1. Setting Expectations: If the City decides to pursue an automated people mover concept, it is crucial to set clear expectations regarding the capabilities and limitations of the service. Additionally, establishing protocols for addressing maintenance issues, accidents, or unforeseen events is essential.
2. Community Engagement: Engaging with the public early and consistently is key to garnering support and addressing concerns. Identifying specific community mobility needs and presenting a compelling case for how AVs can meet those needs is integral to successful engagement.
3. Safety and Reliability: Potential riders place paramount importance on safety and reliability. Therefore, these factors should be a focal point throughout the engagement process.

4 Concept of Operations

Understanding the landscape of the industry and guided by feedback from stakeholders, the project team assembled a plan for CAV readiness and AV pilot operations. This section outlines that approach.

4.1 Scope

The Concept of Operations is broken into three phases: Phase 1 involves preparation for mobility improvements; Phase 2 includes an AV pilot, and Phase 3 plans for the expansion of Phase 2.

Phase 1 – Preparation for Mobility Improvements

Phase 1 of the proposed AV pilot approach involves the preparation necessary for the implementation of an AV pilot program within the City of Laguna Woods. This phase encompasses physical and digital modifications that are required for the operation of an AV service. Although these modifications are not solely dependent on the implementation of AV pilot service, they have the potential to improve Laguna Woods' physical and digital infrastructure, thereby making it better suited for private AVs and other advancements in transportation that are increasingly prevalent in the industry. Some examples of physical modifications include intersection improvements and establishing mobility hubs, while digital modifications could involve creating integrated trip planning, booking, and ride management tools. As such, Phase 1 serves as a precursor to Phase 2 of the AV pilot approach, but it is also a self-contained phase that can be implemented independently.

Phase 2 – AV Pilot

During Phase 2, also known as the ‘City of Laguna Woods AV Pilot Program', a comprehensive and replicable framework for autonomous vehicle service will be created to enable the successful piloting of AVs in the community. The emphasis will be on implementing the necessary systems, processes, and infrastructure for successful operation at a small scale. Implementation of AV service during this phase will be limited to two main thoroughfares, El Toro Road and Moulton Parkway, which will allow for the testing and refining of operations without significant disruption to ridership. However, as a result of this limited deployment, many riders in residential areas may have difficulty accessing AVs. Instead, the focus will be on proof of concept and ensuring that policies and operations are effective before expanding to other areas.

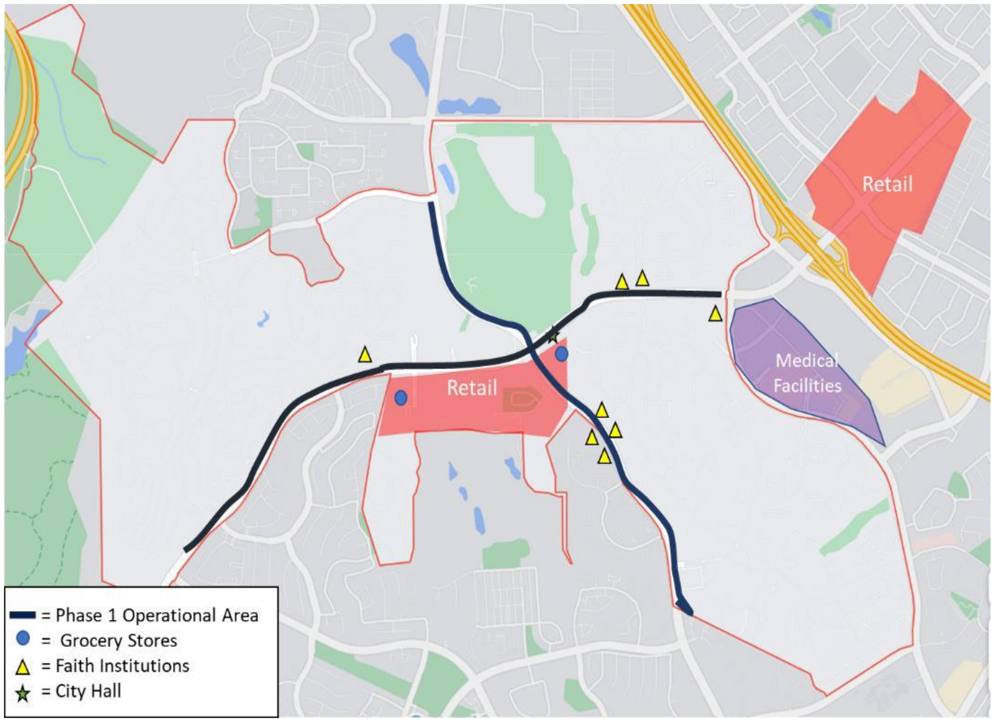

Figure 11. Proposed Phase 2 Operational Area with Potential Destinations

<u>Phase 3 – AV Pilot Expansion</u>

In Phase 3, the AV pilot program can be expanded to encompass additional use cases within the City of Laguna Woods, as well as nearby jurisdictions. Furthermore, the pilot program can serve as a model for the Southern California Association of Governments (SCAG) to collaborate with other municipalities on comparable pilots throughout the region. The additional use cases that are being considered for Phase 3 are as follows:

1. **First/Last mile service within residential communities**: In this scenario, the City extends service from the public right-of-way (ROW) to private streets within residential communities. The service becomes increasingly utilized as a first/last mile solution for older adults and other residents within these communities, who can now book trips to more tailored locations within Laguna Woods and benefit from door-to-door service. A network of private golf cart paths is now available to potentially help carry riders at safe speeds on a protected ROW; autonomous delivery vehicles can also be deployed here for either slow-speed transportation or for first/last mile delivery.
2. **Expanded access to medical facilities**: In this scenario, service is expanded to include access to nearby medical facilities outside of Laguna Woods such as Saddleback Medical Center. Riders can book on-demand rides to and from appointments and medical providers can assist with return trip booking as needed. The new expanded medical destinations serve the needs of older adults and people with disabilities who may lack private transportation to those locations.
3. **Integrated trip planning and booking with regional services**: The integrated trip planning and booking application is expanded further to include additional transit services. Data is shared among multiple regional transit providers and local operators via an integrated data exchange. A joint powers authority governing the platform could be explored as a means of streamlining processes and simplifying information for riders. This

allows users to easily plan and book the most convenient travel possible on a variety of services.

These use cases are not exhaustive and are subject to change, but they serve as examples of how the City of Laguna Woods AV pilot program can expand to serve the needs of SCAG residents more broadly.

4.2 Benefits

The proposed AV program will yield a variety of benefits over each phase.

Phase 1

In Phase 1, the physical and digital infrastructure being implemented would support Phases 2 and 3 but would also provide direct benefits to the City independent of Phase 2 and 3 implementations. These modifications, such as improving intersections and improving trip planning and transit management infrastructure will help prepare the City for an increasingly technology-driven transportation environment and could benefit other areas of transportation such as fixed-route service, pedestrian activity or private EAVs in the future. The transportation paradigm is shifting towards connected and autonomous technologies; the proposed solutions for Phase 1 aim to address that paradigm shift without locking the City into a specific AV pilot.

Phase 2

In Phase 2, the City of Laguna Woods will benefit from the implementation of the Phase 2 pilot, as it provides a safe, reliable mobility options for residents. This AV pilot could demonstrate the many benefits of AV technology, including improved safety, reduced congestion, reduced greenhouse gas emissions, and potentially low costs to riders. Automated vehicles have the potential to be a safer alternative to person-operated trips, by reducing deaths and injuries attributed to human error on roads. Moreover, experimentally, automated vehicles have demonstrated ability to reduce stop-and-go traffic, effectively decreasing congestion and accidents. Lastly, in level 5 automation, labor costs of operation are significantly reduced and help enable lower fares for riders. Overall, the Phase 2 pilot offers an opportunity to explore a unique complement to other mobility services, such as traditional ride-share or taxi services, in a way that allows the City to leverage emerging technologies and place itself at the forefront of innovative transportation models.

