Emerging Technologies

Policy Brief




RTP 2026 Regional Transportation Plan

CEMPEL INTERNATIONAL TRANSPORTATION CONSULTING

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Table of Contents

Introduction

Emerging technologies are transforming the efficiency and value of goods and services offered across both the public and private sectors. This is no different in the field of transportation, where new technologies have the potential to change how we tackle challenges related to planning, design, construction, and maintenance of safe and efficient transportation infrastructure. They present the opportunity to engage in tasks that would otherwise be unsuited for a human to accomplish, accelerate timelines to complete a construction project, or improve the sustainability of existing and future transportation modes. However, the use of emerging technologies presents a risk if due diligence is not performed to ensure they are ready to be adopted to achieve their intended purposes.

Emerging technologies present risks and opportunities for transportation planning in the region. As these technologies come to market and in some cases transform society, CMAP and regional transportation partners must understand how to accommodate them in transportation planning, mitigating the risks and capturing the opportunities. Emerging technologies more specific to transportation further provide alternatives for project solutions in the region, and can change planning, design, construction, and maintenance of our infrastructure.

Several categories of emerging technologies have the potential for these types of impacts. The explored technologies include:

- Electric vehicles (EVs);
- Unmanned aircraft systems (UAS);
- The latest emerging intelligent transportation systems (ITS);
- Connected and autonomous vehicles (CAVs);
- Cybersecurity; and
- Artificial intelligence and predictive analytics.

The paper is organized by each technology, and includes a summary of the technology, current state of the practice and trends, and examples of best practices related to the application (or accommodation) of the technology.[1]

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[1] Several other applications of emerging technologies are captured in other policy papers and as a result are not included in this issue brief. These topics include pavement impacts from EVs; asset management data collection

Electric Vehicles

Introduction

Alternative fuel vehicles utilize fuel sources other than conventional gasoline or diesel to power their propulsion systems. Electricity (itself generated through various means) is the most prevalent alternative fuel, though other sources include hydrogen and biodiesel. Alternative fuels, particularly electricity, are viewed as a strong long-term solution for powering personal automobiles, bicycles, trucks, and public transportation due to their potential cost savings and reduced carbon footprint. This can extend to various aerial vehicles, such as unmanned aerial systems (UAS), as described in a different section.

The first iterations of hybrid vehicles entered the US market in 1999, when Honda released the Insight hybrid vehicle, followed by the Toyota Prius in 2000. Hybrid electric vehicles comprise a traditional internal combustion engine combined with at least one electric motor, forming their propulsion system. Battery electric vehicles primarily rely on a large battery that can be recharged to power the electric motors, which in turn move the vehicle. Several established automotive companies are developing electrified platforms for their existing models and creating dedicated electric vehicles (EVs) and hybrid vehicles to transition away from traditional vehicles. There are also dedicated EV companies. With more options in the EV market, costs for EVs are expected to decrease, making them more accessible to consumers. In an urban environment, range anxiety is less of a concern with the proximity of a charger, which is more likely in a densely populated area; as battery technology improves and charger access increases, this concern will continue to decline. Colder weather also degrades battery life.[i, ii]

This section focuses on EVs, as other alternative fuel technologies have not matured as much or started to penetrate the market.

State of the Practice, Emerging Trends, and Key Issues

EV adoption is gaining traction. EVs have become the most widely adopted alternative fuel vehicles worldwide, with EV car sales surpassing 17 million, equating to a sales share of more than 20% in 2024. Counties served by CMAP make up a combined 97,803 electric vehicle registrations, nearly 70% of the 142,281 electric vehicles registered in the entire state as of June 15, 2025. In Chicago there are 23,977 electric vehicles registered.[iii] EV sales are expected to exceed 20 million vehicles worldwide and are on track to reach 40% of all global car sales by 2030.[iv,v]

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techniques; asset management of ITS and other technologies; technology related to various forms of revenue collection; EV and alternative fuel impacts on revenue generation; and accommodation of high-speed rail.

In the US, several original equipment manufacturers (OEMs) are leading the transition to electrified vehicles; most notable are Tesla, General Motors, and Ford Motor Company, which sold over 182,000 EVs in quarter one of 2025.[vi] With sales of EVs on an upward trend, an extensive and reliable charging network will be required to accommodate the increasing number of EVs traveling on public roads. While consumer vehicles currently make up the majority of EV adoption, e-commerce and delivery services are also in the EV market; Rivian Automotive, an all-electric mobility company, partnered with Amazon in 2019 to bring 100,000 electric delivery vehicles on the road by 2030, with more than 20,000 already in service since 2022.[vii]

EVs have been adopted beyond individual consumers and the private sector; major metropolitan transit authorities have made significant investments to decarbonize their passenger fleets within the next few decades using electric-powered vehicles to reduce costs and minimize their impact on the environment. The Chicago Transit Authority (CTA) has already committed to electrifying its entire fleet of more than 1,800 buses by 2040, planning capital investments to add sufficient slow and fast-charging infrastructure to maintenance facilities and phasing out its diesel bus fleet.[viii] Pace has made the same commitment for 2040.[ix] Metra has purchased its first set of zero-emission, battery-powered trainsets, expected for delivery in 2027-2028.[x]

Electric bike (e-bike) adoption and use as first- and last-mile transportation is covered by other ongoing CMAP work as part of RTP development.

The sections below identify several emerging issues and trends surrounding EVs.

Environmental Impacts

The environmental impacts of EVs can be measured before and after a vehicle rolls off the production line. During the production of an EV, the carbon footprint from battery production (including mining for materials), additional manufacturing, and end-of-life are higher than the production carbon footprint for a typical ICE vehicle. However, researchers at Argonne National Laboratory estimate that the total emissions from an EV are still lower than those of a regular ICE vehicle, including emissions during vehicle production. According to research from the Department of Energy, an electric SUV in the US emits around 50 percent less greenhouse gases than a conventional gasoline vehicle, considering the full life cycle of the vehicle. While EVs do not have tailpipes to generate emissions on the road, there are still emissions from the energy source used for charging the vehicle; renewable sources can further reduce the environmental impact of the transportation system. Illinois generates 55 percent of electricity from nuclear power, 32 percent from fossil fuels (comprising of coal, natural gas, petroleum, and other gases), and 14 percent from renewables (primarily wind, and also including solar, hydropower, and biomass).[xi]

Outside of environmental impacts, EV batteries make the cars heavier than their ICE counterparts. This creates concerns around safety and impacts to asset condition, which are topics discussed in more detail in the Asset Management Policy Brief.

Infrastructure Subsidies

Range anxiety remains a concern for drivers to make the switch from an internal combustion engine to an EV, with a robust charging network needed to ensure potential EV drivers are confident they can reach their destination without fear of their battery draining midway through their journey. Subsidies play a critical role in developing this required infrastructure to accommodate EVs, including charging stations and enhancing the energy grid to provide sufficient power to charge the expected number of EVs.

To support EV charging infrastructure, the National Electric Vehicle Infrastructure (NEVI) Formula Plan provides dedicated funding for states to strategically develop EV charging infrastructure to facilitate data collection, access, and reliability. This program is part of the country's goal of creating a nationwide network of over 500,000 EV chargers by 2030. Illinois was slated to receive $148 million as part of the program over the course of five years, starting from FY2022. IDOT has conducted two rounds of grant applications after receiving approval for the Illinois Electric Vehicle Infrastructure Deployment Plan in September 2023, with Round 1 distributing grants to upgrade or build EV charging infrastructure at 37 sites – ten in the CMAP area – along priority corridors (Figure 1).[xii] In northeastern Illinois, these priority corridors include most interstate corridors with the exception of I-294 and I-355.

