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Creation of impacTX: Improved Mobility Plan for Advancing Connected Transportation

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16. Abstract The state is at a pivotal moment in transportation, where the rate of population growth, infrastructure deterioration, and congestion are outpacing Texas's ability to provide quality service. This document introduces the Texas Technology Task Force, providing highlights on its most recent activities that have led to the creation of a strategy and innovation plan. The Improved Mobility Plan for Advancing Connected Transportation (impacTX) is a strategy and innovation roadmap to build a mobility foundation that will enable Texas to become the first Smart State. The purpose of the plan is to prepare and inform Texas transportation leaders and policymakers about TxDOT's strategic and innovative activities. Communication goals are also identified to guide TxDOT in building trust, garnering support, and generating investment. The plan concludes with three recommendations that encourage TxDOT to take a leadership position, develop a priority CAV pilot strategy, and extend the P3 framework to support smart mobility initiatives.		
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Research Supervisor: C. Michael Walton

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1 Introduction

This research report provides an overview of the research team's activities from September 2015 through July 2016. Leveraging momentum generated at the federal level by USDOT, the main focus has been to establish a foundation and roadmap that would enable Texas to become the first Smart State. The report introduces the Texas Technology Task Force (TTTF), focusing on the themes of people, portfolio, and plan. Next, three stakeholder engagement meetings are outlined and major outcomes are identified.

This report also introduces the concepts behind the TTTF's Strategy and Innovation Plan. Compiling the first draft of this plan was a major task completed in 2016. The plan, titled the *Improved Mobility Plan for Advancing Connected Transportation (impacTX)*, is a strategy and innovation roadmap to build a mobility foundation that will enable Texas to become the first Smart State. The purpose of the plan is to prepare and inform Texas transportation leaders and policymakers about the strategic and innovative activities of the Texas Department of Transportation (TxDOT). The final draft of the plan will be released in 2017.

Finally, other activities and next steps are described for the upcoming phase of work.

2 Background

Texas's 83rd Legislature passed the General Appropriations Bill, S.B. No. 1, Item 44, VII-31 and charged TxDOT with examining and evaluating innovative transportation technologies to achieve cost savings, reduce traffic congestion, enhance safety, and increase economic productivity. As a result of this charge, a Texas Technology Task Force was formally created in 2013 to develop a vision for the future Texas transportation system that furthers the mission of TxDOT via technology-based solutions. TxDOT's mission is to provide a safe and reliable transportation system for Texas, while addressing congestion, connecting Texas communities, and becoming a best-in-class state agency.

Since its creation, the work of the Task Force has been designed to progress through multiple phases leading to a comprehensive Strategy and Innovation Plan, known as impacTX, to guide technology advancement activities in the state. This report provides an overview of that process and focuses on the current phase of work, which centers on the TTTF's proposed initiative to create an organic framework for demonstrating transformative technologies in a user-focused, open-innovation ecosystem. The TTTF believes that this initiative will help further TxDOT transportation goals and demonstrate that Texas is a leader and supporter of emerging technology testing and deployment.

2.1 Early Work

The TTTF began with an internal core group of industry thought leaders that sought experts in various transportation technologies to provide direction for the Task Force. The Task Force has regularly engaged outside subject matter experts (SMEs) over the past three years on selected topics at full-day workshops held quarterly in Austin. Together the Task Force and invited SMEs have discussed emerging transportation technologies, their development stages, evaluation methods, short- and long-term visions, benefits and barriers to adoption, and future deployment scenarios.

2.2 Portfolio

The TTTF has continually monitored industry developments to identify and incorporate new transformational technologies into its Emerging Technology Portfolio. The identified technologies serve as the foundation for planning and research activities by indicating which technologies to focus on. The TTTF regularly evaluates and prioritizes technologies according to market readiness, adoption barriers, alignment with state and national transportation goals, and other relevant criteria.

2.3 Plan

Ultimately the TTTF developed a full Strategy and Innovation Plan to demonstrate the need for public-private partnerships in deploying emerging technologies in the state of Texas. The plan represents a roadmap for enabling Texas to become the first Smart State, launching Texas into a leadership position and signaling to industry that Texas is open for innovation.

3 Stakeholder Engagement Meetings

Operating with these core ideas in mind, the TTTF developed a work plan to progress activities through phases that will develop a strong community of the right expert people and continually refresh the technology portfolio with the most up-to-date technologies, and to create the critical components needed for a full Strategy and Innovation Plan. To accomplish these goals, the TTTF organized a series of stakeholder meetings. These meetings focused on specific objectives and are described in more depth below.

3.1 Seizing Opportunity: December 10, 2015

Objective: Select the three most opportune technology areas for further business case development

Agenda: Opening remarks were provided and the TTTF was introduced to the audience. Transformative topics for airport operations, wireless networks, and alternative energy were presented. A lunch presentation on cybersecurity issues related to connected vehicles was shared. In the afternoon, Task Force members facilitated workshop discussions focused on five key technology areas: Connected Vehicles, Automated Vehicles, Electric Vehicles, Unmanned Aerial Systems, and Big Data. Participants worked together to select and recommend the three most opportune technology areas for further business case development in the next phase.

Speakers: Jim Crites, DFW International Airport; Geri Yoza, Toyota; Myron Gregorek, Alcatel-Lucent; Josh Johnson, SwRI

Outcomes: The Task Force prioritized connected vehicles, automated vehicles, and big data for further business case development. Electric vehicles were thought to be a secondary priority that did not align TxDOT's current trajectory. Unmanned aerial systems were thought appropriate for testing related to highway/bridge/rail inspections, navigating natural disasters such as floods and wild fires, and monitoring construction.

3.2 Making an IMPACT: March 29, 2016

Objective: Develop three business cases for the *impacTX* to secure funding, partnerships, and support from stakeholder groups: 1) TxDOT and the Traveling Public, 2) Public Sector Partners, and 3) Private Sector Partners

Agenda: Opening remarks were provided and the TTTF was introduced to the audience. Transformative topics on data sharing were presented, including privacy concerns from policymakers, data silos within and between organizations, an update on the Smart City Challenge, and private sector innovation for transportation management. TxDOT's current strategy and innovation efforts were shared. In the afternoon, the Improved Mobility Plan for Advancing Connected Transportation was outlined as a concept to enable Texas to become the first Smart State. Task Force members facilitated workshops that focused on different aspects of the plan: 1) Vision, Goals, and Outcomes, 2) Problem Statements and Application Process, 3) Funding and Partnerships, and 4) Accountability and Evaluation Process. Participants identified the next steps for development of the three business cases.

Speakers: Celia Israel, Texas House of Representatives; Kent Marquardt, TxDOT; Jim Dale, City of Austin; Monali Shah, HERE

Outcomes: The Task Force members recommended that strategy and innovation goals be clearly identified to guide TxDOT in building trust, garnering support, and generating investment from the three stakeholder groups. Additional support from internal and external leadership was deemed necessary in order to move the initiative forward.

3.3 The Next 100 Years: June 21, 2016

Objectives: Develop a comprehensive Strategy and Innovation Plan for emerging technologies; define how the TTTF will identify, analyze, and make recommendations for technology deployment projects; define how the State Transportation Innovation Council will implement, evaluate, and scale pilot projects.

Agenda: Opening remarks were provided and the TTTF was introduced to the audience. Transformative topics on the idea of Smart City, Smart State were shared, including a range of perspectives from Austin, San Antonio, Houston, El Paso, and North Central Texas. In the afternoon, small groups were formed to represent three perspectives: urban, rural, and freight. The small groups participated in workshops to provide input to the Strategy and Innovation Plan: 1) Vision, Goals, and Outcomes, 2) Challenges, Priorities, and Technologies, and 3) Communications and Stakeholder Outreach. Participants identified next steps for development of the Strategy and Innovation Plan.

Speakers: Robert Spillar, City of Austin; Terry Bellamy, City of San Antonio; Thomas Lambert, Houston METRO; Eddie Valtier, TxDOT; Michael Morris, NCTCOG

Outcomes: The Task Force members recommended that Texas take a leadership position, develop a priority connected and automated vehicle pilot strategy, and extend the public-private partnership framework to support smart mobility projects. The development of a communications plan was also suggested.

4 Improved Mobility Plan for Advancing Connected Transportation (impacTX): A Strategy and Innovation Plan for Moving Texas Forward

The research team, under the guidance of the Task Force, prepared a draft Strategy and Innovation Plan to help position Texas as a leader in advancing emerging transportation technologies. The plan, to be published in 2017, is divided into the following three sections.

1. **Vision: Preparing Texas for the Age of Technology**, which explains social, economic, and technology trends that are influencing demand for new transportation services and operations. The vision outlines benefits that could be realized from deploying emerging technologies as well as TxDOT goals and resources for strategy and innovation.
2. **Communications: Fostering a Culture of Innovation**, which provides goals, strategies, and tactics in a framework for communicating TxDOT's strategy and innovation activities to key stakeholders. This section also provides snapshots of TxDOT innovation champions who have already promoted forward-thinking practices in the agency along with innovation projects already in the works.
3. **Recommendations: Positioning Texas as a Leader**, which provides three critical recommendations for action in order to position TxDOT as a leader in advancing emerging technologies. The critical actions are for Texas to take leadership position at industry and professional forums and conferences, to develop a priority connected and autonomous vehicle pilot strategy, and to extend the public-private partnership framework to support smart mobility initiatives.

5 Other Activities

The Task Force has also been involved in a number of other activities, including visiting competitive pilot programs, attending conferences, and presenting the Task Force's work to a broader audience. Tech Memo 6 provides a summary of lessons learned from visiting cutting edge pilot programs and Tech Memo 3 places them within a national context according to the types of technologies being deployed, partnership arrangements, and value offered to the field of transportation. Tech Memo 5 describes the conferences attended, presentations and posters presented, and research/planning activities in which the Task Force and research team have participated. Tech Memo 7 summarizes key strategies for communications plan that would guide TxDOT in promoting strategy and innovation with key stakeholders. The combination of the research, communication, and planning activities of the Task Force enable TxDOT to increase its positive visibility on the national stage. These tech memos are provided as Appendix A.

6 Next Steps

The TTTF has proposed impacTX to TxDOT for consideration and refinement. Next steps will require engagement with potential public and private sector partners to better understand their needs and level of interest. Supporting work for the initiative will be required so that TxDOT can make informed decisions on how to best promote the program; such work includes an assessment of TxDOT's leadership position within the state and federal political landscape. Ultimately, the TTTF hopes to continue to work with and support TxDOT by leveraging impacTX as a platform for promoting advanced technology testing and deployment in Texas.

Appendix A: Technical Memoranda 3, 5, 6, and 7

Technical Memorandum#0-6902-TM3

To: RTI Project Manager: Sonya Badgley
From: CTR Research Team: Kristie Chin, Andrea Gold, C. Michael Walton
Subject: TxDOT Project 0-6902 – Technical Memorandum for Task 3
Date: 07/15/16

1 Introduction

This technical memo will identify emerging transportation technology pilots, programs, and initiatives throughout the U.S. that may be viewed as competitive programs centered on one or more of the technologies listed in TxDOT's Texas Technology Task Force's Emerging Technology Portfolio. Each of the emerging technologies is grouped into one of six major categories, which are shown in Figure 1.

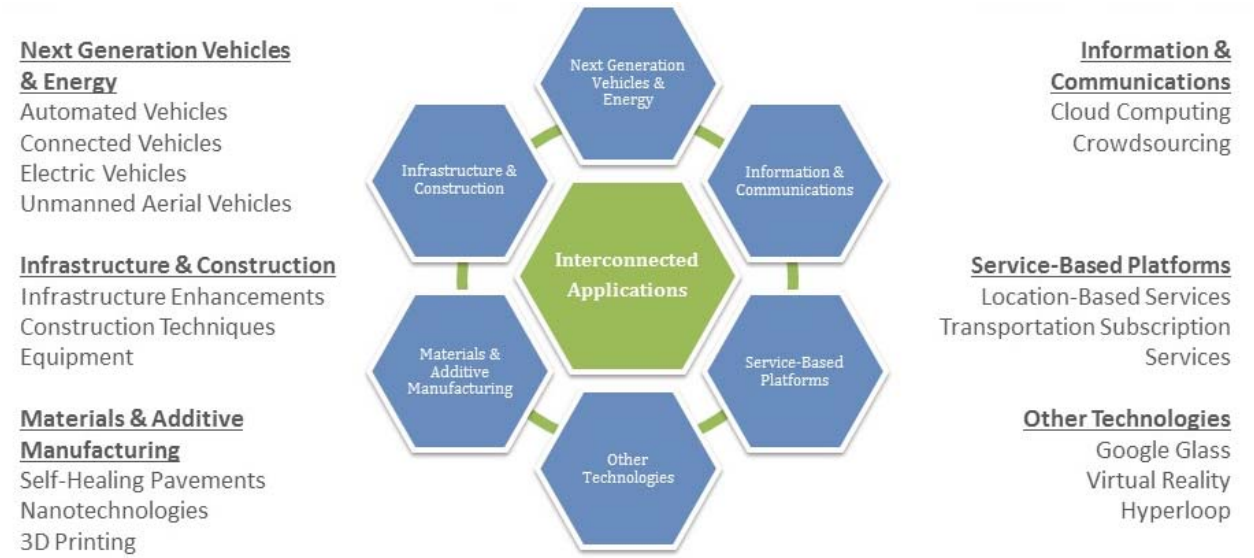


Figure 1: Emerging Technology Portfolio

The competitive analysis has two main objectives:

1. Identify characteristics of each pilot, program, or initiative that make it unique and highlight its objectives.
2. Identify key partners involved in research activities or that provide critical resources such as funding, equipment, or expertise.

Each program, pilot, and initiative was chosen for investigation based on the following factors:

- Includes a non-public-sector partner from industry or a research institution
- Includes a public agency partner such as a state DOT or the USDOT, or is conducted solely by a state DOT alone
- Is currently in or has completed an early testing phase
- Is recognized nationally or internationally
- Is based on a technology in the Emerging Technology Portfolio

2 Summary of Competing Programs

The following section summarizes competing technology pilots, programs, and initiatives, and organizes them by Emerging Technology Portfolio grouping.

2.1 Autonomous Vehicles (AVs)

The University of Michigan's (UM) Mobility Transformation Center (MTC) MCity project

UM's MTC is a public-private partnership among industry, government, and academia. It was developed to establish the foundation for a commercially viable ecosystem of connected and automated vehicles (CAVs) that has the potential to disrupt traditional mobility options. A key MTC goal is to deploy a shared network of CAVs (including driverless) on the road in Ann Arbor by 2021. Its feature project is MCity: a controlled environment specifically designed to test the potential of CAV vehicle technologies.

The MCity testing facility has been designed to offer a realistic off-roadway environment for testing AVs in a closed testing environment before they are transitioned to real environments with higher market penetration. The facility opened for testing on July 20, 2015, with partnerships formed between representatives from government, industry, and the university. The MTC has partnered with the Michigan Department of Transportation for the facility design and operations of Mcity. Industry partners can join at one of two levels: leadership or affiliate. Partners in the Leadership Circle join with government and faculty to serve as thought leaders in guiding and synthesizing the work of the Center. Membership in the Leadership Circle is an investment of $1 million over three years. Affiliate members will be invited to participate in a variety of selected, focused Center activities at an investment of $150,000 over three years.

MCity's main program goals include evaluation of the capabilities of CAVs and systems on the project's 32 acres at the university's North Campus Research Complex. The facilities simulate the numerous complexities that vehicles will encounter in urban and suburban environments. According to the MCity website, the facilities include approximately 5 lane-miles of roads with intersections, traffic signs and signals, sidewalks, benches, simulated buildings, street lights, and obstacles such as construction barriers. Roadway attributes include a 1000-ft north/south straight track; various road surfaces (concrete, asphalt, brick, and dirt); a variety of curve radii and ramps; two-, three-, and four-lane roads; a roundabout and tunnels; and sculpted dirt and grassy areas. Roadside attributes include a variety of signage and traffic control devices; fixed and variable street lighting; crosswalks, lane delineators, curb cuts, bike lanes, and grade crossings; hydrants, sidewalks, etc.; and buildings (fixed and movable). MTC plans to continue to generate partnerships with multiple industries that play an integral part in shaping the future of mobility. These partnerships include agencies with expertise in auto manufacturing and supplies, telecommunications, big data analytics and management, freight, traffic controls and management, insurance, public transportation, payment systems, and parking.

MTC operates its own research program, which is overseen by staff and program partners. Its four research priority areas include technology, risk management, customer value, and societal impacts.

Objective: develop and implement an advanced system of CAVs in Ann Arbor by 2021.