Phase 3

Phase 3 has an even broader universe of potential benefits, including leveraging Phase 1 and Phase 2 infrastructure to pursue Mobility-as-a-Service (MaaS) principles of providing multiple mobility options, bridge gaps between transportation and healthcare, and solve first-last mile issues in transit within residential communities.[4] This phase allows for the expansion of AV technology to assist with more trips while also targeting specific groups such as people with disabilities that may benefit directly from their use . In addition, SCAG and other regional municipalities may benefit from the digital infrastructure that is established as part of the project and could use it as a roadmap for other services even outside the scope of autonomous vehicles. Lastly, the program could utilize zero-emission AVs, which will provide myriad benefits to the community, such as reduced emissions and reduced road noise.

[4] https://nationalcenterformobilitymanagement.org/maas-resource-center/

4.3 Disadvantages and Limitations

Limitations of the AV pilot program in Phase 2 are primarily low anticipated ridership; because AV service will operate exclusively along two main thoroughfares, it may be difficult for many riders within residential communities to access AVs. Instead, the focus will be placed on proof of concept, and ensuring that policies are in place and operations are effective before expanding it to other areas.

Potential origins and destinations will also be limited in Phase 2, because fixed-route stops, or on-demand requests will only be on two roads. This means that the utility of the service may suffer until additional use cases are added.

Phase 3 should present more opportunities for passengers, but specific options will need to be tailored to regional contexts. This document lays out three compelling future use cases for AV service, however the jurisdiction and goals of the future program will greatly impact their use and incorporation into the mobility options in the SCAG region.

AV policies are also constrained by what is permissible under the California Vehicle Code and under California law. More information would be needed to understand and comply with all requirements for AVs in California.

The outcomes of AV service are also dependent on level of available automation. While there are currently level 3 AVs on the road, SAE anticipates levels 4 and 5 might not be available until 2030 or later.[5] This means that an assigned driver would still need to be in the vehicle for the Phase 2 program, which increases cost and reduces the appeal of the innovative concept. Still, experts believe automation will continue to improve and will take hold in the coming decades.

4.4 Alternatives and Tradeoffs Considered

Several alternatives were considered for Phase 2, including providing AV service within residential communities, operating service to and from the Saddleback medical facility, utilizing existing golf cart paths for AV service, and establishing a volunteer network of AV operator/monitors from residential communities. While these ideas would be useful to continue exploring, we determined the scope of Phase 2 would be best focused on proof of concept with a smaller scope. Because of that decision, the City of Laguna Woods AV Pilot Program is simplified to operate on public right-of-way on two roads.

There are several alternatives that could take hold in Phase 3, each with their own benefits and disadvantages. The three use cases proposed in this document are three of the most compelling ways to expand the program and/or integrate it into the broader transit ecosystem. However, many others could be considered in the future as well. If level four or five automation becomes tangible, fixed-route bus fleets could be converted to AVs and leverage the same infrastructure being put in place in Phase 2. Opportunities to partner on AV service with other municipalities in the region may grow stronger with time. Local businesses could subsidize AV service in return for stops or virtual stops at their locations. Overall, the opportunities for AV service are numerous, and depending on the technology available at any given stage of automation, the transit landscape could benefit immensely from its utilization in the years to come.

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[5] https://www.sae.org/news/2022/10/the-autonomous-level-4-horizon

5 Data Sharing

Operating the Phase 2 AV pilot program involves a variety of data needs from a number of sources. This section helps identify what data would be needed and how it would likely be exchanged for planning and operation of the system.

5.1 Data Management

The following types of data are needed to support the operation of an autonomous vehicle pilot service. Each type of data can be used for either eligibility, mapping, service planning, trip planning, operations, or curb use. Eligibility data refers to information used to differentiate between residents or other users to allow access to AV pilot service. Mapping data includes different components of locational data in the service area that could be used to plan trips and routes. Service planning data includes information used to learn where an AV pilot or other modes of transportation are most beneficial based on demand or other demographics. The “trip planning” category refers to data used by a mobility on demand (MOD) platform. Data necessary to the everyday operations and service of the AV pilot falls under the “operations” category. Lastly, curb use includes existing information on the City’s curb policies and data to facilitate AV operations in-line with current policies.

Table 3. Types of Data

#	CATEGORY	DATA	DESCRIPTION	DATA SOURCE	DATA DESTINATION
1	Eligibility	Eligibility Criteria (i.e. funding eligibility, age restrictions, etc.)	Which riders are eligible to use AV pilot service	City of Laguna Woods	MOD Platform
2	Mapping	Street Network	Orientation of roads and associated directions	City of Laguna Woods, MOD Platform	Vehicles, Riders
3	Mapping	Travel Time	Duration of a trip	MOD Platform	Vehicles, Riders
4	Mapping	Jurisdiction	Legal boundary within which AV service may operate	City of Laguna Woods	MOD Platform
5	Mapping	Landmarks / Points of Interest	Locational data about significant specific point locations	City of Laguna Woods	MOD Platform

#	CATEGORY	DATA	DESCRIPTION	DATA SOURCE	DATA DESTINATION
6	Mapping	Traffic Conditions	Real-time information on traffic on roads	City of Laguna Woods	Vehicles, MOD Platform
7	Mapping	Road Conditions	Updated information on road closures, conditions, construction, or accidents	City of Laguna Woods	Vehicles, MOD Platform
8	Service Planning	Demographic Data	Data on race, age, sex, population, income, and employment	U.S. Census Bureau	City of Laguna Woods
9	Trip Planning	GTFS-Flex	On-demand trip information and service schedules	City of Laguna Woods	MOD Platform, Rider
10	Trip Planning	GTFS-RT	Real-time trip routes and service schedules	City of Laguna Woods	MOD Platform, Rider
11	Trip Planning	Payments	Amount paid for a trip and method of payment that will be entered directly by Riders or drivers into the MOD platform	Rider	MOD Platform
12	Trip Planning	Hours of Operation	Time information on when vehicles will be traveling	City of Laguna Woods	MOD Platform, Rider
13	Operations	Vehicle Charging Information	Status of vehicle's electric battery capacity and range	Vehicle	MOD Platform
14	Operations	Vehicle Status	Information related to vehicle trip-readiness and maintenance	Vehicle	MOD Platform

#	CATEGORY	DATA	DESCRIPTION	DATA SOURCE	DATA DESTINATION
15	Operations	Trip Request	Rider request for a trip from a web or mobile device. Includes trip ID, requesting device ID, device type, pick-up location, drop-off location, pick-up time, and drop-off time.	Rider	MOD Platform
16	Operations	Trip Assignment	Trips are automatically assigned to a specified route	MOD Platform	Vehicles
17	Operations	Trip Confirmation	Platform confirms that a trip has been booked	MOD Platform	Rider
18	Operations	Trip Modification	Rider amends or cancels a trip from a web or mobile device. Includes Trip ID device ID, device type, original/modified pick-up location, original/modified drop-off location, original/modified pick-up time, original/modified drop-off time	Rider	MOD Platform
19	Operations	Vehicle Location	Location and heading along with other details for a vehicle in service made available through the MOD platform	Vehicle	Rider, MOD Platform, Signals

#	CATEGORY	DATA	DESCRIPTION	DATA SOURCE	DATA DESTINATION
20	Operations	In-vehicle Communications	Data related to safety warning or traffic information within vehicle network	Vehicle	MOD Platform, Riders
21	Operations	Trip Status	Trip-level log of actual time and location for trips on the manifest along with any no-shows and cancellation events made available through the MOD platform, including information entered by drivers. Includes trip ID, ETA, and actual time of arrival.	Vehicle, MOD Platform	MOD Platform, Rider, City of Laguna Woods
22	Operations	Delays	Information related to incident delays on road	MOD Platform	Vehicle
23	Operations	Detours	Data related to construction or ad-hoc detours on roads	MOD Platform	Vehicle
24	Curb Use	Curb Management Policies	Information related to City policies and practices regarding curb usage, including vehicle drop off regulations and vehicle stop regulations.	City of Laguna Woods	MOD Platform

Figure 12 illustrates how this data would pass between systems for the Phase 2 AV pilot. Each number on the diagram corresponds with the type of data and number outlined in **Table 3**. Each element that appears in the diagram as a box is discussed in more detail below.

