



# Telematics Data Applications for Transportation Operations and Management

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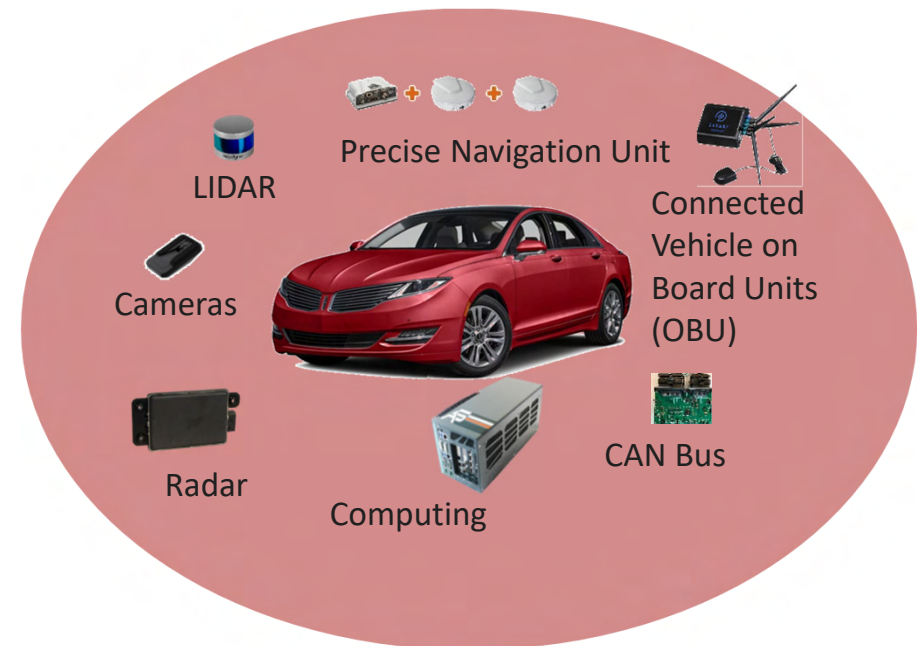
10/6/2023

2023 Southeast Wisconsin Transportation  
Symposium



# Telematics Data – Vehicle as A Sensor

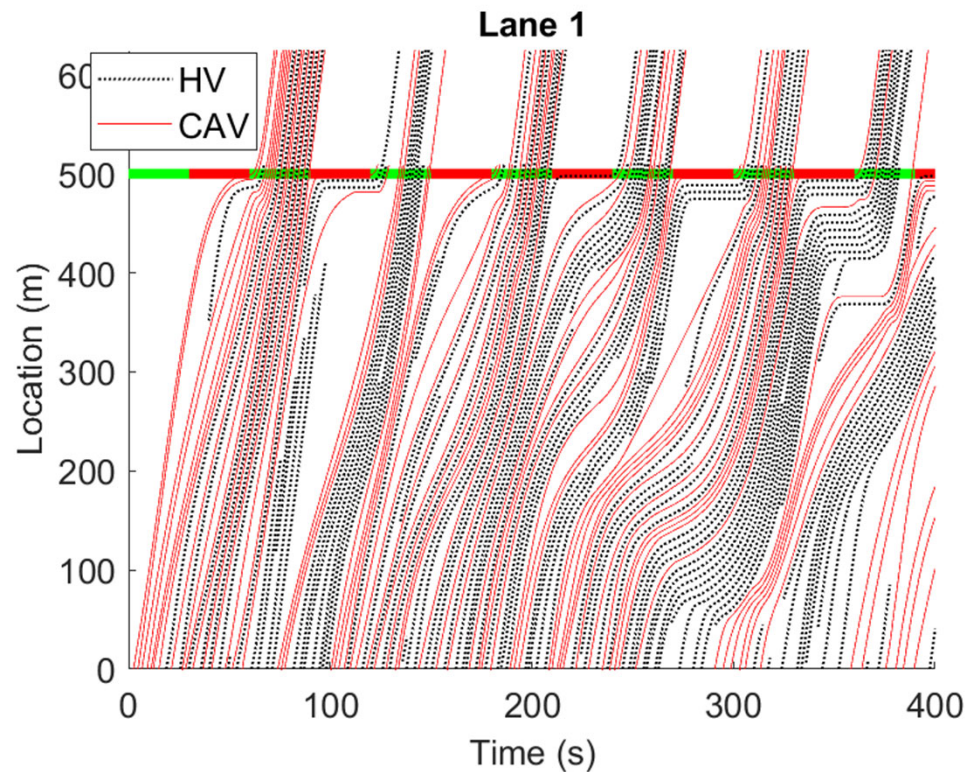
- Modern vehicles with various sensing, computing, and communication devices
- Real-time telematics data
  - Position and kinematic information
  - Vehicle operation states – fuel consumption, battery level, load level, etc.
  - Environmental sensors
    - Surrounding road users
    - Pavement and asset conditions





