UW TOPS Lab Update

ITS Wisconsin, October 16, 2025

Andi Bill, TOPS Lab Associate Director
Steven Parker, TOPS Lab Managing Director

Traffic Operations and Safety (TOPS) Lab

ZERO IN WISCONSIN

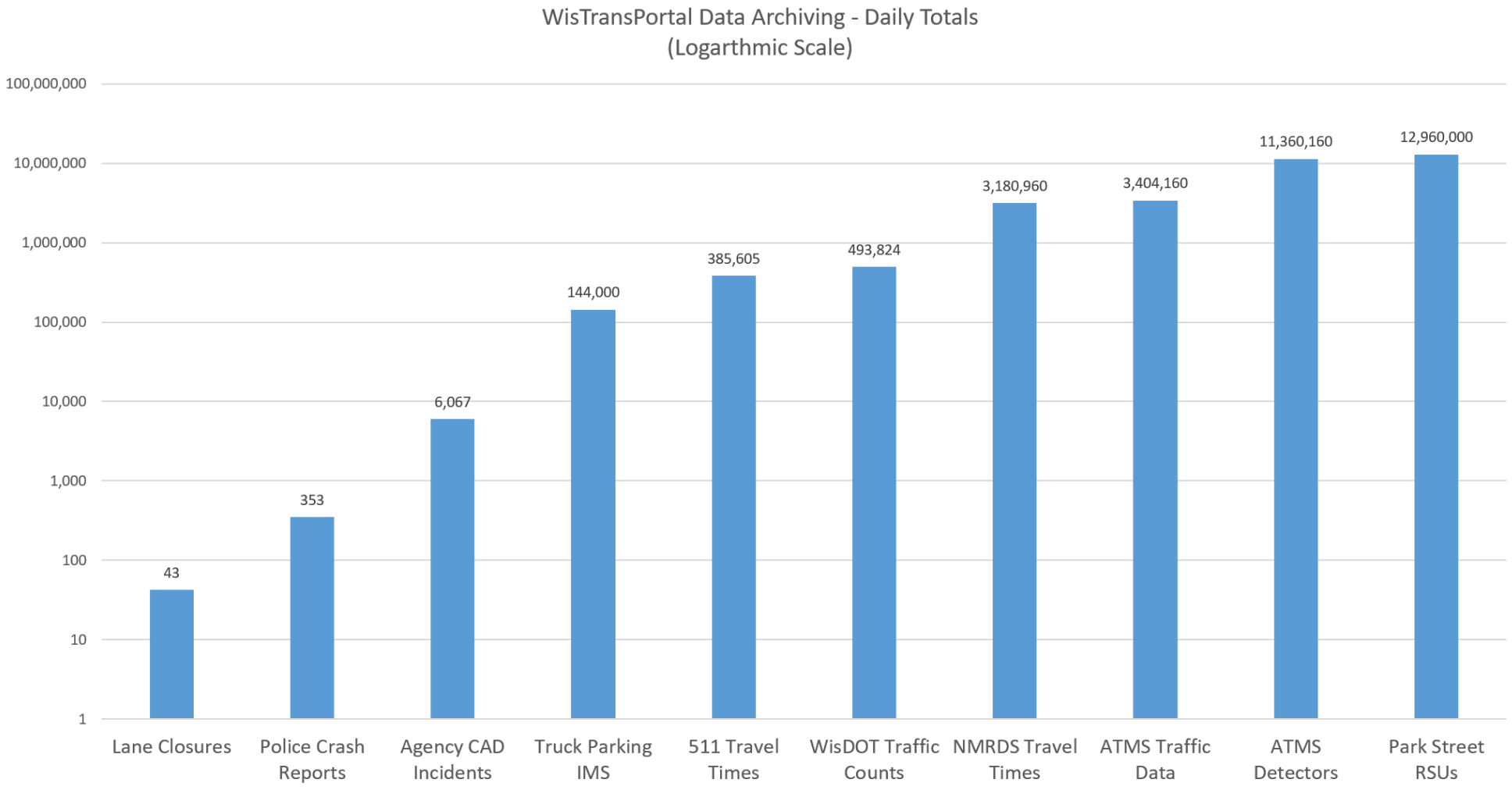
WI LTAP
Wisconsin's Local Technical Assistance Program

WI TTAP
Wisconsin's Tribal Technical Assistance Program

- Formed in 2003
- Part of UW-Madison College of Engineering
- WisDOT Partnerships (BTO, BOTS, BSHP)
- Research / Government Collaboration
- Professional Organizations