Partners: (***Government)*** USDOT, Michigan Department of Transportation, Michigan Economic Development Corporation, City of Ann Arbor. ***(Industry)*** (Leadership Circle) BMW; Delphi Automotive PLC; DENSO Corporation; Econolite Group, Inc.; Ford Motor Company; General Motors Company; Honda Motor Co., Ltd; Intel; Iteris, Inc.; LG Electronics, Inc.; Navistar, Inc.; Nissan Motor Co., Ltd; Qualcomm Technologies, Inc.; Robert Bosch LLC; State Farm Mutual Automobile Insurance Company; Toyota Motor Corporation; Verizon Communications, Inc.; Xerox Corporation. (Affiliate Members) 3M; Allstate Insurance Company; AGC Automotive; Arada Systems, Inc.; Auto Club Enterprises; Autoliv Electronics; Brandmotion LLC; Calspan Corporation; Changan Automobile; Cohda Wireless; Desjardins General Insurance Group, Inc.; DURA Automotive Systems; Faurecia; FedEx Corporation; Guangzhou Automobile Group, Co. Ltd; Harada Industry of America, Inc.; Harman International Industries; HERE; Hitachi, Ltd.; IAV Automotive Engineering; IDIADA; Magna International Inc.; Mechanical Simulation Corporation; Miller, Canfield, Paddock and Stone, PLC; MOBIS; Munich Re; New Eagle Consulting, LLC; Nexteer Automotive; NXP Semiconductors; OSIsoft, LLC; Panasonic Automotive Systems Company; PTC, Inc.; Realtime Technologies, Inc.; Renesas Electronics America Inc.; Savari Inc.; SF Motors, Inc.; Shell Oil Company; Subaru; Sumitomo Electric Industries, Ltd.; Suncorp Group; TASS International, Inc.; TRW Automotive; WSP l Parsons Brinckerhoff; ZipCar, Inc. ***(Research)*** Texas A&M Transportation Institute

Contra Costa Transportation Authority's (CCTA) GoMentum Station, Concord California

GoMentum Station in Concord, California, is led by the CCTA and is a collaborative partnership among multiple automotive manufacturers; OEMs and Tier 1 suppliers; communications suppliers; technology companies; researchers and academia; public agencies, and other partners. These entities come together to support research, development, testing validation, and commercialization of CAV applications and technologies as well as necessary transportation network infrastructure. As a former military base, the site has many barracks and buildings that provide a closed, secure, urban-like environment for vehicle and technology testing. Honda has already been open about testing its autonomous driving technology at GoMentum Station.

The station's four program areas are described below.

AVs: In partnership with CCTA, automobile manufacturers can test and validate their AV technology in a closed, confidential setting.

Connected vehicles (CVs): CCTA will lead the ongoing effort to assemble a team composed of public and private sector entities representing infrastructure owners/operators; vehicle manufacturers; in-vehicle and roadside equipment vendors; technology companies; and academia.

Pilot programs: CCTA's CV program hopes to implement a series of pilot programs throughout Contra Costa. With the support of local jurisdictions and transit agencies, these pilot programs can offer partners an on-the-ground opportunity to test new transportation technologies designed to increase safety and reliability across the transportation system.

Partnering opportunities: GoMentum Station is actively engaging and collaborating with current and new USDOT CV pilot programs by sharing knowledge and best practices.

Objective: research, develop, test, validate, and commercialize CAV applications and technologies and define the next generation of transportation network infrastructure. GoMentum station strives to create a world-class CAV test bed with active industry and government participation.

Partners: ***(Public)*** City of Concord, Bay Area Rapid Transit, Bay Area Air Quality Management District, TriDelta ***(Industry)*** Honda, Stantec, EasyMile, Bishop Ranch, ITS America, Global Automakers, Telecommunications Industry Association, Prospect Silicon Valley.

Program to Watch: Uber & Arizona State University Partnership

In August 2015 Arizona's governor announced an effort to partner with Uber and the University of Arizona for a major economic development partnership, which will focus on research and development in optics for mapping and safety of AVs. The university will become home to Uber's state-of-the-art mapping test vehicles. Additionally, Uber will donate $25,000 to the College of Optical Sciences to help the next generation of researchers continue to explore and develop new innovative technology.

Program to Watch: MTC's Willow Run

A $3 million grant from the Michigan Strategic Fund has been announced to help launch a 335-acre AV proving ground in Ypsilanti, MI, at a former manufacturing site called Willow Run. The funding will enable the property purchase and cover design work costs for the American Center for Mobility (ACM). Partners in the ACM initiative include the Michigan Department of Transportation and Michigan Economic Development Corp., the University of Michigan, Business Leaders for Michigan, and Ann Arbor SPARK, which is a local economic-development organization. The long-range goal of the center is to ensure the U.S. is competitive with AV development in Europe and Asia.

Program to Watch: Google Test Center in Novi, Michigan

In May 2016, Google's Self-Driving Car Project announced plans for opening a 53,000-square-foot development center in Novi, Michigan, (which signifies Silicon Valley's growing interest in of AVs). The City of Novi has been working with Google planning the new center that will serve as a hub for Google to work with a number of partners in the automotive industry. Google's first task at the site will be to work on a self-driving Chrysler Pacifica hybrid minivan. This follows Google's first official automotive partnership with Fiat Chrysler Automobiles NV. The goal is to produce 100 self-driving Pacificas using Google's AV technology.

2.2 Connected Vehicles (CVs)

University of Michigan Transportation Research Institute (UMTRI) & USDOT CV Safety Model Deployment

UMTRI partnered with the USDOT for on-road testing of dedicated short-range communications (DSRC)-based CVs, which is a first-of-its-kind pilot. Titled the Safety Pilot Model Deployment, the pilot represented a critical step in validating safety benefits of vehicle-to-vehicle (V2V) technologies. In total the 3-year program helped to move forward standards development, applications research, and ultimately led the National Highway Traffic Safety Administration (NHTSA) to issue an advanced notice of proposed rulemaking with regards to regulating V2V technology in light vehicles. The fleet and equipped roadways from the safety pilot continue to be used and expanded today for further research and testing of CV technologies.

According to program documentation, test cars, trucks, and buses in the study were mostly supplied by volunteer drivers and equipped with various V2V and vehicle-to-infrastructure (V2I) communication devices to generate, transmit, and store extensive data about system operability and its effectiveness at reducing crashes.

- Sixty-four fully integrated cars and three trucks had electronic devices (integrated safety systems—ISS) installed during vehicle production, which were connected to proprietary databases and provided highly accurate information using in-vehicle sensors. The ISS both broadcasted and received basic safety messages (BSMs) and could process the content through visual, sound, and/or haptic warning of received messages to alert the vehicle driver. Nearly 200 cars were equipped with aftermarket safety device (ASD) and could send and receive BSMs from other vehicles over a DSRC wireless communications link. The ASDs had a driver interface, ran V2V and V2I safety applications, and issued audible and/or visual warnings to the driver of the vehicle.
- Sixteen trucks and three transit buses were fitted with retrofit safety devices. These devices connected to a vehicle data bus and could provide highly accurate information from in-vehicle sensors. The integrated device had a working driver interface, both broadcasted and received BSMs, and could process the content of received messages to provide warnings to the driver of the vehicle.
- Finally, nearly 2000 cars, 60 trucks, and 85 transit buses were equipped with vehicle awareness devices (VADs), an aftermarket electronic device installed in a vehicle without connection to vehicle systems. The VAD was only capable of sending the BSM over a DSRC wireless communications link.

In total, 73 lane-miles were in the deployment and equipped with roadside equipment (RSE) devices, which could send messages to vehicles, such as signal phase and timing (SPaT), curve speeds, etc., to help improve safety and traffic flow using DSRC. A total of 29 RSE devices were in the deployment: 21 at signalized intersections, 3 at curves with curve speed warnings, and 5 at freeway sites. SPaT information was communicated to vehicles on 2 corridors with 12 intersections (6 intersections per corridor).

The model deployment cost $30 million with 80% funding from USDOT.

Building on this experience, the University of Michigan's MTC plans to now expand the deployment to embrace the full range of traffic situations in the greater Ann Arbor area. The expansion is expected to include up to 9,000 equipped vehicles, including private cars, trucks, buses, motorcycles, bicycles, and links with pedestrians. The program area will be scaled to 27 square miles covering surrounding highways and city and suburban streets. Infrastructure equipment will be installed at 45 or more intersections, 3 curve-related sites, and 12 freeway sites, and will provide over-the-air security, all DSRC logs, testing of selected V2I functions, back-haul communications network, and back-end data storage.

Objective: examine how well CV safety technologies and systems work in a real-life environment with real drivers and vehicles. It will test performance and usability, and collect data to better understand the safety benefits of a larger-scale deployment. This deployment will focus on three major activities: 1. Test CV operations in real-world conditions; 2. Understand how regular drivers use CV technologies; 3. Determine the safety benefits of a CV.

Partners: NHTSA, Research and Innovative Technology Administration (RITA), Federal Highway Administration (FHWA), Federal Motor Carrier Safety Administration (FMCSA), and Federal Transit Administration (FTA). The University of Michigan.

USDOT CV Pilot Deployment Program

In the fall of 2015, the USDOT announced the selection of three CV deployment sites in the Connected Vehicle Pilot Deployment Program. Together, the three sites will cover a broad array of applications enabled by CV technologies that are designed to meet site-specific needs. The three pilot sites include using CV technologies to improve safe and efficient truck movement along I-80 in southern Wyoming, using V2V and intersection communications to improve traffic flow and pedestrian safety in priority corridors in New York City, and deploying multiple safety and mobility applications on and in proximity to reversible freeway lanes in Tampa, Florida. Each deployment will progress through multiple phases beginning with an initial concept development phase over 12 months. Phase 1 focused on the refinement of the core concept of operations, system requirements, and a full deployment plan. Extensive deployment planning will support a rapid progression to physical, real-world deployment of these concepts through Phases 2 and 3 of the program. Participants in each of the three pilot sites will work collaboratively amongst themselves and the USDOT.

Total funding for the pilot is unclear. The USDOT launched the CV pilot as a Broad Agency Announcement, a federal solicitation format that avoids placing a spending ceiling on each project. The FHWA estimates that deployments will cost from $2 million to $20 million (depending on the scale of the deployment) over the three waves, and two to five awards are expected in each phase. The first wave, which includes the three selected pilots below, is estimated at $42 million (from USDOT). These deployments will be completed by 2020.

New York City Pilot
The focus of the New York City pilot will be on the installation of V2V technology in 10,000 city-owned vehicles, including cars, buses, and limousines, that frequently travel in Midtown Manhattan, as well as connected infrastructure technology throughout Midtown.

Objective: improve safety and mobility of travelers in New York City through CV technologies. Align with the NYC Vision Zero initiative, which seeks to reduce crashes and pedestrian fatalities, and increase safety of travelers in all modes of transportation

Partners: NYC DOT and Region 2 University Transportation Research Center, MTA, NYCTA

Tampa Pilot
The Tampa program will focus on developing strategies to empower cities to solve congestion and safety issues with connected vehicle technology. The project award of $17 million will go toward solving peak rush hour congestion in downtown Tampa and to protect the city's pedestrians by equipping their smartphones with the same connected technology being put into the vehicles. The Tampa will aim to measure the environmental benefits of using this technology. The program will evaluate the following CV applications: AM peak hour backups and congestion, wrong-way driving, pedestrian safety, transit signal priority optimization and safety, streetcar conflicts, enhanced signal coordination, and traffic progression.

Objective: test and evaluate CV applications for the improving congestion and pedestrian safety. Deploy a variety of V2V and V2I safety, mobility, and agency data applications to create reinforcing benefits for motorists, pedestrians, and transit operations.

Partners: USDOT, Tampa Hillsborough Expressway Authority, Hillsborough Area Regional Transportation Authority.

Wyoming Pilot
The focus of this program will be on the safe and efficient movement of freight vehicles through the I-80 east-west corridor. This is a critical freight corridor that sees 11,000 to 16,000 heavy-duty vehicles moving across the northern portion of the U.S. The focus will be on information gathering and sharing through V2V and V2I technologies.

Objective: collect and disseminate information to and from vehicles not equipped with the new connected technologies.

Partners: USDOT, Wyoming Department of Transportation, freight and logistics partners.

Virginia's Smart Road, Montgomery County, VA

The Virginia Smart Road is a unique, state-of-the-art, full-scale, closed test-bed research facility located in Montgomery County, VA. It is managed by the Virginia Tech Transportation Institute (VTTI) and owned and maintained by the Virginia Department of Transportation (VDOT). The Smart Road was originally studied and conceived as a 5.7-mile future road project to provide a more direct connection between Interstate 81 and Blacksburg, but the idea emerged in the late

1990s to construct a portion of the road to serve as a real-life laboratory for public and private research. It was originally a joint project of VDOT, VTTI, and the FHWA. The Virginia Smart Road is now an FAA-approved testing facility for flight.

Two construction projects have been completed to build the road's 2.2-mile test bed: the initial 1.7-mile, two-lane test bed that opened in March 2000 and a second project completed in May 2001 to build one of Virginia's tallest bridges and provide an additional 200 yards of roadway.

According to the Smart Road website, features include seven wireless RSE units, which have been installed at an approximate spacing of 2,000 feet to enable CV applications. It is equipped with 75 weather-making towers capable of producing rain, snow, and fog. A 500,000-gallon water tank supplies the towers, which produce selected weather across a 0.5-mile stretch of roadway under suitable temperature and wind conditions. Rain capacity is between .08 and 2.5 inches per hour, fog visibility varies from 10 to 300 feet, and snow can be produced at up to 4 inches per hour. Two weather stations with official National Oceanic and Atmospheric Administration weather information are available within one mile of the Smart Road. The Smart Road is equipped with variable lighting to study the effects of lighting technologies on visibility. Visibility Testing System Two road sections (static and dynamic) are used to test the visibility of pavement markings and other objects.

VTTI houses the Smart Road Control Room through which on-road research is scheduled and overseen 24 hours per day/7 days per week. The Control Room also acts as the 511 Virginia Data Quality Assurance/Quality Control (QA/QC) Center. Dispatchers located in the Control Room have the ability to manipulate lighting and all-weather testing systems on the road and can control access to the facility itself.

Objectives: study driving in both controlled environments with the weather-making capabilities of the Smart Road and in uncontrolled, natural environments.

Partners: VTTI, VDOT, FHWA

2.3 Alternative Fuels

California Fuel Cell Partnership (CaFCP), State of California

The CaFCP is a collaboration of organizations, including auto manufacturers, energy providers, government agencies, and fuel cell technology companies, that work together to promote the commercialization of hydrogen fuel cell vehicles. By working together, CaFCP members strive to ensure that vehicles, stations, regulations, and people are in step with each other as the technology comes to market.

Government support has been a key factor in jump-starting the program. Government funding has helped to develop the initial infrastructure needed to support consumer adoption, and the State has committed to spending $200 million to build 100 hydrogen refueling stations. Most of them are clustered in Los Angeles and around the Bay Area. Subsequently, California was chosen by Hyundai, Toyota, and Honda as the U.S. launching point for their respective production hydrogen

fuel-cell cars because it was the only state with any hydrogen-fueling infrastructure in existence at the time of each company's decision. Toyota Motor Corporation has developed and sold its Mirai fuel-cell sedan on the bet that hydrogen-powered (instead of electric) vehicles will be the real future of clean transportation. Currently, California is the only state in the U.S. where it is currently available for sale or lease (at a price of $58,335). The Mirai purchase qualifies for a $5,000 rebate from the State of California as well as a carpool-lane sticker. Honda Motor Co. is working on a reboot of its fuel-cell model, and Seoul-based Hyundai Motor Co. started selling a hydrogen-powered Tucson SUV last year.

California has 13 research hydrogen fueling stations, 9 public stations, and an additional 18 that have been funded and are expected to be operational in the next few years. Some of these stations have been co-funded by the State of California.

Objective: to promote the commercialization of hydrogen fuel cell vehicles by supporting the development of necessary fueling infrastructure.

Partners: ***(Public)*** Bay Area Air Quality Management District, California Environmental Protection Agency Air Resources Board, California Department of Food and Agriculture, State of California Energy Commission, The Governor's Office of the State of California, South Coast Air Quality Management District, US Department of Energy, US Environmental Protection Agency. ***(Industry)*** Air Liquide, AC Transit, Automotive Fuel Cell Cooperation, BAE Systems, Ballard, CalStart, Center for Energy Efficiency and Renewable Technologies, Center for Transportation and the Environment, Daimler, H2 Logic, Honda, Hydrogenics, HydrogeNext, Hyundai, ITM Power, The Linde Group, National Fuel Cell Research Center, Nissan, Southern California Gas Co., SunLine Transit Agency, Toyota, Volkswagen. ***(Research)*** Cal State Los Angeles, ITS UC Davis, NREL, UC Berkeley, Sandia National Laboratories.