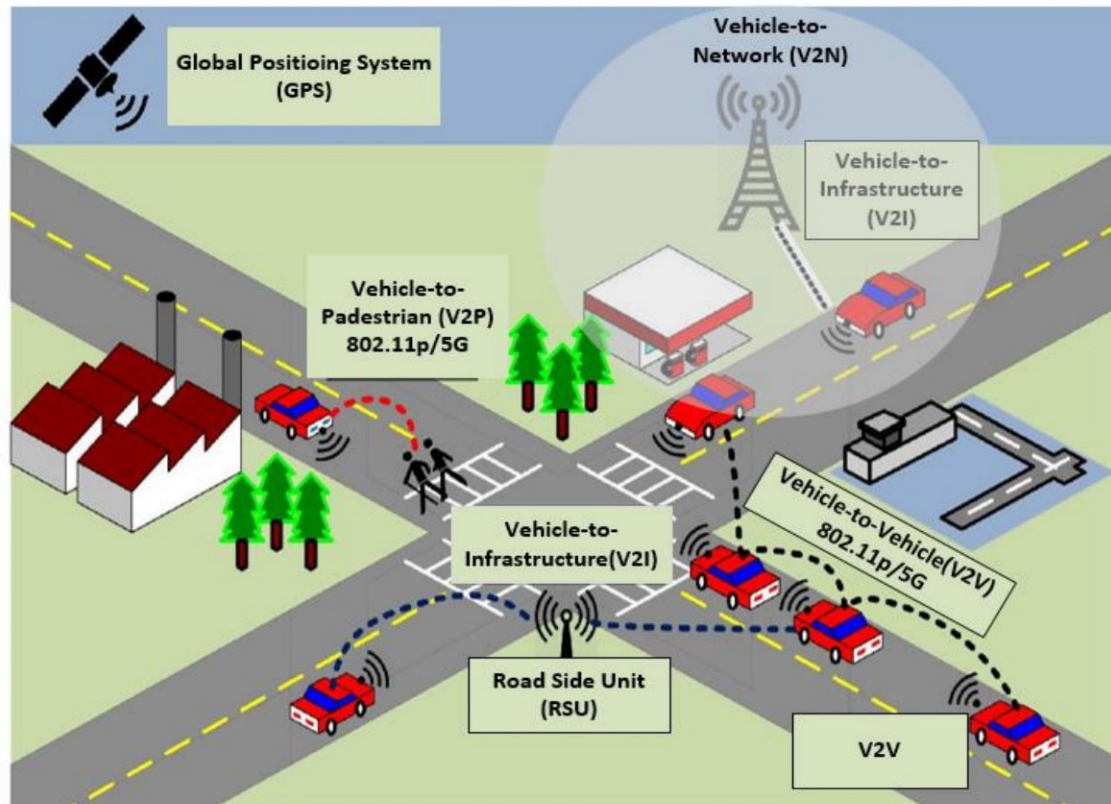
# Position and Kinematic Applications: Real-Time Information for Traffic Operations

- Detailed approach vehicle trajectory information for better signal timing
- Integrated corridor and management and network control



# Position and Kinematic Applications: Real-Time Safety Management

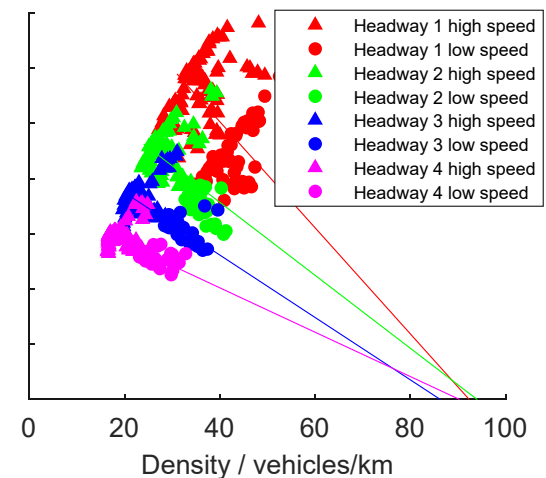
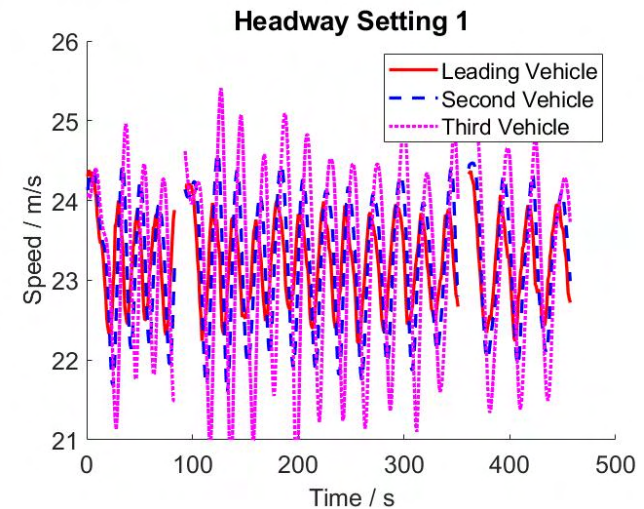
- Collision Warning with V2X communications





