Establishment of the Park Street Connected Corridor

Application for the **ITS Wisconsin Project of the Year Award**

Joint application by:
City of Madison
University of Wisconsin-Madison
Traffic and Parking Control Company

The collaborative team including The City of Madison, the University of Wisconsin-Madison (UW-Madison), and Traffic and Parking Control Company (TAPCO), would like to submit to you the "Establishment of the Park Street Connected Corridor" project as a candidate to become the ITS Wisconsin project of the year for 2021.

Submittal Information

Project Name: Establishment of the Park Street Connected Corridor
Project Address: Park Street, Madison, WI 53715
Date Completed: Primary 15 intersections fully setup as of August 1, 2020 – program work is ongoing
Project Budget: $300,000 (estimated)

Entry Submitted by

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Project Background

The Park Street Connected Corridor team has equipped 15 intersections along a 4-mile corridor with dedicated short-range communication (DSRC) road-side units (RSUs) and associated hardware and software. The installation has laid the foundation for full-scale smart and connected corridor in Madison, Wisconsin. researching communication capabilities and applications of connected vehicle technology.

The corridor is the first such installation of connected vehicle equipment in the state of Wisconsin, and one of the first in the midwestern United States. The corridor project includes several research and development subprojects, many of which have been completed and will be described in the application.

Project Highlights

Corridor Stats

- Includes 4.3 miles of urban principal arterials in downtown Madison
- Connects downtown and UW-Madison to the Beltline (US 12/18)
- Park Street and Fish Hatchery Road are major commuter and event routes for entering and exiting the city core
- Serves eight Metro Transit routes and includes one of four bus transfer points in the city
- Includes several major hospitals, a fire station, and a police station
- Serves an average of 48,000 vehicular trips per day
- Significant presence of bicycle and pedestrian activity
- Serves a large number of Madison's low income residents and people of color

CV Technology

- 15 RSUs using DSRC technology installed on the corridor
- All RSUs are easily upgradable to C-V2X communications
- 4 on-board units (OBUs) on University and City vehicles
- RSUs configured to send signal phasing and timing (SPaT) messages, as well as MAP messages and basic safety messages (BSMs)

Key Info

- A public-industry-academic partnership with inspirations to collaborate to advance state-of-the-art lifesaving and mobility enhancing technologies
- Part of Multi Modal Intelligent Traffic Signal System (MMITSS) – MMITSS in Madison
- A SPaT Challenge operational deployment, one of 18 in the United States
- Several research areas including CV message quality and range, CV interaction with non-CVs, V2I safety applications, V2I mobility applications
- Project documentation creates a blueprint for installations across the state

Project Timeline

After the Smart City Challenge, the City of Madison and TOPS Lab developed a timeline to build a major connected vehicle project in Madison. Our team put together a general vision for the project with objectives and rough milestones. As partnerships and funding made sense, the corridor moved forward to the point where we are now recognized as a fully operational SPaT Challenge corridor. Work continues to fill out the corridor and on corridor research.

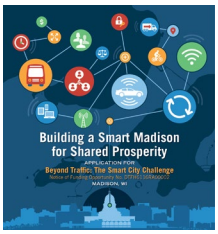
There are four major steps in the project:

1) Initial planning and concept development (2016-17)
2) Initial deployment of three RSUs and testing (2018)
3) Formation of the current team and full deployment (2019-20)
4) Next steps in research and development (2021-23)

The following is a more in-depth timeline of the critical milestones and work done on the corridor.

Dec '15 - Jan '16 Smart City Challenge grant application

- The City of Madison and TOPS Lab collaborated on the Smart City Challenge grant application, and TAPCO supported the application. In drafting this document, the team did some initial research on connected vehicle technology and its potential benefits. CVs were included as one of many elements of the plan, although Park Street was not yet identified.



Mar '16 - Oct '16 Brainstorming automated and connected vehicle projects

- Upon selection of Columbus, Ohio as the Smart City Challenge winner, The City and TOPS met several times to discuss next steps, particularly focused on automated and connected vehicle projects and potential funding sources.