West Coast Green Highway

This multi-state effort aims to promote high-efficiency and cleaner fuel vehicles, including compressed natural gas, biodiesel, hydrogen fuel cell, and plug-in electric vehicles (EVs). Together, Washington, Oregon, California, and British Columbia are collaborating to make the I-5 West Coast Green Highway a national model for sustainable transportation infrastructure. These partners are working with the private sector and other agencies to lay the groundwork for a smooth and rapid shift to the widespread use of vehicles that run on electricity and other sustainable fuels. The highway is an extensive network of EV DC fast charging stations located every 25 to 50 miles along Interstate 5 and other major roadways in the Pacific Northwest. The West Coast has a robust EV charging network with thousands of Level 2 charging pedestals and dozens of DC fast chargers.

This Green Highway project is structured as a public-private partnership so that the costs are shared by the public and private sector partners as well as the users. Much of the funding is provided by the federal government as part of the American Recovery and Reinvestment Act.

The Washington State DOT (WSDOT) leads the charge on the Washington segment, the Oregon DOT heads up the Oregon segment, and the California segment is coordinated by a Governor's Office interagency group. In Washington, initial funding was provided by the US Department of

Energy through the State Energy Program (SEP); the Washington State Department of Commerce leads that program. The Department of Commerce invested $1.6 million of SEP grants as seed funding and WSDOT developed the partnerships to implement the Electric Highways network with private businesses, other agencies, and EV drivers. In Oregon, the state's charging network is funded with a combination of US Department of Energy and USDOT grants. Drivers may need a key fob or RFID card to operate the charging stations and prices may vary depending on the various equipment vendors. Some locations charge by the time connected to the station, others may charge a flat fee per use, and others will offer monthly subscription services for unlimited use. Most locations have a toll-free phone number posted on the equipment so drivers can call and get a guest charge with a credit card.

Objective: promote high-efficiency and cleaner fuel vehicles, including compressed natural gas, biodiesel, hydrogen fuel cell, and plug-in EVs, by supporting fueling and charging infrastructure development.

Partners: WSDOT, Oregon DOT, California Governor's Office interagency group, Washington State Department of Commerce, US Department of Energy.

2.4 Unmanned Aerial Systems (UAS)

Minnesota DOT (MnDOT) Inspection Program

The overall goal of the unmanned aerial vehicles (UAV) Bridge Inspection Demonstration Project was to study the effectiveness of utilizing UAVs, or drones, as they could apply to bridge safety inspections. MnDOT investigated the technology on four bridges located throughout Minnesota. The project team evaluated the UAV's effectiveness as it could apply to bridge inspections based on UAV field results. Various UAV capabilities were employed to evaluate current technologies as they relate to use in bridge inspections.

The study was run in conjunction with Collins Engineers, to ultimately see how UAVs could be used to provide better data and make inspections safer. Phase 1 finished with the inspection of four bridges across the state; the program is moving into phase 2. While phase 1 was about evaluating the safety and effectiveness of UAV technology to produce an initial research report, phase 2 aims to develop a best-practices document, including a full decision tree on UAVs for inspections. This will look to answer when a drone might be more suitable for inspections than a snooper truck, which requires coordination for traffic control and puts inspectors at risk.

Objective: study the effectiveness of using UAV technology for bridge safety inspections.

Partners: Collins Engineers

Federal Aviation Administration (FAA) UAS Test Sites

The FAA chose six unmanned aerial systems test sites across the U.S. to conduct testing and research activities designed to further UAS research goals in the areas of system safety and data

gathering, aircraft certification, command and control link issues, control station layout and certification, ground and airborne sense and avoid, and environmental monitoring.

Each test site operator will manage the test site in a way that will give access to parties interested in using the site. The FAA's role is to ensure each operator sets up a safe testing environment and to provide oversight that guarantees each site operates under strict safety standards. In selecting the six test site operators, the FAA considered the geography, climate, and location of ground infrastructure; research needs; airspace use; safety; aviation experience; and risk. In total, these six test applications achieve cross-country geographic and climatic diversity and help the FAA meet its UAS research needs. The six selected sites are described below.

Partners: Each of the test site lead partners and research and testing objectives are described below.

University of Alaska. The University of Alaska site contains a varied set of range locations in seven climatic zones as well as geographic diversity with locations in Hawaii and Oregon. The research **objective** includes the development of a set of standards for unmanned aircraft categories, state monitoring, and navigation. Alaska also plans to work on safety standards for UAS operations.

State of Nevada. Nevada's project **objectives** concentrate on UAS standards and operations as well as operator standards and certification requirements. Its research will also include a concentrated look at how air traffic control procedures will evolve with the introduction of UAS into the civil environment and how these aircraft will be integrated with NextGen. Nevada's selection contributes to geographic and climatic diversity.

New York's Griffiss International Airport. Griffiss International **objectives** include work on developing test and evaluation as well as verification and validation processes under FAA safety oversight. Work will also focus on sense-and-avoid capabilities for UAS and its sites will aid in researching the complexities of integrating UAS into the congested northeast airspace.

Dakota Department of Commerce. North Dakota research **objectives** include the development of UAS airworthiness essential data and validation of high reliability link technology. North Dakota will also conduct human factors research. North Dakota's application was the only one to offer a test range in the temperate (continental) climate zone and included a variety of different airspaces that will benefit multiple users.

Texas A&M University – Corpus Christi. Texas A&M **objectives** include the development of system safety requirements for UAS vehicles and operations with a goal of protocols and procedures for airworthiness testing. The selection of the Corpus Christi site contributes to geographic and climactic diversity.

Virginia Polytechnic Institute and State University (Virginia Tech). Virginia Tech **objectives** include conducting UAS failure mode testing and identify and evaluate operational and technical risks areas. This proposal includes test site range locations in both Virginia and New Jersey.

2.5 Infrastructure and Construction

e-Construction, State of Michigan

The term *e-Construction* refers to MDOT's initiative to integrate various digital technologies into its business/construction operations so that cost savings, efficiency gains, and other benefits are realized. MDOT has integrated many technological solutions such as electronic bidding, electronic construction files, digital signatures, electronic filing systems, in-field utilization of mobile devices, etc. Many other exciting technologies are being considered by MDOT to integrate into its operations.

E-Construction uses ProjectWise construction document management with features including digitally encrypted electronic signatures, accessibility by mobile devices in the field, and electronic data gathering.

E-Construction pilot projects started in October 2012 and include the following projects:

- I-96 Latson Road
- M-231 Little Robinson Creek
- M-231 over the Grand River
- I-75 Zilwaukee Bridge

Full statewide implementation started in 2014.

MDOT's preliminary analysis of one pilot project shows estimated paper savings of nearly 170,000 pieces of paper from all parties, representing approximately $300,000 (time, total paper, printing, mail, etc.) with $180,000 in MDOT savings and $120,000 in contractor savings. The statewide estimate showed $22 million in productivity gains and incalculable time savings, as contracts statewide are completed faster.

Objective: employ established technologies that are readily available to the transportation community, such as digital electronic signatures, electronic communication, secure file sharing, version control, mobile devices, and web-hosted data archival and retrieval systems, to improve construction documentation management. MDOT has stated that a primary goal is to have all trunkline projects use the ProjectWise construction documentation procedure by the 2015 construction season.

Partners: Contractors and MDOT business partners

2.6 Information and Communications

Senseable City Lab, Massachusetts Institute of Technology (MIT)

The mission of the MIT Senseable City Lab is to develop tools for the analysis of real-time information for better planning and operations of cities. It began in 2005 with the charge of investigating how the ubiquity of digital devices and the various telecommunication networks that

augment cities are impacting urban living. With an overall goal of anticipating future trends, the Lab brings together researchers from many academic disciplines to work on groundbreaking ideas and innovative real-world demonstrations. This research is undertaken in partnership with cities, the private sector, and other universities; through this collaborative approach, the Lab strives to reveal how a new, rapidly expanding network of digital devices is serving to modify the traditional principles of understanding, describing, and inhabiting cities. The Lab's work has been exhibited in leading venues, including the Venice Biennale, the Design Museum Barcelona, the Canadian Centre for Architecture, and the Museum of Modern Art (MoMA) in New York. Among many awards are TIME Magazine's Best Invention of the Year in 2007 (Digital Water Pavilion) and 2014 (Copenhagen Wheel).

Objectives: Develop and deploy tools to learn about cities through design and science.

Partners: ***(Public)*** Dallas Area Rapid Transit, Future City Global Dubai, Cape Town, Copenhagen, Firenze, Italian Ministry of the Environment, Medellín (rutaN), Mexico City (Promexico), Wood Buffalo (Regional Municipality), Rio de Janeiro (State). ***(Industry)*** Accenture China, American Air Liquide, ENEL Foundation, Ericsson, Fondation OCP, Liberty Mutual, Philips, Volkswagen, BBVA, Coca Cola, Ericsson, Expo 2015, Ferrovial Servicios, General Electric, MediaSet, Scottish Highlands and Island Enterprise, Seat Pagine, SNCF—French National Railway Company, Techno Innovation Park South Tyrol, Telespazio, Thessaloniki Chamber of Commerce and Industry. ***(Research)*** Austrian Institute of Technology, Basel Action Network, Fraunhofer Institute, Kuwait-MIT Center for Natural Resources, SMART—Singapore MIT Alliance for Research and Technology, Center for Complex Engineering Systems.

The Michigan Institute for Data Science (MIDAS), UM

MIDAS was created in July 2015 as part of the UM Data Science Initiative. It will comprise an interdisciplinary core faculty of data scientists from statistics, biostatistics, and mathematics; computer science and engineering; information science; and a range of data science intensive application experts. MIDAS will also include a Data Science Challenge Initiatives Program focused on one of four areas: Learning Analytics, Transportation, Social Sciences, and Personalized Medicine & Health. MIDAS will include a Data Science Education and Training Program as well as an Industry Engagement Program.

The intention of the multiyear MIDAS Challenge Initiatives program is to support data science projects that show potential for prompting new partnerships between UM, federal research agencies, and industry. Already, two new data science projects have been chosen in the transportation area to work on solving the major problems facing transportation in the future by developing on-demand, driverless public buses and data-driven accident avoidance systems, with the eventual aim of creating 'smart' traffic systems that dramatically reduce emissions and congestion. Each project will bring together interdisciplinary teams of researchers from UM and UM Dearborn to work with massive amounts of data being produced by CAV testing sites, as well as in conventional driver-directed settings, in Ann Arbor and around the country.

The first project, "Reinventing Public Urban Transportation and Mobility," led by Dr. Pascal Van Hentenryck of the College of Engineering, will help design and operate an on-demand, multimodal

public transportation system for urban areas, in which a fleet of CAVs are synchronized with buses, light rail, shuttles, cars, and bicycles, using predictive models based on high volumes of diverse transportation data. The project aims to address the 'first-mile/last-mile' problem—the challenge of getting people from their homes or final destinations into the transit system. The goal is to begin testing on the UM campus within a year, and will then expand to Ann Arbor and Detroit.

The other project, "Building a Transportation Data Ecosystem," led by UMTRI researchers, will create a system allowing researchers to access massive, integrated datasets on transportation in a high-performance computing environment, which will support future transport research and development. Project objectives are to create a common repository of transportation data, including data on driving, traffic, weather, accidents, vehicle messages, traffic signals, and road characteristics, and will inform the development of CAV systems of the future.

Main objectives: help design and operate an on-demand, multimodal public transportation system for urban areas, in which a fleet of CAVs are synchronized with buses, light rail, shuttles, cars, and bicycles, using predictive models based on high volumes of diverse transportation data. Create a system allowing researchers to access massive, integrated datasets on transportation in a high-performance computing environment, which will support future transport research and development.

Partners: TBD

2.7 Service-Based Platforms

Mobil Punct, Bremen Germany

The Mobil Punct program, which stemmed from the idea of a network of mobility hubs, began with Michael Glotz-Richter in Bremen, Germany, in the mid 1990s. Across the city of Bremen, "Mobil Puncts" were established, so that transit, taxi services, and bicycle amenities could become connected with a new car-share service network they had been developing (Cambio). Bremen linked these options together with a multi-modal fare card and called it the "eierlegende Wollmilchsau," which translates to "egg-laying wool milk sow," a phrase representing something that brings together many dissimilar elements in a positive way. Combining bank card, electronic transit ticket, and access key to car-sharing, the card provides a multi-access pass for users. In addition, the city has established multimodal way-finding through electronic kiosks. The car-sharing operator Cambio has approximately 40 stations around the city. Over 100 vehicles are in the fleet, with over 2,750 customers using the service. Each car-share automobile replaces four to eight private cars, so Cambio has replaced approximately 700 privately owned cars, and eliminated the need for close to 700 parking spaces, which means more space for parks, recreation, pedestrians, and more. The philosophy is "use it, don't own it."

Objectives: tackle problem of an increasing number of cars consuming more and more urban space by organizing mobility more efficiently, regaining street space, and thus improving the quality of urban life.

Partners: City of Bremen, Cambio, the European Union Regional Development Fund, the IVB North Sea Region Programme, CARE-North Plus, as well as a local transit agency, taxis, and bike-share.

Technical Memorandum#0-6902-TM5

To: RTI Project Manager: Sonya Badgley

From: CTR Research Team: Kristie Chin, Andrea Gold, C. Michael Walton

Subject: TxDOT Project 0-6902 – Technical Memorandum for Task 5

Date: 07/15/16

1 Introduction

This tech memo provides information on industry conferences, presentations and posters, and research or planning activities in which the Texas Technology Task Force (TTTF) and research team have participated from August 2015 to July 2016. Items are organized chronologically and include the following sections: a general overview of the conference or activity, a specific description of the presentation or poster, and key takeaways or lessons learned. The purpose of this document is intended to inform the Texas Department of Transportation (TxDOT) of relevant research and developments in the field of transportation as well as to communicate to others the role that the TTTF plays in TxDOT's strategy and innovation process. Presentations and posters given by the research team are provided in the appendix.

2 Conferences and Activities

2.1 2015 AASHTO Annual Meeting | Chicago, IL | September 9, 2015

Overview

The American Association of State Highway and Transportation Officials (AASHTO) Annual Meeting is one of the industry's most important gatherings of transportation, government, and commercial organizations. The Annual Meeting offers transportation executives the opportunity to network and share the latest in industry policies and innovations.

Description (Presentation)

Title: *The 21st Century – How State DOTs are Utilizing New and Emerging Technologies*

This peer exchange highlighted new and emerging technologies and how state departments of transportation are preparing for, implementing, and adjusting workforce demands to be ready for these changes. From the introduction of unmanned aerial systems, GPS and real-time traffic data to the latest in autonomous and connected vehicles in passenger cars, freight, and transit, new technologies are changing the way state departments of transportation do business. This roundtable discussion was an opportunity for delegates to share best practices as well as share challenges faced in the way these new and emerging technologies are being implemented.
Moderator: Don Hunt, Principal, The Antero Company; Senior Fellow, University of Colorado
Speakers: **C. Michael Walton**, Ernest H. Cockrell Centennial Chair in Engineering, UT Austin's Center for Transportation Research; Ken Lund, Managing Director, PricewaterhouseCoopers; Maurice Rached, PE, PTOE, Director of Transportation Services, Maser Consulting, P.A.

2.2 9th University Transportation Center (UTC) Spotlight Conference: Connected and Automated Vehicles | Washington, DC | November 4-5, 2015

Overview

The Transportation Research Board (TRB) sponsored the 9th University Transportation Center (UTC) Spotlight Conference on Connected and Automated Vehicles. The conference focused on the emergence of connected and automated vehicle technology across all modes of transportation. The event identified roles that university transportation research programs may have in developing new tools and concepts to enhance the deployment of these advanced technologies.

Description (Poster)

Title: *Texas Technology Task Force: A Platform for Identifying, Evaluating, and Leveraging Emerging Technologies*

The transportation industry is experiencing disruptive technological, institutional, and cultural changes, prompting transportation agencies to respond to and anticipate the needs of future travelers. To that end, the Texas State Legislature called for the creation of the TTTF to guide the State's active promotion of transformational transportation technologies through TxDOT. The TTTF, which comprises transportation agency officials, industry experts, and a university research team, is focused on facilitating new pilot projects in Texas that further connected and autonomous vehicles (CAV) and their joint implementation with information and communication technologies. Results will be published in a Strategic and Innovation Plan that outlines methods for advancing and integrating critical technologies into the Texas transportation system and outlines steps to take toward establishing partnerships for CAV trials and pilots.

2.3 TECHtalk | Austin, TX | December 8, 2015

Overview

The Texas House Innovation & Technology Caucus in partnership with TxDOT host a series of interactive discussions in which the panelists brief the Texas Legislature and key staff on relevant issues in transportation policy.

Description (Presentation)

Title: *Technologies on the Transportation Horizon*

Texas is on the move again, leading the way in the transportation of people, goods, and information. Join the TTTF for an interactive discussion on the trends and technologies that are shaping the future of our state's transportation system.

Transportation: Getting Ahead of the Curve
Understand the transportation challenges that Texans are facing today and anticipate our needs into the future.

Technology: Saving Lives, Time, and Money
Stay abreast of the technologies that can improve our quality of life and increase the state's economic competitiveness.

Policy: Shaping the Next Generation
Prepare for critical transportation policies by learning about key initiatives and pilot programs from around the country.

