Connected and Automated Vehicles- **What's new and Where are we going?**

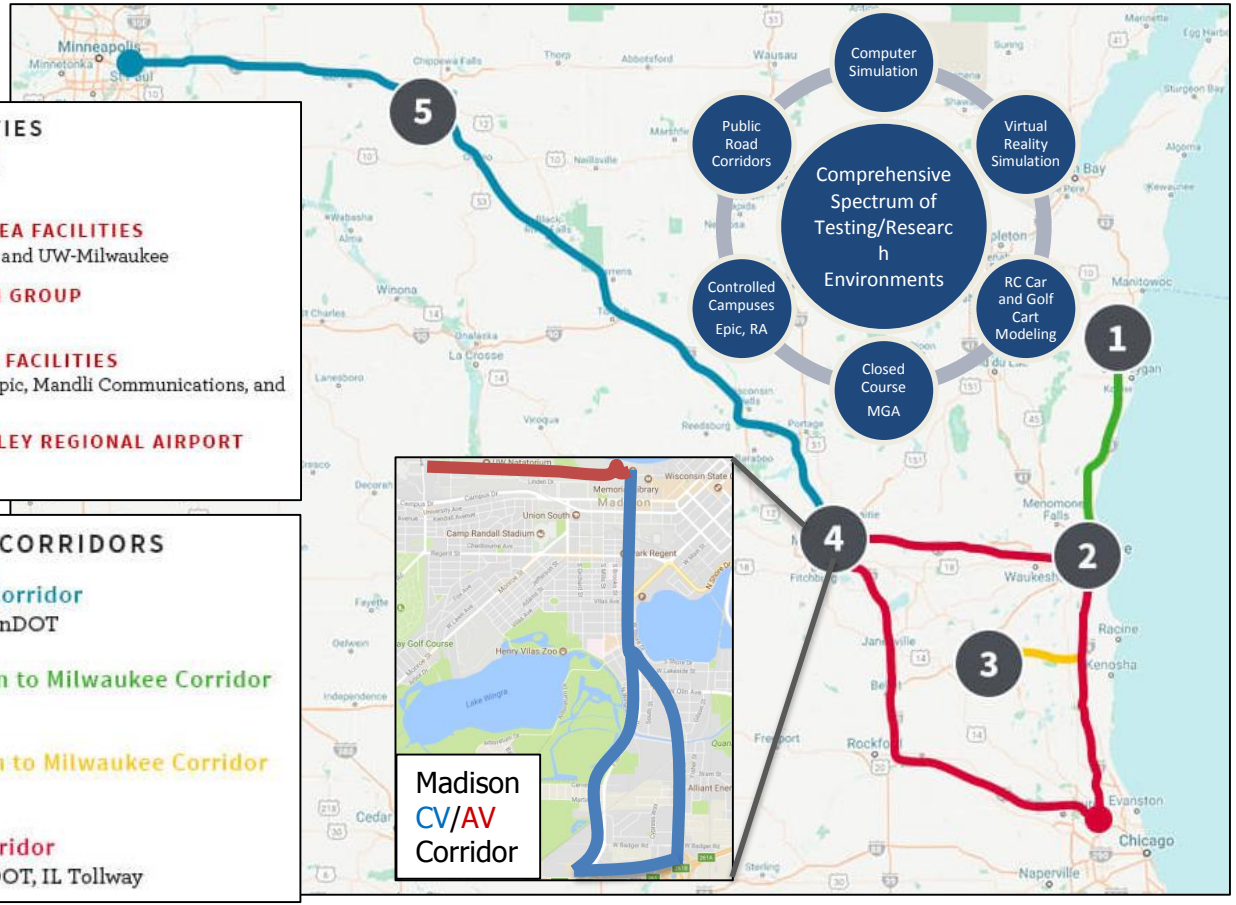
Andrea R. Bill

TESTING FACILITIES

1. **ROAD AMERICA**
   Elkhart Lake, WI
2. **MILWAUKEE AREA FACILITIES**
   City of Milwaukee and UW-Milwaukee
3. **MGA RESEARCH GROUP**
   Burlington, WI
4. **MADISON AREA FACILITIES**
   City of Madison, Epic, Mandli Communications, and UW-Madison
5. **CHIPPEWA VALLEY REGIONAL AIRPORT**
   Eau Claire, WI

