TEXAS DEPARTMENT
OF TRANSPORTATION
2023-2024 EDUCATIONAL SERIES
TRANSPORTATION
TECHNOLOGY

• TxDOT Technology Partnerships
• Technology Strategies
• Connected and Automated Vehicles and Advanced Aerial Systems
• Transportation Management Systems and Intelligent Transportation Systems

TxDOT RESOURCE LINKS
Scan the QR codes with your mobile device or click on the resource link to direct you to additional resources and more details on the information provided in this document.

Texas Department of Transportation
TxDOT’s public website for agency information and resources focused on meeting the needs of drivers, businesses, government officials, and those who want to learn more about TxDOT.

TxDOT 2023-2024 Educational Series
TxDOT’s complete 2023-2024 Educational Series that focuses on a range of transportation issues affecting TxDOT and the State of Texas.
OVERVIEW

In recent legislative sessions, the Texas Legislature authorized the Texas Department of Transportation (TxDOT) to examine and evaluate innovative transportation technologies that may reduce costs and traffic congestion, promote highway and general transportation safety, and increase economic productivity statewide. In an era of ever-evolving technological and mobility advances and pushes from state and federal policymakers to increasingly deploy such technologies, TxDOT and its transportation and technology partners have undertaken efforts to embrace opportunities and work through challenges inherent in applying technology and innovations to help solve transportation challenges.

TxDOT TECHNOLOGY PARTNERSHIPS

TxDOT facilitates and participates in various technology-related groups and partnerships with industry and regional and local transportation entities. The three key partnership organizations described below—the Texas Technology Task Force, the Texas State Transportation Innovation Council, and the Texas Innovation Alliance—provide key platforms for TxDOT to collaboratively consider and plan for future technology-related developments of impact on the Texas transportation system.

The Texas Technology Task Force identifies emerging transportation-related innovations that may directly or indirectly impact TxDOT operations or relate to TxDOT’s mission. Information and insights gleaned from this effort, described in greater detail below, allows TxDOT to undertake initial steps to research, analyze, and plan for what is needed at the state and local levels to prepare for these new capabilities.

In some instances, TxDOT initiates longer-term research projects to delve deeper into emerging technologies and their applications under its federal research program. If research from other states or at the national level already exists, TxDOT works to analyze and apply best practices and lessons learned through the State Transportation Innovation Council.

As innovations or emerging technology become available for deployment, they are examined for TxDOT use and shared with Texas Innovation Alliance members. These partnerships are made of experts from across the transportation and technology industries, as well as other stakeholders with expertise in intersecting industries and academic fields. Knowledge and on-the-ground experience gleaned from using new technology are shared among these partners and coordinated by TxDOT through the Alliance.

TxDOT uses new information gained from these groups to strategize and influence the development of TxDOT’s Long Range Strategic Plan and other supporting strategies and programs. TxDOT incorporates technology into strategies and participates in the state’s Connected and Autonomous Vehicle Task Force while advancing the capabilities of TxDOT’s traffic management systems that will enhance the safety and potential benefits of these technologies.

TEXAS TECHNOLOGY TASK FORCE

In 2013, the Texas Legislature first authorized TxDOT to examine and evaluate innovative transportation technologies for purposes of reducing costs, reducing traffic congestion, promoting safety, and increasing economic activity, which led to the creation of the Texas Technology Task Force.

TxDOT established the Texas Technology Task Force to develop a vision for a future Texas transportation system that uses technology-based solutions to further the mission of TxDOT. The task force identifies emerging technologies that may impact transportation 5 to 15 years in the future, and considers the many related factors as outlined in the figure below. Task Force members include representatives from private industry and public institutions including the North Central Texas Council of Governments, the Central Texas Regional Mobility Authority, INRIX, Econolite, the University of Texas Center for Transportation Research, Houston METRO, and the Southwest Research Institute.
In 2010, the Federal Highway Administration implemented the Every Day Counts initiative to shorten research project delivery and expedite the deployment of proven technologies. The Federal Highway Administration introduced the State Transportation Innovation Council concept to state departments of transportation and industry partners to facilitate Every Day Counts program initiatives. On March 22, 2016, TxDOT and the Federal Highway Administration Texas Division signed the charter to establish the Texas State Transportation Innovation Council. The Texas council’s vision is to foster a collaborative culture for the rapid implementation of ready-to-deploy and beneficial innovations and technologies that will efficiently deliver a safe and effective transportation system to the people of Texas. Membership includes representation from federal, state, and local government, as well as private partners including the Federal Highway Administration, TxDOT and other Texas state agencies, Metropolitan Planning Organizations, tolling authorities, and transportation and innovation industry groups, among others.