May '16 First draft of a connected vehicle corridor

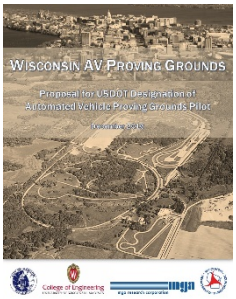
- The first draft of a connected vehicle corridor in Madison was developed, at the time looking at the "East-West Isthmus Corridor." This was changed to Park Street after an assessment of potential corridors that had the potential for the largest benefit from this technology. A five-year plan on filling out the corridor with CV technology and associated work was developed.

Nov '16 SPaT Challenge announced by AASHTO

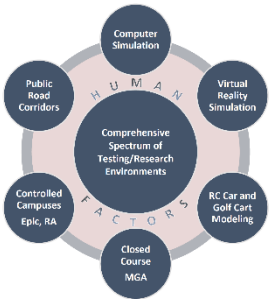
- The SPaT Challenge is officially announced by AASHTO after several months of development by the V2I Deployment Coalition. The official challenge stated that "AASHTO is challenging the state and local public sector transportation infrastructure owners and operators to cooperate together to achieve deployment of DSRC infrastructure with SPaT, MAP, and RTCM broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each of the 50 states by January 2020.

Dec '16 - Jan '17 UW-Madison team designated an AV Proving Ground

- UW-Madison successfully applied to and became one of 10 Automated Vehicle Proving Grounds recognized by the US Department of Transportation. This designation did not come with funding, but began further exploration into CV and AV projects with particular emphasis on meeting the SPaT Challenge in Madison.



WISCONSIN AUTOMATED VEHICLE PROVING GROUNDS



Feb '17 - Dec '17 First Siemens RSU and bench test

- Ongoing discussions with potential partners and providers led to acquiring the first Siemens RSU and bench test. A Siemens RSU was bench tested by the TOPS Lab to determine setup and usability on the corridor.

Jun '17 Corridor officially recognized by NOCoE

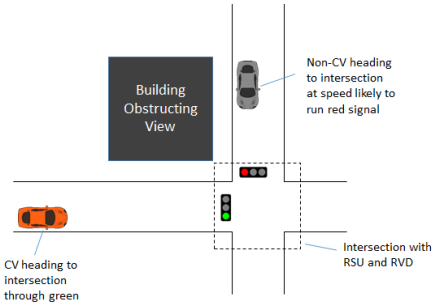
- Officially recognized by the National Operations Center of Excellence (NOCoE) as a "SPaT Deployment Underway" – showing official recognition that our team plans to meet the SPaT Challenge requirements by 2020.

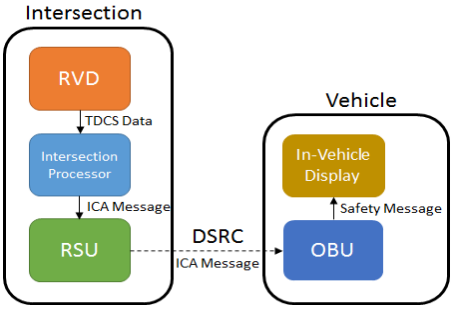
Feb '18 - Jun '18 First RSUs and OBUs installed

- Two additional RSUs and two OBUs were received from Savari. RSUs and OBUs were installed on the corridor. All three RSUs were installed on the Park Street corridor, and the OBUs were installed in a city maintenance vehicle and a university engineering vehicle.

Mar '18 - Jul '19 First major research project on corridor

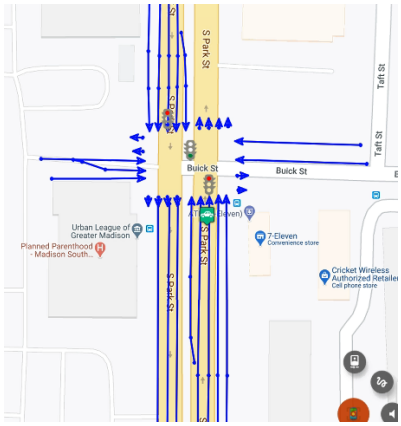
- The first major research project on the corridor was established through a Safety Research using Simulation University Transportation Center (SAFER-SIM UTC) grant, "Safely and Effectively Communicating Non-Connected Vehicle Information to Connected Vehicles."





Jul '18 - Sep '18 OBU-RSU interoperability tests completed

- OBU-RSU interoperability tests were completed. The TOPS Lab and TAPCO worked together on initial tests using multiple OBUs and the three corridor OBUs. SPaT, MAP, and basic safety message (BSM) transmission was verified.