PROPOSED AV CORRIDORS

- **MadMSP Corridor**
  WisDOT, MnDOT
- **Sheboygan to Milwaukee Corridor**
  WisDOT
- **Burlington to Milwaukee Corridor**
  WisDOT
- **MRCM Corridor**
  WisDOT, iDOT, IL Tollway

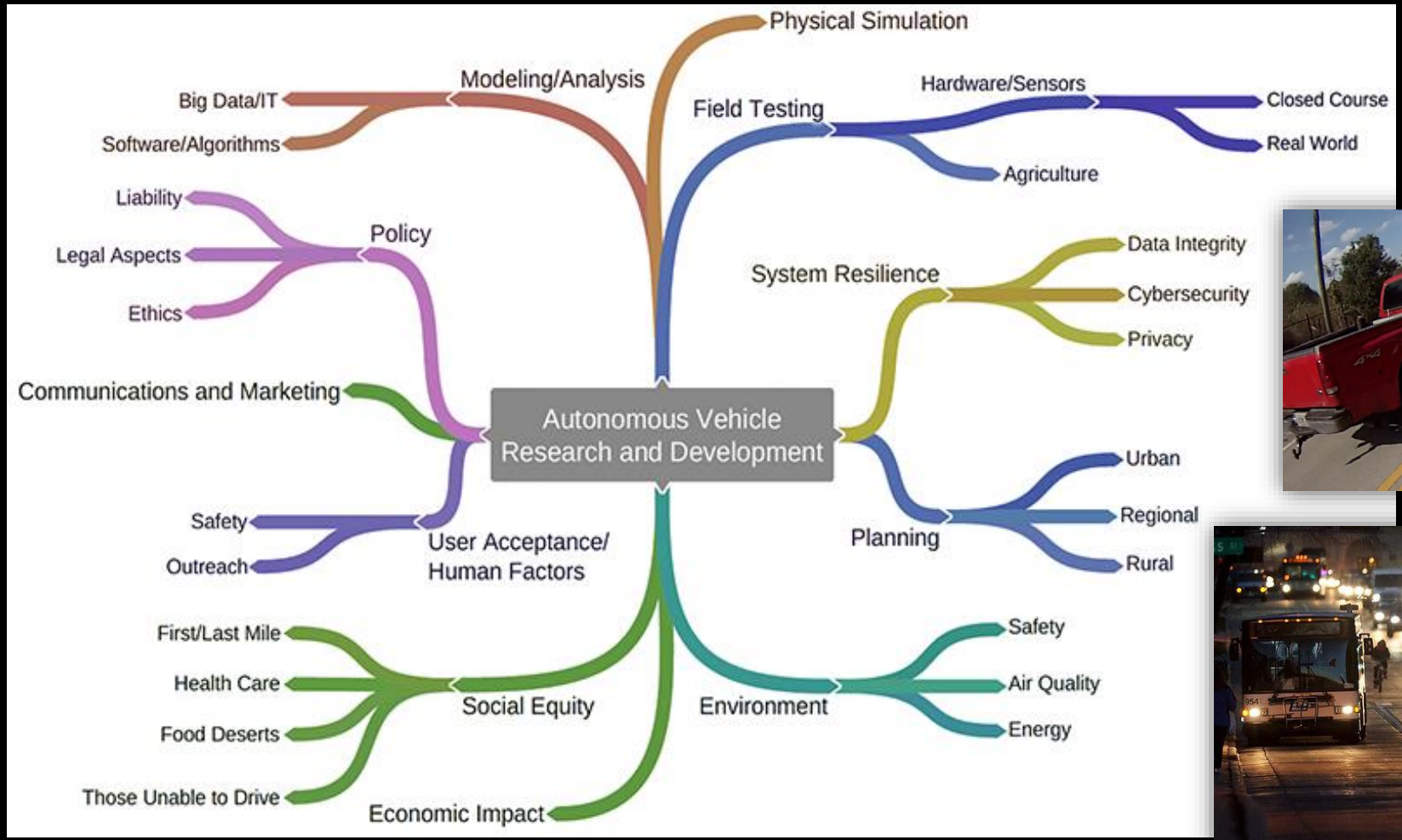


WISCONSIN AUTOMATED VEHICLE PROVING GROUNDS

International

SOUTHEAST UNIVERSITY

Breadth, Complexity, Edge Cases



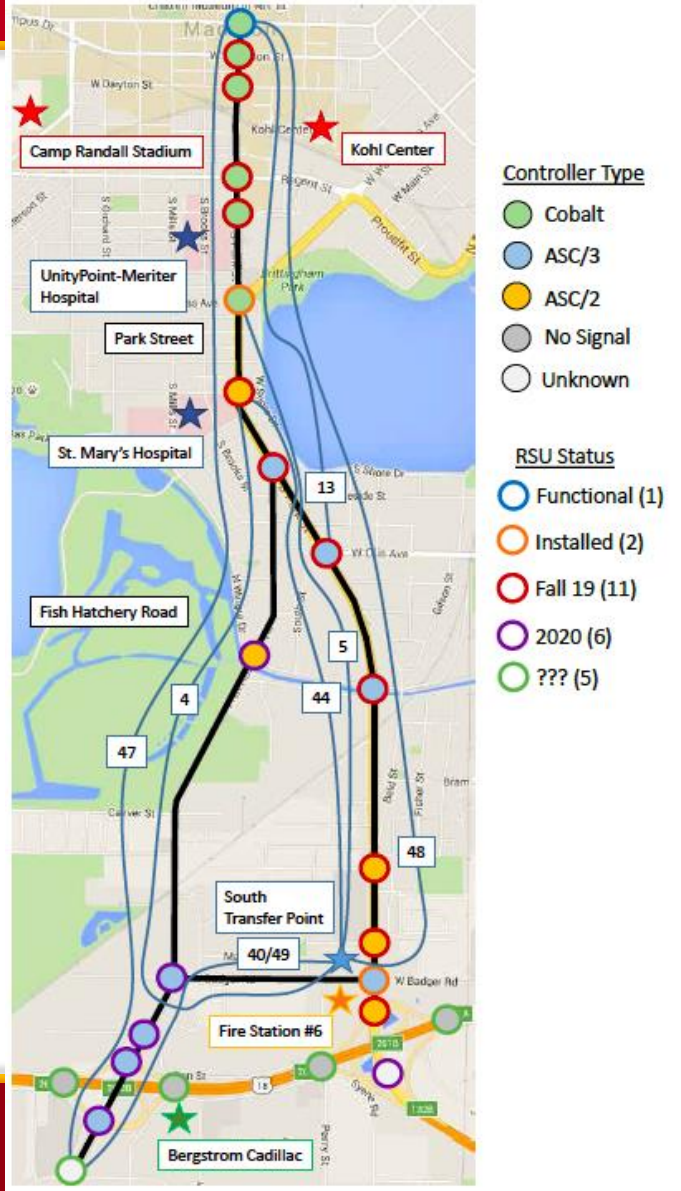