# Position and Kinematic Applications: Mobility Measures for Planning

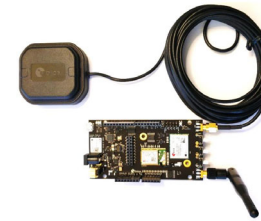
- Vehicle position and kinematic trajectories
- Inference to road capacity, level of services for planning



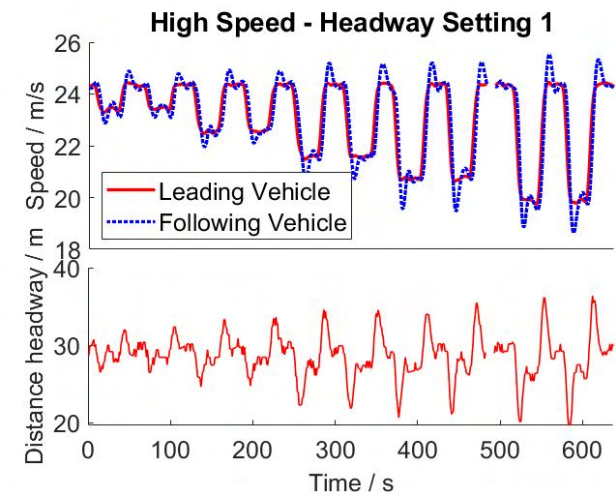


# Position and Kinematic Applications: Emerging Technology Evaluation

- Production Automated Vehicles (PAVs) rapidly increase
  - 2% in 2015 -> 10% in 2025 -> 40% in 2040.
  - 92% new cars L1 automation; 50% L2
- Telematics data collected from the PAVs can be used to evaluate and rank their performance on safety, mobility, and energy consumptions



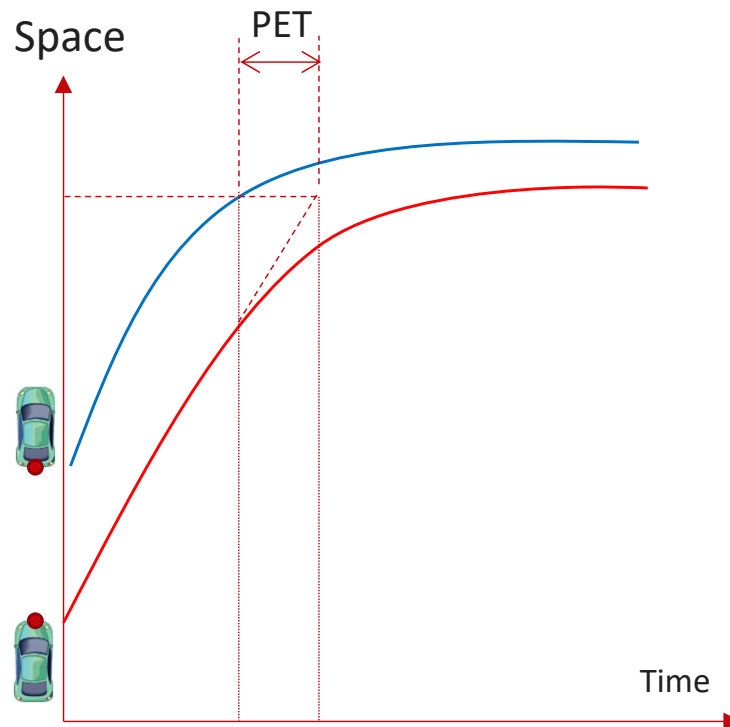
- U-blox GNSS receiver
- