Missouri Department of Transportation

I-70 Smart Corridor

Application for Federal funding through FHWA's "Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Initiative"

Funding Opportunity Number: 693JJ317NF0001

Volume 1: Technical Application

Project Name	I-70 Smart Corridor
Eligible Entity Applying to Receive Federal Funding	State Government, Department of Transportation
Total Project Cost	$9,730,800
ATCMTD Request	$4,865,400
Are matching funds restricted to a specific project component?	No
State in which the project is located	Missouri
Is the project currently programmed in the: Transportation Improvement Program (TIP), Statewide Transportation Improvement Program(STIP), MPO Long Range Transportation Plan (LRTP), and/or State LRTP	Yes, asset management, maintenance, and TSMO functions do appear in plan documents
Technologies Proposed to be Deployed	(A): Integrated Model for Road Condition Prediction (IMCRP); (B): Dedicated Short Range Communications (DSRC) systems and variable message signs; (C): Real-time traffic operations using vehicle probe data; (D): Autonomous truck-mounted attenuator (TMA) vehicles; (E): Mesh networking platform for v2x communications using 4G LTE and DSRC; (F): Predictive analytics and machine learning for incident management; (G): Mobile edge computing system supporting highway IoT applications

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June 12, 2017

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RE: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)

Mr. Harris,

The Missouri Department of Transportation (MoDOT) understands the value of innovation in the provision of safe and efficient transportation options for the movement of goods and people throughout our state. Recognizing the opportunities presented by the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program, MoDOT is pleased to submit our application for Federal funding for this program's implementation. For the consideration of your review committee, MoDOT has assembled a portfolio of connected applications and platforms deployed to improve outcomes related to safety, congestion and unreliability, incident management, and mobile Internet of Things (IoT) connectivity. Nearly all of the program elements relate to the deployment of Dedicated Short Range Communications (DSRC) assets of some type.

The primary rationale for proposing an integrated deployment of these technologies is to respond to the emergence of several generation-scale challenges to the maintenance and operation of Missouri's transportation system. These are, namely:

Rise in highway fatalities provokes a technological response: Gradual economic recovery (and a concomitant rise in VMT) since 2010, compounded by destructive trends in impaired and distracted driving, have been correlated with an increase in highway deaths and injuries in Missouri. The statistical value of these losses approaches **$6 billion per year**, excluding the related economic impacts of injuries and property damage.

Stagnant funding levels compel program innovation: State and Federal excise taxes on the sale of gasoline and diesel fuels—unadjusted since 1996 and 1993 respectively—compel that DOTs derive value from more cost-effective TSMO and ITS functions in place of costlier expansions to highway capacity. The effects of inflation alone represent a loss of **$500 million per** year in state gasoline and diesel taxes. Additional economic costs of traffic delay (**$1.09 billion per year** in Kansas City and **$1.64 billion per year** in St. Louis in 2014) present a beneficial use case for innovative technologies targeting congestion and unreliability.

Extreme weather events underscore critical roadway condition reporting and analytics: A 500-year flood in southern Missouri in April and May of 2017, having caused nearly **$60 million** in damage to public infrastructure, highlights the importance of operational resilience, traveler information systems, and IoT-enabled sensors to report existing (and predict future) roadway conditions. Given the immense economic impacts of these challenges stemming from budgetary, technological, and driver behavior contexts, MoDOT has proactively decided to pursue the operational, safety, and congestion-mitigation benefits possible through a suite of advanced technology applications using TSMO, autonomous vehicles, and IoT platforms.

Recognizing the immense contributions to the fields of ITS, DSRC platforms, and V2X connectivity which have been made by FHWA's ITS-JPO and Office of Operations staff, MoDOT welcomes to the opportunity for significant Federal involvement in the deployment of our ATCMTD projects, through technical assistance and guidance. As with all programs at MoDOT, we are committed to evaluate the post-implementation effectiveness of the proposed technologies and activities funded by this grant.

Should there be any questions regarding MoDOT's application, I ask that you please call my office at (573) 751-4622. We look forward to the response of your review committee and welcome your feedback as we begin to undertake the integrated deployment of these technologies in our state.

With best regards,

Patrick McKenna

Director

Overview of Project Narrative

In this application for funding under the FHWA Office of Operations ATCMTD initiative, MoDOT has proactively decided to pursue the operational, safety, and congestion-mitigation benefits possible through a suite of advanced technology applications using TSMO, autonomous vehicles, and IoT platforms.

Maximizing public value through innovation in operations

The State of Missouri operates and maintains the nation's seventh largest highway system (of nearly 34,000 miles), but ranks 47th in terms of revenue collected per mile. Despite these limitations, MoDOT has long been a center of innovation among state DOTs. In recent years the Department has implemented 49 of 50 FHWA Every Day Counts (EDC) initiatives, and has been a frequent participant in pooled fund, peer exchange, and technology transfer activities. Recognizing the shortcomings of Missouri's non-Federal revenue streams (specifically motor vehicle registration and driver's license fees and excise taxes on fuel sales), it remains central to MoDOT's values that our innovation activities be calibrated to deliver quantifiable public value and return on investment. Accordingly, MoDOT has proposed in its ATCMTD application a portfolio of projects targeted to convey substantive benefit to multimodal transportation system users and the traveling public, with special emphasis upon the following goals:

- Reduce traffic-related fatalities, injuries, and property damage
- Minimize and manage traffic congestion and improved travel time reliability
- Optimize system performance though agile incident management
- Improve access to transportation innovations for low- and medium-income populations that do not use smart phones or own DSRC-enabled vehicles

Achieving these public benefits through **operational** means—rather than through the design and construction of new highway capacity—must by necessity remain a focal point for MoDOT in the coming decade as economic, technological, and demographic trends foretell further diminution of traditional revenue sources.

Embracing integrated corridor management for weather-related events

Equally compelling to MoDOT's value proposition for investment in integrated corridor management applications was the 500-year flood event which took place in Missouri in April/May 2017. This flood caused damage to 407 locations statewide. The MoDOT system lost three bridges, and state highways were affected by major slides in four counties. With total damages to public infrastructure expected to surpass $60 million it is apparent to MoDOT program leaders that the Department must embrace innovative means to predict and respond to inclement weather conditions and their transportation impacts. MoDOT would therefore like to expand upon its previous partnerships with FHWA in enlarging its IMRCP initiative. The extension of the model's analytical capabilities outside of its existing operating area in the KC Scout region will provide transportation management capabilities to a more rural area with fewer system redundancies, in which the collection, analysis, and dissemination of **actionable data** regarding real-time, predicted, and individualized determinants of highway conditions is immensely valuable to travelers. Making this data and its analytical platforms available across multiple regions, crossing multiple state, county, and municipal boundaries presents an opportunity to create public value through integrated corridor management.

