Advancing Safety and Emergency Operations Through a Regional Connected Vehicle Corridor

2023-2024 Advanced Transportation Technology and Innovation (ATTAIN) Program

Volume 1: Technical Application

Eligible Project Costs $6,537,954
2023-2024 ATTAIN Funds Requested $5,037,606

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January 26, 2024

The Honorable Pete Buttigieg
United States Secretary of Transportation
U.S. Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

Dear Secretary Buttigieg:

I write today to ask for your support of the City of Madison's "Advancing Safety and Emergency Operations through a Regional Connected Vehicle Corridor" application to the FY 2023-2024 ATTIMD/ATTAIN Grant program.

Making Madison's streets safe for everyone has been one of my top priorities. In early 2020, I challenged staff across departments to join me in adopting a Vision Zero approach and find solutions to the increasing numbers of serious traffic crashes Madison was experiencing. Our goal is to eliminate traffic fatalities and serious injuries by 2035, and we believe that technology and innovation is a critical part of the solution.

The City's project deploys next generation emergency vehicle traffic signal preemption at 37 intersections and pilots snowplow traffic signal priority in association with red-light running collision warning systems, through signalized intersections in Madison along 10 miles of US 151, a critical roadway in the region serving and connecting many communities. Additionally, the program leverages the existing Smart City investments made along the Smart Park Street Corridor by the City. The Park Street Corridor and US 151 serve multiple priority census tracts and connect the community to hospitals and critical services, as well as serve surrounding municipalities.

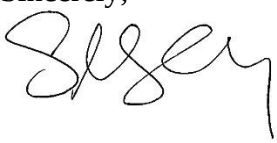
Working together with Madison's Traffic Engineering Division, Fire Department, Streets Division, as well as partnering with Wisconsin Department of Transportation and University of Wisconsin-Madison, the ATTAIN funding will be used to deploy advanced transportation technologies to improve safety, mobility, equity, efficiency, system performance, and infrastructure return on investment.

The project focuses on anticipating and addressing critical safety concerns by predicting traffic trajectory and red-light running conflicts. Additionally, the project will utilize Connected Vehicle (CV) technology that will create vehicle-to-infrastructure and infrastructure-to-vehicle (V2I/I2V) communication to enable the City to develop and deploy next generation traffic signal preemption for emergency vehicles such as fire trucks and ambulances. The project will also enable the City's snowplows to move through the corridor more efficiently to improve the effectiveness of snow

plowing operations and to reduce weather related crashes. This approach aligns with USDOT's strategic goals as well as ATTAIN Grant Program priorities.

The deployment of advanced transportation technologies along the project corridor will strengthen our system of transport, contribute to growth in our region, reduce vulnerable roadway user injuries and save lives and most importantly, provide an example of innovation and a model of city-State collaboration for cities in Wisconsin and across the United States. Our across-agency team has an excellent record in managing federal grants and delivering results. I strongly support the City of Madison's application and look forward to the infrastructure investment in our region through the Bipartisan Infrastructure Law. Please give this 2023-2024 ATTAIN Discretionary Grant proposal your full consideration.

Sincerely,



Satya Rhodes-Conway
Mayor

Advancing Safety and Emergency Operations Through a Regional Connected Vehicle Corridor

Volume 1: Technical Application

Submitted by City of Madison, Wisconsin

2023-2024 Advanced Transportation Technology and Innovation (ATTAIN) Program

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Advancing Safety and Emergency Operations Through a Regional Connected Vehicle Corridor

Volume 1: Technical Application

Submitted by City of Madison, Wisconsin

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Project Name	Advancing Safety and Emergency Operations through a Regional Connected Vehicle Corridor
Eligible Entity Applying to Receive Federal Funding	City of Madison, WI
Total Project Cost (from all sources)	$6,537,954
Advanced Transportation Technology and Innovation Program Request	$5,037,606
Are matching funds restricted to a specific project component? If so, which one?	No
State(s) in which the project is located	Wisconsin
Is the project currently programmed in the: ▪ **Transportation Improvement Program** ▪ **Statewide Transportation Improvement Program** ▪ **MPO Long Range Transportation Plan** ▪ **State Long Range Transportation Plan**	No, however incorporating Connected and Automated technologies are important objectives in local, regional and state transportation plans although this specific project is not programmed. Madison in Motion Master Transportation Plan Regional ITS Strategic Plan for the Madison Metropolitan Area Connect Greater Madison 2050 Regional Transportation Plan WisDOT Connect 2050 Statewide Long-Range Multimodal Transportation Plan
Technologies Proposed to Be Deployed (briefly list)	Advanced Safety Systems and Transportation Technologies for Emergency Response: ▪ CV Based Red-light Running Collision Warning Systems ▪ Next Generation Emergency Vehicle Preemption

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Will the project use connected vehicle technologies? **If so, which technologies will be used—for instance, will the project use:** ▪ **DSRC/5.9 GHz spectrum?** ▪ **Cellular/4G/5G communications?** ▪ **Another connectivity technology? (please specify - e.g., "Wi-Fi," "Bluetooth," "RFID," etc.)** ▪ **If the connectivity technology has yet to be determined, please specify "TBD."**	Yes. Cellular Vehicle to Everything (C-V2X)
Will the project use automated driving system technologies?	No
Rural Considerations: **a) Is the project serving a rural area(s)? A rural area is an area with a population of less than 50,000 residents according to the 2020 Census population estimates.**	No
b) If yes, how much ATTAIN funding is being requested to be put toward serving the rural area(s)?	N/A

II. PROJECT NARRATIVE

Project Summary

The Advancing Safety and Emergency Operations through a Regional Connected Vehicle Corridor Project (herein known as the Project) targets two critical safety needs and deploys next generation traffic signal preemption for emergency vehicles and red-light running collision warning systems, through 37 signalized intersections in Madison along approximately ten miles of US 151, a critical roadway in the region. The Project focuses on anticipating and addressing critical safety and operational concerns by predicting traffic trajectory and red-light running conflicts and by deploying technology to improve emergency operations for roadway safety.

Introduction

The City of Madison, Wisconsin (herein known as the City), in partnership with the Wisconsin Department of Transportation (WisDOT) and the University of Wisconsin-Madison (UW-Madison), requests $5,037,606 in federal discretionary funding through the 2023-2024 Advanced Transportation Technology and Innovation (ATTAIN) Program. The federal funding will advance the goals of the ATTAIN Program and Biden-Harris Administration's Priorities by deploying advanced technologies and integrating them with existing systems to improve safety and access for essential services.

Advancing Administration's Priorities

Safety: Safety is the driving force behind this Project. The construction of a comprehensive Vision Zero Technology and Innovation Corridor along US 151 allows the City to pursue two main connected vehicle applications: Red-Light Running Collision Warning System and Next Generation Emergency Vehicle Preemption (EVP), and to test Snowplow Signal Priority. These systems together will further advance safety along this regionally significant corridor, a crucial goal for the USDOT, City of Madison, and WisDOT, in addition to advancing technology and innovation.

Climate Change and Sustainability: The Project will improve efficiencies in emergency response and build a foundation for numerous future CV applications that will enhance transportation management to the next level. The benefits from the proposed technologies will contribute towards the climate change and sustainability goals established by the USDOT, City of Madison, and WisDOT.

Equity: The development of the Vision Zero Technology and Innovation Corridor, as a result of this Project, removes transportation related disparities to all populations in this regionally significant area, and increases equitable access to project benefits. The proposed safety improvements target disproportionate crash rates associated with vulnerable road users (VRUs) within the City's three disadvantaged census tracts along the corridor, while generating faster, safer, and equitable access to emergency response and healthcare facilities located along US 151.

Workforce Development, Job Quality, and Wealth Creation: The Project will create a pipeline of good paying jobs incorporating strong labor standards by training existing and developing future workforce opportunities. This will be achieved through apprenticeship and internship programs offered through the City's Traffic Engineering Division and UW-Madison. The workforce development program would also provide opportunities for historically underrepresented groups, in alignment with the goals of USDOT, City of Madison, and WisDOT.

Traffic signal preemption systems can do much more than simply giving a green light to an emergency vehicle. The Project will utilize the next generation of preemption systems that combine advanced communication and detection systems to address response times, safety, and intersection collision avoidance in much more comprehensive ways. Using the vehicle location and movement information from connected vehicles (CV) and the infrastructure measurement of non-equipped vehicles, the Project will improve the operations of traffic signal control systems along ten miles of US 151, to address two critical safety needs:

- red-light running collision warning, and
- improved emergency vehicle preemption for faster response.

Description of the Geographic Area

The Project is in Madison, Wisconsin, an urban area with a population of 269,840, per the 2020 Census-designated urban areas definition. It is the capital city of Wisconsin and the county seat for Dane County. Madison is designated as a mid-sized city and is a part of the Greater Madison Metropolitan Planning Organization (MPO). As the regional center for employment, education, and health care, Madison streets serve nearly three quarter million residents and visitors daily. Upon completion, the Project would connect and serve the residents of the region to the key healthcare facilities in the vicinity of this corridor.

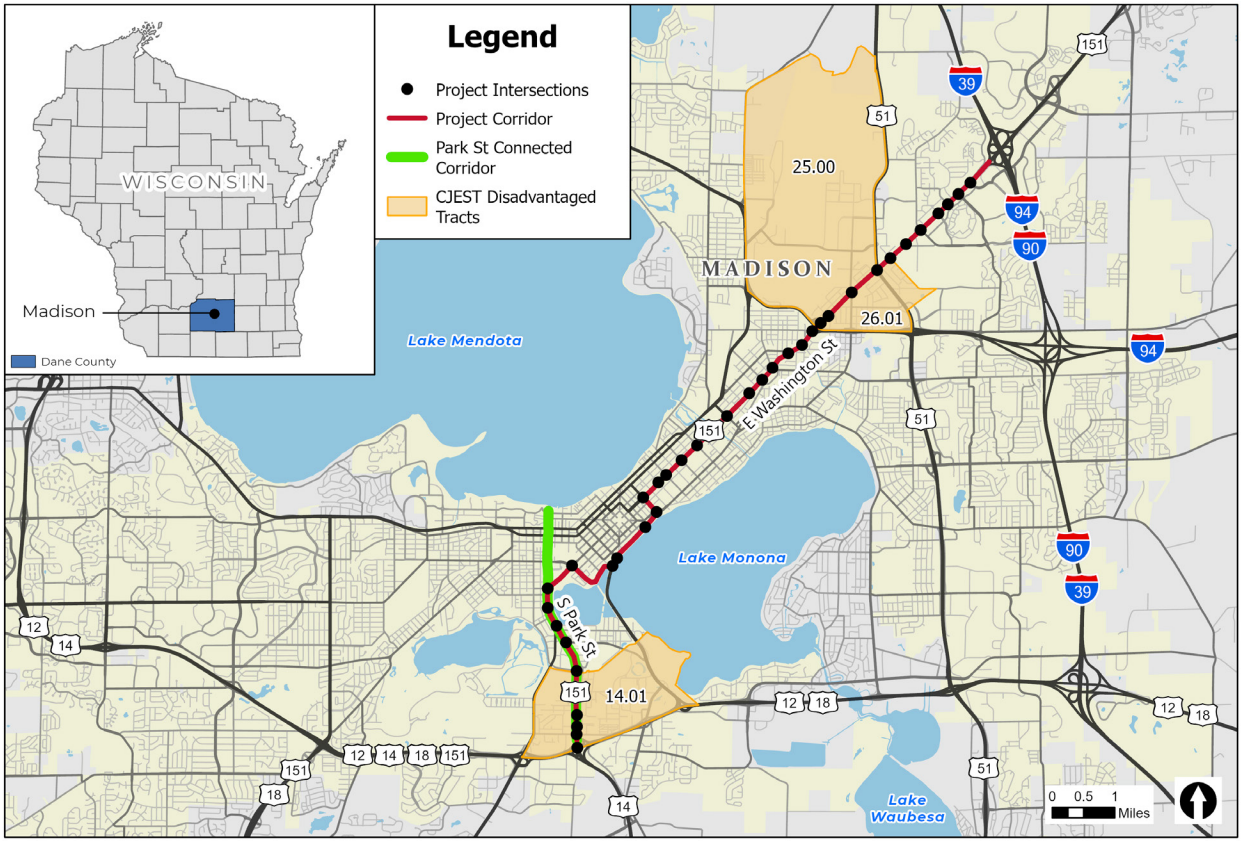


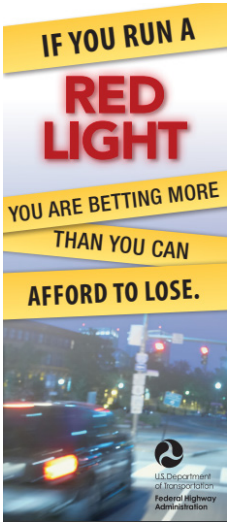
Figure 1-1. Project Location: Vision Zero Technology and Innovation Corridor along US 151

United States Highway (US) 151 is a principal arterial roadway that runs through downtown Madison. The Project deploys and/or pilots advanced transportation technologies at 37 intersections along approximately ten miles of US 151, bound by I-90/I-94/I-39 to the northeast and the Beltline (US 12/14/18/151) to the south (Figure 1-1). US 151 carries an annual average daily traffic (AADT) up to 52,650 vehicles per day (vpd) within these limits, while I-90/I-94/I-39 carries 72,200 vpd and the Beltline carries 129,000 vpd. The north-south section of US 151 between W Washington Avenue and the Beltline is also known as S Park Street, which is a part of Wisconsin's first CV corridor established in January 2017. The Project leverages existing local and state investments in smart city technologies on Madison's Park Street Connected Corridor (PSCC) spurred by the 2015 United States Department of Transportation's (USDOT) Smart City Challenge Grant Application, and synergizes with other Bipartisan Infrastructure Law grants that Madison has received.

