Statement of

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On behalf of:

The Intelligent Transportation Society of America (ITS America)

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON HIGHWAYS AND TRANSIT
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

Innovation in Surface Transportation

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Testimony

Chairman Graves, Ranking Member Holmes Norton, and Members of the Subcommittee, thank you for the opportunity to provide the Intelligent Transportation Society of America's (ITS America) perspective on "Innovation in Surface Transportation."

I am pleased to be joined on this panel by ITS America member Contra Costa Transportation Authority Executive Director Randell Iwasaki.

We applaud the Subcommittee on Highways and Transit for its interest in how intelligent transportation technologies are solving many of our nation's transportation safety, mobility, and infrastructure challenges. We also commend the Subcommittee for its leadership, which made deployment of intelligent transportation technologies an eligible activity in the Fixing America's Surface Transportation Act (FAST Act).

With FAST Act funding, commitments from state and local governments, innovative partnerships with the private sector and research institutions, we see firsthand how deployment of intelligent transportation technologies are saving lives; reducing crashes; extending the life of transportation infrastructure; improving capacity; reducing the rate and growth in congestion; moving more people in fewer vehicles; improving travel times; and reducing greenhouse gas emissions.

A Better Future Transformed by Intelligent Transportation Technologies: Introduction

My name is Shailen P. Bhatt, and I am the President and CEO of ITS America. Before joining ITS America in January, I served as Executive Director for the Colorado Department of Transportation (CDOT). In that role, I oversaw the launch of the RoadX program, which is focused on deploying innovative technology solutions—including connected vehicles—and teaming with the private sector to shape the future of transportation. While at CDOT, I also served as the national Chair of the Vehicle-to-Infrastructure Deployment Coalition and the Chair of the National Operations Center of Excellence. Before CDOT, I served as Cabinet Secretary with the Delaware Department of Transportation and Deputy Executive Director of the Kentucky Transportation Cabinet. I also had the pleasure of serving as Associate Administrator at the Federal Highway Administration under U.S. Department of Transportation Secretary Ray H. LaHood.

It is an honor to testify on behalf of ITS America and our members who have been researching, developing, testing or deploying intelligent transportation technologies. Founded as an official advisory board on road technology to the U.S. Department of Transportation, ITS America

represents state and city departments of transportation, metropolitan planning organizations, automotive manufacturers, technology companies, engineering firms, automotive suppliers, insurance companies, and research and academic institutions. Our Board Chair is Carlos Braceras, Executive Director of the Utah Department of Transportation, and our Vice-Chair is Gary Smyth, Executive Director Global Research and Development Laboratories at General Motors.[1] These members come to one table—ITS America—to shape the next generation of transportation and infrastructure driven by intelligent mobility.

ITS America is united around a shared vision of a better future transformed by intelligent mobility that is safer, greener, and smarter. Our mission is to advance the research and deployment of intelligent transportation technologies to save lives, improve mobility, promote sustainability, and increase efficiency and productivity. For nearly 30 years, ITS America has been educating policy and decision makers at every level of government and in the private sector on policy that supports intelligent transportation technologies. Our focus is policy that accelerates deployment of connected and automated vehicle technology and smart infrastructure; breathes new life into our transportation infrastructure by expanding investments in technologies that support smart and sustainable states and cities; and supports new models and modes of transportation including micro-transit, rideshare, carshare, bikeshare, and unmanned systems. That said, our first and foremost priority has been, and continues to be, safety.

A Better Future Transformed by Intelligent Transportation Technologies: Next Generation of Mobility

Today's hearing takes place at an important time. Just as infrastructure was critical to the development of our economy in the 20th century, maintenance of existing infrastructure and deployment of smart infrastructure will be critical for our global competitiveness in this century. Advances in robotics, artificial intelligence, and wireless communications have inspired a race to make the next generation of mobility a reality.

We are entering a technology revolution that will define the way people, goods, services, and information move in the 21st century. It is a whirlwind of innovation that will change entire industries as well as transform communities large and small as well as urban and rural. It is a

[1] The ITS America Board of Directors includes AAA, Arizona Department of Transportation, California Partners for Advanced Transportation Technology at University of California Berkeley, California Department of Transportation, Conduent, Cubic, Delaware Department of Transportation, Econolite, General Motors, GRIDSMART, HELP Inc., Iteris, Kapsch TrafficCom North America, Metropolitan Transportation Commission, Michael Baker International, National Renewable Energy Laboratory, New York City Department of Transportation, Pennsylvania Department of Transportation, Qualcomm, Serco, Southwest Research Institute, State Farm Insurance, Texas A&M Transportation Institute, Toyota, Utah Department of Transportation, and Virginia Tech Transportation Institute.

new transportation era as dramatic as the period when the car supplanted the horse and buggy. This transformation can positively affect both the safety and operations of our transportation system.

A Better Future Transformed by Intelligent Transportation Technologies: Safer. Greener. Smarter

According to the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA), 37,461 people died in U.S. road crashes in 2016. This is a nine-year high, and it is an increase of 5.6 percent from the 35,485 fatalities in 2015. The 5.6 percent increase, following the 2015 increase of 7.2 percent, is the largest back-to-back percentage increase in fatalities since the 1963-1965 reporting period. In addition, there were 6.29 million crashes in 2015, which resulted in 2.44 million injuries, which is up from 2.34 million in 2014. Another alarming statistic is that pedestrian fatalities rose by nine percent in 2016. Deaths related to reckless behaviors including speeding, alcohol impairment, and not wearing seat belts also continued to increase. Every day on average in the United States, 100 people lose their lives on our roadways.

As fatalities continue to trend upwards, mobility and environmental challenges continue to worsen. According to the 2017 Global Traffic Scorecard by ITS America member INRIX, U.S. drivers spent an average of 41 hours a year in traffic during peak hours, which cost drivers nearly $305 billion, an average of $1,445 per driver. Three of the world's top five most congested cities are in the United States, with Los Angeles (first), New York (tied for second with Moscow) and San Francisco (fifth) costing upwards of $2.5 billion. According ITS America member Texas Transportation Institute (TTI), congestion produced 56 billion pounds of carbon dioxide pollution and contributed to 3.1 billion gallons of wasted fuel in 2015.

Once the envy of the world, our increasingly outmoded roads, bridges, transit, freight, and intercity passenger systems are struggling to move the nation's technology-driven economy. Our transportation infrastructure is the backbone of our nation's economy. It is also increasingly overcrowded, in poor condition, and more dangerous. The most recent American Society of Civil Engineers Report Card gave our infrastructure a D-plus. Highways were ranked a D and public transportation a D-minus. Bridges were only slightly better with a C-minus. The 2015 U.S. Department of Transportation Conditions and Performance Report highlighted that current freight demands are straining existing capacity. Forecasts for population growth, freight growth, trade volume, and vehicle miles traveled all point to a dramatic increase over the next several decades.

We need a safer, greener, smarter future where lives aren't lost on our roads, goods are transported to markets quickly, states and cities prioritize investments in technology to enable

scare infrastructure funds to reach farther and with longer-lasting results, and people get back their most precious resource: time.

Today, we are on the cusp of that future transformed by intelligent transportation technologies. The modern world literally turns on the boundary of where the tire rubber meets the paved road. For over a century, this was the most important interface between the car and the infrastructure. For automakers, the objective was always to design vehicles that were "road friendly" to the greatest extent practical. However, with new information and wireless technologies, there is a new interface -- a digital interface between the car and driver and the road infrastructure. This has presented an opportunity for infrastructure operators to improve safety, manage traffic, and introduce new models and modes of transportation in ways that were previously unknown. By applying intelligent transportation technologies to our existing infrastructure, we can maximize the efficiency of our system and make it more sustainable, accessible, and equitable.

Connected and automated technology is an example of innovative transportation technology that will transform mobility and our communities. Connected and automated technologies have the potential to expand access to transportation. Older Americans and people with disabilities are demographics that are impossible to ignore. According to the U.S. census, residents age 65 and over grew from 35.0 million in 2000, to 49.2 million in 2016, accounting for 12.4 percent and 15.2 percent of the total population, respectively; and nearly one in five people have a disability. They also represent a significant demand for transportation services, with explosive growth in travel occurring should fully automated vehicles succeed in expanding mobility access. We hope to have a future in which people with disabilities have full freedom of transportation; older adults have greater independence; and people in underserved communities and transit deserts—who are often low-income, minority, and immigrant—will have better work opportunities, better education, and access to better healthcare.

Connected vehicle technology has arrived, and automated vehicle technology is coming, but this should come as no surprise because we have seen technology being added to cars, trucks, and buses since the 1950s. Cruise control, an early example of vehicle automation, was first introduced in the 1958 models of the Chrysler Imperial, New Yorker and Windsor. According to NHTSA, vehicle safety technologies have been researched, developed, tested, and deployed safely over nearly 70 years—including cruise control, anti-lock brakes, electronic stability control, blind spot detection, forward collision warning, lane departure warning, rearview video systems, automatic emergency braking, pedestrian automatic emergency braking, rear cross traffic alert, and lane centered assist.

New transportation technologies are game changers. We now have the technical capability to connect vehicles to other vehicles, to the infrastructure, and to pedestrians—collectively referred to as Vehicle-to-Everything (V2X) communications or Connected Vehicle—via the 5.9 GHz

spectrum band. Advanced traffic management infrastructure, Vehicle-to-Infrastructure (V2I) communications, and Vehicle-to-Pedestrian (V2P) communications can reduce crashes, smooth traffic flow, reduce pollution, and most importantly, save lives.

NHTSA estimates that safety applications enabled by V2V and V2I could eliminate or mitigate the severity of up to 80 percent of non-impaired crashes, including crashes at intersections or while changing lanes. More than 30 states and 45 cities are deploying V2I communications that use the DSRC safety spectrum band to enhance safety, reduce crashes, and decrease fatalities. V2I deployments include expansions of the Safety Pilot Model Deployment in Ann Arbor (MI), large Pilot Deployments in New York City (NY), Tampa (FL), and Wyoming, and the Smart City Challenge in Columbus (OH).

Electric vehicle infrastructure will be key to the deployment of the next generation of mobility. An increasing number of vehicle manufacturers are committing to deploy electric vehicles. ITS America believes that electric vehicles represent one of the best ways to reduce carbon dioxide pollution and our nation's dependence on oil from volatile and unpredictable regions of the world.

One of my last acts as the head of CDOT was to work across state agencies to help implement Governor John Hickenlooper's Executive Order D 2017-015, "Supporting Colorado's Clean Energy Transition." The executive order directs state agencies to develop a plan to electrify Colorado's transportation corridor.

Despite the recent growth in Colorado's electric vehicle (EV) market, including that the first eight months of 2017 saw EV sales jump 73 percent over the same period in 2016, we found significant barriers to adoption. These barriers included a lack of public charging stations, particularly EV fast-charging along major transportation corridors. Consumers were apprehensive about the availability of public charging—including local, community-based charging stations and fast-charging stations along Colorado's transportation corridors and the cost of building out of an EV fast-charging network that would likely require significant public funding due to the high cost of installation. These barriers are not unique to Colorado.

Now, as head of a national association, I hear similar concerns from our member states and cities as well as vehicle manufacturers. As companies increase their commitment to deploy electric vehicles, ITS America calls on federal, state, and local governments and the private sector to build-out the charging infrastructure to support the next generation of mobility powered by electricity.

A Better Future Transformed by Intelligent Mobility: FAST Act Reauthorization

Before I provide a preview of ITS America's intelligent transportation technology best practices report, I would be remiss if I did not strongly urge Congress and the Administration to identify long-term and sustainable funding for the Highway Trust Fund to ensure the FAST Act is reauthorized before the law expires in 2020. Maintaining our infrastructure is vital. Funding for ongoing intelligent transportation research also is important. This kind of research requires funding. Changes are happening today that will fundamentally affect how people interact with transportation in the months and years ahead. ITS America is helping states, cities, the private sector, and researchers work toward our vision of a better world transformed by intelligent transportation technologies - one that is safer, greener, and smarter.

A Better Future Transformed by Intelligent Transportation Technologies: Best Practices

I am pleased today to provide the Subcommittee on Highways and Transit with a preview of ITS America's *"*Intelligent Transportation Technologies Best Practice Report: A Better Future Transformed by Intelligent Mobility*"* that the association is preparing for the reauthorization of the FAST Act.

This report will provide best practices on current intelligent transportation technology deployment in the United States including: project sponsor; location; description of technology and why technology was selected; transportation safety, mobility or infrastructure challenge the project is addressing; project cost information, including federal match, state and local match, and private funding; how the project contributes to the overall state of good repair of the system; how the project helps freight and goods movement; how the project improves the environment; how the project will support the deployment of connected and automated vehicle technologies and smart infrastructure; how the project supports larger smart communities objectives; the project's economic benefits; and level of support from federal, state, and local elected officials.

The report will provide a detailed body of data on intelligent transportation technology deployment. We will use the data to inform Congress and the Administration on the need to prioritize intelligent transportation technologies in the reauthorization of the FAST Act. We will also use the best practices to inform the owners and operators of most of nation's transportation infrastructure—state, city, and county elected officials and policymakers.

The ITS America's "Intelligent Transportation Technologies Best Practice Report: A Better Future Transformed by Intelligent Mobility" project was announced on August 9, 2018. We have received best practices from 12 state departments of transportation, two metropolitan planning

organizations, three research institutions, and one private sector company. Although it is early in the process, the best practices received to date provide excellent examples of how intelligent transportation technologies are helping to address transportation infrastructure challenges from metropolitan areas to rural communities across the country.

Best practices focus on deployment of congestion-reduction technologies available today such as current generation active traffic management, managed lanes, incident response management and smart signal operations. Current travel demand management strategies include systems that provide availability and pricing of capacity on roads, highways, parking, and curb space.

The current generation of intelligent transportation systems don't simply report congestion to infrastructure operators or road users, but also actively manage transportation assets (e.g., highway/intersection/bridge lanes, ramps, parking stalls, etc.) to leverage their maximum capacity, capabilities, and lifespan for all. The next generation systems will tightly integrate data from automated and connected vehicles, which further improve the productivity of our transportation infrastructure by orders of magnitude over current systems.

ITS America will be compiling intelligent transportation best practices through the end of 2018. We look forward to an opportunity to again appear before this Subcommittee with our complete report on intelligent transportation technologies best practices.

Summary of Intelligent Transportation Technology Best Practices

Arizona Department of Transportation Interstate 10 Dust Detection and Warning System (Pages 16-18)

The Arizona Department of Transportation is in the process of creating a first-of-its-kind dust detection and warning zone on a busy rural stretch of Interstate 10 between Phoenix and Tucson that has frequently seen hazardous blowing dust. The dust storm early warning system uses both spot detection technology and remote sensing technology to measure both the visibility along the roadway and to detect the development of dust events at a distance from the highway to allow for advance warning time. The visibility alerting capability will be integrated with automated response using Variable Speed Limit (VSL), Dynamic Message Sign (DMS), and in-pavement detection (speed loops) to warn travelers of actual or potential dust events prior to encountering them within the corridor, and closed-circuit cameras will be installed that allow staff at ADOT's Traffic Operations Center in Phoenix to see the real-time conditions on the roadway. This entire system will be connected via fiber optic cable, which results in faster information dissemination for motorists and for ADOT when blowing dust develops suddenly in this 10-mile stretch.

California Department of Transportation Interstate 80 Safety, Mobility, and Automated Real-time Traffic (SMART) Corridor (Pages 19-21)

The Interstate 80 Safety, Mobility, and Automated Real-time Traffic (SMART) Corridor project combines traditional traffic operations management strategies and technologies, with new approaches, such as active traffic management and the use of overhead lane control signs to alert travelers and harmonize traffic speeds to conditions. These measures are being combined with adaptive ramp metering, the use of arterials, and information display boards to give travelers the information needed to make wise travel route and mode choices. The integrated corridor management approach relies on interconnecting Transportation Management Centers (TMCs) operated by local jurisdictions with Caltrans' regional TMC, video monitoring, and playbooks for planned events and incidents.

Colorado Department of Transportation SMART 25 Managed Motorways Pilot Demonstration (Pages 22-24)

The managed motorways concept first developed and implemented by the Victoria State Department of Transportation (VicRoads) in Melbourne, Australia, is a complex coordinated ramp metering and freeway management system which adjusts to real-time traffic conditions to prevent the breakdown of corridor traffic-flow. The complexity of the system requires a robust deployment of traffic detection on ramps and the freeway mainline to fully understand and control for real-time congestion conditions.

Colorado Department of Transportation RoadX's Smart Pavement Project (Pages 25-26)

RoadX Smart Pavement is a precast concrete panel embedded with digital technology and fiber optic connectivity that acts like a laptop tracking pad.

Colorado Department of Transportation RoadX's Smart Cone Pins Project (Pages 27-28)

RoadX in partnership with iCone developed a low cost ($600/unit to buy) GPS pin that fits into a standard roadway cone. When that "smart cone pin" is activated, it sends its true location and status to a cloud environment that anyone one can ingest and display on a map.

Florida Department of Transportation Truck Parking Availability System (TPAS) (Pages 29-31)

Truck parking shortages are a national safety concern. The current deployment of TPAS is 68 public sites located throughout Florida's state highway system along Interstate 10 (SR 8), Interstate 75 (SR 93), Interstate 95 (SR 9), and Interstate 4 (SR 400). TPAS uses a combination of in-pavement space occupancy detection for the location with mixed vehicle type usage (welcome centers and rest areas) and microwave vehicle detection for monitoring of ingress/egress at the weigh stations. The data are aggregated at the District Regional Transportation Management Center (RTMC) and disseminated to the commercial vehicle operators through dynamic roadside signs as well as through Florida's 511 system and third party data feeds.

Georgia Department of Transportation Statewide Traffic Signal Software Upgrades (Pages 32-33)

By deploying an advanced and open traffic signal control platform, Georgia Department of Transportation (GDOT) seamlessly manages arterial operations with local agency partners across jurisdictional boundaries. With an additional suite of operational tools, as well as real-time monitoring using high-resolution data and automated traffic signal performance measures, GDOT leverages technology to extend engineering and maintenance resources across the entire state. Targeting issues proactively and responding to maintenance issues before they impact the traveling public improves the mobility of all users on the arterial network.

Maryland Department of Transportation: Coordinated Highways Action Response Team (CHART) Development (Pages 34-36)

The CHART Advanced Traffic Management System (ATMS) is a set of software programs running on a combination of Windows 2008 Servers, connected to a statewide network of Closed Circuit Television (CCTV) cameras, overhead and portable Dynamic Message Signs (DMSs), Highway Advisory Radios (HARs), Traffic Sensor Systems (TSSs) (microwave traffic flow detectors), remote weather stations, and On/Off devices (electronic relay devices such as for horns and fog beacons). It is used to identify and track traffic flow disruptions, send responders to correct the disruption and notify the public using the DMS and HAR devices, as well as sending notifications to the media and feeding data to a live traffic web site (http://www.traffic.maryland.gov) and Maryland 511.

Maryland Department of Transportation: Freeway Traffic and Safety Patrol/Response (FTSP) Vehicle Acquisition (Pages 37-38)

The FTSP vehicles include both heavy duty and light duty vehicles. To perform incident management and emergency response functions efficiently, these FTSP vehicles are equipped with state-of-the-art technologies such as Automated Vehicle Location (AVL), Permanently mounted Closed Circuit Television (CCTV) cameras, two-way radio communications and Capital Wireless Information Net (CapWIN) capabilities.