Round 2 made available up to $24 million to continue developing charging stations within one driving mile of eligible locations, with grant applications due in January 2025.[xiii] However, in February 2025, the US Department of Transportation issued a letter to state DOTs suspending approval of their EV infrastructure deployment plans, subsequently making no further monetary obligations while a review of the current NEVI Formula Program Guidance is conducted. As a result, IDOT's Round 2 awards have not yet been made.

Illinois' Climate and Equitable Jobs Act mandates that utilities like ComEd develop and submit Beneficial Electrification (BE) plans to promote EVs. Recent plans approved for 2026-2028 include funding for residential EV charger rebates, business EV purchases, EV charging site readiness, and electric school bus-to-grid programs.[xiv]

Figure 1: Illinois EV Corridors

The prior plan included $231 million; the new plan includes an additional $168 million. The programs include rebates of up to $2,500 per household to support the purchase and installation of residential chargers and rebates for covering business and public sector costs associated with making sites ready for public or private fast charging equipment. The programs already have incentivized the purchase and installation of nearly 5,000 public and private EV charging ports. More than 70 percent of the rebates awarded have gone to low-income customers or business and public sector organizations, which are eligible for higher rebate amounts.[xv]

The Illinois Finance Authority (IFA) received a $14.9 million federal grant in 2024 from the US Department of Transportation's Charging and Fueling Infrastructure (CFI) program, to deploy EV charging infrastructure in various communities across Illinois. This award aims to expand access to EV charging in rural areas, low-income neighborhoods, and multi-unit dwellings, complementing other efforts described above.[xvi]

Other programs through various entities and agencies with funding that can be applied to EV infrastructure.

Vehicle Subsidies and Credits

Subsidies for alternative fuel vehicles, primarily EVs, have changed at the federal level over the last three years, notably after the Inflation Reduction Act was passed in 2022; these may change in the future. The clean vehicle tax credit provides a credit up to $7,500 for personal EV purchases. The federal Commercial Clean Vehicle Tax Credit provides a credit of up to $7,500 for eligible vehicles under 14,000 pounds and $40,000 for vehicles over that weight.[xvii] The Illinois Environmental Protection Agency offers $4,000 rebates to customers for the purchase of a new or pre-owned EV; this amount decreases to $2,000 in 2026 and $1,500 in 2028.[xviii]

The Illinois Environmental Protection Agency administers funds allocated to Illinois from the Volkswagen Environmental Mitigation Trust, created through national legal settlement with Volkswagen. Illinois' $108 million in settlement funds are to be used to fund mobile source diesel emission reduction projects. Through the State's Beneficiary Mitigation Plan, the funds will be used for electric public transportation vehicles, school buses, trucks, and charging equipment; both government and non-government entities can apply for funds.[xix]

ComEd's Business and Public Sector EV Purchase Program as part of its BE plans offers rebates for the purchase or lease of new or pre-owned fleet EVs of all weight classes. The program has resulted in the purchase or lease of nearly 1,000 vehicles.[xx]

The market still depends on subsidies to grow; unpredictability in the availability of these subsidies can impact EV production plans by auto manufacturers.

Training

The Metropolitan Mayors Caucus' EV Readiness Program allows qualifying local governments to apply to join a cohort and receive free technical assistance and training in a variety of critical areas as they work toward the designation of "EV Ready Community." Municipalities must adopt the Greenest Region Compact to participate in the program.[xxi]

ComEd's Customer Education and Awareness Program as part of its BE plans will fund multiple efforts to empower and support customers to make informed decisions about vehicle

Peer Snapshot: Puget Sound Regional Council (PSRC)

→ PSRC launched the Puget Sound Regional Electric Vehicle (REV) Collaborative, which has developed a suite of tools and resources to educate and guide interested parties on the electrification process for transportation.

electrification and charging infrastructure deployment. This includes free access to ComEd support tools including Fleet Electrification Assessments, EV Toolkits and training programs for municipalities interested in achieving "EV Ready" status, and free Fleet Electrification Assessments.[xxii]

Charging Options

Most drivers of EVs charge their vehicles overnight at home.[xxiii] Therefore, availability of EV charging at home can greatly influence one's decision to purchase an EV. However, people living in multifamily housing, such as apartments and condominiums, may have a more difficult time gaining access to at-home charging infrastructure due to additional barriers caused by homeowner associations, landlords, and other parties. Even if there are no organizational barriers, an individual owner or renter in a multifamily building may not have access to appropriate power supplies and infrastructure to install an EV charger for their vehicle, or building and electrical codes for larger complexes may prohibit it. Illinois law requires new construction of single-family and small multifamily housing (MFH) to include a minimum of one EV-capable parking spot for each residential unit that has a designated parking space. New single-family homes or small MFH that qualify as affordable housing must have one EV-capable parking space per dwelling. All parking spaces at newly constructed or renovated large multifamily dwellings must be EV-capable. [xxiv]

Local regulations can add additional layers of difficulty in making changes to existing buildings to allow for EV charging infrastructure: local codes and permitting may not yet be adapted to allowing for this modern technology. These issues can also result in equity impacts around EV availability. Illinois law requires that condominium or common interest associations may not prohibit or restrict the installation or use of EV charger in a unit owner's designated parking space, and tenants may install a charger at a parking space allotted for the lessee.[xxv]

<u>Peer Snapshot: San Jose & Seattle</u>

→ San Jose, California, was one of the first cities to issue requirements for installing vehicle charging systems in single-family homes and duplexes. The City of Seattle provides tip sheets for both residential and commercial EV charging installations.

In-pavement charging is a new technology that is still being researched and developed for large-scale applications. For example, the Indiana Department of Transportation and Purdue University are working on a ¼ mile testbed segment of magnetizable concrete that is capable of charging EVs at highway speeds. Once successful testing is completed, INDOT will work to identify an interstate highway segment within Indiana to electrify further using the new technology.[xxvi,xxvii] Similarly, Michigan DOT installed a ¼ mile segment along a public roadway in Detroit.[xxviii] Overseas, Germany is also experimenting with in-pavement charging, as well as overhead catenaries for charging trucks.

Opportunities

- With variability in federal funding, consider ways to financially support EV infrastructure development in the region and provide planning guidance.
- Develop tools and resources to educate and guide interested parties on the electrification process for transportation.
- Encourage local governments to update local codes and building requirements to accommodate EV charging, and provide standard templates and language for their use. This can include other tools and resources for local government and citizens.
- Incorporate changing vehicle fleet considerations in transportation planning, travel demand forecasting, asset condition modeling, safety analysis, and environmental analysis.

Unmanned Aircraft Systems

Introduction

An unmanned aircraft system (UAS) is an aircraft, along with accompanying equipment and supplies, that does not use direct human intervention from within or on the aircraft to operate. They are classified based on both size and range of travel, with applications including vertical take-off and landing vehicles (VTOLs) for passenger flights, package delivery drones, reconnaissance drones at crash sites or in disaster zones, bridge inspection, and mapping and surveying for design and construction.[xxix] UAS are typically electric.