Moderator: Caroline Joiner, TechNet
Speakers: Darran Anderson, TxDOT; **Kristie Chin**, UT Austin's Center for Transportation Research; **Andrea Gold**, UT Austin's Center for Transportation Research; **C. Michael Walton**, UT Austin's Center for Transportation Research.

2.4 Transportation Research Board 95th Annual Meeting | Washington, DC | January 10-14, 2016

Overview

TRB's 95th Annual Meeting attracted more than 12,000 transportation professionals from around the world. The TRB Annual Meeting program covers all transportation modes, with more than 5,000 presentations in nearly 750 sessions and workshops addressing topics of interest to all attendees—policy makers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions.

Notable Sessions and Takeaways

Standing Committee on Performance Management (ABC30)
This committee is concerned with the use of performance measurement in a broad range of transportation applications. The committee spans the range of performance measurement in transportation through its membership and joint activities with committees across the TRB spectrum. The committee provides a forum for the exchange of ideas, sharing experience, developing research topics and statements, developing and disseminating resource material.

Fast-forward 10 Years: How Information Technology Is Changing Transportation Planning, Engineering, and Operations
Information technology plays an increasingly important role in transportation planning, system operations, infrastructure monitoring, and decision making. Panelists shared their thoughts on current and emerging applications in the areas of connected vehicles, sensing technologies, and social media and discuss the benefits and challenges of these innovations.
Speakers: Frances Harrison, Spy Pond Partners, LLC; Peter Sweatman, UMTRI; Yichang Tsai, Georgia Tech; Colin Brooks, Michigan Technical University; Shawn Blaesing-Thompson, Iowa DOT; C. Douglas Couto, Public Services

Beyond Traffic Megaregion Panel: Trends Impacting our Nation's Megaregions
The Beyond Traffic Draft Framework outlines key trends facing our nation's transportation system and potential policy considerations. The session presented insights from USDOT's Beyond Traffic Megaregion Tour, a national conversation on how new technologies and public policy—including the FAST Act—will shape U.S. transportation systems to enable safety, mobility, growth, and economic benefits over the next 30 years. The session also introduced an upcoming new chapter in Beyond Traffic dealing with transportation equity.
Speakers: Carlos Monje, Office of the Secretary of Transportation; Barry Seymour, Delaware Valley Regional Planning Commission; Keith Parker, Metropolitan Atlanta Rapid Transit Authority; Elizabeth Kneebone, The Brookings Institute; Marcia Hale, Building America's Future Educational Fund; Charles Carr, Mississippi Department of Transportation

Connected and Autonomous Vehicles: Impacts on Users, Design, and Society
Panelists shared their vision for connected and autonomous vehicles, including major barriers and opportunities. Topics included the impacts these next-generation vehicles will have upon users, design, and society.
Speakers: Tracy Larkin Thomason, Nevada DOT; Randell Iwasaki, Contra Costa Transportation Authority; Monali Shah, HERE; Bennett Pierce, Battelle Memorial Institute; Joe Verrendia, Arrow; Loren Bloomberg, CH2M

Key Takeaways

- There is a communications gap in performance management between the transportation agency and its primary stakeholders.
- There is a need to integrate disparate data sources within a transportation agency and by collaborating across other public and private organizations.
- The USDOT Smart City Challenge will have a significant impact on accelerating the smart city movement through public-private partnership models.
- Connected and automated vehicles have major safety and reliability benefits, yet there are also major privacy and public acceptance barriers to overcome.

2.5 South by Southwest (SXSW) | Austin, TX | March 11-15, 2016

Overview

SXSW dedicates itself to helping creative people achieve their goals. Founded in 1987 in Austin, Texas, SXSW is best known for its conference and festivals that celebrate the convergence of the interactive, film, and music industries. The SXSW Conference provides an opportunity for global professionals at every level to participate, learn, and network. Featuring a variety of tracks that allow attendees to explore what's next in the worlds of entertainment, culture, and technology, SXSW proves that the most unexpected discoveries happen when diverse topics and people come together.

Notable Sessions and Takeaways

Beyond Traffic: The Emergence of a Connected City

The U.S. Department of Transportation (USDOT) Secretary Anthony Foxx and five finalists had a conversation about the first-of-its-kind Smart City Challenge. This competition seeks to create an innovative, fully integrated model city that uses data, technology, and creativity to shape how people and goods move in the future. The winning city will be awarded up to $40 million from the USDOT to implement bold, data-driven ideas that make transportation safer, easier, and more reliable. The winning city will also benefit from a number of partnerships, including Paul G. Allen's Vulcan Inc., who has announced its intent to award up to $10 million to the challenge winner to support electric vehicle deployment and other carbon emission reduction strategies; Mobileye, who has announced that it would outfit the entire fleet of the winning city's public bus system with its Shield +TM driver-assistance safety technology; and other technology companies.
Speakers: Anthony Foxx, USDOT; Spencer Reeder, Vulcan

Rides, Drives and Hyperloops: The New Transportation

In virtually every industry, there's a huge movement toward access to goods vs. ownership of them, and transportation could prove the most revolutionary. On average, many of us pay tens of thousands of dollars to own a car that we utilize less than 2 hours a day. By 2020 70% of the US population will be living in cities. With "rides" and now "drives" becoming more accessible, and affordable, owned transportation is headed towards major decline—so what happens next? Silvercar CEO, and former Zipcar CTO, Luke Schneider, shared the technological developments, use cases, and trends driving major change in transportation, and spoke on how letting go of car payments doesn't necessarily mean letting go of the wheel.
Speakers: Luke Schneider, Silvercar

Technology Driven Accessible Transportation Apps
Mobility of travelers with disabilities including veterans and older adults is hindered by lack of accessible transportation options. A number of emerging personal mobility options can change this and provide better options for all travelers to get from point a to point b. Whether it be on-demand operations, virtual concierge travel assistance through mobile devices, or assistive robot, research in accessible transportation has gained new momentum in recent years as a result of USDOT research activities in cooperation with federal and other partners. The USDOT is beginning to identify and develop transformative transportation applications for all, including those with disabilities.
Speakers: Bob Sheehan, USDOT; Chris George, Vinli; Mohammed Yousuf, FHWA; Susan Maxrui, AT&T

Designing the Internet of Things for Privacy
It's not just smartphones anymore—everything from our watches to our refrigerators can be connected to the Internet today. But will companies want to use our heart rates to show us ads? Will insurers be interested in how much ice cream we eat? As the devices we use every day fill with sensors and gain new connectivity, they become far more useful. But they can also collect new kinds of information—about our most intimate habits and interactions—multiplying the privacy challenges for companies and consumers alike. Traditional ways of explaining privacy choices don't always work in this space. To win loyalty and avoid costly mistakes, a new approach to privacy by design will be key.
Speakers: Fauzia Musa, IDEO; Jules Cohen, Microsoft Corporation; Matt Cagle, ACLU of Northern California; Sarah Goyette, Intel Corporation

Key Takeaways:

- Transportation systems should be designed to create ladders of opportunity
- Hyperloop is still in early phases of research and development.
- Travelers are demanding increased access to reliable, timely, and relevant traveler information.
- The Internet of Things should be designed with privacy and security in mind.

2.6 TECHtalk | Austin, TX | May 12, 2016

Overview

The Texas House Innovation & Technology Caucus in partnership with TxDOT host a series of interactive discussions in which the panelists brief the Texas Legislature and key staff on relevant issues in transportation policy.

Description (Talk)

Title: *Smart City, Smart State?*

Austin is one of seven finalists in the U.S. Department of Transportation's Smart City Challenge. What's in their innovative, ambitious, and forward-thinking plan? How are we driving the innovation at TxDOT and other state agencies?
Moderator: Caroline Joiner, TechNet
Speakers: Darran Anderson, TxDOT; Rob Spillar, Austin Transportation Department; Josh Johnson, SwRI; **Kristie Chin**, UT Austin's Center for Transportation Research.

2.7 Congress for the New Urbanism 24 | Detroit, MI | June 8-11, 2016

Overview

The 24th annual Congress for the New Urbanism in Detroit brought together over 1,500 individuals from North America and around the world for four days of education, collaboration, discussion, and debate on the policies, designs, and emerging approaches that create great places. Detroit and its residents have endured the trauma of transformation from an industrial economy to the information age. They have confronted social, political, and economic challenges familiar to many other urban areas, only at a scale and complexity beyond what most could imagine. Now, Detroiters are emerging from that experience as pioneers of innovation at every level from neighborhood to region. What better place for planners, designers, and policymakers to gather, to learn, to share, to celebrate what this work-in-progress is producing?

Notable Sessions and Takeaways

Open Streets, Open Cities

Open Streets initiatives temporarily close streets to automobile traffic so that people may use them for walking, bicycling, dancing, playing, and socializing. With more than 130 documented initiatives in North America, open streets are increasingly seen in cities large and small as an innovative way to achieve environmental, social, economic, and public health goals.

This introductory session provided an overview of the open streets movement, share best program development practices, and go behind the scenes with two cities—Detroit and Windsor—launching programs in the summer of 2016.
Speakers: Mike Lydon, The Street Plan Collaborative; Lisa Nuszkowski, Detroit Bike Share; Michael Cooke, City of Windsor

The High Road: From State Highway to Complete Street

In recent years, Corktown has seen an exciting commercial resurgence. New businesses like Slow's BBQ, Astro Coffee, and Two James Distillery have received national attention and brought exciting buzz to Detroit's oldest neighborhood. This growth has happened in spite of a built environment that favors automobiles over people. The ability for Corktown to flourish is severely limited by the presence of a state highway that runs through the center of the neighborhood—the result of a 1939 highway expansion along all of Detroit's spokes. To counter this, and to bring back the essence of the historic fabric that will put people first, Corktown has recently embarked on a two-pronged strategy to transform Michigan Avenue into a complete street.
Speakers: Chad Rochkind, Human Scale Studio

#toddlerurbanism & Innovations in Mobility

Mobility drives urban growth, and today's city dwellers have more options than ever before. Learn trends in parking management, shared-vehicle use, transit, and pedestrian planning, and more are challenging the urban mobility paradigm. Talks included:

1. Fusing the Practical and the Symbolic in Trains
2. The Future of Mobility of the Motor City
3. A Toddler's Guide to Improving Downtown Legibility
4. Walking in the Modernist City
5. The Hidden Dangers of Vision Zero in Texas

6. What if We Based Parking Decisions on Actual Data
7. Building your Own Mobility Hub and Reducing Carbon Emissions

Speakers: Peter Baird, Perkins + Will; Patrick Braga, Cornell University; Daniel Emerine, DC Office of Planning; Tim Frisbie, Shared Use Mobility Center; Michael Johnson, SmithGroupJJR; Matthew McNicholas, MGLM Architects; Robert Munson, CNU Illinois; Paul Nichols, Urban Planner

The Car: A Transit Solution?
Technology is rapidly changing the way people move around their cities. Car-sharing, autonomous automobiles, urban sensing and intelligent streets—can these rapidly emerging innovations foster better urbanism and safer more livable streets or are they inevitably going to harm cities, promote sprawl and entrench automobile dependence even more deeply? The leaders in this conversation discussed where all of these new and rapidly emerging transportation technologies and services fit into creating walkable places. The opportunity to positively affect the regulation and design of these platforms to benefit the creation of sustainable, urban places is now. This session addressed the fundamental question of whether new automobile services and technologies are shaping up to be good or bad for urbanism and what's the best way for progressive urbanists to begin to influence the direction that these companies are moving.
Speakers: Russell Preston, Principle Group; Andrew Salzberg, Uber; Susan Zielinski, SMART

Key Takeaways

- Multimodal transportation systems are critical to providing a diverse range of mode options, including biking and walking.
- Complete Street design principles can be used to encourage economic development.
- In order to link land use with transportation, planners are moving towards developing compact and connected communities.
- Planners are struggling to understand how to incorporate emerging technologies into future scenario development.

2.8 USDOT Smart City Challenge | Austin, TX and Washington, DC | December 2015-June 2016

Overview

The USDOT developed the Smart City Challenge to give one city a chance to demonstrate how we can solve critical problems using innovative transportation technologies, data, and applications. The USDOT has pledged up to $40 million (funding subject to future appropriations) to one city to help it define what it means to be a “Smart City “and become the country’s first city to fully integrate innovative technologies—self-driving cars, connected vehicles, and smart sensors—into their transportation network.

Activities of the Research Team and Task Force Members

The research team and task force members performed the following activities in support of the City of Austin’s application to the USDOT Smart City Challenge:

- Task Force members offered subject matter expertise, strategic planning services, and independent review of the final Phase II submittal.

- Research team members offered subject matter expertise, strategic planning services, and project management.
- A member of the research team participated in the Phase II USDOT workshop for the seven finalists, assisted in the City of Austin's vendor workshop, led the Smart Stations team, directed the visualization team, and served on the team that presented the final Phase II pitch to the USDOT.

Lessons Learned

Lessons learned through the Smart City Challenge process include the following:

- Start with Why – Knowing the ultimate purpose for why each stakeholder should engage in the process is vital to launching a grassroots effort.
- Own Your Challenges – Identify the priority pain points early in the process and focus your efforts there.
- Build Your Team – Engaging the right leadership from public agencies, research institutions, community partners, and the private industry is critical for collaborations to be successful in the long-term.
- Unify the Vision and Goals – Coalescing around a common purpose early in the process is essential for moving the team forward in a common direction.
- Start Small – Identifying manageable projects ensures the team has the resources, level of commitment, and specificity needed to bring the project to fruition.
- Integrate and Synergize – Complex problems require complex solutions; multiple technologies and agencies are often necessary to tackle the challenge holistically.
- Leverage Funding and Resources – The value of magnifying initial investment is important to demonstrate that partners are also invested in the success of the projects.
- Communicate Effectively – Develop appropriate organization schemes and main messages for all stakeholder groups in order to convey a consist vision.
- Engage Leadership – Strengthen relationships with high-profile leadership to solicit their input and full support.
- Learn and Evolve Quickly – The process is iterative and it is necessary to readily adapt to a range of political, technological, social, and economic factors.

2.9 Smart Cities Innovation Summit | Austin, TX | June 13-15, 2016

Overview

The Smart Cities Innovation Summit is co-located with the Global City Teams Challenge (GCTC) and the US Ignite Application Summit creating the most comprehensive showcase and accelerator of smart city innovation world-wide. While these events are co-located, the GCTC Expo is a separate and distinct event. All registrants for the Smart Cities Innovation Summit or US Ignite Application Summit had full access to all three events, including the GCTC Expo.

Description (Poster)

Developing an intelligent transportation system is critical to a state's economic success, mobility, and quality of life for its citizens. In recognition of this these critical links, TxDOT is exploring a concept to advance its system by connecting and enabling a network

of smart cities and creating the nation's first smart state. TxDOT established the TTTF as an external strategic advisory group and charged them with examining critical technologies and transitioning them into the appropriate initiatives. To this aim, the TTTF is developing an initiative currently identified as the Improved Mobility Plan for Advancing Connected Transportation (IMPACT)—transforming the state into a living laboratory for piloting emerging technologies. IMPACT is designed to create a user-focused, open-innovation ecosystem by awarding emerging technology projects that advance TxDOT's goals, including multimodal and multijurisdictional projects that are difficult to fund through traditional State programs. Successful IMPACT projects will leverage limited funding and resources through partnership opportunities while catalyzing investment and growth.

2.10 ASCE International Conference on Transportation & Development | Houston, TX | June 29, 2016

Overview

The ASCE International Conference on Transportation & Development (ICTD 2016) is organized to facilitate exchange of information, knowledge, and best practices among transportation and development practitioners and researchers, public infrastructure owners, policy makers, government engineers and planners, operations managers, and leading academics from around the world.

Description (Presentation)

Title: *Preparing Cities for the Technology Age*

This session focused on the importance of developing an emerging technology portfolio in order to sustainably manage disruption. Subject matter experts discussed how technologies in the areas of big data, drones, connected and automated vehicles, and sensors are transforming the transportation system as we know it. Other key topics included data visualization, drone regulations, and V2X applications. Participants learned what emerging technologies are coming down the pipeline, how they may be integrated into legacy systems, and what synergies may be leveraged by combining the technologies.
Moderator: Zhanmin Zhang, UT Austin's Center for Transportation Research
Speakers: **Kristie Chin**, UT Austin's Center for Transportation Research; Steve Dellenback, SwRI; Daniel Mendez, Lone Star UAS Center of Excellence; Thomas Lambert, Houston METRO

2.11 SciPy 2016 | Austin, TX | July 11-17

Overview

SciPy 2016, the 15th annual Scientific Computing with Python conference, brought together over 650 participants from industry, academia, and government to showcase their latest projects, learn from skilled users and developers, and collaborate on code development. The full program consisted of two days of tutorials, three days of talks, and two days of developer sprints.