Michigan Department of Transportation: US-23 Flex Route (Pages 39-41)

Completed in 2017, the US-23 Flex Route is nine miles in length from M-14 to M-36 north of Ann Arbor. The project included construction of road, bridge and interchange operational improvements and Active Traffic Management (ATM) strategies for the US-23 corridor to address daily recurring and non-recurring traffic, incident management and overall motorist safety. Using the Flex Route's lane control gantry system, MDOT can now dynamically manage recurrent and non-recurrent congestion through technology and operational ATM strategies including dynamic lane control and shoulder use, variable speed advisories and queue warning.

Metropolitan Transportation Commission of the San Francisco Bay Area: Bay Bridge Forward (Pages 42-45)

Bay Bridge Forward is a suite of projects that moves more people in fewer vehicles to make the most efficient use of the bridge's capacity. It includes implementation of near-term, cost-effective operational improvements that offer travel time savings, reliability and increased capacity for carpooling and bus/ferry transit. These improvements will not only increase person throughput and improve access to jobs in San Francisco but also reduce congestion, incidents, and emissions in the bridge corridor.

Pennsylvania Department of Transportation: Interstate 76 Integrated Corridor Management (Pages 46-49)

The project is located along the I-76 corridor in Montgomery and Philadelphia Counties. The mainline component of the program consists of junction control and flex lanes using a collection of ITS technologies such as dynamic lane assignment, variable speed limits and queue warning, also known as Active Traffic Management (ATM). Traffic signal equipment on arterial roadways will be upgraded and standardized, and control and maintenance responsibilities for these corridor signal systems will transfer from the municipalities to PennDOT. Both the mainline and arterial roadways will be outfitted with communications equipment that will allow for the bi-directional flow of information between roadway infrastructure, automobiles, transit

vehicles, pedestrians, and bikers. These deployments will support the Commonwealth's commitment to furthering vehicle-to-infrastructure connected vehicle initiatives.

Regional Transportation Commission of Southern Nevada: Waycare (Page 50)

Located in southern Nevada, Waycare helps improve safety and efficiency on freeways, including key freight corridors and major arterials by compiling and analyzing data to report in real-time the location of accidents and predict where dangerous driving conditions or congestion may occur. This technology enables faster validation and response to roadway incidents as well as a more efficient use of resources to proactively deploy traffic patrols and abatement efforts with the goal of preventing incidents.

Regional Transportation Commission of Southern Nevada: INRIX (Pages 51-52)

INRIX's state-of-the-art platform allows cities and road authorities to digitize their traffic rules and restrictions, such as speed limits, crosswalks, turn restrictions and bikes lanes, so they can communicate with highly automated vehicles (HAVs), allowing them to operate safely and effectively.

Regional Transportation Commission of Southern Nevada: Audi (Pages 53-54)

Audi debuted the first-of-its-kind "Time to Green" feature that provides the driver with a countdown to when a red light will turn green. The Regional Transportation Commission of Southern Nevada's (RTC) advanced traffic management system provides specially-equipped Audi vehicles real-time traffic signal information through countdown in the instrument panel. The "Time to Green" feature helps reduce stress and keep drivers more informed when approaching intersections. Thanks to data provided from the connected vehicle, traffic signal timing sequences can be adjusted to keep traffic flowing and reduce idling time and congestion that leads to increased emissions and air pollution.

Regional Transportation Commission of Southern Nevada: AAA and Keolis (Pages 55-56)

The Regional Transportation Commission of Southern Nevada (RTC), along with the city of Las Vegas, provides traffic signal data to a self-driving shuttle sponsored by AAA and Keolis that operates in mixed traffic along a half mile loop in downtown Las Vegas. The shuttle is the country's first autonomous bus to be fully integrated with "smart city" infrastructure. The shuttle is fully electric and does not produce emissions that lead to air pollution. Lessons learned from a fully autonomous deployment in a complex urban setting will inform other use cases and lead to environmental benefits.

Regional Transportation Commission of Southern Nevada: Nexar (Pages 57-58)

Nexar is an app that uses smartphone dash cams and wireless technology to provide drivers real-time alerts to prevent vehicle, cyclist and pedestrian collisions. The app records video outside of a vehicle and measures vehicle dynamics related to speed, braking and turns. Warnings from adjacent vehicles are communicated to drivers via the app, such as the need to brake for a hazard. The Nexar network is well established in New York City and San Francisco, where it reported a 24 percent reduction in collisions since its inception.

Tennessee Department of Transportation: I-24 SMART Corridor (Pages 59-61)

Tennessee Department of Transportation is implementing an Integrated Corridor Management (ICM) system that will seamlessly manage the corridor as a multimodal system through institutional collaboration and integration of infrastructure. This ICM system will implement ramp metering, multijurisdictional traffic signal coordination, electronic signs for traveler information, incentivized removal of disabled vehicles, transit service enhancements, incident management strategies.

Utah Department of Transportation: Multiple Intelligent Transportation Technology Projects (Pages 62-64)

The signal interconnected projects improved signal coordination through signal controller time clock syncing. Variable message sign project improved communication of road conditions and safety messaging to traveling public. The fiber optic communications projects improved communications with ITS devices (CCTV, VMS, Traffic Signals, RWIS, etc.) and improved communications/emergency services to remote areas.

Washington State Department of Transportation: US 395/ Hawthorne Road Channelization & Signal Modification (Page 65)

This project revised the lane configuration and upgraded the existing signal system at Hawthorne Road and US 395 in Spokane, Washington. US 395 (Division Street) is a major at-grade arterial route in/through Spokane and a major freight route. Channelization revisions created exclusive left turn lanes on Hawthorne going east and west, a combined through lane and right turn lane for eastbound traffic, and exclusive through lanes and right turn lanes for west bound traffic. These changes allowed the signal to run in a standard eight-phase operation under new signal controllers capable of expansion to automated vehicle technologies and increased operational efficiency of the intersection. The total reduction in vehicle delay is 22,637 minutes/day.

Washington State Department of Transportation: Centralized Signal System-Joint ATMA throughout Clark County (Pages 66-67)

Clark County, Washington, is part of the Portland, Oregon metropolitan service area. As the second densest county in Washington, smart solutions are necessary to extend the service life of existing infrastructure to sustain the region's rapid growth. Clark County negotiated with their vendor to transform their local centralized traffic signal system into a regionally shared Advanced Traffic Management System (ATMS). This upgrade by Clark County enabled the remaining local jurisdictions to share traffic data, and remotely operate traffic signals, within each other's systems. As part of the agreement, WSDOT-owned-and-operated signals from the seven-county region of Southwest Washington may utilize the regional signal system. These automated processes will maximize utilization of existing infrastructure, reduce delays and emissions, and increase mobility.

Wyoming Department of Transportation: Mobile App Enhancements (Pages 68-69)

WYDOT developed a mobile application for smartphones to share pre-trip and en route traveler information. This application had three major components:

- A map for pre-trip planning that provides information including road conditions, traffic incidents, weather sensor data, web camera images, road construction notifications, and truck parking locations.
- A hands free/eyes free feature that speaks road condition, traffic incident, and road construction information as drivers travel down the road, alerting them in advance to adverse conditions ahead.
- A "Where am I?" feature that correlates the user's GPS location to the nearest route and mile marker. This can be used in an emergency when a driver needs to be able to share his or her location. The location can easily be sent via text or email.

Wyoming Department of Transportation: Revised Commercial Vehicle Operator Portal (Pages 70-72)

The Commercial Vehicle Operator Portal (CVOP) is a web-based system focused on providing a one-stop shop for current road conditions and road weather forecast information on the most commonly traveled commercial routes in the state. This information is shared with the trucking community and was designed based on feedback provided directly from fleet managers.

Econolite: Lakeview Avenue Overcrossing Orange County Transportation Authority (Pages 73-74)

On June 6, 2017, the Lakeview Ave. overcrossing in Orange County, California, officially opened to drivers. The overcrossing now routes vehicular traffic over Burlington Northern Santa Fe (BNSF) railroad line uninterrupted. Nearly 70 individual trains use the BNSF tracks daily, regularly blocking the way of drivers travelling north or south along the busy corridor. As part of the project, several intersections along Lakeview Ave. were upgraded with new NEMA traffic control cabinets and 2070 controllers. This provides the traffic management technology that enables programming of signals to help optimize traffic flow through the corridor. In addition, emergency vehicles and first responders, including ambulances, fire, and police are now able to respond more quickly and cross the rail line without interruption, which is critical for life-saving calls.

Southwest Research Institute: ActiveITS (Pages 75-76)

ActiveITS is a proven and stable system, capable of obtaining 99.99%+ uptime, and can run in clustered virtualized and cloud-hosted configurations. Key features of the ActiveITS system include automated event management response plans for dynamic message sign (DMS) postings, email notification, traveler information alerts, highway advisory radio (HAR) messages; archiving and reporting to enable performance-based oversight of event management operations; interconnected operations for information sharing and control between traffic management centers; and management of field devices, events, and other functions by an operator in a single integrated browser/map-based/application-based interface in a Windows environment.

Texas A&M Transportation Institute and Virginia Tech Transportation Institute: Implications of Truck Platoons for Roadside and Vehicle Safety Hardware (Pages 77-78)

Researchers and students at the Texas A&M Transportation Institute (TTI) are examining how roadside safety devices, such as guard rail and median barriers, will react to an impact from a truck platoon. Researchers and students at the Virginia Tech Transportation Institute (VTTI) are examining how crashes such as these would affect the occupants of the vehicle. The research will inform policy on truck platoon operating rules and roadside safety device standards.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Arizona Department of Transportation
FASTLANE Grant: Interstate 10 Dust Detection and Warning System

Funded in part by a 2016 FASTLANE grant, the Arizona Department of Transportation is in the process of creating a first-of-its-kind dust detection and warning zone on a busy rural stretch of Interstate 10 between Phoenix and Tucson that has frequently seen hazardous blowing dust. The system, being installed now along 10 miles of I-10 along with a widening project in that area, is expected to be complete in fall 2019. The project is located on Interstate 10 between mileposts 209 and 219. This area, between Eloy and Picacho Peak, is about 40 miles northwest of Tucson and 50 miles southeast of Phoenix. I-10 between Phoenix and Tucson, Arizona's two largest metropolitan areas, is the busiest stretch of rural interstate in Arizona.

The dust storm early warning system uses both spot detection technology and remote sensing technology to measure both the visibility along the roadway and to detect the development of dust events at a distance from the highway to allow for advance warning time. The visibility alerting capability will be integrated with automated response using Variable Speed Limit (VSL), Dynamic Message Sign (DMS), and in-pavement detection (speed loops) to warn travelers of actual or potential dust events prior to encountering them within the corridor, and closed-circuit cameras will be installed that allow staff at ADOT's Traffic Operations Center in Phoenix to see the real-time conditions on the roadway. This entire system will be connected via fiber optic cable, which results in faster information dissemination for motorists and for ADOT when blowing dust develops suddenly in this 10-mile stretch.

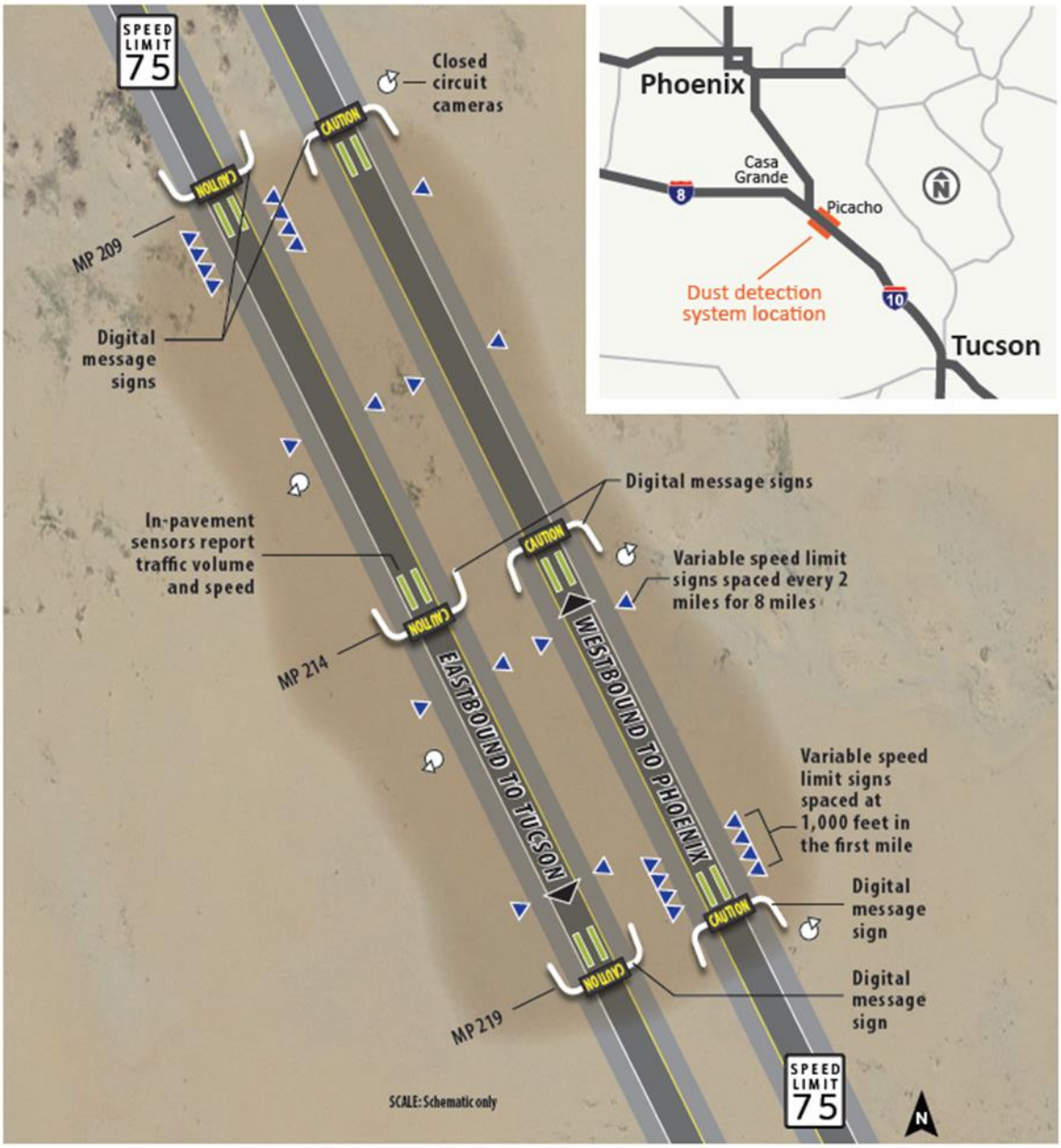
The challenge of sudden blowing dust, a problem across much of Arizona, is especially acute on busy Interstate 10 between Phoenix and Tucson, which has significant freight traffic. In addition to injuries and fatalities, crashes caused by blowing dust can lead to extended closures of I-10 that affect great numbers of drivers of private and commercial vehicles. In addition to providing earlier warnings about blowing dust in this especially troublesome area, this innovative system will advance ADOT's understanding of whether similar systems can be effective in other locations around Arizona.

The dust detection project was imbedded in the cost of the larger I-10, SR87 to Town of Picacho widening and realignment project. The portion of the project funding relative to the dust detection and warning system, per the terms of the FASTLANE Grant, is an 80/20 (Federal/State) ratio and the total for the dust portion of the project is $4,755,246 federal and $1,188,812 state matching funds.

ITS AMERICA

I-10 Dust Detection System

BETWEEN MILEPOST 209 AND MILEPOST 219



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ADOT

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As of 2017, nearly 50,000 vehicles a day used this stretch of Interstate 10. Many of these are commercial vehicles carrying goods from Arizona businesses to markets in California, Texas and Mexico, and vice-versa. In addition to the human toll, crashes that result from blowing dust hinder movement of commercial vehicles. They also hinder personal travelers who contribute to Arizona's robust tourism industry.

As Arizona Department of Transportation Director John Halikowski has noted, the efficient flow of commerce in Arizona drives our state's economic vitality. As part of this commitment, Arizona, California, New Mexico and Texas have established the I-10 Corridor Coalition to the support innovations that help create friction-free commercial travel. This project is aligned with that objective.

This project helps to reduce crashes which leads to fewer closures and reduces the emissions that otherwise would have resulted from long queues on this busy and highly freight traveled stretch of road. Additionally, fewer deadly crashes means less disturbance to environment especially with freight and hazardous materials transported through the corridor.

Collection of weather and visibility data and advanced detection of dust will play an important role in safety of connected and autonomous vehicles and supports the deployment of those technologies in this important stretch of the road. The segment of I 10 that would receive the ITS enhancements is identified as the center of dust storms along the entire length of I 10. The application of the technology as proposed could lead to a wealth of information to inform other regions in the United States on averting crashes that have significant societal costs in terms of loss of life, incapacitation and delay.

Support for this project is spread throughout the corridor. During the development of the FASTLANE Grant application, numerous entities offered formal support for the project, including Arizona Governor Douglas A. Ducey; Arizona's Congressional members (Ann Kirkpatrick, David Schweikert, Martha McSally, Matt Salmon, Paul Gosar, Krsyten Sinema, Ruben Gallego and Trent Franks); Pinal County; Pima County; Maricopa Association of Governments; Pima Association of Governments; SunCorridor Metropolitan Planning Organization; the City of Tucson's Mayor and City Manager; City of Phoenix's Mayor; City of Casa Grande; City of Coolidge; City of Eloy; and the Arizona Trucking Association.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
California Department of Transportation
Interstate 80 Safety, Mobility, and Automated Real-time Traffic (SMART) Corridor

The Interstate 80 Safety, Mobility, and Automated Real-time Traffic (SMART) Corridor is a partnership between Caltrans, the Alameda County Transportation Commission (ACTC) and the Contra Costa Transportation Authority (CCTA), along with other local partner agencies and municipalities, which have taken a "SMART" approach to the management of one of the busiest corridors in the Bay Area. The project is located on a 20-mile segment of Interstate 80 in Alameda and Contra Costa Counties, from the Carquinez Bridge to the San Francisco/Oakland Bay Bridge. The freeway serves commuters, recreational traveler and freight.

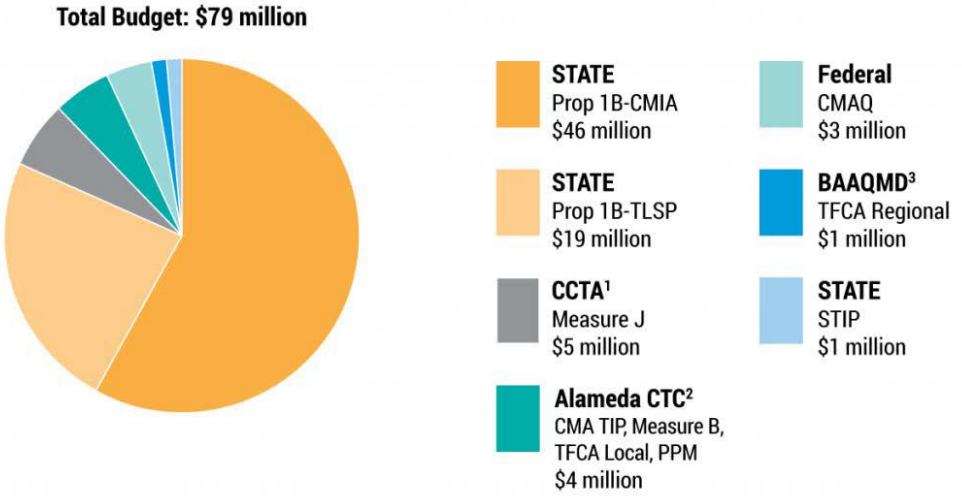
This highly congested corridor is physically constrained by adjacent urban development and the San Francisco Bay. Additional freeway widening is not possible. The SMART corridor project combines traditional traffic operations management strategies and technologies, with new approaches, such as active traffic management and the use of overhead lane control signs to alert travelers and harmonize traffic speeds to conditions. These measures are being combined with adaptive ramp metering, the use of arterials, and information display boards to give travelers the information needed to make wise travel route and mode choices. The integrated corridor management approach relies on interconnecting Transportation Management Centers (TMCs) operated by local jurisdictions with Caltrans' regional TMC, video monitoring, and playbooks for planned events and incidents.