State of the Practice, Emerging Trends, and Key Issues

A UAS can be used for a broad range of applications. Its compactness and low entry-level cost make it a cost-effective and agile solution for responding to time-sensitive scenarios. Extensive research and policies developed by the FAA also provide significant guidance on accessing and utilizing the technology, resulting in greater ease in adopting the technology for deployment.

Rules for commercial/non-model small drones require that each individual drone must be registered. From January to December 2024, over 124,000 commercial operators in the US registered their drones, up by 9,000 units compared to the same period in 2023, with a rate of 10,370 new registrations every month in 2024. In the third quarter of 2023, there were 9,768 small UAS registrations in Illinois. The FAA predicts the number of drones in the commercial fleet in the US will exceed one million in 2025, and reach 1.118 million by 2029.[xxx, xxxi]

The requirement for registering individual drones for commercial purposes may increase the amount of start-up time required before deploying the technology; drone pilots must also be FAA certified. Based on the type of UAS, its operation may be limited with respect to range or battery life, which can hinder its use for extended periods of time. Further, FAA limits UAS use related to altitude, speed, visual line of site, restricted airspace and near airports, and over people, although operators can apply for waivers. Operators can fly drones at night, over people, and moving vehicles without a waiver in certain situations.[xxxii]

The sections below describe emerging applications of UAS.

Package Delivery

The FAA's UAS Integration Pilot Program was conducted from 2017 to 2020 to test and integrate drone operations in the national airspace. The program was succeeded by the UAS BEYOND program to continue understanding challenges of integrating UAS technology, such as operation beyond visual line of sight, and grant program participants with drone operating licenses for various applications. Such participants included Wing Aviation, UPS Flight Forward, and Zipline. Amazon, another participant of the original program, has been conducting commercial drone operations for deliveries since 2020, and received FAA permission to operate their drones beyond visual line of sight in 2024, a significant milestone to expand commercial drone operations in the United States.[xxxiii, xxxiv]

Delivery drones have the potential to reduce delivery-related truck trips, which have grown in recent years with the increase in online shopping, particularly since COVID. However, there may be navigation and safety challenges with delivering packages in dense urban areas.

Infrastructure Inspection

An FHWA Global Benchmarking Study on the "Use of Unmanned Aircraft Systems (UAS) to Enhance the Design, Construction, Inspection, and Maintenance of Transportation Infrastructure" included visits to the UK and Germany. One notable recommendation from the final report states, "State DOTs could evaluate enhancements gained from highly automated and repeatable UAS flight paths for data collection. US DOT could contribute to the development of data quantity, data quality, and data management standards for bridge inspection and other infrastructure inspection and survey tasks."[xxxv] Currently, some off-the-shelf drones are already equipped with the necessary hardware and software to collect and analyze data for infrastructure inspections and other civil applications.[xxxvi]

In 2016, IDOT purchased two drones to begin exploring applications for aerial infrastructure and bridge inspections. As of February 2025, the IDOT Structure Services Manual includes drones as inspection equipment that may be required to conduct a complex bridge inspection. However, they may be only considered for specific cases, and such cases would require a proposal outlining the intended scope of the drone inspection prior to its use.[xxxvii]

As part of the process of replacing the eastbound McClugage Bridge structure, explosives were required to remove large pieces of the bridge to remove the structure. To monitor the detonations, IDOT used drones to provide live video of the events.[xxxviii]

In addition to asset management and maintenance, drones are being used in monitoring building construction.

Crash Investigations

UAS is a technology that is being increasingly adopted by agencies for traffic incident management (TIM) in the US. The FHWA released a primer on UAS for TIM applications in 2022 to describe the technology, demonstrate examples of its use throughout the US, and provide guidance on how to implement the technology. The report cited 1,578 public safety agencies using drones as part of their operations, with law enforcement making up around 70% of these agencies. In terms of additional capabilities, UAS can provide centimeter-accuracy measurements of crash sites. The aerial photography facet of the technology enables crash measurements and scene documentation at faster speeds compared to human-enabled operations. The low price point of the technology is also an incentive for agencies to deploy units to different crash sites at the same time.[xxxix]

<u>Peer Snapshot: Iowa State Patrol</u>

→ Eight members of the Technical Collision Investigation Unit were reassigned as full-time "Reconstructionalists" for collision investigations and trained in forensic scene mapping by using drones .

UAS for this purpose has several advantages, including ability to access more remote sites faster; the ability to avoid congestion on a roadway caused by the crash that will hinder emergency response times; the ability to assess a situation remotely and send the proper emergency response equipment and teams; and the ability avoid sending personnel into a dangerous situation.

Passenger Trips

UAS for passenger transportation are still far from reaching commercial viability, but the development of current VTOLs suggests a potential alternative for regional travel. One example US company provides a snapshot into the current state of the industry. The company has completed over 40,000 miles of testing, having conducted its first full transition flight with a pilot on board in April 2025, and is continuing to test the vertical-to-horizontal transition of its air taxis. The company has garnered support from industry leaders in mobility, including a commitment of $500 million to help the company accelerate the development of its electric VTOLs (eVTOLs). They are partnering with major airlines to establish hubs to provide air taxi services in New York City, London Heathrow, and Manchester.[xl, xli]

For eVTOLs to be viable at such airports and in the cities that surround them, additional space will be needed for landing pads, which will require investing in new infrastructure or retrofitting existing infrastructure to meet the needs of these aircraft. Electric charging infrastructure will also be necessary.

Peer Snapshot: New York City

→ Ongoing efforts to support eVTOLs include electrification the Downtown Manhattan Heliport, as well infrastructure development at LaGuardia and JFK Airports in collaboration with the Port Authority of New York and the New York Economic Development Corporation.

Opportunities

- Facilitate knowledge sharing on applications of UAS technology.
- Consider purchase of UAS technology and training as part of grant applications and award.
- Encourage shared use of technology amongst smaller units of local government.

Intelligent Transportation Systems

Introduction

ITS are advanced applications of information and communication technologies to enhance transportation safety, efficiency, and sustainability. They involve integrating technologies like sensors, communication networks, and data analytics to manage and optimize transportation systems. ITS applications range from basic traffic signal control and coordination to more complex systems like automated incident detection and predictive traffic management. They span across roadways, personal automobiles, trucks, buses, and other modes, and have been prevalent for many decades, including in northeastern Illinois.

With the increasing ability to use real-time data, internet, and broadband technology, along with AI, the abilities and applications of ITS continue to grow. CAVs also present an increased need to include technology for vehicle-to-infrastructure communication.

State of the Practice, Emerging Trends, and Key Issues

> **Peer Snapshot: Jacksonville, FL**
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> → Jacksonville's MPO opened a regional transportation management center with the Florida DOT. Additionally, the creation of the Smart North Florida Coalition has led to local agencies pilot testing cutting-edge technology.

IDOT, the Tollway, counties, municipalities, and transit operators in northeastern Illinois have a long history of implementing and operating ITS technologies, which are well-established in the region. The Northeastern Illinois Regional ITS Architecture is one tool for the region's ITS planners and operators to use as a roadmap for transportation systems integration and information sharing. The Architecture has been developed through a cooperative effort by the region's transportation agencies, covering all modes and all roads in the region, with strong linkages to the Illinois Statewide ITS Architecture. Within the region, DuPage County has adopted the DuPage County Transportation Coordination Initiative, and the Regional Transportation Authority has adopted the Regional Transit Intelligent Transportation Systems Plan - both of which are supported and included within the Regional ITS Architecture.[xlii] CMAP's Transportation Technology and Operations Coalition (TTOC) is a further regional platform for discussion and information sharing around ITS, among other technology topics.