An important objective of the Project is to leverage the strong collaboration between the City and WisDOT by connecting the City's CV corridor to the State managed interstates at the south and the northeast edges of the City. Building on the previous city-state system collaboration with the S Park Street CV project, which included city-state operational data sharing, the Project will create a corridor that extends from I-90/I-94/I-39 to the northeast, through the most significant transportation and economic artery of the city, to the Beltline (US 12/14/18/151) to the south, known as the Vision Zero Technology and Innovation Corridor. The City and WisDOT will work together to integrate data sharing between the two jurisdictions that handle significant freight and economic importance for the region.

The Project lies partially in disadvantaged communities within census tracts 55025001401 (14.01), 55025002601 (26.01), and 55025002500 (25.00). Based on the Climate and Economic Justice Screening Tool (CEJST), both tracts 14.01 and 26.01 are designated as disadvantaged in Transportation (traffic proximity and volume AND low income) and Water and Wastewater (underground storage tanks and releases OR wastewater discharge and volume AND low income) categories, while tract 25.00 is designated as disadvantaged in Legacy Pollution (formerly used defense sites AND low income) and Workforce Development (low median income AND high school education) categories.

Real World Issues and Challenges



One of the primary needs of the Project is to improve the safety and operational challenges through the 37 signalized intersections along US 151. The following is a discussion of the real-world issues and challenges and proposed technology deployment to address those challenges.

1. Red-Light Running Intersection Crashes

According to National Highway Traffic Safety Administration (NHTSA) Fatality Analysis and Reporting System (FARS), one-third of all intersection fatalities occur at signalized intersections, including a large proportion that involve red-light running. There have been 54 fatal and serious injury crashes along US 151 within the Project corridor over the last five years (December 2018 – November 2023). Of these, 61 percent or 33 crashes were at intersections or were intersection related. Further, 20 percent or 11 crashes involved red light running.

Half of the fatal and serious injury crashes occurred at nighttime while four percent of the crashes had snow or icy roadway conditions. It must be noted that most of the snow-related crashes were documented as lower severity crashes.

12	42	260	295	1301
fatal crashes	serious injury crashes	minor injury crashes	possible injury crashes	property damages only

Table 1-1. Total Crashes by Severity along Project Corridor from December 2018 – November 2023

Successful CV implementation is expected to minimize the severity and frequency of incidents with rapid detection response and better real-time traveler information.

2. Emergency Vehicle Response Time

Madison boasts a robust health system along US 151 that provides comprehensive medical services to the region. Several reputed healthcare facilities such as UW Health System, UnityPoint Health-Meriter Hospital, and SSM Health St. Mary's Hospital are in the vicinity of the Vision Zero Technology and Innovation Corridor (Figure 1-2). These include Level I and Level II Trauma Centers. The proximity of US 151 to these facilities ensures convenient and timely access for all users. In addition, there are several fire stations and police stations located within half a mile of the Project corridor.

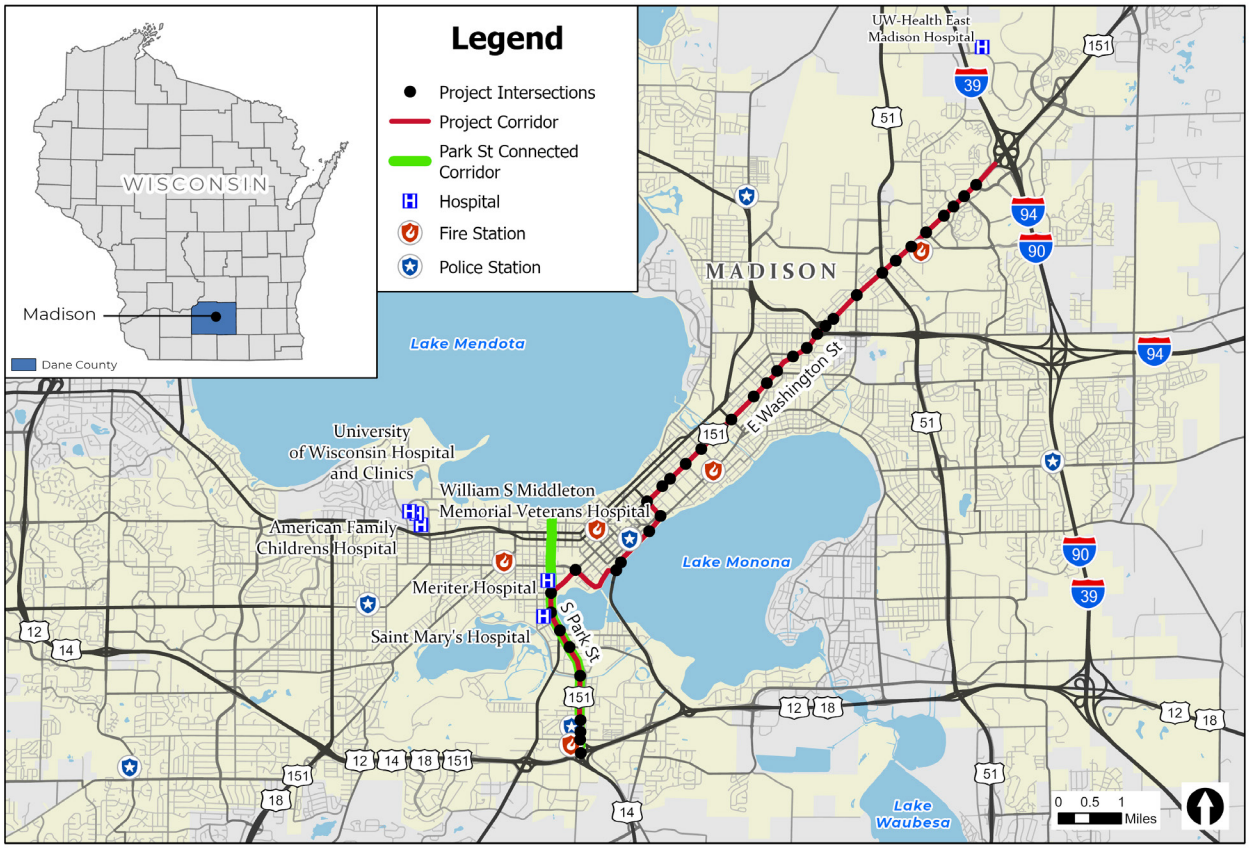


Figure 1-2. Madison's Healthcare Facility near the Vision Zero Technology and Innovation Corridor.

Based on City of Madison's Emergency Management Office data, the Vision Zero Technology and Innovation Corridor averaged 50 emergency vehicle responses per day between August 2022 and July 2023. Of these, an average of 30 responses per day were along the existing Park Street Connected Corridor. Each incident had unique circumstances and needs for first responders. Some responses were relatively short in duration, while others consisted of return trips including patient stabilization and transport extending up to two hours. Due to this complexity, the reported Global Positioning System (GPS) speed data of zero (0) mph was omitted from further analysis.

The average non-zero speed of emergency vehicles was reported to be 26 mph on the existing Park Street Connected Corridor and 30 mph on the Vision Zero Technology and Innovation Corridor. This leads to impaired incident management and emergency response as Madison's emergency response departments (Fire, Police, and Healthcare systems) are not able to optimize their response to events and incidents. The lower travel speeds result in longer periods to time-on-scene, which delays emergency response, delays care to injured victims, and slows law enforcement interventions.

Proposed Technologies

The Project envisions a comprehensive approach to intersection safety that leverages connected vehicle and detection technologies to improve emergency operations and user safety. There are two major subsystems of the Project that interact to enhance the safety of the corridor:

1. **Connected Vehicle (CV) Red-Light Running Collision Warning System**: The City and project partner WisDOT are committed to leveraging existing investments along PSCC and further deploys connected vehicle technologies along the Vision Zero Technology and Innovation Corridor, to advance their shared vision of enhancing the safety and efficiency of transportation systems. The red-light running collision warning system warns of impending red-light violations using thermal cameras, roadside units (RSUs), and machine learning to an on-board unit (OBU) in a vehicle (Figure 1-3). Compact video units with integrated connected vehicle (C-V2X) hardware are now available and include object detection and recognition. Using these advanced units, an unsafe condition can be determined and communicated to a vehicle mounted OBU to provide driver alerts. By alerting drivers to a potential collision with a red-light violator, the system can reduce fatal and serious injury crashes.

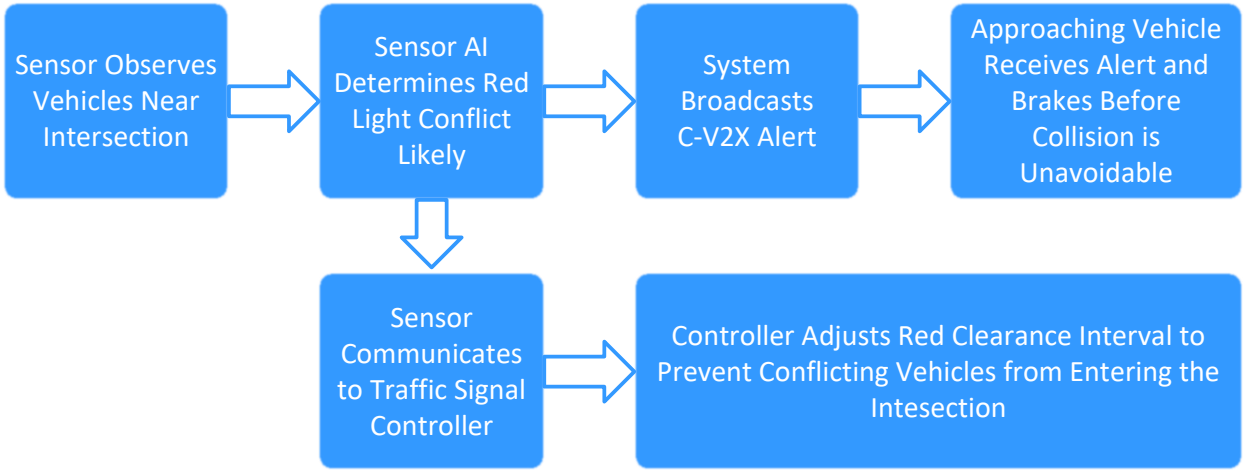


Figure 1-3. CV Red-Light Running Collision Warning System

1. **Next Generation Emergency Vehicle Preemption (EVP):** The Project will incorporate the architecture of the Multi-Modal Intelligent Traffic Signal System (MMITSS) to deploy the next generation of traffic signal systems that seeks to provide a comprehensive traffic information framework to service all modes of transportation, including general vehicles, transit, emergency vehicles, freight fleets, and pedestrians and bicyclists in a connected vehicle environment (Figure 1-4).

The Automatic Vehicle Location (AVL) based EVP is distinguished by several features:

- The system is based on data communications from the vehicle to a central management system rather than a simple optical or acoustic transmitter on the vehicle and receiver at each equipped intersection.
- Preemption calls to signal controllers are based on vehicle's position and path, rather than a simple optical receiver at the intersection.

- Next Generation EVP is managed centrally by software such as Centracs Priority, which leverages both AVL and Computer Aided Dispatch (CAD) data. By knowing both the current position and destination of a vehicle, Next Generation EVP can clear traffic queues before a responder arrives. Legacy systems may begin a green phase, only to have the route impassable due to other vehicles blocking the road.
- The centrally managed nature of Next Generation EVP also allows for strategies to minimize traffic congestion that can result from preemption. In addition to improving mobility, minimizing congestion also decreases the likelihood of secondary crashes in traffic queues.

The CV-based EVP is distinguished by several features:

- The system is based on data communications from the vehicle to RSUs using radio frequencies that do not require line-of-sight which significantly increases the range of preemption calls and allows phases to be cancelled and queues cleared before the vehicle arrives at the intersection.
- The low-latency technology allows two-way communication between the vehicle and traffic signal to both pass preemption requests to signals only when appropriate and provide feedback to the vehicle operator of traffic signal status and other travelers when using traffic signal-based sensors.

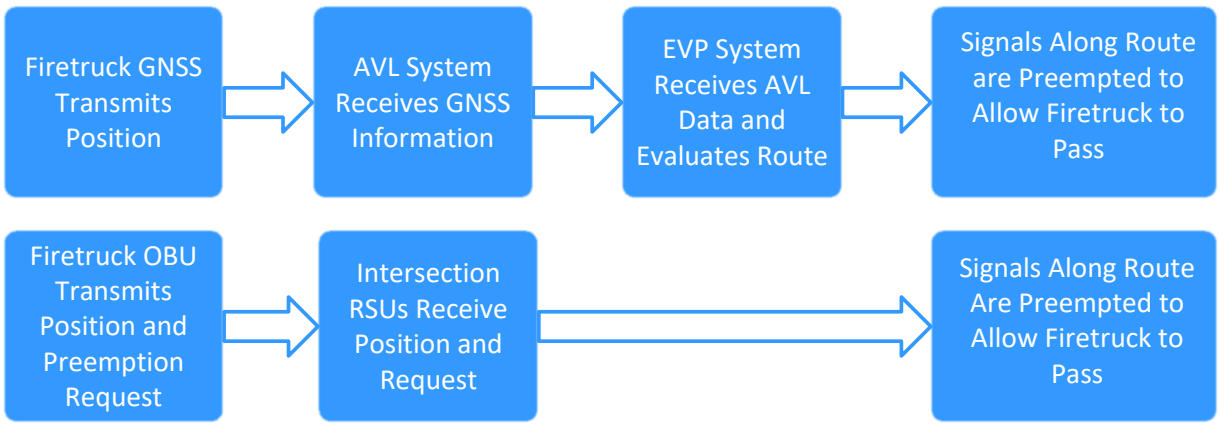


Figure 1-4. Next Generation Emergency Vehicle Preemption

Road Traffic Digital Twin System: The Project will develop a Road Traffic Digital Twin (DT) System aimed at efficiently monitoring, alerting, and managing traffic systems. The foundation of the DT system is comprehensive data collection, encompassing both static and dynamic data. Static data would include GIS map data and high-precision mapping from radar-equipped vehicles (Figure 1-5). Dynamic data would comprise of real-time traffic updates from the WisDOT 511 platform and additional radar and video data from roadside detectors (Figure 1-6).