- **City of Laguna Woods**: The City of Laguna Woods serves as a 'center' and refers to the City's existing transportation staff, operational facilities, and supporting digital infrastructure such as dispatching software, file sharing services, and servers.
- **MOD platform**: The MOD platform pertains to the software used by Laguna Woods staff for dispatching, scheduling, and monitoring AV service. It also includes a rider-facing application that allows for trip planning, booking, and fare payment. Because the city does not currently have these features in place for AV service, the MOD platform would serve as a transportation management center (TMS) for these functions. The platform would be established in Phase 1 and incorporate data exchange related to AV service in Phase 2.
- **Vehicle**: Vehicles include all transit vehicles being used for AV service in the Phase 2 AV pilot program. While vehicles will be developed and sold by a third-party provider, the City of Laguna woods serves as the owner and operator of these vehicles. Data from these vehicles will be shared with the MOD platform and owned by the City.
- **Traveler**: traveler refers to the individuals or groups who are the primary users of the City of Laguna Woods AV pilot program; the types of data they will receive via their personal device include trip schedules, real-time vehicle ETAs, trip alerts, and notifications.

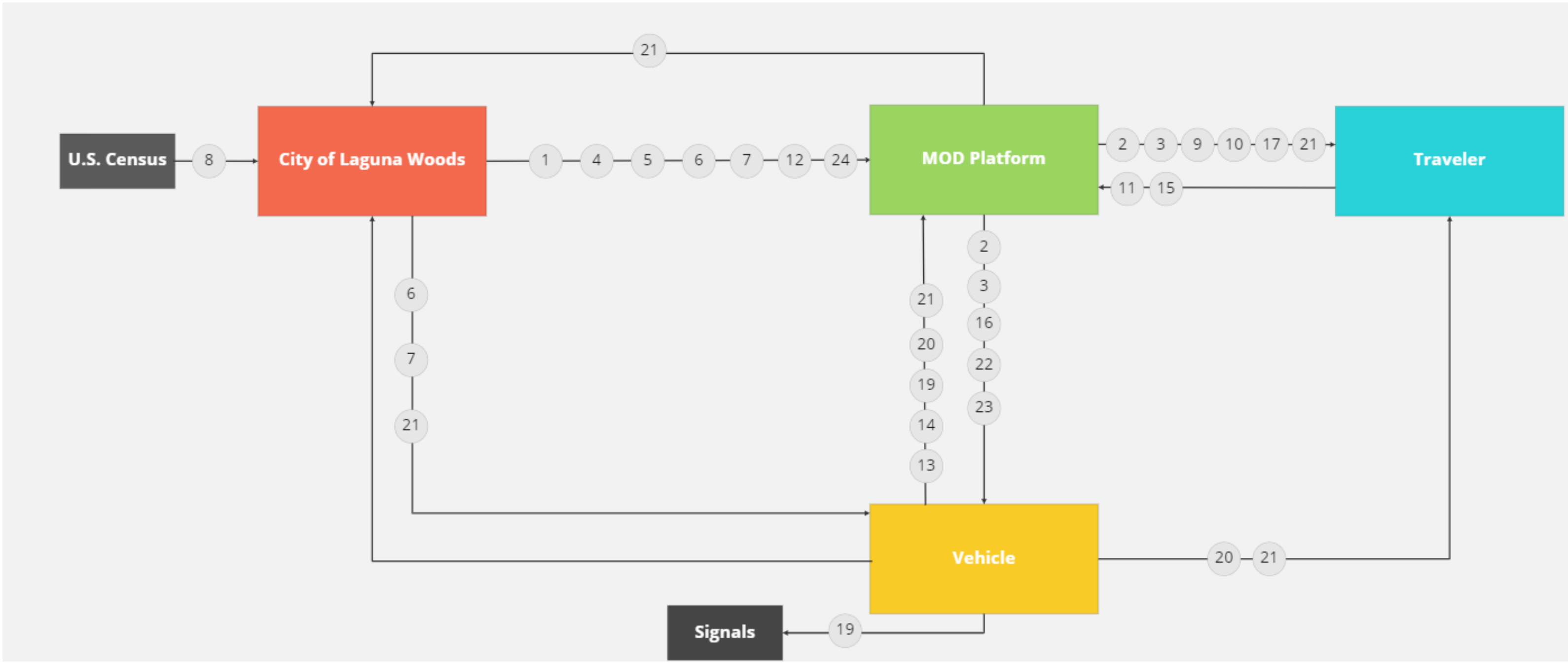

Figure 12. Data Exchange for Phase 2 AV Pilot Program

Integrated Data Exchange: To achieve effective data storage and communication in Phase 3, the project team will need to create a centralized regional datahub for effectively sharing data. The Integrated Data Exchange (IDE) would be a web-based platform that collects data input by various organizations and provides access to multi-source transportation data to support the AV program. In this scenario, additional data providers such as Uber or Lyft as well as Taxi companies and OCTA could be able to access the exchange.

Data being stored in the IDE would include regional trip level data, eligibility requirements, real-time traffic, and real-time transit information. In Phase 3, the IDE could be owned and operated by a joint powers authority such as SCAG (future use case 3) or other service providers.

6 Supporting Infrastructure

Implementing CAV technology requires the establishment of supporting infrastructure, including both physical and digital infrastructure. Digital and communications infrastructure in Phase 1, which includes the implementation of an MOD platform and upgrading network connectivity and signal controllers, will have benefits in the absence or presence of an AV pilot. In Phases 2 and 3, more AV-specific infrastructure, including onboard units (OBUs), roadside units (RSUs), and SCMS, will be implemented. Similarly, physical infrastructure and technology proposed for Phase 1 will not only be instrumental in operating a CAV pilot program during Phases 2 and 3 but will also be conducive to facilitating increased private CAV usage. Additionally, it will provide numerous benefits to transit riders, micromobility users, and pedestrians.

6.1 Digital and Communications Infrastructure

6.1.1 CAV Communications Channels

There are several interfaces that make up the complete CAV communications framework. These can be broken down into five distinct subcategories, but the combined communications framework is commonly referred to as vehicle-to-everything communications (V2X). These communications channels are presented in Figure 2 and are described below.

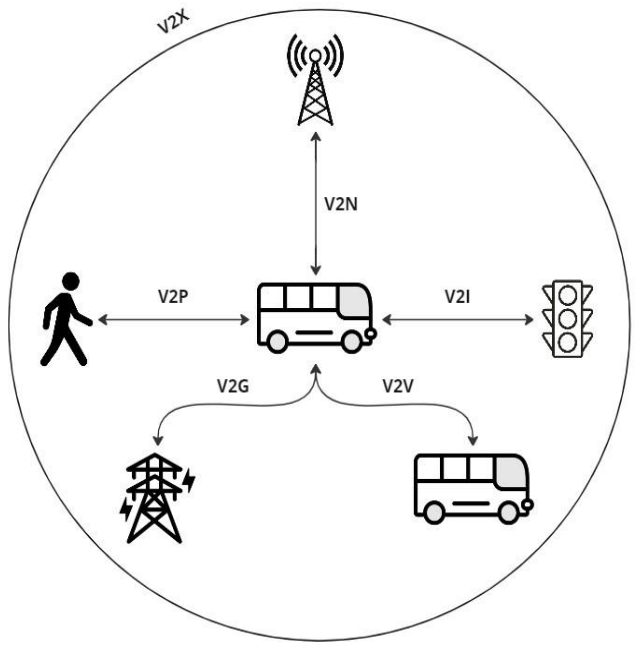

Figure 13. Overview of CAV Communications Channels

6.1.1.1 Vehicle-to-Network (V2N)

V2N communications consist of a vehicle communicating with a broader network to access data related to traffic conditions, weather, and other real-time information. Cellular communications represent a type of V2N communications, as do communications with satellites and communications with cloud-based infrastructure.

6.1.1.2 Vehicle-to-Vehicle (V2V)

V2V communications consist of different vehicles on the roadway exchanging information, such as position and speed, in real time. V2V communications function best when the sending vehicle and the receiving vehicle are both equipped with V2V technology. Though not widely adopted yet, it is expected that vehicles will be manufactured to include this technology in the near future.

6.1.1.3 Vehicle-to-Infrastructure (V2I)

V2I communications primarily consist of roadside units (RSUs) mounted along the roadway communicating with an OBU in a vehicle via radio communications. This allows drivers to receive information in real time via a graphical user interface hardwired to the OBU, such as a phone, tablet, or built-in interface. This enables the use of applications such as red-light violation warning, curve speed warning, and transit signal priority (TSP). Note that V2I infrastructure is primarily the responsibility of the road authority to procure, install, operate, and maintain.