The following technologies have been implemented as part of the project:
• Adaptive Ramp Metering
• Automated Incident Detection
• Incident Response Plans
• Variable Advisory Speed Signs
• Lane Use Signs
• Information Display Boards
• Trailblazer Signs
• Coordinated Traffic Signal Operations
• Arterial and Freeway Detection

• Transit Signal Priority

Safer, more efficient and reliable traffic flow along Interstate 80 is essential to the current and future vitality of the San Francisco Bay Area. As many as 270,000 vehicles use Interstate 80 every day and approximately 25 accidents occur on the route per week. On one portion of westbound Interstate 80, the accident rate is twice as high as the statewide average for similar highways. As a result, motorists experience as much as 25-35 minutes of delay during typical commute hours. Emergency vehicle access is impacted due to the congestion, resulting in slower incident response and recovery times. Some motorists may choose to exit onto San Pablo Avenue, a parallel local arterial, to avoid the traffic jam, but the traffic signals on San Pablo Avenue and other arterials are not currently equipped to handle the resulting increase in traffic. Gridlock occurs, impacting bus operations and traffic flow on these streets. Without knowledge of the accident location, diverted motorists stay on city streets, and traffic jams persist. Even if motorists don't detour, they don't know how long it will take them to reach their destination due to inconsistent and unreliable travel times.

The I-80 Smart Corridor project was $79 million. The funding breakdown is as follows:



Early indications show the Interstate 80 Smart Corridor likely helped reduce the rate of growth in congestion and improved travel times on the freeway during certain periods of the day. Although some have speculated travel times would be decreased because of the project, it's unrealistic to expect such impact when freeway demand has gone up significantly in the past decade. Further after-studies will have more definitive conclusions and analysis. Interstate 80 is a major freight route from the ports of Oakland and San Francisco as well as the San Francisco Airport, to the western United States. Reducing travel times and increasing reliability reduces transportation costs to business.

This project will reduce the rate of growth of congestion. It will reduce emissions and the need to widen freeway. The project also coordinates traffic signals between the State highway and local streets, which will reduce idling, thereby reducing GHG emissions. Message signs comparing transit travel times and freeway travel times can promote transit, hopefully reducing congestion and single vehicle ridership. Transit signal priority helps buses move through the corridor more quickly, adding to their appeal and shifting demand. The SMART corridor infrastructure has the capability to detect incidents and notify external systems.

This is the first effort to integrate freeway, arterial and transit operations and share data with cities and other partners. This project should be viewed as a building block to identify the many risk and challenges and future projects will take these lessons learned. There are many traffic flow and safety benefits to the project, including: enhanced safety and roadway operations throughout the corridor; travel-time savings and reliability by optimizing the use of existing lanes; congestion relief along the corridor during incidents; reduction of secondary accidents associated with congestion; improved emergency access and incident recovery time with less congested routes for emergency vehicles; and transit travel-time savings along San Pablo Avenue.

Beyond the $10 million cost share from the local Commissions and Air Quality Management District, local agencies are working together for unified operations and maximize efficiency of the system.

"By making I-80 smarter, we are making it work better for everyone — commuters, goods movement, transit, carpools, and local road users. The commitment of local voters who passed both the Alameda and Contra Costa County sales tax measures, as well as the state bonds in 2006, is what made this critical work possible. We are proud to work together to bring these solutions to our communities to make sure people can reliably get where they need to go — to work, to education or to families." – Rebecca Kaplan, Oakland City Council member

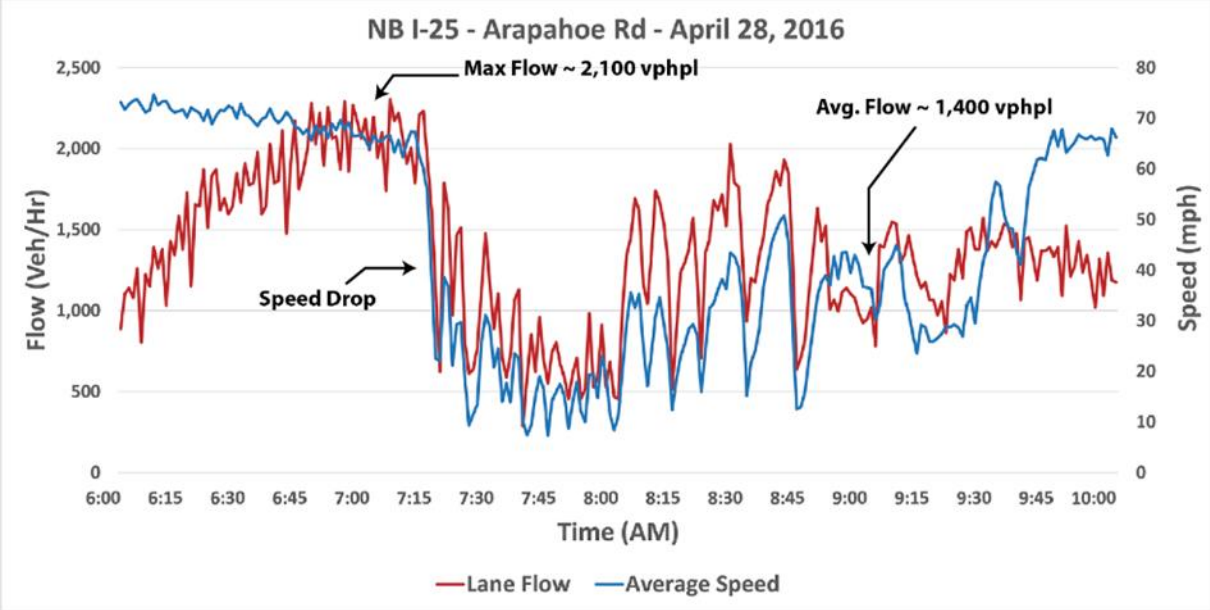
Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Colorado Department of Transportation
SMART 25 Managed Motorways Pilot Demonstration

The SMART 25 Managed Motorways Pilot is located on I– I-25 northbound between Ridge Gate Parkway and University Boulevard, connecting Denver's central business district and the Southeast Denver business corridor.

The managed motorways concept first developed and implemented by the Victoria State Department of Transportation (VicRoads) in Melbourne, Australia, is a complex coordinated ramp metering and freeway management system, which adjusts to real-time traffic conditions to prevent the breakdown of corridor traffic-flow. The complexity of the system requires a robust deployment of traffic detection on ramps and the freeway mainline to fully understand and control for real-time congestion conditions. On the M1 Motorway in Melbourne, the managed motorways system was shown to increase traffic flow by 25%, improved average traffic speed between 35-60%, and improved overall travel time reliability between 150% (AM peak) and 500% (PM peak).

The primary goal of the SMART 25 Project is to address recurring peak-period congestion and severe unreliability on this vital I-25 corridor, by providing a more efficient, productive, and reliable freeway corridor using advanced transportation management technologies, without expanding interstate capacity. This approach will help to regain the productivity lost due to congestion. As

shown in the graph below, once a bottleneck location breaks down, a max flow of 2,100 vphpl is reduced to 1,400 vphpl for the remainder of the period. SMART 25 will coordinate ramp signals to prevent this breakdown from happening in the first place.



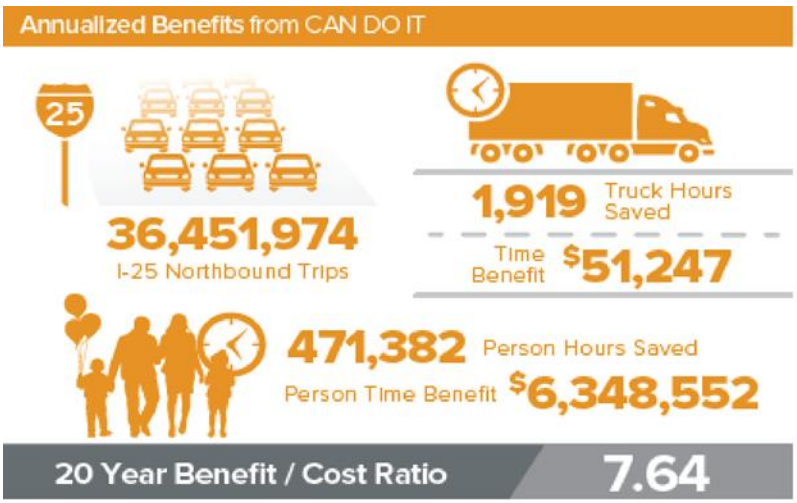
The total $11,310,923 project cost will be funded through state sources, and a $1 million FHWA AID grant.

The deployment of advanced traffic detection on ramps and the freeway mainline will provide a real-time understanding of freeway conditions to aid in normal operations, incident management, and identify the location of bottlenecks for potential spot improvements. The elimination of freeway breakdown will improve throughput, travel time reliability, and average speed for all vehicles, including freight movement. By improving traffic flow and reducing recurring congestion and the associated start-stop conditions, vehicle emissions are also reduced.

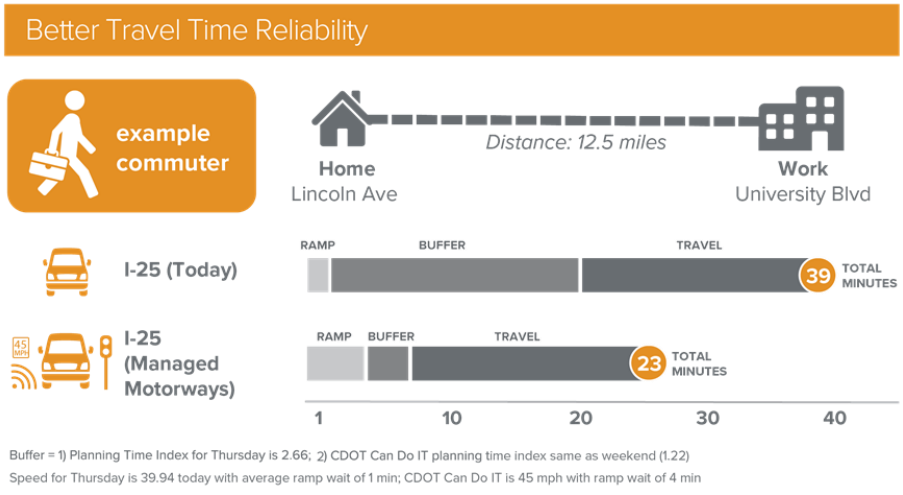
The advanced traffic detection devices deployed throughout the SMART 25 corridor will provide real-time traffic conditions at a level of accuracy currently unavailable anywhere in North America. Once in place, this high-quality real-time data will be available to inform connected and automated vehicle (CAV) applications. In addition to providing high-quality real-time data to CAV applications, the same data can also be utilized by numerous Smart City programs.

The economic benefits of the SMART 25 project were calculated as part of a recent FHWA ATCMTD grant initiative. Through its predictive flow control of the freeway mainline, the managed motorways concept has been proven to add upwards of 500 vphpl in peak periods on

the M1 in Melbourne. A similar benefit for SMART 25 would be equivalent of adding a new lane of travel without the expense, resulting in a 20-year Benefit / Cost Ratio of 7.64.



SMART 25 is a priority project for CDOT and a designated FHWA Project of Division Interest. CDOT is confident that the SMART 25 will demonstrate that a limited technological investment can generate the same benefits as hundreds of millions of dollars in freeway lane expansions. The pilot deployment will alleviate congestion, enhance access, improve safety, and reduce emissions, thereby delivering massive economic benefits to the Denver Metropolitan Area.



Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Colorado Department of Transportation
RoadX's Smart Pavement Project

RoadX Smart Pavement is a precast concrete panel embedded with digital technology and fiber optic connectivity that acts like a laptop tracking pad.

As proposed along US 285, a rural roadway with steep grades and reverse curves where a usually high number of incidents have occurred where vehicles depart the roadway and traverse down a steep embankment, the system has the capability to sense when vehicle leaves the roadway with automated notification to alert emergency responders to a possible incident. The emergency responders will be able address the incident immediately so that they do not go undetected for days.

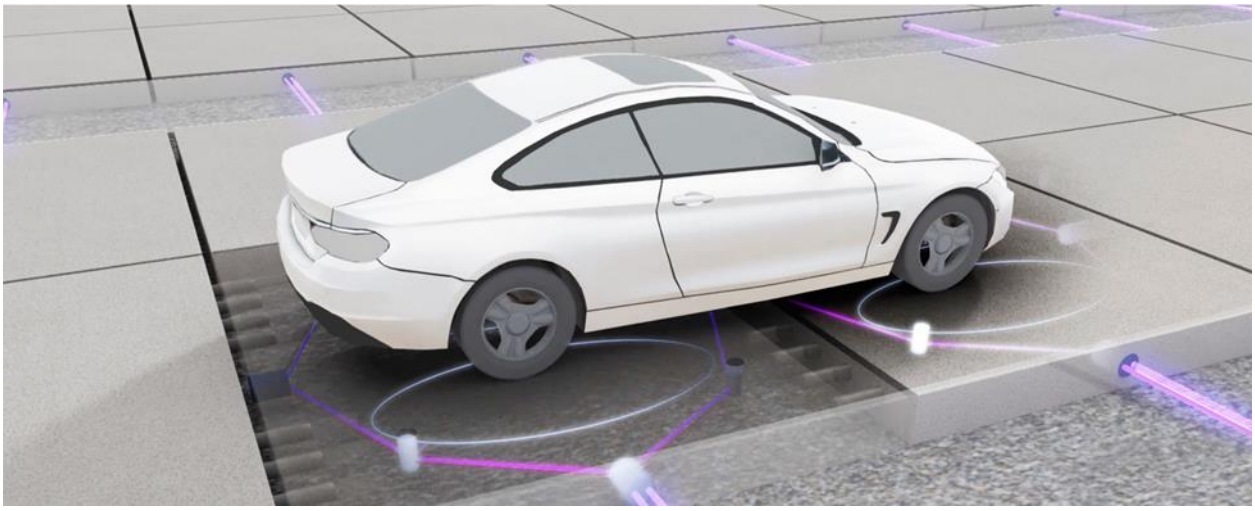
The total cost of the Smart Pavement project is estimated at $10M, with State and Federal funds providing a not to exceed amount of $2.75M and private investment making up the remainder. The $2.75M is 80/20 federal/state funds. Another example of a RoadX P3 extending dollars in the advanced mobility space.

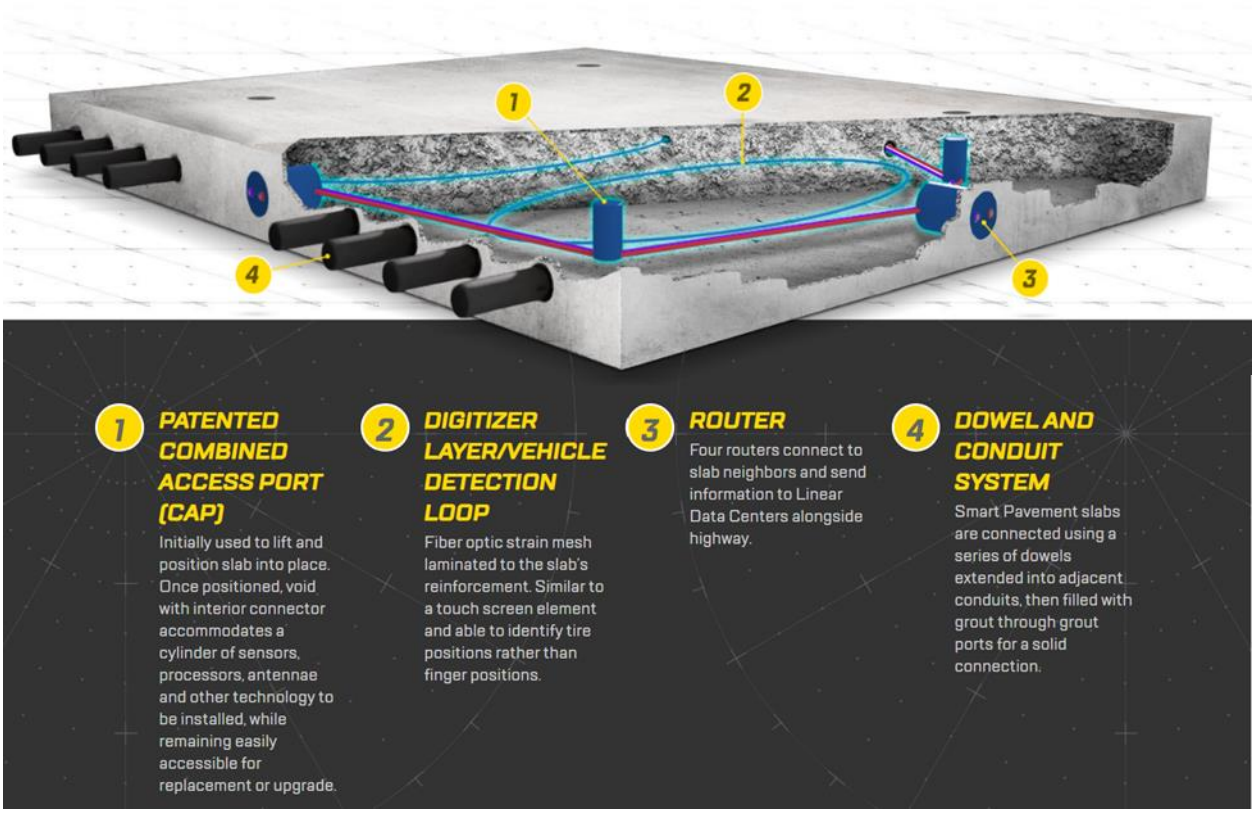
This project will be able to monitor the pavement condition and communicate real-time maintenance needs when detected. This project will also be able to monitor the weather conditions at the site and provide real-time information to CDOT. CDOT maintenance staff can quickly address adverse weather conditions as they occur and enhance the safety for passenger and freight vehicles. This project will be constructed within the existing roadway envelope and will not negatively impact the rural characteristic of the area.

An understanding, in real-time, about the location and status of connected vehicles is a very important data set that could benefit the connected vehicle ecosystem being constructed in Colorado.

This section of roadway is prone to adverse and extreme weather conditions. The economic benefits of can be recognized by ensuring safe and available passage of the roadway for freight traffic servicing the rural communities.

This project is a high priority for CDOT and FHWA as this pavement will enhance the safety and reliability of the roadway through vehicle to infrastructure technology.




1
2
3
4
1 PATENTED COMBINED ACCESS PORT (CAP)
Initially used to lift and position slab into place. Once positioned, void with interior connector accommodates a cylinder of sensors, processors, antennae and other technology to be installed, while remaining easily accessible for replacement or upgrade.
2 DIGITIZER LAYER/VEHICLE DETECTION LOOP
Fiber optic strain mesh laminated to the slab's reinforcement. Similar to a touch screen element and able to identify tire positions rather than finger positions.
3 ROUTER
Four routers connect to slab neighbors and send information to Linear Data Centers alongside highway.
4 DOWEL AND CONDUIT SYSTEM
Smart Pavement slabs are connected using a series of dowels extended into adjacent conduits, then filled with grout through grout ports for a solid connection.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Colorado Department of Transportation
RoadX's Smart Cone Pins Project

RoadX in partnership with iCone developed a low cost ($600/unit to buy) GPS pin that fits into a standard roadway cone. When that "smart cone pin" is activated, it sends its true location and status to a cloud environment that anyone one can ingest and display on a map.