At the state level, the Illinois Statewide Architecture and Strategic Plan contains an assessment of the current use of ITS in Illinois and recommends approaches to enhance the integration and deployment of ITS. Plan development included coordination with IDOT's District offices, Metropolitan Planning Organizations (MPOs) and Regional Planning Commissions (RPCs); as part of this, IDOT also assisted in updating many regional ITS architectures throughout the State.[xliii]

One example application of ITS in northeastern Illinois is Lake County's PASSAGE: this ITS provides drivers real time traffic congestion information due to crashes and construction events. Real-time camera and traffic signal data, and event data transmitted through the police department's Computer Aided Dispatch system, are sent directly to the Transportation Management Center, then communicated back to highway users via the web site, radio, and variable message signs. Controllers can also directly adjust signal timings. This linking of data from federal, state and local governments and local and county police agencies provides a comprehensive information resource for Lake County travelers.[xliv]

Emerging trends in ITS globally involve a focus on cybersecurity; effective traffic management through AI and machine learning for adaptive traffic lights and route optimization; enhanced safety via real-time monitoring and incident detection; and vehicle-to-everything (V2X) integration. These topics are discussed in separate sections throughout the paper.

Vehicle-to-Infrastructure Technology

Many of the latest developments in ITS relate closely to CAVs, linking them to real-time traffic signal data. For example, technology currently being sold with one auto manufacturer's current models informs drivers when traffic lights will change colors and advises them on the optimal speed to travel to avoid red lights. In order to get this information, the manufacturer works with local governments, but it has also developed predictive technology that can estimate when the light will change using real-time data. The company is tracking over 20,500 intersections and has partnered with 96 agencies and cities and 26 metropolitan areas. The algorithms consider when pedestrians push crosswalk buttons or traffic flow at different times of the day. Data can come from multiple other sources, such as traffic signal control programs, real-time traffic data, cameras, detector loops, transit vehicles, and pedestrian buttons.[xlv]

Vehicle-to-Pedestrian Technology

A significant amount of research is currently being conducted on vehicle-to-pedestrian (V2P) systems, specifically on how to alert pedestrians and vehicles to potential crashes. These technologies still face challenges with false warnings, delays in processing time, and problems with detection in poor weather. There is some debate amongst developers and engineers whether the most effective systems are vehicle-based, smartphone-based, or infrastructure-based.[xlvi]

Digital Twins

Digital twins use real-world mapping data from sources such as LIDAR and combine them with historical system data, such as traffic data. Using these data, engineers can simulate a variety of scenarios. Digital twin technology has been applied to a wide range of topics and conditions.[xlvii]

For example, the Federal Emergency Management Agency's (FEMA) HURREVAC integrated data from the National Weather Service (NWS) as well as a variety of CCTV cameras and sensors placed around a city to predict the best evacuation routes and aid to people impacted by hurricanes.[xlviii]

There is currently an ongoing research project that is applying digital twin technology to determine the condition of bridges and other infrastructure. Using a variety of sensors and cameras, they intend to gather a large amount of data about the structure's condition that could not be obtained otherwise, such as anchor cable forces and lateral bridge movement. This Interstate bridge accommodates a wide range of trains, vehicles, buses, and trucks that cross it daily, making it an ideal location for collecting a diverse dataset. The project is expected to yield a large return-on-investment.[xlix]

Opportunities

- Continue to leverage CMAP's TTOC to keep local governments current with the latest ITS technology and opportunities.

- Conduct a pilot digital twin project for a major regional transportation facility.
- Consider V2I and V2P technologies as potential roadway safety solutions in the future.
- Consider creation of a regional coalition for piloting innovative technologies.

Connected and Autonomous Vehicles

Introduction

CAVs take advantage of a plethora of communications technologies to receive and send data that provide them with information about their surroundings to make real-time driving decisions. Vehicles can be connected in various ways, such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), or vehicle-to-everything (V2X). Several large cities in the US already have connected vehicle deployments for preliminary research and testbeds, including Georgia (City of Atlanta Smart Corridor Demonstration Project), Cambridge (Hope TEST), and New York City (New York City Connected Vehicle Project Deployment). There are 77 total operational connected vehicle deployments across the country, with an additional 104 deployments planned.[l]

The inclusion of CAVs on public roads provides opportunities to improve transportation efficiency in different areas; currently, much focus is in optimizing the use of current infrastructure to accommodate autonomous ridesharing vehicles. Dedicated infrastructure for connected vehicles also could improve traffic flow with real-time data shared between vehicles, allowing them to make optimized decisions while on the road. Consequently, these decisions can reduce traffic incidents between vehicles and with pedestrians.[li]

The main drawback to connected and autonomous vehicles is that the technology is largely incomplete, and fully autonomous vehicles capable of operation without human engagement are still far away from full market penetration. Investments in new infrastructure to accommodate connected vehicle technologies on existing roads will also be expensive and can cause further traffic disruption if mixed with regular vehicles, which can impede inter-vehicle communication. There are also concerns about the potential impacts to development patterns and land use and uncertainty around net consequences for traffic.[lii]

State of the Practice, Emerging Trends, and Key Issues

CAVs are still being developed and refined. The Society of Automotive Engineers (SAE) has defined six levels of autonomy for vehicles, ranging from L0, where a human is manually in control of a vehicle at all times, to L6, where a vehicle can operate autonomously in all conditions (Figure 2). Elements of L1, such as adaptive cruise control and lane-keeping technologies, are now commonly included in new vehicles. The World Economic Forum predicts that about 30% of new vehicles sold by 2027 will have L2/2+ autonomy capabilities; this includes vehicles such as Tesla with "Autopilot" and "Full Self-Driving" modes. It also predicts that up to 10% of new vehicle sales could be L3 vehicles by 2030, with an estimated global fleet of a few million autonomous vehicles for ridesharing. Waymo's current autonomous rideshare vehicles, operating in Phoenix, San Francisco, Los Angeles, Atlanta and Austin, and expanding to other cities globally, operate at L4.

CAVs depend on ongoing advancements in many other technologies mentioned in this brief: internet and mobile communications, applications, data processing, AI, ITS, and cybersecurity.

Illinois has taken several steps to prepare itself for, and lead in, CAV development. In 2018, the Autonomous Illinois initiative was established to enable IDOT to partner with state agencies to address best practices in the region regarding CAVs, infrastructure requirements, and to pursue collaborations with industry experts on the latest developments in CAV systems. In 2024, IDOT signed a $48 million agreement with the Illinois Center for Transportation at the University of Illinois Grainger College of Engineering for a joint research program to develop and implement next-generation mobility technologies. Northeastern Illinois robust and evolving ITS infrastructure will further serve as a strong foundation for CAV adaptation.

Peer Snapshot: Miami, FL

→ The Miami-Dade Transportation Planning Organization created a Study Advisory Group (SAG) to enable continued coordination and alignment surrounding CAV and other emerging technologies Four scenarios were vetted: Current Trends, Smart Roads and Vehicles, Smart Transit, and Smart Infrastructure.