WISCONSIN TOPS

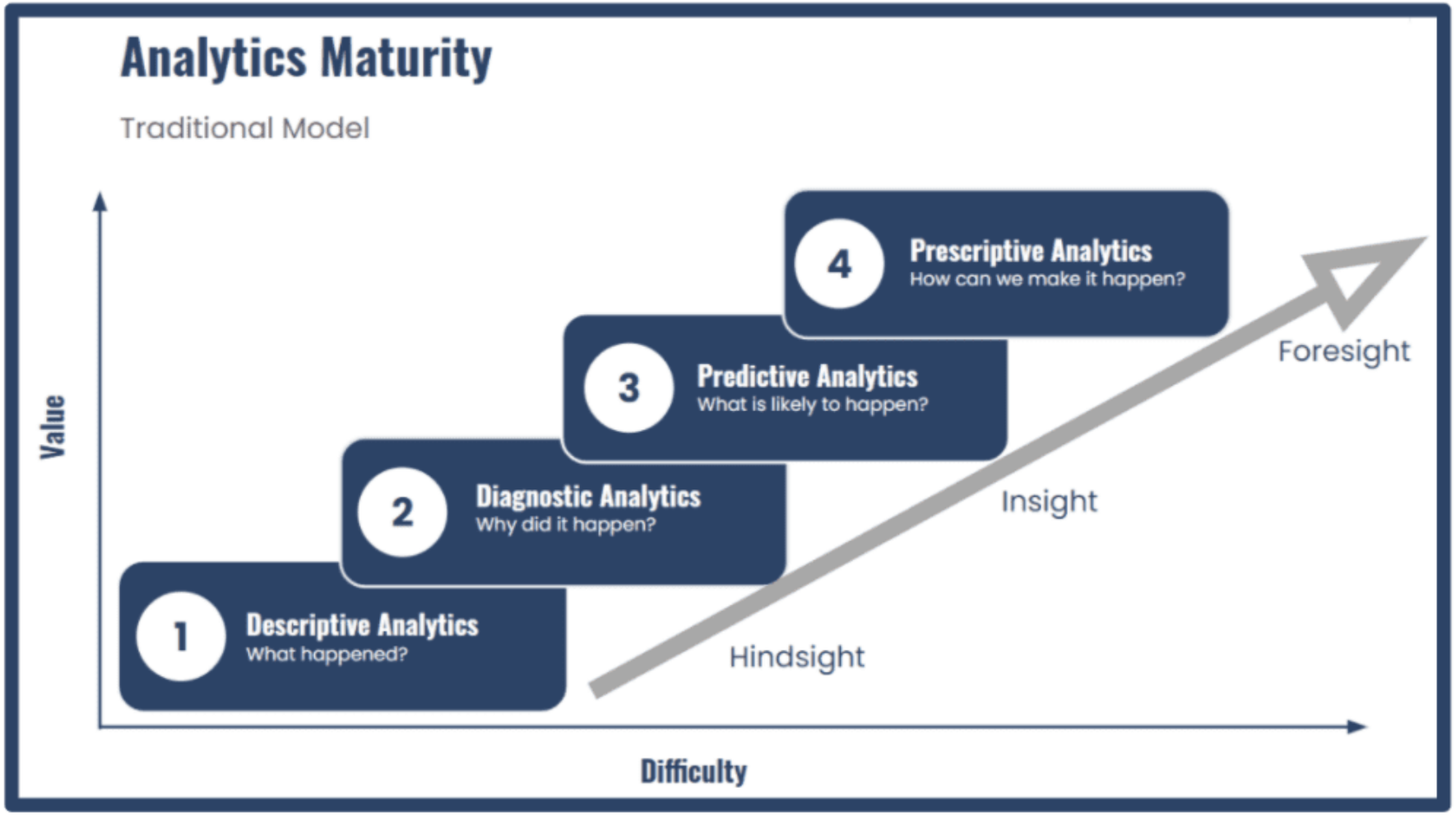
The TOPS Lab Data Journey



Big Data & Analytics Research and Development

- The application of **new and emerging data sources** in combination with **new and emerging methods** to derive **insights** and support **decision making**
- Typically real-time, high frequency, high volume datasets; often from **non-traditional** sources
- May involve **modernization** of traditional data sources

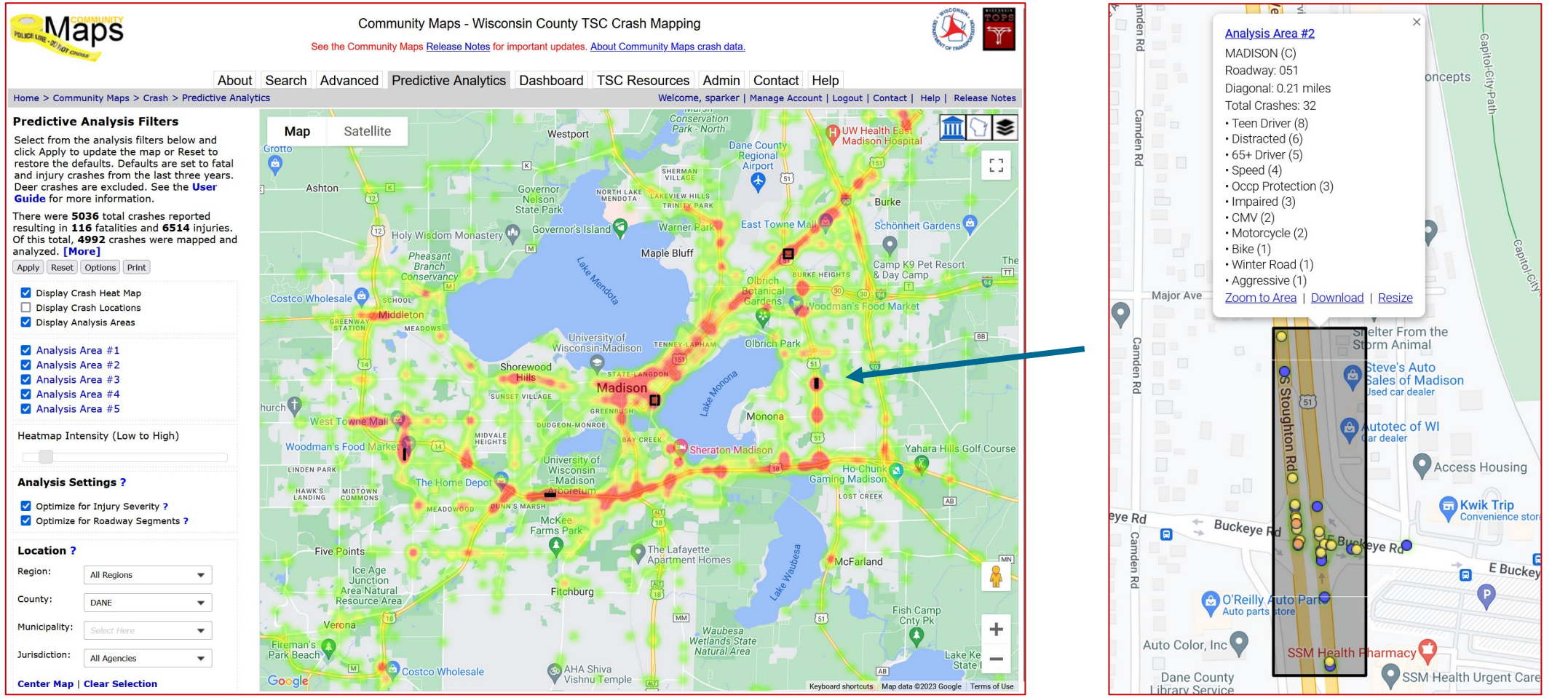
The Analytics Maturity Model



The More Things Change …

- Key Data Performance Measures:
  - Timeliness
  - Data Quality
  - Completeness
  - Data Standards
  - Data Integration
  - Accessibility