Work zones are a large frustration for the traveling public and a very dangerous location for workers and commuters. The location and status of work zones is often unknow. This is a problem today but will be a bigger problem when highly automated vehicles are involved, given the variability of work zones. "Smart Cone Pins" can be added to a work zone for under $1,000 per lane closure to provide real-time location and status of work zones. This information can be used today by navigation apps but more so is preparing us for the future when vehicle will be needing to ingest information for the infrastructure to make better decision on how they travel – improving travel times and reducing delays.

The cone pins are $600/unit with first 100 units being deployed with 80/20 federal/state funds.

By the project contributes to overall state of good repair of the system by improving the understanding of the location and status of work zones, which can help expedite construction and improve the system. The project helps freight and goods movement by reducing delays at construction zones, thereby improving freight movement. By reducing back-ups and congestion air quality can be improved.

Connected and ultimately automated vehicles desperately need the information smart cone pins can provide. Today, as the human drives, connected vehicles could share work zone activates with their network of other connected vehicles helping to distribute traffic around work zones. In the future, as automated vehicles operate on behalf of a human, they will look to avoid work zones at all costs given the complex nature of work zones (ever changing lane markings, humans giving hand signals, sudden speed changes,

narrow lanes…). The real-time information smart cone pins will provide will allow automated vehicles to understand, via their connected aspect, where to avoid so they can operate as designed. An understanding, in real-time, about the location and status of work zones is a very important data set that could benefit smart communities extensively.

Smart work zone is a high priority for the ITS JOP office within the FHWA. The standardization of data, about work zone, is currently underway – these smart cone pins can become the basis for this standardization.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Florida Department of Transportation
Truck Parking Availability System (TPAS)

Truck parking shortages are a national safety concern. The results of insufficient or underutilized truck parking spaces can have negative social and economic impacts. Due to the lack of truck parking availability information and lack of safe and convenient truck parking spaces, tired commercial vehicle operators may continue to drive while searching for a place to park and rest, resulting in fatigue-associated crashes. Additionally, truck drivers may park at unsafe locations such as on the shoulders of roads or ramps or in vacant lots, causing safety related issues. Mobility is also impacted as the drivers utilize available time searching for parking instead of moving freight.

The current deployment of TPAS is 68 public sites located throughout Florida's state highway system along Interstate 10 (SR 8), Interstate 75 (SR 93), Interstate 95 (SR 9), and Interstate 4 (SR 400). The public sites include Welcome Centers, Rest Areas, and Weigh Stations where commercial vehicle parking is provided. TPAS uses a combination of in-pavement space occupancy detection for the location with mixed vehicle type usage (welcome centers and rest areas) and microwave vehicle detection for monitoring of ingress/egress at the weigh stations. The data are aggregated at the District Regional Transportation Management Center (RTMC) and disseminated to the commercial vehicle operators through dynamic roadside signs as well as through Florida's 511 system and third-party data feeds.

Based on early research by Florida International University (BDK80 977-14 (2012)), the proposed technology was selected as in-pavement sensors for the mixed-use facilities (rest areas and welcome centers) for spot detection while side-fired radar (microwave vehicle detection system (MVDS)) would be used for ingress/egress monitoring of the weigh stations. As limited in-situ data were available to document the performance of the in-pavement sensors, research projects (BDV31 977-56 (2016) and BDV31 977-85 (2018)) were conducted at the Columbia County, FDOT District 2 rest areas was used to validate the vendor data. Based on the research data, FDOT prepared a Developmental Specification governing the requirements of the detection sensors and associated hardware.

Total project deployment cost was $24 million state contribution was 48% and federal contribution was 52%. There were no local or private funds for this project.

The project will reduce truck parking in locations such as shoulders or other non-designated locations, resulting in reduced maintenance activities. Additionally, trucks can maintain routes along the interstate system, reducing impacts to the arterial network. Also, trucks parked on

freeway shoulders or on the ramps are detrimental to the mobility and safety of the motoring public and can potentially lead to incidents.

With the real-time truck parking availability information, truckers will be able to make informed decisions on truck parking during or prior to making trips that will save time and allow dispatchers to pre-plan the trips. Proper information dissemination on truck parking availability will save an average of 30 minutes of driving time for most of truck drivers, i.e. less truck trips and more capacity available to the other motorists. Additionally, trucks searching for parking adds to congestion levels on the Interstate system.

Florida residents will benefit from reduced emissions and a reduction in overall truck trips and crashes impacting fellow motorists' safety and mobility. The manufacturers and shippers in the region will benefit from the more efficient movement of cargo and drayage, which enhances the global competitiveness of the Florida economy. The port authorities will benefit from the efficient freight parking management in their last mile drayage movement.
The project leverages the Intelligent Transportation System (ITS) infrastructure and deploys additional technology to provide real-time data for efficient decision making. Future upgrades, including the third-party data feeds, can provide for additional integration with connected and automated vehicle technologies. TPAS promotes advance route planning for freight movement and supports just in time goods delivery by helping truckers know about available parking as close to their destinations as possible.

The economic benefit of the system is divided into three categories, in addition to the intangible benefits of safety and convenience for the truck drivers as well as enhancing freight operations and Interstate commerce. The economic benefits are described in the table below, based on the benefit cost ratio.

PARAMETERS	UNDISCOUNTED	NPV (3% DISCOUNT)	NPV (7% DISCOUNT)
BENEFITS			
Safety Benefits	$76,362,558	$51,148,887	$31,690,366
Driver Travel Time	$63,922,560	$42,247,838	$25,831,499
Environmental	$34,385,185	$22,563,639	$13,671,718
Total Benefit	**$174,670,303**	**$115,960,364**	**$71,193,582**
COST			
Deployment Cost	$23,983,850	$20,999,010	$17,698,659
Operations and Maintenance Cost	$21,585,465	$14,653,914	$9,202,638
Total Cost	**$45,569,315**	**$35,652,924**	**$26,901,297**
Benefit to Cost Ratio	**3.83**	**3.25**	**2.65**

The project is fully supported by the Federal and State (FDOT) funds and is included as key areas of emphasis in multiple plans, including the Moving Ahead for Progress in the 21st Century Act (MAP-21), the National Strategic Freight Plan and Florida's Freight Mobility and Trade Plan and Motor Carrier System Plan. The project is also supported by other state agencies, including the Florida Department of Highway Safety and Motor Vehicles. Finally, the project is supported by the Florida Trucking Association.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Georgia Department of Transportation
Statewide Traffic Signal Software Upgrades

The Georgia Department of Transportation (GDOT) has long enjoyed the benefits of a common traffic signal control platform. An identification of operational limitations led the department to update this environment to a modern platform built on open standards and the Advanced Traffic Controller (ATC) specifications through the systems engineering process. The outcomes identified for this effort were for improved operations, tracking of performance metrics, and maintenance practices through expanded operations and automated monitoring using high-resolution data. This project updated over 9,500 traffic signals across the state of Georgia to a modern platform.

Through open procurement, GDOT selected Intelight MaxTime and MaxView for its signal control software and central system, respectively. The platform and deployment included updating all of Georgia's 2070 traffic signal controllers with ATC Linux based processor boards. The technology was based on open standards that would enable GDOT to innovate well into the product's lifespan to best handle arterial management across jurisdictional boundaries. Other public agencies including Utah DOT, Minnesota DOT, Oregon DOT, and the city of Dallas, use this software.

By deploying an advanced and open traffic signal control platform, GDOT seamlessly manages arterial operations with local agency partners across jurisdictional boundaries. With an additional suite of operational tools, as well as real-time monitoring using high resolution data and automated traffic signal performance measures, GDOT leverages technology to extend engineering and maintenance resources across the entire state. Targeting issues proactively and responding to maintenance issues before they impact the traveling public improves the mobility of all users on the arterial network.

Total project cost is $18,000,000 over 5 years – 80/20 Federal/State, the Federal share through FAST Act appropriations.

The system informs users on where and when operational and maintenance intervention is needed for targeted response and better allocation of resources. Automated alerts of system health provide GDOT and local agencies the opportunity to identify operational and maintenance issues as quickly as possible and the ability to intervene as needed. The prioritized and proactive approach to arterial management provides the optimum approach to maintenance and operations. Data analytics provide additional intelligence for data driven decisions. The regional signal control architecture that this project provided was essential in managing traffic in the I-85 bridge collapse and reconstruction in 2017. The technology was paramount in providing unified control of detour routes and arterial management during reconstruction of a critical viaduct that carried 250,000 vehicles every day.

The system is deployed across the state at all 9,500 traffic signals. This broad deployment allows for innovative applications to accommodate freight through traffic responsive or adaptive approaches to arterial operations. The system has the flexibility to adjust operations and accommodate heavy freight movement as needed, while improving operations on arterials across the state. Improved mobility through enhanced arterial operations across jurisdictional boundaries reduces stops, travel times, and improves traffic flow. This in turn reduces vehicle emissions.

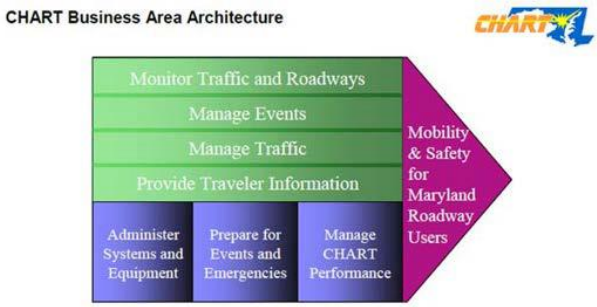
Because GDOT is deploying a common system on an advanced Linux based architecture, it can establish an ecosystem for the state that provides for broad deployment of connected vehicle technologies that support both autonomous and non-autonomous vehicles. GDOT has deployed 54 dedicated short-range communications (DSRC) devices already with this approach. Due to the scalable nature of the system, GDOT is in a position for a broad deployment of connected devices across the entire state. GDOT intends deploy more than 1700 DSRC radios over the next two years to deliver vehicle to infrastructure-based applications, all built on this common signal control network.

Additionally, GDOT is leveraging this technology to provide an open data platform that supports third party applications by providing all connected vehicle data to users. This will ensure that GDOT supports not only low-latency DSRC V2i applications, but also the wide range of Vehicle-to-Everything (V2X) applications that will come in the future.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Maryland Department of Transportation
Coordinated Highways Action Response Team (CHART) Systems Development

The Federal Highway Administration (FHWA) provides funding support for the development and maintenance of the CHART Systems project. The funding support is provided under the Fixing America's Surface Transportation (FAST) Act's Surface Transportation Block Grant (STBG) Program – Z240. The total approved funds for the five years beginning in fiscal year 2017 (FY 17) and ending in fiscal year 2021 (FY 21) is $29.2 million, out of which $13. 04 million was activated for the three years beginning in fiscal year 2017 (FY 17) and ending in fiscal year 2019 (FY 19). This funding is provided by the FHWA at 80% with 20% Maryland State matching funds.

The three main components of the CHART Systems Development are:
a) CHART Advanced Traffic Management System (ATMS),
b) Emergency Operations Reporting System (EORS); and
c) Lane Closure Permitting (LCP).
The goal of the CHART Systems Development is to fulfill the business process requirements defined in the Maryland Department of Transportation State Highway Administration's CHART Business Area Architecture (BAA).



The CHART Advanced Traffic Management System (ATMS) is a set of software programs running on a combination of Windows 2008 Servers, connected to a statewide network of Closed Circuit Television (CCTV) cameras, overhead and portable Dynamic Message Signs (DMSs), Highway Advisory Radios (HARs), Traffic Sensor Systems (TSSs) (microwave traffic flow detectors), remote weather stations, and On/Off devices (electronic relay devices such as for horns and fog beacons). It is used to identify and track traffic flow disruptions, send responders to correct the disruption and notify the public using the DMS and HAR devices, as well as sending notifications to the media and feeding data to a live traffic web site (http://www.traffic.maryland.gov) and Maryland 511.

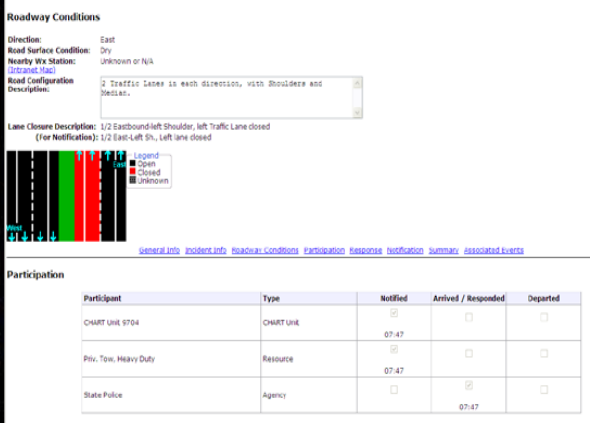
The Emergency Operations Reporting System (EORS) application includes:

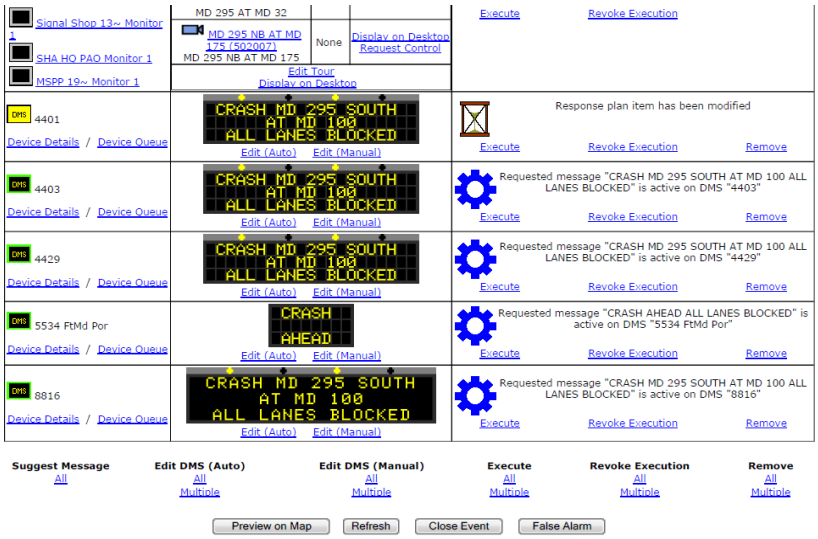
- Storm Event Reporting – Provides the ability to manage and report on the utilization of personnel, equipment, materials and conditions for an event.
- Snow Emergency Plans – Provides the method by which snow emergencies are managed for MD counties.

- Event Mapping – Provides the ability to specify conditions of predefined roadway segments.
- Route Restrictions – Provides the ability to manage vehicle restriction information.
- Post Storm Review & Archive – Provides the ability for a shop to add information about a previous storm event.
- Situational Awareness Reporting (SARS)/ Archive – Provides the ability to add event data at the district, EOC, CHART and PIO level. Also provides the ability to generate a summary report of the data entered.
- The Lane Closure Permitting (LCP) application includes:
    - Permit Mapping – Provides the ability to map the geolocation of a lane closure permit. This functionality is provided by the LCP through integration with external web services and a User Interface (UI) provided by the CHART Mapping application.
    - LCP Data Exporter services – Provides an interface for external applications to get LCP permit data. There are two basic interfaces: CHART Mapping and Public. The Public service resides in the demilitarized zone (DMZ) outside of the MDOT network. The Public interface contains a subset of the data available internally, although the data is much the same.

The current CHART System connects 909 CCTV cameras, 375 DMS, 68 HARs, 104 Weather Stations, 45 Warning Flashers, and 394 speed sensors to over 80 control centers statewide. This project will continue to better automate incident response, as well as build the CHART ATMS out to additional first responders and transportation agencies from across Maryland, Virginia, the District of Columbia, as well as Federal agencies in the National Capitol Region and beyond.

The following pictures are Statewide Operations Center (SOC) video wall, screen shots from the CHART reporting tool and other ATMS networking equipment (servers, decoders, etc.).




Signal Shop 13~ Monitor 1
SHA HQ PAO Monitor 1
MSPP 19~ Monitor 1
MD 295 AT MD 32
MD 295 NB AT MD 175 (502007)
MD 295 NB AT MD 175
None
Display on Desktop
Request Control
Edit Tour
Display on Desktop
Execute
Revoke Execution
DMS 4401
Device Details / Device Queue
CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED
Edit (Auto) Edit (Manual)
Response plan item has been modified
Execute Revoke Execution Remove
DMS 4403
Device Details / Device Queue
CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED
Edit (Auto) Edit (Manual)
Requested message "CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED" is active on DMS "4403"
Execute Revoke Execution Remove
DMS 4429
Device Details / Device Queue
CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED
Edit (Auto) Edit (Manual)
Requested message "CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED" is active on DMS "4429"
Execute Revoke Execution Remove
DMS 5534 FtMd Por
Device Details / Device Queue
CRASH AHEAD
Edit (Auto) Edit (Manual)
Requested message "CRASH AHEAD ALL LANES BLOCKED" is active on DMS "5534 FtMd Por"
Execute Revoke Execution Remove
DMS 8816
Device Details / Device Queue
CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED
Edit (Auto) Edit (Manual)
Requested message "CRASH MD 295 SOUTH AT MD 100 ALL LANES BLOCKED" is active on DMS "8816"
Execute Revoke Execution Remove
Suggest Message All
Edit DMS (Auto) All Multiple
Edit DMS (Manual) All Multiple
Execute All Multiple
Revoke Execution All Multiple
Remove All Multiple
Preview on Map
Refresh
Close Event
False Alarm

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Maryland Department of Transportation
Freeway Traffic and Safety Patrol/Response (FTSP) Vehicles Acquisition

Federal Highway Administration (FHWA) also supports the acquisition of FTSP vehicles for the Office of CHART's Emergency Traffic Patrol (ETP) program. This acquisition of FTSP vehicles is also funded under the FAST Act's Surface Transportation Block Grant (STBG) Program – Z240. The total approved funds for two Fiscal Years; 2017 through 2018, is $2.86M, funded by both FHWA and State funds at 80% and 20% match respectively.

The FTSP vehicles include both heavy duty and light duty vehicles. To perform incident management and emergency response functions efficiently, these FTSP vehicles are equipped with state-of-the-art technologies such as Automated Vehicle Location (AVL), permanently mounted Closed Circuit Television (CCTV) cameras, two-way radio communications and Capital Wireless Information Net (CapWIN) capabilities.

The AVL system allows CHART to record and analyze the performance of its vehicles in real time. This facilitates enhanced public services through better on-time performance and an improved response time to statewide emergencies. It also allows CHART to evaluate and pursue new ways of adjusting its services to meet the ever-changing needs of the Baltimore-Washington metropolitan area.

The CCTV cameras mounted on CHART FSP vehicles aid in the delivery of services by allowing remote operation of the camera from the operations center, thereby reliving responders of the need to set-up, manage and control the cameras before, during or after servicing an event or incident. Since a high definition camera is mounted on top of the vehicle, operators back at the operations center can control the pan, tilt, and zoom functions of the camera remotely, view a higher quality picture from a higher vantage point while allowing the responder to focus more on delivering services on site. The cameras provide CHART with valuable real-time information to be more efficient in incident management and incident clearance. It also allows CHART operators and managers to communicate information about the incident scene with their peers as well as field operators more effectively to speed recovery times and restore traffic to normal conditions.

