ARCADIS

Shifting toward Smart Mobility

Are you prepared to shift?

Transportation systems are advancing at an unprecedented pace. Autonomous driving, connectivity, electrification, and shared mobility offer exciting advantages for the future, but transportation system owners and operators must work tirelessly to stay ahead of the curve.

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This paper details how connected, autonomous, shared, and electric (CASE) vehicle technologies can enable us to address mobility challenges, and why a well-planned infrastructure will be the key to unlocking CASE's potential. Use it to navigate mobility challenges in your community.

You'll read about our 6-step process for laying out and achieving a strategic vision for connected and autonomous vehicles (CAV). It's all about installing a sustainable user experience using a future-proof transportation system. To ensure your plan is future proof, your organization must:

1. **Create a strong communications backbone.** CAV will bring monumental levels of data exchange into the transportation sphere. Take advantage of other initiatives to install a strong communications backbone, preferably using fiber optics (although fiber-wireless systems could work). For example, if you widen a roadway, include a fiber installation as part of the project. Public-private partnerships could offer ways to lower costs on these implementations, as companies are looking to tap into robust communication networks for the coming 5G revolution. Companies will "pay" public agencies in fiber strands in exchange for right-of-way.
2. **Be technology agnostic.** Although public-private partnerships can be very useful, don't get locked into one specific vendor or technology. Just because something is fancy and exciting doesn't mean it's right for your system, any advances you deploy should be interoperable and scalable over the long-term.
3. **Look to your peers for great ideas**. Identify specific use cases that address problems similar to yours. Organizations in the U.S. are experimenting with ideas like smart work zones, integrated data portals and truck platooning. See how others use emerging technologies and consider how they might enhance transportation in your area.

Keeping these principles in mind will help you develop a roadmap of policy, planning, and infrastructure milestones that your organization can strive for in a systematic and safe manner.

Arcadis' interactive Future Mobility experience explores what lies ahead for mobility through the eyes of citizens on the move. It details how evolving infrastructure and modes that use intelligent technology (smart mobility) can make every journey seamless, efficient and safe.

Embedded within smart mobility is people's desire to travel without stress, challenge or uncertainty. A majority of these journeys will be facilitated by CAV and intelligent transportation systems (ITS) that allow CAV to thrive.

Mobility favors the bold. Agencies that build a strategic foundation for CAV now will realize greater long-term benefits regarding safety, congestion and the environment.

Navigating the challenge of change

The wave of change can be traced to the future demand that will be placed on mobility as well as the new modes and the infrastructure advances that will innovate demand management.

Cities are bracing for an influx in population, with approximately 2.5 billion people expected to move to urban areas across the world by 2050.[1] What might the surge in citizens mean? In San Francisco, for example, people take one million car trips and more than 700,000 passenger trips via transit daily.[2] By 2040, car use in the city core area will increase 30% without intervention, potentially plaguing the streets with constant gridlock.[3]

In addition to more passenger traffic, freight traffic across the nation could increase up to 27% as online shopping cements its place atop the retail industry.[4] Urban areas in particular must strategize for managing the influx of large freight vehicles and limited curb space.

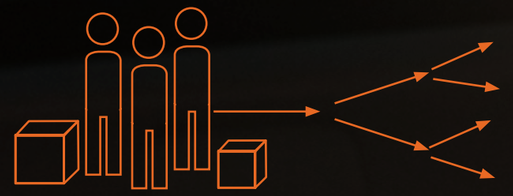
But it's not just about urban areas. Increasing demand will also affect the Interstate Highway System, the main corridor for passenger and freight movement across the country. Yearly increases in vehicle-miles traveled guarantees recurrent congestion and threatens the system since, according to a Transportation Research Board report, "many of its segments are decades old, subject to much heavier traffic than anticipated, and are operating well beyond their design life without having undergone major upgrades or reconstruction."[5]

Safety is an ever-present discussion in mobility. Forty thousand people die on U.S. roadways each year – that is nearly the same as a jumbo jet crashing on U.S. soil every single day.[6] It's our responsibility to explore innovative solutions for reducing casualties.