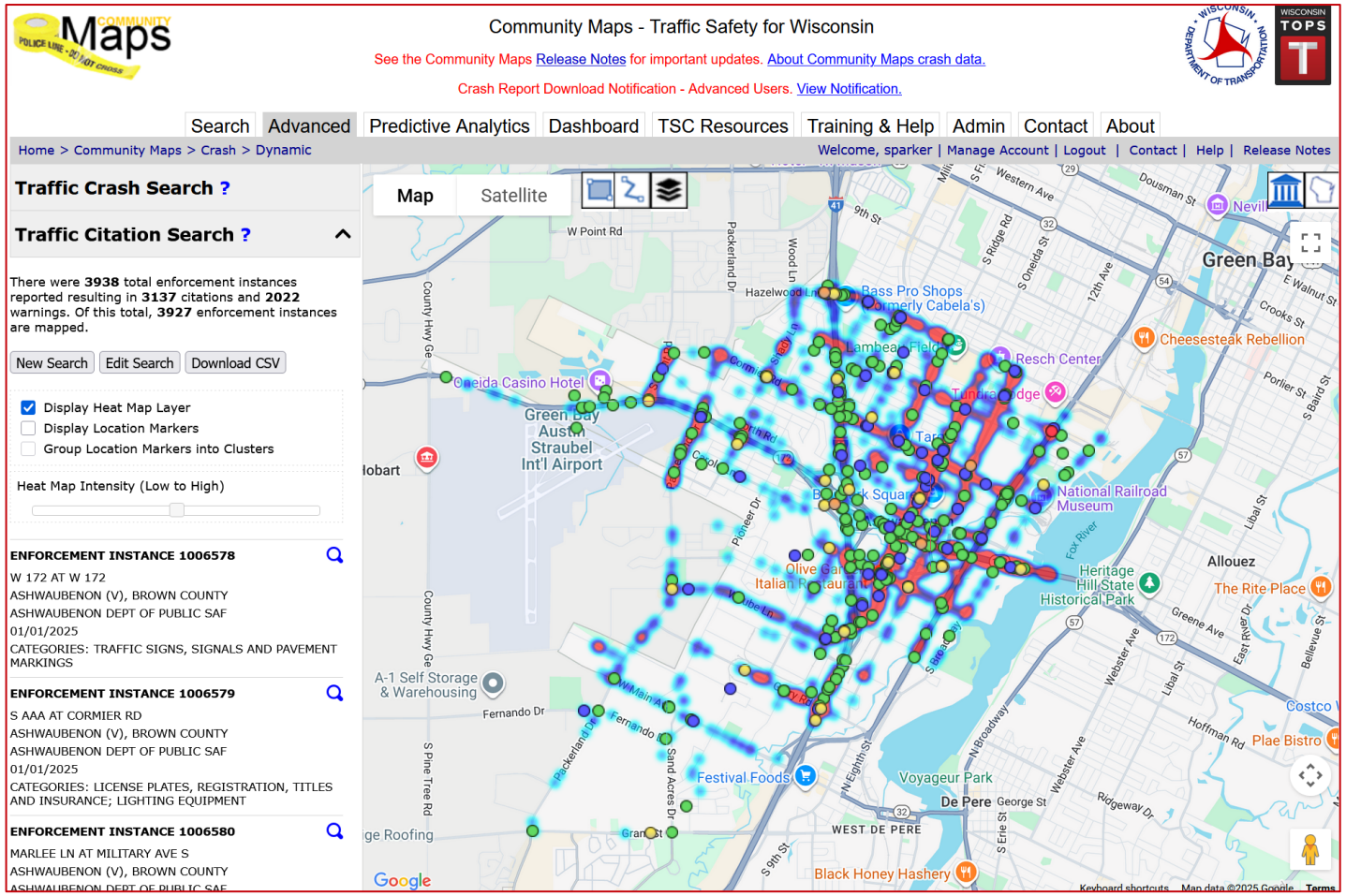
Crash Mapping Improvements



Community Maps Automated Crash Hot Stop Detection

WISTAR: Traffic Safety Records Data Integration

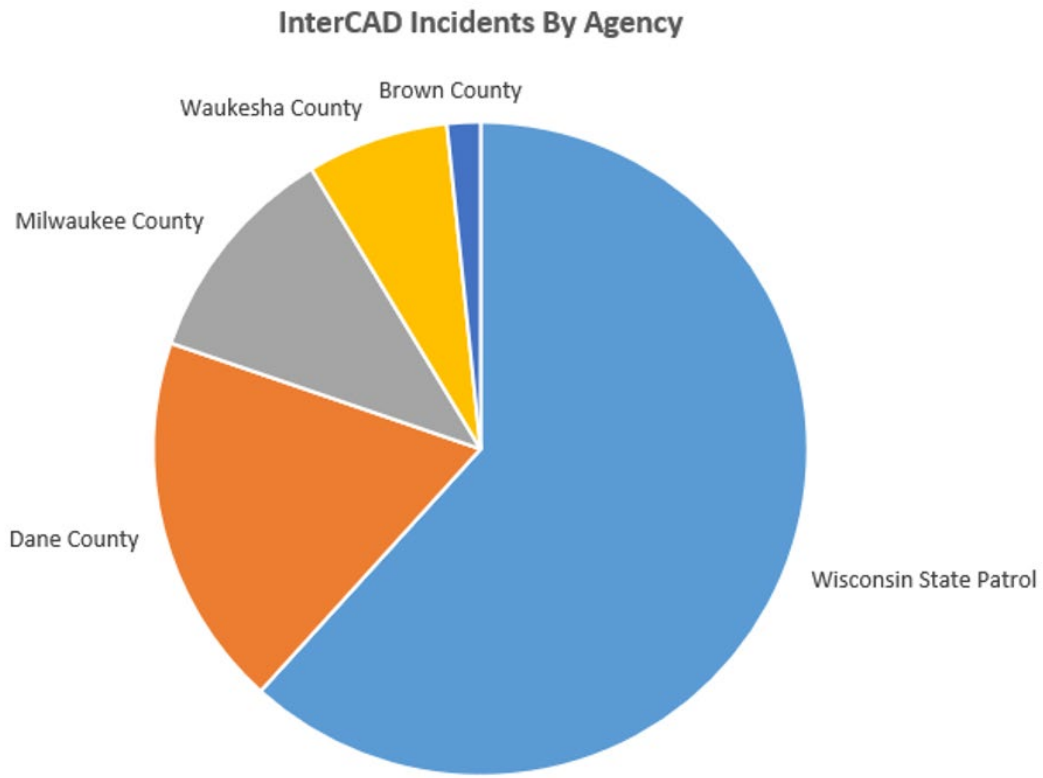
NHTSA Crash Data Improvement Program (CDIP)



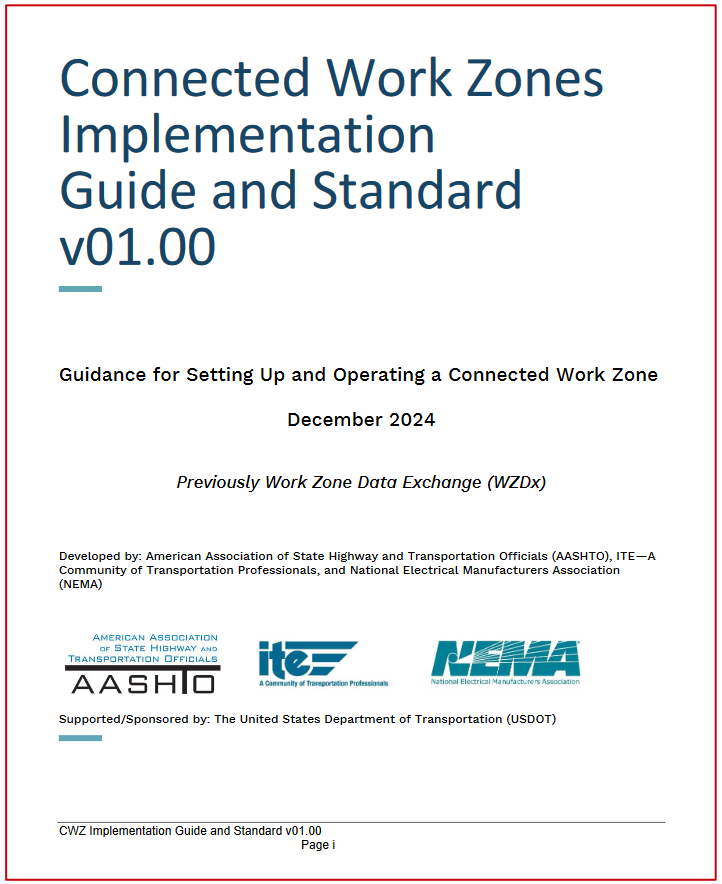
Community Maps Crash and Traffic Citation Dynamic Overlays

InterCAD: Center-to-Center Traffic Incident Data Exchange

- Wisconsin State Patrol – 2009 (SunGard HTE)