Improving safety through innovative infrastructure maintenance practices

In addition to leveraging innovation to assist MoDOT's districts in managing and controlling the performance of the state highway system, MoDOT plans to deploy limited vehicle autonomy, in a leader-follower context, to improve work zone safety for the Department's employees and contractors. Nationally, thousands of DOT employees and contractors are injured and killed in work zones annually. Since 2000, 18 MoDOT employees have been killed in highway work zones, and MoDOT vehicles in work zones are struck 15-20 times per year, often causing injury. Accident reports have shown that the top three contributing circumstances to crashes in work zones are distracted and inattentive driving, following too closely, and driving at speeds surpassing those permitted by weather and roadway conditions. Deployment of semi-autonomous leader-follower truck-mounted attenuators (TMAs) in MoDOT work zones will remove vulnerable laborers from some of the most dangerous locations in the work zone: those closest to the fastest-moving vehicles at the edge. Additionally, these connected work zone vehicle deployments can be used as hubs for other DSRC-enabled devices on MoDOT's highways, helping to sustain the IoT platform for other V2X and V2I applications deployed along the I-70 corridor in rural and urban locations.

Repurposing common hardware to transition to DSRC-enabled operability

While the future is unclear concerning rates of mass market adoption and consumer acceptance for vehicles with DSRC chip sets, MoDOT recognizes that the Department must play a role in establishing some momentum in creating and sustaining the ITS architectures and protocols for this technology prior to the market allowing a minimum demonstrable scale of deployments targeting DSRC-enabled vehicles directly. Accordingly, in deploying conventional VMS hardware to convey parameters sourced from real-time, predicted, and individualized information (collected from other DSRC-enabled assets along the corridor) MoDOT will be making additional efforts to broaden access to the benefits of this innovative technology. **VMS displays will communicate directly to highway users of all income groups, regardless of the age of the vehicle, or whether the driver has a smart phone.**

Facilitating rural technology deployments

Roughly half of MoDOT's vehicle miles traveled (VMT) in most years take place upon rural segments of Interstate, National Highway System, and other highway miles, and a disproportionate share of MoDOT's highway system is comprised of farm-to-market roads that became a state maintenance responsibility in previous decades and remain so today. Understanding the particular challenges of these rural highway corridors:

- Lack of redundancy and vulnerability to incident management and weather disruptions
- Generally low- to middle-income and above-average concentrations of senior citizens
- Prominence of aging, poor condition and weight restricted bridges
- Increasingly large and slow moving farm equipment for larger farms with fewer laborers

Accordingly, MoDOT has targeted rural areas for several of its ATCMTD technology deployments, notably the predictive analytics and machine learning, weather and roadway condition prediction, real-time traffic operations using probe vehicle data, DSRC-enabled (and semi-autonomous) leader-follower truck-mounted attenuator (TMA) vehicles.

A more in-depth description of the technologies is provided in the following project narrative.

Vision, Goals, and Focus Areas of Smart Corridor Portfolio

MoDOT plans to implement a portfolio of integrated corridor management, autonomous and connected vehicle, and smart infrastructure technologies which provide cross-network travel management capabilities supporting the safe and efficient movement of people and freight. Using funds provided by the ATCMTD initiative, MoDOT will implement statewide (rural and urban) deployments of:

- A: Integrated Model for Road Condition Prediction (IMCRP)
- B: Dedicated Short Range Communications (DSRC) systems and variable message signs
- C: Real-time traffic operations using vehicle probe data
- D: Autonomous truck-mounted attenuator (TMA) vehicles
- E: Mesh networking platform for v2x communications using 4G LTE and DSRC
- F: Predictive analytics and machine learning for incident management
- G: Mobile edge computing system supporting highway IoT applications

Project Descriptions

The estimated project cost of this portfolio of deployments is **$9,730,800.** MoDOT is requesting 50% of these funds be supplied by the ATCMTD program through a Federal grant of **$4,865,400.**

Part A: Integrated Model for Road Condition Prediction (IMRCP)

Kansas City, Missouri region and rural I-70 to Central Missouri

Implementation region for expanded deployment of IMRCP initiative covering urban and rural highways

Issues and challenges addressed by the selected technology

Missouri's roadways are subject to a range of threats to the continuity of safe and efficient operations. The Midwest's variable and frequently severe weather creates challenges in all four seasons. Winter snow and ice storms can occur between October and May. Heavy and persistent rainfall incurs flooding risks along both the state's major rivers and small streams. These kinds of events, coupled with congestion in the major urban areas and along rural interstate corridors, can create compounded operational risks. Slight variations in conditions can have major impacts when rain is falling at 33° or as vehicles are pulling to the shoulder due to poor visibility in a sudden downpour. The complexity of these challenges led the FHWA's Office of Operations to sponsor MoDOT's development of an Integrated Model for Road Condition Prediction (IMRCP) to inform operational responses. With the ATCMTD initiative, MoDOT proposes to **expand the geographic and operational reach of its IMRCP capabilities**.

Project Vision, Goals, and Objectives

Expansion of the IMRCP service area involves defining and implementing the road network, the traffic demand model, and traffic, weather and hydrological sensor data collection for the region covered by the network. The IMRCP deployment in the Kansas City area has demonstrated that data and forecast methods can be sufficiently integrated to provide an enhanced awareness of operational risks from potentially hazardous road conditions. The current deployment is limited in geographic scope and in the strategies and remedies available to operators for interventions. Therefore, MoDOT proposes to use ATCMTD and state matching funds to expand the data gathering capabilities and geographic range modeled by the system to provide more accurate road and traffic condition risk assessment on a rural, corridor-length scale reaching from the state line to Columbia. Extending the model along the I-70 corridor to Mid-Missouri will enable operators to respond to high-risk events with more advance warning, thus providing travelers with more information and routing options.

Concept and Technical Approach

Traffic data to support the expanded area will be collected from additional vehicle detection stations on state highways in the Kansas City area and along I-70. Mobile road weather sensors will be added to MoDOT maintenance vehicles to provide higher resolution collection than can be provided by fixed environmental sensor stations.

The accuracy of traffic estimation and forecast improves with more traffic sensors. Although the Scout system adequately covers the interstate and some of the state highways in the metro, additional sensor deployments would be needed to adequately cover the expanded service area. Microwave detection equipment would be added on US-71, US-40, US-24, MO-350, and MO-291 and along the rural portions of I-70.

The previous IMRCP study used data from the National Weather Service (NWS) and from fixed environmental sensor stations to feed the road weather forecast models. It did not, however, have any data from snow plow trucks to indicate which roadways would have been treated or plowed during winter storms. It is proposed to build an interface from the Pinpoint automated vehicle location (AVL) system being deployed by MoDOT to the IMRCP. Data from the AVL-equipped trucks can then be used to bring real-time conditions into the system and to enhance the area forecasts with confirmed treatment and plow routes.

The road weather component of the IMRCP can be further enhanced by equipping snow plow trucks with mobile road weather sensor such as the Surface Sentinel and IceSight devices. These sensors provide high-resolution data on pavement and air temperatures against which MoDOT will calibrate estimates across the road network, and the mobile IceSight units can discern pavement icing and snow-coverage conditions. Getting these measurements from the field before and during severe winter weather conditions greatly enhances forecast accuracy.

Deployment Plan

Forecasts for atmospheric weather and hydrological conditions can be drawn from NWS sources. Current traffic measures and incident reports from advanced transportation management systems (ATMS) establish the initial road network condition. Work zones and special events, both current and planned, are provided by agency and third-party sources. All these elements are then fed into road weather condition and traffic models to generate system-wide estimates of current conditions and forecasts of future conditions.