Finally, the more we learn about climate change, the more we realize that the billions of gallons of fuel burned on roadways each year isn't sustainable. Reducing mobility's environmental impact will be crucial.

Organizations will have to reassess mobility holistically to tackle these issues. Fortunately, emerging mode and infrastructure advances will help.

Smart Mobility:
Key terms



Demand

People and goods need to move across urban and rural areas more efficiently, reliably and safely than ever.

Modes

In response to increased demand and environmental factors, emerging modes can improve how people and goods move across a region.

Infrastructure

To support all modes in meeting mobility challenges, transportation network infrastructure must be improved and modernized.

CAV can enhance how we address mobility challenges

The mobility landscape is shifting to make journeys safer, cheaper and more efficient. Vehicles are evolving to sense and share journey data that can increase reliability and limit delays.

Connected vehicles (CV)

By transcending traditional communication barriers such as bandwidth and distance, CV technology facilitates the exchange of data via vehicle-to-everything (V2X) communications, including vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communication.

The connected aspect of CAV will put real-time data to work to enhance safety and combat travel delays. Vehicles will form a roving network of traffic data sensors using V2V, V2I and V2P solutions to map timely routes for travelers and help them avoid hazards.

Another benefit of CV is the potential to shrink transportation's carbon footprint. According to the Environmental Protection Agency, transportation accounted for the largest portion (29%) of total U.S. Greenhouse Gas Emissions in 2017.[7] CVs using V2X applications can curtail congestion, reducing gasoline consumption and emissions.

Autonomous vehicles (AV)

According to National Highway Traffic Safety Administration, 94% of serious crashes can be attributed to human error.[8] Imagine the potential for fewer collisions, injuries and deaths by taking human error out of the equation via automated passenger vehicles and freight – research suggests it could potentially cut the number of car crash fatalities in half.[9]

Connected and autonomous vehicles

CAV incorporates CV and AV benefits at once. For example, an AV that's forced to slam on its brakes can share that information through V2V applications with other vehicles outside its AV sensor range immediately, limiting not only the potential for a collision but also the ripple effect of unnecessary stops and starts that can cause traffic backups.

Right now, the U.S. Department of Transportation (USDOT) plans to reserve the 5.9 GHz part of the spectrum for dedicated short-range communications for CV applications, but other technologies that use cellular technology, such as 4G or 5G, could be incorporated to maximize the benefits of V2X communications.

Shared mobility

Thanks to emerging technologies and business models, people's relationships with mobility options will change as well. Vehicle ownership is trending downward. In 2017, 250,000 people gave up owning a car due to the availability of ridesharing services.[10]

Shared mobility, from ridesharing and automated shuttles to e-scooters and bikesharing services, will expedite journeys and help reverse the impact of climate change by reducing the number of gas-powered cars on the road.

Smart Mobility: **Key terms**

Connected vehicle

A vehicle equipped with technologies that allow it to electronically communicate with other vehicles, roadside infrastructure, traffic management centers, mobile devices, etc. in real-time.

Autonomous vehicle

A vehicle that requires no human input to successfully complete a journey. AVs rely on sets of sensors (typically video cameras and Lidar) to detect their environment. See page 9 for more on levels of automation.

Connected and autonomous vehicle

A vehicle that combines CV and AV features to create safe, efficient, interconnected and environmentally friendly transportation networks.

Shared mobiltiy

Modes-for-hire that transport people or goods. These include cars, bike and scooter-sharing, mass transit, private shuttles, buses, taxis, auto-rickshaws and urban delivery vehicles.

First- and last-mile mobility

First- and last-mile mobility (journeys from origins/destinations to the main transportation network) are the least efficient piece of the puzzle, comprising up to 28% of the total cost of moving goods and taking an inordinate amount of time and effort for individuals on the move.[11]

CAV – and especially shared mobility – could change that. They could allow citizens to use more energy efficient modes to bookend their trips and lessen the need for parking, saving citizens time and money while also reducing the need for parking structures.