Figure 2: Levels of Autonomy for Vehicles[liii]

		Explanation	Sample features	Hands-on	Eyes-on	Mind-on
Assisted	L0 **Manual**	– Safety warnings or temporary assistance – Driver retains all driving tasks	– Automatic emergency braking – Lane departure warning	Driver	Driver	Driver
Assisted	L1 **Assisted driving**	– Steering OR speed control by the system – Driver remains hands-on and eyes-on	– Adaptive cruise control (ACC) – Lane-keeping assist system (LKAS)	Driver	Driver	Driver
Assisted	L2 **Partially automated driving**	– Steering AND speed control by the system – Driver remains hands-on and eyes-on	– Coupled ACC & LKAS	Driver	Driver	Driver
Assisted	L2+/++ **Advanced partially automated driving**	– Steering AND speed control by the system – Driver remains eyes-on	– Navigate on Autopilot (NOA) **Driver must be able to immediately take full control whenever requested**	System	Driver	Driver
Automated	L3 **Automated driving under conditions**	– System drives under pre-defined conditions – Driver needs to step in within ~10 seconds upon system request	– Traffic jam pilot – Valet parking **Critical change: liability switches from the driver to the system**	System	System	Driver
Autonomous	L4 **Autonomous driving under conditions**	– System drives under pre-defined conditions – No take-over by the driver is required (within the ODD)	– Autonomous driving in approved ODDs **Can differentiate between L4 Highway and L4 Urban, due to their different complexities**	System	System	System
Autonomous	L5 **Autonomous driving in all conditions**	– System drives in all conditions – No take-over by the driver is required	– Ubiquitous autonomous driving	System	System	System

Driver System

The sections below describe specific impacts of CAVs on the transportation system and built environment.

Land Use, Parking, and Traffic Impacts

The continuous adoption and use of CAVs has the potential to change land-use patterns and transportation infrastructure needs. The technology allows for faster decision-making than humans, with closer spacing, faster start and stop times, and generally more efficient vehicle throughput. This, in turn, can result in increased capacity on existing facilities.

Fully autonomous personal vehicles could result in vehicles dropping off passengers directly at destinations (similar to rideshare vehicles) before then parking elsewhere, or circulating until the passenger is ready to be picked up. This can reduce travel time for passengers who otherwise would walk from a parking area to a destination. This also changes trip patterns (creating new bottlenecks, such as at front entrances of workplaces) and the need for parking; it may also increase vehicle-miles traveled (VMT) for zero-occupant vehicles.[liv, lv]

Fully autonomous vehicles may increase convenience for drivers, allowing them to accept longer in-vehicle travel times and to accept living in locations farther from work or services. This in turn may further decrease density in the region and increase single-occupant vehicle trips and VMT, thereby negating some of the potential operational benefits for traffic from CAVs.

Safety Impacts

With faster decision-making and the ability to program software to follow traffic laws, CAVs have been forecast to benefit roadway safety in the long term. Driverless Waymo vehicles (at L4 autonomy) have traveled over 71 million miles. They are reported to have 93% fewer crashes with injuries to pedestrians, 81% fewer cyclist crashes with injuries, 78% fewer injury-causing crashes overall when compared to crash rates for human drivers under similar conditions.[lvi]

However, CAV software and sensors still continue to evolve and in many cases fall short of predicted abilities, resulting in concerns about risks to others – especially vulnerable uses. These technologies also attract increased scrutiny, and several high-profile crashes have occurred, particularly with L2 vehicles.[lvii]

Trucking Efficiency

Trucks with autonomous capabilities can improve efficiency, specifically for long-haul journeys. Such journeys operate primarily over rural Interstate Highways, which provide a more consistent and predictable environment for CAVs. These long-haul, cross-country journeys also pose staffing challenges, increasing the business case for this use of CAVs. First-/last-mile travel to and from Interstates will still require human drivers in early stages of truck CAV development, with transfer points required as places to make this hand-off.

A McKinsey report suggests that using autonomous trucks operating at SAE level 5 may eliminate the need for such transitions, though this level is far from reaching commercial use.[lviii]

Transit Opportunities

L4 autonomous vehicles may provide opportunities for more cost-effective and reliable first- and last-mile transit services in lower density areas. Jacksonville Transportation Authority's NAVI is the "first fully autonomous public transportation system network in the United States", operating along a 3.5-mile route through downtown Jacksonville. The service began in July 2025.[lix]

Peer Snapshot: Arlington, TX

→ In partnership with Via Transportation, May Mobility, and the University of Texas at Arlington (UTA), the City of Arlington led a demonstration of a dynamically routed fleet of Level 4 automated vehicles in a one-square-mile area: it provided over 28,000 rides without any safety incidents.

CAV Transition Period

While CAVs offer theoretical benefits to transportation efficiency when widely adopted, the preceding transition period creates challenges for efficiency and safety. Roadway environments mixed with regular vehicles limit the ability of connected vehicles to communicate with one another, hindering the exchange of data necessary for making quick decisions while driving on the road. Regular vehicles that interfere with these communications can subsequently cause CAVs to react more slowly, resulting in unstable traffic flows that contribute to congestion. One potential solution is the use of designated lanes or CAV-only zones to enable vehicles to communicate properly with one another. However, this would provide value when at the stage of larger-scale adoption and use of CAVs. One approach includes installing roadside units equipped with sensors and communication devices to enhance the range of vehicle sensing and detection of CAVs on the road. [lx,lxi]

Opportunities

- Incorporate these topics for discussion in CMAP's current Transportation Technology and Operations Coalition (TTOC) group. This could include ongoing coordination and alignment around CAVs, as well as a more detailed review of CAV strengths, weaknesses, opportunities, and threats for the region. .
- Incorporate autonomous rideshare vehicles as a "mode" in future forecasts for the RTP.

Cybersecurity

Introduction

The existence of internet, mobile communications, CAVs, ITS, and all the other technologies identified in this paper has allowed for extraordinary advances in transportation and society. Unlimited access to the internet and the prevalence of mobile devices helps companies and agencies collect data to improve infrastructure, operations, and navigation. However, this permeation of such technology creates new cybersecurity challenges.

State of the Practice, Emerging Trends, and Key Issues

Edge devices such as smartphones and sensors, which act as an entry point to networks, are highly vulnerable to cyber-attacks as they generally lack robust cyber features and connect a variety of smaller devices to larger servers. With additional edge devices being required for increased access to the internet and broadband, including applications like paying tolls and transit fare, it exposes larger data sets to ransomware attacks, data breaches, infrastructure attacks, or, in some cases, long-term infiltration.[lxii]

One behavioral analytics system under development can detect unusual behavior in how data is accessed. Essentially, the system will track standard activities that occur within an originating network; once a standard is established, deviations from this standard can be addressed as threats or vulnerabilities based on how much they differ from the standard. These systems are often trained on the MITRE ATT&CK Framework, which is a matrix of over 188 techniques and 379 sub-techniques and tactics that hackers can use to infiltrate a system.[lxiii]

AI is playing roles as both a beneficiary and detractor for cybersecurity. AI systems are being developed to assist in detecting and responding to cyberattacks, while AI systems are being developed to exploit these systems and remain undetected. This is discussed further in the AI section below.

While the impacts may be felt locally, the cybersecurity ecosystem is very much global. Constantly evolving technology and approaches to attacks require vigilant advances in technology for agencies. However, many of the challenges around cybersecurity relate to effective governance, education, and information sharing within and between relevant agencies and organizations.