**TEXAS INNOVATION ALLIANCE**

In October 2016, following several Texas cities’ submissions for the United States Department of Transportation’s Smart City Challenge, TxDOT convened teams representing 10 Texas cities and three Texas research institutions to identify ways to build off momentum and implement transportation innovations in Texas. The teams discussed options to advance “Smart State” collaboration, encourage public-private dialogue, and galvanize key leadership to develop innovative solutions to the state’s mobility challenges. Texas cities pledged to engage in open dialogue with each other and with Texas research institutions and the public and private sectors.

From this foundational meeting, TxDOT created the Texas Innovation Alliance, a collaboration of Texas city teams committed to addressing mobility challenges by creating a platform for innovation and technology deployments. Teams from Arlington, Austin, Bryan-College Station, Dallas-Fort Worth, El Paso, Frisco, Houston, San Antonio, and the Coastal Bend region meet regularly to share knowledge and best practices. The Alliance’s first action was to cooperate and partner on a Texas application for the United States Department of Transportation Automated Vehicle Proving Grounds program. The Texas Automotive Proving Grounds Partnership was selected from a competitive group of over 60 applicants.

Furthermore, the Texas Innovation Alliance empowers public agencies, research institutions, and industry partners to leverage collective resources, co-create solutions, and share results to improve mobility for all Texas communities. The Alliance’s initiatives are to:

- Reform procurement;
- Create a comprehensive data strategy;
- Host industry and stakeholder meetings;
- Assist partners with strategic and financial planning;
- Form a knowledge base for members; and
- Provide research services in support of pilot projects.

**TECHNOLOGY STRATEGIES**

TxDOT has established several internal working groups to prepare the agency for an array of new advanced technologies being developed across the ever-changing transportation landscape. Specific focus areas include, but are not limited to, emerging transportation technologies, cooperative and automated transportation (which includes connected and autonomous vehicles), freight technology and operations, urban air mobility and advanced aerial vehicle deployment, and the connectivity needed to support all of these.

**EMERGING TRANSPORTATION TECHNOLOGIES**

TxDOT recognizes that although new technologies emerge at a rapid pace, certain underlying principles must be applied to each. Specifically, within TxDOT, each new technology requires data management, robust planning exercises, project and program development, and business processes support. Having identified these principles as common across all new transportation technology, TxDOT maintains a starting point to address everything from advanced aerial systems to blockchain security to innovative lane configurations.

**COOPERATIVE AUTOMATED TRANSPORTATION**

Through the efforts of a dedicated workgroup, TxDOT seeks to ensure that not only is the transportation system Connected and Automated but also Cooperative—meaning that all facets of the transportation system work together to maximize safety and efficiency. This working group proposes agency policies, strategies, pilot programs, and deployments for emerging connected vehicle and autonomous vehicle technologies and serves as a clearing house for information and educational material for TxDOT staff. Additionally, through TxDOT’s Research and Technology Implementation Division, the workgroup has championed research projects with the University of Texas San Antonio to: (1) propose updates to Texas, and in particular TxDOT, roadway design standards, given the emerging landscape of autonomous
vehicles; and (2) research and model changes in standards of lane widths, parking requirements (including new types of parking infrastructure), lane designations, and other roadway design elements to determine the most efficient outcomes. Alongside the Texas Transportation Institute, the workgroup is conducting research to investigate the legal frameworks surrounding such emerging technologies and how TxDOT can ensure full compliance with all legal requirements while responsibly enabling these technologies.

LEVELS OF DRIVING AUTOMATION

TEXAS FREIGHT NETWORK TECHNOLOGY AND OPERATIONS

Based on a recommendation from the 2018 Texas Freight Mobility Plan, TxDOT developed the Statewide Freight Network and Technology Operations Plan. TxDOT recognizes that roadway infrastructure investments alone will not be able to meet the freight system’s stakeholder needs related to safety, economic competitiveness, asset preservation and utilization, mobility and reliability, and multimodal connectivity. In addition, TxDOT recognizes that emerging technology applications can improve freight system efficiency, improve logistics reliability, reduce freight industry costs, and improve safety.

The plan outlines 12 technology-based strategies, six of which were advanced to Concept of Operations, to help improve freight transportation safety and mobility in Texas. The Concepts of Operations include:

- Automated Vehicle Infrastructure, Connected Signing, and Data Concept of Operations
- Blocked Rail Crossing Traffic Management System Concept of Operations
- High-Resolution Advanced Freight Traveler Information System Concept of Operations
- Safety Warning Detection System Concept of Operations
- Smart Freight Connector Concept of Operations
- Statewide Traffic Operations Center Concept of Operations

Beginning in 2023, TxDOT plans to advance some of the recommendations and Concepts of Operations identified within the plan.