Automation can revolutionize goods delivery as well. By 2030, the global market for delivery bots is expected to reach $17 billion.[12] These automated freight and delivery fleets could change workforce demand, and replacing trucks and vans with drones and bots could free up space on congested streets and curbsides.

The mobility landscape is shifting to make journeys

SAFER, CHEAPER and MORE EFFICIENT

Society of Automotive Engineers (SAE) Automation Levels

You might see the SAE automation levels referenced often while researching your strategic CAV plans. Here is a quick guide you can use to understand each level.

0	1	2	3	4	5
No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
Zero autonomy; the driver performs all tasks.	The vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	The vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	The driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Some automotive providers, such as Tesla, offer level 2 vehicles, and the next few years will see more companies and modes reaching higher levels. Your CAV plans must consider how to accommodate mixed fleets as more public transit, commercial and passenger vehicles advance toward full automation.

Well-planned infrastructure unlocks CAV's full potential

Transportation modes are like chess pieces, each with their own unique move set. Infrastructure layers their strengths together in a successful strategy. Intelligent communications and electric vehicle (EV) infrastructure will be as essential to mobility as traditional concrete and pavement.

Intelligent transportation systems

High-speed communication networks and advanced traffic management systems are required for making CAV a core piece of a transportation network. Agencies must equip their streets and freeways with ITS tech before citizens can realize the full benefits of CAV.

Cameras, radars and other roadside sensing equipment are crucial for capturing real-time data. But a robust communication infrastructure, from sophisticated fiber optic networks to backend systems that store, analyze and share data, must be in place to turn the data into actionable insights.

Electric vehicle infrastructure

There will be 559 million EVs on the road globally by 2040.[13] Cities and states will have to install many more charging stations and account for the impact on the power grid.

To allow easy access to power, four types of charging infrastructure points will be needed: Residential, workplace, destination, and in-transit charging points.

Region-specific enhancements

There's no one-size-fits-all approach to smart mobility. New modes and network solutions will reshape environments according to citizens' specific needs. Not only that, infrastructure might have to evolve in phases, adopting modes and network advances incrementally.

Think about freeways. A mixed fleet of automated and human-operated vehicles presents a set of challenges wholly different from entirely driverless or human-operated fleets. Organizations must plan for interim changes like dedicated lanes, striping and signing for CAV while still considering future opportunities like narrowing lanes when fleets are fully automated.

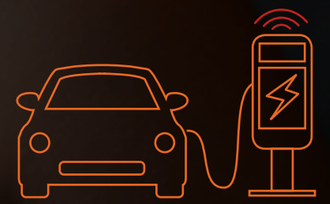
On the urban side, cities will have to adapt to heightened curbside demand as ridesharing grows, perhaps with ridesharing vehicle pickup and drop-off hubs. Increased ridesharing and alternative first- and last-mile solutions will render some parking structures obsolete, creating opportunities to repurpose them in ways that improve livability.

Cities need to adapt to heightened CURBSIDE DEMANDS as ridesharing grows

Smart Mobility:
Key terms

Intelligent transportation system

The collection of electronics, communications and information processing in transportation infrastructure and vehicles to improve transportation safety, mobility, and accessibility.



Electric vehicle

A vehicle that uses an electric motor for propulsion, typically using an electric battery as a power source.

Case Study:

Testing CAV solutions in real-time along Atlanta's first Smart Corridor

Challenge:

The City of Atlanta's (the City) North Avenue's daily influx of drivers, cyclists and pedestrians keep it abuzz with activity. Unfortunately, its popularity makes it ripe for traffic jams, collisions and heavy emissions outputs.

Solution:

The North Avenue Smart Corridor (the Corridor) acts as a "living lab," experimenting with traffic theory and technology-driven solutions for safe, efficient and environmentally friendly mobility. The City selected Arcadis to manage the ITS design and support day-to-day operations.