Current traffic and incident conditions are provided by KC Scout. Weather conditions and forecasts were collected from NWS Rapid Update (RAP) and Real-time Model Assessment (RTMA) systems, along with hydrological data from the NWS Advanced Hydrological Prediction System and the local StormWatch system. The model includes over 2,000 links and 870 nodes in a 65 square mile area with 194 vehicle detection stations, 205 signalized intersection, and 26 environmental sensor stations.

Quantifiable system performance improvements

The proposed expansion of the IMRCP service area and data-gathering capabilities in Kansas City will enable MoDOT and KC Scout to better anticipate and plan response strategies for traffic, weather, and hydrological events affecting the road network. This will then provide opportunities for improved safety and enhanced mobility in the KC metro area and along its eastern I-70 access. Traveler information based on the improved condition monitoring and prediction will enable system users to make better travel decisions, reducing congestion and travel times. Another benefit of the IMRCP to transportation operations is that potentially hazardous road conditions can be identified early enough to make decisions and take action to reduce the risks and mitigate the consequences of events. Active operations strategies can augment integrated corridor management systems to: (A) reduce the number of seriousness of fatalities, injuries, and property damage (per VMT) on Missouri highways, and (B) reduce the amount of wasted salt and other winter treatments.

Challenges

MoDOT expects no regulatory, legislative, or institutional challenges to expanding the geographic reach of its existing IMRCP deployment to rural Missouri.

Part B: Dedicated Short Range Communications (DSRC) and VMS system

Statewide in urban (Kansas City and St. Louis) and rural I-70

Issues and challenges addressed by the selected technology

Infrequent and severe weather events present challenging operational environments for state DOTs across the nation. Severe weather events in Missouri typically move from west to east, slowing traffic and potentially stranding vehicles moving into the storm along I-70. Flooding can occur anywhere along the Missouri River and its tributaries in the I-70 corridor. A bridge hit by an over-height vehicle can close the interstate for days with detours onto rural alternatives not meant to handle large traffic volumes. In such events, MoDOT's ability to evaluate real-time information and isolate operational risks to travelers before they become apparent is critical.

The USDOT currently reserves the 5.9 GHz frequency band as the only wireless communication technique that provides fast network acquisition time, low latency, high reliability, priority for safety applications, interoperability, security, and privacy. While DSRC-enabled ITS assets would provide immense benefits to the traveling public:

- V2I applications allow the vehicle to alert the driver of safety, mobility or environment-related conditions ahead, and
- V2X applications allow the vehicle to transmit and receive up to 1,000 messages per second from vehicles up to 1,000 feet away

However, as of June 2017, very few vehicles currently traveling Missouri's highways are DSRC-enabled. At current rates of vehicle replacement in Missouri, it will take approximately 12 years until today's newest vehicles "cycle through" and are among the oldest on the road, meaning that it will take nearly **15 years** before DSRC-enabled applications are universally acceptable across nearly all vehicles. **It is also a goal of FHWA to make the benefits of innovative technology available to all system users, and not limiting beneficiaries to smart phone users or owners of new vehicles.** Furthermore, state DOTs are not certain of the minimum thresholds of market acceptance required to efficiently deploy DCRS enabled platforms to enable more reliable and accurate integrated corridor management environments, smoothly directing highway users around work zones and incident management locations.

Vision, Goals, and Objectives

The future deployment of DSRC technology requires DSRC-based applications to be integrated with existing traffic management techniques—such as variable message signs (VMS)—so that non-DSRC-equipped vehicles can also benefit from deployment of the technology during the early phases of DSRC development. Therefore, MoDOT will implement a set of DSRC-enabled VMS displays to assess this wireless communication standard's ability to support connected vehicle applications and technologies allowing real-time information regarding hazardous road and traffic conditions. In this manner, MoDOT and system users will begin to enjoy the benefits of the DSRC technology while market penetration rates for in-vehicle chip sets are still low.

Concept and Technical Approach

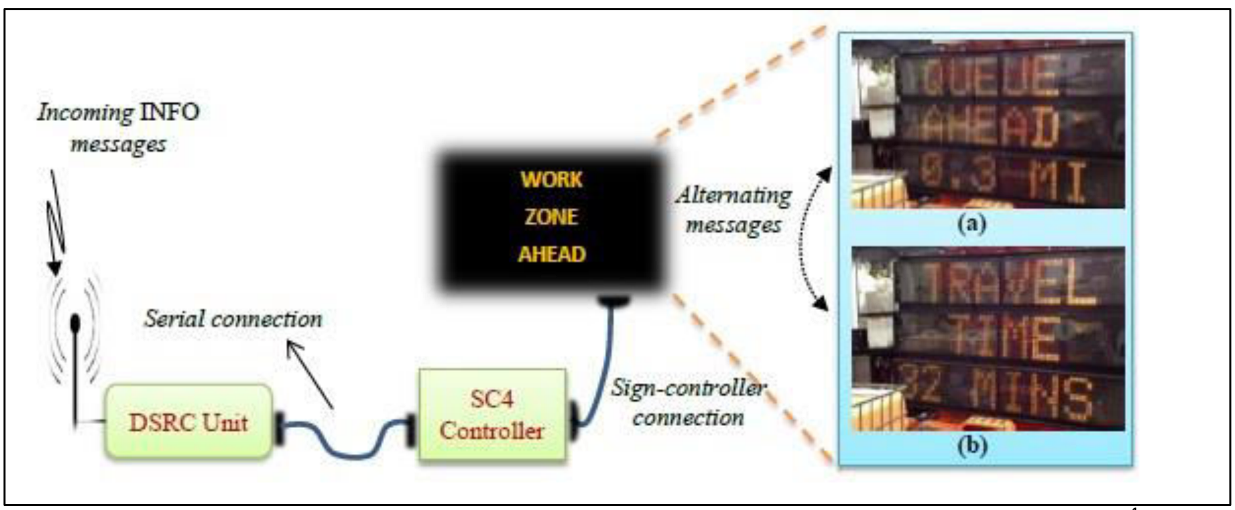
MoDOT proposes to field demonstrate a hybrid traffic-information system combining DSRC technology and VMS for work zones and other environments to improve traffic mobility, and as a result, driver safety. This project uses DSRC-based V2I and V2V communication to acquire travel safety parameters such as travel time and starting location of congestion, and disseminate this information to both DSRC-equipped vehicles and DSRC-equipped VMS, which will be placed alongside MoDOT highways. Using the DSRC-VMS interface designed for this purpose, VMSs can receive travel safety parameters from nearby DSRC-equipped vehicles on the road via DSRC-based V2V communication, and display them for the drivers of the vehicles lacking DSRC capability.

Finally, MoDOT will conduct an analysis conducted to investigate the minimum DSRC market penetration rate needed for the DSRC system to successfully function, with respect to both acquisition and dissemination of information on travel times and starting locations of congestion. Using a realistic traffic flow model, guidelines will be developed to estimate a minimum DSRC penetration rate needed in Missouri to deploy the DSRC-VMS system under a variety of traffic scenarios.

Deployment Plan

MoDOT's DSRC-enabled VMS hardware interface will be implemented using a RS232 serial port connection, such as a PCMS device manufactured by ADDCO and similar firms. The VMS consists of a display matrix (3 lines x 8 characters), a controller for display control, a power supply with solar panel, and a portable cart. This particular VMS type is considered the most sold type in the North America and is fully compliant to the national transportation communications for ITS protocol (NTCIP) standards. This VMS comes with a proprietary logic controller (SC4), and utilizes modified higher data link layer control (HDLC) language to let the external agents communicate with the controller. The DSRC unit connected with the VMS constantly looks for the updated safety message and once it finds a new message, it will process it and communicate it to the SC4 controller of the PCMS which displays it accordingly.

