Photo: Christine Gerencher

Harnessing Technology for a Safe, Equitable, Resilient System

FINDINGS FROM THE TRANSPORTATION RESEARCH BOARD'S 2018 STATE PARTNERSHIP VISITS PROGRAM

Above: Small airplanes are a common mode of transportation in Alaska, whose vast distances and inaccessible terrain make road travel difficult.

The Technical Activities Division of the Transportation Research Board (TRB) conducts the State Partnership Visits Program, in which TRB staff with expertise in various modes and topics visit state departments of transportation (DOTs), university transportation centers, transit and other modal agencies, and private industry. By identifying needed and in-progress research and by disseminating the results of completed research, these visits support TRB's mission of promoting innovation and progress in transportation through research and information exchange.

State visits last one or two days and typically consist of meetings with DOT management, discussions with DOT staff involved in various topic areas, exchanges of issues and ideas, and often a visit to DOT facilities or sites of ongoing projects. Technical Activities Division staff members contributed to the following summary of the issues facing state DOTs that were revealed through the State Partnership Visits Program in 2018.

Planning

For several years now, state DOTs, transit agencies, and metropolitan planning organizations (MPOs) have been transitioning their planning processes and plans to produce performance-based plans, performance measures, and targets in accordance with federal law and regulations. Several critical deadlines for establishing

Photo: Vertical Aerospace, Wikimedia

Vertical Aerospace's eVTOL (electric vertical takeoff and landing) aircraft takes flight for the first time. States are grappling with technological advances that could bring services like flying taxis into commercial use.

performance targets occurred in 2018; thus agencies spent most of that year focusing on these activities. Agencies recognize the benefits of performance-based planning and management in creating efficient transportation project planning and delivery, but many continue to grapple with the challenges that come with a shift in decision-making paradigms.

Several conferences and peer exchanges held in 2018 and planned for 2019 focus on these issues, with the goal of facilitating the transformation of state DOTs into multimodal transportation system agencies that focus on the outcomes of transportation decisions and systems operations. Rather than simply concentrating on the performance of an individual facility or mode or infrastructure, agencies wish to transition to a systems-wide focus that is driven by purpose—personal mobility, reliability, resilience, freight distribution, safety, and the efficient delivery of energy—in a way that minimizes environmental and cultural harm to current and future generations.

Planning addresses the role of transportation in serving the needs of the future. Planners use research, data, and models that predict future needs and challenges based on past trends. Travel forecasting models based on land use, economic, and transportation trends are the foundation of transportation planning, with an emphasis on finding the "sweet spot" between transportation demand and supply. From there, agencies can look to policy; pricing; and infrastructure development, operations, and management to develop projects and maintain operations performance and efficiency.

The ability to use past trends to predict current and future travel behavior is disrupted, however, by many factors that offer scant history to learn from and model; for example, the rapid proliferation of mobility as a service and service types, the ubiquity of instantaneous communications and apps that influence travel choices in real time, and the progress of technology in vehicle fleets that affect all modes—from new sources of energy fueling vehicles to increased automation and connectivity.

Data

The use of data by state DOTs to understand the use of their transportation networks is increasingly important. As a result many states are managing data as an asset, incorporating business plans and governance. Utah is a leading example. States now recognize that data will outlive current business systems. No longer can one data set provide a full understanding of the complex issues faced by state DOTs—for example, crash analysis is conducted with crash data cross-referenced to traffic and weather data. As more data are automated, a need is emerging for data flow between systems and for decisions to be made more quickly, in or near real time.

Big data and data analytics are emerging tools for many states. The opportunity and challenge for states is to develop teams with the expertise and understanding of transportation issues. Those teams need to care passionately about informing the decisions of the DOTs, their customers, and their states.