Notable Sessions and Takeaways

Large Scale Geospatial Analytics with Python, Spark, and Impala
We harnessed the power of three different computing platforms—Spark, Impala, and scientific Python—to perform geospatial analysis on mobile phone users. We discussed data processing techniques for comparing billions of user locations per day with millions of places of interest, easily extractible insights, and methodologies for estimating impacts of

treatment on these movement patterns. Our workflow has potential for application for other use cases involving geospatial movement of populations.
Speakers: Evan Wyse

Automating Machine Learning?
Recent years have seen a widespread adoption of machine learning in industry and academia, impacting diverse areas from advertisement to personal medicine. As more and more areas adopt machine learning and data science techniques, the question arises on how much expertise is needed to successfully apply machine learning, data science, and statistics. Not every company can afford a data science team, and not everyone has PhD-level expertise in computer science and statistics. This talk summarized recent progress in automating machine learning and gave an overview of the tools currently available. It also pointed out areas where the ecosystem needs to improve in order to allow a wider access to inference using data science techniques. Finally, some open problems regarding assumptions and limitations of what can be automated were identified.
Speakers: Andreas Mueller, NYU Center for Data Science

Datashader: Revealing the Structure of Genuinely Big Data
Current plotting tools are inadequate for revealing the distributions of large, complex datasets, both because of technical limitations and because the results vary dramatically depending on the dataset itself. Avoiding these problems requires either prior knowledge of the distribution or tedious trial-and-error parameter adjustment, neither of which is necessarily feasible for the data now being collected. The new datashader library (https://github.com/bokeh/datashader) makes it practical to work with data at a large scale, easily and interactively visualizing millions or billions of points. In this talk, it was demonstrated how datashader provides a flexible pipeline for data processing that allows automatic or custom-defined algorithms at every stage. Datashader makes it easier to reveal the underlying structure of the dataset and to focus on the specific aspects of interest.
Speakers: James Bednar, University of Edinburgh; Jim Crist, Continuum Analytics; Joseph Cottam; Peter Wang

Key Takeaways:

- In order to understand complex travel patterns, large-scale geospatial analytics will be required to gather insights from GPS and Bluetooth datasets.
- Machine learning represents a tremendous opportunity for automating transportation operations, such as adaptive signal timing and phasing.
- Data sets that are as large as those potentially produced by the connected vehicle market will require sophisticated structures for extracting critical information.

2.12 Automated Vehicle Symposium | San Francisco, CA | July 19-21

Overview

Attendees heard leading speakers, participated in interactive breakout sessions, and networked with key innovators in this exciting field.

Notable Sessions and Takeaways

Traffic Signal Control with Connected and Automated Vehicles (CAVs)
In this breakout group, participants discussed and investigated the transitional traffic signal control issues from a very low percentage of CAVs (i.e., the current state of the practice) to a high percentage of CAVs, and eventually to fully automated transportation systems, in

which traffic signal control may no longer be needed. Although the duration of the transitional period is uncertain, it is important for both traffic management agencies and the traffic control industry to understand what might be happening during the transitional process and how we can better prepare and facilitate the transition. The team solicited inputs not only from academic researchers, but also practicing engineers from government agencies as well as from traffic control industry.
Speakers: Henry Liu, University of Michigan; Larry Head, University of Arizona

AV-Ready Cities or City-Ready AVs
While the focus of road automation is still on interurban transport, the major challenges of a full take-up of AV are the complex conditions of inner-urban mobility. How can cities create an environment where AVs are very likely to deliver the promised benefits of increased safety and accessibility, less space consumption, as well as better environmental and economic performance? How should AVs and AV-based services be designed to help create products/policies that support key policy goals of cities and allow cities meet their multiple functions to more effectively (rather than enhancing mainly the comfort of driving)? This interactive session addressed some of the key aspects of road automation from an urban policy perspective. The aims were to increase the awareness within the AV community of urban policy needs as well as enabling urban policy makers to better understand the opportunities and issues related to AV when drafting their city's AV roadmap.
Speakers: Stephen Buckley, City of Toronto; Philippe Crist, International Transport Forum; Siegfried Rupprecht, Rupprecht Consult; Jane Lappin, Toyota Research Institute

Policy Making for Automated Vehicles: A Proactive Approach for Government
This session discussed the top automation policy priorities facing public agencies and identified strategies for policymakers to achieve desired outcomes. Rather than shy away from uncertainty, the group faced it head on, by exploring a range of automation scenarios to understand the broader policy implications. The session highlighted different policy perspectives and discuss strategies that can enable public agencies to encourage the benefits from automated vehicles, while also steering us away from its potentially negative impacts. Topics included:

- Helping policymakers cut through the 'hype' and getting to a realistic vision of the automated vehicle future
- Desired roles for public agencies at all levels
- Using policy to reach desired outcomes (how do we formulate policy and when do we need them?)

Speakers: Nathaniel Beuse, Associate Administrator for Vehicle Safety Research, NHTSA; Bernard Soriano, Deputy Director, California DMV; Tracy Larkin-Thomason, Deputy Director for Southern Nevada, Nevada DOT; Mike Alexander, Director, Atlanta Regional Commission Center for Livable Communities; Karla Taylor, Chief of Staff, City of Austin Transportation Department; Keith Jasper, Program Coordinator, Northern Virginia Transportation Authority; Traffic Flow of Connected Automated Vehicles; Robbie Diamond, President, CEO and Founder of SAFE, Securing America's Future Energy; David Strickland, Counsel, Self-Driving Coalition for Safer Streets; Paul Scullion, Safety Manager, Association of Global Automakers, Inc.; Jill Ingrassia, Managing Director of Government Relations and Traffic Safety Advocacy, AAA; Chandra Bhat, Director, UT Austin's Center for Transportation Research.

Traffic Flow of Connected Automated Vehicles
This breakout session provided an opportunity to bring together the cyber-physical/communications, vehicle control, and traffic flow communities to better understand the fundamental characteristics of traffic flow with varying levels of automation and identify research needs for developing models to assess the safety, environment, and mobility implications of CAVs. This breakout session focused on discussion of innovative modeling of CAV traffic flow, CAV-based traffic control and management methods, cyber-physical communication frameworks, and related technologies translatable to traffic flow modeling.
Speakers: Hani Mahmassani, Northwestern University; Pravin Varaiya, UC Berkeley; Osman Altan, FHWA; Simeon Calvert, TNO; Jan-Niklas Meier, CAMP

Key Takeaways:

- There is a need to well-define the research questions and tools to analyze the large volumes that are being produced by connected and automated vehicles.
- There are different levels of readiness for AV technologies and cities should prepare different environments to further test and refine each.
- Information is needed to educate policymakers regarding the safety, privacy, and security threats to the public to help them understand when regulation is and is not appropriate.
- New models are needed to support long-range transportation planning efforts that include a range of scenarios for CAVs.

TEXAS DEPARTMENT OF TRANSPORTATION

Texas Technology Task Force

The Future of Transportation

Overview

Background | Technologies | Best Practices

Is Texas making a STATEment?

Background

TEXAS TECHNOLOGY TASK FORCE

VISION	High-performance transportation system
MISSION	Outline clear, actionable strategies to enhance the delivery of quality transportation services
OBJECTIVES	▪ Identify emerging technologies ▪ Analyze economic, engineering, and policy impacts ▪ Develop key strategies to integrate critical technologies

Overview

Background | Technologies | Best Practices

Background

TEXAS TECHNOLOGY TASK FORCE

VALUE TO TXDOT

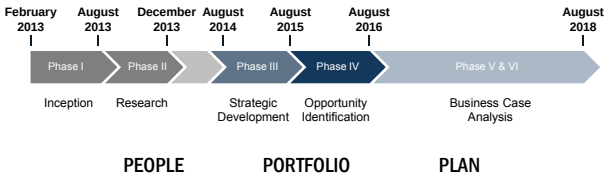
- Community of Expertise
- Relevance
- Knowledge Transfer
- Actionable Recommendations
- Positive Visibility

VALUE TO CUSTOMER

- Customer Trends
- Transparency & Accountability
- Technology Transfer

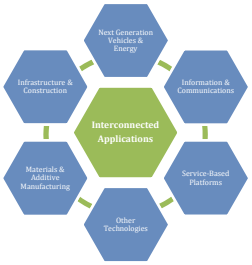
Background

TEXAS TECHNOLOGY TASK FORCE



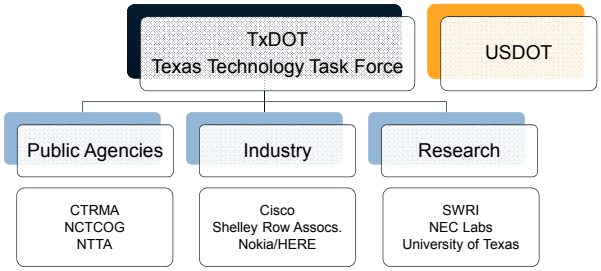
PEOPLE **PORTFOLIO** **PLAN**

Background: People – PORTFOLIO – Plan



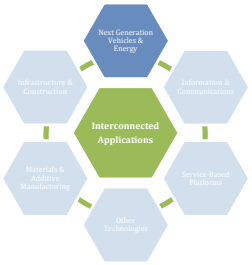
PHASE III PORTFOLIO

Background: PEOPLE – Portfolio – Plan



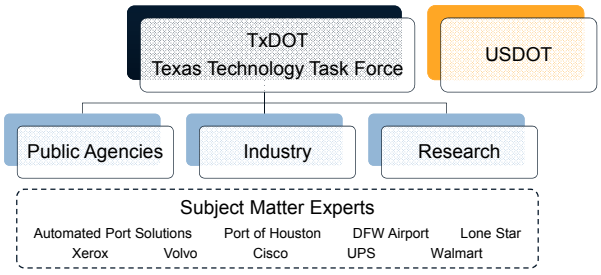
Background: People – PORTFOLIO – Plan

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles



PHASE III PORTFOLIO

Background: PEOPLE – Portfolio – Plan



Background: People – PORTFOLIO – Plan

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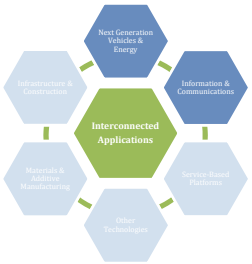


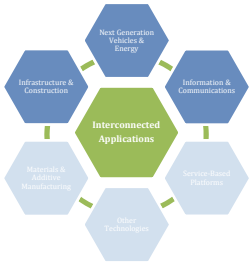
Information & Communications
Cloud Computing
Crowdsourcing

PHASE III PORTFOLIO

Background: People – PORTFOLIO – Plan

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles

Infrastructure & Construction
Infrastructure Enhancements
Construction Techniques
Equipment



Information & Communications
Cloud Computing
Crowdsourcing

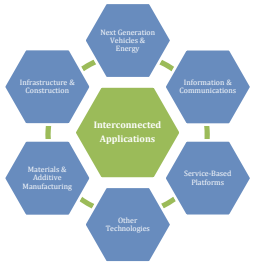
PHASE III PORTFOLIO

Background: People – PORTFOLIO – Plan

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles

Infrastructure & Construction
Infrastructure Enhancements
Construction Techniques
Equipment

Materials & Additive Manufacturing
Self-Healing Pavements
Nanotechnologies
3D Printing



Information & Communications
Cloud Computing
Crowdsourcing

Service-Based Platforms
Location-Based Services
Transportation Subscription Services

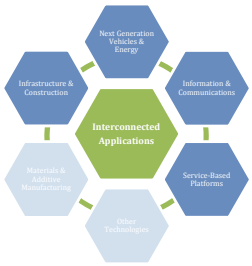
Other Technologies
Google Glass
Virtual Reality

PHASE III PORTFOLIO

Background: People – PORTFOLIO – Plan

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles

Infrastructure & Construction
Infrastructure Enhancements
Construction Techniques
Equipment

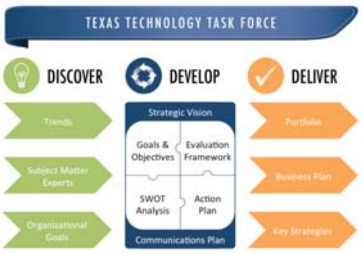


Information & Communications
Cloud Computing
Crowdsourcing

Service-Based Platforms
Location-Based Services
Transportation Subscription Services

PHASE III PORTFOLIO

Background: People – Portfolio – PLAN



Background: People – PORTFOLIO – Plan

Next Generation Vehicles & Energy
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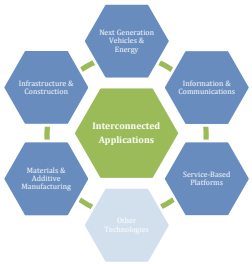


Information & Communications
Cloud Computing
Crowdsourcing

Service-Based Platforms
Location-Based Services
Transportation Subscription Services

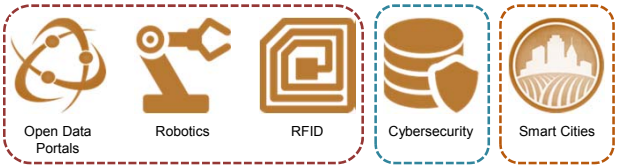
PHASE III PORTFOLIO

Overview

Background | **Technologies** | Best Practices

Technologies – May 11 Meeting

Technologies – August 11 Meeting

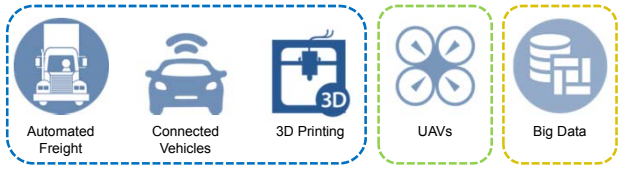


Developing Ports as Gateways to Innovation

Protecting the Privacy & Cybersecurity of Civic Data

Fueling Smart Cities through Intelligent Commerce

Technologies – May 11 Meeting



Revolutionizing the Global Logistics Industry

Opportunities & Challenges of UAVs

Using Data to Manage Customer Relationships

Overview

Background | Technologies | Best Practices

Technologies – August 11 Meeting

Best Practices – Understanding the Customer of the Future

KEY STRATEGIES

- Study the Customer Profile
- Discover the Customer Experience
- Respond to Consumer Behavior

GAME CHANGERS

By the year 2020, the average person will be connected to four devices.

- Strategy Analytics

Best Practices – Revolutionizing the Global Logistics Industry

KEY STRATEGIES

- Understand the Full Suite of Technologies
- Develop an Interface between Modes
- Identify Future Markets and Influences

GAME CHANGERS

The U.S. population is projected to grow to 70 million between 2010 and 2035, generating 2.8 billion more tons of freight, a 22 percent increase.

- Federal Railroad Administration

Best Practices – Formulating a Communications Strategy

KEY STRATEGIES

- Build the Agency Brand
- Embrace Digital Marketing
- Empower Champions of Change

GAME CHANGERS

Google now receives more searches from mobile devices than desktops in the U.S. and nine other countries.

- eMarketer

Best Practices – Identifying the Opportunities & Challenges of UAVs

KEY STRATEGIES

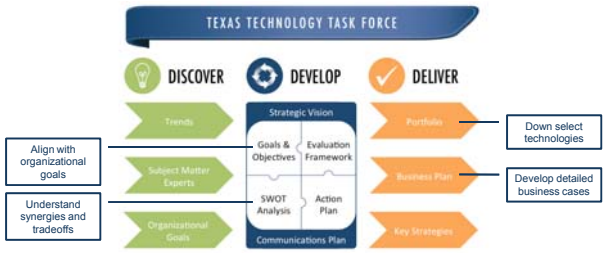
- Develop an Ecosystem to Support UAV Integration
- Monitor FAA Rulemaking and Regulations
- Identify Commercial and Civil Applications

GAME CHANGERS

The drone industry will create more than 100,000 new jobs and $82 billion in economic impact within the first 10 years they become legal to fly.

- AUVSI

Future Work & Next Steps



Best Practices –Managing Customer Relationships Using Big Data

KEY STRATEGIES

- Integrate Silos of Information
- Analyze for Insight
- Leverage Data to Create Value

GAME CHANGERS

On the roads, about one in five vehicles worldwide will have some form of wireless network connection by 2020.

- Gartner

Texas is making a STATEment.