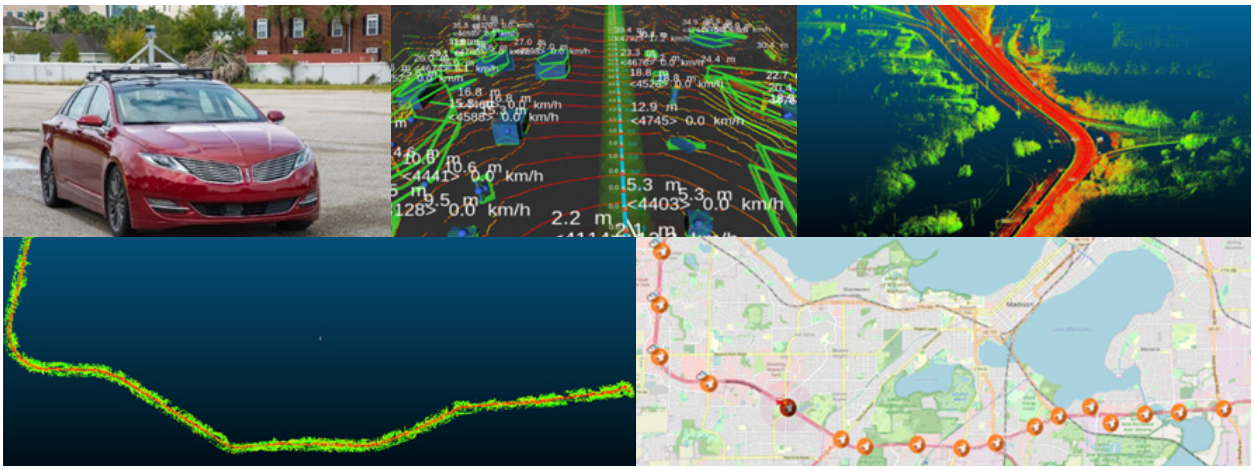


Figure 1-5. Static Data Collection for Digital Twin System

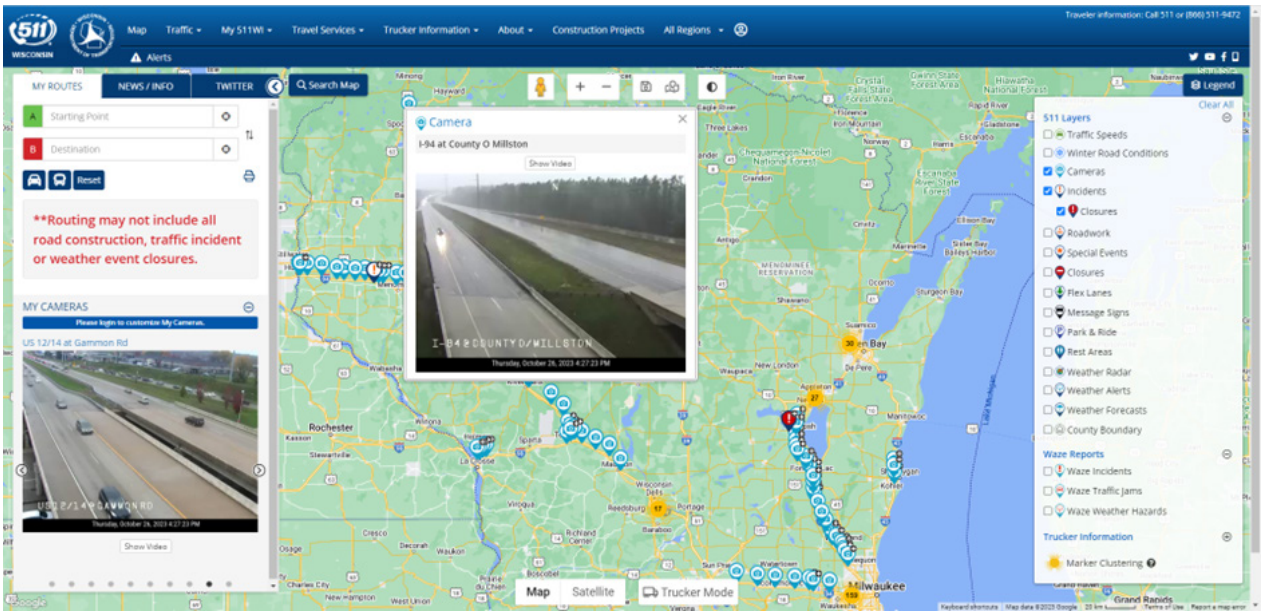


Figure 1-6. Real-time Traffic Conditions on 511 Wisconsin Website.

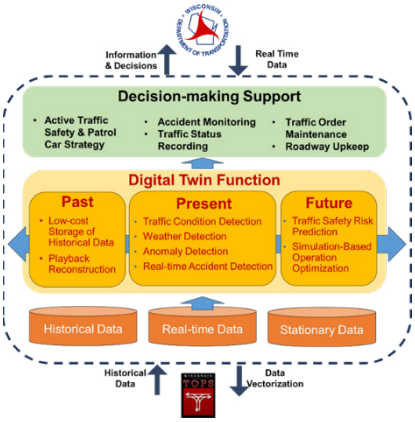


Figure 1-7. Digital Twin System Framework

The DT system would create a real-time Digital Twin of traffic scenarios, reconstructing current conditions based on comprehensive data. The Digital Twin will serve as a crucial tool for analyzing historical trends, monitoring present situations, and predicting future traffic patterns. Based on the twinning of the physical traffic system, the DT system would provide traffic managers with real-time decision support, including monitoring and evaluating traffic conditions for swift decision-making, pinpointing and responding to anomalies like snow accumulation or unexpected road blockages, and employing predictive analytics to anticipate and prevent potential accidents (Figure 1-7).

Foundation for Future CV Safety Applications: This Project will also provide a framework to expand application of the CV technology to detect and warn pedestrians, at a later stage. The same technology that warns of red-light running collisions can also provide indications of pedestrian presence to increase driver awareness. Deploying a compact, reliable detection and RSU unit can identify pedestrians in low visibility conditions and broadcast alerts to vehicles. The increased situational awareness enables drivers to take actions earlier, and in more operational cases, to avoid crashes with crossing pedestrians. Some of the future safety applications are the following:

- Snowplow Signal Priority during inclement weather, (see page 18)
- Adaptive Traffic Signal Control
- SPaT: Signal Phasing and Timing will be based on CV traffic volume
- Congested Intersection Adjustment
- Left Turn Assist (LTA)
- Turning Assistant - Vulnerable Road User Avoidance
- Crossing Vulnerable Road User Advisory
- Freight Signal Priority
- Dilemma Zone Protection

These proposed advanced technology solutions together will create foundations for further enhancement of connected vehicle corridor technology.

Project Alignment with the ATTAIN Program

Appendix B, Table B-1 identifies how the Project addresses the vision and goals of the ATTAIN program, along with its alignment with Administration's Priorities and DOT Focus Area. The creation of Vision Zero Technology and Innovation Corridor will be a major and vital step in providing the backbone and foundation of a connected technology system which will enable the City to implement the two main elements of the Project and be the basis for future deployments of additional safety applications that support the USDOT's goals and objectives.

Alignment with Program Vision and Program Goals

The continued efforts of the City and its partners, since technological advancements and investments began in 2016 along the Park Street Connected Corridor, directly addresses critical safety concerns along US 151 in Madison by employing red-light running coalition warning system that will warn vehicles equipped with OBUs of impending red-light violations and enhance the safety of this connected corridor. Between 2018 and 2023, 20 percent of the 54 fatal and serious injury crashes along the Project corridor involved red-light running. The vehicle-to-infrastructure (V2I) technologies will address the high crash rates by improving signal phase and timing.

The Project aligns with Federal Highway Administration's (FHWA) vision and goals for the ATTAIN program as advanced traveler information system technologies are integrated into the routine operations of Madison's Fire Department and Emergency Medical Services (EMS) to provide real-time, predicted, and individualized information about travel choices based on data from traffic sensors. This integration of technology plays a critical role in local transportation infrastructure by enhancing both safety and operational efficiency of the Fire Department and EMS.

The Project also provides benefits by maximizing efficiencies based on the management of assets and the sharing of information using integrated technology solutions. The City and its partners, WisDOT and UW-Madison, intend on employing these advanced technology solutions and the lessons learned from this deployment to other locations throughout Wisconsin, by scaling up the scope and size, thereby, providing widespread benefits to the public and agencies. The Project will advance the objectives of the Program through reproducibility of successful systems and services for technology and knowledge transfer to other locations facing similar challenges.

Alignment with Administration's Priority

The Project seeks to advance the priorities of the Biden-Harris Administration by advancing safety and mobility of emergency operations. The proposed technologies will lead to a cohesive solution with a goal of achieving zero roadway deaths through a Safe System Approach. The City of Madison believes that fatalities and injuries on city streets are preventable and has committed to a proactive approach of prioritizing human life over the movement of motor vehicles, as adopted in the City's Vision Zero plan and in alignment with National Roadway Safety Strategy (NRSS). The Project also focuses on reducing greenhouse gas and criteria pollutant emissions by improving mobility and reducing idling and travel times (through signal priority, intelligent traffic signal systems, and work zone applications), which then leads to enhancing environmental sustainability by reducing overall fuel consumption and emissions.

As the Project generates safety and mobility benefits to communities in CEJST designated disadvantaged tracts 14.01, 26.01, and 25.00, it will lead to creating proportional impacts to all populations in a Project corridor by improving emergency response time, removing transportation related disparities, and increasing equitable access to project benefits. In addition, the Project also generates quality jobs and access to wealth creation by developing future workforce opportunities through the use of apprenticeship and internship programs.

Alignment with DOT Focus Area

The Project investments will help ensure a state of good repair by monitoring transportation assets to improve infrastructure management, reduce maintenance costs, prioritize investment decisions, and ensure a state of good repair. Results of the research associated with investigating the snowplow signal priority systems in Madison will assess improvement to the durability and extension of the life of transportation infrastructure, further leading to informed policy decisions. The City commits

to making relevant data available to FHWA and the public to further advance the objectives of the ATTAIN program.

Description of Transportation Systems and Services

The Project will employ technologies at the roadside, on vehicles, and in remote locations for data processing. Hardware systems include an additional 30 RSUs deployed in the corridor, 25 emergency response and snowplow* mounted OBUs, and 30 upgraded intersection traffic signals. Software deployed will include the new Next Generation EVP system to provide enhanced preemption and shortened response times. The Project will also deploy a variety of software systems to enable functionality along the corridor. Hardware and software are summarized in the table below.

Table 1-2. Project Hardware

Type	Quantity
Connected Vehicle Camera and Roadside Units (RSU) for Signal Phasing & Timing (SPaT)	16
Connected Vehicle Roadside Units (RSU) only	14
Upgraded Traffic Cabinets	15
Temporary Signals	15
Signal Upgrades	17
Fire EVP Onboard Units (OBUs)	10
Snowplow OBUs *(after state statute update to allow deployment)	15

Table 1-3. Project Software

Type	Quantity
Next Generation EVP Software (Centracs Priority) Licenses	14
EOS Controller Software Updates	2
Machine Learning (ML) Traffic Prediction Server	1
API for AVL-CAD Compatibility	1

Deployment Plan

Project Leadership Team

The City of Madison and project partners WisDOT and UW-Madison have an extensive history of successful intelligent transportation system (ITS) and transportation systems management and operations (TSMO) deployments and have created a robust staffing and organizational structure to ensure effective operations and maintenance of their investments. The Project leverages and builds on the existing local and state investments in Madison's PSCC project, Wisconsin's first CV corridor. Therefore, the project management and leadership structure for planning, designing, deployment, operations, and maintenance is already in place. Section III Management Structure

provides further discussion of individual roles and responsibilities among the project team including an organizational chart and specific contacting mechanisms.

Consultants and Vendors

The City will identify a project team consisting of vendors, contractors, and on-call consultants, to issue contracts lasting throughout the lifecycle of the Project. Refer to the Schedule in section II.12 for high-level work breakdown structure of the Project. Additionally, on-call consultants will prepare the preliminary engineering and final engineering design; vendors and contractors along with researchers at UW-Madison will perform the software development and deployment, and on-call "areawide" contractors will perform the infrastructure construction. The City will also issue on-call contracts for field infrastructure and software maintenance (preventative and emergency).

Operations and Maintenance

The CV system will be vendor-developed and operated, but the City will operate and maintain the connections of City's systems to the CV ecosystem. Data analysis and visualizations will be provided through City's existing agreement with UW-Madison. The City, WisDOT, and UW-Madison have a comprehensive team including ITS technical analysts, system managers, IT support, developers, ITS field technicians, and project management support that maintains the existing ITS assets and systems. This experienced team will guide the development of the proposed technologies and their connection to other systems, and they will provide the day-to-day operations and maintenance functions and oversee development of future system enhancements.

The Project team assembled for this project, the City of Madison, the Wisconsin Department of Transportation, and the University of Wisconsin-Madison Traffic and Operations Safety (TOPS) Laboratory, have proven their capability to deliver based on their previous collaboration on the City of Madison's Park Street Connected Vehicle Corridor, which is the predecessor to this ATTAIN grant proposed project. The team have the proven expertise and qualifications to successfully manage and sustain the deployed systems through their full life cycle, well beyond the period of performance.

Continued operations and maintenance funding is anticipated in the City's future budget allocations to ensure long-term program success beyond the period of performance.