The CapWIN is a program that was created by and continues to operate under the direction of a coalition of law enforcement, fire/Emergency Medical Services (EMS), and transportation agencies in Maryland, Virginia, and the District of Columbia to advance data communications across agency, jurisdiction, government, and discipline boundaries. The CapWIN program facilitates enhanced incident response communications by integrating transportation, public safety and voice communications systems data throughout the Baltimore-Washington region. CapWIN supports effective incident management coordination and information sharing capabilities among multiple responders which include: law enforcement, fire and rescue, EMS, transportation agencies, motorist assistance services, information service providers (ISPs), and the media.

The pictures show examples of FTSP vehicles and the permanent camera mounted on one of the vehicles.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Michigan Department of Transportation
US-23 Flex Route

The US-23 freeway between Brighton and Ann Arbor carries approximately 66,000 vehicles per day. Outside of the Detroit metropolitan area, it is the most congested corridor in Michigan. During light traffic and ideal conditions, the drive between Brighton and Ann Arbor only takes about 20 minutes, but during rush hour, it can take more than an hour. And without a good alternate route in the area, traffic can be at a near standstill whenever there is an incident.

The US-23 corridor north of Ann Arbor experiences heavy peak hour directional traffic southbound in the morning and northbound in the afternoon and has been the subject of study and improvements for 20 years. In 2009, the Michigan Department of Transportation (MDOT) completed the US-23 Corridor Feasibility Study that identified short-term and long-term corridor improvements. While MDOT was able to address the short-term recommendations and implement a corridor Intelligent Transportation System (ITS) and expand the regional Freeway Courtesy Patrol, a long-term solution to adequately address safety, recurring and non-recurring congestion and incident management was needed. Due to the State of Michigan's infrastructure funding challenges and an estimated construction cost of over $185 million to widen this section of the US-23 corridor, MDOT investigated other innovative ways to solve the corridor's operational and safety problems.

In 2017, MDOT opened its first Flex Route along US-23 in Washtenaw and Livingston counties. For years, the problems of peak hour directional traffic, incident management and corridor operations and safety eluded the department. All short-term solutions for congestion, operations and incident management were exhausted through the implementation of Intelligent Transportation System and expansion of a Freeway Courtesy Patrol. However, a long-term solution to adequately address safety, recurring and non-recurring congestion and incident management was still needed. Due to the State of Michigan's infrastructure funding challenges and an estimated construction cost of

over $185 million to widen the US-23 corridor, MDOT investigated other innovative ways to solve the corridor's operational and safety problems. The US-23 Flex Route was the solution. Completed in 2017, the US-23 Flex Route is nine miles in length from M-14 to M-36 north of Ann Arbor. The project included construction of road, bridge and interchange operational improvements and Active Traffic Management (ATM) strategies for the US-23 corridor to address daily recurring and non-recurring traffic, incident management and overall motorist safety. Using the Flex Route's lane control gantry system, MDOT can now dynamically manage recurrent and non-recurrent congestion through technology and operational ATM strategies including dynamic lane control and shoulder use, variable speed advisories and queue warning.

Real-time data is being used to actively manage traffic to open the shoulder, harmonize speeds, warn drivers of conditions ahead and respond to incidents. Dynamic Message Signs (DMS), Microwave Vehicle Detection Systems (MVDS), Closed Circuit Television (CCTV) cameras and fiber optic cable are all being used in a new and innovative way. A new software module was developed for the project and integrated into MDOT's existing Advanced Traffic Management System (ATMS) software package. The software includes: response plans for the MDOT Statewide Operations Center (STOC) Flex Route Operators to open the shoulder during peak periods; an algorithm to analyze real-time data and propose advisory speeds to harmonize traffic flow; and logic for dynamic response plans to react to incidents that may require lane closures and/or shoulder openings.

Along with the Flex Route system and road, bridge and interchange improvements, MDOT also incorporated other safety innovations and multi-modal opportunities into the project. MDOT added truck parking ITS in advance of the rest area, seven emergency pull-off sites and a park and ride facility that is enabled with ITS for future transit service.

Benefit Cost Analysis using TOPS-BC, FHWA's Tool for Operations Benefit Cost Analysis

TOPS-BC FHWA's Tool for Operations Benefit Cost Analysis	**Costs**	**Benefits***
Model Inputs	capital costs - $16,421,000 (2017 dollars) operations and maintenance costs - $971,000 (annually)	change in capacity- 28% change in speed- 10% reduction in crash rate- 20% reduction in crash duration- 30% reduction in fuel use- 9% time device is disseminating useful information – 80% drivers using information – 80% time saved by drivers- 2 mins all other TOPS inputs left at default
Average Annual Value	$2,300,517	$11,645,248
Annual Benefit to Cost	**5.06**	

*values were estimated from VISSIM modeling and MDOT ITS customer survey

Since deployment, the US-23 Flex Route has improved planning time by 57% and travel time by 32% during the morning peak hours, and corridor speeds have increased by approximately 20 mph. MDOT anticipates that over time, the incidents of primary and secondary crashes will be reduced. With a total project cost of $119,000,000 and an ITS budget of $16,421,000 this project showed an annual ITS Cost/Benefit Ratio of 5.06 as seen above. This project used a number of funding types, including, but not limited to; CMAQ, R&R, Bridge R&R all contributing towards an 80:20 federal match. Overall, the US-23 Flex Route has improved congestion and advanced transportation systems management and operations for the corridor. It has also had a significant impact on the reliability, safety
and mobility for the motorists who travel US-23.

Below is a list of objectives met with the US-23 Flex Route:

1. Improved system reliability and planning time during the peak hour by 57% southbound in the morning and 22% northbound in the evening.
2. Improved system travel time during the peak hour by 32% southbound in the morning and 9% northbound in the evening.
3. Improved corridor speeds from 40 mph to 59 mph southbound in the morning and from 51 mph to 56 mph northbound in the evening.
4. Improved corridor incident management.
5. Added seven crash investigation sites and emergency pull offs.
6. Improved interchange operations by improving ramp terminals and adding ramp extensions at five interchanges.
7. Reconstructed three interchanges and three bridges and added non-motorized accommodations for future connection. Bridge improvements included raising the under clearance to address high load hits.
8. Reduced primary and secondary crashes in the first month of operation by over 50%
9. Improved work zone operations by providing for an additional flex lane to manage traffic during maintenance and construction activities
10. Improved corridor aesthetics through CSS coordination with the local communities

In 2018, the US-23 Flex Route project was awarded the Best of Intelligent Transportation Systems (ITS) Award for Transportation Systems Operations from ITS America and the Engineering Eminent Conceptor Award from the American Council of Engineering Companies (ACEC) of Michigan. The ACEC Michigan award is the highest honor awarded to the infrastructure project with the most impact on the citizens of the State of Michigan.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Metropolitan Transportation Commission of the San Francisco Bay Area
Bay Bridge Forward

Funding: $49.4M ($16.5M Federal, $32.9M Regional/Local). The Metropolitan Transportation Commission (MTC) approved funding for the program in 2016. The Commission is comprised of locally elected officials (mayors, city councilmembers, county supervisors) as well as non-voting state and federal officials from—the U.S. Department of Transportation, U.S. Department of Housing and Urban Development, and California State Transportation Agency.

The San Francisco-Oakland Bay Bridge Corridor is the single most congested travel corridor in the 9-county Bay Area region. This bridge corridor endures nearly 27,000 vehicle-hours of daily delay and carries over 270,000 vehicles across the bay. Not only does this corridor top the Bay Area in congestion, but rail, ferry and bus transit services also experience crowding.

Bay Bridge Forward is a suite of projects that moves more people in fewer vehicles to make the most efficient use of the bridge's capacity. It includes implementation of near-term, cost-effective operational improvements that offer travel time savings, reliability and increased capacity for carpooling and bus/ferry transit. These improvements will not only increase person throughput and improve access to jobs in San Francisco but also reduce congestion, incidents, and emissions in the bridge corridor. The Bay Bridge Forward Project began implementation in 2016, and most projects are underway and expected to be completed over the next two years. Below are descriptions of Bay Bridge Forward projects with ITS elements.

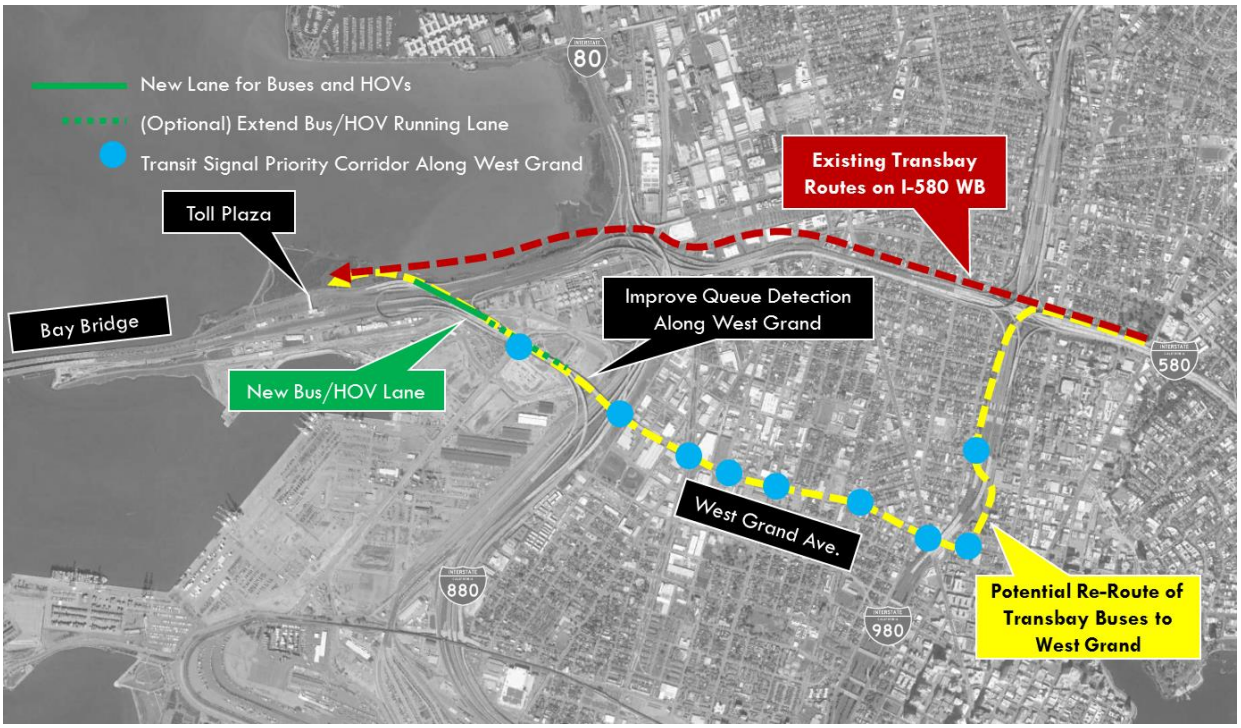
West Grand HOV/Bus Only Lane, West Grand Transit Signal Priority (TSP), Dynamic Transit Routing

West Grand High Occupancy Vehicle (HOV)/Bus Only Lane
During the morning commute periods, westbound approaches to the Bay Bridge experience significant delays, which include traffic from the I-80, I-580, I-880, and the West Grand Avenue on-ramp in Oakland. The West Grand Avenue on-ramp provides access to the northbound I-880 connector approaching the Bay Bridge, as well as access to eastbound I-580. Buses using the West Grand Avenue on-ramp can access the bridge via a bus-only ramp that is also open to other HOVs during carpool hours.

The project is intended to increase Transbay person throughput by providing access and operational improvements for transit buses and eligible carpools through the conversion of approximately 1,300 feet of the right shoulder on the West Grand Avenue on-ramp and

northbound I-880 connector to a bus lane. This project allows buses and carpools to access the HOV/Bus Only lane earlier and bypass queues during congested conditions.

West Grand Transit Signal Priority (TSP)
MTC, in conjunction with the city of Oakland and Alameda-Contra Costa Transit District (AC Transit), is also implementing TSP along West Grand Avenue in the city of Oakland. Buses traveling on West Grand Avenue and continuing to the West Grand on-ramp across the Bay Bridge will benefit from travel time savings and reliability with both TSP and the HOV/Bus Only Lane.



Caption: West Grand Ave. On-Ramp Bus/HOV Lane, Transit Signal Priority, and Dynamic Transit Routing

Dynamic Transit Routing
AC Transit currently has one bus route that uses the West Grand on-ramp. However, with the West Grand HOV/Bus Only Lane and West Grand TSP, AC Transit has identified several other routes that often get stuck in congested conditions on the I-580 bridge approach that would benefit from rerouting to West Grand. MTC is working with AC Transit to develop a decision support system for dispatchers to reroute buses to West Grand based on real-time traffic conditions.

Vehicle Occupancy Detection
In the Bay Area, 58% of HOV lanes are degraded, meaning that they fail the federal performance standard of maintaining an average speed of 45 mph at least 90 percent of the time during the peak hour over a consecutive 180-day period. Additionally, occupancy violations average 24% in the Bay Area and range as high as 39%, contributing to degradation.

To enforce such widespread violations, MTC is testing a pilot deployment of automated vehicle occupancy detection systems. The second phase of the pilot will include custom features such as an app to alert California Highway Patrol officers of frequent violators. This pilot is a step towards the wider deployment of vehicle occupancy detection technology to enforce managed lanes.

Integrated Bridge Corridor
The Bay Bridge is central to and an integral part of the Bay Area transportation system that connects between I-80, I-880, I-580 and US101. There are currently several Integrated Corridor Management (ICM) systems and Express Lanes being planned and implemented in the area on I-80 and I-880; the existing Bay Bridge metering lights are also being upgraded to an advanced system with an adaptive algorithm to account for bridge capacity and to increase throughput. The Integrated Bridge Corridor component of the Bay Bridge Forward will develop and implement a system to manage the collective system of traffic management strategies on these major freeway corridors feeding the Bay Bridge to optimize system performance based on real-time traffic information.

Commuter Parking Initiative
The Commuter Parking Initiative will construct three new commuter parking lots using underutilized airspaces under freeways. These parking lots will be actively managed and employ technologies such as real-time availability to allow commuters to know whether spaces are available, mobile payment, and license plate readers for efficient enforcement.

Flexible Transit
Hospitals are among the largest employers in San Francisco; most are located outside of downtown and not directly served by regional transit providers. After reaching out to some large employers, MTC decided to work with University of California, San Francisco (UCSF) and Kaiser Foundation Hospital (KFH). Both hospitals have a growing share of their employees living outside of the city due to housing affordability, which has challenged their ability to recruit and retain staff.

UCSF is piloting new flexible on-demand transit routes between the East Bay (Oakland, Berkeley, and Emeryville) and UCSF in San Francisco. The goal is to develop a transit service that can divert drive-alone East Bay drivers to transit. This service employs technology that allows users to reserve their pickup time and location; drivers can also skip stops if they know that riders are not alighting at particular stops.

KFH is implementing a commute management platform to help reduce employee drive-alone rates, offer ridesharing options, and manage parking. KFH is implementing a platform that integrates with parking systems, mobility providers, and HR systems; captures a baseline and measures employee commute activity across all modes, especially parking; applies more efficient management of employee transportation programs; helps employees find and share rides to and from work; and measures the effectiveness of different commuter incentives and commute mode options.

Caption: Near-Term, Low-Cost, and High-Impact Efficiency Strategies

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Pennsylvania Department of Transportation
Interstate 76 Integrated Corridor Management

This is a PennDOT District 6-0 project, included on the Delaware Valley Regional Planning Commission (DVRPC) TIP. The project was identified and developed through a comprehensive analysis of Transportation Systems Management and Operations (TSMO) measures along the I-76 corridor, culminating in a Concept of Operations (ConOps) for Intelligent Transportation Systems Enhancements published in September 2016. Out of the initial ConOps effort, four separate consultant services projects have been advanced: one for the design of Active Traffic Management enhancements on the I-76 mainline; two for design of parallel arterial corridor traffic signal enhancements in Montgomery and Philadelphia counties; and one for the management and coordination of TSMO initiatives within the entire corridor.

The project is located along the I-76 corridor in Montgomery and Philadelphia Counties. The overall project location includes 13 miles of mainline I-76 between the Pennsylvania Turnpike (I-276/I-76) in King of Prussia and US Route 1 in Philadelphia. Also included are the parallel and intersecting arterial roadways, rail and bus transit facilities, and pedestrian and biking paths within roughly the same limits.

The mainline component of the program consists of junction control and flex lanes using a collection of ITS technologies such as dynamic lane assignment, variable speed limits and queue warning, also known as Active Traffic Management (ATM). These technologies were selected because I-76 in the project limits experiences recurring and non-recurring traffic congestion and has a history of congestion-related crashes.

Traffic signal equipment on arterial roadways will be upgraded and standardized, and control and maintenance responsibilities for these corridor signal systems will transfer from the municipalities to PennDOT in line with state legislation and resultant legal agreements. This will allow for a more seamless coordination and operation of signals during congested periods and incidents on the expressway and make these corridors a more reliable transportation alterative. Arterial ITS deployments will also be expanded to help facilitate the active monitoring of these corridors and the provision of traveler information to motorists.

Both the mainline and arterial roadways will be outfitted with communications equipment that will allow for the bi-directional flow of information between roadway infrastructure, automobiles, transit vehicles, pedestrians, and bikers. These deployments will support the Commonwealth's commitment to furthering vehicle-to-infrastructure connected vehicle initiatives.

ATM, flex lanes and junction control are proven technologies for dynamically managing all the pavement (including shoulders), allowing traffic to utilize lanes/shoulders at different times of the day for the movement(s) that require them the most. ATM technologies can also reduce rear-end crashes that result from motorists' inability to reduce speed quickly enough when congestion is initially observed, crashes related to adverse weather conditions, and secondary crashes.

Operating and maintaining traffic signals on corridors across jurisdictional boundaries will allow for them to operate more efficiently and reduce operations and maintenance costs through economies of scale. Standardization of signal and communications equipment will make the system more reliable and support preventative and response maintenance activities.

Enhancements to bicycle, pedestrian and transit facilities and the integration of PennDOT highway and SEPTA transit data and operations will allow for these modes to be more attractive as a transportation option within the corridor and provide travelers with more reliable information with which to make mode and route decisions.

Funding for all parts and phases of the I-76 ICM Program, as noted in the soon-to-be-adopted Delaware Valley Regional Planning Commission's FY 2019-22 Transportation Improvement Program (DVRPC TIP), are federal transportation dollars in the National Highway Performance Program (NHPP) category. PennDOT has chosen to allocate these funds to the program from statewide funding sources, rather than within the fiscally-constrained regional programming budgets.

As shown in the Regional Interstate Management Program summary, the I-76 ICM Program is funded in the following categories and amounts per fiscal year (previous TIP funding supports the ongoing Preliminary design phase):

	FY 2019	***FY 2020***	***FY 2021***	***FY 2022***	***FY 2023-26***
Final Design		$1.0 M	$3.5 M	$3.485 M	$0
Utility			$4.24 M	$1.75 M	$0
Right-of-Way			$6.24 M	$4.0 M	$0
Construction				$12.0 M	$107.025M
Total	**$0**	**$1.0 M**	**$13.98 M**	**$21.235 M**	**$107.025 M**

When combined with the previously programmed Preliminary Design and Regional Traveler Information construction funding, the I-76 Integrated Corridor Management Program has been allocated nearly $170 million, divided among its major program components.