6.1.1.4 Vehicle-to-Pedestrian (V2P)

V2P communications consist of vehicles communicating with pedestrians and bicyclists to enhance safety. For instance, through smartphones or wearable devices, pedestrians can communicate with nearby CAVs to alert them to their presence and avoid potential conflicts. V2P communications are currently available through in-vehicle systems that include blind spot detectors, object sensors, and other in-vehicle warning systems that can detect people in roadways.

6.1.1.5 Vehicle-to-Grid (V2G)

V2G communications consist of vehicles communicating with the electrical grid, allowing them to supply power to the grid when parked or draw charge for their batteries during off-peak hours when electricity rates are lower.

6.1.2 CAV Communications Technology

6.1.2.1 Direct Short-Range Communication (DSRC)

DSRC is a wireless communications technology in the 5.9 GHz radio spectrum specifically designed for reliable, low latency, connected vehicle applications. DSRC enables both V2V and V2I communications.

DSRC operates on the Wireless Access in Vehicular Environments (WAVE) wireless standard.[1] DSRC has well-established standards, practices, and lessons learned, having been used since the first testbed in California in 2005.[2] However, recent decisions by the Federal Communications Commission (FCC) ordered that intelligent transportation systems (ITS) operations transition from DSRC technology to cellular vehicle-to-everything (C-V2X) technology.[3] To maintain flexibility with an evolving regulatory environment, many vendors have developed dual units, i.e., OBUs and RSUs, with DSRC and C-V2X radio capabilities.

6.1.2.2 C-V2X

C-V2X is a recent wireless communications technology that uses cellular radios rather than purpose-built DSRC radios. The “C” in C-V2X specifically denotes cellular radio communications, distinguishing it from consumer cellular networks.[1]

C-V2X is based on the Long-Term Evolution (LTE) wireless standard, with radio frequencies intended to be used within the 5.9 GHz band. [1] The next generation of C-V2X, based on the 5G wireless standard, is already in development. As it is developed, 5G New Radio (NR) C-V2X will coexist with, be compatible with, and eventually replace 4G LTE C-V2X.[4]

While DSRC is an established technology, bench tests have indicated better range for C-V2X compared to DSRC under various scenarios.[3]

6.1.3 Cybersecurity

Due to their reliance on advanced software and communication infrastructures, CAVs are particularly vulnerable to cybersecurity risks. Those risks are critical to mitigate for a number of reasons. First, it’s necessary to protect the safety of both passengers and other road users. One core advantage of CAVs is a possible future with fewer crashes and injuries. However, if a system is breached, compromised systems can lead to *added* collisions and injuries.

Cybersecurity is also important for building up public trust and acceptance of the technology. Cybersecurity risks pose a threat to public perception and adoption. Lastly, compromised data can affect both program evaluation (i.e., distorted KPIs) or render CAV services inoperable (i.e., data injections that alter location data).

Cybersecurity concerns include both communications and sensor attacks. Communications attacks involve targeting the wireless communications network and protocols that CAVs use to exchange data with other elements (V2X). Communications attacks aim to compromise data being passed between CAVs and other infrastructure and can impact the coordination and decision making of CAVs. Types of communications attacks include unauthorized access to communications networks, man-in-the-middle attacks[6], denial of service attacks on communications, impersonation, spoofing, and data tampering.

Sensor attacks involve targeting the physical equipment used by CAVs to navigate and gather data. These sensors include components such as radar, lidar, cameras, and GPS. Sensor attacks aim to disrupt or corrupt the data being collected by CAVs to deceive the perception system, which can lead to unsafe vehicle decisions and outcomes. Types of sensor attacks include spoofing, jamming, data injection, sensor deactivation, and sensor data privacy attacks.

6.1.3.1 Best Practices

Best practices for cybersecurity measures can be classified as either proactive measures or reactive measures. Proactive measures are taken in advance of any cybersecurity breaches to protect CAVs and related infrastructure from potential threats. These measures can include cryptography, physical security, and privacy preservation. Reactive measures are actions taken after a security breach or event has occurred to mitigate the impact and respond effectively to the situation. Reactive measures can be signature based, anomaly-based, or context-based. When implementing AV pilot program, Laguna Woods should engage in proactive measures while training relevant staff on reactive measures as needed. This could also be combined with any existing IT training that exists.

6.2 Physical Transportation Infrastructure

This section provides a summary of the physical infrastructure that would be beneficial in Phase 1, and critical to the success of an AV pilot program in Phases 2 and 3.

[6] Man-in-the-middle (MITM) attack is a cyberattack where the attacker secretly relays and possibly alters the communications between two parties who believe that they are directly communicating with each other, as the attacker has inserted themselves between the two parties.

6.2.1 Phase 1

6.2.1.1 Mobility Hubs

Mobility hubs serve as centralized locations where various modes of transportation intersect and connect, thereby facilitating seamless transfers between different modes of travel. These hubs are designed to enhance transportation options, improve accessibility, and promote sustainable and efficient urban mobility. They often serve as focal points for public transportation, private vehicles, cycling, walking, and other forms of transit, allowing passengers to transition smoothly from one mode to another. OCTA's mobility hub study identified locations for hubs. While most of these locations, however, are not in Laguna Woods, the city can lend the findings in the report in their implementation of mobility hubs.[7] In Phase 1, the City could establish mobility hubs incorporating the elements outlined in **Table 4**. A more detailed discussion of these elements follows in the subsequent sections.

Table 4. Phase 1 Mobility Hub Elements

CATEGORY	ELEMENT	DESCRIPTION
Mobility Hubs	Bike racks	Provides infrastructure to allow use of personal bikes and connect bikers with other transportation options
	Bike lockers	Allow for secure storage of bicycles or other small personal mobility devices on site.
	Micromobility services	Offers bike-share or scooter-share services at a low cost
	Transit stops	Integrates transit options offered by Orange County Transportation Authority (OCTA), Metrolink, or OC-Flex
	Carshare station	Allows for short-term rentals for medium-long distance use or connection from transit accessible to transit inaccessible areas
	Pick-up/Drop-off Zones	Allows for more seamless Transportation Network Company (TNC) ridesharing and other microtransit loading/unloading
	Charging station	Provides public level 2 chargers (240 Volts, up to 20 miles per hour of charging) or level 3 chargers (480 Volts, generally up to 80% charge in 20-30 minutes)

Most elements above provide benefits to transit riders and active transportation users. However, charging stations could be used by private CAVs as well. In Phases 2 and 3, CAV operation could be integrated into mobility hubs as key destinations to connect public CAV riders to other transportation services. It also allows for booking AV services via kiosks and facilitates easy pick-up and drop-off by planning at established rideshare loading zones.

[7] https://www.octa.net/programs-projects/programs/plans-and-studies/completed-studies/mobility-hubs-study/

6.2.1.1.1 Bike racks

Bike racks at mobility hubs are instrumental in promoting sustainable and multimodal transportation. Providing secure bike parking encourages commuters to combine cycling with other transit options, bridging the gap between transit stations and final destinations. This approach reduces road congestion, greenhouse gas emissions, and the demand for traditional parking spaces, benefiting the environment and urban mobility. Additionally, bike racks can enhance accessibility, encourage physical activity, and support local businesses, contributing to healthier and more vibrant communities. Implementing such infrastructure should be in coordination with OCTA active transportation planning efforts and active transportation plans in nearby communities.

6.2.1.1.2 Bike lockers

Bike lockers are secure storage units designed to safeguard bicycles from theft, vandalism, and the elements. These lockers offer several benefits, including enhanced security for cyclists, protection from weather-related damage, and convenience. In a mobility hub, bike lockers can play a crucial role by encouraging more people to use bicycles as a sustainable mode of transportation. Commuters can store their bikes in these lockers while using other forms of transportation like buses or trains, promoting seamless multi-modal transit options. This integration not only promotes eco-friendly commuting but also reduces traffic congestion and supports healthier urban environments.