Performance Measurements

The Project team has noted the following potential measurements, likely to be included in performance reporting:

Table 1-4. Potential Performance Measures

Performance Category	Potential Metrics
Emergency vehicle related metrics	Traffic crashes with emergency vehicles
	Corridor segment travel time
	Number of stops at signalized intersections
	Total delay at signalized intersections
	Number of slowdowns at signalized intersections
Snowplow related metrics, (see page 18)	Traffic crashes with snowplows
	Corridor segment travel time
	Number of stops at signalized intersections
	Total delay at signalized intersections
	Number of slowdowns at signalized intersections
	Fuel consumption
	Emissions
Other corridor safety and operations metrics	Total crashes
	Total serious injury and fatal crashes
	Total red-light running crashes
	Total snow-related crashes
	Vehicles arriving on red-light
	Intersection delay after emergency vehicle preemption
	Corridor segment travel time during and after snowstorms

Challenges or Obstacles to Deployment

There are no anticipated challenges in the regulatory, legislative, or institutional environments to deployment of the technology behind the red-light running collision warning systems. The CV red-light safety sensors and the RSUs used for the Project are products/technology readily available. Wisconsin state law does not allow video for vehicle identification and speed enforcement. This system will not retain video recordings that conflict with Wis. Stat. § 349.02(3) regarding the use of photographic identification to determine compliance with state or local traffic laws.

Similarly, there are no challenges expected with the procurement of digital hardware and software infrastructure to support the deployment of next generation emergency vehicle traffic signal preemption.

The City, along with project partner WisDOT, is working with the City of Madison Fire Department (MFD) and Emergency Medical Services (EMS) to phase the deployment of OBUs on emergency vehicles and address any obstacles identified during the process.

WisDOT is a key partner and a strong champion of deployment of advanced traffic technologies and supports the City in leveraging the existing investments in this regionally significant Connected Vehicle Corridor.

The deployment of red-light technology comes with an Information Technology Cybersecurity concern. The City will appropriately address any cybersecurity concerns in the deployment of these technologies through its established risk management guidelines and procedures. The regional infrastructure of the Statewide and Regional ITS Architectures will also be updated.

Quantifiable System Performance Improvements

The proposed Project consists of multiple integrated applications with four main parts:

- Advanced Detection - Optical, LIDAR, thermal, and radar-based sensors at traffic signals
  - » Road user trajectory tracking and near-miss detection
  - » Road user trajectory tracking and translation to CV-based basic safety messages
  - » Vehicle tracking and red-light running collision prediction
  - » Pedestrian tracking and pedestrian phase call and extension
- Fleet Tracking - Automatic Vehicle Location (AVL) system
  - » GPS-based devices for traffic signal preemption for emergency vehicles
- Advanced Traffic Controller
  - » Enables detection and provision of rules to provide advanced priority and timing changes
- Connected Vehicle Equipment - Roadside units (RSU) and onboard units (OBU) for connected vehicle applications. This system will include a security credential management system to maintain integrity, authenticity, privacy, and interoperability.
  - » Connected-vehicle-based traffic signal preemption for emergency vehicles
  - » Red-light collision warning messages for equipped vehicles
  - » Communication of road user basic safety messages to equipped vehicles where advanced detection is installed, enabling conflict warning messages
  - » Signal Phase and Timing messages for equipped vehicles

Benefits to Affect Traffic-Related Crashes

The proposed Project components have the potential to reduce traffic-related crashes. The Vision Zero Technology and Innovation Corridor includes three CEJST designated disadvantaged census tracts that have a higher presence of VRUs. These non-motorized users will benefit from safety improvements due to the Project. Historically, 20 percent of serious injury and fatal crashes on the corridor involved red-light running. The red-light running collision warning system will use advanced detection to predict red-light collisions, transmit a warning to OBU-equipped vehicles, and extend the red-light for conflicting signal phases. Red-light running crashes have been documented to be reduced by 32 percent by using dynamic all-red extension in a multi-lane context. This would equate to a six percent reduction in serious injury and fatal crashes along the corridor.

Historically, 46 percent of serious injury and fatal crashes on the corridor involved pedestrians, with roughly half of those occurring at signalized intersections. Passive pedestrian detection at signalized intersections is a promising technology with a recent study noting 89 percent accuracy using a

thermal camera. The study also noted that 25 percent of pedestrians who crossed during the "Do Not Walk" phase did so without pushing the pedestrian pushbutton. Using advanced detection, pedestrian calls to the traffic signal can be placed and dynamic pedestrian phase extension can be used to extend walk phases to safely allow slower moving pedestrians to fully cross the project corridor. This walk phase extension has been found to reduce pedestrian crashes by 51 percent equating to 12 percent reduction in serious injury and fatal crashes along the corridor.

In addition to the real-time applications of the advanced detection proposed in the Project, patterns of near-miss events can be used to adjust traffic signal timing and roadway geometric features to improve safety over time. This data-driven approach of using surrogate measures to diagnose and evaluate safety has been used by City staff for other Vision Zero projects throughout the City and offers significant long-term safety benefits for this corridor.

Optimizing System Efficiency

Post-Crash Care is a critical element in USDOT's Safe System Approach and National Roadway Safety Strategy (NRSS). Several technologies are currently deployed across the country to preempt traffic signal operations for emergency vehicles. These technologies include acoustic, optical, radio, and GPS. The City currently has optical EVP installed at many of the traffic signals along the Project corridor. Where installed, the EVP offers some travel time reduction benefits for emergency vehicles, but there are several limitations for the use and expansion of optical EVP:

- Preempts traffic signals unnecessarily when an emergency vehicle turns before a traffic signal that is within its line-of-sight
- Has limited range which delays the request for preemption and can lead to queuing of vehicle traffic on approach to the intersection and minimization of a preemption during a pedestrian crossing phase

The Next Generation traffic signal preemption included in the Project will deploy GPS-based and CV-based systems to enable an evaluation of these improved technologies over the same corridor. Specifically, the GPS-based preemption allows specific routes to be incorporated into the preemption algorithm that gives only traffic signals that will be along the emergency vehicle's path to receive advanced notice of the preemption request. This will improve the travel for the emergency vehicle, minimizes the effects on other travelers at traffic signals it passes, and does not affect other adjacent traffic signals. The CV-based system will leverage radio communication to extend the range of preemption requests and when coupled with advanced detection allows communication from the traffic signal about the movements of other road users in the intersection to assist emergency vehicles safely navigating the intersection.

Quantifiable Safety, Mobility, and Environmental Benefit Projections

The safety, mobility, and environmental benefits of CV infrastructure investments through this Project and the existing PSCC project will significantly and positively impact the transportation system of Madison. Connected vehicles are expected to improve safety by reducing crashes, improve mobility by reducing travel times (through signal priority and intelligent traffic signal systems), and enhance environmental sustainability by reducing overall fuel consumption and emissions. As noted in the

preceding section, the Project will improve safety and operational outcomes along the corridor, with specific emphasis on emergency vehicles, snow clearing, and red-light running.

Vision, Goals, and Objectives

The City and WisDOT both recognize the importance of deploying advance transportation technologies towards improving the safety of overall transportation network in Madison as well as enhancing the operational efficiencies of the emergency vehicles and inclement weather operations. The proposed technologies will support City's priority of "implementing traffic safety measures in a fair and equitable manner to eliminate traffic deaths and serious injuries on City streets", thereby improving the status quo of the existing transportation system in Madison.

The High Injury Network, Areas of High Poverty, & Communities of Color

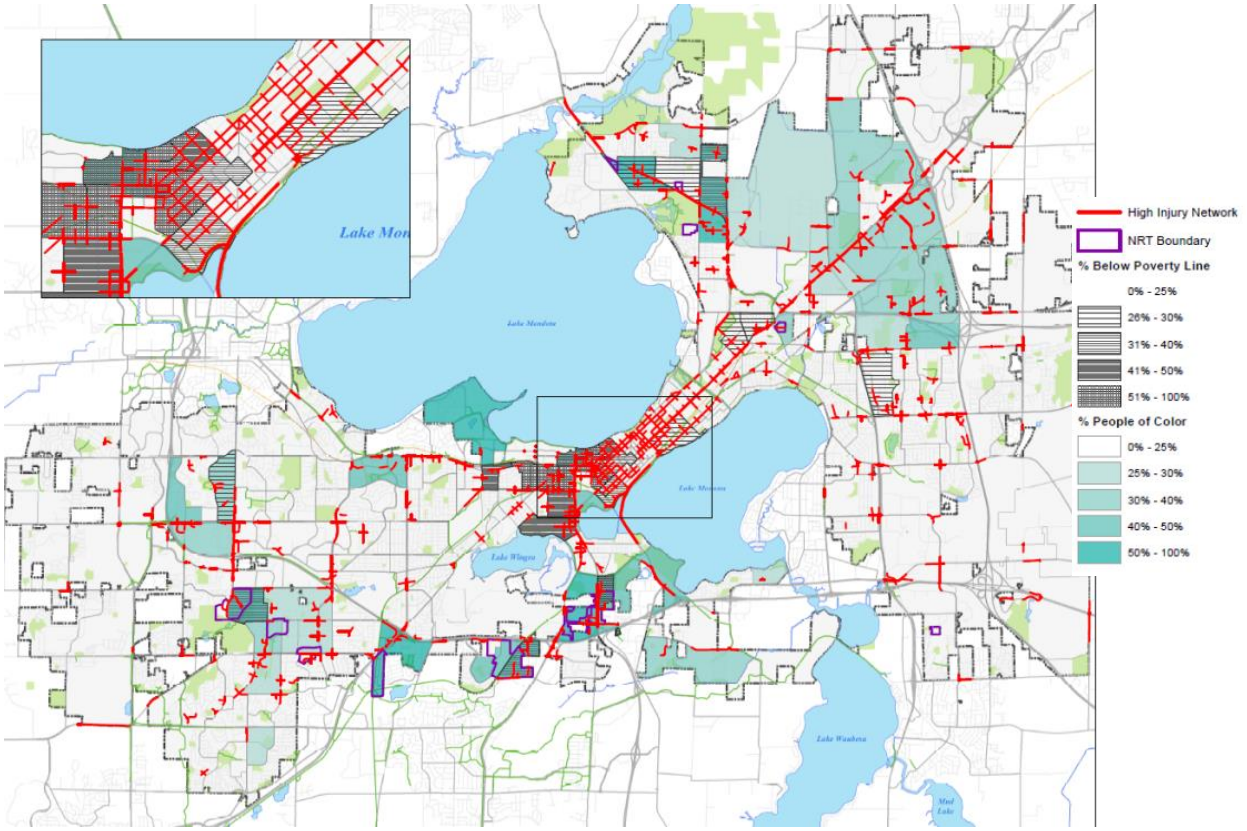


Figure 1-8. Madison's Vision Zero High Injury Network (HIN)

The majority of the Vision Zero Technology and Innovation Corridor is identified as part of Madison's Vision Zero High Injury Network (HIN), a map of sites with the highest likelihood of fatal or serious injury crashes (Figure 1-8). The Vision Zero Action Plan and Safe Streets Madison Program are based on Safe System Approach outlined in USDOT's NRSS. Madison's plan employs Safe Streets, Safe People, Safe Vehicles, Safety Data, and Safety Focused Enforcement as its core elements. The vision, goals, and objectives of this Project directly align with the City's goals of safety and integrity. The proposed CV ecosystem will leverage the existing investment made in PSCC and will further

build on short-range communication technologies adding another layer of communications using the Internet and cellular network.

The Project also implements strategies identified in WisDOT's CAV initiatives and supports the vision and goals of Connect 2050, WisDOT's multimodal long-range transportation plan, including:

Goal 3. Pursue continuous improvement and expand data-driven decision-making processes

Connected vehicle data will provide a large amount of information about traffic operations and road design that will facilitate new improvements in transportation.

Goal 5: Maximize technology benefits

Improvements like high-contrast lane markings and other infrastructure can support current and future vehicle automation. Alert systems like WI511 that already provide traveler information through apps can be integrated into new vehicle communication systems and supported by the statewide Traffic Management Center.

Goal 6. Maximize transportation safety

Automated vehicles have the potential to significantly reduce human error caused crashes and fatalities while future connected vehicles will be able to communicate and coordinate in traffic thereby also reducing human error caused crashes even before automated vehicles are available.

Leverage and Optimize Existing Local and Regional Investments

The Project leverages the existing smart city investments made along the Park Street Connected Corridor (PSCC) by the City and its partners Traffic Operations and Safety Laboratory (TOPS Lab) at UW-Madison, WisDOT, and TAPCO, a Brown Deer, WI-based traffic safety equipment manufacturer and service provider, which were spurred by the 2015 USDOT Smart City Challenge Grant Application and synergizes with other Bipartisan Infrastructure Law grants that Madison has received.

Wisconsin's first connected corridor along Park Street in Madison includes 15 intersections that are retrofitted with dual-band dedicated short-range communication (DSRC) RSUs. As connected vehicles move through the corridor, they transmit basic safety messages (BSMs) about speed, location, and direction of traffic. The intersection sends back information on signal phasing and timing, often referred to as SPAT messaging. The CV infrastructure also sends out support messages such as a map of the intersection, so a connected vehicle knows what lane it's in and whether that lane is used for turning. The PSCC project is valuable not only as a means to collect data in a real-world connected corridor, but to provide the City, WisDOT, and UW-Madison researchers opportunities to use that data to explore how to improve traffic safety and flow.

This Project will leverage and optimize those investments by deploying the next generation of signal priority for emergency vehicles, which with the right onboard equipment could work with a smart corridor to more efficiently move through traffic. Such a system could adjust its signals in real time to prioritize getting first responders to their destination. Further, the Project will also investigate signal priority for snowplows, while improving safety and mobility for all users. This will help establish Madison and Wisconsin as the Upper Midwest hub for CV and AV.

Investigating Snowplow Signal Priority during Crash Prone Weather

This CV corridor provides an excellent opportunity to prepare for CV snowplow signal priority to improve safety during bad weather events. However, current state law reserves signal "preemption" for emergency vehicles but is silent on "priority". Wisconsin bills AB869/SB840 are currently being circulated for comments to allow snowplows to use signal priority. No on-road portion of the Project would be deployed until the law is revised.

As part of the planning and design process this project will include research into how snowplow signal priority could positively impact operations, safety, and congestion during crash prone weather. It is important to plan ahead for how to integrate this technology and traffic operations into the design of the connected vehicle corridor.