The VMS hardware will be connected and deployed with an SC4 controller capable of key functionalities such as local creation, editing, and storage of messages using three different ports: sign, central, and auxiliary. The SC4 controller will receive information encoded in higher data link layer control (HDLC) language. The deployment will likely use Savari DSRC units, though other types may be considered in the procurement phase for best value of project delivery. To display a MoDOT message, the DSRC-enabled VMS will encode the message in proprietary encoded frame and then transmit it to the SC4 controller via serial communication. As soon as the SC4 controller receives the message data in the encoded format, it will send the appropriate pixel lighting commands to the display matrix. Work zones and plowing sites will be augmented with roadside units (RSUs) to add density to the coverage region. While designing and deploying the DSRC-VMS interface, the message format will retain format guidelines suggested by the Manual on Uniform Traffic Control Devices (MUTCD).



Schematic of DSRC-enabled VMS deployment which allows non-DSRC vehicles to benefit from the technology (University of MN[1])

[1] U. Ibrahim and M. Hayee, 2013. Development of Hybrid DSRC-PCMS Information Systems for Snowplow Operations and Work Zones, University of Minnesota, Center for Transportation Studies.

Challenges

MoDOT foresees no institutional, regulatory, or legislative challenges to the implementation of the DSRC environment and related safety applications. The primary challenge will be in optimizing the geographic scale and density of the implementation site. Beginning MoDOT's DSRC experience with an implementation at the minimum demonstrable scale will require an investment of $2.5 million, even for a limited DSRC/VMS implementation.

Quantifiable system performance improvements

MoDOT supports this program as a part of an ongoing effort to eliminate traffic related deaths, and will compare the rate of injuries and fatalities (per VMT) within the deployment zone to control segments located outside of the deployment zone. After linking DSRC-enabled data collection to TMC information architectures, proactive response planning will have longer lead times and more accurate scenarios. Emergency response teams will be dispatched earlier and be more effectively positioned to respond to events. Event recovery and clearance will be safer with more information, and potentially faster in terms of response time.

Part C: Real-time traffic operations using vehicle probe data

Rural Missouri on I-70 and I-44

In addition to parameters received from DSRC-enabled assets in the MoDOT right-of-way, the deployed VMS signs will also be populated with messages derived from analytics sourced from vehicle probe data. This will enable greater geographic coverage of VMS deployment while also recognizing the cost-effectiveness of probe data and related analytics when compared to the costs of a complete corridor-length DSRC deployment. The capture rate of this data source has steadily improved over the last decade, and MoDOT program managers are now ready to increase their investment in this particular data source by purchasing third-party data sources at a much greater level of granularity, which will allow more geographic detail and specificity as MoDOT analyzes and responds to changing congestion and incident management conditions.

Issues and challenges addressed by the selected technology

Vehicle probe data is a cost-effective means to monitor traffic flow, delivering both speed and travel time information for the purposes of advanced traffic management systems and advanced traveler information services applications, as well as supporting a myriad of other transportation agency requirements, including monitoring the impacts of construction activities, planning, and engineering. However, MoDOT recognizes the high cost of installing and maintaining fixed-point loop detectors, and are now purchasing vehicle probe data from third party vendors. This data addresses two functions: (A) GPS data obtained from fleet management services, and (B) geo-location abilities that leverage cellular phone infrastructure. The proliferation of GPS and mobile data services is fueling these industries and strengthening the demand from travelers for accurate real-time traffic information. One major point of value for the use of vendor-supplied data is that it allows MoDOT program managers to avoid the cost of installing additional fixed-point speed sensors, as well as the cost of operating and servicing high-maintenance sensors, such as loop detectors.

Vision, Goals, and Objectives

Similar to the deployed program elements described above, the vehicle probe data plays a part in MoDOT's efforts to decrease the extent and duration of congestion and unreliability and to expedite incident response activities when necessary. As a majority of congestion hours are linked to incidents and incident clearance, MoDOT program managers believe that (A) progress made toward preventing incidents and secondary incidents through better analytics and TSMO technology deployments, and (B) avoidance and rerouting of traffic flows around current incidents will yield a net economic benefit to the state's traveling public.

Concept and Technical Approach

Traffic speeds and volumes information will be the key value derived from vehicle probe data vendors. The primary sources are cell phone probes (whereby vehicle location is inferred by the user's cell phone (GPS) location and hand-offs between associated towers) and automated vehicle location (AML) data derived from Bluetooth enabled devices, fleet telematics, GPS receivers, satellite communications devices, and other location-enabled assets.

Challenges

While the market penetration of devices capable of generating location information that is aggregated into third party vehicle probe products is growing rapidly, the quality of traffic information derived from cell phone probe and AVL data depends on the quantity and distribution of vehicles reporting through these systems. For example, long-haul freight movements typically avoid peak hours in urban highways. As a percentage of traffic, interstate trucking tends to be low during peak traffic demand and high during off-peak and nighttime hours. Particular to Missouri, low volume rural routes may not yield adequate volumes of location-enabled devices in vehicles to interpolate accurate traffic speed and volume information. A secondary, but manageable, technological challenge is that MoDOT must procure an interface to analyze and curate parameters sourced from probe vehicle data prior to populating the VMS displays described in Part B.

Quantifiable system performance improvements

Key performance indicators (KPIs) currently analyzed by MoDOT in our Tracker system and related dashboards appear on a statewide, district, and corridor level of analysis. Relevant metrics will be trends in traffic-related injuries and fatalities, incident response times, incident clearance times, annual hours of delay, and travel time reliability.

Part D: Semi-autonomous truck-mounted attenuator (TMA) vehicles

Urban and rural MoDOT highways within Kansas City district

Toward the goal of reducing work zone injuries and fatalities affecting MoDOT staff, contractors, and other highway users, MoDOT will begin investing in semi-autonomous leader and follower (rear advanced warning) truck mounted attenuator (TMA) vehicles. MoDOT will retain a driver in the leader truck, and use technology to eliminate the need for a human operator in the follower truck. This will substantively reduce the risk of injury to employees and contractors in Missouri's highway work zones.

Slow moving operations vehicles have been struck 82 times in work zones by distracted and impaired drivers since 2013, resulting in many injuries to state employees and contractors. Since May of 2017 alone, two MoDOT follower vehicles have been struck in work zones by distracted or impaired drivers. At a rate surpassing **1.5 TMA strikes per month**, it is unsustainable to continue current work zone practices without consideration of technological innovations that would provide a safety benefit to highway workers.

Issues and challenges addressed by the selected technology

MoDOT has already taken many steps to reduce these crashes by adding lights, audible alerts, and additional conspicuity markings, but distracted driving and increased traffic volumes continue to pose more of a risk to our employees every day.

Vision, Goals, and Objectives

MoDOT's mobile and slow moving operations (such as striping, sweeping, bridge flushing and pothole patching) are critical for efficient and safe operation of the state's highway system. A successfully implemented semi-autonomous Leader-Follower TMA System will eliminate most injuries to MoDOT employees in follower trucks.