6.2.1.1.3 Micromobility services

Micromobility devices such as electric scooters and shared bicycles can offer efficient and sustainable transportation solutions to supplement other travel. These devices serve as valuable first/last mile options, allowing commuters to easily connect with public transit networks or complete shorter journeys. By offering micromobility options at mobility hubs, the City can enhance connectivity and reduce reliance on personal vehicles, decreasing traffic congestion and lowering carbon emissions. At mobility hubs, well-maintained fleets of shared electric scooters and bicycles offer riders relatively affordable and efficient alternatives. However, their implementation should coordinate with existing bike-share services or scooter-share vendors and programs should be evaluated for potential ridership before any investment is made.

6.2.1.1.4 Transit Stops

At their core, mobility hubs are designed to facilitate the transfer of passengers between various modes of transportation. Transit stops are the focal points of that effort, where passengers can easily switch from one mode to another or from one route to another. When establishing mobility hubs, it is typical to locate them at a location where multiple transit lines or services come together. As with other services, Laguna Woods must coordinate with other transit agencies in developing hubs to accommodate transit. Further coordination with the Orange County Transportation Authority (OCTA) should be done to identify high ridership stops along El Toro Road and Moulton Parkway to incorporate transit services as best as possible. A map and additional information of transit services offered in Laguna Woods can be found in their transportation guide.[8]

6.2.1.1.5 **Charging Stations**

During Phase 1, charging stations would provide value to private vehicle owners. As all California vehicle sales transition to electric vehicles (EVs) by 2035, public charging infrastructure will become increasingly crucial. These chargers could also be designed to provide level 1 charging to golf carts, which are used throughout the community, many of which are becoming electric vehicles as well. During Phases 2 and 3, charging stations will also be needed if Laguna Woods chooses to use electric vehicles for CAVs. In that case, these same stations could be leveraged for charging and could also allow for CAV charging in the future.

6.2.1.1.6 **Pick-up/Drop-off Zones**

Pick-up and drop-off zones would allow for seamless Transportation Network Company (TNC) rides such as Uber and Lyft, or public on-demand ridesharing that does not impede traffic. In Phase 2 and 3, the same designated area could facilitate efficient and safe passenger boarding and alighting from CAVs. These zones typically feature the following elements:

- Clear signage: Clearly marked signs and symbols indicating the pick-up and drop-off areas to ensure that passengers and CAVs can easily identify and locate the designated zones.
- Safe access: Incorporation of safe pedestrian pathways with ramps, tactile indicators, and curbside markings to guide passengers and ensure accessibility for all.
- Shelter and seating: Provision of shelters and seating areas where passengers can wait for their CAV to arrive. These stops can also include closed circuit television cameras (CCTVs), digital signage, wayfinding assistance, and other accessibility features.
- Curbside space: Designated curb space for CAVs to stop temporarily for passenger pick-up or drop-off without obstructing regular traffic flow.
- Loading/unloading zones: Dedicated areas where passengers can load and unload their belongings, often marked with appropriate signage and symbols.
- Local regulations and permits: Adherence to local regulations and permits for operating CAVs in the designated zones.

6.2.1.1.7 **Carsharing**

As part of Phase 1, mobility hubs could offer carshare stations, in which residents can rent cars short-term and park them at various stations. Carsharing can also play a crucial role as a first/last mile solution in the CAV pilot, addressing the challenges of CAV route limitations and bridging other transit gaps. In Phase 1, the City will need to coordinate with major carshare vendors to allow use in Laguna Woods and viable locations for pick-up and drop-off. In Phase 2, the CAV pilot will only service Moulton Parkway and El Toro Road, in which other modes of transportation, including carshare, will be needed to bridge first/last mile scenarios.

[8] https://lagunawoodsvillage.com/documents/view/952/VMS_Transp_Guide_FINAL_FOR%20WEB.pdf?v=1579129606

6.2.1.2 ***Roadway Alterations***

Roadway alterations in Phase 1 emphasize changes that would be helpful for all drivers and private CAV operators in the future. These are generally broken down into three categories.

6.2.1.2.1 **Road Surface Markings**

Road surface markings can include lane line markings to signal lane boundaries and give information about traffic direction or rules (e.g., dashed lines). Visible and unambiguous road markings are critical for CAV because humans and vehicles must be able to interpret the marking. Coordination with traffic engineers in Phase 1 and future phases is recommended to ensure maximum visibility.

6.2.1.2.2 **Improved Crosswalks**

Safe and visible crosswalks are imperative to pedestrian or cyclist safety when CAVs are deployed. Improving crosswalks in Phase 1 can ensure roadways are as safe as possible, even before CAV deployment. These improvements generally include pavement markings, safety warnings, dedicated signaling devices, and timing devices to improve pedestrian safety. Planning will require identifying appropriate crosswalks to upgrades (if necessary).

6.2.1.2.3 **Signage**

Signage can include any road signs that convey regulations, instructions, or warnings to vehicles. Upgrading signs to be clear and visible, similar to road markings, is necessary for vehicles to interpret their meaning. For successful CAV deployment, all signage should be MUTCD compliant. A summary of all roadway modifications that should be considered in Phase 1 is listed in **Table 5** below.

Table 5. Phase 1 Roadway Modification Checklist

INDEX	ISSUE	RELEVANCE TO CAV READINESS	POTENTIAL SOLUTION
1	Missing shoulder lines	High quality pavement markings are needed for AVs to understand the physical boundaries that they must operate within.	Apply shoulder pavement markings where they are missing.
2	Missing pedestrian crossing lines	High quality pavement markings are needed for AVs to understand the physical boundaries that they must operate within.	Apply pedestrian crossing pavement markings where they are missing.
3	Incorrect stop bar width	High quality pavement markings	Update stop bar widths.

INDEX	ISSUE	RELEVANCE TO CAV READINESS	POTENTIAL SOLUTION
		are needed for AVs to understand the physical boundaries that they must operate within.	
4	Faded signs	AVs require highly visible and consistent signs so that they can adjust their behavior accordingly.	Replace faded signs.
5	Sign placement	AVs must be able to perceive signs within their field of view.	Place signs to meet the proper location requirements.
6	Sign height	AVs must be able to perceive signs within their field of view.	Adjust sign height to meet height requirements.
7	LED sign and signal refresh/flicker rate	A suitable refresh/flicker is needed to ensure that AVs are able to perceive LED signs and signals.	Use a refresh/flicker rate for LED signs and signals greater than 200 Hz.

6.2.2 Phase 2 and 3

Additional development and additions to the infrastructure established in Phase 1 may be beneficial for deploying a CAV pilot as envisioned for Phases 2 and 3. In particular, further enhancements to traffic control devices and signal infrastructure will need to be implemented. Installing roadside units and exploring lane designation would also be recommended.

6.2.2.1 Traffic Control Devices

Traffic control devices in Phases 2 and 3 will build upon roadway alterations made in Phase 1, as outlined in section 6.2.1.2. Traffic control device work in Phases 2 and 3 should consider the following:

- Connected traffic signals: Traffic signals equipped with Vehicle-to-Infrastructure (V2I) communication capabilities can exchange data with CAVs. These signals transmit real-time information about signal phase and timing, enabling CAVs to adjust their speed and behavior accordingly.
- Digital signs: Digital signs equipped with wireless communication can relay dynamic information to CAVs and other vehicles, such as traffic congestion, detours, road closures, and weather conditions, allowing CAVs to make informed decisions.

- Crosswalk signals: Crosswalk signals with communication capabilities can provide direct information to CAVs about pedestrian crossings, indicating when pedestrians are crossing or about to cross.
- Lane control signals: Lane control signals equipped with V2I technology can guide CAVs in real-time, indicating which lanes are open, closed, or reserved for specific purposes.
- Intersection priority signals: These signals can facilitate communication between CAVs and the traffic signal system, ensuring optimal traffic flow by granting priority to CAVs when needed.

6.2.2.2 Roadside Units (RSUs)

Roadside Units (RSUs) provide wireless communications from roadside infrastructure to CAVs. RSUs allow for vehicle-to-everything (V2X) communication, enabling data exchange between vehicles, pedestrians, infrastructure, and traffic management systems. RSUs can act as communication hubs, relaying information between vehicles and other entities, such as traffic signals, road signs, pedestrians, and other RSUs. Additionally, RSUs transmit and receive data using wireless technologies like Dedicated Short-Range Communication (DSRC) ensuring seamless connectivity between vehicles and the roadside. In Phase 2, RSUs will need to be installed along El Toro Road and Moulton Parkway but can be added to other roads in Phase 3. It is recommended that RSUs be installed at each signaled intersection along the operational corridors.