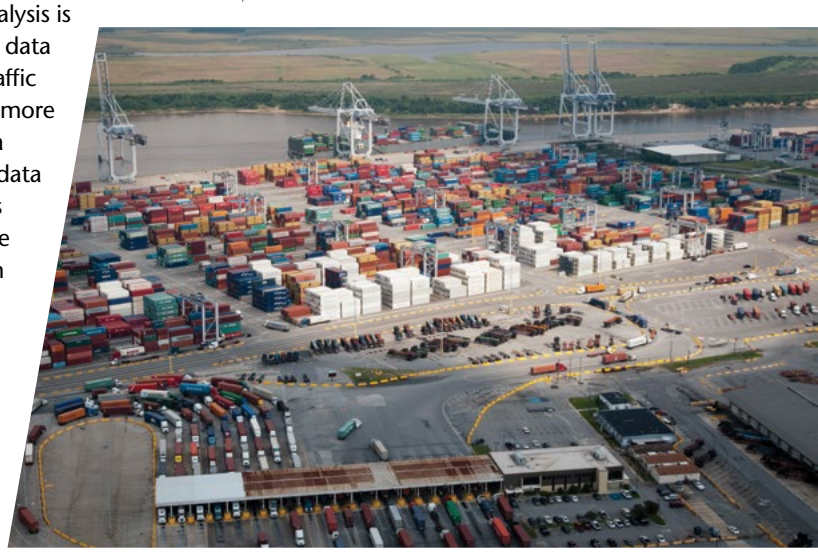
Aviation

The rise in use of unmanned aircraft systems (UASs) has spurred states not only to facilitate opportunities for the use of UASs in day-to-day transportation department operations but also to determine the role of UASs in managing and monitoring public operations via cooperation with state legislatures, local airports, and the Federal Aviation Administration (FAA). The rapid change in technological advances also has states looking at the aviation system impacts of urban air mobility in the nearer term, as full-scale flight testing is under way on several electric vertical takeoff and landing, or eVTOL, vehicles, with approval for commercial use likely within the next decade.

Several states also support efforts to facilitate commercial space operations and the opportunities the industries that use and support these operations can bring to their states.

Freight

The steady cadence of autonomous freight vehicle testing and adoption continued throughout 2018. Since 2015, when Nevada issued the first license for an autonomous



Infrastructure investments will allow the Port of Savannah to double its rail capacity by 2020, relieving congestion caused by a surge in megaships.

Photo: U.S. Army Corps of Engineers

Photo: California High-Speed Rail Authority, Wikimedia

The San Joaquin River Viaduct will carry the California High-Speed Rail over the San Joaquin River. It is the second major river crossing constructed as part of rail project.

commercial truck to operate on the state's open public highways, a total of 37 states have enacted laws or executive orders regarding autonomous vehicles and 16 states have authorized truck platooning. U.S. DOT released the report "Preparing for the Future of Transportation: Automated Vehicles 3.0," in which the administration revealed guiding principles that call for consistency in the national regulatory and operational environment for autonomous adoption.

The technology company Embark successfully completed a coast-to-coast test of a fully autonomous truck in early 2018, traveling from Los Angeles to Jacksonville, Florida, with sensor-enabled technology handling most of the driving. In the last-mile urban context, Udelv is poised to deploy electric autonomous delivery vans in Northern California and Oklahoma City after a year of successful testing. Market possibilities include deliveries of groceries, flowers, auto parts, and baked goods.

Ports and Waterways

With megavessels increasingly deployed in international waterborne commerce, U.S. coastal ports are feeling the pressure of maintaining port productivity in an environment that is more operationally complex than ever before. With more robust crane and yard equipment requirements and increased time at berth required to load and unload these massive ships, productivity can be hindered by many factors. Chief among these are ship schedule delays, which have become increasingly common given larger cargo volumes. When weather or delays at previous port calls cause vessels to miss their anticipated port call windows, schedule slippage cascades into many follow-on issues: labor availability and shift challenges, equipment availability, gate hours and trucking limitations, and chassis availability for container movements within and out of the port area. In some ports, schedule lapses can cause bunching of multiple vessel calls during certain times of the week, exacerbating port congestion and straining overall port capacity and resources.

States and ports continue to invest millions in near-port intermodal infrastructure to create capacity for these surges caused by megaship calls. The Port of Savannah is investing $128 million in a mega–rail terminal to stem the effects of increasing congestion and local impacts from truck traffic. Funded partially by leveraging a $44 million federal FASTLANE grant, the project promises to double the Port of Savannah's rail capacity when operations commence in 2020.

Rail

Three intrastate, intercity, high-speed rail projects in the United States made significant strides in 2018:

- Florida's Brightline began service in early 2018 between Miami and West Palm Beach. Late in the year, Brightline announced a strategic partnership with Virgin Group of the United Kingdom, bringing Virgin's brand recognition to the U.S. rail sector.
- Texas Central, which will provide service between Houston and Dallas, achieved several milestones in 2018: selection of a firm to provide construction project management, a civil construction consortium, and a contract operating partner.