Opportunities

- Incorporate this topic into discussions with CMAP’s current Transportation Technology and Operations Coalition (TTOC) group, including a more detailed review of cybersecurity practices and protocols.

Artificial Intelligence and Predictive Analytics

Introduction

AI is a broad field of computer science that encompasses many different types of technologies such as Natural Language Processing (NLP) like ChatGPT or Microsoft Copilot, computer vision like facial recognition or object detection, or machine learning, which uses large amounts of data to make predictive analytics. Training these models requires a large amount of high-quality data, access to high-quality computing power, and human input and manipulation. AI has many direct real-world applications and can be used to simplify or automate a variety of tasks. AI algorithms are also able to run 24/7 in a variety of conditions and interpret and adjust how they analyze data.

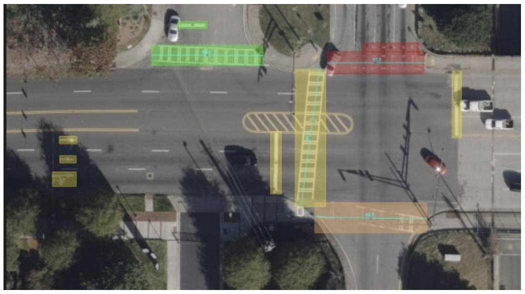
AI can both add cybersecurity challenges to the transportation system and help to solve them. The computing power needed to support AI also creates several community impacts.

State of the Practice, Emerging Trends, and Key Issues

Many agencies around the globe are experimenting with AI and predictive analytics for a variety of applications. It is already being used to predict crash hotspots, identify small changes in asset condition that could signal a concern (such as bridges that have been struck by overheight vehicles and have sustained damage), and analyze and classify large amounts of traffic data. AI also facilitates CAV integration into the transportation system.

One company is using a combination of AI and machine learning with drones to collect GIS data from communities. Specifically, the information is being used to assess the condition of pavement markings on public roads (Figure 3). With this technology, the drone is even able to identify the specific type of restoration work that needs to be performed on the pavement. This technology has been deployed on several roads in Georgia, North Carolina, and Texas; the aerial imagery could be leveraged to perform a larger variety of assessments, such as fire risk assessments, before-and-after comparisons for natural disasters, bike lane mapping, and others.[lxiv]

Figure 3: Intersection Pavement Marking Assessment[lxv]



Item (Tag)	Count	Poor Condition Count (<=0.10)	Replacement Cost (Materials)
stopbar	4235	333	32967
straight_arrow	3848	528	78672
leftturn_arrow	5569	154	26180
rightturn_arrow	1870	81	13770
cw_diagonal	123	3	3000
cw_ladder	396	37	37000
cw_zebra	100	3	3000
handicap_symbol	856	0	0
straightleft_arrow	198	8	2592
cw_solid	219	11	8250

Additional issues with obtaining GIS data using traditional methods, such as “urban canyon effects”, can be solved using AI technology. Skyline Nav AI is using computer vision and machine learning technology to attempt to fix this problem. Using images obtained from Google Maps as training data, Skyline’s “Pathfinder” will be able to take an image and compare the façade of the building, the skyline, and other features to the Google Maps database, obtaining the exact location the image was taken to within one meter. This technology also does not require constant Wi-Fi access; the company claims that with other sensors like inertial, radar, and LiDAR, they can decrease this error down to 0.1 meters.[lxvi] Not only does this decrease the potential for confusion and human error in regards to navigation, but it will also allow Google to collect data on the condition of the exterior of the building. Everything, from the condition of the columns, sidewalk, façade, windows, and other elements, can be recorded, documented, and stored; for transportation, this has implications for asset management.

Every day, Google Maps collects an estimated 70 terabytes of data from rides, with a stockpile of over 20 petabytes of data. Google has implemented several neural networks and artificial intelligence technologies into their map software, thereby improving travel time predictions and anticipating congestion.[lxvii]

Finally, Proactive Smart City Maintenance trials using predictive analytics have been used to detect maintenance problems on roads, find the exact coordinates of these issues, and schedule a team to fix the problem.[lxviii]

Peer Snapshot: Hawaii DOT

→ Hawaii DOT is using predictive analysis to predict crash hot spots an better implement safety countermeasures.

Supporting Cybersecurity

Zscaler is using AI technology to help organizations approach cybersecurity in a proactive way; this is critical since most companies and organizations still rely on user-reported issues to identify problems, and one hour of downtime costs an average of $250,000 per hour. This technology enables companies and organizations to monitor the health and activity of various networks worldwide, detect anomalies when they occur, and identify the circumstances surrounding these anomalies. This allows for the detection and reaction of potential cyber-attacks significantly faster than using traditional methods.[lxix]

Impacts

Implementing such AI applications successfully requires large amounts of data. The data collection and AI tools often require large startup costs, despite potential long-term benefits and potential savings. Large data centers are also needed for extensive AI applications.

These data centers impact infrastructure and resources differently than other types of development. They consume large amounts of energy and water; consume land similarly to warehousing; and generate relatively minimal transportation impacts.

Data centers are typically over 100,000 square feet; Lakeside Technology Center in Chicago is 1.1 million square feet, and one data center in China reaches 10.8 million square feet.[lxx] In the US data centers currently use about four percent of total energy per year; however, by 2028, data centers could be using upwards of 12 percent of total energy per year.[lxxi] In terms of the traffic generated from data centers, the Institute of Transportation Engineers (ITE) has included data centers in the 11th edition of the ITE Trip Generation Manual. Compared to other industrial facilities, data centers are not large traffic generators, with ITE predicting 0.09 new trips per 1,000 gross square feet of data center – half the rate of warehouses, which already have low employment and trip rates per square foot.[lxxii]

<u>Peer Snapshot: Ashburn, VA</u>

→ To mitigate data center impacts, Ashburn has a 2-phase plan, including requiring additional steps before zoning approval and stricter performance standards, including on-site renewable energy.

Opportunities

- Leverage AI to analyze state and local data at the regional level. Results can be used to inform the RTP and can also be fed back to other agencies to inform their decision-making.
- Identify opportunities to partner with technology firms to more effectively collect regional data at scale to support AI applications and predictive analytics.
- Make AI applications available to local governments for their use.
- Encourage local governments to update local codes and building requirements to consider data centers, and provide standard templates and language for their use. This can include other tools and resources for local government and residents.

Appendix A. Peer Examples

Electric Vehicles

States across the country are enacting legislation and offering incentives to encourage individuals and organizations to use alternative fuels and EVs. California is leading the way, with 241 recorded laws and incentives, followed by Texas and Washington, with 102 and 101, respectively.[lxxiii] Below are selected examples of outcomes from regions in each of these states.