May '19 - Jul '19 Research on RSU range and signal quality

- Research on RSU range and signal quality was completed by students at the TOPS Lab.

Jun '19 Aug '19 Mobile OBU setup developed

- Two Danlaw/Kapsch OBUs purchased and tested. A mobile OBU setup was developed that can be installed in minutes and used by pedestrians, bicycles, and vehicles.

Jun '19 - Present Monthy team meetings begin

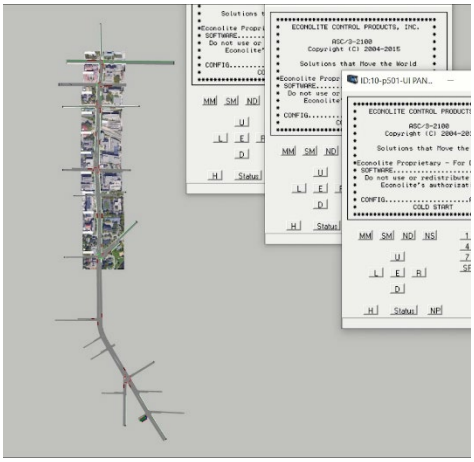
- Monthly team meetings including the three main project partners and others as needed have occurred each month since the kick-off meeting in June 2019. Meetings include people from management, engineering, and technician roles from each of the three partners.

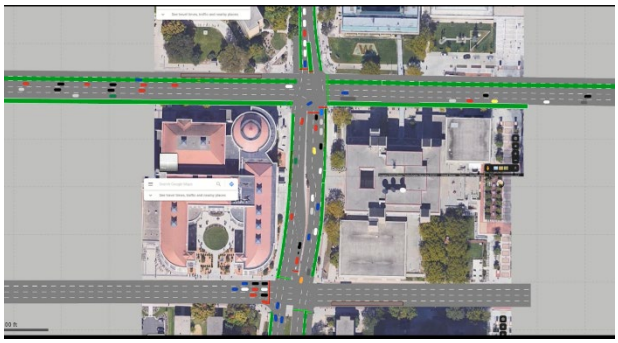
Jul '19 MMITSS in Madison established

- Selected as a demonstration corridor for the Multi-Modal Intelligent Traffic Signal Systems (MMITSS) program, known as MMITSS in Madison.

Aug '19 - Present Simulation model built in Vissim

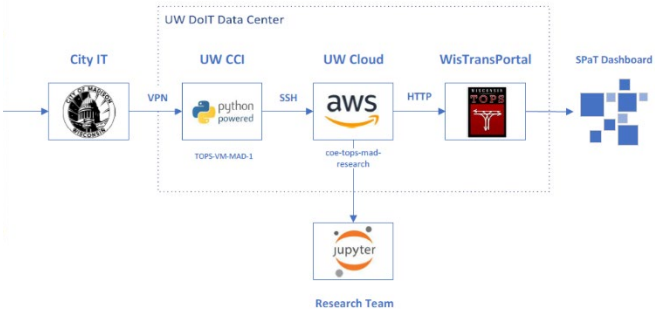
- Building a virtual simulation corridor in Vissim to test the MMITSS model and support simulation trials for transit signal priority (TSP).





Aug '19 - Present CV Data pipeline and data dashboard begin development

- Development of the CV data pipeline and data dashboard. Work is ongoing.



Sep '19 - Dec '19 Five additional RSUs installed

•Five additional Siemens RSUs purchased, installed, and tested on the corridor.

Mar '20 - May '20 Nine additional RSUs installed, totalling 15 units

•9 additional Siemens RSUs purchased and installed on the corridor and two Savari units decommissioned. These units were tested and verified to be fully functional, bringing the corridor to 15 total units of the 25 total units specified for the corridor, including the full run of Park Street from the Beltline to the University.

Oct' 20 Recognized as a "SPaT Deployment Operational" corridor

•Officially recognized by NOCoE as an "SPaT Deployment Operational" – meeting the requirements of the SPaT Challenge and becoming the first successful SPaT Challenge Corridor in Wisconsin. This is one of around 25 operational corridors in the country.