TEXAS TECHNOLOGY TASK FORCE:
A Platform for Identifying, Evaluating, & Leveraging Emerging Technologies

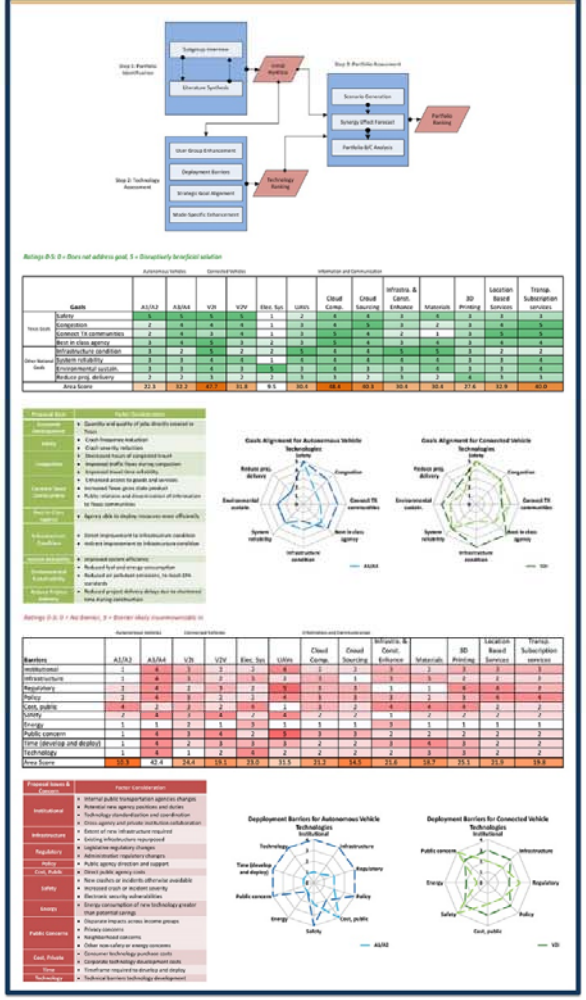
Andrea Gold, Kristie Chin, C. Michael Walton, Ph.D., P.E.
The University of Texas at Austin, Texas Department of Transportation

Background

Authorized by Texas's 83rd Legislature, the Texas Department of Transportation (TxDOT) established the Texas Technology Task Force (TTTF) in 2013 to develop a vision for the future of Texas's transportation systems.
The Task Force offers services in the following areas:

- ***People*** – Form a core knowledge group and network of subject matter experts.
- ***Portfolio*** – Identify emerging technologies and analyze potential impacts.
- ***Plan*** – Develop key strategies to integrate and advance critical technologies.

Matrix Evaluations



Key Strategies & Recommendations

Understanding the Customer of the Future
- U.S. population is projected to increase by 80 million between 2014 and 2050, with 13.5 million occurring in Texas alone.
- Study the customer profile to learn travel behavior insights.
- Provide quality traveler information, roadway maintenance, and roadside assistance services, to increase customer satisfaction.

Revolutionizing the Global Logistics Industry
- Boeing Company has projected the global air freight market will double in the next 20 years.
- Understand the full suite of technologies in order to enhance intermodal connectivity.
- Identify future markets and influences, such as e-commerce.

Identifying the Opportunities and Challenges of UAVs
- UAVs will present greater communication needs compared to current manned aircraft in part due to issues like communication bandwidth.
- Develop an ecosystem to support UAV integration.
- Monitor FAA rulemaking and regulations.

Managing Customer Relationships Using Big Data
- Balance privacy and cybersecurity concerns by developing policies for ethical data management.
- Integrate silos of information by encouraging cross-agency collaboration.
- Analyze data and incentivize changes in traditional travel patterns.

Formulating a Communications Strategy
- Develop customized communications strategies.
- Build the agency brand by crafting clear, tangible messages that resonate with each stakeholder group.
- Empower champions of change within the agency to promote a culture of innovation.

Next Steps

In December of 2015 the Task Force will initiate the down selection process in order to identify technology areas and opportunities with the greatest potential for Texas. The next phase will include a competitive analysis of other pilots, trials, and programs; a proposed list of technology initiatives for consideration in Texas; and detailed business cases evaluating the strengths, weaknesses, opportunities, and threats of each proposed technology initiative.

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TECHtalk

TECHNOLOGIES ON THE TRANSPORTATION HORIZON

INNOVATION & TECHNOLOGY CAUCUS TEXAS DEPARTMENT OF TRANSPORTATION

TECHtalk

TECHNOLOGIES ON THE TRANSPORTATION HORIZON

INNOVATION & TECHNOLOGY CAUCUS TEXAS DEPARTMENT OF TRANSPORTATION

Why do we need a Task Force?

"Let's form a committee to create a task force to develop a team to determine the fastest way to deal with the problem."

Background

TEXAS TECHNOLOGY TASK FORCE

VISION	Develop a high-performance transportation system
MISSION	Outline clear, actionable strategies to enhance the delivery of quality transportation services
OBJECTIVES	▪ Identify emerging technologies ▪ Analyze economic, engineering, and policy impacts ▪ Develop key strategies

Blueprint

Value Proposition

TEXAS TECHNOLOGY TASK FORCE

VALUE TO TXDOT

- Community of Expertise
- Relevance
- Knowledge Transfer
- Actionable Recommendations
- Positive Visibility

VALUE TO POLICYMAKERS

- Information Resource
- Opportunity Identification
- Transparency and Accountability
- Technology Transfer

TxDOT Mobility Toolbox

Congestion

What vs. Why

The Three Whys

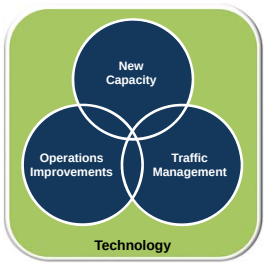
- **Capacity < Demand**
- **Inefficient Operations**
- **"Rush-Hour" Effect**

TxDOT Mobility Toolbox

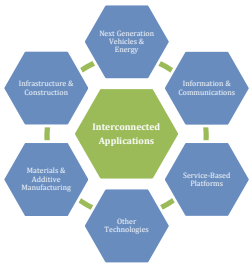
Congestion

What vs. Why

TxDOT Mobility Toolbox



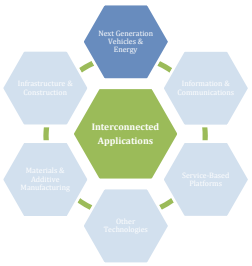
Emerging Technology Portfolio



PHASE III PORTFOLIO

Emerging Technology Portfolio

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles



PHASE III PORTFOLIO

Emerging Technology Portfolio

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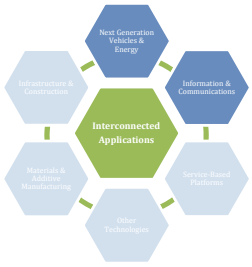


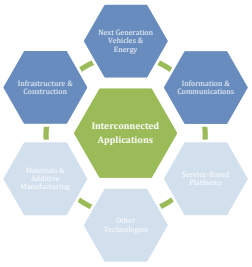
Information & Communications
Cloud Computing
Crowdsourcing

PHASE III PORTFOLIO

Emerging Technology Portfolio

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles

Infrastructure & Construction
Infrastructure Enhancements
Construction Techniques
Equipment



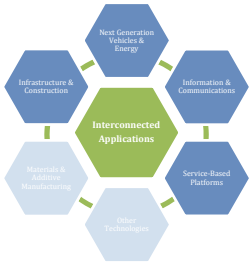
Information & Communications
Cloud Computing
Crowdsourcing

PHASE III PORTFOLIO

Background: People – PORTFOLIO – Plan

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles

Infrastructure & Construction
Infrastructure Enhancements
Construction Techniques
Equipment



Information & Communications
Cloud Computing
Crowdsourcing

Service-Based Platforms
Location-Based Services
Transportation Subscription Services

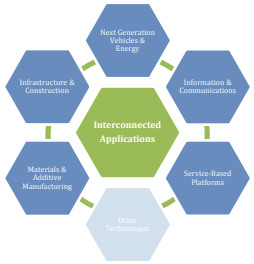
PHASE III PORTFOLIO

Emerging Technology Portfolio

Next Generation Vehicles & Energy
Automated Vehicles
Connected Vehicles
Electric Vehicles
Unmanned Aerial Vehicles

Infrastructure & Construction
Infrastructure Enhancements
Construction Techniques
Equipment

Materials & Additive Manufacturing
Self-Healing Pavements
Nanotechnologies
3D Printing



Information & Communications
Cloud Computing
Crowdsourcing

Service-Based Platforms
Location-Based Services
Transportation Subscription Services

PHASE III PORTFOLIO

Emerging Technology Portfolio

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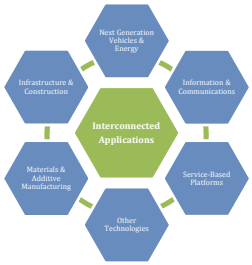


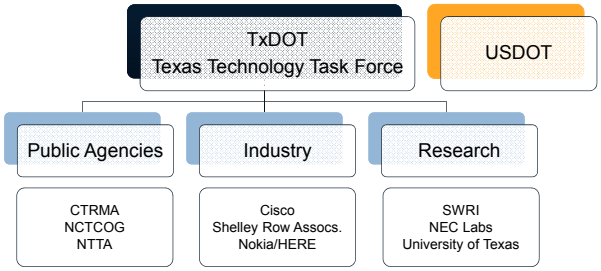
Information & Communications
Cloud Computing
Crowdsourcing

Service-Based Platforms
Location-Based Services
Transportation Subscription Services

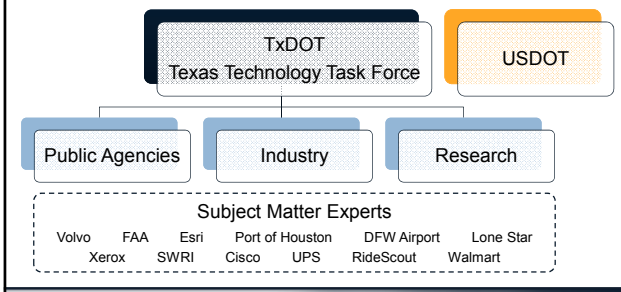
Other Technologies
Google Glass
Virtual Reality
Robotics
RFID

PHASE III PORTFOLIO

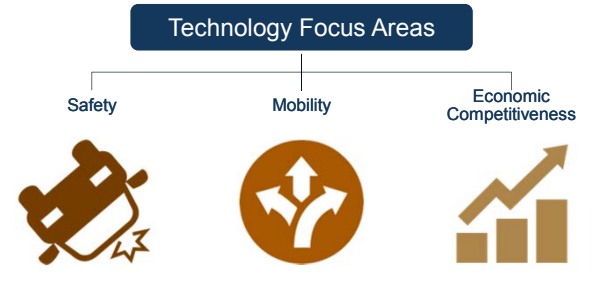
Community of Expertise



Community of Expertise



Integrating Technology



Complex problems require a comprehensive solution.

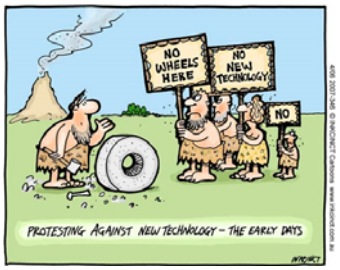
TECHtalk

TECHNOLOGIES ON THE TRANSPORTATION HORIZON

TECHtalk

TECHNOLOGIES ON THE TRANSPORTATION HORIZON

Why is technology important?



Competitive Edge

Safety	Mobility	Economic Competitiveness
Saving Lives	*Saving Time*	*Saving Money*

Key Technologies

Autonomous Vehicles	Connected Vehicles	UAS	Energy	Big Data

Key Technologies

Autonomous Vehicles (AV)

- Google and Apple testing
- Uber and Lyft research activities
- GM and Ford achievements

GAME CHANGERS

It's important for us to get experience testing our software in different driving environments, traffic patterns, and road conditions – so we're ready to take on Austin's pedicabs, pickup trucks, and everything in between.

- Google

Key Technologies

Connected Vehicles (CV)

- Ann Arbor, Michigan deployment
- USDOT/NHTSA partnership findings
- Virginia Smart Road test site

GAME CHANGERS

On the roads, about one in five vehicles worldwide will have some form of wireless network connection by 2020.

- Gartner

Key Technologies

Unmanned Aerial Systems (UAS)

- Amazon and Google initiatives
- Bridge inspection
- Emergency response applications

GAME CHANGERS

The drone industry will create more than 100,000 new jobs and $82 billion in economic impact within the first 10 years they become legal to fly.

- AUVSI

Key Technologies

Energy

- Tesla and Toyota efforts
- Battery development
- Smart-grids and charging systems

GAME CHANGERS

The global light duty EV market is expected to grow from 2.7 million vehicle sales in 2014 to 6.4 million in 2023 under a base scenario.

- Navigant Research

Key Technologies

Big Data

- RideScout and Metropia apps
- Open data portals
- NYC Taxi Hackathon

GAME CHANGERS

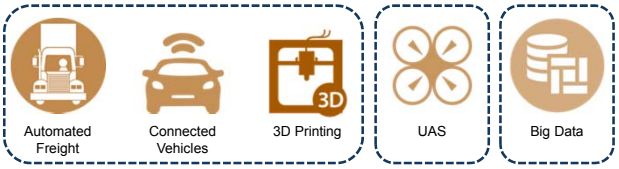
The Internet of Things (IoT) offers a potential economic impact of $4 trillion to $11 trillion a year in 2025.

- McKinsey

Synergies

Synergies

Knowledge Transfer



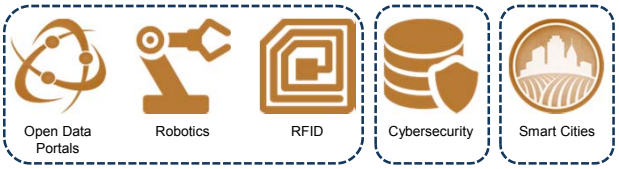
Revolutionizing the Global Logistics Industry

Opportunities & Challenges of UAVs

Using Data to Manage Customer Relationships

Synergies

Synergies



Developing Ports as Gateways to Innovation

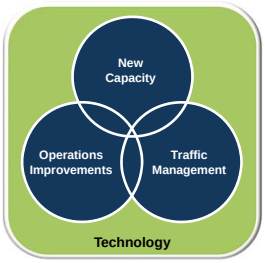
Protecting the Privacy & Cybersecurity of Civic Data

Fueling Smart Cities through Intelligent Commerce

Competitive Edge

Saving Lives *Saving Time* *Saving Money*

TxDOT Mobility Toolbox



TECHtalk

TECHNOLOGIES ON THE TRANSPORTATION HORIZON

INNOVATION & TECHNOLOGY CAUCUS

TEXAS DEPARTMENT OF TRANSPORTATION

TECHtalk

TECHNOLOGIES ON THE TRANSPORTATION HORIZON

INNOVATION & TECHNOLOGY CAUCUS

TEXAS DEPARTMENT OF TRANSPORTATION

How do we balance strategic planning with innovation?

Key Policy Areas

Connected/Autonomous Vehicles

UAS

Big Data

Key Policy Areas

Connected/Autonomous Vehicles (CAVs)

- NHTSA AV statement
- Three-year research plan
- Decision on connectivity

POLICIES TO WATCH

February 3, 2014: USDOT announced decision to move towards dedicated short range communication (DSRC) rulemaking. Expected to make regulatory decision in 2016.

Key Policy Areas

Unmanned Aerial Systems (UAS)

- FAA rulemaking
- Certification process
- National airspace management

POLICIES TO WATCH

FAA has proposed a framework of regulations that would allow routine use of certain small unmanned aircraft systems (UAS) in today's aviation system. 60-day public comment period on NPRM closed on April 24, 2015.

Key Policy Areas

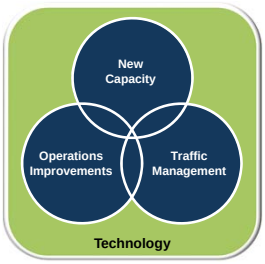
Big Data

- Privacy and cybersecurity
- White House OSTP examples
- Preventing vehicle hacks

POLICIES TO WATCH

Senators Ed Markey [D-MA] and Richard Blumenthal [D-CT] introduced an automotive security bill meant to set new digital security standards for cars and trucks on June 21, 2015.

TxDOT Mobility Toolbox



Action Items

- Attend the next TTTF meeting on December 10
- Reach out to constituents regarding their transportation needs
- Check out the TTTF's resources on emerging technologies
- Continue the conversation

Texas is striving to become the leader in transportation innovation.