New York – Metropolitan Transportation Authority (MTA)

The MTA in New York City has been implementing its own plan to decarbonize its fleet of over 5,900 buses by 2040 through the MTA Zero-Emission Transition Plan. It is currently in Stage 2 of its plan, when it expects to purchase a total of 1,000 zero-emission buses, primarily battery-electric vehicles, and also switch to 100% zero-emission fleet purchases for the remainder of its plan.[lxxiv] The MTA attributed its purchase of an additional 265 buses and upgrades to one of its bus depots to Congestion Pricing.[lxxv]

Texas – North Central Texas Council of Governments (NCTCOG)

In 2024 NCTCOG, in partnership with the Interstate Renewable Energy Council (IREC), announced the creation of Charging Smart, a designation program to help municipalities develop and execute policies that enable equal and equitable expansion of EVs and EV charging. The Charging Smart program has since expanded nationwide to further encourage local municipalities to adopt electrification.[lxxvi]

Washington – Puget Sound Regional Council (PSRC) and Puget Sound Energy (PSE)

In 2019, the PSRC, along with the Puget Sound Clean Air Agency, launched the Puget Sound Regional Electric Vehicle (REV) Collaborative to support agencies and organizations in the region with electrification efforts. Since its creation, the Puget Sound REV has developed a suite of tools and resources to educate and guide interested parties on the electrification process for transportation.[lxxvii]

The PSE developed its Transportation Electrification Plan framework to guide new electric vehicle mobility programs in the region as part of its efforts to expand access to EV charging infrastructure in an equitable manner.[lxxviii]

Building Codes

San Jose, California, was one of the first cities to issue requirements for installing vehicle charging systems in single-family homes and duplexes; the City also provides clear explanations for the permitting process and location planning for a home charging unit. The City of Seattle provides tip sheets for both residential and commercial EV charging installations.[lxxix]

Unmanned Aircraft Systems

New York City

Support from local governments in cities such as New York City has helped accommodate future eVTOLs, including the electrification of the Downtown Manhattan Heliport, as well as efforts to develop infrastructure at LaGuardia and JFK Airports in collaboration with the Port Authority of New York and the New York Economic Development Corporation (NYEDC).[lxxx]

Michigan State Police (MSP)

The MSP was the first police agency in the United States to receive statewide authorization from the FAA to fly a UAS to support public safety efforts. In the first year of its purchase, the UAS was deployed to 40 incidents across the state, providing enhanced survey and damage assessment capabilities during and after incidents. For instance, responders were able to use images from the UAS to assess property damage after a tornado in Portland, Michigan, and responders in Ottawa County were able to use real-time data from UAS to better understand the scope and location of a fire.[lxxxi]

Iowa State Patrol (ISP)

In 2020, eight members of the Technical Collision Investigation Unit were reassigned as full-time "Reconstructionalists" for collision investigations and trained in forensic scene mapping by using drones. This consequently launched the ISP's UAS program, with 28 drones now in operation across Iowa. They assist in documenting scenes for the Division of Criminal Investigation and the State Fire Marshal, among other state agencies.[lxxxii]

Noble County Sheriff's Department – Albion, Indiana

In 2017, the Noble County Sheriff Department created a Small Unmanned Aerial Systems (sUAS) Division, becoming one of the first departments in the state to do so. The division currently consists of a team of five operators, each equipped with four quadcopters of varying capabilities, with the primary application being search and rescue missions. However, they have also been deployed to document crash scenes and respond to active shooter incidents.[lxxxiii]

Helios Visions – 220 North Ada

Drone-based infrastructure inspection company Helios Visions created a 3D visualization of the construction progress at 220 North Ada in the West Loop neighborhood using advanced drone technologies to capture footage and create a visualization of the site to help monitor progress at the site. Construction monitoring such as this has applications for large transportation infrastructure projects.[lxxxiv]

Intelligent Transportation Systems

Metropolitan Transportation Commission (San Francisco Bay Area)

The Metropolitan Transportation Commission (MTC) regional ITS architecture (RITSA) is a blueprint for ITS project coordination and integration. This tool is designed to facilitate coordinated ITS project planning, development, procurement, and delivery throughout the region. It gives anybody access to current and future projects and project-specific data and serves as a starting point for inter-jurisdictional and inter-agency collaboration and optimization.[lxxxv]

In connection with this Architecture, the MTC created and maintains the Bay Area ITS website. This dashboard, an interactive integration of connected mobility projects, is a blueprint for integrating and coordinating various transportation technologies. Website users are able to make changes to the status of their ITS projects directly.[lxxxvi]

Atlanta Regional Council

In 2016 the Atlanta Regional Council (ARC) held a Transportation Systems Management and Operations (TSMO) Capability Maturity Model Self-Assessment Workshop to evaluate the state of the practice and develop next steps in advancing the effectiveness of regional TSMO efforts, which are strongly connected to ITS applications. From that, ARC began a new TSMO plan and ITS Architecture update. The process created several new resources for planners in the region to develop and implement TSMO projects:

- ARC TSMO Regional Inventory Summary
- Data Governance Best Practices
- Regional ITS Architecture Website
- Identify Pilot Concepts for Advanced Technology Deployment
- ARC TSMO Local Agency Deployment Guide
- ARC TSMO Strategic Plan[lxxxvii]

North Florida Transportation Planning Organization (Jacksonville Area)

The North Florida Transportation Planning Organization (TPO) has an established history of leading regional ITS efforts. The TPO led the formation of the North Florida ITS Coalition in 2006 and produced the region's first ITS Master Plan in 2007. In 2010 the Master Plan was updated to evaluate ITS accomplishments, identify and prioritize ITS needs, and plan for future technologies.[lxxxviii]

The North Florida TPO and Florida Department of Transportation opened the Regional Transportation Management Center (RTMC) in 2015. Staff from the Florida Department of Transportation (FDOT), Florida Highway Patrol (FHP) and other agencies work together to provide safe, efficient travel throughout our region; the Center is housed in the same building as the TPO. Operators at the RTMC use traffic cameras, sensors, signal controllers, dynamic message signs and other field devices to identify problems, manage the system, and disseminate information to travelers. The Florida Highway Patrol provides dispatch for 10 state law enforcement agencies from the RTMC.[lxxxix]

Working with stakeholders across agencies and industries, the TPO developed a Smart Region vision for North Florida in 2017. The resulting master plan became the starting point for forming the Smart North Florida Coalition. Through this coalition, local, county, and state agencies can submit applications for pilot testing cutting-edge technology that enhances infrastructure, safety, and resiliency.[xc]

The Coalition has completed several unique projects, including:

- The coalition connected FDOT with TRAINFO, a technology using acoustic data to predict rail traffic. TRAINFO was able to accurately and reliably predict rail traffic and up-track road closures 99.9% of the time. These data now integrate into the road traffic management system to route on a real-time basis and provide critical data to EMS to avoid blocked crossings.[xci]
- The North Florida TPO and Clay County conducted a pilot using RoadBotics mobile apps which turn a smartphone into an intelligent data collection device. Smartphones are mounted on county trucks and used to take pictures of the pavement. The imagery is collected, uploaded, and fed through artificial intelligence (AI) algorithms that provide objective, actionable data. These resources are mapped on an interactive platform to plan for maintenance and construction. The success of the pilot has led to other counties and municipalities adopting this technology into their asset management approaches.[xcii]

Connected and Autonomous Vehicles

California Department of Motor Vehicles

California is currently in the process of formal rulemaking to update its regulations for testing and deploying CAVs. While its current rules allow for operation of autonomous vehicles only with a gross vehicle weight rating of 10,000 pounds or less, the department's proposed regulatory approach involves removing the prohibition of vehicles 10,001 pounds or over, creating a path for manufacturers to test and deploy commercial heavy-duty autonomous vehicles. This proposed change involves following the same phased permitting process as light-duty vehicles, from testing with a driver up to full deployment. Other amendments include expanding data reporting requirements from manufacturers to monitor and track the operation of autonomous vehicles on public roads and adding clarification to processes for the department to request information from manufacturers regarding incidents involving the operation of their autonomous vehicles.[xciii]