6.2.2.3 High Occupancy Vehicle (HOV) and Bus-Only Lanes

HOV lanes are dedicated lanes on highways or roads reserved for vehicles carrying multiple occupants, typically requiring a minimum number of occupants (such as carpooling) to use the lane. Similarly, bus-only lanes are dedicated lanes reserved exclusively for buses, providing faster and more reliable transit for public transportation. Each type of lane could be implemented independently of Phases 2 and 3, but understanding jurisdictional considerations over the right-of-way, these would not be implemented. In Phases 2 and 3, it is worth noting that such lanes could benefit not just transit vehicles and high-occupancy vehicles but also CAVs. The technology typically used for HOV and bus-only lanes, including camera systems, license plate recognition systems, message signs, V2X communication infrastructure, and other enforcement systems, can give CAVs access to HOV or bus-only lanes. In turn, traffic and the overall number of vehicles encountered by CAVs may decrease and result in a safer system.

6.2.2.4 Transit Signal Priority

Transit signal priority (TSP) is a traffic management strategy prioritizing public transit vehicles at signalized intersections. By using real-time communication between vehicles and traffic signal systems, TSP aims to reduce delays and improve service efficiency. Transit vehicles send priority requests directly to intersection signals in a distributed TSP model. This design type requires less control by the transit management center and allows faster travel times along a designated corridor. In Phases 2 and 3, this type of system could be deployed along El Toro Road and Moulton Parkway to give preemption to emergency vehicles, CAVs operating during the pilot, and priority to regional transit vehicles such as OCTA vehicles. Transit priority could be conditional and only occur when criteria are met (e.g., vehicles encountering substantial delay when occupancy is more than a certain number, carrying a passenger to a medical appointment, etc.)

Note, if this were extended to other agencies regionally, it would require coordination with OCTA to ensure vehicles were equipped with TSP-capable technology and signal providers for installation of the technology.

7 Performance Monitoring

Monitoring the performance of CAV pilot operations will be critical in evaluating the program's success. Key performance indicators (KPIs) can be established to evaluate a number of factors like ridership, maintenance, environmental impacts, and more. KPIs can also be used to evaluate potential locations and/or communities of focus to expand the program in Phase 3. **Table 6** provides a framework for the KPIs that should be considered for the program. In partnership with a CAV vendor and after further discussions regarding implementation, more specific targets can be identified.

Table 6. Performance Monitoring Framework for CAV Operations

EVALUATION CATEGORY	KEY PERFORMANCE INDICATORS (KPIS)	TARGETS	DATA SOURCES
Safety Evaluation	Collisions	Less than X% of collisions or incidents	Accident reports, CAV sensors
	Traffic Compliance	100% adherence to the rules of the road	Surveys, video analytics
	Manual intervention	Number of manual overrides required is less than X a month.	CAV data log
Utilization	Ridership	Serve at least X riders a month	CAV data log, Mobility On Demand (MOD) platform*
	CAV Utilization	Serve at least X trips/hour	CAV data log, MOD platform*
Efficiency	CAV travel time	Accommodate travel in less than X minutes per trip	CAV data log, MOD platform*
	Corridor travel time	Reduce overall travel times by X%	GPS data, traffic flow analysis
Environmental Impact	Emissions	Decrease emissions by X%	Emission sensors, CAV data
	Range Efficiency	CAVs can operate at least X miles without charge	Fuel consumption data, CAV data logs
	Energy efficiency	Use less than X MW of energy in a month	Charge management data

EVALUATION CATEGORY	KEY PERFORMANCE INDICATORS (KPIS)	TARGETS	DATA SOURCES
User Experience	Rider experience	High user satisfaction ratings	Surveys, user feedback
	Accessibility	100% inclusive transportation options	Accessibility audits, surveys
	Public perception	High public perception ratings	Surveys
Fleet Management	Maintenance	Less than X maintenance issues/year, less than $X in maintenance required	Maintenance records, CAV diagnostic codes
Infrastructure Readiness	Roadside Equipment	Infrastructure has no defects and requires limited maintenance	Infrastructure logs, maintenance records
	Communication Infrastructure	Communication network is available 99% of the time	Communication system logs, network data
Regulatory and Legal	Compliance	Full compliance with regulations	Regulatory documentation, compliance reports
	Liability	Clear liability arrangements in place	Legal agreements, liability reports
Economic Viability	Cost-Benefit Analysis	Positive investment in the community	Financial reports, cost analysis
	Program Cost	Overall program cost in terms of equipment and staff hours below X amount	Financial reports, cost analysis

** MOD platform not currently in place- once procured, the technology would assist with tracking this data*

8 Summary

The City of Laguna Woods *Mobility Technology Plan* outlines a comprehensive strategy to harness innovative technology for the benefit of the community. The plan proposes an approach that will help support lifelong mobility, remove access barriers, introduce new mobility options, and improve overall quality of transportation. It provides a roadmap for CAV readiness and the potential operation of an AV pilot program within the city. It also offers the potential for replication in other municipalities within the SCAG region.

In coordination with stakeholders and based on research into best practices, a phased approach was developed to help guide the transition. This phased approach is summarized below.

Table 7. Summary of Phased Approach

PHASE	DESCRIPTION	INFRASTRUCTURE IMPROVEMENTS	TARGET GROUPS
Phase 1	CV and AV preparedness, and groundwork for an AV pilot program within the City of Laguna Woods in the future. Improvements in this phase provide independent value regardless of City-approved AV pilot service through improved infrastructure and other mobility improvements that would interface with AV operations.	• Mobility hubs • Roadway alterations • Mobility on demand platform • Enhanced network connectivity • Signal controllers and detectors	• General road users • Future AV owners/ operators
Phase 2	Operation of the City of Laguna Woods AV Pilot Program, which initiates small scale, replicable AV services. Implementation of AV service is limited to two main arterial roadways within the City of Laguna Woods - El Toro Road and Moulton Parkway.	• Additional traffic control devices • Roadside units • High occupancy vehicle and bus-only lanes • Transit signal priority	• Existing transit riders • Local residents
Phase 3	Expands the PhasePhase 2 pilot to additional jurisdictions and use cases, including, but not limited to: first/last mile service within residential communities, expanded access to medical facilities, and integrated trip planning.	• Additional roadside units as needed	• Local residents • Visitors/ tourists • Regional travelers

Across all phases, there are several improvements to both digital and physical transportation infrastructure that can prepare the City for CAV operations. These can also be seen in **Table 7.**

Understanding that Phase 2 and 3 of the plan would require system integration and data sharing across several platforms, the project team then created a detailed list of data needs and data flows between systems. Should the City pursue implementation of an AV pilot service, this should serve as a reference for what data would be involved in system operations and planning. If AV pilot operations are established, the City can also make use of the performance measurement framework presented in this plan, designed to measure the effectiveness of the program against a number of variables including financial success, sustainability, safety, ridership and more.

Overall, the *Mobility Technology Plan* outlines clear next steps for CAV readiness and AV pilot operations that can be implemented in Laguna Woods and replicated in similar municipalities across the region.

Glossary of Terms and Acronyms

ACRONYM	TERM	DEFINITION
ADA	Americans with Disabilities Act	A federal law that prohibits discrimination against people with disabilities and mandates accessible facilities and services.
APM	Automated People Mover	A type of public transportation system that consists of driverless vehicles on a dedicated guideway, often found in urban areas.
ASCE	American Society of Civil Engineers	A professional organization dedicated to advancing civil engineering and infrastructure-related knowledge and practices.
AV	Autonomous Vehicle	A self-driving vehicle capable of operating without human intervention depending on the level of automation.
CV	Connected Vehicle	A vehicle equipped with technology to communicate with other vehicles and infrastructure, enabling safer and more efficient transportation.
DMV	Department of Motor Vehicles	Agency responsible for vehicle registration, driver licensing, and regulation of motor vehicles.
EV	Electric Vehicle	A vehicle powered by electricity, typically stored in batteries, rather than internal combustion engines.
FMVSS	Federal Motor Vehicle Safety Standards	A set of safety regulations established by the National Highway Traffic Safety Administration (NHTSA) for motor vehicles sold in the United States.
GHG	Greenhouse Gas Emissions	Gases such as carbon dioxide and methane trap heat in the Earth's atmosphere, contributing to climate change.