Projects

College of Engineering

UNIVERSITY OF WISCONSIN–MADISON

Madison CV/AV Corridor – Connected Corridor

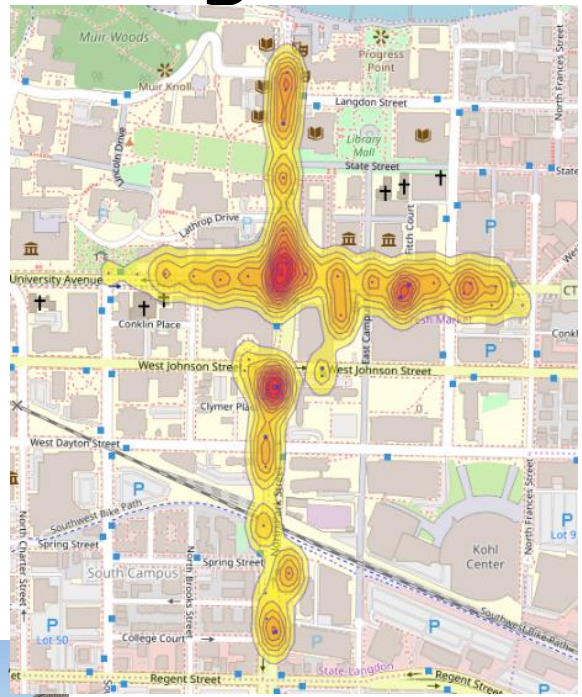
- Satisfies SPaT (Signal Phasing and Timing) Challenge
- Goal: 26 DSRC deployment
- TSP/MMITSS application
- Transit/VRU interaction apps
- Red light violation warning
- V2I general testing
- Simulation-to-design
- Preparation for 5G