Concept and Technical Approach

MoDOT will procure a fully functional Leader-Follower TMA system—consistent with those undergoing NCHRP 350 Level 3 testing—capable of operating a driverless rear advanced warning vehicle in mobile highway operations. The complete system will include trucks, TMA, hardware, software, training plan, and an evaluation plan. MoDOT will purchase the trucks and TMAs through our existing truck replacement plan from International, Freightliner, Mack, or Western Star. After purchasing the standard vehicle, MoDOT contractors will provide aftermarket autonomy and V2V connectivity solutions for deployment. The vehicles will be operated manually while traveling to the work location. Once operating in the work zone with the leader-follower activated, speeds will typically be less than 15 miles per hour.

The MoDOT-supplied (NCHRP 350 Level 3 compliant) TMA will be in the form of a dump bed Class 6, 7, or 8 truck that is able to perform multiple functions, including snow removal and salt spreading. The vehicle will weigh between 19,000 to 20,833 pounds. The follower truck will have a lateral accuracy of six inches, and a following distance accuracy of two feet when operating at a consistent speed or at typical acceleration and deceleration rates.

Aside from operational challenges, MoDOT and its contractors will develop or procure failsafe systems for cyber security, V2V communication, and other safety elements compliant with national standards and protocols. These systems of V2V communication and optics must work I Missouri's environment of rolling hills and dense tree and vegetation coverage near the right-of-way. The contractor will also develop a testing plan and training plan that will enable these vehicles to be rapidly, but safely, deployed in MoDOT work zones in the Kansas City district.

Challenges

MoDOT has statutory authority to deploy a semi-autonomous Leader-Follower TMA system as long as a licensed driver is in the driver's seat with the ability to manually take over control of the vehicle. MoDOT sees no other regulatory hurdles that must be overcome to achieve successful implementation.

Part E: Mesh network platform for V2X communications via DSRC and 4G/LTE

Urban MoDOT highways within Kansas City district

MoDOT is now preparing for widespread adoption of IoT applications across Missouri's highways and nearby urban areas and will soon pilot a number of distributed and heterogeneous means of supporting this connectivity through RSUs, OBUs, and even "smart highways" with access points integral to the highway structure itself.

One such approach is to deploy a mesh network comprised of a combination of onboard hardware, fixed access points and cloud components that provide unlimited internet access on highways while collecting actionable urban data from connected vehicles and a cloud-based storage system. Fixed access points will be deployed throughout the corridor to provide both free Wi-Fi (on a standard 50 meter range) to the highway users while also providing DSRC or fiber backhaul (up to 1 kilometer in range) connectivity to the vehicles themselves.

Issues and challenges addressed by the selected technology

It is expected that full corridor-length deployment of the next generation (5G) of mobile internet connectivity and IoT applications for vehicles and infrastructure will require a V2X communications platform that is distributed, heterogeneous, and larger than those currently existing. V2X deployments that will benefit MoDOT staff and the traveling public—allowing better location-based services, emergency assistance, vehicle diagnostics, traffic analysis, incident management, and Wi-Fi hotspots for system users. **Accordingly, MoDOT recognizes**

that such a network, or combination of networks, must be able to move literally terabytes of data daily from each vehicle to other vehicles, infrastructure, and cloud-based systems.

Accordingly, MoDOT proposes the creation and deployment of a third-party mesh network supported by on-board units (OBUs) on fleet vehicles and other MoDOT assets that will augment other access points and add density to MoDOT's connectivity resources. The actionable corridor data collected by the mesh network can be used to understand driving patterns and make recommendations for increased safety measures or changes to traffic flow.

Vision, Goals, and Objectives

In promoting V2V connectivity, MoDOT will create a mesh network enabling IoT applications supporting the connectivity demands of other highway users (online media, vehicle diagnostics, emergency assistance, and Wi-Fi hotspots). This will allow "multi-hop" technology, whereby vehicles daisy-chain each other to connect to the closest access point (up to two "hops" away). This occurs when the multi-hop DSRC connection offers better service than 4G/LTE. Additionally, the mesh network will allow communication between vehicles, enabling the network to disseminate emergency information to connected vehicles during a catastrophe. Also, connected vehicles can communicate their respective positions and speeds to each other and to the network to help avoid collisions and allow vehicle tracking in real time.

Concept and Technical Approach

MoDOT will deploy up to 45 fixed access points to provide high bandwidth and low latency connectivity to onboard units (OBUs), with those OBUs providing premium Wi-Fi on board the vehicles, to the passengers. The OBUs are multi-network and can handle seamless handovers (requiring less than 10 milliseconds) from DSRC to 4G/LTE for when the vehicle is out of DSRC range. The handovers will not affect the users' internet session or any other onboard services.

MoDOT's mesh network will collect telematics data on MoDOT fleet vehicle speeds and braking patterns, as well as driver performance. MoDOT will then analyze relationships between driving patterns in order to mitigate situations in which the driver performance decreases. The mesh network can also collect data from nearby passenger vehicles to analyze vehicle use by measuring the flow of passengers to and from various destinations.

OBUs deployed on MoDOT fleet vehicles will be capable of switching between DSRC, 4G/LTE, and Wi-Fi, and will include GPS, gyroscope, and accelerometers. The technical specification of the GPS system involved will allow precision to one meter, even when operating within an "urban canyon" environment surrounded by tall buildings and other structures. The network will support over-the-air software updates and configuration management and will be supervised through a network management dashboard user interface. Finally the network will make available its application programming interface (API) for data streams and connected vehicle applications, while also implementing a software development kit (SDK) for mesh network-enabled devices. Finally, the access points will be installed on traffic lights, lamp posts and other utility poles, MoDOT buildings, and other structures as appropriate.

Once deployed, connected vehicles and other mesh network users will be able to receive data from external mobile sensors. This will enable a number of IoT applications that promote additional work zone safety, such as the wearing of DSRC-enabled devices on clothing items worn by MoDOT staff and contractors.

Challenges

MoDOT foresees no regulatory challenges to implementation. Some institutional challenges that may appear include the potential benefits (and complications) of adding network density through deployment of OBUs on other public sector fleet vehicles (such as transit vehicles) outside of MoDOT's control. However, this approach would be optional.

Part F: Predictive analytics and machine learning for incident management

Urban MoDOT highways in Kansas City district

Predictive analytics and machine learning capabilities are implemented through models consisting of multiple complex and dynamic algorithms. This machine learning model will take in many data points and use the data points to consider many "if, then" statements. Drivers and infrastructure operators must consider, and respond to, a number daily factors and environmental conditions before selecting and implementing appropriate strategies for action. MoDOT's proposes to deploy a machine learning model that uses many algorithms to arrive simultaneously at multiple answers to very specific questions, and to find overarching trends and conclusions within the answers. The core value of this service will be to predict the location and timing of future highway incidents in relationship to the confluence of factors related to infrastructure condition, direction of travel, weather and precipitation, direction of sunlight, driver behavior, and the occurrence of special events.