Miami-Dade Transportation Planning Organization, Florida

The Miami-Dade Transportation Planning Organization created a Study Advisory Group (SAG) to enable continued coordination and alignment surrounding CAV and other emerging technologies for transportation. Four scenarios were developed and presented at a vision workshop for feedback from the public and government agency staff regarding Current Trends, Smart Roads and Vehicles, Smart Transit, and Smart Infrastructure. Each scenario was built upon the previous one to demonstrate technology adoption and implementation over time. The findings determined that technologies should be developed and invested across all transportation modes, done so through an integrated management operations partnership and approach.[xciv]

City of Arlington, Texas

In partnership with Via Transportation, May Mobility, and the University of Texas at Arlington (UTA), the City of Arlington led a demonstration of a dynamically routed fleet of Level 4 automated vehicles in a one-square-mile area including downtown Arlington and the UTA campus. The year-long demonstration that ended in 2022 provided over 28,000 rides without any safety incidents. From the demonstration, the team provided recommendations and guidance on selecting use cases for the technology, considerations for fare structure, measuring ridership metrics for ensuring consistent and efficient service, and gathering direct feedback from riders to inform current and future service.[xcv]

Phoenix Area Waymo Service, Arizona

Waymo operates fully autonomous rides in Phoenix, San Francisco, Los Angeles, Atlanta and Austin, and it is beginning to expand in and explore other cities globally. Metro Phoenix represents the largest autonomous ride-hail territory in the US across 315 square miles, including a partnership with the Salt River Pima–Maricopa Indian Community to operate on their land. Service to Phoenix Sky Harbor International Airport represented the first autonomous rideshare airport service in the world.[xcvi,xcvii]

Waymo's sixth generation self-driving technology, with smarter sensors to help the cars better navigate in extreme weather. This technology will be part of the new all-electric Zeekr vehicle, which features a flat floor, more head- and legroom, adjustable seats and a removable steering wheel and pedals. Waymo also plans to open a new 239,000-square-foot autonomous vehicle factory in the Phoenix area.[xcviii]

Artificial Intelligence and Predictive Analytics

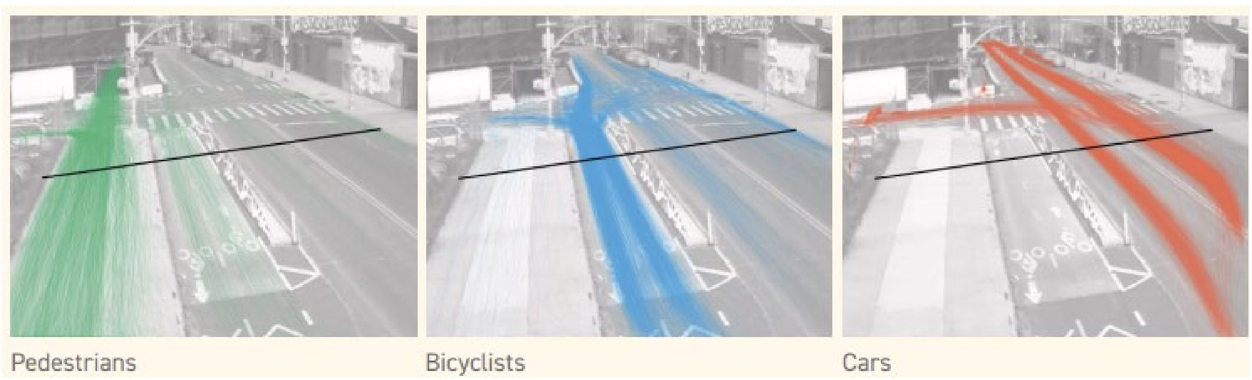
Memphis, Tennessee

The City of Memphis partnered with Google and SpringML to apply AI and machine learning to identify and fix transportation network problems faster, including potholes. The City expects this to reduce potholes and insurance claims; Google expects that this could be applied to other assets as well.[xcix]

New York City, New York

Numina is a company that uses computer vision technology to track the movements of bicycles, buses, cars, motorbikes, pedestrians, trucks, and vans through a system (Figure 4). Personally identifiable information (PII) technology has been integrated into the system to ensure that the privacy of individuals being observed is protected throughout this study. This primarily utilizes two techniques: "obfuscation," which automatically blurs identifying markers such as faces and license plate numbers, and "edge," which is the actual computer vision unit. It ensures that nothing is transmitted from these cameras other than the pathways.[c]

Figure 4: Pathways of traffic movement generated by Numina



Overall, the computer vision model can identify pedestrians with 89% accuracy, bikers with 77% accuracy, and buses with 95% accuracy, but it can struggle with differentiating between trucks, cargo bikes, and cars. It may also be confused by shadows or vehicles moving non-linearly. [ci]

In 2024, New York City had these cameras installed at various intersections and recorded data every Tuesday, Wednesday, Thursday, Saturday, and Sunday for the whole year, excluding holidays for days New York Public Schools had off. Currently, the data is being processed, and the next steps are being determined; the city hopes that this technology will eventually be able to assist with the following issues and assist with collecting data to train further AI models:

- Detect parking occupancy;
- Monitor bus lane usage;
- Identify double parking;
- Track and count vehicles; and
- Develop an expandable framework to accommodate potential future needs of new features or add-ons to the current system. [cii]

Hawaii Department of Transportation (HDOT)

In Hawaii, predictive analysis is being used to help guide improvements for the state DOT. It uses a combination of metrics such as lives saved and speed reductions, as well as historical crash modification factors on strategies and devices such as rumble strips, raised pedestrian beds, pavement markings, signage, lighting and reflectivity, enforcement techniques, or complete redesigns. Researchers found that the model could predict crash hot spots with an accuracy of over 85 percent. The HDOT team has plans to implement additional AI technology into various aspects of its practices and projects over the next few years, partly due to the effectiveness of this technology.[ciii]

Ashburn, Virginia

Ashburn, Virginia, has the largest concentration of data centers in the Northern Hemisphere. Today, Ashburn is estimated to have over 35 million square feet of data centers, with 55 million square feet expected to be in place by the end of 2025, consuming more than 40 gigawatts of energy per year. The town has experience capturing the economic benefits of data centers while experimenting with ways to mitigate their impacts.[civ]

Residents fear that noise pollution, visual impact, environmental impacts, and strain on natural resources and the energy grid could compromise their property values. In 2024 almost 25 percent of all energy in Virginia was being used to power these data centers.[cv]

In 2024, Ashburn proposed a two-phase plan to address these concerns. Phase 1 requires that any new developments within 500 feet of a residential area must complete a special application and undergo additional steps before the land is rezoned. Phase 2 will introduce stricter performance standards, setbacks from residential areas, and mandates for on-site renewable energy to move towards net zero energy consumption. It will also mandate environmental impact studies and additional public input before the rezoning is approved. To prepare for Phase 2, several data centers are investing in solar energy estimated to produce between 300 megawatts and 1.5 Gigawatts of the estimated 40 Gigawatts per year needed.[cvi]

Despite resident concerns, home values in Ashburn have increased over the last two years. As of 2023, the data centers in Virginia supported approximately 74,000 jobs, $5.5 billion in labor income, and $9.1 billion in Virginia GDP annually.[cvii]

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