Photo: Patrick Hamilton, Flickr

Florida's Brightline rail service opens commuting options between Fort Lauderdale and West Palm Beach.

- The California High-Speed Rail project continued construction in the Central Valley, with almost 2,500 workers engaged on what is considered the largest infrastructure project in the country. Several major viaducts now are under construction, including one that spans the San Joaquin River in Fresno.

State-supported initiatives that involve freight railroads include the Chicago Region Environmental and Transportation Efficiency (CREATE) Program, whose grade crossing and rail bottleneck elimination projects have been completed. Elimination of the rail bottlenecks has resulted in increased fluidity of both the freight and passenger rail systems in and around the nation's busiest rail hub. Illinois DOT played a large part in the CREATE program.

Photo: Bill VanderMolen, Flickr

Mcity, the outdoor laboratory at the University of Michigan, simulates real traffic conditions to test automated vehicles.

Public Transportation

Transit agencies nationwide are experiencing sluggish ridership. The Transit Cooperative Research Program is studying the trend, which has been attributed variously to attitudes of young people; the effect of transportation network companies (TNCs), or ride-hailing services; and increased teleworking. Meanwhile, the public transportation industry is experimenting with innovative service delivery options and technologies, including opportunities to use TNCs in the provision of Americans with Disabilities Act paratransit services and to complement transit service in low-density areas.

The state of Michigan is sponsoring an $8 million Mobility Challenge that offers demonstration grants for solutions to mobility gaps—such as service to seniors, travelers with disabilities, and veterans—using new technologies and public–private partnerships. Nine projects have been funded. Many of these issues will be explored at TRB's upcoming International Conference on Demand–Responsive and Innovative Transportation Services, which will be held in Baltimore, Maryland, in April.

Autonomous vehicles present possible opportunities for the transit industry. Many pilot projects employing automated buses or shuttles have sprung up on college campuses. Michigan is testing automated vehicles at Mcity, a 32-acre outdoor laboratory on the University of Michigan campus for testing the safety and performance of connected and automated vehicles. Mcity combines physical roadway features with traffic simulation. The state of Michigan also is building a large test facility, called the American Center for Mobility, on the site of the former Willow Run bomber plant. In Florida, SunTrax in Polk County is a similar test bed under construction.

Photo: Seattle DOT

Transit agencies work with various proposals to better serve those in need of paratransit services.

Many on-street test beds around the country feature automated transit vehicles in pilot test service. In states like Michigan and Florida, laws make it easier to conduct on-street testing of autonomous transit vehicles. The Federal Transit Administration is sponsoring Mobility on Demand Sandboxes around the country to further test shared-mobility business models and automated vehicles.

Environment, Energy, and Climate Change

As the 50-year legacy of the National Environmental Policy Act (NEPA) approaches, states continue to address environment and energy challenges. Through collaboration with state and industry peers, states examine how they can use new processes and technologies to address existing problems—but also explore how to best meet the challenges of the future. For example, states are finding ways to better map environmental effects of transportation projects on cultural and natural resources, air quality, noise, and public health. States also are investigating future infrastructure needs to meet increasing demand for alternatively fueled vehicles—particularly as some auto manufacturers have announced plans this year

to focus on greater electric- and hydrogen-based vehicle production lines within the next 10 years.

Legal

By identifying associated legal issues and potential statutory and regulatory solutions, attorneys representing state DOTs continue to focus on the legal intricacies related to transformational technologies and their incorporation into state transportation systems. Of particular concern are data privacy and security issues associated with connected and autonomous technologies and liability issues associated with potential tort actions involving connected and autonomous vehicles, UASs, and associated infrastructure.

Innovative project delivery and finance methodologies are recurring areas of interest and involvement for state DOT counsel. Evolving concepts of diversity in public procurement, equal access to public transportation, and the potential for DOT projects to have disparate impacts on underrepresented communities also pose challenges for state and local agency legal departments. The booming demand for and availability of on-demand transportation—including ride services, electric scooters, and bicycles—pose new aesthetic, tort liability, and risk management challenges.

On the environmental front, federal regulatory streamlining and reduction initiatives are being closely followed and analyzed by agency counsel.

Highway Design

Digital terrain models help highway designers visualize, plan, and model, but applying them during construction can be a challenge. The Kentucky Transportation Cabinet is exploring better ways to format and to provide the right amount of detail so that digital terrain models can be used seamlessly from design to construction inspection.