SAE J3016™ LEVELS OF DRIVING AUTOMATION™

Learn more here: sae.org/standards/content/j3016_202104

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<table>
<thead>
<tr>
<th>SAE LEVEL 0™</th>
<th>SAE LEVEL 1™</th>
<th>SAE LEVEL 2™</th>
<th>SAE LEVEL 3™</th>
<th>SAE LEVEL 4™</th>
<th>SAE LEVEL 5™</th>
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<tr>
<td>You are driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering</td>
<td>You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety</td>
<td>When the feature requests, you must drive</td>
<td>These automated driving features are engaged – even if you are seated in “the driver’s seat”</td>
<td>These automated driving features will not require you to take over driving</td>
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What does the human in the driver’s seat have to do?

What do these features do?

These are driver support features

- These features are limited to providing warnings and momentary assistance
- automatic emergency braking
- blind spot warning
- lane departure warning

These are automated driving features

- These features provide steering OR brake/acceleration support to the driver
- These features provide steering AND brake/acceleration support to the driver
- These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met
- This feature can drive the vehicle under all conditions
- traffic jam chauffeur
- local driverless taxi
- pedals/steering wheel may or may not be installed
- same as level 4, but feature can drive everywhere in all conditions

Example Features

- lane centering
- adaptive cruise control
- adaptive cruise control at the same time

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CONNECTED AND AUTOMATED VEHICLES AND ADVANCED AERIAL SYSTEMS

While people often categorize and reference connected and automated vehicles as a single technology, connected and automated vehicles are distinct and separate technologies. Connected vehicle technology enables vehicles to receive and share mobility and safety information between vehicles, people, other roadway users, and transportation management systems. Automated vehicles are those in which at least some aspects of a safety-critical control function, such as steering, throttle, or braking, occur without direct driver input. Automated vehicle types currently include freight trucks, passenger vehicles, advanced aerial systems for packages and passengers, low-speed shuttles, low-speed delivery vehicles, personal delivery devices (sidewalk robots), and others. The Society of Automotive Engineers created automation levels zero through five that industry and those involved in automated vehicle technology use as a standard.

TxDOT regularly provides connected and automated vehicle-related comments and input on proposed legislation and rulemaking to the United States Department of Transportation and its offices, including the National Highway Transportation Safety Administration and the Federal Highway Administration, as well as to the United States Congress.

CONNECTED AND AUTONOMOUS VEHICLE TASK FORCE

In January 2019, TxDOT established the Connected and Autonomous Vehicle Task Force at the direction of Texas Governor Greg Abbott. The task force is the central point for connected and autonomous vehicle advancement in Texas. In addition to representatives from local and state governmental entities, the task force includes representatives from various segments of the connected and autonomous vehicle industry, including partners involved with original equipment manufacturing, autonomous vehicle start-ups, advanced aerial systems, intelligent transportation systems, mobility as a service, transit, telecoms, and research. The task force serves as a one-stop resource for information and coordination on all ongoing connected and autonomous vehicle projects, investments, and initiatives in Texas. In addition to documenting public and private entity efforts and facilitating partnerships, the task force hosts industry forums and provides reports on lessons learned to facilitate progress and encourage increased collaboration.

TxDOT maintains a keen interest in the progress of connected and autonomous vehicles as they have the potential to greatly reduce crashes and improve roadway safety over time. Connected and autonomous vehicles also provide opportunities to reimagine personal and commercial mobility, bringing potential quality of life and economic benefits. For example, connected and autonomous vehicle technology could enable greater mobility for those who rely on others for their transportation to health care and routine appointments, such as the elderly and people with disabilities.

The task force will continue to support companies to pursue innovative ideas around connected and autonomous vehicle technology in a business-friendly way. It will also build on state legislation governing how connected and autonomous vehicles can operate in the state. Starting in 2020, the task force announced the creation of five subcommittees that address specific areas of interest to Texas. These subcommittees focus on the following issues:

- Data, Connectivity, Cyber Security, and Privacy;
- Education, Communication, and User Needs;
- Safety, Liability, and Responsibility;
- Licensing and Registration; and
- Freight and Delivery.