- Waukesha County - 2012 (InterGraph)
- Milwaukee County - 2013 (ProPhoenix)
- Dane County - 2013 (TriTech)
- Wisconsin State Patrol – 2018 (MACH CAD)
- Brown County - 2022 (Motorola)



Work Zone Data Management: Connected Work Zones and the Work Zone Data Exchange



Connected Work Zones Implementation Guide and Standard v01.00

Guidance for Setting Up and Operating a Connected Work Zone

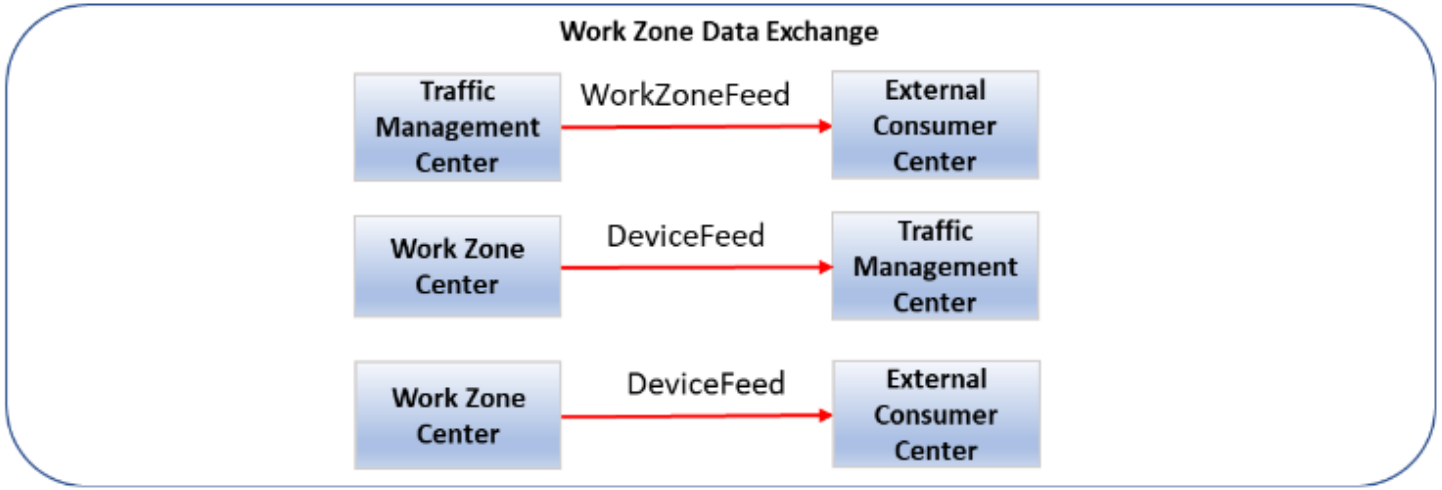
December 2024

Previously Work Zone Data Exchange (WZDx)