Along mainline I-76, the ICM project will partially reconstruct the shoulder to provide sufficient width for a third travel lane. This is consistent with TSMO goals, in that shoulder expansion to provide a temporary third running lane is a fraction of the cost required to reconstruct and widen the entire highway and will buy time before a full reconstruction needs to be completed. However, this work will support future reconstruction when it is economically feasible by providing the width necessary to maintain traffic as the highway is expanded.

The mainline design team is looking at facilities within the I-76 corridor (bridges, culverts, storm water management facilities) that are deficient or in need of repair as site investigation progresses. Upgrades or repair of these facilities to address deficiencies and extend service life will be included in the overall project. Along arterial corridors, as previously noted, this project will be upgrading and standardizing traffic signal equipment for 160 traffic signals, reducing the burden of future maintenance.

This project will provide congestion relief during peak travel times and help facilitate goods movement to/from the city of Philadelphia and the Philadelphia Port Facilities. The reduction of stop and go traffic conditions during daytime hours will reduce tailpipe emissions. Additionally, a comprehensive analysis of stormwater management and permitting will address groundwater and infiltration requirements. As previously indicated, both the mainline and arterial corridors will be outfitted with connected/automated vehicle communications equipment. The systems integration portion of the project will include the transport, processing, and dissemination of CAV data at the District's Regional Transportation Management Center (RTMC). The project supports smart communities' objectives by providing a robust, redundant communications backbone that can be enhanced and extended through the region with existing data access points.

Per Regional Integrated Transportation Information System (RITIS) data, congestion along the referenced 13-mile section of I-76 costs Pennsylvania drivers over 3 million hours of delay annually, which equates to a user delay cost of $73 million. In addition, the impact of higher-than-average accident rates along the corridor leads to additional economic costs. The implementation of ICM and ATM improvements along I-76 is focused on providing economic benefits for in both areas. It is not anticipated that the implementation of Flex Lanes along I-76 will provide much in the way of trip generation but it will instead better service existing regional trips.
This project is supported by three primary regional stakeholder groups. These groups have been meeting regularly during both the Concept of Operations development as well as through conceptual/preliminary engineering for the corridor project. Feedback has been constructive and substantive from all member agencies. Stakeholder groups are broken up as follows:

- Executive Stakeholder Group
    - PennDOT (District and Central Office)
    - SEPTA

  - PA State Police
  - FHWA
  - Delaware Valley Regional Planning Commission
  - City of Philadelphia
  - Montgomery County

- Emergency Responder Stakeholder Group
  - Local EMS, Fire, Police agencies.
  - Most Coordination has been facilitated through the DVRPC's I-76/I-476 Incident Management Task Force Group.

- Advisory Committee
  - All members of the Executive and Emergency Responder Groups plus:
    - Local Municipality Representatives
    - Additional County Government Agencies
    - Local Transportation Advocacy Groups

General public information sharing is accomplished via a project website and social media. The program is frequently discussed as one of the region's highest profile projects.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Regional Transportation Commission of Southern Nevada
Waycare

Waycare is a partnership between Regional Transportation Commission of Southern Nevada (RTC), Nevada Department of Transportation (NDOT), Nevada Highway Patrol, and Waycare. Located in southern Nevada, Waycare helps improve safety and efficiency on freeways, including key freight corridors and major arterials by compiling and analyzing data to report in real-time the location of accidents and predict where dangerous driving conditions or congestion may occur.

This technology enables faster validation and response to roadway incidents as well as a more efficient use of resources to proactively deploy traffic patrols and abatement efforts with the goal of preventing incidents. So far, early incident identification through Waycare has shown to be 11.9 minutes faster on average than prior modes of incident identification. Waycare is quantifying travel reliability and that information is used to make measurable impacts on safety and efficiency.

The project cost is $779,000 and is funded with local dollars.

By enabling faster incident response times and proactively addressing problematic traffic areas, Waycare helps ensure a safer and more efficient movement of freight and goods on highways and arterials. The project reduces congestion, which, in turn, reduces emissions of greenhouse gases. The project demonstrates how multiple entities collaborate to successfully deploy vehicle-to-vehicle and vehicle-to-infrastructure technology. It proves that data from a multitude of providers can be successfully integrated to solve problems.

Waycare supports smart communities objectives in several ways, including the sharing of data and promoting the collaboration between multiple agencies to make roadways safer and travel more efficient. Traffic congestion can be reduced (thus allowing for more efficient travel for all) when roadway incidents are cleared more quickly, which Waycare has achieved in Southern Nevada.

RTC is working with state officials from the DOT and the Department of Public Safety as well as local traffic agencies and emergency responders. Key local, state, and Federal elected officials have been updated on the project.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Regional Transportation Commission of Southern Nevada
INRIX

The Regional Transportation Commission of Southern Nevada (RTC) is partnering with INRIX on a new platform called AV Road Rules (AVRR), which provides the foundation for jurisdictions and road authorities to digitize and communicate traffic rules to connected and autonomous vehicles, allowing them to operate safely and effectively within roadway limitations such as speed limits, turn restrictions, bikes lanes and more.

INRIX's state-of-the-art platform allows cities and road authorities to digitize their traffic rules and restrictions, such as speed limits, crosswalks, turn restrictions and bikes lanes, so they can communicate with highly automated vehicles (HAVs), allowing them to operate safely and effectively.

The project includes no local or federal dollars. Minimal staff time is required for coordination and digitizing.

AVRR also enables HAVs to report infrastructure needs, such as potholes, inadequate lane striping and inadequate signage, to the appropriate road authorities. This is a valuable tool for cities to more quickly identify infrastructure needs and leverage HAV operation to improve the safety and comfort of streets for all users.

AVRR will be distributed to freight and goods movement providers, thereby improving their efficiencies. AVRR deployment to HAVs will improve traffic flow and reduce greenhouse gas emissions.

As connected and autonomous vehicles continue to develop, a central challenge to consumer acceptance is the question of how the vehicles will operate safely and understand local rules of the roads. The first-of-its-kind AV Road Rules (AVRR) platform will help ensure the safe and effective operation of highly automated vehicles (HAVs) on public roads. In addition to helping build public acceptance of autonomous vehicles, the platform will also help cities and authorities prepare now to test and deploy connected and automated vehicles.

Smart infrastructure and data sharing processes must be in place to enable vehicle-to-infrastructure and vehicle-to-vehicle communication, and the AVRR platform supports this objective. This partnership allows third-party providers, such as Inrix, and regional transportation agencies, such as RTC, to identify best practices and opportunities. These results can be shared

with agencies throughout the country, resulting in decreased transportation costs and improved mobility.

RTC, one of a few state and local agencies participating in the program, is collaborating with state and local agencies.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Regional Transportation Commission of Southern Nevada
Audi

Audi debuted the first-of-its-kind "Time to Green" feature that provides the driver with a countdown to when a red light will turn green. The Regional Transportation Commission of Southern Nevada's (RTC) advanced traffic management system provides specially-equipped Audi vehicles real-time traffic signal information through countdown in the instrument panel. Traffic Tech Services runs the predictive analysis to determine whether a traffic light's countdown is accurate. If the countdown meets certain confidence levels, it is released to Audi for display in the car. The RTC's traffic management center, which operates across all jurisdictions in southern Nevada, provides the means (hardware and software) for data to be pushed to Traffic Tech in real time.

The "Time to Green" feature helps reduce stress and keep drivers more informed when approaching intersections. In addition, the RTC's traffic management center receives real-time anonymous traffic signal timing data from the connected vehicle to help better manage congestion on crowded roadways.

There is no cost to RTC. Hardware and software were already in place to support this effort. Minimal staffing hours are needed to implement and maintain the program. The project enables RTC to receive real-time feedback related to the performance of software and the communication network. RTC is working with Audi and its engineers to design analytics using the real-time feeds.

The RTC's traffic management center receives real-time anonymous traffic signal timing data from the connected vehicle to help better manage traffic on crowded roadways, helping to keep freight and goods moving more smoothly. Thanks to data provided from the connected vehicle, traffic signal timing sequences can be adjusted to keep traffic flowing and reduce idling time and congestion that leads to increased emissions and air pollution. Eventually, the V2I information can be integrated into a vehicle's start/stop behavior, navigation system to optimize routing, and predictive services (such as presenting the driver with a speed recommendation designed to maximize the number of green lights one can make in sequence). These services are designed to improve efficiency, drive time or traffic management.

This precedent--setting partnership will help establish the foundation for how local governments and auto manufacturers can develop meaningful policies, build infrastructure and connect systems to accommodate V2I technology to achieve smart community objectives, including improving mobility, increasing safety and reducing congestion. The economy can benefit from

signal timing that reduces delays and improves reliability. Data from projects like Audi can support these analytics.

RTC works with state and local agencies to ensure that traffic signal hardware and software as well as communication networks can provide real-time signal data that Audi and its engineering team can use.

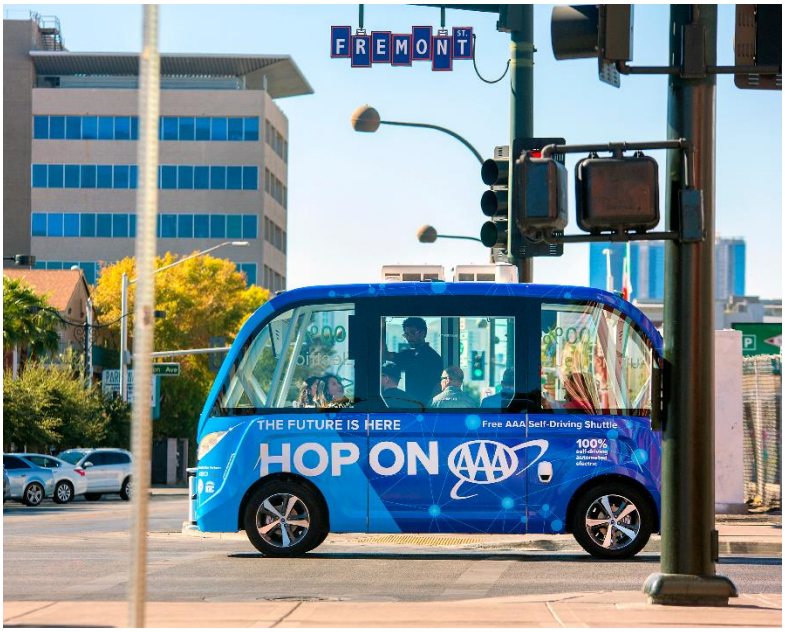
Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Regional Transportation Commission of Southern Nevada
AAA and Keolis

The Regional Transportation Commission of Southern Nevada (RTC), along with the city of Las Vegas, provides traffic signal data to a self-driving shuttle sponsored by AAA and Keolis that operates in mixed traffic along a half mile loop in downtown Las Vegas. The shuttle is the country's first autonomous bus to be fully integrated with "smart city" infrastructure. The project furthers the development and deployment of autonomous shuttle technology that can serve as a viable transportation option to improve safety and traffic flow. This project includes local and private sector funds.

RTC and its partners monitor the health of the infrastructure system using the data generated from the infrastructure and the shuttle. They are also developing best practices regarding cyber security, which will contribute to state-of-good-repair of technology deployments.

Lessons learned from autonomous vehicle performance are directly transferable from the shuttle use to freight and goods movement use. The shuttle is fully electric and does not produce emissions that lead to air pollution. Lessons learned from a fully autonomous deployment in a complex urban setting will inform other use cases and lead to environmental benefits.

This pilot will help the partners understand the customer experience on board an autonomous shuttle and learn more about how autonomous vehicles operate in mixed traffic. The project will help the entities begin to develop standards for sharing data with connected and autonomous vehicles as federal standards don't currently exist.



Currently, the shuttle is offering free rides and is attracting more than 150 passengers a day. However, in the future, an autonomous shuttle like this could

be a viable transit option and part of a fare-based transit system.

Project is a collaboration of local and regional agencies, a private-sector transit provider and shuttle manufacturer, and AAA. State and federal partners are aware of the project successes. The project concept was used in recent Federal grant applications to address first-mile last-mile challenges.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Regional Transportation Commission of Southern Nevada
Nexar

Nexar is an app that uses smartphone dash cams and wireless technology to provide drivers real-time alerts to prevent vehicle, cyclist and pedestrian collisions. The app records video outside of a vehicle and measures vehicle dynamics related to speed, braking and turns. Warnings from adjacent vehicles are communicated to drivers via the app, such as the need to brake for a hazard. The Nexar network is well established in New York City and San Francisco, where it reported a 24 percent reduction in collisions since its inception.

The National Highway Traffic Safety Administration (NHTSA) believes implementing V2V networks can help reduce crashes, not including those involving drivers under the influence, by 79 percent. Thus, the Nexar network can help increase vehicular and pedestrian safety on Nevada roadways. Nexar's data also enables the RTC / local and state governments to leverage car-sourced information to improve infrastructure and traffic management, roadway maintenance, regional transportation planning and policy-making, and ridesharing/transit applications. There are currently no direct costs incurred by state or local agencies. Minimal staff time is being used to assist with deployment and analytics.

Nexar's street level car-sourced information, including congestion, traffic patterns, infrastructure defects, road hazards, and collision instances, is shared with the RTC/ local and state governments in real-time. The real-time traffic data Nexar provides can help the RTC better manage busy roadways, thus improving the movement of freight and goods. The data Nexar provides can help reduce CO2 emissions by identifying impediments to traffic flow.

V2V is a critical safety feature that extends the line-of-sight and allows for communication between human drivers and autonomous vehicles. As the network develops, Nexar will train Nevada traffic operations officials and help enable, monitor, manage and ultimately certify autonomous vehicles.

Nexar's platform allows state and local transportation officials access to previously unavailable real-time anonymous data related to roadway use, traffic patterns and transportation infrastructure. The data can help local governments achieve smart community objectives, including improving safety, efficiency and system performance; reducing CO2 emissions by identifying impediments to traffic flow; and enacting a more holistic road management policy by leveraging the data Nexar generates to understand road velocities, traffic blockers, and human braking effectiveness. To support the statewide V2V network, Nexar expects to add more than a dozen new full-time jobs in Nevada as the network grows. In addition, establishing the V2V

network has the potential to support growth of the transportation ecosystem and foster hundreds of additional jobs in technology, insurance, data management, software development and autonomous vehicle training.

RTC, the State and various local transportation providers are the key project supporters in Nevada.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Tennessee Department of Transportation
I-24 SMART Corridor

The I-24 SMART Corridor runs from Nashville to Murfreesboro, Murfreesboro Pike (parallel arterial running the entire length of I-24), connecting arterials between I-24 and Murfreesboro Pike.

Transportation technology has long been proven as an effective tool for managing traffic congestion. Along I-24, traffic volumes have increased by more than 60%. Accident rates along this segment are the highest in the state. To respond to this increased traffic demand, the Tennessee Department of Transportation is implementing an Integrated Corridor Management (ICM) system that will seamlessly manage the corridor as a multimodal system through institutional collaboration and integration of infrastructure.

This ICM system will implement ramp metering, multijurisdictional traffic signal coordination, electronic signs for traveler information, incentivized removal of disabled vehicles, transit service enhancements, incident management strategies, and many other complementary elements to achieve the following objectives:

- Enhance safety along the corridor
- Inform travelers of freeway and arterial conditions
- Establish interagency coordination
- Promote the use of alternate travel modes
- Create reliable travel times along the corridor
- Prepare the corridor for future technology

This project is expected to directly contribute to these measures by creating the following corridor performance enhancements:

- Reliable and regular traffic flow along the freeway will reduce secondary, rear-end accidents that cause significant additional delay.
- Rapid removal of disabled vehicles from the freeway shoulder will improve safety by reducing or eliminating the possibility of vehicles side-swiping or rear-ending disabled vehicles, causing substantial congestion.
- Incident management strategies deployed along the arterials will improve the ability to increase throughput of freeway traffic that uses arterials to bypass a freeway incident. These strategies enable the arterial to return to normal traffic flow more quickly.
- New fiber communications will fill gaps in existing infrastructure to enable agencies to remotely monitor traffic conditions and optimize traffic operations in a proactive manner.

- Transit operations will be enhanced through improvements in infrastructure and deployment of field technology by facilitating transit reliability, which is expected to increase ridership.

The estimated cost for the I-24 ICM project is $68M. This includes project development, design, construction, and system integration. The project will be delivered through 11 different deployments in multiple project phases, including design/construction, equipment procurement, and service procurement. Project funding consists of the following:
80% federal – National Highway Performance Program – Surface Transportation Block Grant
20% state.

Development of this project includes an Operations and Maintenance strategy that outlines roles and responsibilities for routine, preventative, and replacement maintenance activities. By supplementing these responsibilities and activities with estimated annual costs to operate and maintain the equipment, TDOT will be able to sustain a Smart Corridor program that has reliable functional performance.

I-24 is a major freight corridor into and through the Nashville metropolitan area, with critical distribution centers located throughout the corridor. Advanced traveler information to freight traffic will be used to alert freight operators of current conditions before vehicles enter the corridor. This will inform drivers to avoid the corridor, delay entry to the corridor, or use alternate routes to bypass the corridor in the event of significant incidents causing congestion. Greenhouse gas (GHG) emissions are increased when vehicles spend more time in the corridor and on the road. The I-24 ICM will reduce travel time and reduce vehicle delay for all vehicles. This will reduce GHG on the freeway as well as arterials.

I-24 will be equipped with electronic changeable message signs between each interchange along the freeway in both directions. Each sign will be equipped with a Dedicated Short-Range Communication (DSRC) radio transmitter/receiver that will send traveler information messages to subscribed vehicles approaching each sign location. These devices also will collect valuable vehicle information to be stored in a central database for traffic flow analytics. DSRC also will be installed at signalized intersections along the parallel arterial and connector routes to assist with future CV/AV applications and help fulfill FHWA's Signal Timing and Phasing (SPaT) challenge issued to the state DOTs.

Regarding smart infrastructure, the communications network will be integrated such that field devices (e.g., video cameras, traffic signals, electronic signs) will remotely communicate with central management centers in each jurisdiction. The central management centers will be connected to each other to share of video and data from agency to agency and promote collaboration of traffic management strategies across agency boundaries.

Introducing connected vehicle technology to the region will promote smart communities by providing drivers and potential drivers with advanced corridor traffic information, enabling drivers to make informed decisions about specific routes and time of departure. This also positions the corridor to accommodate other smart community technology related to one-stop services for shopping, travel modes, and other services. This project will promote increased productivity through regular travel enhancements as well as freight and goods movement. Improved corridor performance will create a desirable community for future residential and commercial development, supporting a vital and vibrant economy.

This project has full support from federal, state, and local entities. The Federal Highway Administration (FHWA) is a valuable partner in defining and developing project concepts and overall project process. FHWA approved the project, which was developed according to its Systems Engineering process. TDOT is the lead agency for the overall project and has provided full support for its development and delivery. All stakeholders along this corridor, which includes the cities of Nashville, LaVergne, Smyrna, and Murfreesboro, Rutherford County, MTA, and RTA, have been full and active partners in the development of project strategies. These stakeholders have contributed to project direction, concept definition and review, and overall project support for the establishment of a Smart Corridor within their jurisdictions. Each city's governing body has executed a Project Charter and a Resolution of Support memorializing their backing of the project.