ACRONYM	TERM	DEFINITION
HOV	High Occupancy Vehicle	A lane or vehicle category reserved for vehicles with multiple occupants to encourage carpooling and reduce congestion.
IDE	Integrated Data Exchange	A system that facilitates the sharing and exchange of data among various entities for improved decision-making and coordination.
IOS	International Organization for Standardization	An international body that develops and publishes industry standards for various sectors, including technology and transportation.
KPI	Key Performance Indicator	A metric is used to evaluate the success or failure of any one or multiple hypotheses or goals.
MOD	Mobility on Demand	A service that provides on-demand access to various modes of transportation, such as ridesharing, transit, AV shuttles and more through a mobile app.
NHTSA	National Highway Traffic Safety Administration	A government agency responsible for setting and enforcing vehicle performance standards and regulations related to traffic safety.
OCTA	Orange County Transportation Authority	Agency responsible for public transportation in Orange County, California.
PUC	California Public Utilities Commission	A state agency that regulates public utilities, including telecommunications and transportation services in California.
RSU	Roadside Unit	A component of a connected vehicle system located along roadways to facilitate communication with vehicles.
ROW	Right of Way	The legal right to use a specific corridor of land for transportation or utility purposes.
SAE	Society of Automotive Engineers	A global professional organization that develops and publishes industry standards for automotive engineering and technology.
SCAG	Southern California Association of Governments	The regional metropolitan planning organization in Southern California.

ACRONYM	TERM	DEFINITION
SCP	Sustainable Communities Program	A SCAG program aimed at strengthening partnerships between local agencies and strategic partners to achieve unified land use and transportation goals.
TSP	Transit Signal Priority	A system that gives priority to public transit vehicles at traffic signals to improve transit efficiency.
V2G	Vehicle to Grid	A technology that allows electric vehicles to supply electricity back to the grid, helping manage energy supply and demand.
V2N	Vehicle to Network	Communication between a vehicle and a network or cloud-based system to exchange data and information.
V2P	Vehicle to Pedestrian	Communication between vehicles and pedestrians, enhancing safety by alerting drivers to nearby pedestrians.
V2V	Vehicle to Vehicle	Communication between vehicles to share information, enhancing safety and efficiency on the road.
V2X	Vehicle to Everything	Communication between vehicles and various elements, including other vehicles, infrastructure, pedestrians, and more, to enhance transportation safety and efficiency.
VMT	Vehicle Miles Traveled	A measure of the distance vehicles travels within a specific region or time frame, often used to assess transportation impacts.

Appendix A: Current Services, Systems, and Stakeholders

This appendix provides an overview on the transportation services and systems currently provided in the service area. It also includes a list of relevant stakeholders for this project.

City Provided

- City's Senior Mobility Program (taxi bucks / non-emergency medical vouchers)

Laguna Woods Village

- Easy Rider: Nine fixed routes operating Monday through Friday from 9 a.m. to 5 p.m.
- Boost (Lyft): partnered with Lyft rideshare service to offer rides to residents within the transportation system parameter range.
- Journey (non-emergency medical transportation): Scheduled ride service for preapproved riders with medical needs.

Regional

- Age Well Senior Services non-emergency medical transportation service (to/from medical appointments).
- OCTA Fixed Route: Orange County Transportation Authority (OCTA) is the transit agency of Orange County, whose bus system comprises of 60 fixed-route bus routes throughout the county.
- Metrolink: Metrolink is the region's commuter rail line; there are two lines serving Orange County, the Orange County Line and the Inland Empire/Orange County Line.
- OC-Flex: OC-Flex is OCTA's on-demand, curb-to-curb, shared shuttle service pilot program.

Private

- Uber: Private ride-hail service
- Lyft: Private ride-hail service
- Taxi: Pertains to all private taxi services that serve Laguna Woods. Laguna Woods also offers the Senior Mobility Program, which subsidizes the cost of taxi travel for residents over 60 years of age.

Current Stakeholders

Table 8. **Current and Proposed Project Stakeholders** shows all project stakeholders and their role with regards to the Mobility Technology Plan. Each stakeholder can perform one or more of the following roles:

- Advise: The stakeholders give guidance on one or many parts of the mobility technology plan, including information and advice on current systems, constraints, needs, and goals of the project.
- Manage: A stakeholder in a managing role is accountable for supporting and operating one or many parts of the project.
- Use: Stakeholders in a use role refer to an enterprise of group that interacts with the pilot and will utilize the services provided by the pilot.
- Provide: Stakeholders in providing roles will be responsible for procuring and supplying the necessary technology and services for the pilot.

For each role, there are also associated ‘resource objects’ that stakeholders interact with. These objects represent what or who stakeholders are responsible for throughout the project.

Table 8. Current and Proposed Project Stakeholders

STAKEHOLDER CATEGORY	STAKEHOLDER	ROLE	RESOURCE OBJECTS
City	City Council	Advise	Project
	Transit Staff	Manage	Project
Region	SCAG	Administers, Provides	Project, Funding
	Orange County	Advises	Project, Service
	OCTA	Advises	Project
Advocacy Groups	Age Well Senior Services	Advises	Project, Residents
	Braille Institute	Advises	Project, Residents
	Dayle McIntosh Center	Advises	Project, Residents
	The Villages	Advise	Project, Residents
Users (Types)	Residential Community Riders	Use	Pilot
	Non-Residential Community Riders	Use	Pilot
Private Entities	MOD Vendor	Provides	MOD Platform
	AV Vendor	Provides	Vehicles

Appendix B: AV Case Studies

B.1 Palo Alto, CA

Key Facts

- Projects funded by FTA with local match
- Two projects in development
- Vehicles in operations: TBD
- Status: Planning

Located in the heart of the Silicon Valley, the Santa Clara Valley Transportation Authority (VTA) serves approximately 120,000 riders per day with three light rail and 70 bus lines. The agency's Board of Directors are very focused on innovation, and its autonomous vehicle pilot programs were championed internally by the agency's recently retired Chief Innovation Officer. The agency is developing two autonomous vehicle pilot programs aimed at serving the Palo Alto Veterans Affairs (VA) Hospital, a major activity center with multiple buildings across a large campus, and a significant number of transit-dependent or non-ambulatory visitors. The hospital is located roughly equidistant from two Bay Area Rapid Transit (BART) heavy rail stations.

The first pilot project was expected to operate within the VA Hospital campus, aiming to connect patients with their appointments and medical services internally. VTA planned to use small Olli vehicles built by Local Motors, operating on a fixed route on private roads within the campus at a maximum speed of 25 mph. However, with Local Motors going out of business in January 2022, it is unclear if the pilot will continue with another vehicle or if the project will be modified in some other way. Funding came from a local match and FTA funds through an IDEA Grant administered by the Metropolitan Transportation Commission (MTC), the metropolitan planning organization (MPO) for the San Francisco Bay Area.

The second pilot project will connect the Palo Alto VA with Stanford University and the Palo Alto BART station and is expected to begin operations in 2023. It will use the larger, higher-capacity AV Star vehicle manufactured by GreenPower Motor Company that is capable of higher speeds on larger arterial roads. The vehicle will first be deployed in Youngstown, Ohio, with the intent of applying any additional lessons learned to the project in Palo Alto. It is also being paid for with a local match combined with FTA funding from the Accelerating Innovative Mobility (AIM) program. The project will be free to riders in its first year, with fares collected after that.

In addition to the information provided above, VTA staff identified additional recommendations to plan for deployment of AVs, listed below.

<u>Key takeaways:</u>

- Define what success looks like early on. AVs may not provide a benefit beyond what can already be accomplished by a traditional vehicle and operator.
- During early assessment of vehicles, VTA found that AV research and development is focused on travel and not necessarily on meeting the needs of all riders, such as people

with disabilities. Not every vehicle is capable of addressing many of the ADA needs of paratransit riders, such as whether or not to deploy a ramp, and these limitations need to be considered during vehicle selection.