Developed by: American Association of State Highway and Transportation Officials (AASHTO), ITE—A Community of Transportation Professionals, and National Electrical Manufacturers Association (NEMA)

Supported/Sponsored by: The United States Department of Transportation (USDOT)

CWZ Implementation Guide and Standard v01.00
Page i



Illinois Department of Transportation

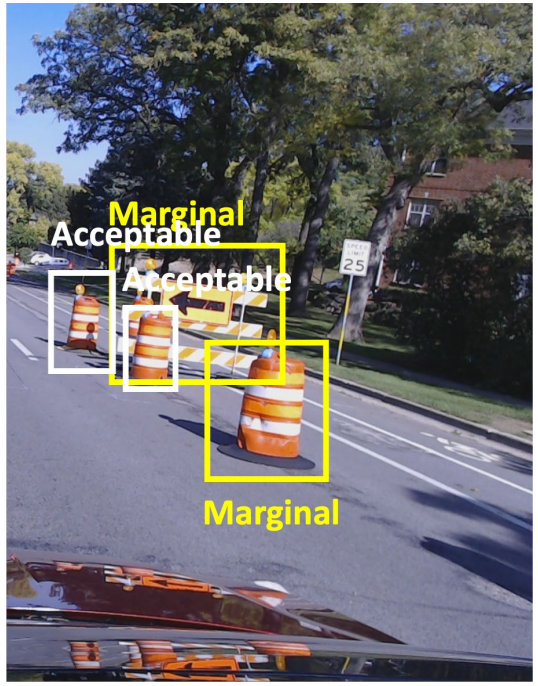
Iowa State University
Institute for Transportation