Operational and Safety Issues for Snowplows

Figure 1-9. Snowplow Operations in Madison.

Madison averages 42 inches of snow per year. The City has close to 1,800 lane miles that need to be treated during winter storms. A recent snowstorm (in the second week of January 2024) dumped 15 inches of snow in Madison followed by a subzero cold spell throughout the region. The City's Streets Division's priority is to maintain safe and effective snowplow operations through its fleet of over 150 plow trucks, loaders, graders, tractors, one-ton trucks, and other equipment (Figure 1-9). These include both heavy equipment contractors and all city vehicles.

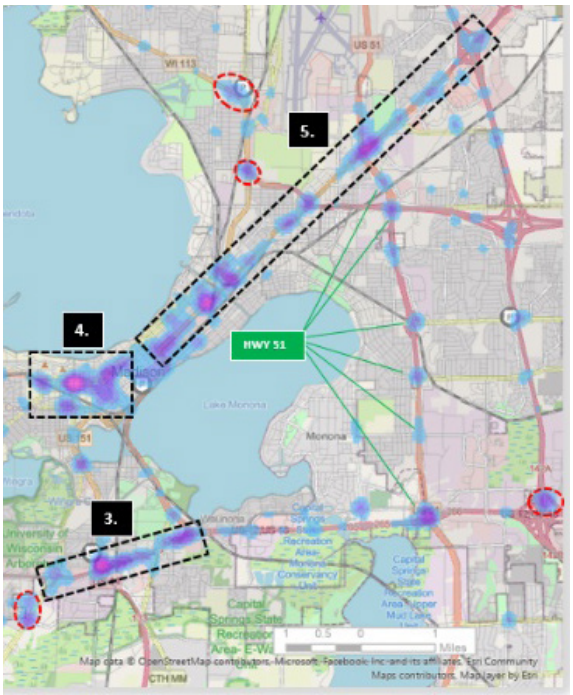


Figure 1-10. Snow Related Crashes in Project Corridor.

Historic data indicate that arterial travel speed is reduced by 30 to 40 percent on snowy or slushy roadways. This is especially problematic for a signalized corridor where these slowdowns can inhibit coordinated signal progression resulting in more vehicles arriving at red traffic signals and leading to further delays due to slow starts on low-traction surfaces. Snow and ice accumulation on paths, sidewalks, and roadways make biking and walking difficult, especially for people with mobility impairments. These issues lead to both safety and operational challenges for all travelers, including snowplows.

The Vision Zero Technology and Innovation Corridor has a relatively high number of crashes documented as snow-related crashes. Based on historical crash data between 2018 to 2022 for the months of November to March, the highest percentage of crashes (16.3 percent) in Madison were documented

along US 151/E Washington Avenue from Blair Street to I-90 (area #5), which forms a significant portion of the Project corridor.

Snowplow Signal Priority research, data collection and planning: The Project will also investigate Traffic Signal Priority for snowplow operations along US 151. The Next Generation EVP system may allow AVL data from vehicles to be used for priority (as opposed to preemption) functionality. Enhancing the MMITSS system in Madison could provide snowplows with the ability to request modified signal operations such that preferential treatment will be tested by optimizing the timing of traffic signals (Figure 1-11). Signal optimization can reduce intersection conflicts between snowplows and other vehicles and reduce plow route completion times, which will make travel safer and faster for all vehicles. The Project will collect data to investigate efficiencies in plowing operations along US 151 during inclement weather and incorporate a Road Traffic Digital Twin System to simulate operations for design. On-road testing and deployment will proceed when the signal priority law is revised.

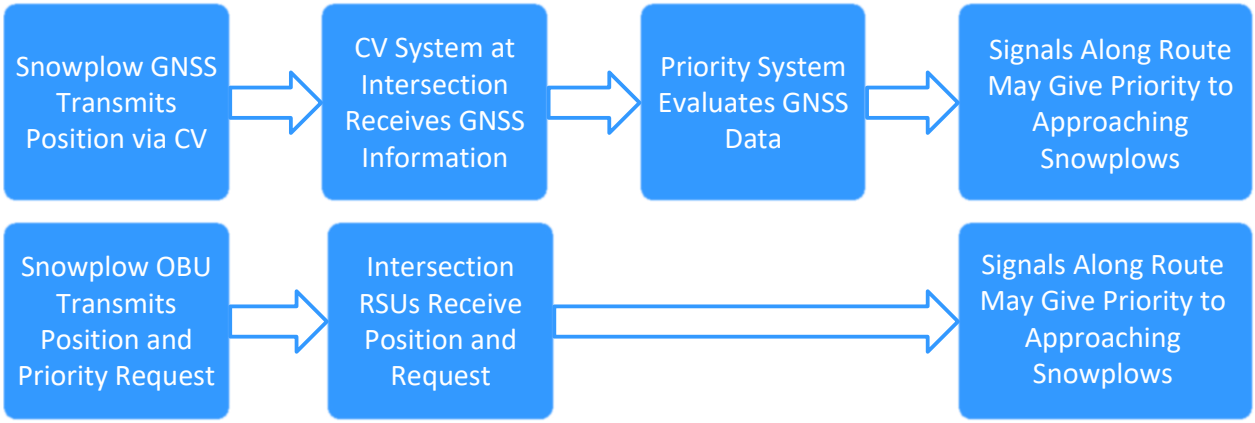


Figure 1-11. Investigating Snowplow Signal Priority

Challenges

There are no challenges expected with the procurement of digital hardware and software infrastructure to support the investigation of snowplow traffic signal priority.

Benefits to Congestion

Data from FHWA indicate that arterial travel speed is reduced by 30 to 40 percent on snowy or slushy roadways. This is especially problematic for a signalized corridor where these slowdowns can inhibit coordinated signal progression resulting in more vehicles arriving at red traffic signals and leading to further delays due to slow starts on low-traction surfaces. Speed data from the 2019-2020 Utah V2X pilot of CV-based snowplow preemption indicated that corridors equipped with the CV technology were less negatively affected than non-equipped corridors. The Project will use similar equipment, as well as GPS-based equipment, to enable priority through traffic signals along the corridor.

Schedule

The proposed technologies can be piloted or deployed as soon as the grant funds are obligated. The hardware and software infrastructure supporting the traffic signals systems upgrade, AVL compatibility, and OBUs are commercially available products that do not require additional exemptions, waivers, permits, or special permissions.

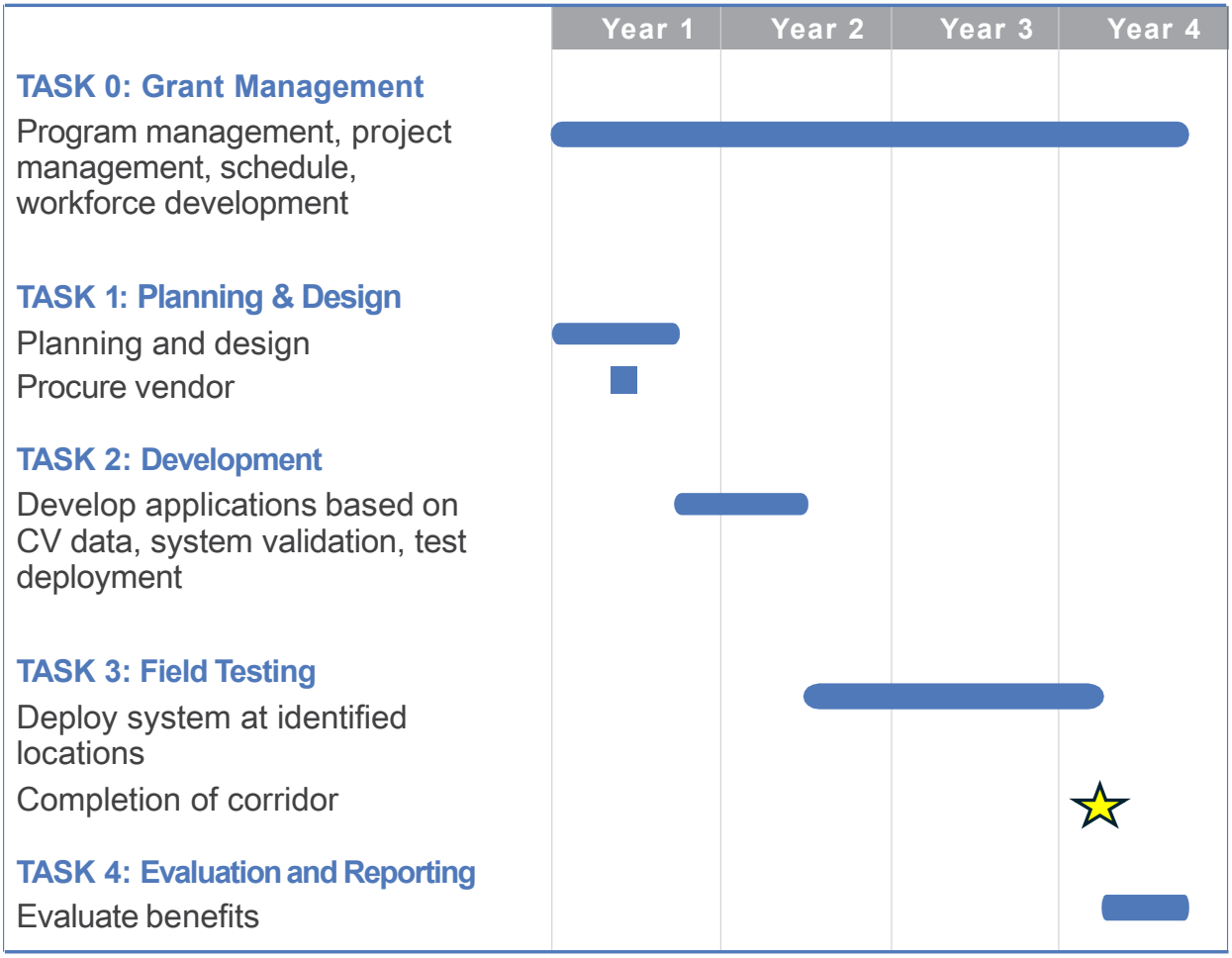


Figure 1-12. Project Schedule

The work plan represents a methodical approach to create and deploy the Project in a four-year schedule (Figure 1-12). Each of the four tasks listed below provides the foundation for the next, with the result of a clearly defined, tested, and evaluated prototype system. Additionally, workforce development will occur concurrently to use training and education programs for meeting future workforce capacity needs. The Project tasks will be:

Task 1: Planning and Design (8 months) – The Project team will engage with project partners and stakeholders for the system engineering of the project. Final stakeholder requirements will be identified and incorporated as design constraints.

Task 2: Development (8 months) – Based on input from the first task, system components will be procured, and configured on a limited scale. Each component will first be independently tested.

Initial system integration will be completed and validated with a lab-based bench test. The bench tests will be followed by closed course testing and a test deployment at one site along the corridor.

Task 3: Field Testing (21 months) – Once the system is successfully tested it will be deployed at identified locations along the Vision Zero Technology and Innovation Corridor. The system will first be tested along a portion of the corridor and expanded incrementally once all functions are verified to be consistently working. This approach will lessen system iteration and rework to a smaller portion of the corridor. Although the CV and AVL-based emergency vehicle preemption priority system will ultimately be enabled at every signalized intersection along the corridor, it will be tested independently on two separate sections. The systems will be switched quarterly to enable a fair evaluation.

Task 4: Evaluation and Reporting (8 months) – Using an evaluation process created in the Planning and Design task, data collected from field tests will be used to determine the accuracy, efficiency, and scalability of the system.

Task 5: Workforce Development (concurrent) – The City and its partners, WisDOT, and UW-Madison, will create opportunities to train existing staff across the public agencies on connected vehicle technologies as well as create a pipeline of developing future workforce opportunities through the use of apprenticeship and internship programs. The educational partners will be offering courses for students geared towards learning the skills required on the job. Additionally, the City will hire interns to work alongside City engineering team and apprentices to assist field technicians, with the potential to absorb the trained workers within its workforce. The workforce development program would also provide opportunities for historically underrepresented groups, especially for those living along or attending public schools near the corridor, in alignment with City of Madison's ongoing initiatives and priorities.

Exemptions Required

The Project will not require any exemption from the Federal Motor Vehicle Safety Standards (FMVSS), Federal Motor Carrier Safety Regulations (FMCSR), or any other regulations. The City is preparing to request a Waiver from the Federal Communications Commission (FCC) to allow cellular-vehicle-to-everything (C-V2X) technology to be used in the upper 30-megahertz portion of the 5.850-5.925 GHz band prior to adoption of the final C-V2X-based rules. This waiver has been requested and granted to several other government agencies for use of the C-V2X technology before the rules are finalized.

Compliance with Buy America Act

All vendor and contracts used for procuring Project components will be compliant with the Buy America Act as per USDOT requirement. The Project proposes to procure Centracs Priority, an add-on module to the Centracs Advanced Traffic Management System (ATMS), which is developed by Econolite Systems, Inc. based in Anaheim, CA. The API for the AVL-CAD system is proposed to also be developed by Econolite Systems. The EOS operating system for the traffic signal controllers is developed by Econolite Systems. The Project proposes to procure a CV system which would include

video cameras, radar detectors, and RSUs, to which many manufacturers of this equipment exist within the United States.

ITS Program Innovative Technology Initiatives

- ✓ EMERGING AND ENABLING TECHNOLOGIES
- ✓ DATA ACCESS AND EXCHANGES
- ✓ AUTOMATION
- ✓ ACCELERATING ITS DEVELOPMENT

The Project will support and leverage several key initiatives of the USDOT's ITS Program, as listed in the ITS Strategic Plan 2020–2025, through collaborative and innovative research, development, and implementation of ITS to improve the safety and mobility of people, vehicles, and goods. The outcomes of the proposed project and its specific advancement of C-V2X communications for mobility and safety applications play a key role in supporting and leveraging development and research priorities for the future of transportation innovation.