- The Olli vehicle was selected in part for its built-in ADA accommodations, but it is unclear whether the pilot will continue with another vehicle or be modified in some way.
- Strong partnerships are important to project success. The Palo Alto VA is a highly valuable partner on the project, helped define the use case and project motivation, and facilitated outreach to potential riders.
- Managing expectations is also important. Riders and key stakeholders need to know what to expect from the service, as well as what will happen if something unexpected occurs, such as a maintenance issue.
- A long-term question for VTA is whether or not these systems can scale to better serve the needs of riders.

B.2 Chandler, AZ

Key Facts

- Project funded by FTA but operated primarily by Waymo
- Pilot operated 2019-2020
- Vehicles in operation: 50-75
- Status: Complete

Chandler is one of the many large cities comprising the greater Phoenix metropolitan area. It is served by Valley Metro, the region's primary transit operator. Valley Metro's AV pilot project was developed as a retooling of a previous Mobility on Demand (MOD) Sandbox Program grant from FTA. Valley Metro partnered with Waymo, whose fleet of autonomous vehicles (modified Chrysler minivans) was already operating in a defined service area around the company's facility in Chandler, and which are capable of moving at the relatively high speeds (45 mph) found on arterial streets in the Phoenix area. Researchers at Arizona State University also provided program management support to survey riders and collect data about their experiences.

From a regulatory standpoint, Arizona is operating under an executive order from the Governor's office that reduces barriers to AV operations in the state. The City of Chandler also operates its pilot program with Waymo and has developed special pick-up and drop-off zones in some locations. Because Waymo was already operating in the selected service area and other coordinating departments such as police and fire were familiar with the service, partnering with them streamlined the program's implementation for the agency.

The program began with exclusive access to Valley Metro employees who lived in the service area but was quickly expanded to other paratransit riders. Service was focused on door-to-door travel similar to the agency's existing paratransit RideChoice program. However, all riders selected for the pilot are ambulatory due to the limitations of the Waymo vehicles. The existing service area also comes close to but needs to connect to Valley Metro's light rail service. The fares charged for the service are the same as for the existing RideChoice program; Valley Metro subsidizes the cost, which is much lower than the agency's Dial-a-Ride service.

The program's local officials and participants were very positive, and representatives of other jurisdictions expressed interest in Valley Metro deploying a similar service. In addition to the information provided above, Valley Metro staff identified additional recommendations to plan for deployment of AVs, listed below. which areKey takeaways:

- Data sharing agreements with private firms can be complicated, as the companies are focused on protecting their intellectual property, and public agencies are subject to public information requests.
- Working with ASU allowed for greater confidentiality between the project partners since the research conducted by the university is not subject to the same FreedomFreedom of Information ActInformation Act requests. The university conducted extensive surveys of riders and paid them for their participation.
- Fully autonomous AV service cannot provide service to non-ambulatory passengers as a result of the vehicles used.
- Although the service is on-demand and does not operate on a fixed route, all roads and locations within the service area must be mapped and incorporated into the mobility platform.
- Many smaller AVs available are unsuitable for the project area's public roads, as they do not travel at a high enough speed to flow with traffic.
- Arizona's regulatory environment is less restrictive than California's, and the project depended upon the existing operations of Waymo.

B.3 Arlington, TX

Located in northern Texas between Fort Worth and Dallas, Arlington is home to approximately 400,000 residents, the University of Texas at Arlington (UTA) campus, a major General Motors manufacturing plant, and many entertainment destinations such as theme parks and professional sports stadiums.

Key Facts

- Funded by FTA IMI Program
- Service began March 2021
- Status: In operation
- Vehicles in operations: 6

The City of Arlington has pursued several innovative transportation programs over recent years, with the current program representing the third pilot. Its focus is to expand on the work and lessons learned in previous programs, to continue testing in a real-world environment on public roads, to identify what works and does not work with current vehicles, to educate the public on AVs, and to serve the travel needs of UTA's students. May Mobility operates the program and uses a fleet of five vehicles, four of which are Lexus SUVs and the other one a Polaris GEM converted for ADA use, providing wheelchair-only service. An FTA Integrated Mobility Innovation program grant funds the pilot.

Via Transportation provides an existing rideshare service in the City's 99 square miles. The City identified a one-square-mile service area covering the UTA campus and the main downtown core within that area. It worked with May Mobility to analyze routes and stops and incorporate their service into Via's platform. When located in the AV service area, riders request a ride through the Via application just as they would book another rideshare option. UTA students make up the majority of riders, and their trips are free; the general public would generally pay $3-5 for a ride within the AV service area, depending on distance. The service provided approximately 200 rides per day at its peak in November 2021 and has received high marks for safety and comfort. In addition to the information provided above, City of Arlington staff identified additional recommendations to plan for the deployment of AVs, listed below.

Key takeaways:

- Insurance provisions for contracts required extra coordination between the City's attorneys, Via, and May Mobility as a subconsultant.
- Previous pilot projects over several years helped socialize the technology with the public.
- Perception of wheelchair-accessible vehicle is lower than that of the general vehicle; agencies should look for vehicles with comparable features for all riders.
- Identifying roles and responsibilities is very important, especially within service providers if the project is not a turnkey solution. Agency staff may be juggling many other priorities unrelated to the project, and it is very helpful to have a point person in the local jurisdiction who can help coordinate between departments.
- A well-defined user case and service area are equally important to managing expectations and providing quality experience for riders.

B.4 Golden, CO

Golden is a small city of approximately 20,000 residents located approximately 10 miles west of downtown Denver. Its recent AV deployment is coordinated by the Colorado Smart Cities Alliance, a statewide nonprofit organization promoting innovative solutions to urban challenges.

Key Facts

- Funded through a coalition of stakeholders.
- Pilot project ran September-December 2021
- Status: Complete
- Vehicles in operations: 9

The Alliance includes government members (such as cities and departments of transportation), private companies, and a range of universities, research centers, and other nonprofits. AVs in Colorado operate under regulations established by a statewide task force that is encouraging deployments, but special exemptions with the Department of Motor Vehicles for the vehicles are needed.

As part of its work, the Alliance is developing a CityForward Playbook to help with AV deployment and has been working to identify locations in which to test and learn. Golden was selected because of its unique location where the Colorado School of Mines is located adjacent to a compact, walkable downtown area in need of additional transportation options. The team partnered with EasyMile to deploy a fleet of nine EZ10 vehicles (branded as the "Mines Rover"), which carry up to 12 passengers and operate at speeds up to 25 mph.

The team created three fixed routes to connect key destinations in and adjacent to the campus (such as student housing, parking lots, and athletics fields) within the downtown Golden area. For ease of deployment, routes were selected where the vehicles would not encounter traffic signals. The service was free to riders—most of whom were students—and operates from 7:30am-4:30pm Monday-Friday. The pilot project ran for four months between September and December 2021.

In addition to the information provided above, Colorado Smart Cities Alliance staff identified additional recommendations to plan for deployment of AVs, listed below.

Key takeaways:

1. Detailed Site Assessments: While cities may have a general idea of what they want to connect, conducting detailed site assessments in collaboration with specific companies is crucial. This approach helps identify all the necessary components required for successful AV operations.
2. Continuous Collaboration: Ongoing collaboration among vendors, the City, the University, and the Alliance is essential for success. Financial contributions from each entity have also played a vital role in supporting the project.
3. Charging and Maintenance Facility Location: A charging and maintenance facility's strategic location is paramount. Proximity to the AV route is vital to ensure uninterrupted service and optimal range.
4. Flexible Procurement Process: A rigid procurement process can pose significant risks to AV implementation. Given the dynamic nature of AV technology, agencies should be prepared for potential equipment and vendor changes.
5. Contingency Planning: Developing a contingency plan for addressing maintenance issues and temporarily taking vehicles out of service is essential to minimize disruptions in AV operations.
6. Public Education: Setting clear expectations and educating the public about the capabilities of AVs is crucial. Understanding and familiarity with the technology can impact ridership, as when ridership dropped after students became more acquainted with the vehicles' speeds and capabilities.

7. Reliability: Maintaining the reliability of AV services is paramount to sustaining ridership and preventing the service from being perceived as a novelty.
8. Student Ambassadors: The successful engagement of students as onboard ambassadors for the shuttles has proven effective in promoting the adoption and acceptance of AV services.

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