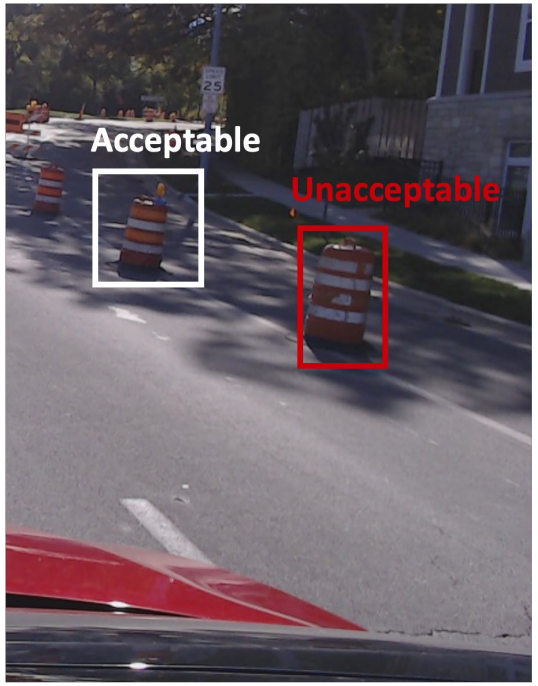
Wisconsin Department of Transportation

ARCADIS

IBI GROUP

Dynamic Work Zone Inspection – Computer Vision

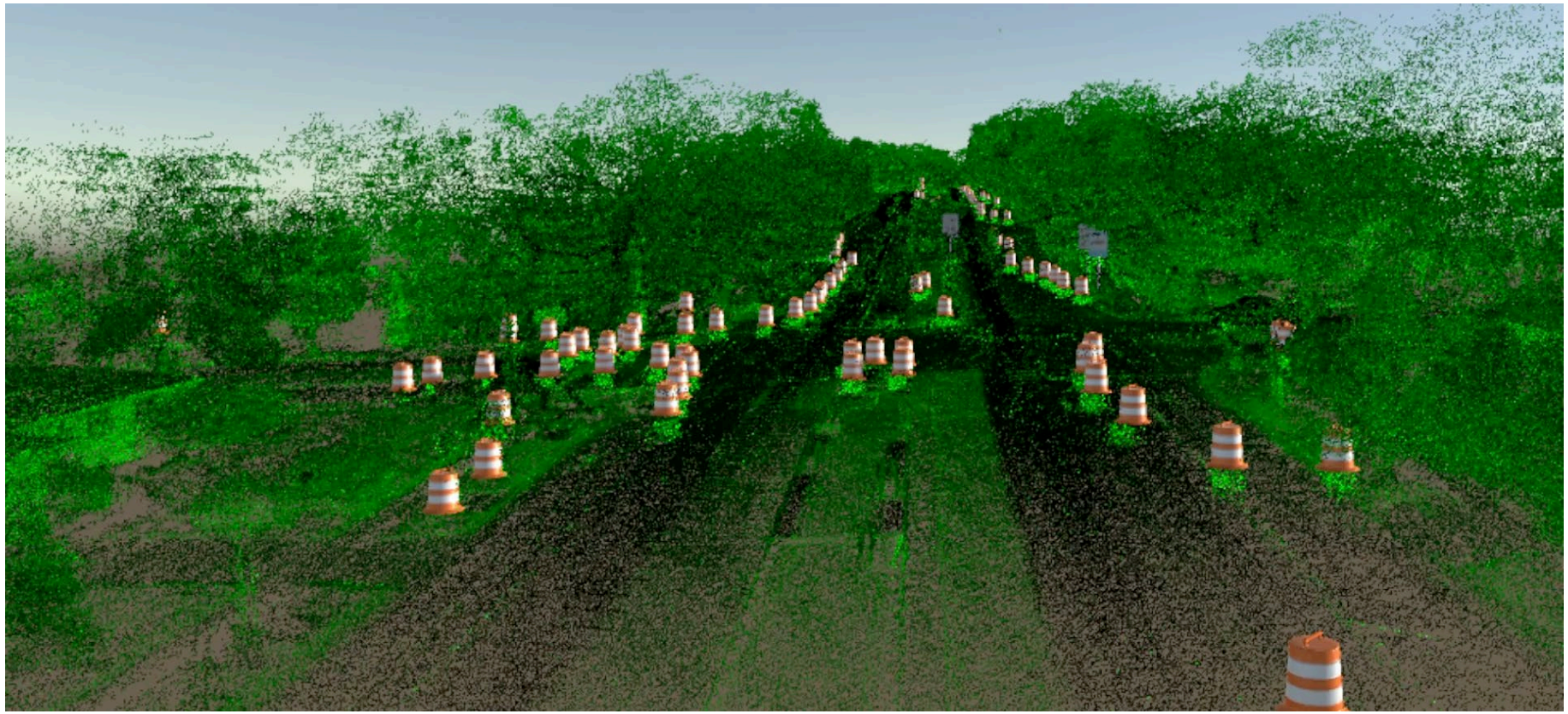




Collaboration with CATS Lab

CONNECTED & AUTONOMOUS TRANSPORTATION SYSTEMS

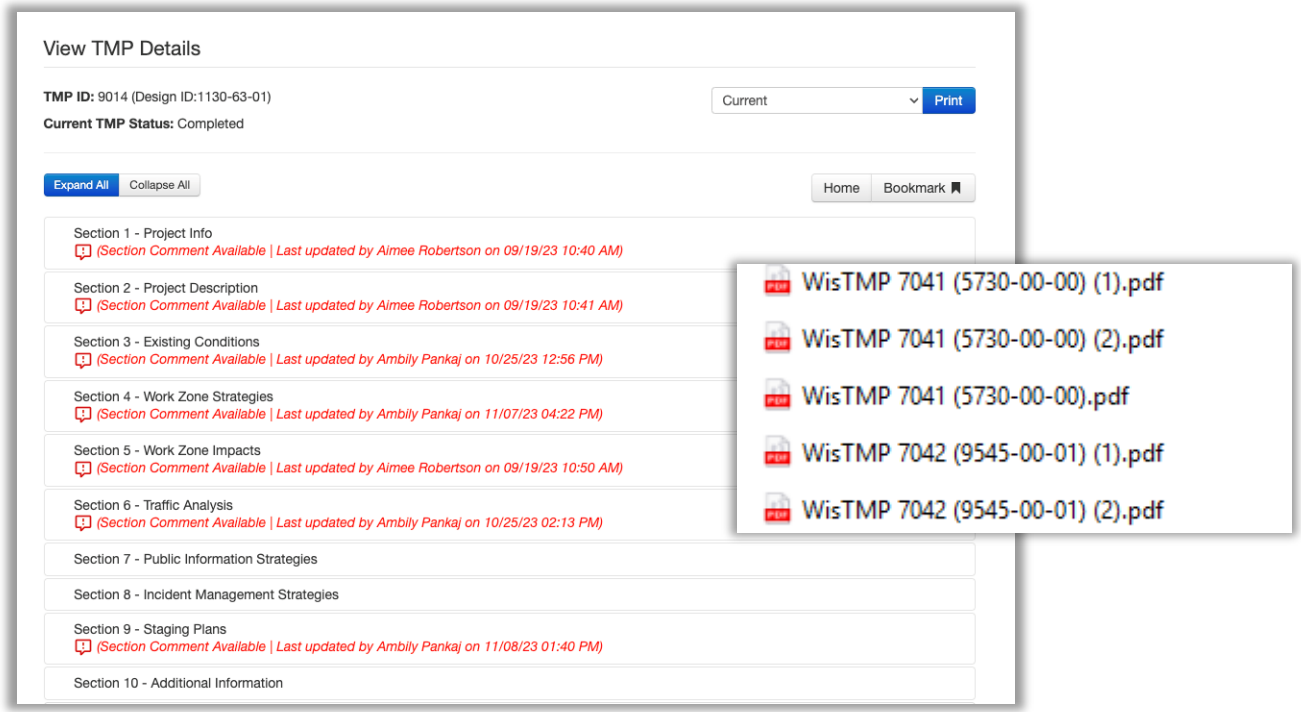
Dynamic Work Zone Inspection – Digital Twin



Collaboration with CATS Lab

CONNECTED & AUTONOMOUS TRANSPORTATION SYSTEMS

LLM-Assisted TMP Strategy Preparation



Input

```
# **WisDOT Transportation Management Plan**

TMP Form Version 2.0 TMP ID: 7041 - Current Version

### **Section 1A - Project Information**

| TMP Type:          | 2                                                                |
|--------------------|------------------------------------------------------------------|
| Region:            | SW                                                               |
| Local Program:     | No                                                               |
| Created Comment:   |                                                                  |
| Federal Oversight: | No                                                               |
| Design ID:         | 5730-00-00                                                       |
| Project Title:     | VIROQUA - RICHLAND CENTER (BISHOP BRANCH BRIDGE, B-62-258        |
| County:            | VERNON                                                           |
| Highway:           | WIS 56                                                           |
```

LLM

```
1  List of chosen strategies:
2
3  | Strategy
4  |-----------------------------------------
5  | Construction<br>phasing<br>/staging
6  | Continuous<br>Full Closure<br>(for a proj
7  | Flagging<br>Operation<br>/One-lane,<br>Tw
8  | Detour Route
9  | Portable<br>Changeable<br>Message<br>Sign
```