Impact:

- 20-35% collision reduction along the Corridor (depending on exact location).
- 6 seconds/intersection saved for emergency vehicles by preemption system (on average).

Digitizing the traffic ecosystem

The North Avenue Smart Corridor project team prioritized connectivity. They selected Arcadis to design an ITS that would allow technologies from various third-party vendors to communicate seamlessly.

A network of hundreds of sensors at 26 signalized intersections combines artificial intelligence with traffic theory to support the flow of transit and protect citizens. Advanced video detection systems and V2I communications track traffic statistics such as speed and volume. The system even identifies modes of travel, allowing bicyclists and pedestrians to safely traverse crosswalks without pushing a button.

When an emergency arises, it prioritizes first responder vehicles. Similarly, the system can accommodate special traffic patterns used for events like the Super Bowl, which the city hosted in 2019.

The power of data is a two-way street

Atlanta is maximizing the value of the real-time data by sharing it with travelers via a free mobile app. The app incorporates users into a network of knowledge, providing details on signal phase timing and safety hazards like speeding while in a school zone or approaching a dangerous curve.

The app also warns drivers of impending rear-end collisions and cautions cyclists/pedestrians of vehicles traveling above the speed limit. Progress regarding safety has been remarkable, with crashes down 20-35% along different sections of the Corridor. The new system also consumes less energy than before, supporting the team's mission to improve the environment along with mobility and safety.

The Smart Corridor will continue to evolve. Arcadis installed a digital mobility center nearby where Arcadis experts and project team members continually monitor the network and test potential improvements. It is also prepared to support AV technology, should that be needed in the future.

Proactive CAV planning: 6 key steps

The North Avenue Smart Corridor is a prime example of smart mobility's fast-approaching future. CAV and ITS will soon reach a tipping point, and unprepared organizations will find themselves steps behind in adapting to driverless mobility. Follow these 6 steps to put your agency in a better position to capitalize on smart mobility.

Step 1: Create your CAV vision

Create a vision that is unique to your area. Identify your statewide and regional mobility needs, including specific objectives for ITS and CAV planning.

Incorporate the safety, congestion, multi-modal and infrastructure elements impacting your region's mobility environments (e.g. urban, rural, intercity, freight corridor, etc.) into your vision and consider how trends in ridesharing, micro-mobility (e.g. e-scooters) and transit might help.

Your vision should be high-level and aspirational. Arcadis has worked closely with departments of transportation (DOT) in forming strategic CAV plans, and a glance at the programs' visions and goals reveals common threads that you can weave into your strategy. For example:

DOT A

Vision

Support a framework for CAV technologies to improve customer experience and provide access to safe and reliable transportation solutions.

Goals

- Maximize customer experience with the latest vehicle technology.
- Improve safety and travel time reliability.
- Seek opportunities to partner with technology providers and automakers.
- Prepare the workforce.
- Communicate with customers on use of CAV technologies on facilities.

DOT B

Vision

Capitalize on the safety and operational benefits of CAV technologies and position the state as the most attractive state for industry to deploy, test, operate and evolve CAV products and services.

Goals

- Increase safety.
- Improve mobility.
- Reduce infrastructure investments.
- Enhance traveler information.

How your CITIZENS experience mobility MATTERS MOST

While not clearly stated in every plan, many CAV plans:

- Outline potential benefits for integrating ITS applications and CAV.
- Address the need for workforce change management programs.
- Consider partnerships with other organizations to optimize CAV.
- Include a strategy for increasing public awareness.

Keep user experience paramount

Looking at mobility through the eyes of the citizens, travelers and industries in your region can reveal day-to-day challenges and potential solutions that would enhance their experiences with CAV. Develop travel personas for predominant user types in your area – the ways they experience mobility matters most, so picture their optimal journeys and plan for ways to provide them.

Step 2: Assess your current ITS infrastructure

A thorough understanding of your ITS network will help define realistic project scopes and establish consistency. Knowing your capabilities and opportunity areas allows for incremental implementations that maximize resources and eliminate redundancies.