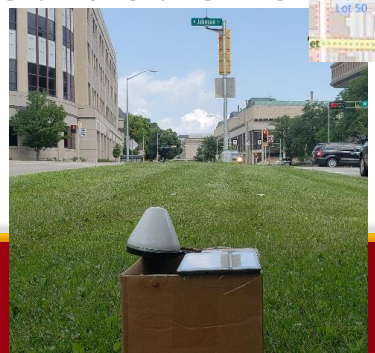


Madison CV/AV Corridor – Connected Corridor

Reliability of Connected Vehicles Messages in DSRC Connected Environments

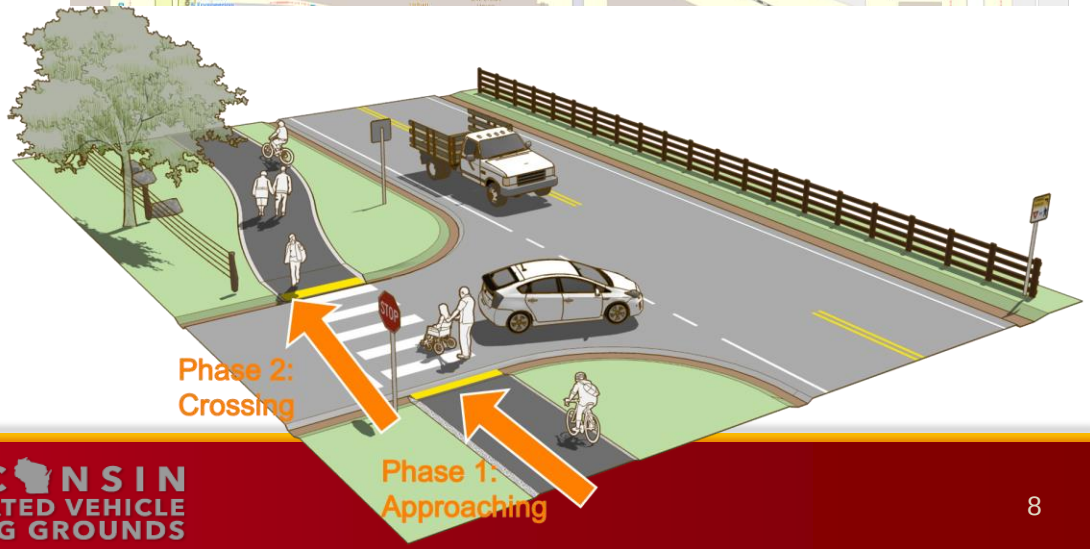
- Delivery range & quality of CV Messages
- N Park St & University Ave, Madison
- RSU transmitting SPaT and MAP messages
- Mobile OBU for measurements
- 40+ locations
- Range up to 284 meters, without obstructions
- Obstructions impact reception





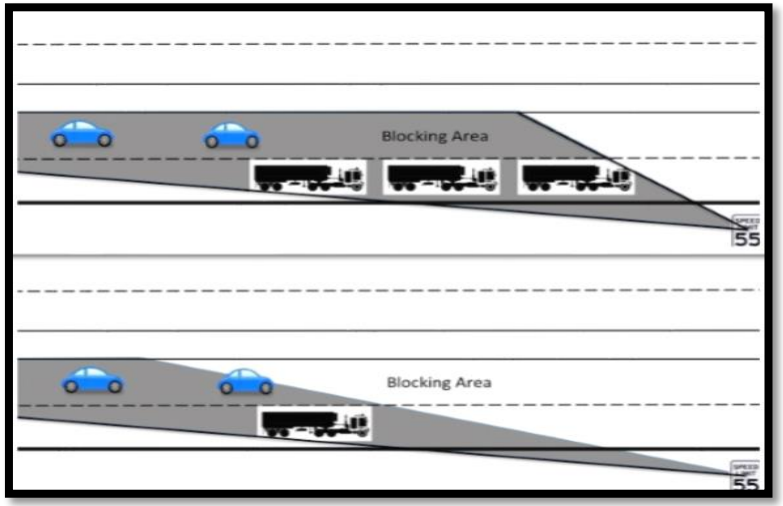
Mobile AdHoc Networks for Vulnerable Road User Safety