SPaT deployment underway SPaT deployment operational

Dec' 20 Proving Grounds rebranded as Wisconsin Connected and Automated Transportation Consortium

•The Park Street Connected Cooridor is a flagship project of CV work at UW-Madison. The AV Proving Grounds was rebranded as the Wisconsin Connected and Automated Transportation Consortium to more directly encompass the CV projects at the University and our partnerships within AV and CV.

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TRANSPORTATION CONSORTIUM

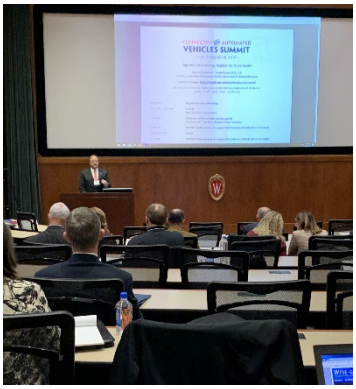
Project Details

Our project has setup a network that will allow for improvements in all six criteria areas for the Wisconsin Project of the Year application. Although only a few of these areas have currently realized gains, future impacts from work on this corridor are enabled by the groundwork completed in this implementation phase of the project. The following sections describe these impacts of the corridor.

Innovative Partnerships and Stakeholder Involvement

This project has benefitted from a unique business model using a public-industry-academic partnership in which all of our stakeholders have contributed resources to help establish the corridor. This partnership is innovative in many ways. One of the main innovations is a flat team model for decision-making and completing project work. Several ad hoc meetings have happened between partners when needed to get work done and make progress towards our goals. No one agency could have done this project alone, as each group brought their strengths and expertise to synergize efforts to complete the corridor.

- This project is the result of longstanding, open collaborative environment between the three project leads, as described in the project timeline.
    - UW-Madison has provided program management, engineering services, and IT support.
    - The City of Madison has provided traffic engineering services and equipment installs.
    - TAPCO has provided field support, equipment setup, and MAP message design.
- This public-industry-academic partnership has persisted due to a commitment of each group to the values and purpose of the project and our shared and complimentary goals.
- Companies such as Siemens and Econolite provided demonstration equipment to get the project started.
- Wisconsin DOT has helped advance the project through the MMITSS partnership.
- Our team has benefitted from best practice knowledge from the V2I Deployment Coalition, the University of Arizona, and others.
- Team meetings are open and attended by people in all areas of involvement, including management, engineering, and technicians. This flat model allows all to have equal input and access to the project.
- The team has been open and collaborative with others working on CV in Wisconsin and the Midwest, including sharing best practices with MAASTO (image below), WisDOT's WAVE (Wisconsin Automated Vehicle External) Advisory Committee, and Wisconsin ACES (a private consortium).



Engineering and Planning Innovation

Our team put together a corridor vision document and map in 2016, which involved several phases of installations and other milestones to be completed as we moved through the project. We started small and took a measured approach to spending money on hardware for the project. With just three units on the corridor, we conducted testing and other research to determine the feasibility of next steps in the project.

Our initial vision has generally been followed, though many small changes have been introduced throughout the process. The overall objectives have stayed the same, and we were able to meet our goal of being an officially recognized SPaT Challenge corridor by 2020.

Our engineering innovations include:

- The data dashboard is a website that will show real-time messages from all RSUs on the corridor, including SPaT and BSM messages. The data dashboard also includes a data repository which will be available to independent developers (will not include personal identifying information).
- The Vissim model incorporates simulated traffic controllers that are identical to the setup on the actual corridor and allow for in-depth simulation of different software algorithms on the corridor. This allows for these algorithms to be proven before their deployment.
- We will be continuing our partnership with WisDOT to add another innovation to the corridor, in adding four interchange RSUs, part of five additional units that will bring the corridor up to 20 RSUs by mid-2022. RSUs installed in locations other than intersections are rare, and generally used along freeway corridors. Our interchange RSUs will allow for better interchange traffic management and sharing of information with signalized intersections on the corridor.

Our planning innovations include:

- A real-time simulation model which allows us to test complex algorithms in a multitude of scenarios before deploying algorithms on the corridor.
- Advancement of communications infrastructure – Madison already had an extensive fiber network which was leveraged as part of the Smart City approach. The team is developing best practices and documentation for other communities to prepare for a CV future. Additionally, we are working to build a common communication network across multiple agencies / jurisdictions.
- A flat model of participation, allowing for input and contribution from employees at all levels in each organization.
- Not being confined by a particular grant or contract – instead relying on joint benefits of all project member organizations and shared desires to promote innovative technologies to solve mobility, safety, and environmental problems.