Workforce Development Opportunities

The City and its partners, WisDOT and UW-Madison, will use the ATTAIN grant funds to train existing workforce and create a pipeline of developing future workforce opportunities through apprenticeship and internship programs. If funded, the City would be able to build on the workforce development programs and absorb the trained workers to its workforce. The technologies introduced through the project also increase the quality of the jobs. These jobs are part of the City's collective bargaining associations. Some existing positions will be restructured, and additional training will be provided for the workforce. The workforce development program would also provide opportunities for historically underrepresented groups, in alignment with City of Madison's ongoing initiatives and priorities, especially as the Project serves a large number of historically underserved population.

Federal Funding Opportunities

The City is committed towards advanced technology innovation and deployment through its multiple ongoing efforts in partnership with WisDOT and UW-Madison. In Fall 2023, the City submitted a SMART grant application for Stage 1: Planning and Prototyping Grant funding for implementing a strategy to help eliminate all traffic deaths and severe injuries on city-wide roadways, bikeways, and sidewalks. The SMART project would create a safety net of layered sensors and warning systems to improve the vulnerable road user (VRU) safety, through detection, prediction, and communication. Stage 1 implementation would test the effectiveness of the proposed solutions along Park Street Connected Corridor. Potential Stage 2 activities would include deploying this system to other identified segments of the high injury network (HIN) across Madison including the East Washington Avenue and University Avenue corridors. The scope of the SMART grant project does not overlap with the scope of the proposed ATTAIN grant project.

III. MANAGEMENT STRUCTURE

Grant Recipient

The City of Madison is the lead agency managing the project and the grant recipient entering into agreement with FHWA, upon award. The City guarantees that all necessary activities will be completed within the period of performance, i.e. within two to four years of grant execution. It has extensive experience delivering projects funded through successful federal grants on time. Madison City Council passed a resolution in January 2024 to support the City's application for the ATTAIN program. The local matching funds for this Project have been identified to be included in the City's 2025 Adopted Capital Budget and is documented in the resolution.

The City is well-versed with delivering large-scale projects completed through the National Environmental Policy Act (NEPA) review process. All proposed projects and strategies will conform to current USDOT, AASHTO, and WisDOT standards for design and ADA compliant pedestrian infrastructure. All major project and strategy milestones as identified in the Project schedule.

Project Partners

Wisconsin Department of Transportation

The Wisconsin Department of Transportation (WisDOT) is a multimodal transportation agency responsible for planning, building, and maintaining Wisconsin's network of state highways and Interstate highway system. The department shares the costs of building and operating county and local transportation systems - from highways to public transit and other modes. WisDOT plans, promotes, and financially supports statewide air, rail and water transportation. WisDOT will provide matching funds to the Project in the form of both cash and in-kind contributions.

University of Wisconsin – Madison

The University of Wisconsin-Madison (UW-Madison) is a nationally recognized, top ten research institution. The Traffic Operations and Safety Laboratory (TOPS Lab) has a mission to improve traffic operations and safety through research, partnership, service, and training. For over twenty years, researchers at the TOPS Lab have conducted various studies focused on detecting road users using different ITS applications and predicting road users' movements and conflicts, which will be utilized as a solid foundation for developing the proposed solutions.

Partnering Plan

In addition to project partners WisDOT and UW-Madison, the City will partner with City of Madison's Fire and Police Departments. All project partners are crucial stakeholders in the transportation system serving Madison and represent leadership in technology adoption and innovation.

Grant Subrecipients

The City of Madison will be the sole agency responsible for this grant. Collected data and the project subsystems will be accessible by all partner agencies and third parties. The University of Wisconsin-Madison will utilize the grant funding to staff key faculty and student researchers through the duration of the Project.

Project Organizational Chart

Figure 1-13 shows the Project Organizational Chart of the key staff within the project team. The Deployment Plan contains a discussion detailing how the project team will deliver the project through existing contractual relationships. Additionally, the Key Staff Roles and Responsibilities section highlights the individual key staff roles and responsibilities for the Project.

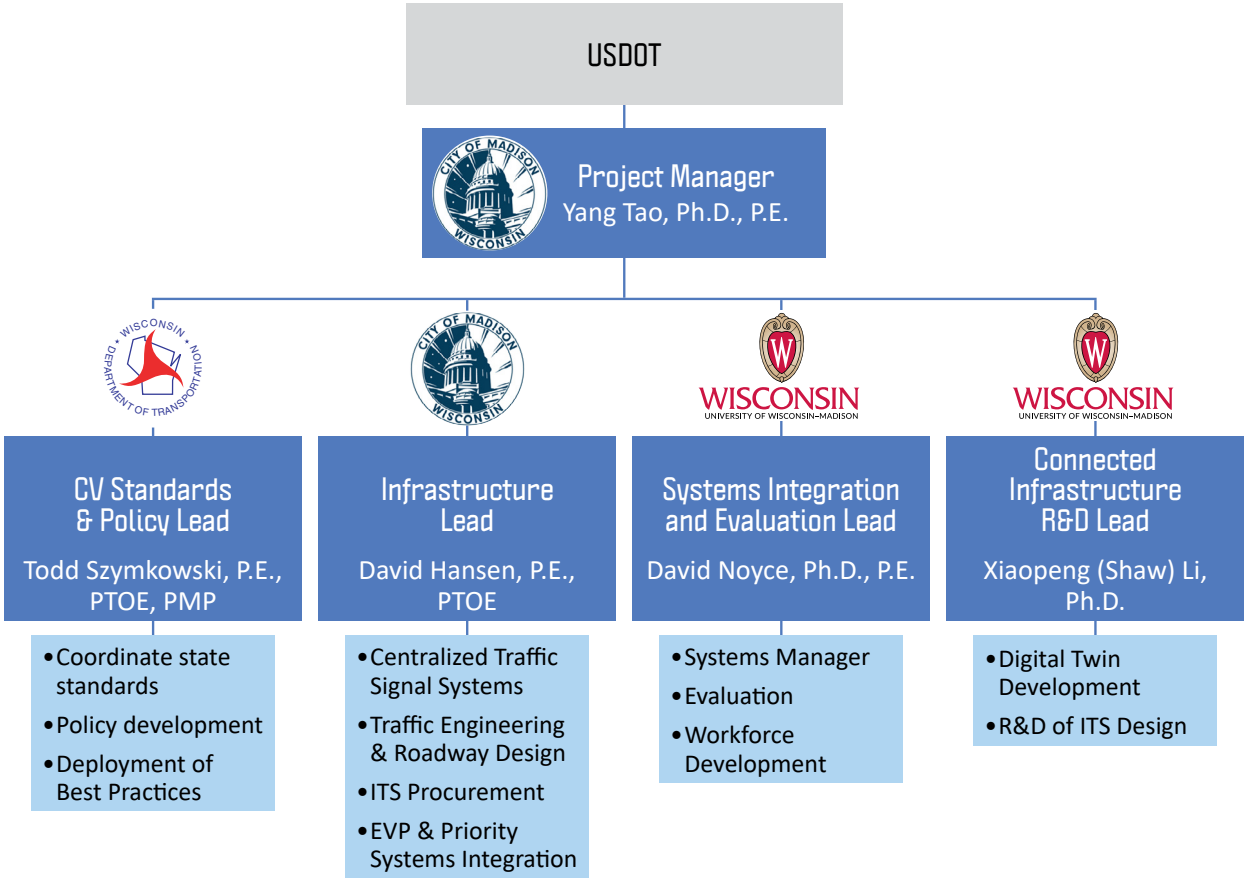


Figure 1-13. Project Organizational Chart

IV. STAFFING DESCRIPTION

Key Staff Roles and Responsibilities

Key Personnel #1, Project Manager: Yang Tao, Ph.D., P.E. is the Director of Traffic Engineering and the agency head of the City of Madison's Traffic Engineering Division, which has over 150 employees and is responsible for the City's pedestrian, bicycle, and motor vehicle transportation systems. Dr. Tao has also been overseeing Madison's Smart Cities and Vision Zero Initiatives, and has been working closely with WisDOT, various City agencies, universities, and a consortium of other public and private entities in envisioning and building a next- generation people and data centered, safe, efficient, equitable and climate- friendly transportation system for Madison. Dr. Tao has also been playing leadership roles in the transportation professional, such as having served as the inaugural chair of the Institute of Transportation Engineers (ITE) International Standing Committee on Smart Communities and is recognized as a national leader in advanced transportation technology and innovation.

Dr. Tao will serve as the primary point of contact and the Project Manager for the Project. He will be responsible for the overall project delivery including budget and schedule adherence, progress reporting, liaison with USDOT, and coordination with partnering agencies WisDOT and UW-Madison, as well as project consultants and vendors. Dr. Tao has successfully managed over a dozen projects that utilized federal discretionary grants and has extensive experience and knowledge of post-award grant administration. He expects to dedicate ten percent of his work time to the Project during the period of performance.

Key Personnel #2, CV Standards & Policy Lead: Todd Szymkowski, P.E., PTOE, PMP is the Statewide Traffic Systems Engineer for Wisconsin Department of Transportation (WisDOT) and currently serves as the technical lead for WisDOT's CAV Program with 28 years of experience in management, research, planning, design, construction inspection, and transportation project evaluation with an emphasis in traffic operations, intelligent transportation systems (ITS), freight operations, and transportation systems management and operations (TSMO). Prior to recently joining WisDOT, Mr. Szymkowski led an Advanced Mobility Group at an engineering consulting firm. Projects he was involved with include the FHWA Connected Vehicle Pilot Deployment Evaluation, New Jersey DOT CAV Plan, Pennsylvania DOT CAV Plan, Oregon DOT Connected Vehicle Ecosystem, Iowa Advisory Council on Automated Transportation Strategic Plan, and the FHWA Highway Automation Concept of Operations. He also led a variety of state level TSMO Plans and was the Co-PI and Project Manager for NCHRP 20-7(408) TSMO Workforce Development Guidebook and several related follow-up assignments with the National Operations Center of Excellence.

Mr. Szymkowski will serve as a key partner to the team on state level policies, standards, and procedures that may impact the deployment of the proposed project. He expects to dedicate ten percent of his work time to the Project during the period of performance.

Key Personnel #3, Infrastructure Lead: David Hansen, P.E., PTOE is the lead traffic engineer and section head of Traffic Signals, Lighting, and Fiber Section at the City of Madison Traffic Engineering Division, which owns and maintains nearly 400 traffic signals for the City of Madison and multiple

outside agencies in Dane County, as well as the City's streetlighting and traffic fiber communications systems. He has 30 years of experience in the traffic engineering field with a majority of his career spent as City Traffic Engineer in the City of Green Bay, WI where he served as the City's Traffic Engineer for nearly 18 years where he oversaw the day-to-day operations of the City's traffic signal and streetlighting systems and represented the Department of Public Works at City Traffic, Bicycle, and Pedestrian Commission meetings.

Mr. Hansen will serve as the infrastructure lead which will manage the team developing the project plans, specifications, and estimate, bid the project, and oversee the construction. He expects to dedicate 25 percent of his work time to the Project during the period of performance.

Key Personnel #4, Systems Integration and Evaluation Lead: David Noyce, Ph.D., P.E. has over 39 years of experience in transportation engineering including state government, private consulting, and academia. He has held positions at the University of Massachusetts-Amherst, Texas A&M University, the Illinois Department of Transportation, and several US civil engineering consulting firms. Dr. Noyce currently serves as the Executive Associate Dean of the UW-Madison College of Engineering and as the Director of the Traffic Operations and Safety (TOPS) Laboratory at UW-Madison. The TOPS Laboratory has over 40 research professionals conducting research in the areas of traffic safety, traffic operations, information technology, freight operations, ITS, CAV, and product development. Dr. Noyce also leads the Wisconsin Driving Simulator Laboratory and directs the UW-Madison partnership in the SAFER-SIM University Transportation Center (UTC).

Dr. Noyce will serve as the systems manager for the proposed project to ensure the automated systems operate in accordance with stakeholder requirements and state law. He will also lead the advancement of evaluation methodologies as well as workforce development. He expects to dedicate 15 percent of his work time to the Project during the period of performance.

Key Personnel #5, Connected Infrastructure R&D Lead: Xiaopeng (Shaw) Li, Ph.D. is currently a Professor in the Department of Civil and Environmental Engineering and an affiliate in the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison (UW-Madison). Prior to joining UW-Madison, he was a faculty member at the University of South Florida, and he served as the director of one USDOT national university transportation center, National Institute for Congestion Reduction (NICR). He established the Connected and Automated Transportation Systems Lab that developed a multi-scale CAV testbed including multiple full-scale and reduced-scale CAVs and associated system units. He was the holder of the Susan A. Bracken Faculty Fellowship and the Vasant Surti Fellowship at USF. He is a recipient of a National Science Foundation (NSF) CAREER award. He is a senior member of IEEE. He has served as the PI or a co-PI for a number of federal (NSF, USDOT, USDOE), local (e.g., state DOTs, UTCs, I-4 Corridor Program), and industry grants. He has published over 100 peer-reviewed journal papers. His major research interests include automated vehicle traffic control and connected and interdependent infrastructure systems). He received a B.S. degree (2006) in civil engineering from Tsinghua University, China, an M.S. degree (2007), and a Ph.D. (2011) degree in civil engineering along with an M.S. degree (2010) in applied mathematics from the University of Illinois at Urban-Champaign, USA.

Dr. Li will serve as a key partner to the team to lead the digital twin development as well as lead the research, development, and evaluation of ITS design. He expects to dedicate 20 percent of his work time to the Project during the period of performance.

Primary Point of Contact

The primary point of contact and the Project Manager will be:

Name & Position | Yang Tao, Ph.D., P.E., Director of Traffic Engineering, City of Madison, Wisconsin

Address | 215 Martin Luther King Jr Blvd, Suite 109, Madison, WI 53701-2986

Phone | 608.266-4761

Email | YTao@cityofmadison.com

V. SUPPORTING DOCUMENTS

Links to supporting documents are included throughout this narrative. All supporting documents and the ATTAIN grant application narrative are available to view at the following webpage:

https://www.srfconsulting.com/city-of-madison-attain/

APPENDIX A - RESUMES FOR KEY PERSONNEL

Yang Tao, Ph.D., P.E.