Wisconsin DOT has had success including performance-engineered mixtures

Did You Know?

Pioneering Transportation Routes

In the 1800s the Commonwealth of Pennsylvania and private investors built more than 1,240 miles of canals, mostly along existing rivers to enable navigation. These were the original freight and passenger routes that carried the beginning of the great westward migration across the United States.

A portion of "The Old Brick Road" in St. Johns and Flagler counties in Florida is still intact. Only 9 feet wide and paved with millions of bricks, 10.6 miles of the road can still be driven today. This road was part of the Dixie Highway, a series of connected roads built to serve travelers from Ontario to Florida.

Photo: Ebyabe, Wikimedia

Portions of the Old Brick Road, part of the Dixie Highway in Florida, still exist and are in use today.

Established in the 1920s, the original transcontinental air mail route ran between New York and Chicago. Night flying was facilitated by rotating beacons placed every 3 to 5 miles. The route eventually had approximately 1,500 of these towers, built on concrete arrows 50 to 75 feet long and painted yellow, which pointed to the next beacon on the route. Some of these arrows are still visible today.

Photo: Andrew J. Russell, Yale University Libraries

The Golden Spike ceremony in Promontory, Utah, in 1869. Although the historic rail line still exists, it is no longer in use.

The Golden Spike that commemorated the completed the Transcontinental Railroad in 1869 was driven at Promontory Summit in Utah.[1] Many improvements have been made to the route through the years, including many relocations. In 1904, the Southern Pacific Railroad built a more direct route to the Pacific, across the Great Salt Lake, that bypassed Promontory Summit. The original line was scrapped in 1942 for the war effort. Today, Promontory Summit is the location of the Golden Spike National Historic Site. Tracks at the site are used for ceremonial and demonstration purposes but are not connected to the general railroad system. This year marks the 150th anniversary of the completion of the Transcontinental Railroad.

[1] www.nps.gov/gosp/index.htm

in rigid pavement designs, providing the opportunity to work toward specifying the performance characteristics of concrete mixtures and allowing design mixtures that address specific pavement performance requirements. New test methods to evaluate concrete can result in improved performance and economics.

Persistent leadership from state DOTs, cooperating with the Federal Highway Administration and academic and industry partners, has continued to advance accelerated bridge construction (ABC) techniques. ABC uses innovative planning, design, materials, and construction methods safely and cost-effectively to reduce onsite construction time when building new bridges or replacing and rehabilitating bridges.

In 2018, Georgia DOT fully replaced the 111-year-old Courtland Street Bridge in downtown Atlanta using ABC techniques. The $25 million project replaced all 28 spans of the Courtland Street Bridge over Decatur Street and the MARTA and CSX rail lines. These techniques also were used to rehabilitate the East Street Bridge, built circa 1911, that carries the Massachusetts Bay Transportation Authority Franklin Commuter Rail Line in Westwood. This project featured precast concrete abutment caps, precast concrete approach slabs, and two steel superstructures, installed over two separate weekends. Before the weekend closures, deep foundation–drilled shafts were installed behind existing abutments, utilities were relocated, and tracks were restored.

Highway Construction and Materials

In New England, transportation agencies have begun chemically fingerprinting highway materials with rapid techniques using X-ray fluorescence and infrared spectrometers. Fingerprinting applications range from tracking the aging of and additives in asphalt materials to deterioration signatures in bridge deck cores to the chemical content and acceptability of paints.

New Hampshire DOT has studied asphalt mixtures with higher-than-ordinary recycled content for more sustainable, cost-effective pavements. A large study correlated performance test results from laboratory and plant samples to help illuminate mix design methods and ensure adequate field performance. Massachusetts DOT has begun using American Association of State Highway and Transportation Officials (AASHTO) PP 84 standards for performance-engineered concrete pavement mixtures and has gathered data from new test methods on local materials to identify quality assurance and acceptance characteristics. Maine DOT is studying ways to improve concrete bridge deck durability, with a strategy to use lower-alkali cement; measure how mixes shrink during curing; and improve modeling of chloride diffusion.

The wide-ranging impacts of CAVs include transportation operations; safety; land use; geometric, pavement, and bridge design; transit and transit operations; freight and goods movements; and more.

Photo: Pmattes, Flickr

Hawaii DOT is installing 1,279 precast panel pieces on the H1 Freeway in Honolulu to complete a much-needed infrastructure rehabilitation.