Begin by establishing legacy statewide and regional ITS systems. Then, review your existing ITS architecture, programs and projects to establish a current framework for expansion that incorporates V2I and V2V communications. Agencies must equip their streets and freeways with strategic ITS before citizens can realize the full benefits of CAV.

Step 3: Review industry initiatives

Review plans from other state, federal and international organizations to see what you can use to enhance your region's mobility environments.

Find mobility plans you can relate to

Agencies are already working to leverage ITS and CAV, possibly innovating around constraints or needs similar to yours. Analyze their pilot programs, public demonstrations and program activities to inspire and supplement your vision.

Gain insights from standardized guides

The USDOT provides Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) as a guide for designing and implementing ITS so that agencies maximize the ITS network tools and applications at their disposal.

Use ARC-IT for an overview of emerging safety, mobility and environmental applications, including security implications and potential benefits. Details on applications under development and expected deployment availability can help you map the timing of your own ITS plan.

Build your CAV timeline around the market

Transportation organizations and the private sector are already running AV pilots. Their progress can provide a rough timeline for when certain levels of automation will penetrate the market.

City and state projects will also highlight physical infrastructure and signing changes that should feature in your plan. Beyond physical changes, these initiatives can inform new policy, legal and legislative considerations, including updates to the vehicle code and insurance standards. When needed, look to federal AV guidance to help develop new policies and ensure compliance with nationwide regulations.

Step 4: Determine CAV opportunities

After you've thoroughly examined the latest mobility, safety and environmental applications, consider how they might enhance mobility in your organization's environments. This includes urban, rural, intercity, freight corridor and other settings as defined by your agency.

Prioritize initiatives according to needs and goals or industry deployment status. There might be some low-hanging fruit to pick immediately, like identifying traffic control and management activities that could be supplemented with CAV technology. Search for other relatively low-risk, early-start initiatives where possible. For example, engaging the public, private and university sectors for potential partnerships in this step could kickstart preliminary CAV initiatives.

Step 5: Secure funding

For some organizations, successfully integrating CAV with infrastructure represents a mighty investment, and there will be plenty of questions on how to cover the tab.

Traditional funding

Thoroughly research eligibility requirements for grants, including the Advanced Transportation and Congestion Management Technologies Deployment Program. It will be important to identify the differences between CAV projects and other ITS projects.

Non-traditional funding

The smart mobility frontier will be marked with non-traditional funding opportunities, and uncommon partnerships could make your vision a reality.

Private companies might be interested in sharing the cost of deployment in exchange for data access, such as work zone information, while universities and research centers might find great value in analyzing CAV in live environments. Working together could help pilots or projects that depend on grants to get off the ground.

CREATIVE THINKERS will help propel your smart mobility journey

Step 6: Give smart mobility the greenlight

With funding in place, begin laying your foundation for smart mobility success. Start by viewing the targeted projects through institutional, policy, and technical lenses.

Institutional changes

Changes could also come from the legislative arena. Louisiana House Bill 455, for one, created new responsibilities for the Louisiana Department of Transportationand Development (LaDOTD), including certifying the safety and compliance of commercial vehicles without a driver, such as AVs or vehicles with teleoperation systems.

Workforce training (or building capacity) will also be crucial to implementing your action plan. You'll need staff that are familiar with the new data management and digital infrastructure tools featured in your plan. Implement training programs and prioritize desired skills in your recruitment and retention efforts.

The way your organization works might change as well. Creative thinkers will be valuable in maximizing data-driven network tools and discovering new solutions. Consider how to encourage innovation within your working teams and target out-of-the-box thinkers for CAV projects.

Policy changes

Broad policy changes might be required, such as funding sources for public works in the face of declining gas tax revenues or changes to motor vehicle codes. Determine the additional policy steps and stakeholder buy-ins needed to establish a thriving CAV environment.