Director of Traffic Engineering, City of Madison

Yang Tao is the Director and the agency head of the City of Madison's Traffic Engineering Division, which has over 150 employees and is responsible for the City's pedestrian, bicycle, and motor vehicle transportation systems. He has been overseeing Madison's Smart Cities and Vision Zero Initiatives, and has been working with various City agencies, state DOTs, universities, and a consortium of other public and private entities in envisioning and building a next-generation people and data centered, safe, efficient, equitable and climate-friendly transportation system for Madison. Dr. Tao has also been playing leadership roles in the transportation professional both locally and nationally, such as having served as the inaugural chair of the Institute of Transportation Engineers (ITE) International Standing Committee on Smart Communities and is recognized as a national leader in advanced transportation technology and innovation.

PROJECT ROLE: **Project Manager**

Dr. Tao will serve as the project manager for the proposed project. He will be responsible for the overall project delivery including budget and schedule adherence, progress reporting, liaison with USDOT, and coordination with partnering agencies WisDOT and UW-Madison, as well as project consultants and vendors.

EDUCATION

- Doctor of Philosophy in Civil and Environmental Engineering, University of Wisconsin-Madison
- PhD Minor in Business, University of Wisconsin-Madison
- Bachelor of Science in Civil Engineering, Tsinghua University

PROFESSIONAL LICENSES

- Professional Engineer in Wisconsin, License No. 41428 (2011)

PROFESSIONAL EXPERIENCE

DIRECTOR OF TRAFFIC ENGINEERING DIVISION/CITY TRAFFIC ENGINEER, CITY OF MADISON, WI

- Direct the staff (over 150 employees) and activities of all units of the Traffic Engineering Division
- Manage, operate, and maintain the City's pedestrian, bicycle and motor vehicle systems
- Deliver eight major services to City residents: Pedestrian Bicycle, Signing, Pavement Marking, Traffic Signals, Streetlighting, Fiber Communication, Radio Communication, and Planning and Data Services
- Provide leadership on cross-departmental initiatives such as Vision Zero and Smart Cities, and work with various City agencies, UW-Madison, State DOT, and a consortium of other

public and private entities in envisioning and building a next-generation people and data centered, safe, efficient, equitable and climate friendly transportation system for Madison
- Served as the inaugural Executive Secretary for the City's new Transportation Commission from 2018 to 2020, drafted the Commission's first annual work plan, and played a major role in developing procedures, training materials and its day-to-day operation
- Inspired staff and kept staff highly motivated, and quadruped Traffic Engineering project delivery through capital budget since 2019
- Collaborate with alders and neighborhood representatives to address resident requests and complaints, for which the number has increased significantly due to the impact of the pandemic and the growth of the City
- Led the Traffic Engineering Division in achieving major successes in multiple aspects despite all the challenges brought by the pandemic

INTERIM CITY TRAFFIC ENGINEER AND PARKING MANAGER, CITY OF MADISON, WI

- Coordinated and directed the staff (over 180 employees) and activities of all units of the Traffic Engineering Division and Parking Division
- Managed, operated, and maintained the City's pedestrian, bicycle and motor vehicle systems
- Managed, operated, and maintained the City's public parking systems

VARIOUS LEVELS OF PROFESSIONAL AND MANAGERIAL POSITIONS, CITY OF MADISON, WI

- Continuously advanced from an entry level engineer position to the assistant director of Traffic Engineering Division
- Gained ground knowledge of all aspects of transportation engineering and planning, roadway design, project delivery, community engagement, and customer service

RESEARCH ASSISTANT, PROJECT ASSISTANT, WISCONSIN TRAFFIC OPERATIONS AND SAFETY LABORATORY

- Conducted research and project work on Intelligent Transportation Systems and transportation safety for transportation agencies such as Wisconsin Department of Transportation

RELEVANT ACCOMPLISHMENTS

- Managed over a dozen projects that utilized federal discretionary grants and has extensive experience and knowledge of post-award grant administration, including Highway Safety Improvement Program (HSIP), Surface Transportation Program-Urban (STP-U), Transportation Alternative Program (TAP), Carbon Reduction Program (CRP), and Safe Streets and Roads for All Program (SS4A).
- Spearheaded the City of Madison's Smart City Initiative, brought advanced transportation technology to the City, and received the 2018 International Transportation Achievement Award from Institute of Transportation Engineers
- Led Madison's cross departmental Vision Zero team in improving traffic safety. Data shows significant declines in traffic fatalities and serious injuries for two consecutive years and by 29% since launch of the initiative. Madison's Vision Zero program is nationally recognized by multiple organizations.

- Partnered with UW-Madison, Wisconsin DOT and other partners and successfully built the first Connected Corridor in Wisconsin along Madison's Park Street to improve safety, mobility and equity via Connected Vehicle (CV) technology. Received the 2021 Project of the Year Award from Intelligent Transportation Society of Wisconsin.
- Promoted effective Transportation Systems Management and Operations (TSMO) practices to improve mobility efficiency and accommodate the City's growth in a more sustainable manner and received the 2021 Institute of Transportation Engineers (ITE) International Transportation Systems Management & Operations Council Organization Award.
- Led the Madison team in building and operating the City's Advanced Traffic Management System (ATMS), which was recognized by the 2020 Project of the Year Award from Intelligent Transportation Society of Wisconsin.
- Partnered with elected and appointed officials, fellow City agencies and the greater community to keep improving the City's multimodal transportation systems. Achieved Gold Status for Walk Friendly Community in 2021, further strengthened Madison's status as a Platinum Level Bicycle Friendly Community, and supported Metro Transit in improving transit in the City such as accommodations for transit users and infrastructure improvements.
- Incorporated equity considerations into Traffic Engineering programs, partnered with Neighborhood Resource Teams (NRTs), and significantly increased investments in historically underserved neighborhoods.
- Engaged residents, especially traditionally underserved residents, in discussions on how the City should build our streets and approach traffic safety, through programs such as Let's Talk Streets. An estimated 1,513 residents were engaged through these efforts.
- Played leadership roles in the transportation profession both locally and nationally, elected as the 2018 Institute of Transportation Engineers (ITE) Wisconsin president, and served on national Transportation Research Board (TRB) committees on Bicycle Transportation (2006-2018) and Intelligent Transportation Systems (2007-2010).
- Recognized as a national leader on advanced transportation technology and innovation:
    - Inaugural chair of the Institute of Transportation Engineers (ITE) International Standing Committee on Smart Communities, 2017-2021
    - Vice chair of the Institute of Transportation Engineers (ITE) International Transportation Systems Management and Operations (TSMO) Council, 2018-2021
    - Member, National Strategy for Transportation Automation Task Force, 2019-2020
    - Public Agency Representative, USDOT/ITE/AASHTO/NACTO Roadway Transportation Systems Cybersecurity Working Group, 2018
    - Member, Wisconsin Automated Vehicle External (WAVE) Advisory Committee, 2020-present

SELECTED AWARDS

- Distinguished Service Award in Transportation, Institute of Transportation Engineers Wisconsin, 2022
- Transportation Professional of the Year Award, Institute of Transportation Engineers Midwestern District, 2018
- Young Professional Award, Institute of Transportation Engineers Wisconsin, 2012
- Martin Bruening Award, Institute of Transportation Engineers Wisconsin, 2007

TODD D. SZYMKOWSKI, P.E., PTOE, PMP

Statewide Traffic Systems Engineer, Wisconsin Department of Transportation

Todd Szymkowski is currently the Statewide Traffic Systems Engineer in the WisDOT Bureau of Traffic Operations where he is responsible for setting engineering-related policies and procedures related to connected and automated vehicles.

PROJECT ROLE: Connected Vehicle Standards & Policy Lead

Mr. Szymkowski will serve as a key partner to the team on state level policies, standards, and procedures that may impact the deployment of the proposed project.

EDUCATION

- Master of Science in Civil and Environmental Engineering, University of Wisconsin-Madison
- Bachelor of Science in Civil Engineering, University of Wisconsin-Milwaukee

PROFESSIONAL LICENSES

- Professional Engineer in Wisconsin, License No. 34989-6 (2001)
- Professional Engineer in Illinois, License No. 062.056129 (2002)
- Professional Engineer in Iowa, License No. 22189 (2014)
- Professional Engineer in Arizona, License No. 62400 (2016)
- Professional Engineer in Indiana, License No. PE11800226 (2018)
- Professional Engineer in Nebraska, License No. E-17754 (2019)
- Professional Engineer in Tennessee, License No. 123103 (2019)
- Professional Engineer in Kansas, License No. PE27204 (2019)
- Professional Engineer in Utah, License No. 11558846-2202 (2019)
- Professional Engineer in Arkansas, License No. 19436 (2020)
- Professional Engineer in Florida, License No. PE91046 (2021)
- Professional Traffic Operations Engineer (PTOE), License No. 1184 (2003)
- Project Management Professional (PMP), License No. 2860969 (2020)

PROFESSIONAL EXPERIENCE

TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO) PLAN, ANCHORAGE, AK

Metropolitan Area Transportation Solutions. Project Manager, as a subcontractor, developed a TSMO plan for the Anchorage, Alaska metropolitan region. The scope of work included interviewing stakeholders, creating an existing conditions technical memorandum, and recommending a package of projects, services, and activities to improve safety, mobility, and equity throughout the region.

Transportation Systems Management and Operations Summit Facilitation Services, Nationwide, U.S.

American Association of State Highway Transportation Officials and National Operations Center of Excellence. Project Manager for the planning and execution of the 2021 National TSMO Workforce Development Summit, which was used as a basis to develop a 5-year workforce development plan for the National Operations Center of Excellence and it key partners. Work also included developing several white papers in advance of the event and event proceedings. An addendum was used to engage the team with a May 2022 Workforce Development Peer Exchange. The team served as break-out session leads. Several white papers were also developed based on the recommendations from the previously developed 5-year plan.

Transportation Systems Management and Operations (TSMO) Plan, Statewide, WA, Washington Department of Transportation.

Project Manager as a subcontractor developing a TSMO Plan for WSDOT that is focused on integrating multimodal and equity elements and throughout. Leading the development of the Program including a comprehensive list of approximately three dozen action plans that define the scope of activities that need to be performed over the next five years to mature TSMO as WSDOT. Follow-up work included developed a variety of case studies that were used to update the TSMOWA.org website.

Route 9, Salem Hill Road to Texas Road Intersections with Transit Systems Priority, Monmouth and Middlesex Counties, NJ, New Jersey Department of Transportation.

Project Manager providing systems engineering support for identifying technology for traffic signal operation improvements. Work includes development of systems engineering documents and a concept of operations for adaptive traffic signal systems, Intelligent transportation systems (ITS) devices such as connected vehicle technology and transit signal priority in a connected vehicle environment in accordance with NJDOT and FHWA requirements. Coordinated with roadway designers on alternatives analysis for bus queue jump lanes at the intersections to work in conjunction with the technology alternatives. The concept of operations will identify the requirements to be included in the specifications for the signal systems during final design and included a conceptual project architecture for the transit signal priority operation.

US Route 5/Route 15 Computerized Traffic Signal System and Connected Vehicle Project, Newington, CT, Connecticut Department of Transportation.

Project Manager providing systems engineering support for the full replacement of traffic signal equipment at 15 signalized intersections along the US Route 5/Route 15 corridor, including preparation of traffic signal design plans for new traffic signal mast arms, controller cabinets, adaptive signal control technologies (ASCT), automated traffic signal performance measures (ATSPM), and design of closed-circuit television (CCTV) cameras and connected vehicle devices. The deployment of new technology also required updates to the intelligent transportation systems (ITS) Regional Architecture via the creation of a project architecture.

CONNECTED VEHICLE (CV) PILOT DEPLOYMENT EVALUATION PROJECT, VARIOUS LOCATIONS, U.S., U.S. DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION.

Initial Project Lead for the evaluation support for the Wyoming CV pilot location along I-80. The project created an evaluation methodology, developed site specific evaluation plans. In the process of conducting the evaluation, reporting results as well as collaborating with the prime contractor, Texas A&M Transportation Institute, on the creation of a data plan, a safety management plan, training and evaluation outreach plan, an equipment acquisition and installation plan and others. The project also included evaluation of Smart Columbus.

TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO) WORKFORCE: SKILLS, POSITIONS, RECRUITMENT, RETENTION, AND CAREER DEVELOPMENT, WASHINGTON, DC, NATIONAL ACADEMY OF SCIENCES: NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM.

Project Manager and C0-Principal Investigator conducting research related to defining the workforce needs of the future for emerging technologies. Work included defining existing post-secondary education training, best practices scan of state departments of transportation, and academic literature searches on recruiting and retaining public sector staff. After two virtual workshops, 19 emerging TSMO positions descriptions and associated knowledge, skills, and abilities (KSA) have been defined. A gap analysis assessed the previously defined post-secondary training with each position and identified areas where course need to be developed. All the work was integrated into a TSMO Guidebook that highlights best practices for recruiting, professional development, and retaining TSMO staff.

AWARDS

- Distinguished Service Award, Great Lakes Transportation Enterprise Institute (GLTEI), 2014
- Distinguished Service Award, ITE Wisconsin, 2013
- Martin Bruening Paper Award (Professional), ITE Wisconsin, 2011
- Distinguished Service Award, ITS Wisconsin, 2010
- Young Professional Award, ITE Wisconsin, 2004
- Martin Bruening Paper Award (Student), ITE Wisconsin, 1996
- Student Paper Award, ITE Midwestern District, 1996

DAVID HANSEN, P.E., PTOE

Traffic Engineer, City of Madison

David Hansen is the head of the Signal and Lighting Section within the City of Madison Traffic Engineering Division. His work involves the planning, coordination, and performance evaluation of a wide variety of traffic signals, streetlighting, & fiber optic communication systems, and provides staff supervision and professional development.