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Utah Department of Transportation
Highlights of Technology Projects

Signal Interconnect Projects

Benefits Realized:

- Improved traffic signal coordination through signal controller time clock syncing
- Daily alerts when signal detection is down, leading to faster mitigation of detection issues
- Full situational awareness of signal operations quality for connected signals
- Ability to remotely manage signals for special events and incidents, which results in improved efficiency of operations and safety of personnel
- Remote operations capabilities reduce need for afterhours maintenance deployments, saving time and money, and improving worker safety
- Improved interagency coordination and operation of signals on state and local corridors

Other Statistics/Facts:

- 97% of UDOT owned traffic signals are connected
- 82% of non-UDOT owned traffic signals are connected
- All traffic signals statewide (UDOT and non-UDOT) are on the same system and can be controlled by UDOT and local agencies

Variable Message Sign (VMS) Projects

Benefits Realized:

- Improved communication of road conditions and safety messaging to traveling public
- Route diversion for improved congestion/incident management
- Reduced primary and secondary crashes through improved communication with traveling public
- Realtime travel time communication to traveling public

Studies/Statistics Regarding VMS Effectiveness (not specific to Utah, but indicative of general b enefits of VMSs):

- Study done by Wisconsin DOT published May 2002 indicated up to 72% of motorists sur veyed adjusted their travel routes based on VMS messaging
- 94% of motorists surveyed traveling on rural roads took actions provided by VMSs in a Missouri study published December 2011

- In the San Francisco Bay Area, 8% of motorists switched to transit when VMSs communi cated travel time savings of 20 minutes or greater (study published September 2009)
- University of Minnesota study from November 2002 showed VMSs reduced travel times by 12.1% during non-peak hour incidents
- Study done in 4 major metro areas published by FHWA in July 2014 indicated an averag e of 86% of drivers surveyed feel Public Service Announcements (PSAs) on VMSs are so metimes, often, or always more effective compared to other media

Federally-Funded (FAST Act) Technology Projects Completed, Active, or Planned Since 2015

Completed Projects by Region:

PIN	Project Name/Description	Region	STIP Year	Funding Type	Federal Funds
10712	Weber-Davis Signal Interconnect	1	2015	CMAQ	$18,000
10543	Ogden Area Fiber & Signal Interconnect	1	2015	CMAQ	$540,000
12631	Ogden/Layton Traffic Signal Interconnect	1	2018	CMAQ	$680,000
10542	Commuter Link Web Enhancements	2	2016	CMAQ	$200,000
7123	ITS Standards Development	2	2016	CMAQ	$180,000
8241	Variable Message Sign Optimization	2	2017	CMAQ	$110,000
8242	Salt Lake County Traffic Signal Interconnect	2	2017	CMAQ	$161,000
12637	9400 S, 1300 E, 9000 S Fiber Optics	2	2018	CMAQ	$990,000
12583	SR-201; 8400 W to I-80 Fiber Optics	2	2018	CMAQ	$1,250,000
12640	Variable Message Signs I-15 MP 292, I-215 MP 7, SR-201 MP 15	2	2018	CMAQ	$1,874,700
14910	Salt Lake Area Traffic Signal Detection	2	2018	CMAQ	$2,507,000
12106	NB I-15; Lehi Variable Message Sign	3	2016	CMAQ	$426,000
13243	NB I-15; Springville/Provo Variable Message Sign	3	2017	CMAQ	$500,000
14149	I-15; Payson to Santaquin Fiber Optics	3	2018	CMAQ	$350,000
13244	Utah County Signal Interconnect	3	2018	CMAQ	$406,000
10713	St George Area ITS	4	2015	STP	$170,000
13675	ATMS Expansion and Upgrades	4	2018	STP	$245,000
13676	SR-9 Fiber Optics and Signal Interconnect	4	2018	STP	$650,000
7124	Statewide Fiber Optic Support	Statewide	2016	CMAQ/STP	$1,414,000
				Total $:	$12,671,000

Active Projects by Region:

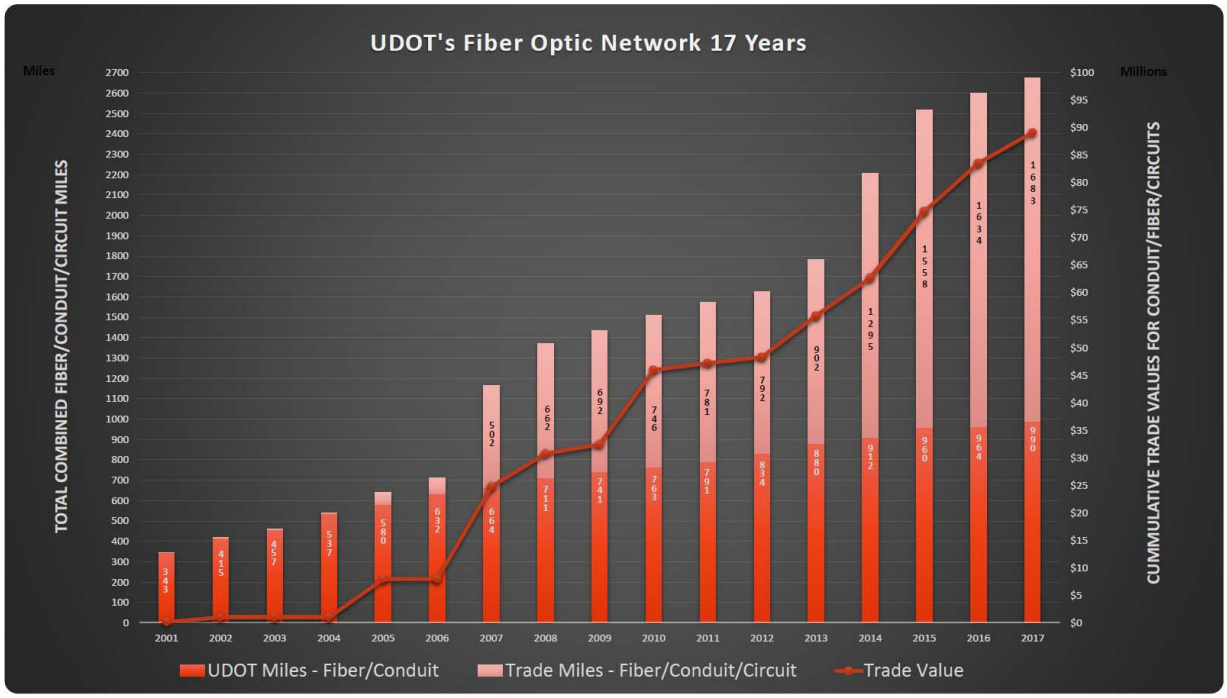
PIN	Project Name/Description	Region	STIP Year	Funding Type	Federal Funds
16041	Region 1 ATMS Expansion for Congestion Mitigation – 5 VMS	1	2018	CMAQ	$2,951,000
14646	Fiber and Signal Interconnect – SL City Area	2	2018	CMAQ	$400,000
11641	SL County Metro Area Signal Interconnect	2	2018	CMAQ	$400,000
12638	Salt Lake Area Traffic Signal Interconnects	2	2018	CMAQ	$1,300,000
14908	Dixie MPO ITS Upgrades	4	2018	STP	$173,000
11143	Fiber Optic Expansion Program	Statewide	2018	CMAQ	$800,000
15063	Signal Performance Measures Study	Statewide	2018	SHRP2	$50,000
15040	Incident Management Study	Statewide	2018	SHRP2	$140,000
				Total $:	$6,041,000

Fiber Optic Communications Projects

Benefits Realized:

- Improved communications with ITS devices (CCTV, VMS, Traffic Signals, RWIS, etc.)

- With improved communications, improved efficiency of operations and traffic manag ement, response times to incidents, and employee and public safety
- Improved communications/emergency services to remote areas



Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Washington State Department of Transportation
US 395/ Hawthorne Road Channelization & Signal Modification

This project revised the lane configuration and upgraded the existing signal system at Hawthorne Road and US 395 in Spokane, Washington. US 395 (Division Street) is a major at-grade arterial route in/through Spokane and a major freight route. The existing traffic signal at Hawthorne Road did not permit the east and west lanes to move at the same time due to lane configuration restrictions. Channelization revisions created exclusive left turn lanes on Hawthorne going east and west, a combined through lane and right turn lane for eastbound traffic, and exclusive through lanes and right turn lanes for west bound traffic. These changes allowed the signal to run in a standard eight-phase operation under new signal controllers capable of expansion to automated vehicle technologies and increased operational efficiency of the intersection. The total reduction in vehicle delay is 22,637 minutes/day.

Figure 1 Before

The total project cost approximately $1 million – state contribution is $100,000 and federal contribution is $900,000 (CMAQ).

The Spokane metropolitan area and Spokane County qualify as a Transportation Management Areas (TMA) and a federally-designated maintenance area for air quality. Through the area Metropolitan Planning Organization, Spokane Regional Transportation Council, WSDOT applied for a Congestion Mitigation & Air Quality Improvement (CMAQ) program grant. The project was a joint venture with Spokane County Public Works.

Figure 2 After

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Washington State Department of Transportation
Centralized Signal System-Joint ATMS throughout Clark County

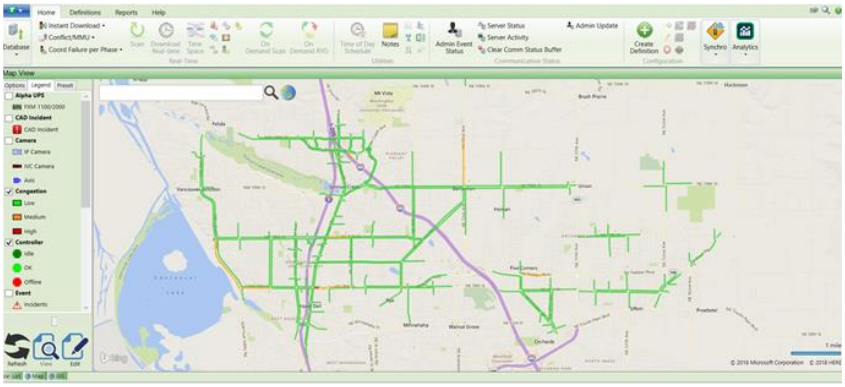
Clark County, Washington, is part of the Portland, Oregon metropolitan service area. As the second densest county in Washington, smart solutions are necessary to extend the service life of existing infrastructure to sustain the region's rapid growth. As the region has grown, increasingly traffic signal systems operated by different jurisdictions interact. For example, a county highway that crosses I-5 will be operated by the county, however the interchange traffic signals are operated by WSDOT. This creates segmented systems that can cause breakdowns in the transportation system. Clark County and WSDOT, in coordination with the area Metropolitan Planning Organization (MPO), have a history of working collaboratively to share infrastructure such as fiber to lower the overall cost of infrastructure to residents of Clark County.

In this spirit, Clark County negotiated with their vendor to transform their local centralized traffic signal system into a regionally-shared Advanced Traffic Management System (ATMS). This upgrade by Clark County enabled the remaining local jurisdictions to share traffic data, and remotely operate traffic signals, within each other's systems. The shared centralized signal system is documented in an interagency agreement. As part of the agreement, WSDOT-owned-and-operated signals from the seven-county region of Southwest Washington may utilize the regional signal system. WSDOT successfully obtained a Congestion Mitigation & Air Quality Improvement (CMAQ) program grant through the Southwest Washington Regional Transportation Council for this work.

The CMAQ grant will fund WSDOT's needed system upgrades to effectively communicate with Clark County's systems. For the centralized signals systems to communicate thru ATMS, WSDOT must make signal controller upgrades to the controller's CPU's (central processing units) on existing signals on SR 500 and SR 503 to communicate and share data with our local partners. Additionally, to better define and track individual traffic movements within each intersection, additional detection loops and detectors will be installed.

ATMS is capable of adaptively managing and adjusting traffic signal timing to meet real time demand. These automated processes will maximize utilization of existing infrastructure, reduce delays and emissions, and increase mobility. Once the signal controller upgrades are completed in this project, high resolution signal data captured by the system will be used to create performance measures to evaluate efficiency of the traffic signal system. During traffic

incidents, engineers working in the WSDOT Traffic Management Center will remotely adjust county and WSDOT systems to assist in managing the associated congestion.



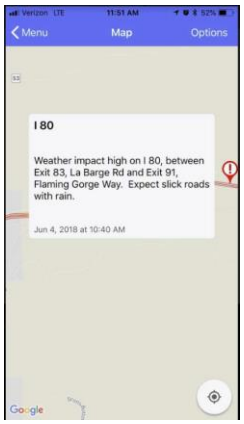
Screen Shot of ATMS 1

ATMS has an eye on the future, broadcasting signal phasing and timing (SPAT) data over the internet to third party vendors (Tidalwave) as well as from physical field devices via dedicated short-range communications (DSRC). This data will be crucial as the region transitions to connected and autonomous vehicles.

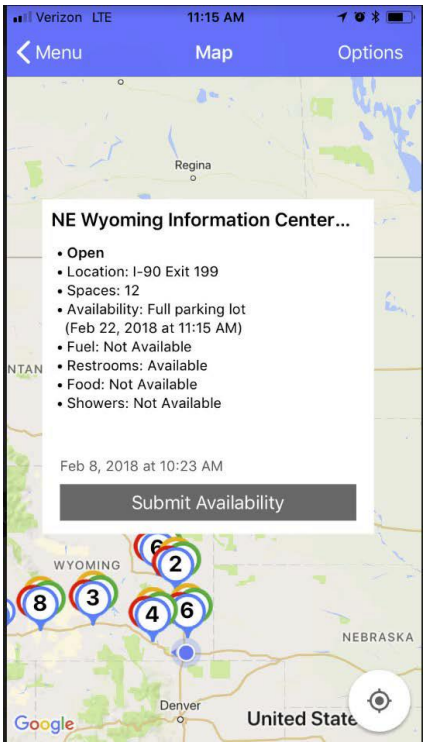
The total project cost approximately $200,000 million, out of which, state contribution is $51,000 and federal contribution is $149,000 (CMAQ).

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Wyoming Department of Transportation
Mobile App Enhancements

WYDOT developed a mobile application for smartphones to share pre-trip and en route traveler information. This application had three major components:



- A map for pre-trip planning that provides information including road conditions, traffic incidents, weather sensor data, web camera images, road construction notifications, and truck parking locations.
- A hands free/eyes free feature that speaks road condition, traffic incident, and road construction information as drivers travel down the road, alerting them in advance to adverse conditions ahead.
- A "Where am I?" feature that correlates the user's GPS location to the nearest route and mile marker. This can be used in an emergency when a driver needs to be able to share his or her location. The location can easily be sent via text or email.



Based on feedback from the public, we realized we had a real opportunity to improve the application to provide better information for travelers in Wyoming. Funding from the FAST Act allowed us to improve the app to include improved features:

- Submit an Image, which allows users to "pass it to the passenger" and submit images of road conditions or traffic incidents directly to the state's Transportation Management Center. Images and/or text submitted through the app can then be shared with the public, or information gleaned from the photos can be used to update information reporting systems.
- Report on truck parking availability. By sharing information about the number of spaces available in public parking areas, truck drivers can share with each other important information that can be used to make decisions about whether to park or to continue driving. During road closures due to adverse weather, this can also help truck drivers navigate to safe parking locations.

Transportation safety, mobility, or infrastructure challenge the project is helping address: This application helps the agency provide accurate, timely road condition information to the traveling public. Because of the long distances between towns, travelers often don't have the option to take an alternate route or choose to stop a trip due to poor conditions once they've committed to driving. This application provides relevant information about truck parking availability to help drivers with that decision-making process. It also allows the public to communicate with WYDOT if information systems are not accurately reporting conditions.

Project cost information, including federal match, state/local match, and private funding: About $21,000

By allowing travelers a direct line to the Transportation Management Center allows WYDOT to respond to conditions as reported by travelers. Limited staff means that we rely on the public to help alert us to issues on the roadway. This application facilitates that.

This application provides vital road and traffic condition information to truck drivers while they are en route. By providing them timely, accurate condition information, truckers can make decisions about whether and when to travel. In addition, the app allows truck drivers to post information about parking availability. This provides near real-time updates to other drivers to help give them the information they need when making decisions about where to park. This becomes more important when limited visibility or high winds result in road closures. Providing road and traffic condition information can ease traffic congestion, which has a benefit to the environment.

Information received through the truck parking availability and submit a picture features will be broadcast via roadside units as part of WYDOT's Connected Vehicle Pilot.

By providing accurate, timely road condition information, travelers can make informed decisions about whether and when to travel. This provides situational awareness for drivers who can choose to stay home, take an alternate route if one is available, or delay a trip. Safer drivers reduce the risk of crashes, which have a substantial economic impact.

Demonstrate the level of support from federal, state, and local elected officials and other key policymakers: The mobile app has been downloaded by the public more than 130,000 times. Given Wyoming's population of about 560,000 people, this level demonstrates a significant uptake of the system.

Report 571589: Two crashes at the 283 I-80. One in each direction
Status: New
Road: I 80, East, at 283
District: 1, County: ALBANY
Longitude: -106.053011, Latitude: 41.506338, Altitude:
Submitted Timestamp: 2017-12-14 10:15:21
Digitized Timestamp: 2017-12-14 10:13:39 (when the picture was taken, in the device's time zone)
Source: samsung/SM-G930V
Location: -106.053011,41.506338,I 80 East,283.0
View Report Details

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Wyoming Department of Transportation
Revised Commercial Vehicle Operator Portal

The Commercial Vehicle Operator Portal (CVOP) is a web-based system focused on providing a one-stop shop for current road conditions and road weather forecast information on the most commonly traveled commercial routes in the state. This information is shared with the trucking community and was designed based on feedback provided directly from fleet managers. Because of their feedback, WYDOT provides road weather forecasts for pavement condition, wind, and visibility in 12-hour increments for a total of 72 hours in advance. WYDOT's contract meteorologist also provides a more detailed wind grid in three-hour increments, so fleets can make important safety and delivery decisions. More than 800 firms from all but five states are using the system.

Pre-trip decision support information is vital to fleet operators, and WYDOT provides this road forecast information through a simple, web-based interface available to all commercial fleets and operators.

WYDOT estimates that the current system cost no more than $25,000 to build and deploy. The system was funded using FY 2018 FAST Act funds with a 90/10 federal/state match.