Issues and challenges addressed by the selected technology

MoDOT program leaders have developed an interest in machine learning and predictive analytics as a means of optimizing our limited operational resources in order to more rationally deploy enforcement and incident response assets in a complex and rapidly changing traffic context. At the same time, MoDOT division directors have observed other state governments using machine learning to model traffic crash data and predict where traffic crashes are most likely to occur. Machine learning and predictive analytics are appropriate tools for highway traffic analysis in that they attempt to draw conclusions from data sets that are:

- Affected by a variety of factors,
- Derived from many different data sources, and are
- Rapidly changing in complex ways

Because traffic crashes occur for a variety of reasons that may vary greatly depending on time of day, driver behaviors involved, and crash location, the use of machine learning provides value in understanding crash and incident trends to predict future crashes and incidents.

Vision, goals, and objectives

MoDOT will deploy a predictive analytics platform capable of using complex algorithms to draw nuanced conclusions from traffic and incident data to better inform Missouri's deployment of costly and limited state enforcement, winter maintenance, and incident response resources. Where machine learning systems have been deployed for highway crash and incident analytics purposes state DOT program managers have noted beneficial effects, successfully predicting crashes and equipping patrol officers to forestall crashes. (Tennessee, for instance, recorded a decrease in traffic crashes to 20 percent below the 50-year average. However it is unclear to what extent these gains may be attributed to management techniques made possible through machine learning.)

Concept and Technical Approach

MoDOT will procure a machine learning model, designed to consider several different factors when predicting future crashes including historical crash data, weather forecasts, and special events. This predictive analytics platform will include each of these factors into the model and then produce a map that depicts the likelihood of crashes in specific areas at certain times of day and days of the week. The model will show crash likelihoods in defined geographic areas, approximate to 30 square miles each. This will allow law enforcement agencies to identify ranges of time in which the likelihood of a crash is the greatest in a specific area and to increase patrol of that area in order to mitigate crashes. In addition to honing enforcement and patrol strategies, MoDOT's traffic crash predictions will assist other efforts to reduce crashes. The model's data collection and predictions can help in the identification of the causes of crashes in certain areas, provide data for public safety campaigns, and assist engineers in identifying areas where a roadway redesign may reduce crashes.

As MoDOT's model continues to collect crash data, its efficacy will also increase as crash trends may become more observable over time with a growing body of information. Concatenation of several large series of data is crucial for a machine learning model to draw conclusions that are complex enough to aid in successful practical applications. For example, alcohol-related crashes may significantly increase each Friday night in certain areas directly following a major sporting event that occurs nearby those areas. MoDOT's machine learning model will consider several factors before it predicts an increase in alcohol-related crashes in areas nearby such a sporting event. The machine learning model may consider the area's proximity to the sporting event, the season in which it is predicting the number of alcohol-related crashes, the day of the week it is considering, the time it is considering, whether a sporting event is completed, the weather, the visibility, the complexity of the roadway it is considering, the history of alcohol-related crashes in the specific area, as well as other factors.

Challenges

The consideration of these many factors minimizes the possibility of error in the model's prediction. A more simplified model may incorrectly predict an increase in alcohol-related crashes every Friday night in the areas nearby where the sporting event occurs, even if the sporting event does not occur that night. Alternatively, a simplified model could predict an incorrectly low likelihood for alcohol-related crashes if it did not take into account a heavy fog in the area that greatly lessened visibility and rendered an impaired driver's reaction time even more delayed than usual.

Part G: Mobile edge computing system supporting highway IoT applications

Suburban MoDOT highways in St. Louis district

As autonomous vehicles and 5G networks begin market introduction in the coming years, the current highway and infrastructure use cases for wireless technology are creating demand for new approaches to connectivity, bandwidth and network architecture. The evolution toward 5G will bring about several new ways of designing networks so that the promise of always-on, high-bandwidth, low latency, massive networks can become reality. Mobile edge computing (MEC) is one example of an innovative network design that will provide the platform for vehicle autonomy, in-vehicle diagnostics, and media content.

Issues and challenges addressed by the selected technology

With the rise of IoT and V2X technologies heavily dependent on low latency networks, the evolution of MEC is very significant for the establishment and growth of these technologies. As network speeds and capabilities continue to increase toward that of a 5G network, mobile edge computing assists to increase the network's functionality to capacities demanded by technologies such as the internet of things, mobile broadband, virtual reality, and self-driving vehicles. The 4G and 4G/LTE networks are currently the most functional networks in use; however, a 5G network will soon reach much greater levels of functionality, which can be augmented by MEC capabilities. MoDOT will deploy a MEC platform which ensures that the high functionality of the 5G network is available at any point within the network.

Vision, Goals, and Objectives

MEC is a concept in which the capabilities of a wireless network that only formerly could exist near the center of a wireless network are now functional at the network's edge. MEC accomplishes this by transforming an individual device into a hub so that the individual device has nearly identical capabilities as one located at the exact center of the network. This dramatically decreases latency and cost of utilizing the network. This means that a network user located far from the center of the network can download a video or complete any other function whose latency may be greater at the edge of a network at the same speed of a user at the center of the network. Latency indicates the speed at which an internet downloading or computing task is accomplished.

MoDOT's MEC platform will facilitate critical network uses that require very low latency, such onboard vehicle diagnostics, V2X communications, motorist assistance, and in-vehicle Wi-Fi and streaming media. In the coming years, autonomous vehicles will be constantly engaged in rapid, low latency V2V communication in order to coordinate movements and avoid collisions.

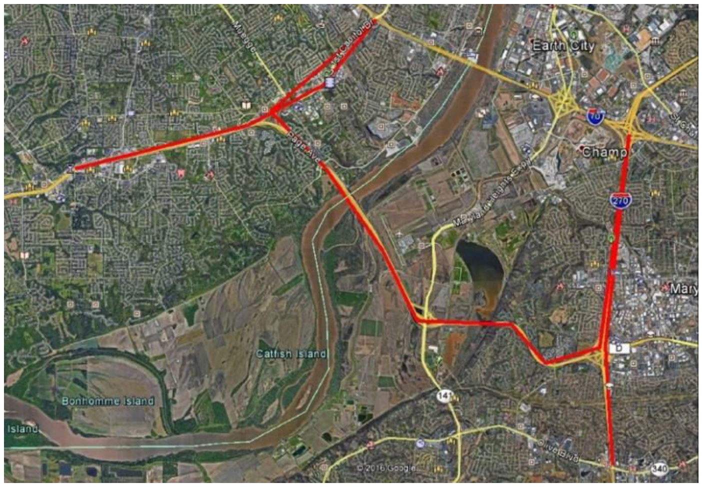
Concept and Technical Approach

MoDOT will deploy an MEC platform through an implementation concept centered upon the creation of a distributed antenna system (DAS) on designated roadways that currently have fiber optic network installed in or near the right-of-way in the St. Louis metropolitan region. DAS is best described as a series of antennae that are physically linked to a central or main antenna.

It is expected that DAS will provide higher reliability in packet delivery and more consistent coverage along the roadway, rather than a traditional cell tower approach. Under the traditional tower model, a series of stand-alone structures results in inconsistent packet delivery and coverage. This is due to the tower covering the road, as well as areas surrounding the road. Instead, MoDOT's MEC platform will use DAS to isolate the coverage area to the roadway itself. Additionally, DAS offers higher capacity for delivery of data due to the fiber link connecting each antenna. This ensures each and every vehicle is served while traveling at a high rate of speed. To ensure proper time synchronization of signal from antenna to antenna, software or additional fiber spooling at each site will be employed. Hand-offs between DAS systems will occur every two to three miles along the highway.