Output

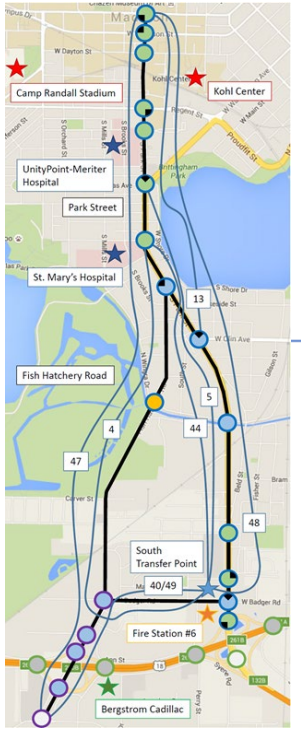
Collaboration with Sky Lab

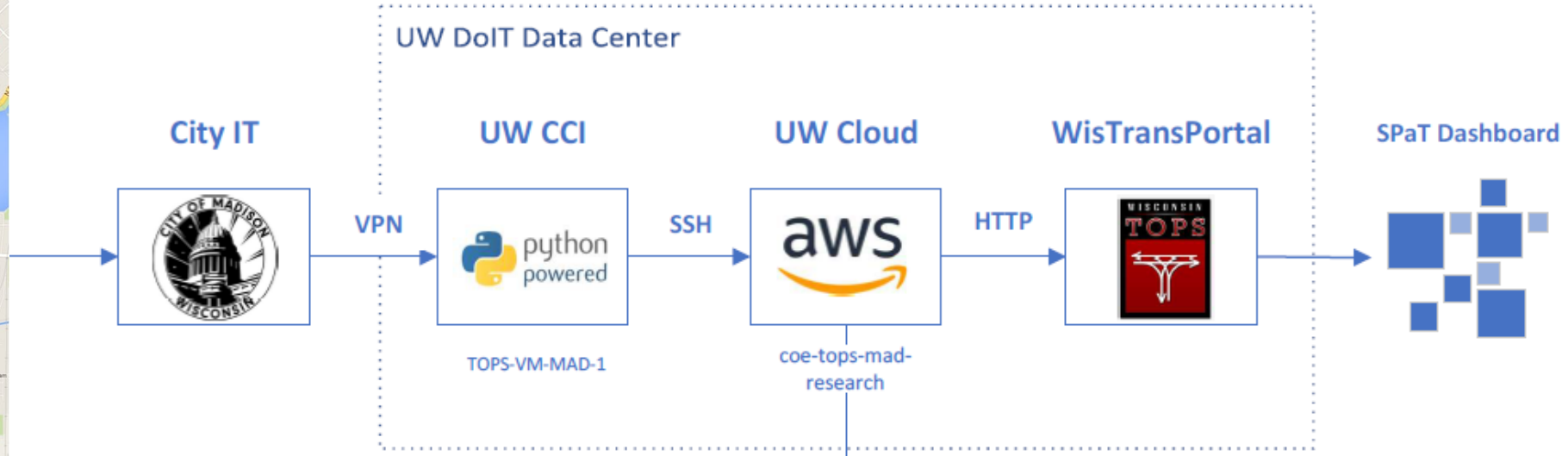
Sky Human-centered AI & Transportation

Safe System


DEATH AND SERIOUS INJURIES ARE UNACCEPTABLE
HUMANS MAKE MISTAKES
HUMANS ARE VULNERABLE
RESPONSIBILITY IS SHARED
SAFETY IS PROACTIVE
REDUNDANCY IS CRUCIAL
SAFE SYSTEM APPROACH
Safer People
Safer Vehicles
Safer Speeds
Safer Roads
Post-Crash Care

City of Madison CV Corridor – Data Pipeline





CAEV Systems

The “Badger” Automated Vehicle

Connected Vehicle Pilot Phase 3

Connected & Autonomous Transportation Systems (CATS) Laboratory

Xiaopeng (Shaw) Li, Harvey D. Spangler Professor, Ph.D., P.E., F.ASCE, CATS Lab Director
Civil & Environmental Engineering, Electrical & Computer Engineering
University of Wisconsin-Madison
xli2485@wisc.edu | 608-263-2464

Test Facilities

- *Three connected & automated vehicles (CAVs)*
  - *Two Lincoln sedans*
  - *A Ford van*
- *Portable sensor racks*
  - *LiDAR*
  - *Camera*
  - *Radar*
  - *Inertial navigation system (INS)*
  - *V2X On-board unit (OBU)*
  - *Module controller*
  - *Laser profiler*
- *Portable roadside units*
  - *Controllable signal lights*
  - *V2X Roadside units (RSU)*
- *Reduced-scale CAVs*
  - *Pololu*
  - *F1-tenth*
  - *Crazyfile*
- *Automated ground robot*
  - *Robotic ground vehicle*
  - *Robotic arm*
- *And more .....*

Two automated Lincoln sedans

LiDAR | Camera | INS | Radar | V2X OBU | Module controller | Drone

Automated ground robot

Automated van

Laser profiler

Crazyfile

Roadside units

Pololu

F1-tenth

Highlighted Projects

- **US DOE – Visual-Enhanced Cooperative Traffic Operation System (VECTOR)**

VECTOR utilizes dynamic visual signs (e.g., flashing lights) as an innovative way of CAV communications to enable low-case Cooperative Driving Automation (CDA).

- **USDOT FHWA – Cooperative Automation Research Mobility Applications (CARMA)**

CATS Lab has led the development of the USDOT CARMA Ecosystem core module development. We are the ONLY external team that has successfully demonstrated it in field tests (e.g., TSMO applications, highway platooning & merging)

- **NSF – Cyber-Physical Phase of Mixed Traffic**

This project takes advantage of the CATS lab scaled-CAV testbed and two full-size L3 CAVs to investigate the characteristics of the mixed traffic flow (i.e., Modular & Autonomous Vehicles) regarding dynamics, impacts, and management.