Project-specific technical specifications

Of the CAV options that apply to your mobility needs (Step 4), asses potential projects by identifying:

- Areas where CAV will positively impact mobility and safety.
- V2I applications that will provide the most mobility and safety benefits.
- Security, data and support systems needed to manage and monitor networks.
- The potential for pilot projects and test beds to experiment with new concepts.
- A system for documenting system architecture using ARC-IT with Regional Architecture Development for Intelligent Transportation and Systems Engineering Tool for Intelligent Transportation software.

Case Study:

Helping Louisiana create a strategic CAV framework

Challenge

Maximizing the near- and long-term benefits of smart mobility and CAV investments in Louisiana requires careful planning around LaDOTD's needs, including a systematic and timely transition from legacy infrastructure to new technologies.

Solution

Arcadis provides technical advisory and planning support in developing, delivering and implementing strategic CAV, advanced traveler information systems, advanced transportation management systems, and transportation data mining and dissemination services.

Building a specialized smart mobility program

LaDOTD wants to be proactive in providing efficient mobility solutions to its users, so it is utilizing Arcadis in researching and implementing new technologies. The LaDOTD is leveraging Arcadis' extensive smart mobility experience to support CAV and ITS planning projects, including:

- **Guiding LaDOTD's CAV Stratigic Plan**
  Arcadis' team leads development of the LaDOTD CAV strategy, including the overall vision, mission, goals and needs. The team reviews ITS architecture and CAV initiatives; readiness from institutional, policy, legal and technical infrastructure perspectives; and short-, medium- and long-range action plans. It also provides recommendations for partnership opportunities.
- **Need-based CAV planning support**
  Arcadis leads and facilitates workshops for LaDOTD's inter-disciplinary CAV technology team. The planning activities provide insights on recent technology trends and LaDOTD's needs to provide direction to a CAV strategic implementation plan.
- **Real-time traffic data Systems Engineering Analysis (SEA)**
  To transition from a legacy roadway sensor infrastructure to a new traffic probe data service, the project team developed a Concept of Operations to determine how real-time traffic data (big data) could be utilized to achieve traffic management goals. The SEA included the physical infrastructure, system requirements, procurement options, alternative analysis configurations, and applicable ITS standards to guide project development.

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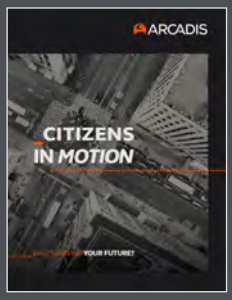
Related Content

Arcadis experts work with communities around the world to provide connected, sustainable, stress-free journeys. To access their insights on mobility's future, read:

Future Mobility is people-centric

Developing sustainable travel that integrates existing infrastructure with new technologies.

http://arcad.is/FutureMobility



Citizens in Motion

The emerging connected and autonomous vehicles evolution opens a new frontier of disruption in transport, infrastructure and urban living. For our cities, this presents a huge opportunity to radically transform urban mobility.

http://arcad.is/NACAV

Driverless Future

Analyzing CAV readiness in three U.S. cities by assessing three elements critical to a successful CAV network.

http://arcad.is/whosdrivingyourfuture

Pave the way for smart mobility with CAV

Smart mobility is an exciting evolution for our industry. It has the potential to alleviate congestion, increase traveler safety and protect our environment. While advanced CAV plans might not be in reach for every agency today, preparing now can help you seize smart mobility benefits more quickly in the future.

Building your unique strategic CAV implementation plan is the first step toward citizen journeys without stress, challenge or uncertainty. Align emerging solutions with your needs and goals to propel your organization toward successful smart mobility.

Contact our experts for more on how we can help you prepare your shift toward smart mobility.

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About Arcadis

Arcadis is the leading global design and consultancy firm for natural and built assets. Applying our deep market sector insights and collective design, consultancy, engineering, project and management services we work in partnership with our clients to deliver exceptional and sustainable outcomes throughout the lifecycle of their natural and built assets. We are 27,000 people, active in over 70 countries that generate $3.5 billion in revenues.

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