Initial construction of the MEC platform's DAS network will have minimal impact on highway operations. Existing road and information signs, as well as light poles, will be utilized for colocation of the antennae. Additionally, existing fiber along this corridor will be utilized to backhaul the data to and from the antennae to the primary carrier base station. Both of these factors are extremely beneficial from an implementation standpoint, because each significantly reduces time and cost required to go to market.

MoDOT proposes to deploy the MEC platform along Missouri Route 364, between Missouri Route 94 and Interstate 270 in St. Louis. The location would extend for several miles along Missouri Route 94 and Interstate 270 as well for maximum coverage.



Proposed deployment site of MEC platform in St. Louis metropolitan area

Challenges

MoDOT predicts no institutional, regulatory, or legislative challenges in implementing this innovative technology deployment.

Scheduling of Deliverables and Attainment of Project Milestones

MoDOT proposes an expedited, but achievable, schedule of deliverable completion. Though excluded due to space limitations, detailed Gant charts are available for the review of ATCMTD program staff by request to MoDOT's primary point of contact.

Program Part (A – G)	Deliverable	Due Date	Section 508 Compliance (Documents)	Title VI Compliance (LEP)
All (A – G)	Kick-off meeting with FHWA and ATCMTD program staff at agreed location	Within four weeks of the award date	No (N/A)	Yes
All (A – G)	Monthly progress reports to document activities performed, anticipated activities, and any schedule changes proposed	Monthly	Yes	Yes
All (A – G)	Report to the Secretary	Annually	Yes	Yes

	of Transportation	beginning one year after the award		
All (A – G)	Final report to the Secretary of Transportation, tracking before/after performance of assets	September 30, 2023	Yes	Yes
A	Procurement of IMRCP contractor services	Within four weeks of FHWA-MoDOT kick-off meeting	No (N/A)	Yes
A	IMRCP kick-off meeting	Within four weeks of IMRCP contract award	No (N/A)	Yes
A	Completion of IMRCP modeling	Within 19 months of Project A kick-off meeting	No (N/A)	Yes
A	Completion of IMRCP services	Within 24 months of Project A kick-off meeting	No (N/A)	Yes
B	Procurement of DCRC and VMS project	Within 12 weeks of FHWA-MoDOT kick-off meeting	No (N/A)	Yes
B	DSRC/VMS kick-off	Within 6 months of FHWA award	No (N/A)	Yes
B	Complete deployment of DSRC/VMS system	Within 36 months of Project B kick-off	No (N/A)	Yes
C	Probe data kick-off meeting	Within 6 weeks of FHWA-MoDOT kick-off	No (N/A)	Yes
C	Probe data procurement complete	Within 8 weeks of Project C kick-off (above)	No (N/A)	Yes
C	Interface for probe data and VMS parameters complete	Within 6 months of probe data acquisition	No (N/A)	Yes
D	Award to successful (TMA) bidders	September 1, 2017	No (N/A)	Yes
D	TMA testing starts	March 1, 2018	No (N/A)	Yes

D	Draft final reports due for TMA analysis/tests	March 1, 2019	Yes	Yes
D	Final reports due for TMA analysis/tests	April 1, 2019	Yes	Yes
E	Mesh platform kick-off	Within 12 weeks of FHWA-MoDOT kick-off meeting	No (N/A)	Yes
E	Acquisition of OBUs and access points	Within 90 days of Project E kick-off meeting	No (N/A)	Yes
E	Completion of mesh network deployment	Within 6 months of Project E kick-off meeting	No (N/A)	Yes
F	Machine learning procurement	Within 18 weeks of FHWA-MoDOT kick-off meeting	No (N/A)	Yes
F	Procurement complete	Within 6 weeks of RFP issue date	No (N/A)	Yes
F	Machine learning Notice to Proceed	Within 3 weeks of contract	No (N/A)	Yes
F	Machine learning deployment completed	Within 18 months of notice to proceed	No (N/A)	Yes
G	MEC kick-off meeting	Within 18 weeks of FHWA-MoDOT kick-off meeting	No (N/A)	Yes
G	MEC (DAS) construction begins	Within 90 days of contract	No (N/A)	Yes
G	MEC (DAS) construction ends	Within 13 months of contract	No (N/A)	Yes
G	MEC system testing	Within 18 months of contract	No (N/A)	Yes
G	MEC highway user testing	Within 20 months of contract	No (N/A)	Yes
G	MEC data mining and coordination	Within 24 months of contract	No (N/A)	Yes
G	MEC fully operational	Within 28 months of contract	No (N/A)	Yes

Management practices for MoDOT cooperative agreement with FHWA

MoDOT regularly enters into project-related cooperative agreements with FHWA and is both familiar and comfortable with FHWA's expectations pertaining to the timeliness of agreement execution and the transparency of financial reporting and milestone tracking.

Applicant Eligibility

The authority for FHWA and MoDOT to enter into a cooperative agreement for this effort is found under 23 U.S.C. §502 - Surface Transportation Research, Development, and Technology,

> "(3) **cooperation, grants, and contracts. —** The Secretary may carry out research, development, and technology transfer activities related to transportation—
> **(A)** independently;
> **(B)** in cooperation with other Federal departments, agencies, and instrumentalities and Federal laboratories; or
> **(C)** by making grants to, or entering into contracts and cooperative agreements with one or more of the following: the National Academy of Sciences, the American Association of State Highway and Transportation Officials, any Federal laboratory, Federal agency, State agency, authority, association, institution, for-profit or nonprofit corporation, organization, foreign country, or any other person."

As a state DOT, MoDOT has over six decades of experience in mutually beneficial cooperation with FHWA, and has previously participated in innovation, peer exchange, pooled fund, and technology transfer activities. MoDOT's Financial Services Division staff have an acute understanding of the financial management and reporting requirements incumbent upon receipt of this grant and performance of the proposed project deployment activities.

Proposed structure of cost-sharing arrangement

The estimated total project cost of this portfolio of deployments is **$9,730,800.** MoDOT is requesting 50% of these funds be supplied by the ATCMTD program, with a Federal grant of **$4,780,800**. Accordingly, **MoDOT will bring $4,865,400 in non-Federal matching funds** to the cost-sharing arrangement.

The majority of MoDOT's contribution will be monetary, derived from the State Road Fund ($2,435,000, or 50.1 percent). Less than half ($2,429,600, or 49.9 percent) will be non-monetary match. Within that amount, $2,275,000 will be contributed by a mobile edge computing (MEC) facility developer, several of which having committed to building an MEC platform in Missouri at a cost greater than that amount. The final $154,600 of MoDOT's non-monetary match will be comprised of staff compensation (from non-Federal sources) throughout the performance period of the project.