- Infrastructure-free
- Smartphones in adhoc networks
- Broadcast presence messages
- Pedestrian crossing prediction
- Hierarchical mapping of conflicts
- Warning message to road users



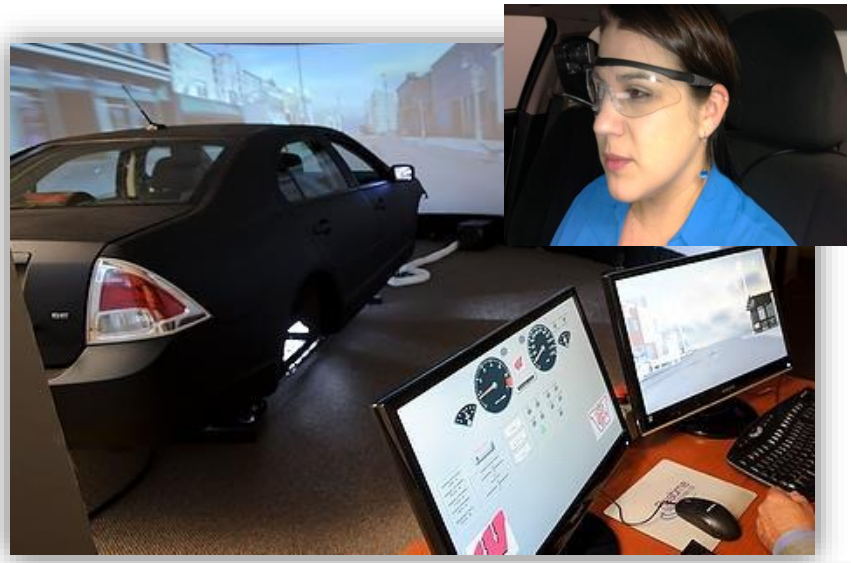
Truck Platooning – Sign Occlusion

- Platooning beneficial
  - Fuel consumption
  - Emissions
  - Capacity
- Platoons occlude signs
- Simulation modeling of occlusion
- Over 400,000 scenarios modeled
- Significant sign occlusion (up to 80%)



HAVI – Human AV Interaction

- Full-scale driving simulation
- Partial automation research
- Driver reengagement
- Disengagement scenarios
- Driver attentiveness / distraction
- ADAS/CV driver notification strategies
- AV interaction with human drivers
- Vehicle assertiveness