Thank You

TEXAS TECHNOLOGY TASK FORCE

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Professor of Civil Engineering,
University of Texas at Austin
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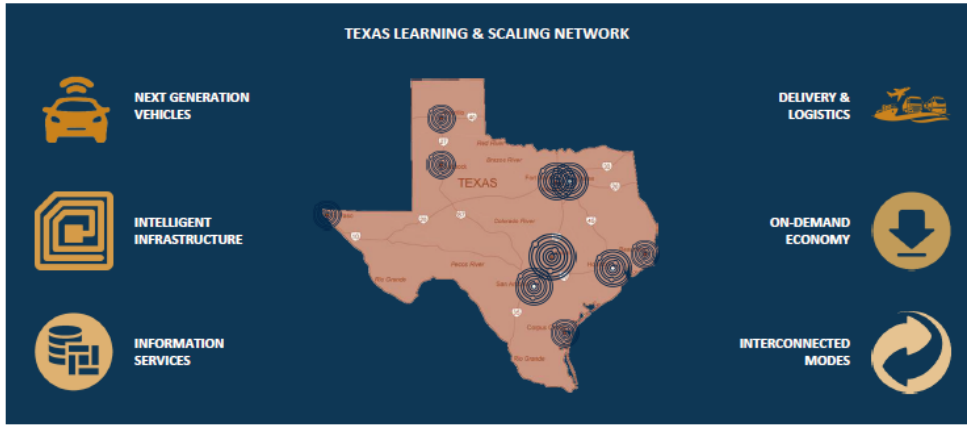
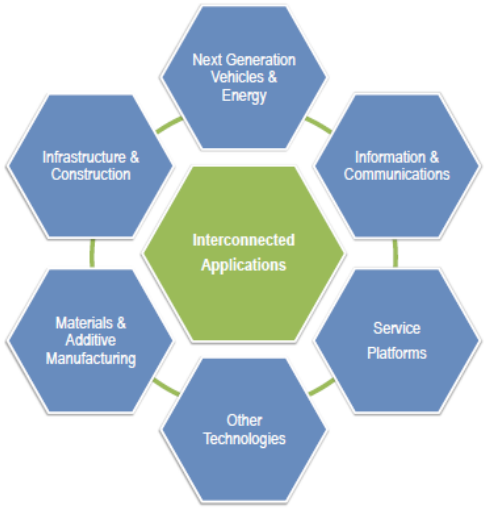
SMART CITY SMART STATE



EMERGING TECHNOLOGY PORTFOLIO



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Transportation Subscription Services

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Equipment

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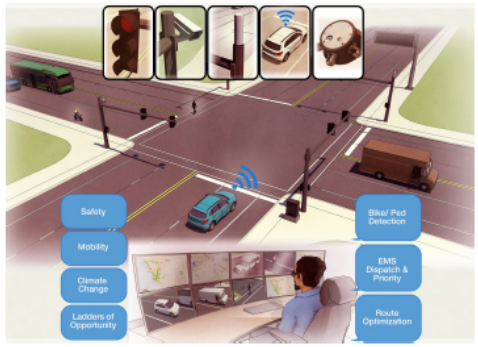
Crowdsourcing

Other Technologies
Hyperloop
Google Glass
Virtual Reality

AIRPORT: Accelerating Technology Development & Adoption

DOWNTOWN: Connecting Communities to Opportunity



RIVERSIDE: Enabling a Connected Environment

RUNDBERG: Bridging the Digital Divide

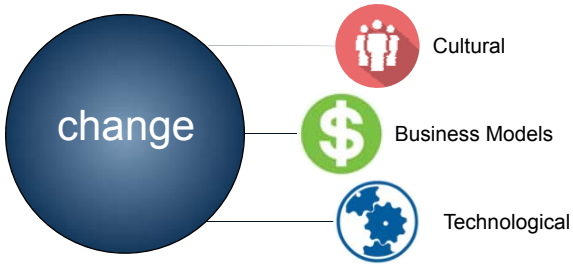
Source: City of Austin Smart City Challenge Application

TEXAS DEPARTMENT OF TRANSPORTATION

TEXAS TECHNOLOGY TASK FORCE

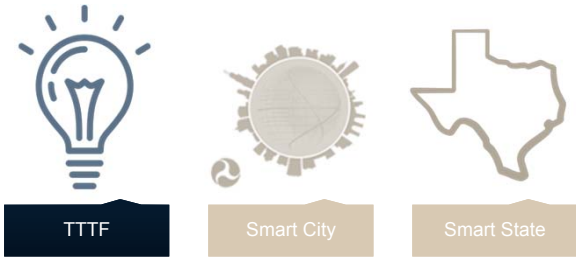
The Future of Transportation

Why do we need a Task Force?



Overview

Overview



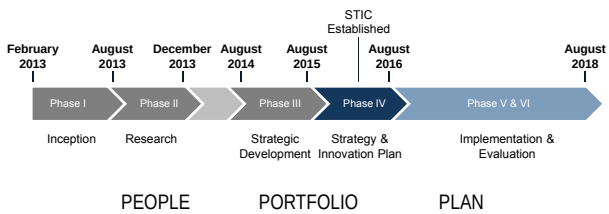
TTTF

TEXAS TECHNOLOGY TASK FORCE

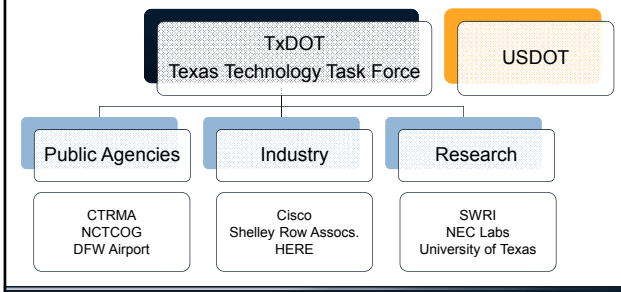
VISION	High-performance transportation system
MISSION	Outline clear, actionable strategies to enhance the delivery of quality transportation services
OBJECTIVES	▪ Identify emerging technologies ▪ Analyze economic, engineering, and policy impacts ▪ Develop key strategies to integrate critical technologies

TTTF

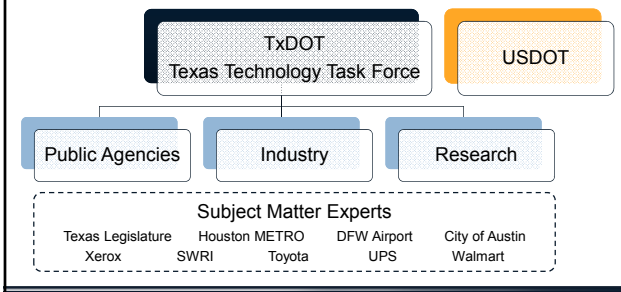
TEXAS TECHNOLOGY TASK FORCE



TTTF: PEOPLE – Portfolio – Plan



TTTF: PEOPLE – Portfolio – Plan



TTTF: People – PORTFOLIO – Plan

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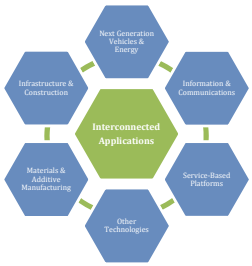


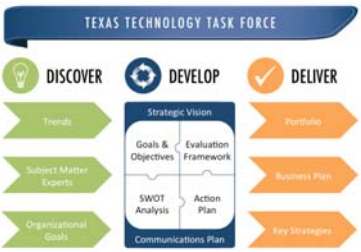
PHASE III PORTFOLIO

Information & Communications
Cloud Computing
Crowdsourcing

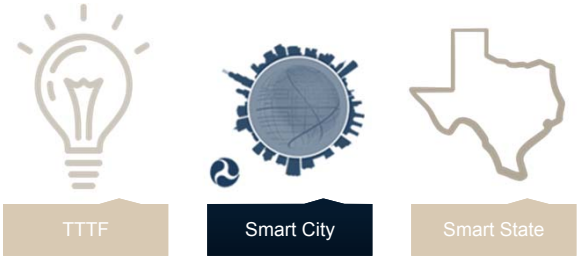
Service-Based Platforms
Location-Based Services
Transportation Subscription Services

Other Technologies
Hyperloop
Google Glass
Virtual Reality

TTTF: People – Portfolio – PLAN



Overview

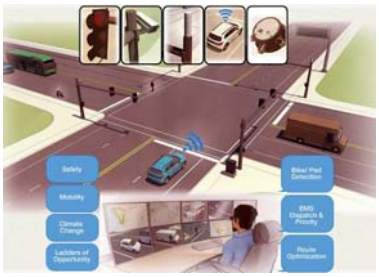


Smart City Challenge

Smart City Challenge

Austin Bergstrom International Airport
Automated Shuttle Service
Taxi and TNC Fleet Electrification
Public Acceptance & Adoption

Smart City Challenge



Riverside Corridor
V2V & V2I Applications
Transit and Freight Priority
Regional Operations Management Center

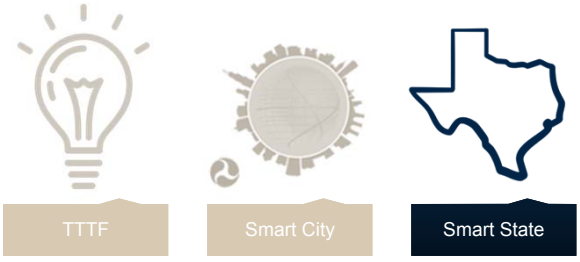
Smart City Challenge

Downtown – Pflugerville Smart Stations
Mobility Services
Travel Amenities
Informational Resources

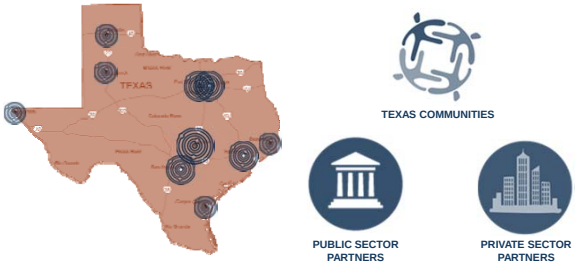
Smart City Challenge

Eastern Crescent Opportunities
Connected Traveler App
Ladders of Opportunity
Smart Ambassadors

Overview



Smart State



Thank You

Kristie Chin
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Technical Memorandum#0-6902-TM6

To: RTI Project Manager: Sonya Badgley
From: CTR Research Team: Andrea Gold, Kristie Chin, C. Michael Walton
Subject: TxDOT Project 0-6902 – Technical Memorandum for Task 6
Date: 07/15/16

1 Introduction

This technical memo will report on information learned from visiting technology pilot studies, trials, and labs within the U.S. in order to discover more in-depth details such as startup and planning efforts, partnership and operational characteristics, program governance and leadership structure, funding strategies, study goals and planned outcomes, measures of success, and lessons learned.

The three programs and pilots visited were affiliated with the University of Michigan and centered on connected and autonomous vehicles and big transportation data. The programs were The University of Michigan Transportation Research Institute's (UMTRI) Safety Pilot Model Deployment (in partnership with the USDOT), The University of Michigan Mobility Transformation Center's MCity, and The University of Michigan Data Science Institute (MIDAS) programs for transportation data. The technical memo will provide the following information for each program or pilot visited.

- **Establishment:** how each program was started, including details on startup funding, planning, and critical stakeholders
- **Objectives:** details on intended short-, medium-, and/or long-term effects and planned accomplishments
- **Details and operations:** including necessary equipment, expertise, and research staff, as well as operational characteristics
- **Future plans:** information on program extensions, planned activities, and major milestones
- **Partners:** including a list of participating partners providing expertise, equipment, or funding

2 Summary of Pilot Programs

This section summarizes the information and insights learned at each of each of the three visited programs.

The University of Michigan's (UM) Mobility Transformation Center (MTC) MCity project

Establishment: The MTC is an entrepreneurial entity established at UM in a public-private partnership among industry, government, and academia. It was developed to establish the foundation for a commercially viable ecosystem of connected and automated vehicles (CAVs) that has the potential to disrupt traditional mobility options. MTC activities began in 2014 with seed money from UM and from support from select private companies that served as its founding partners (and each committing a total of $1 million over three years). The MTC's feature project is MCity: a controlled environment specifically designed to test the potential of CAV technologies.

Research Objectives: develop and implement an advanced system of CAVs in Ann Arbor by 2021. This broad objective will be achieved by supporting rigorous, repeatable testing of new technologies in a safe, controlled, and realistic environment before testing them in scaled or real-world settings.

Program Details: The MCity testing facility was designed to offer a realistic off-roadway environment for testing AVs in a closed testing environment before they are transitioned to real environments with higher market penetration. The facility opened for testing on July 20, 2015, with partnerships formed between representatives from government, industry, and the university. The MTC has partnered with the Michigan Department of Transportation for the facility design and operations of MCity. Industry partners have been asked to join at one of two levels: leadership or affiliate. Partners in the Leadership Circle join with government and faculty to serve as thought leaders in guiding and synthesizing the work of the Center. Membership in the Leadership Circle is an investment of $1 million over three years. Affiliate members are invited to participate in a variety of selected, focused Center activities at an investment of $150,000 over three years.

MCity's main program goals include evaluation of the capabilities of CAVs and systems on the project's 32 acres at the university's North Campus Research Complex. The facilities simulate a broad range of the complexities that vehicles encounter in urban and suburban environments. It includes approximately 5 lane-miles of roads with intersections, traffic signs and signals, sidewalks, benches, simulated buildings, street lights, and obstacles such as construction barriers. Roadway attributes include a 1000-ft north/south straight track; various road surfaces (concrete, asphalt, brick, and dirt); a variety of curve radii and ramps; two-, three-, and four-lane roads; a roundabout and tunnels; and sculpted dirt and grassy areas. Roadside attributes include a variety of signage and traffic control devices; fixed and variable street lighting; crosswalks, lane delineators, curb cuts, bike lanes, and grade crossings; hydrants, sidewalks, etc.; and buildings (fixed and movable). MTC will continue to establish partnerships with a range of industries that play an integral part in shaping the future of mobility. These partnerships include agencies with expertise in auto manufacturing and supplies, telecommunications, big data analytics and management, freight, traffic controls and management, insurance, public transportation, payment systems, and parking.

MTC operates its own research program, which is overseen by staff and program partners. Its four research priority areas include technology, risk management, customer value, and societal impacts.

Partners: (***Government)*** USDOT, Michigan Department of Transportation, Michigan Economic Development Corporation, City of Ann Arbor. ***(Industry)*** (Leadership Circle) BMW; Delphi Automotive PLC; DENSO Corporation; Econolite Group, Inc.; Ford Motor Company; General Motors Company; Honda Motor Co., Ltd; Intel; Iteris, Inc.; LG Electronics, Inc.; Navistar, Inc.; Nissan Motor Co., Ltd; Qualcomm Technologies, Inc.; Robert Bosch LLC; State Farm Mutual Automobile Insurance Company; Toyota Motor Corporation; Verizon Communications, Inc.; Xerox Corporation. (Affiliate Members) 3M; Allstate Insurance Company; AGC Automotive; Arada Systems, Inc.; Auto Club Enterprises; Autoliv Electronics; Brandmotion LLC; Calspan Corporation; Changan Automobile; Cohda Wireless; Desjardins General Insurance Group, Inc.; DURA Automotive Systems; Faurecia; FedEx Corporation; Guangzhou Automobile Group, Co. Ltd; Harada Industry of America, Inc.; Harman International Industries; HERE; Hitachi, Ltd.; IAV Automotive Engineering; IDIADA; Magna International Inc.; Mechanical Simulation Corporation; Miller, Canfield, Paddock and Stone, PLC; MOBIS; Munich Re; New Eagle Consulting, LLC; Nexteer Automotive; NXP Semiconductors; OSIsoft, LLC; Panasonic Automotive Systems Company; PTC, Inc.; Realtime Technologies, Inc.; Renesas Electronics America Inc.; Savari Inc.; SF Motors, Inc.; Shell Oil Company; Subaru; Sumitomo Electric Industries, Ltd.; Suncorp Group; TASS International, Inc.; TRW Automotive; WSP l Parsons Brinckerhoff; ZipCar, Inc. ***(Research)*** Texas A&M Transportation Institute.

Future Plans: Staff at the MTC will help launch a larger test facility for CAVs near the Detroit airport, set up for testing technologies that have been proved at MCity. A $3 million grant from the Michigan Strategic Fund will help launch the 335-acre site in Ypsilanti, MI, at a former manufacturing site called Willow Run. The funding will enable the acquisition of the property and cover design work costs for the American Center for Mobility (ACM). Partners in the ACM initiative include the Michigan Department of Transportation and Michigan Economic Development Corp., UM, Business Leaders for Michigan, and Ann Arbor SPARK, a local economic-development organization. The long-range goal of the center is to ensure the U.S. is competitive with AV development in Europe and Asia.

University of Michigan Transportation Research Institute (UMTRI) & USDOT CV Safety Model Deployment

Establishment: UMTRI partnered with the USDOT for on-road testing of dedicated short-range communications (DSRC)-based connected vehicles (CVs). Titled the Safety Pilot Model Deployment (SPMD), it represented a critical step in validating the anticipated safety benefits of vehicle-to-vehicle (V2V) technologies. UMTRI won the competitive grant in the amount of $14.9 million from the USDOT for the first-of-its-kind real-world, DSRC-based CV pilot program in Ann Arbor, Michigan. Initially the model deployment was estimated to cost a total of $30 million (later estimates were closer to $50 million) with funds going toward CV equipment for 2,800 vehicles and 29 infrastructure sites.

Objectives: Primary objectives were to examine how well CV safety technologies and systems work in a real-life environment with real drivers and vehicles. The trials were set up to test the

real-world performance and usability of DSRC, to collected vehicle and infrastructure data, and to better understand the safety benefits of a larger-scale deployment. The SPMD focused on three major activities: 1. testing CV operations in real-world conditions; 2. understanding how regular drivers use CV technologies; 3. determining the safety benefits of a CV. Ultimately, the SPMD was used to support the 2013 decision by the National Highway Traffic Safety Administration (NHTSA) to issue an advanced notice of proposed rulemaking with regards to regulating V2V technology in light vehicles by obtaining empirical data on user acceptance and system effectiveness.