MoDOT's proposal for the non-monetary portion of the state match complies with the Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards specified in **2 CFR Part 200**, including section 200.306 of Part 200 on cost sharing or matching:

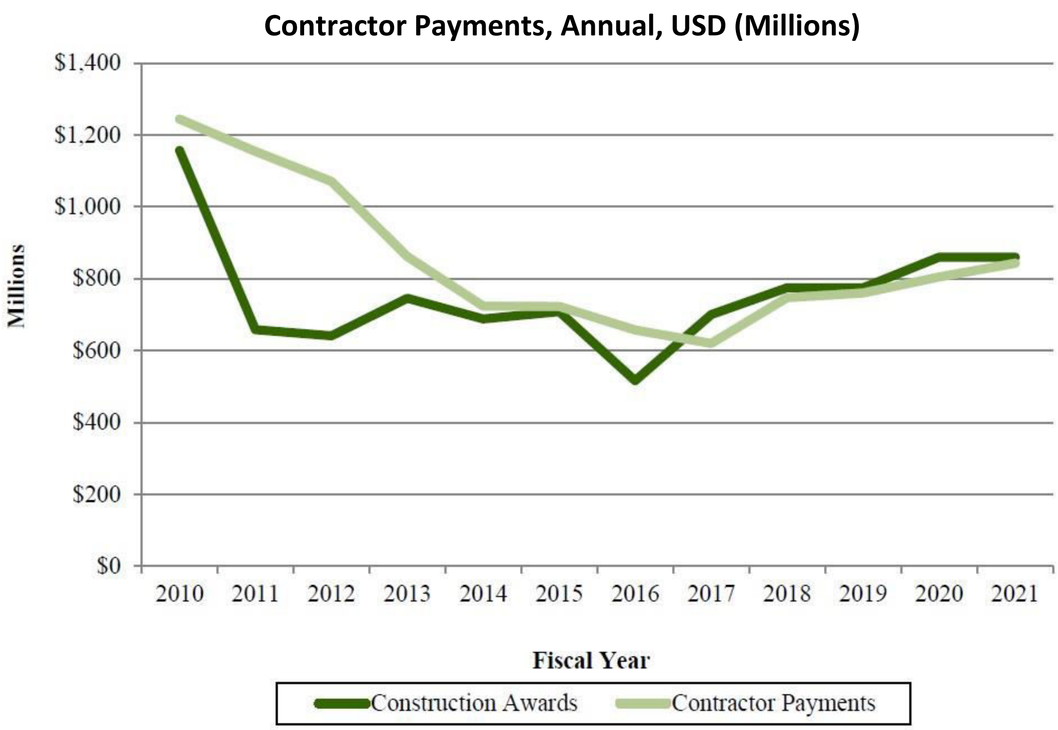
(b) For all Federal awards, any shared costs or matching funds and all contributions, including cash and third party in-kind contributions, must be accepted as part of the non-Federal entity's cost sharing or matching when such contributions meet all of the following criteria:
(1) Are verifiable from the non-Federal entity's records;
(2) Are not included as contributions for any other Federal award;
(3) Are necessary and reasonable for accomplishment of project or program objectives;
(4) Are allowable under Subpart E—Cost Principles of this part;
(5) Are not paid by the Federal government under another Federal award, except where the Federal statute authorizing a program specifically provides that Federal funds made available for such program can be applied to matching or cost sharing requirements of other Federal programs;
(6) Are provided for in the approved budget when required by the Federal awarding agency; and
(7) Conform to other provisions of this part, as applicable.

Financial stability of the Department

As indicated in Volume 2 (Budget Application) of MoDOT's ATCMTD proposal, the Department, and its financial statements pertaining to capital and operating expenditures, are subject to audit and review by both the Office of the State Auditor and FHWA. The most recent audit, completed in March 2017, covers the year ending June 30, 2016.

Summary of Actual and Projected Construction Awards and Contractor Payments

The graph below displays the relationship between construction awards and contractor payments. Prior to fiscal year (FY) 2011, MoDOT averaged annual construction awards of $1.2 billion. Most projects are not completed in the year awarded, but are built and paid for in subsequent years.



For example, approximately $250 million of projected FY 2017 contractor payments is for projects awarded in FY 2017. The remainder is for projects awarded in prior years. Awards declined dramatically in FY 2011, but contractor payments remained high as the prior year projects were completed. The FY 2013 contractor payments declined because awards in FY 2011 and FY 2012 reduced significantly. The information is based on the latest financial forecast that was used to develop the 2017-2021 STIP.

Commitment to DBE participation

MoDOT continuously strives to be a source of opportunity for all, and the Department maintains an active and responsive External Civil Rights (ECR) Division which administers our disadvantaged business enterprise (DBE) certification and promotion program. The Division also oversees a number of programs and resources which provide vital information in a variety of DBE and compliance areas, such as: business and work force development, contract compliance, and recruitment and retention. Notably, MoDOT's ECR Division organizes annual DBE symposia and related educational workshops to help expand contracting opportunities for eligible firms statewide.

ECR Division staff are responsible for MoDOT's external affirmative action, equal opportunity and non-discrimination programs, which include the Disadvantaged Business Enterprise Program, On-the-Job Training Program, Equal Employment Opportunity, Title VI, ADA and all other non-discrimination or affirmative action programs related to federal-aid contracting activities. Additionally, MoDOT's ECR Division staff members are the lead administrators of the Missouri Unified Certification Program, which includes St. Louis Lambert Airport, Bi-State Development (the St. Louis metropolitan region's primary transit operator), the City of Kansas City, and the Kansas City Area Transportation Authority.

Nationally, MoDOT ECR staff members are renowned as leaders in development and implementation of DBE best practices as they relate to innovative project types—both in terms of innovative project content and alternative delivery or P3 approaches—in what has become known nationally as "the Missouri Model." Generally, through extensive outreach and engagement with the DBE and WBE community, MoDOT has remained able to demonstrate results benchmarked against a number of comparatively aggressive DBE participation goals, even for non-traditional and highly innovative project types.

For larger projects and high-profile technology deployments, MoDOT's ECR Division has in the past created and staffed two regional Workforce/DBE Advisory Committees constituted through a series of community roundtable meetings for each project. These groups typically meet throughout the duration of the project to provide guidance and oversight to DBE and workforce initiatives in MoDOT's St. Louis and Kansas City District Offices.[2]

MoDOT continues to set high DBE goals and strives to meet those goals every year. The Department has been tracking DBE utilization is tracked for each construction project and the measure has been collected beginning in FFY 2012. For federal fiscal year (FFY) 2017 the MoDOT **overall DBE goal is 15.38 percent**. Through rigorous engagement and consultation with DBE/WBE partners in Missouri and nationwide, MoDOT will commit to retain our statewide and regional DBE goals for all uses of funds supported through the ATCMTD initiative.

Staffing Description

The project will be managed exclusively by MoDOT staff with some implementation support provided by vendors and contractors supplying and integrating the products and services being deployed. At the time of application (June 12, 2017) no specific vendor has been identified for any technology deployment described in this application, as the proposed Request for Proposal (RFP) documents will be issued in Federal Fiscal Year (FFY) 2018.

Primary Point of Contact

The primary point of contact for this proposal shall be Michael DeMers, Director of Innovative Partnerships and Alternative Funding at MoDOT. His contact information appears below:

Michael DeMers
Director of Innovative Partnerships and Alternative Funding
Missouri Department of Transportation
105 West Capitol Avenue
P.O. Box 270
Jefferson City, MO 65102

573-751-7452 (office)
Michael.DeMers@modot.mo.gov

Organization of MoDOT Program Management Staff

The following MoDOT staff members are slated to play key project management roles:

[2] "MoDOT ECR Connects the Dots Between Opportunity and Community," in *American DBE*, September 22, 2016.

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