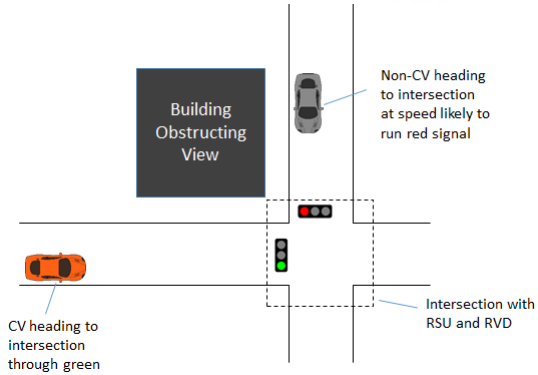


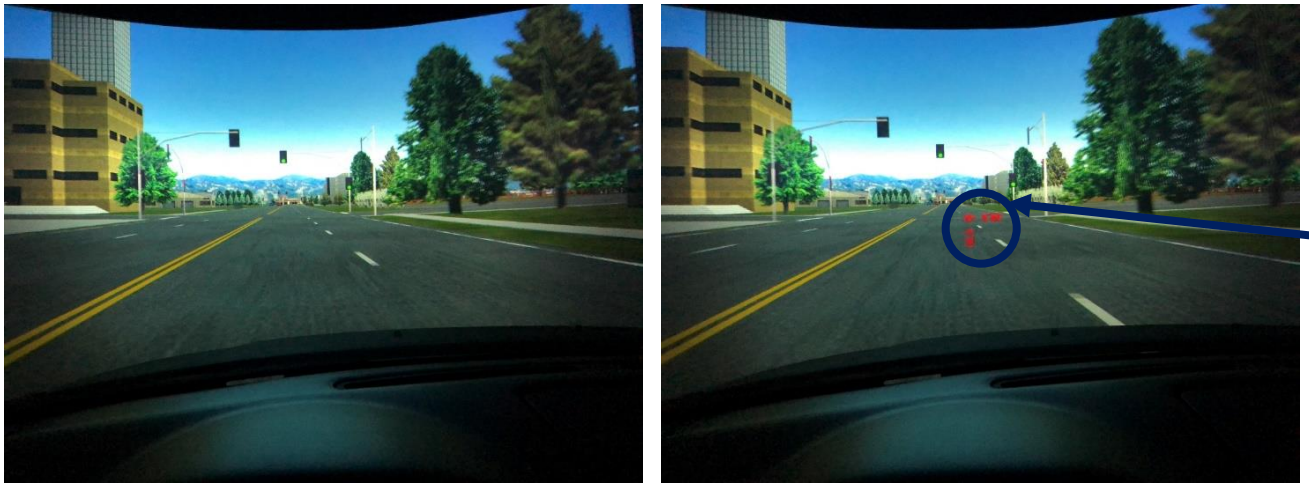
Augmented Reality (AR) Traffic Signs

- AR signs
  - Reaction time (RT)
  - Distraction
  - Flashing rate
- Driving simulation scenarios
- AR signs direct attention to road
- Equivalent RT to post-mounted signs
- RT impacted by flashing rate

Communicating Non-CV Info to CV

- Evaluate RLR warning message
- Full-scale driving simulation
- Location of activation of warning system





Integrating AV into Transit Service

- Integrating AV with transit
  - Small urban areas great potential
- Online surveys
  - Travel habits, AV opinion/attitudes, transit usage
  - Eau Claire completed (217 responses)
  - Janesville and Wisconsin Rapids (just completed)
- Welcome automation and ADAS
- Fully automated transit vehicle
  - >75% concerned without operator
  - > 70% comfortable with an operator