Photo: Elmschrat, Wikimedia

Big Thompson Canyon, Colorado. Colorado DOT used soil mixing for stabilizing and rebuilding parts of US-34 through the canyon.

Agencies also are exploring new technologies for improved construction. Maine DOT has investigated the ability of push-type rolling pavement density meters to measure asphalt compaction and joint density more quickly. Vermont Agency of Transportation is researching the use of acoustic monitoring sensors, which detect cracks and damage in prestressed and prefabricated concrete bridge components that can occur during the forming, transportation, and installation phases of rapid bridge construction projects. North Dakota DOT used GPS-based intelligent compaction rollers on an Interstate Highway paving project. Four different pieces of equipment digitally mapped the coverage of rollers—and project data indicated that the density exceeded requirements. Hawaii DOT utilized innovative techniques for freeway construction, deploying precast concrete pavement panels in the rehabilitation of a high-volume section of roadway and reducing the duration of the construction closure.

Geotechnical Engineering

More and more, transportation agencies recognize the need to manage geotechnical assets. Maine DOT has started to manage slopes as part of its asset management program, and New Jersey DOT has developed a collaborative approach to implementing its rockfall mitigation program. In Montana, a comprehensive rock slope asset management program combines fiscal modeling with technical decision-support tools to aid policy makers, planners, and technical personnel, reducing risk both to users and to the agency.

Many states are recognizing that slope stability is critical to corridor resiliency and is especially important along emergency evacuation routes. Hawaii DOT has installed instrumentation on slopes to monitor many variables for a better understanding of the sequence of mechanisms that contribute to slope instability.

Advanced technology and innovative practices allow many DOTs to tackle complex geotechnical challenges. Oregon DOT completed fast-tracked projects in parallel with geotechnical analysis through landslide-prone areas with advance monitoring and by developing a green–amber–red response system to slope stability. Kentucky Transportation Cabinet saved both time and money using continuous horizontal drilling to explore subsurface conditions along tunnel alignments. Colorado DOT opted for soil mixing to stabilize and rebuild parts of US-34 through the Big Thompson Canyon, and Pennsylvania DOT used an innovative system of lightweight foamed concrete and geosynthetics to tackle a complicated reconstruction of an I-95 interchange over soft soils.

Highway Maintenance and Preservation

Maintenance departments also are preparing for a future in which an increased amount of roadway and other data will be available via connected and automated vehicles (CAVs). In order to grapple with issues of being data rich and information poor, agencies are exploring the application of artificial intelligence and machine-learning techniques to

- Analyze National Bridge Inventory ratings and bridge element data;
- Forecast optimal times of maintenance, repair, and rehabilitation; and
- Conduct autonomous visual classification of road assets.

Several agencies have developed internal maintenance innovations programs to develop pioneering employee-driven solutions. These types of programs are part of a broader strategy for employee engagement and retention. Colorado DOT and the Front Range Community College have developed a two-year applied science associate's degree in highway maintenance management. Other state agencies also are pursuing similar programs to better prepare the maintenance workforce of the future.

Highway Operations

At no time within memory has a new transportation technology emerged more quickly—and with more potential to spur transformation—than CAVs. The wide-ranging impacts of CAVs include transportation operations; safety; land use; geometric, pavement, and bridge design; transit and transit operations; freight and goods movements; and more.

The availability of CAVs is no longer a science-fiction vision of the future but is quickly becoming a reality as auto manufacturers, suppliers, and state DOTs aggressively develop, advance, test, and implement vehicles that can operate autonomously under varying conditions with minimum human interaction. CAV technologies also are turning roads into connected highways by using short-range communication technology among vehicles and infrastructure. This is known as "vehicle-to-everything" communication technology, or V2X.

AASHTO has implemented a nationwide challenge to deploy dedicated short-range communications (DSRC) infrastructure with signal phase and timing (SPaT) broadcast in at least one corridor (containing approximately 20 signalized intersections) in each of the 50 states by 2020. At present, more than 200 signals operate in 26 states, with approximately 2,100 more planned for the next few years. The primary purpose of the SPaT challenge is to offer state and local DOTs a clear first step for deploying vehicle to infrastructure, or V2I, technology and operations and for gaining experience with the technologies. This program will provide valuable experience and lessons learned in the procurement, licensing, installation, and operations of DSRC infrastructure.