- **CCAT – Roadway Friction Screening and Measurement with Automated Vehicle Telematics and Control**

This project introduces an innovative road friction screening and measurement system that utilizes telematics data from instrumented regular vehicles (RVs) and automated vehicles (AVs) for a comprehensive analysis of road friction values at the network level. The AV control technology based on Physics-Enhanced Residual Learning (PERL) method can reach and maintain optimal slip ratios for the peak Tire-Road Friction Coefficient (TRFC) value without causing excessive sliding or tire wear.

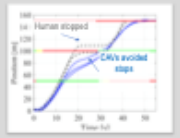
- **US DOT – Tribal & Rural Autonomous Vehicles for Equity, Livability and Safety (TRAVELS) System Applications**

The TRAVELS program is dedicated to implementing efficient, sustainable Autonomous Vehicle (AV) solutions for rural and tribal communities. Leveraging diverse expertise and resources, such as CAV testbeds, technology providers, and support in data, infrastructure, and policies, the program strives to ensure the benefits of AV technologies are accessible to all populations, including disadvantaged groups in rural and tribal regions.

- **CCAT – Evaluation of Vehicle Telematics and Infrastructure-based Connected Vehicle Data for Real-Time Safety and Mobility Application**

This project leverages vehicle telematics data to enhance real-time traffic safety monitoring. A data-driven algorithm was developed for crash detection on freeways, and a web-based framework was built to visualize safety analytics and identify high-risk hotspots for proactive mitigation.

- **ANL – Evaluating Energy and mobility impacts of connected and automated vehicles Using Real-World Data**



This project demonstrates ANL's eco-driving CAV control algorithms on UW–Madison's automated driving platforms under realistic driving scenarios to quantify potential energy savings. Public-road experiments are conducted using UW–Madison CAVs and aerial drones to collect mixed-traffic data and reproduce observed behaviors in high-fidelity simulations for further analysis and validation.

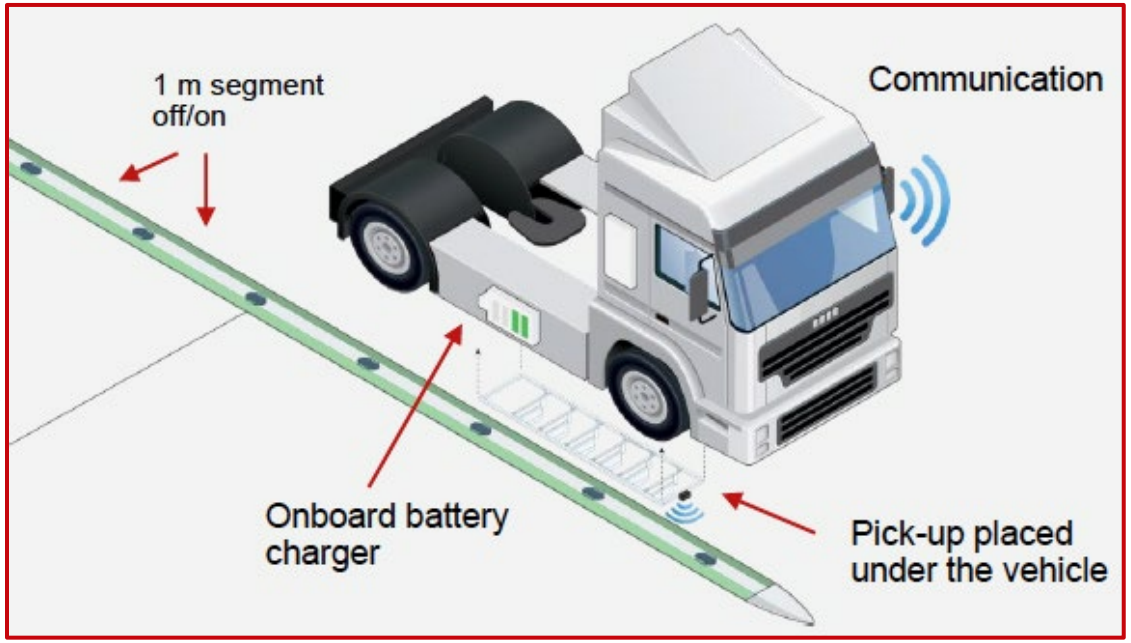
Our Sponsors

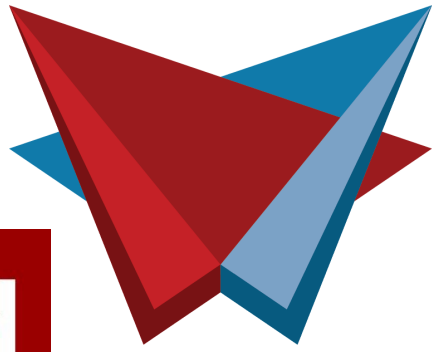
Connected and Automated Transportation System Course

- This course provides a comprehensive introduction to connected vehicle (CV) and automated vehicle (AV) technologies and their applications in transportation systems. Participants will explore the three primary technologies essential for automated vehicles: sensing, trajectory planning, and vehicle control. The course examines connected vehicle technologies, system-level operations, and planning considerations, along with relevant policy issues. Through a combination of theoretical foundations and practical applications, participants will gain the knowledge needed to understand and work with emerging CAV technologies in engineering and transportation contexts.
-

Connected, Automated, Electric Vehicle Demonstration Corridor

- Congressional Discretionary Spending Opportunity
- Conductive Charging
- Living Lab
- Demonstration and Evaluation





Wisconsin Transportation Center

Thank You!

Questions?

Andi Bill
bill@wisc.edu

Steven T. Parker
sparker@engr.wisc.edu