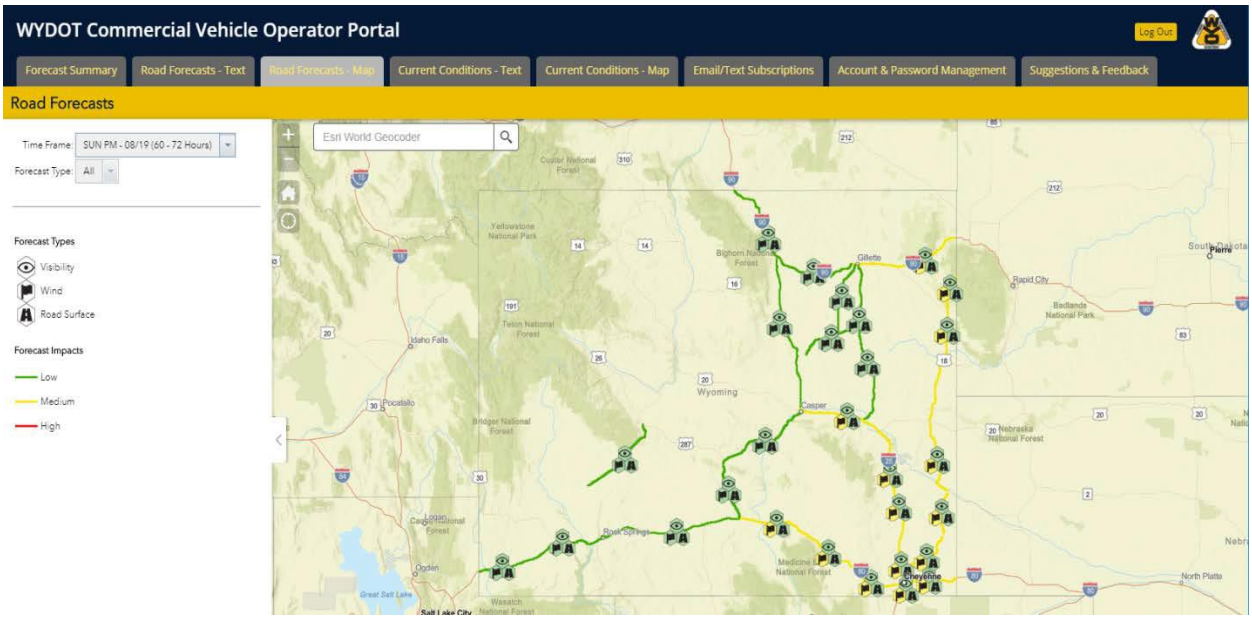
Providing truck drivers and fleet operators with accurate road weather forecasts and current conditions in one place allows them to know what their drivers are facing and to advance shipments, delay shipments, or re-route their cargo if needed. The primary reason for the project is to provide the freight community with accurate road weather forecast information so they can make important delivery decisions. A recent survey of CVOP users revealed that most fleets are using the information WYDOT provides to their deliveries (advancing shipments, delaying shipments or re-routing) before and during forecasted storm events. The project reduces emissions by minimizing the time commercial vehicles spend idling behind a road closure gate.

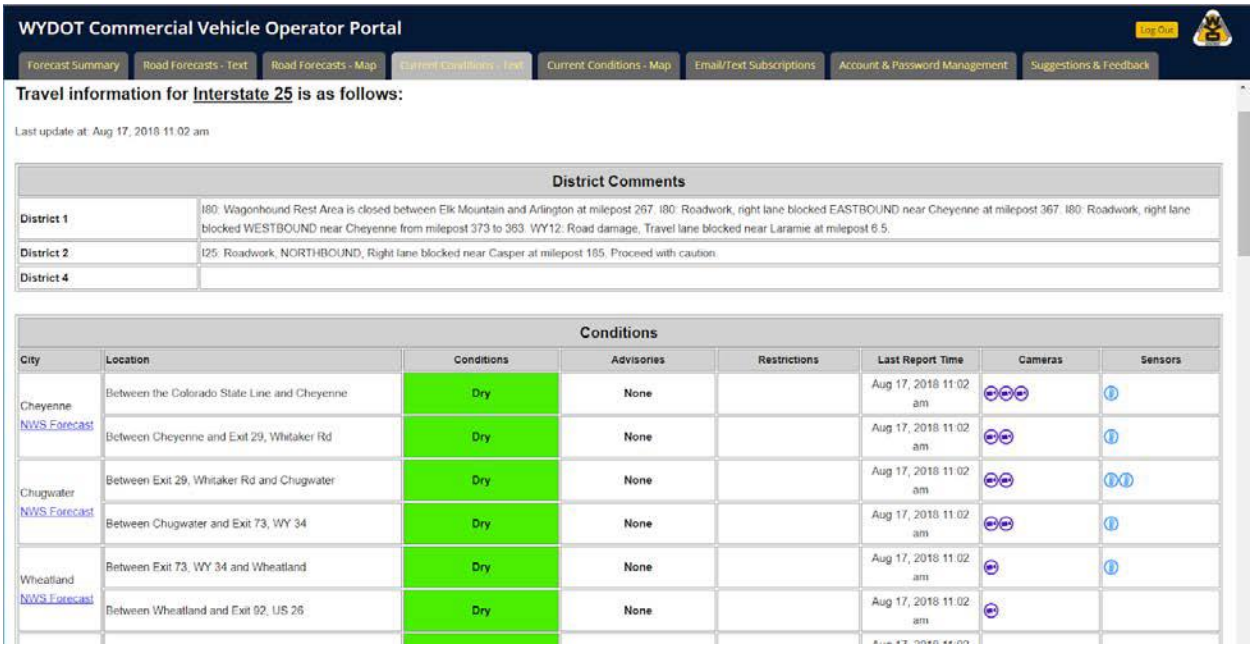
WYDOT was one of three entities selected for the first wave of Connected Vehicle Pilot Projects. Integral to the Wyoming Pilot is the enhancement of the CVOP system, which was recently completed to include both forecast and current conditions in map and text formats. The new CVOP will incorporate the Pikalert system originally developed by the National Center for Atmospheric Research. In time, it is expected that Pikalert will allow WYDOT to forecast all routes in the state.

WYDOT's mission is to provide a safe, high quality, and efficient transportation system. The CVOP provides information directly focused on keeping drivers safe and moving efficiently. During a recent survey, 96.12 percent of the respondents said they are either very satisfied (75.19 percent) or somewhat satisfied (20.93 percent).

Demonstrate the level of support from federal, state, and local elected officials and other key policymakers: The key stakeholders for this project are commercial trucking companies, the Governor's Transportation Safety Coalition, and the Wyoming Trucking Association. All key stakeholders support this project.

Sample tabs from the WYDOT Commercial Vehicle Operator portal are below.





WYDOT Commercial Vehicle Operator Portal

Log Out

Forecast Summary | Road Forecasts - Text | Road Forecasts - Map | Current Conditions - Text | Current Conditions - Map | Email/Text Subscriptions | Account & Password Management | Suggestions & Feedback

Travel information for Interstate 25 is as follows:

Last update at: Aug 17, 2018 11:02 am

District Comments	
District 1	I80: Wagonhound Rest Area is closed between Elk Mountain and Arlington at milepost 267. I80: Roadwork, right lane blocked EASTBOUND near Cheyenne at milepost 367. I80: Roadwork, right lane blocked WESTBOUND near Cheyenne from milepost 373 to 363. WY12: Road damage, Travel lane blocked near Laramie at milepost 6.5.
District 2	I25: Roadwork, NORTHBOUND, Right lane blocked near Casper at milepost 185. Proceed with caution.
District 4	

Conditions

City	Location	Conditions	Advisories	Restrictions	Last Report Time	Cameras	Sensors
Cheyenne NWS Forecast	Between the Colorado State Line and Cheyenne	Dry	None		Aug 17, 2018 11:02 am		
	Between Cheyenne and Exit 29, Whitaker Rd	Dry	None		Aug 17, 2018 11:02 am		
Chugwater NWS Forecast	Between Exit 29, Whitaker Rd and Chugwater	Dry	None		Aug 17, 2018 11:02 am		
	Between Chugwater and Exit 73, WY 34	Dry	None		Aug 17, 2018 11:02 am		
Wheatland NWS Forecast	Between Exit 73, WY 34 and Wheatland	Dry	None		Aug 17, 2018 11:02 am		
	Between Wheatland and Exit 92, US 26	Dry	None		Aug 17, 2018 11:02 am		

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Econolite
Lakeview Avenue Overcrossing Orange County Transportation Authority

On June 6, 2017, the Lakeview Ave. overcrossing in Orange County, California, officially opened to drivers. The overcrossing now routes vehicular traffic over Burlington Northern Santa Fe (BNSF) railroad line uninterrupted. It is the fifth of seven over-crossings and under-crossings the Orange County Transportation Authority (OCTA) planned to improve the safety and travel time of thousands of residents along the corridor and rail line in the cities of Anaheim and Placentia, and to improve the freight operations that utilize the vital and heavily used rail line.

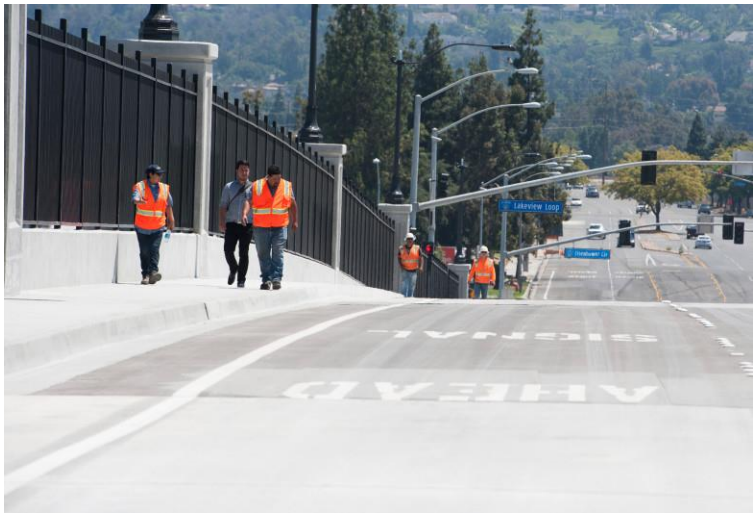
Nearly 70 individual trains use the BNSF tracks daily, regularly blocking the way of drivers travelling north or south along the busy corridor. By 2030, OCTA estimates that 130 trains per day will use the rail line, creating more traffic congestion, emissions, and safety concerns without an overcrossing solution.

Beginning in mid-2014, construction began on Lakeview Ave. to elevate and realign the corridor to separate car traffic from train traffic. In addition to increasing safety and reducing travel times, the overcrossing is also helping to reduce vehicle and freight emissions and noise. The overpass is between Orchard Drive to the north and Eisenhower Circle to the south.

In conjunction with the overcrossing, a ramp was constructed connecting Lakeview Ave. to Orangethorpe Ave. As a result, North Bubach St. was rerouted to connect to the new Connector Road with a new signalized intersection. A new frontage road was built for local resident and business access, and another road also built at the southwest corner, which connects the new frontage road to Lakeview Ave.

As part of the project, several intersections along Lakeview Ave. were upgraded with new NEMA traffic control cabinets and 2070 controllers. This provides the traffic management technology that enables programming of signals to help optimize traffic flow through the corridor. In addition, emergency vehicles and first responders, including ambulances, fire, and police are now able to respond more quickly and cross the rail line without interruption, which is critical for life-saving calls.

The OCTA is spending an estimated $635 million on the overcrossing and undercrossing projects that cross the BSNF rail line, and the Lakeview Overcrossing project is $70 million. In addressing improved freight operations and emissions reduction, the Lakeview Overcrossing project received $7.8 million in CMAQ funding.



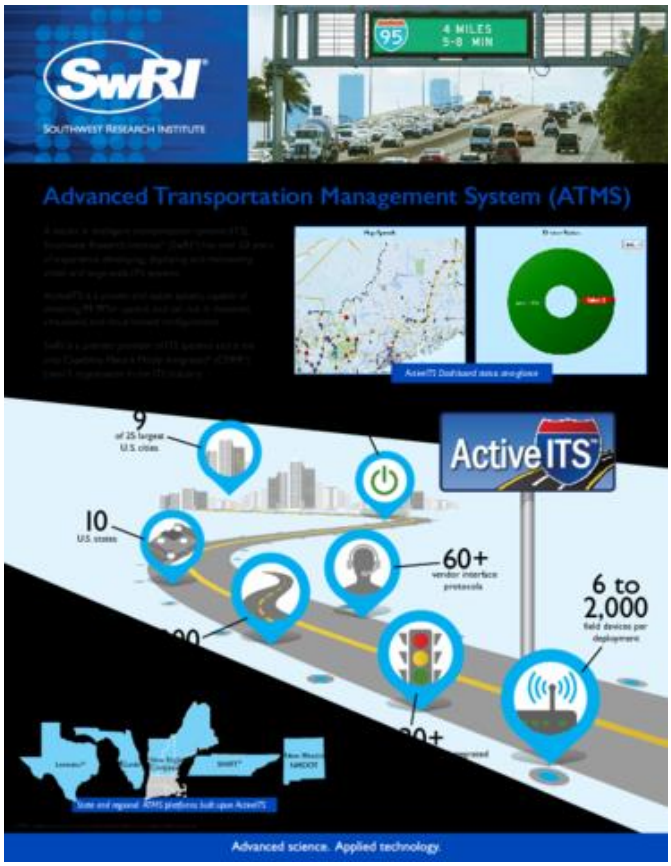
The Lakeview Overcrossing project grand opening was supported by city officials of Anaheim, Placentia, including Placentia Mayor Craig Green, Yorba Linda Mayor Peggy Huang, and Anaheim Mayor Tom Tait – a few of the cities that are directly impacted by the Lakeview Ave. corridor and the BNSF rail overcrossing. The overcrossing project specifically targets and provides:

- Enhanced Safety for all roadway users (vehicle, pedestrians, bicyclists, transit, etc.)
- Quicker Emergency Response
- Elimination of Rail Crossing Delays
- Easier Commerce and Business Access
- Sustainable Economic Growth
- Reduced Vehicle and Freight Emissions
- Reduced Vehicle and Freight Travel Noise
- Improved Quality of Life

Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Southwest Research Institute
ActiveITS

A leader in intelligent transportation systems, Southwest Research Institute (SwRi) has over 20 years of experience developing, deploying, and maintaining small- and large-scale ITS systems. ActiveITS is a proven and stable system, capable of obtaining 99.99%+ uptime—and can run in clustered virtualized and cloud-hosted configurations.

System Functionality



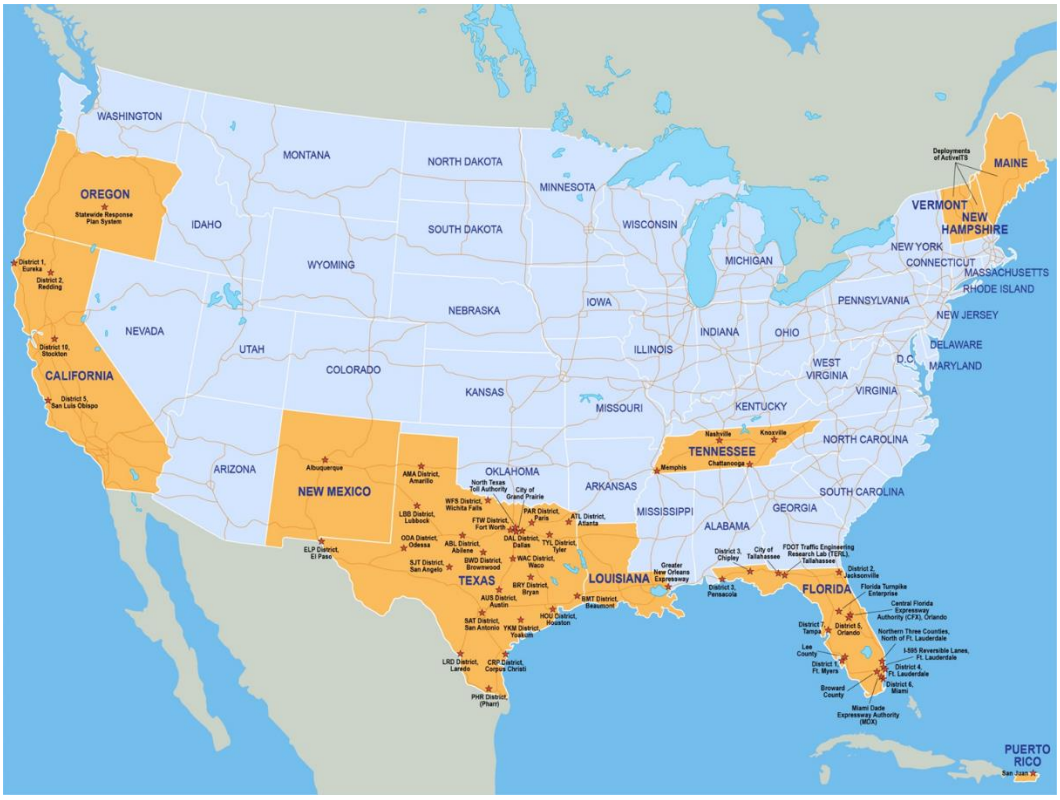
Key features of the ActiveITS system include:

- Event Management
  - Automated event management response plans for dynamic message sign (DMS) postings, email notification, traveler information alerts, highway advisory radio (HAR) messages, and more
- Performance Measures
  - Archiving and reporting to enable performance-based oversight of event management operations, ITS field equipment maintenance, service patrol, and ATMS operations
- Center-to-Center Connectivity
  - Interconnected operations for information sharing and control between traffic management centers
- Integrated User Interface

- Management of field devices, events, and other functions by an operator in a single integrated browser/map-based/application-based interface in a Windows environment

State-owned Software

By instilling a non-proprietary approach to ITS software solutions, SwRI leverages previous ActiveITS software deployments as the baseline ATMS solution and then customizes and enhances the system based on client requirements. SwRI's approach to develop once and deploy repeatedly provides clients additional cost value through efficiency as well as freedom to openly integrate all utilized ITS systems. States have spent about $95 million on ActiveITS software over a period of 20 years and approximately 50% of that has been federal money.



Intelligent Transportation Society of America
Innovation in Surface Transportation Best Practice
Texas A&M Transportation Institute and
Virginia Tech Transportation Institute
Implications of Truck Platoons for Roadside and Vehicle Safety Hardware

Using automated and connected vehicle technology, truck platoons may operate in the future with spacing between vehicles as little as 50 feet. Researchers and students at the Texas A&M Transportation Institute (TTI) are examining how roadside safety devices, such as guard rail and median barriers, will react to an impact from a truck platoon. Researchers and students at the Virginia Tech Transportation Institute (VTTI) are examining how crashes such as these would affect the occupants of the vehicle. The research will inform policy on truck platoon operating rules and roadside safety device standards.

Finite Element Analysis is a computer modeling technique that uses mathematical computations of impact forces. Computer models of trucks are used that detail their weight and movement characteristics (See Figure 1). Computer models of roadside hardware such as concrete median barrier is also used in these computations to assess the potential damage to the barrier and the truck when a collision occurs. The use of computer modeling allows many variables to be evaluated without the expense and time involved in crash testing actual vehicles. Simulations were run for two different styles of concrete median barrier (see Figure 2).

Figure 1

Truck platooning will improve freight movement in an era of driver shortages and to increase fuel efficiency up to 12%. These trucks, however, are still susceptible to loss of control crashes due to hydroplaning and emergency braking. Roadside hardware protects the occupants of the truck and vehicles in opposing lanes by redirecting errant vehicles back to the roadway. Federal and state highway safety improvement funds are used to install and maintain this roadside hardware. It is important to understand the effect that truck platoon crashes may have on this vital piece of infrastructure. This research project will identify which design of roadside hardware will best withstand multiple impacts and what damage will be caused to the hardware that will need repair.

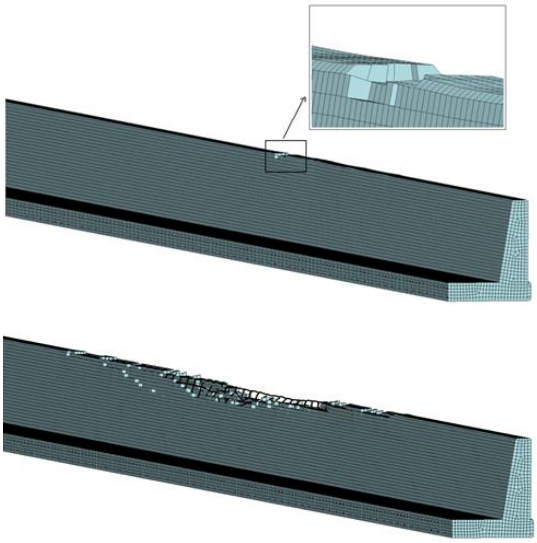


Figure 2

This project will help prepare state and local agencies for the operation of truck platoons on their facilities. It will provide information for planning on future improvements and maintenance of roadside hardware.

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