REACT – Resident Engagement on Automated and Connected Technologies

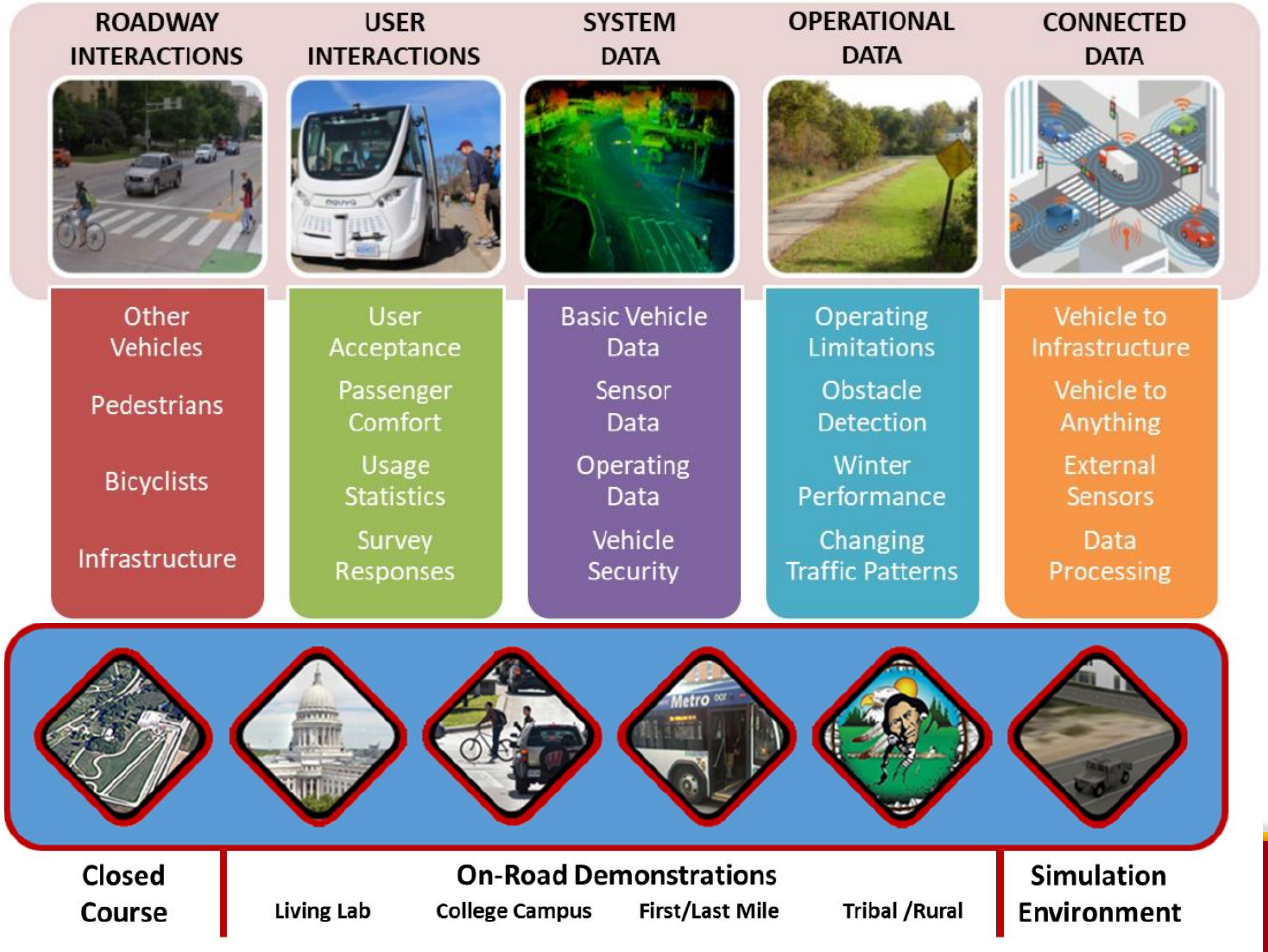
- Rural engagement workshops
- Aging community outreach
- Low-income community outreach
- Users with disabilities
- Vulnerable industry sector research
- Public outreach and education events
- Multidisciplinary graduate degree development

Where are we going?

SC&C – Smart and Connected Communities

- Dynamic routing
- First-mile/last-mile connectivity
- Food and transit deserts
- Shared Madison data platform
- Smart parking algorithms
- IoT compatibility
- Urban analytics

Automated Shuttle Deployment



CAVH

Development Directions of CAVH

Vehicle Based Approach

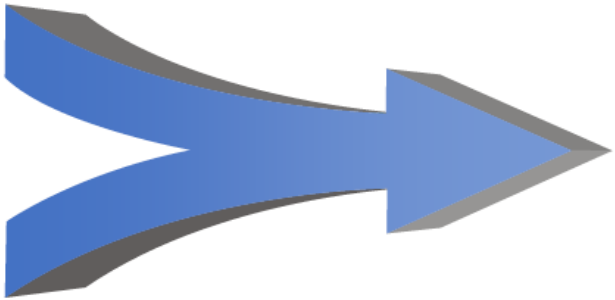
IT & OEM Firms

Connected Automated Vehicle

Infrastructure Based Approach

Transportation Industry

Connected Automated Highway



CAVH

System Based Approach: Simple Vehicle , Smart System (Simple Vehicle , Smart Road)

Technical Features:

- The majority of the sensor functions can be achieved using sensor systems on highway infrastructure or vehicle/highway system
- The majority of the vehicle operation and control functions can be achieved via the cooperation of control systems on highway infrastructure and vehicle
- Multiple redundant systems for sensor system, computing system, control system, communication system, information safety

Thank You

Andrea R. Bill
TOPS Lab
Civil & Environmental Engineering
UW-Madison
bill@wisc.edu

WISCONSIN AUTOMATED VEHICLE PROVING GROUNDS

College of Engineering
UNIVERSITY OF WISCONSIN–MADISON