In July 2020, an additional subcommittee was created to study the impacts of connected and autonomous vehicles on the Texas economy. This subcommittee, named Future Workforce and Economic Opportunities kicked off in the fall of 2020 and continues to meet. The Task Force adopted their first report in June of 2020, which can be found on its comprehensive website, cavtaskforce.texas.gov. This report provided a list of opportunities for the Texas Legislature and Governor’s Office to consider as connected and autonomous vehicle technologies advance in Texas.

These efforts will ensure that Texas is prepared for the safe and successful roll-out of connected and autonomous technologies statewide.
TEXAS CONNECTED FREIGHT CORRIDORS PROJECT

Improving freight operations improves mobility, reliability, and safety while reducing environmental impacts for both freight operations and for others traveling in freight corridors.

The Texas Connected Freight Corridors project focuses on the I-35 (extending the freight corridor to Laredo, Texas), I-45, and I-10 corridors that make up the Texas Triangle. The project deployed vehicle-to-vehicle and vehicle-to-infrastructure technology applications in commercial vehicles to address the greatest safety and mobility needs of the state. The project builds the necessary infrastructure and communications for developing connected automated vehicle technology.

In the near term, freight partner trucks will receive more timely and accurate information about traffic and roadway conditions that affect safety and mobility, such as work zones, vehicle crashes, upcoming traffic queues, wrong-way drivers, and pedestrians in the roadway and unsafe weather conditions, including low visibility. The truck operators will also experience benefits from smarter traffic intersections around their distribution centers, which will enable the vehicles to interact with traffic signals to reduce truck idling time. This benefits the environment and saves money for freight operators.

In the long term, as more and more trucks use the technology, travel times will decrease, fuel efficiency will increase, and safety will improve. The Texas Connected Freight Corridors project uses the following connected vehicle technology:

**Vehicle-to-Infrastructure**
- In-vehicle Traveler Information
- Eco-Dynamic Routing
- Work Zone Warning
- Signal Timing for Pedestrians and Bikes
- Truck Parking Reservations
- Border Wait Times
- Truck Signal Priority
- Low Bridge Height Warning
- Queue Warning
- Road Weather Warning
- Wrong-Way Driving

**Vehicle-to-Vehicle**
- Truck Platooning
- Emergency Electronic Brake Lights

ADVANCED AERIAL SYSTEMS

TxDOT has developed processes to use advanced aerial systems when such technology would improve safety, reduce data collection costs, and improve data quality. Activities in which TxDOT could use advanced aerial systems, include emergency response assistance, traffic incident management, construction monitoring, topographic mapping, drainage analysis, bridge inspections, and pavement forensics. Currently, TxDOT is in the process of developing a new advanced aerial system training program throughout TxDOT’s regional districts and divisions to equip TxDOT employees with the tools to strategically and effectively use advanced aerial technology in their daily job functions.

TxDOT is also working with industries using advanced aerial systems to plan for when these systems operate more broadly providing services for people, businesses and governments, and incorporating them into the overall mobility environment. A key facet of this work includes the recently convened Urban Air Mobility Advisory Committee, established by Senate Bill 763 (87th Regular Legislative Session, 2021). The Federal Aviation Administration coined the term “Urban Air Mobility” as a future aviation transportation system that employs highly automated aircraft, such as drones, to transport passengers or cargo at relatively low altitudes in urban and suburban areas. The vision for Urban Air Mobility involves an elaborate ecosystem and framework that reflects careful consideration of aircraft safety and technology, best practices for operation, airspace access, infrastructure development, and community engagement. In anticipation of plans to test this framework and technology in Texas, the Urban Air Mobility Advisory Committee studied potential changes to state law needed to facilitate this industry’s development, safety, and regulatory system.

With the help of the Texas A&M Transportation Institute, TxDOT coordinates and carries out various aspects of the advisory committee, including facilitating meetings, gathering necessary information from external sources, and assisting in the report’s development. Committee membership includes those representing the state’s diverse geographic regions, law enforcement, the urban air mobility and broad transportation industries, commercial airports and vertical takeoff and landing operator, local governments, and the public to gain a diversity of perspectives and insights for the future deployment of such technology in Texas.