Colorado DOT recently launched a $67 million project to turn I-70, I-76, I-25, and I-270 into connected highways. In the next 20 years, the V2X project is projected to reduce crashes by more than 85,000, injuries by more than 22,000, and fatalities by more than 300. Wyoming DOT's connected vehicle pilot on I-80 uses V2I as well as vehicle-to-vehicle and infrastructure-to-vehicle connectivity to improve monitoring and reporting of road conditions to vehicles traveling on the Interstate.

Express toll lanes (ETLs) are another operations technology rapidly being adopted to improve travel time predictability. ETLs are a form of managed lanes that feature a variable toll rate based upon traffic demand. The purpose of ETLs is to offer drivers the option to buy into a free-flowing lane or roadway for a variable toll fee when their schedules require a more dependable travel time and adjacent general-purpose lanes are congested. These ETLs have been implemented in several states, including Virginia, California, Maryland, and Florida.

Safety

After two consecutive years of significant increases, motor vehicle–related fatalities decreased last year, according to National Highway Traffic Safety Administration data. In 2017, 37,133 people died in motor vehicle crashes—a decrease of almost 2 percent from 2016. Despite the improvement, however, this figure remains unacceptably high and has not reached the low fatality rates that occurred between 2010 and 2014. Speeding, distracted driving, and driving under the influence still represent significant contributing factors and states continue to implement a combination of behavioral and infrastructure countermeasures in an attempt to reduce fatal and serious injury crashes.

A collaborative effort between Minnesota DOT and the Minnesota Department of Health, Minnesota Walks creates safe, desirable, and convenient environments for pedestrians. Minnesota DOT also is examining how to build upon years of strategic safety planning at the state and county levels and ways to adopt a safe systems approach to future safety management and implementation.

Alabama DOT updated the state's multiyear, comprehensive strategic highway safety plan (SHSP) in 2017, working with local, state, federal, and other public and private stakeholders. Aligning with the Toward Zero Deaths initiative for all transportation system users and the goal to reduce fatalities and serious injuries by 50 percent by 2035, the SHSP 3rd Edition emphasizes high-risk behavior, at-risk road users, infrastructure and operations, and decision and performance improvement.

Conclusion

The 2018 State Partnership Visits Program offered TRB staff and state DOT personnel many opportunities to meet face to face and discuss the most pressing transportation issues facing the nation. These visits informed all participants on the many and varied policies and programs that state DOTs are using to improve the transportation system and support and promote the economy and quality of life.

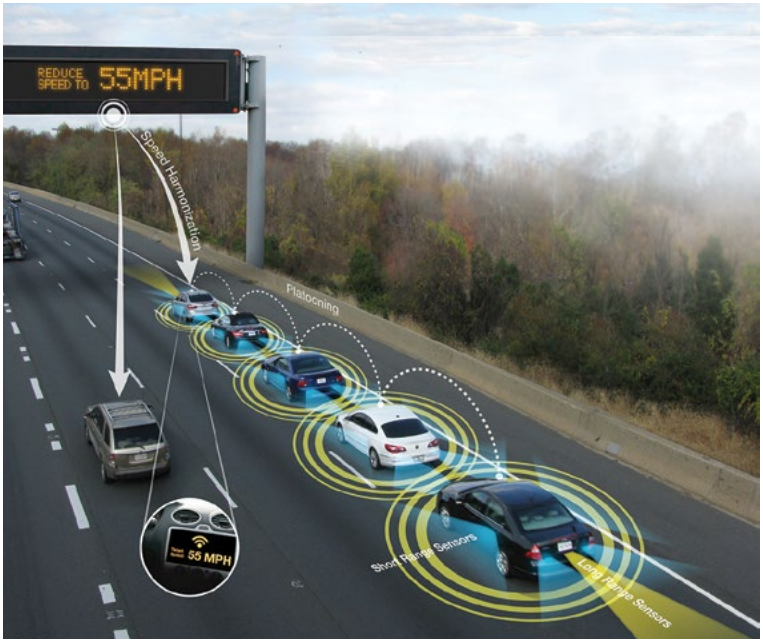


Photo: U.S. DOT

Photo: Tony Webster, Flickr

Left: Connected and automated vehicle technologies use short-range technology to facilitate communication among vehicles and infrastructure. Above: Express toll lanes allow drivers to buy into a lower-congestion lane or roadway, paying a toll that varies based on traffic.