Program Details: In total, the three-year program helped to move forward standards development, applications research, and ultimately led NHTSA to issue an advanced notice of proposed rulemaking with regards to regulating V2V technology in light vehicles. The fleet and equipped roadways from the safety pilot continue to be used and expanded today for further research and testing of CV technologies.

Test cars, trucks, and buses in the study were mostly supplied by volunteer drivers and equipped with various V2V and vehicle-to-infrastructure (V2I) communication devices to generate, transmit, and store extensive data about system operability and its effectiveness at reducing crashes.

- Sixty-four fully integrated cars and three trucks had electronic devices (integrated safety systems—ISS) installed during vehicle production, which were connected to proprietary databases and provided highly accurate information using in-vehicle sensors. The ISS both broadcasted and received basic safety messages (BSMs) and could process the content through visual, sound, and/or haptic warning of received messages to alert the vehicle driver. Nearly 200 cars were equipped with aftermarket safety device (ASD) and could send and receive BSMs from other vehicles over a DSRC wireless communications link. The ASDs had a driver interface, ran V2V and V2I safety applications, and issued audible and/or visual warnings to the driver of the vehicle.
- Sixteen trucks and three transit buses were fitted with retrofit safety devices. These devices connected to a vehicle data bus and could provide highly accurate information from in-vehicle sensors. The integrated device had a working driver interface, both broadcasted and received BSMs, and could process the content of received messages to provide warnings to the driver of the vehicle.
- Finally, nearly 2000 cars, 60 trucks, and 85 transit buses were equipped with vehicle awareness devices (VADs), an aftermarket electronic device installed in a vehicle without connection to vehicle systems. The VAD was only capable of sending the BSM over a DSRC wireless communications link.

In total, 73 lane-miles were in the deployment and equipped with roadside equipment (RSE) devices, which could send messages to vehicles, such as signal phase and timing (SPaT), curve speeds, etc., to help improve safety and traffic flow using DSRC. A total of 29 RSE devices were in the deployment: 21 at signalized intersections, 3 at curves with curve speed warnings, and 5 at freeway sites. SpaT information was communicated to vehicles on 2 corridors with 12 intersections (6 intersections per corridor).

Future plans: Building on this experience, the MTC plans to move forward with plans to expand the deployment to embrace the full range of traffic situations in the greater Ann Arbor area. The expansion will include up to 9,000 equipped vehicles, including private cars, trucks, buses, motorcycles, bicycles, and links with pedestrians. Coverage will be scaled to 27 square miles, including surrounding highways as well as city and suburban streets. Infrastructure equipment will be installed at 45 or more intersections, 3 curve-related sites, and 12 freeway sites, and will provide over-the-air security, all DSRC logs, testing of selected V2I functions, back-haul communications network, and back-end data storage.

Partners: (***Government)*** NHTSA, Research and Innovative Technology Administration, Federal Highway Administration, Federal Motor Carrier Safety Administration, and Federal Transit Administration. (***Research)*** UM.

The Michigan Institute for Data Science (MIDAS), UM

Establishment: MIDAS was created in July 2015 as part of the UM Data Science Initiative, and ultimately it will comprise an interdisciplinary core faculty of 40 data scientists (from statistics, biostatistics, and mathematics; computer science and engineering; information science; and a range of data science intensive application experts). MIDAS will also include a Data Science Challenge Initiatives Program focused on one of four areas: Learning Analytics, Transportation, Social Sciences, and Personalized Medicine & Health. MIDAS will include a Data Science Education and Training Program as well as an Industry Engagement Program. The goal of the multiyear MIDAS Challenge Initiatives program is to foster data science projects that have the potential to prompt new partnerships between UM, federal research agencies, and industry. Two new data science projects will be working toward solving the major problems facing transportation in the future, by developing on-demand, driverless public buses and data-driven accident avoidance systems, with the eventual aim of creating 'smart' traffic systems that dramatically reduce emissions and congestion. The projects bring together interdisciplinary teams of researchers from UM and UM Dearborn to work with massive amounts of data being produced by CAV testing sites, as well as in conventional driver-directed settings, in Ann Arbor and around the country.

Objectives: help design and operate an on-demand, multimodal public transportation system for urban areas, in which a fleet of CAVs are synchronized with buses, light rail, shuttles, cars, and bicycles, using predictive models based on high volumes of diverse transportation data. Create a system allowing researchers to access massive, integrated datasets on transportation in a high-performance computing environment, which will support future transport research and development.

Program Details:
The first project, *Reinventing Public Urban Transportation and Mobility*, led by Pascal Van Hentenryck of the College of Engineering, will help design and operate an on-demand, multimodal public transportation system for urban areas, in which a fleet of CAVs are synchronized with buses, light rail, shuttles, cars, and bicycles, using predictive models based on high volumes of diverse transportation data. The project aims to address the 'first-mile/last-mile' problem—the challenge

of getting people from their homes or final destinations into the transit system. The goal is to begin testing on the UM campus within a year, and will then expand to Ann Arbor and Detroit.

The other project, *Building a Transportation Data Ecosystem*, led by UMTRI researchers, will create a system allowing researchers to access massive, integrated datasets on transportation in a high-performance computing environment, which will support future transport research and development. The project aims to create a common repository of transportation data, including data on driving, traffic, weather, accidents, vehicle messages, traffic signals, and road characteristics, and will inform the development of CAV systems of the future.

Future plans: TBD

Partners: TBD

3 Conclusion

Contributing factors that led to the establishment and success of the pilot programs are summarized below.

- Key political leadership was helpful in generating momentum and launching new programs, specifically the Governor's Office, the Director of the Michigan Department of Transportation, and the Michigan Economic Development Commission.
- Michigan was able to leverage industry expertise, capital, and existing relationships to garner support and resources necessary for experiments and trials.
- The interdisciplinary composition of UMTRI supported connections between ideas and concepts across different disciplinary boundaries and helps UMTRI remain a cutting-edge research institute.

Technical Memorandum#0-6902-TM7

To: RTI Project Manager: Sonya Badgley

From: CTR Research Team: Kristie Chin, Andrea Gold, C. Michael Walton

Subject: TxDOT Project 0-6902 – Technical Memorandum for Task 7

Date: 07/15/16

1 Introduction

This tech memo provides a strategy and innovation communications plan framework and establishes a process to assist the Texas Department of Transportation (TxDOT) in developing and strengthening partnerships with key stakeholders. Goals, strategies, and tactics are recommended to communicate the benefits of technologies within the Emerging Technology Portfolio, in particular the priority technologies of connected vehicles, automated vehicles, big data, electric vehicles, and unmanned aerial systems. The framework is designed to engage the following five audiences on the topics of strategy and innovation: TxDOT Administration and Texas Transportation Commission, policymakers, the general public, public partners, and private partners. Included are strategies and tactics to support the overall goals.

2 Purpose: Goals, Strategies, & Tactics

TxDOT's vision is to be a forward-thinking leader delivering mobility, enabling economic opportunity, and enhancing quality of life for all Texans. Strategy and innovation play an important role by providing leadership and direction for the innovation and continuous improvement of people, processes, and technology of the agency. Effective communication of strategy and innovation principles contributes to the success of the agency by:

- Building trust
- Garnering support
- Generating investment

The following are three goals, supported by strategies and tactics, to enable TxDOT to be recognized as a forward-thinking leader. Using these techniques, customized communication strategies may be developed to build awareness within each stakeholder group and constructively influence the decision-making process.

2.1 Foster a Culture of Innovation

Empower a Network of Innovation Champions

Identifying innovative leaders throughout all levels of the agency would encourage the dialogue and exchange of ideas related to strategy and innovation. When employees feel valued for their ingenuity, they are more likely to engage in critical and creative thinking. Empowerment creates a healthy environment in which good ideas are encouraged to bubble up to management, leading to increased worker productivity, improved system efficiencies, and better service delivery.

Build Awareness & Interest in Emerging Technologies & Trends

Sharing information about emerging technologies and trends would enable TxDOT to support a skilled workforce and maintain a competitive edge. Distributing resources about the benefits and barriers that technologies offer enables Districts, Divisions, and Offices (DDOs) to stay abreast of new developments and anticipate disruptive change.

Coordinate Knowledge & Technology Transfer

Facilitating the transfer of best practices and lessons learned would improve the flow of innovation across organizational silos. A combination of formal and informal processes work together to create a collaborative culture, ensure that the innovation process remains dynamic, and improve technology adaption/adoption.

2.2 Develop & Strengthen Partnerships

Conduct Outreach to Policymakers

Serving as a resource to policymakers engenders trust, garners support, and ultimately generates investment for the state. Taking the initiative to inform policymakers about the strategic direction of the agency and understand their priorities is a positive way to open up communication channels. As innovations arise, the agency may work with policymakers to ensure that private interests are meeting public needs (e.g., privacy, security, etc.).

Conduct Outreach to Public Agency Partners

Engaging other public agencies is critical to developing comprehensive solutions and serving customer needs. Collaboration with regional and local transportation agencies, including MPOs, COGs, RMAs, and transit agencies, will become increasingly important as the rapid trends of urbanization and megaregions continue to progress. Non-transportation agencies such as chambers of commerce, public works, public safety, and health and social services are also vital to creating ladders of opportunity.

Conduct Outreach to Private Industry Partners

Attracting private industry partners capitalizes upon their expertise, leverages public investment, and mitigates risk associated with innovation. A unique value proposition effectively conveys the assets and opportunities that Texas offers, perpetuating its business-friendly environment that enables public-private partnerships to thrive.

2.3 Differentiate Texas as a Leader

Promote Examples of Successful Innovations

Earning recognition for success and creativity creates a positive presence in the media. Publishing results, synthesizing best practices, and sharing lessons learned also contribute to an agency's reputation for being a leader in advancing technology in the field. Building the agency's brand influences stakeholders' perception of the agency; a positive image correlates to increased trust, support, and investment.

Take a Leadership Role in Relevant Industry and Professional Conferences

Networking in professional, government, and industry forums creates opportunities to promote the agency, learn about competitors, and develop partnerships. Attendees are ambassadors for the agency with the power to influence policymakers, regulators, and industry leadership. Technical and policy sessions are key to remaining relevant and aware of new developments.

Anticipate Change & Readily Adapt

Being aware of social trends, technological advancements, economic situations, and political climates enables the agency to take a proactive rather than a reactive approach. Balancing a conviction in innovation with shifting priorities will enable the agency to evolve while still responding to the needs of its stakeholders.

3 Situational Analysis

The following section describes the factors that are defining the current environment surrounding strategy and innovation in Texas.

3.1 Communication Challenges

Traditional Views of Transportation

TxDOT has historically concentrated its efforts on the construction and maintenance of highways. While the highway system has been critical to the development of the state's economy, the rapid population growth and advancements in technology have outgrown the traditional construction-focused strategy. A new paradigm of technology-enhanced mobility solutions through public-private partnerships is necessary to address the comprehensive challenges the state is facing.

High Leadership Turnover

In recent years, TxDOT has experienced a high rate of leadership turnover in conjunction with multiple reorganizations, leading to strategic ambiguity and a loss of institutional knowledge. A comprehensive strategy and innovation plan is needed to effectively communicate the purpose, activities, and value that strategy and innovation offer to TxDOT's stakeholders. A cohesive plan would provide continuity and a common purpose that could withstand multiple administrative changes.

Complex Stakeholder and Funding Landscape

Traditional funding structures are not designed to address the transportation system from a holistic perspective. A new mechanism is needed to encourage collaboration across multiple jurisdictions and modes. If the system can only be funded on a piecemeal level, customers will receive a piecemeal solution.

3.2 Communication Opportunities

Customer Demand for Information

Customers are increasingly expecting to have access to timely, accurate, and relevant information to enable them to make rapid decisions. Providing customers with the information they want is an effective way to manage expectations, promote the brand, and ensure a positive transportation experience.

Daily Interactions with the Transportation System

Customers experience the frustrations of traffic on a near-daily basis and it has been shown that the most negative experiences leave the strongest impressions. If the agency focused on generating positive transportation micromoments, TxDOT could improve the image of the agency and the quality of life for all Texans.

Ladders of Opportunity

Using the Smart City Challenge, the USDOT has launched a campaign to communicate ways in which transportation can serve as a "ladder of opportunity." TxDOT should support the campaign by making better connections between the transportation system and healthcare, affordable housing, education and workforce development opportunities, and jobs.

4 Key Audiences & Main Messages

Five primary audiences were identified: TxDOT Administration & Texas Transportation Commission, policymakers, general public, public partners, and private partners. Main messages are developed and tailored so that strategy and innovation resonate with each audience. The objective of each message to influence the decision making process in a way that builds trust, garners support, and generates investment.

4.1 TxDOT Administration & Texas Transportation Commission

The TxDOT Administration and Texas Transportation Commission are the champions for the agency and are responsible for effectively communicating its strategic direction, innovation goals, and areas of need. Armed with the right narrative, TxDOT leadership has the power to build trust, garner support, and generate investment. The following are the main messages that TxDOT could use to engage policymakers and the general public.

Main Messages

- Dynamic: TxDOT is a dynamic agency that uses a proactive rather than reactive approach to anticipate change.
- Adaptive: TxDOT embraces technology to meet the diverse and evolving needs of its customers.
- Economic Generator: An intelligent transportation system attracts private sector interest and serves as a platform to enable economic development.

4.2 Policymakers

Developing relationships and earning credibility with policymakers are essential to demonstrate that the projects selected for delivery are the right investments to meet the state's needs. Communicating results relevant to the policymaker's constituents or areas of interest show that the agency is dedicated to strengthening the relationship. When policymakers are less familiar with technology and innovation, additional effort should be made to justify its need, provide objective research results, and use concrete examples.

Main Messages

- New Paradigm: Traditional transportation projects are no longer meeting the needs of Texans and a new paradigm of technology-enhanced mobility solutions is needed.
- Responding to Constituent Pain Points: TxDOT offers a portfolio of technology-enhanced solutions that may be tailored to serve a range of community needs, including addressing congestion, enhancing traveler information, and improving incident management.
- Fiscally Responsible: Public-private partnerships offer a way to deliver innovative projects in a fiscally responsible manner by leveraging public funds and allocating risk to the appropriate entity.

4.3 General Public

The perception that the general public has of the transportation system as a whole heavily impacts the perception of the agency, which ultimately affects levels of trust, support, and investment. Whether a customer has a positive or a negative experience determines whether the agency is viewed as competent, responsive, and relevant, or ineffectual, passive, and outdated. Travelers will share their experiences by word of mouth, social media, and/or the news media; therefore, it is important to deliver excellent customer service and manage a range of traditional and social media communication channels.

Main Messages

- Value: TxDOT uses innovation to develop solutions that save its customers time and money.
- Safety: Technology presents many opportunities as well as challenges; TxDOT is dedicated to protecting its customers' safety, privacy, and security.
- Convenience and Choice: TxDOT offers all customers convenience and choice by supporting multiple modes of transportation.

4.4 Public Partners

To deliver an integrated transportation system to customers, collaboration with a range of transportation and non-transportation public partners is often necessary. Furthermore, customers rarely distinguish between transportation jurisdictions, therefore public agencies need to work together to manage the reputation of the transportation system holistically. TxDOT can offer a statewide perspective while drawing upon domain knowledge of the regional and local agencies.

Main Messages

- Collaboration: TxDOT facilitates collaboration in order to breakdown organizational silos and encourage exchange of best practices.
- Flexible: TxDOT relies upon public partners to be nimble in their procurement and project delivery processes to deploy innovations in a timely and efficient manner.
- Context-Sensitive: TxDOT depends upon regional and local leadership to customize solutions to fit the community context.

4.5 Private Partners

The agency can make a compelling case to engage the private sector in public-private partnership opportunities in order to leverage their expertise and capital. TxDOT can promote the state's business-friendly environment, offer controlled testing environments, and encourage mutually beneficial data exchange programs. Public-private partnerships are an effective way to manage risk, leverage public funds, and advance innovation.

Main Messages

- Open for Business: Texas offers a business-friendly environment that promotes rather than restricts innovation.
- Open for Innovation: TxDOT is interested in developing public-private partnerships in the areas of information management, connected and automated vehicles, and intelligent transportation systems.
- Access to the Texas Market: Deploying technologies in Texas offers opportunities to test the technology readiness in controlled environments, understand the customer experience, and perform market research.

5 Conclusion

A TxDOT communications plan for strategy and innovation is needed to build trust, garner support, and generate investment for continued strategy and innovation activities. Communication efforts should strive to foster an innovative organizational culture, develop external relationships, and position Texas as a leader in delivering innovative mobility solutions. Messages should be crafted and tailored to each audience, ensuring that the points resonate and effectively influence each stakeholder's decision-making process.