BROADBAND DEPLOYMENT

Fiber optics, cellular connections and other broadband technology provide the backbone for communication among TxDOT assets. TxDOT must consider two networks: (1) a traffic network, which connects signals, message boards, cameras, and other Intelligent Transportation Systems (ITS); and (2) TxDOT’s internal business network, which enables TxDOT staff to send emails, make transactions and perform other normal business processes. While TxDOT maintains several connected assets across the state, TxDOT and the state faces an ongoing need to cover broadband access gaps and extend services to the traveling public. To do this, TxDOT includes broadband connectivity in its construction projects when feasible and appropriate, and vigilantly seeks funding and partnership opportunities with the public and private sectors. One significant change to TxDOT’s approach to broadband recently originate from Senate Bill 507 (87th Regular Session, 2021), which allows broadband providers wider access to state highway right of way. This change aims to help broadband providers expand their networks and provide more services to Texans across the state. By simultaneously encouraging the sharing of duct banks and exploring partnership opportunities, both TxDOT and the private sector may better coordinate to reduce individual costs. Additionally, the Texas Legislature created a Broadband Development Office under the Office of the Comptroller, which offers new opportunities for TxDOT to collaborate on and seek funding for broadband deployment with the Broadband Development Office and other state agencies.

TRANSPORTATION MANAGEMENT SYSTEMS AND INTELLIGENT TRANSPORTATION SYSTEMS

Traffic Management Systems improve safety and mobility, reduce congestion, and save lives. Traffic signals at intersections are an example of traffic management systems that have been around for decades. TxDOT is upgrading traffic signal equipment to utilize the latest technology in computing, sensing, and communication. For instance, intersection light synchronization can improve safety at intersections by connecting traffic signal controllers and associated equipment to computer networks to ensure that traffic lights work at their maximum effectiveness. This synchronization also generates data that governments can use to evaluate signalized intersections and determine areas in need of improvement.

Intelligent Transportation Systems improve transportation safety and mobility and enhance productivity by integrating advanced communication technologies into vehicles and infrastructure. Examples of intelligent transportation systems include data sharing and capturing, connected and automated vehicles, and advanced aerial systems.

Intelligent transportation systems also include more recent advances in technology that better inform drivers and enable them to make safer, more coordinated and smarter use of transportation networks. This includes deploying roadside equipment such as dynamic messaging signs, closed-circuit television cameras, vehicle detectors, weather sensors, enhanced networking, and software to communicate and operate the systems. Intelligent transportation systems also include vehicle-to-vehicle technology, where vehicles communicate with one another; vehicle-to-infrastructure technology, in which infrastructure transmits messages to vehicles; and vehicle-to-everything technology, which builds on the previous two technologies.

CONNECTED CAR DATA

Many vehicles today directly report telematics data back to their manufacturers on a continuous basis. This data—potentially including everything from vehicle speed and heading to whether seatbelts are latched, or windshield wipers are on—is anonymized and made available for purchase to certain entities on the open market. TxDOT is exploring the use of such data to gain insights on roadway activity, which were otherwise impossible to determine and understand prior to the availability of connected car data. Through an enterprise-level contract with leading data providers and partnerships with Texas Universities, TxDOT is responsibly acquiring the data and launching studies and efforts to produce tools based on modeling and artificial intelligence. The goal of this work is to equip TxDOT with real-time roadway conditions to enable quicker, more effective issue identification, response, and future planning.

LOOKING FORWARD

TxDOT monitors state and federal rules and legislation, studies and implements effective intelligent transportation systems, and is in partnership with several technology groups. Through these efforts, TxDOT is engaging in emerging technologies to allow TxDOT to better plan for a more technological future. The goal of these efforts is to prepare TxDOT to implement future transportation solutions as laws and technology swiftly change.
CONNECTING YOU WITH TEXAS

RESOURCES

TEXAS DEPARTMENT OF TRANSPORTATION

PROJECT TRACKER
Project Tracker is the gateway to up-to-date information about TxDOT highway improvement projects, providing 24/7-access to the public, employees, and elected officials.

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TEXAS DEPARTMENT OF TRANSPORTATION

GOVERNMENT AFFAIRS
TxDOT’s Government Affairs Division works closely with government on both the state and federal levels though the State Legislative Affairs and Federal Affairs sections.

TxDOT is committed to your safety and to the reliability of the information contained on this site. While road conditions can change rapidly, DriveTexas.org is an industry leader in providing some of the most accurate and up-to-date travel-related information currently available to drivers in Texas. Information presented here is as close to real time as possible. For those who use our roads, please do not use this site while operating a motor vehicle.

Be Safe. Drive Smart. Thank you!

PERFORMANCE DASHBOARD
STRATEGIC GOALS
TxDOT’s performance dashboard provides a transparent way to show how we are doing as an agency. We highlight performance measures related to the seven strategic goals that guide our mission of Connecting You with Texas: Promote Safety, Optimize System Performance, Preserve Our Assets, Deliver the Right Projects, Focus on the Customer, Foster Stewardship and Value Our Employees.