PROJECT ROLE: **Infrastructure Lead**

Mr. Hansen will be leading design, engineering, and deployment of centralized traffic signal systems. His work will also involve the procurement of all ITS components and its integration to EVP and Priority Systems. He will manage the team developing the project plans, specifications, and estimate, bid the project, and oversee the construction.

EDUCATION

- Bachelor of Science in Civil Engineering with a technical emphasis in transportation and municipal engineering, University of Wisconsin-Milwaukee

PROFESSIONAL LICENSES

- Professional Traffic Operations Engineer, Certification Number 1341 (2004)
- Professional Engineer in Wisconsin, License No. 34931-6 (2001)

PROFESSIONAL EXPERIENCE

TRANSIT SIGNAL PRIORITY SYSTEMS DEVELOPMENT, BUS RAPID TRANSIT (BRT) SYSTEM, CITY OF MADISON, WI

Traffic Signal Priority Systems Deployment. Supervising the implementation and development of the Econolite Centracs ATMS Transit Signal Priority (TSP) system and associated systems upgrades at 110 signalized intersection locations along two BRT routes throughout the Madison metropolitan area. Tasks also include materials procurement, building and testing traffic signal controller cabinets, managing ongoing traffic signal reconstruction, and adjusting work zone signal timings.

WEST MASON STREET TRAFFIC SIGNAL SYSTEMS RECONSTRUCTION, CITY OF GREEN BAY, WI

City Traffic Engineer and Project Manager. Project planning and reconstruction of seven signalized intersections along the city's highest volume principal arterial. Work included securing a grant and local funds match, obtaining the needed committee and council approvals for the project, design of a fiber interconnected signal system with video detection cameras and streetlighting, providing construction oversight, and developing final signal timing plans for the improved corridor.

CITYWIDE RRFB DEPLOYMENT, CITY OF GREEN BAY, WI

City Traffic Engineer and Project Manager. Managed the plan development and ongoing deployment of 64 RRFB systems throughout the City of Green Bay. Work included securing project funding, materials procurement, project plans, specifications, and estimate, utilities coordination, development of an online interactive project progress map, and working with the Mayor's Office and local alders on constituent RRFB education.

SAFE WALK & BIKE PLAN (SAFE ROUTES TO SCHOOL & BIKE-PEDESTRIAN PLAN), CITY OF GREEN BAY, WI

City Traffic Engineer and Project Oversight Team Member. Scoped project objectives cooperatively with stakeholders from the Green Bay Area Public School District, Department of Community and Economic Development, and Green Bay Metropolitan Planning Organization; participated in consultant selection; assisted in obtaining multiple project funding through WisDOT grants, obtained the needed committee and council approvals; and provided staff resources and document review during all stages of plan development and project implementation.

RELEVANT ACCOMPLISHMENTS

- Thirty years of experience in transportation and traffic engineering including local & state government and private consulting. (1994-2024)
- City Traffic Engineer in Green Bay, Wisconsin for nearly 18 years prior to his current position with the City of Madison. In his previous role, David served as the technical advisor and recording secretary to the Green Bay Traffic Commission, created new safety programs including the Neighborhood Traffic Calming Program, and managed the day-to-day operations of the city's traffic engineering systems. (2006-2023)
- Strong leadership skills developed through involvement in local and state initiatives including assisting in a bill that became Wisconsin State Statute requiring all motorists to stop at dark or snow-obstructed traffic signals. (2015)

DAVID A. NOYCE, Ph.D., P.E., F. ASCE, F. ITE

Executive Associate Dean, University of Wisconsin-Madison

David Noyce is the Executive Associate Dean and Arthur F. Hawnn Professor of Transportation Engineering, College of Engineering at the University of Wisconsin-Madison. He is also the Executive Director of the Traffic Operations and Safety (TOPS) Laboratory and the Wisconsin Driving Simulator Laboratory. His research focusses on the operational and behavioral aspects of transportation safety and operations.

PROJECT ROLE: **Systems Integration and Evaluation Lead**

Dr. Noyce will serve as the systems manager for the proposed project to ensure the automated systems operate in accordance with stakeholder requirements and state law. He will also lead the advancement of evaluation methodologies as well as workforce development.

EDUCATION

- Doctor of Philosophy in Civil Engineering, Texas A&M University
- Master of Science in Civil and Environmental Engineering, University of Wisconsin-Madison
- Bachelor of Science in Civil and Environmental Engineering, University of Wisconsin-Madison
- Master of Business Administration, University of Wisconsin-Whitewater

PROFESSIONAL LICENSES

- Professional Engineer in Wisconsin, License No. 25726 (1988)

PROFESSIONAL EXPERIENCE

PARK STREET CONNECTED CORRIDOR, PROJECT INVESTIGATOR, 2017-2024

- Investigating the use of connected vehicle technologies for a variety of applications

CITY OF RACINE AUTOMATED VEHICLE TESTING, PROJECT INVESTIGATOR, 2019-2025

- Investigating the use of automated vehicle in outreach, education, and research projects, as well as establishing connected vehicle technologies at City traffic signals to allow the group's automated vehicles to drive through signalized intersections without human assistance

NATIONAL SCIENCE FOUNDATION (NSF), COLLABORATIVE RESEARCH: FW-HTF-R: THE FUTURE OF TRUCKING: PATHWAYS TO POSITIVE SOCIETAL OUTCOMES, PROJECT INVESTIGATOR, 2022-2025

- Investigating the cooperative automation of future trucking including network architecture and vehicle control algorithms.

RELEVANT ACCOMPLISHMENTS

- More than 39 years of experience in transportation engineering including state government, private consulting, and academia
- Strong leadership skills developed through extensive involvement in state, national, and international initiatives
- Director, Wisconsin Driving Simulator Laboratory, 2010-present
- Associate Director, SaferSim University Transportation Center, 2013-present
- Director, Wisconsin's Federally Designated Automated Vehicle Proving Grounds, 2017-2019
- Co-author of chapter on traffic signals in Traffic Control Devices Handbook. Second Edition, Institute of Transportation Engineers, Washington, D.C., 2013, pp. 295-437

Xiaopeng (Shaw) Li, Ph.D., P.E.

Professor, University of Wisconsin-Madison

Xiaopeng (Shaw) Li is currently a Professor at the Department of Civil & Environmental Engineering, Affiliate Professor at Department of Electrical & Computer Engineering, and the Director of Connected & Autonomous Transportation Systems (CATS) Laboratory at the University of Wisconsin-Madison.

PROJECT ROLE: **Connected Infrastructure R&D Lead**

Dr. Li will serve as a key partner to the team to lead the digital twin development as well as lead the research, development, and evaluation of ITS design.

EDUCATION

- Doctor of Philosophy in Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
- Master of Science in Applied Mathematics, University of Illinois at Urbana-Champaign
- Master of Science in Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
- Bachelor of Engineering in Civil Engineering, Tsinghua University

PROFESSIONAL LICENSES

- Professional Engineer in Wisconsin, License No. 100171-6

PROFESSIONAL EXPERIENCE

ARGONNE NATIONAL LAB, EVALUATING ENERGY AND MOBILITY IMPACTS OF CONNECTED AND AUTOMATED VEHICLES USING REAL-WORLD DATA, PROJECT INVESTIGATOR, 2023-2024

- Conducted comprehensive analysis of energy and mobility impacts of connected and automated vehicles using real-world data.
- Developed models and simulations to predict future trends and impacts in the field of autonomous transportation.

DEPARTMENT OF ENERGY (DOE), VISUAL-ENHANCED COOPERATIVE TRAFFIC OPERATIONS (VECTOR) SYSTEM, PROJECT INVESTIGATOR, 2022-2025

- Led the development of the VECTOR system, focusing on enhancing traffic operations through visual technology.
- Implemented and tested advanced traffic management strategies using cooperative systems and visual analytics.
- Led field tests and data analysis to assess system reliability and effectiveness in improving traffic flow.

NATIONAL SCIENCE FOUNDATION (NSF), CPS: SMALL: CYBER-PHYSICAL PHASES OF MIXED TRAFFIC WITH MODULAR & AUTONOMOUS VEHICLES: DYNAMICS, IMPACTS AND MANAGEMENT, SOLE PROJECT INVESTIGATOR, 2020-2022

- Investigated the dynamics of mixed traffic scenarios involving modular and autonomous vehicles in cyber-physical environments.
- Developed management strategies and frameworks for effectively integrating autonomous vehicles into existing traffic systems.

NATIONAL SCIENCE FOUNDATION (NSF), EAGER/COLLABORATIVE RESEARCH: ENABLE ELASTIC CAPACITY FOR TRANSPORTATION INFRASTRUCTURE THROUGH A TRANSMODAL MODULAR AUTONOMOUS VEHICLE SYSTEM, LEAD PROJECT INVESTIGATOR, 2020-2022

- Focused on enhancing the capacity of transportation infrastructure through the development of a transmodal modular autonomous vehicle system.
- Collaborated with researchers to create innovative solutions for integrating autonomous vehicles into multi-modal transportation networks.

USDOT FHWA, FHWA COOPERATIVE AUTOMATION RESEARCH: COOPERATIVE AUTOMATION RESEARCH MOBILITY APPLICATIONS (CARMA) PROOF-OF-CONCEPT TRAFFIC SYSTEMS MANAGEMENT AND OPERATIONS (TSMO) USE CASE TESTING, PROJECT INVESTIGATOR, 2019-2021

- Led the CARMA proof-of-concept testing for TSMO use cases to validate the effectiveness and feasibility of the CARMA platform in various traffic scenarios and conditions.
- Compiled comprehensive research reports showcasing the performance outcomes of the CARMA system and its potential contributions to modern traffic management strategies.

RELEVANT ACCOMPLISHMENTS

- Director of National Institute for Congestion Reduction (NICR), a FAST-Act National University Transportation Center 2020-2022
- Recipient of a National Science Foundation (NSF) CAREER award
- PI or a co-PI for a number of federal, state, and industry grants, with a total budget of around $30 million
- Director of Connected and Autonomous Transportation Systems (CATS) lab housing 3 full scale connected and automated vehicles and associated sensing and communication devices

APPENDIX B – EXHIBITS AND ATTACHMENTS IN SUPPORT OF SECTIONS II-IV

Table B-1. Project Alignment with the ATTAIN Program

Technologies	Implemented/Addressed by Application
1. Advanced traveler information systems	Yes
2. Advanced transportation management technologies	Yes
3. Advanced transportation technologies to improve emergency evacuation and response by Federal, State, and local authorities	Yes
4. Infrastructure maintenance, monitoring, and condition assessment	Yes
5. Advanced public transportation systems	Yes
6. Transportation system performance data collection, analysis, and dissemination systems	Yes
7. Advanced safety systems, including V2V and V2I communications, technologies associated with automated vehicles, and other collision avoidance technologies, including systems using cellular technology	Yes
8. Integration of intelligent transportation systems with the Smart Grid and other energy distribution and charging systems	No
9. Integrated corridor management systems	Yes
10. Advanced parking reservation or variable pricing system or system to assist trucks in locating available truck parking	No
11. Electronic pricing, toll collection, and payment systems	No
12. Technology that enhances high occupancy vehicle toll lanes, cordon pricing, or congestion pricing	No
13. Integration of transportation service payment systems	No
14. Advanced mobility and access technologies, such as dynamic ridesharing and information systems to support human services for elderly and disabled individuals	No
15. Retrofitting DSRC technology deployed as part of an existing pilot program to C–V2X technology, subject to the condition that the retrofitted technology operates only within the existing spectrum allocations for connected vehicle systems	Yes

16. Advanced transportation technologies, in accordance with the research areas described in section 6503 of Title 49	Yes
Program Goals	**Implemented/Addressed by Application**
1. Reduction in the number and severity of traffic crashes and an increase in driver, passenger, and pedestrian safety;	Yes
2. Delivery of economic benefits by reducing delays, improving system performance and throughput, and providing for the efficient and reliable movement of people, goods, and services;	Yes
3. Demonstration, quantification, and evaluation of the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, equity, and sustainable movement of people and goods;	Yes
4. Improvement in the mobility of people and goods;	Yes
5. Improvement in the durability and extension of the life of transportation infrastructure;	Yes
6. Reduced costs and improved return on investments, including through the enhanced use of existing transportation capacity;	Yes
7. Protection of the environment and delivery of environmental benefits that alleviate congestion and streamline traffic flow;	Yes
8. Measurement and improvement of the operational performance of the applicable transportation networks;	Yes
9. Collection, dissemination, and use of real-time transportation-related information including, but not limited to, work zone, weather, transit, and paratransit, to improve mobility, reduce congestion, and provide for more efficient and accessible, and integrated transportation, including access to safe, reliable, and affordable connections to employment, education, healthcare, freight facilities, and other services;	Yes
10. Facilitating account-based payments for transportation access and services and integrating payment systems across modes;	No

11. Monitoring transportation assets to improve infrastructure management, reduce maintenance costs, prioritize investment decisions, and ensure a state of good repair;	Yes
12. Accelerated deployment of V2V, V2I, vehicle-to-pedestrian, and technologies associated with automated vehicle applications and other advanced technologies;	Yes
13. Integration of advanced technologies into transportation system management and operations;	Yes
14. Reproducibility of successful systems and services for technology and knowledge transfer to other locations facing similar challenges;	Yes
15. Incentivizing travelers— (I) to share trips during periods in which travel demand exceeds system capacity; or (II) to shift trips to periods in which travel demand does not exceed system capacity.	No
Administration's Priorities	**Implemented/Addressed by Application**
1. Safety	Yes
2. Climate Change and Sustainability	Yes
3. Equity	Yes
4. Workforce Development, Job Quality, and Wealth Creation	Yes
DOT Focus Areas	**Implemented/Addressed by Application**
1. State of Good Repair	Yes
2. Integration of intelligent transportation systems with the Smart Grid and other energy distribution and charging systems	No
3. Advanced public transportation systems	Yes
4. Freight (or Port) Community Systems	No
5. ROUTES Initiative	No
6. Complete Trip Program	No
7. Data Availability	Yes