Safety Improvement

The Park Street Corridor is on Madison's High Injury Network. CV messages will be used on the corridor to improve safety in the following ways:

- Vulnerable road users (VRUs) at pedestrian crossings and in bicycle lanes by creating smart phone apps that will send their positions to vehicles on the corridor and send VRUs information about vehicles on the corridor encroaching into their space.
- As demonstrated in our research, other ITS systems can be used to support CV messaging. In the project example, radar detectors can judge the speed-time continuum of approaching vehicles and map this into an intersection collision avoidance (ICA) message. This can be transmitted to CVs using the route to five advance warning of red-signal runners.
- Various bus applications are being considered such as right turning bus warnings.
- Emergency vehicle preemption is being tested on the Vissim corridor to allow for emergency vehicles to navigate the corridor more quickly. This will assist ambulances trying to reach one of the two major hospitals on the corridor.
- Currently, many safety applications are relatively expensive, as they are usually one-off deployments needing independent hardware. With CV radios, one device allows for multiple uses. Thus, sharing CV data will likely drive more innovation as many safety improvements are now software problems that can run on existing hardware.
- Madison recently launched a Vision Zero initiative aiming to eliminate all fatalities and serious injuries on Madison's roadways. Our CV corridor project not only directly improves transportation safety on the Park Street Corridor, but also pilots the new lifesaving technology and sets up an implementation framework for the rest of Madison and beyond.

Economic Impact

It is often stated that the costs of ITS is small, but the impact is large. Our team believes that CVs will be an integral part of the future of transportation. CVs can support traditional transportation modes as well as automated vehicles. In urban areas, building new roads and expanding roads is very difficult and costly. CVs offer the ability to improve mobility, safety, and the environment, thereby making a strong economic impact for relatively low cost. This project has a direct economic impact by:

- Enabling the technology needed for mobility improvements in Madison, one of the fastest-growing regions in the state of Wisconsin, including the ability to more efficiently control signals along the corridor to reduce time spent stopped and improve signal phasing dynamically. This will improve travel times and on-time performance for personal vehicles, public transit, and taxi/ride-share services.
- Improving mobility through technology will help support the continued economic stability of the region as rapid growth is anticipated to continue.
- Laying the groundwork for other deployments across the state by sharing best practices.
- Allowing for multiple improvements from a single piece of hardware, which streamlines operations. This CV deployment can support TSP, adaptive signal control, traffic analysis, etc.
- Allowing for different modes to use the same technology, including transit, public works, snowplows, personal vehicles, bicycles, and pedestrians.
- Fostering technology entrepreneurship in Wisconsin related to CV and smart transportation. Data on the corridor will be made available through public APIs to allow for entrepreneurs to use the data and develop algorithms to improve their business models and expand public offerings.

Customer Satisfaction

For our project, customers are the road users of the Park Street corridor facilities. This includes people in personal cars, transit vehicles, taxis and other ridesharing services, public service vehicles, bicycles, and pedestrians. Any improvements to mobility, safety, and environment are considered positive for customer service impacts. The impacts are also far reaching, as the Park Street corridor servers not only residents of the Madison area, but also visitors who work, do business, play or seek healthcare in Madison from all over the State of Wisconsin and beyond.

Specifically, success in customer satisfaction for this project includes:

- Improved on-time reliability for transit.
- Improved quality of service for personal vehicles.
    - Decreased number of stops incurred / time spent stopped on corridor
    - Improved travel time reliability
    - Less interrupted flow along corridor
- Decreased crashes on the corridor.
- Improved road user perception using surveys.
- Improved transportation equity, as the Park Street Corridor serves as a major arterial connecting low income residents to work, education, services, and recreation.

Environmental Impact Mitigation

The connected vehicle technology we have deployed has the potential to mitigate environmental impact of transportation through the following methods:

- Reduce daily recurring traffic congestion and time spent stopped by more efficiently assigning green time based on real-time traffic demands.
- Improve special events traffic flow.
- Provide improved transit signal priority algorithms for busses to increase the on-time performance and speed of the bus system, especially new bus rapid transit (BRT) routes, thereby increasing transit ridership.
- Better monitor current air quality allowing for improved policy decisions.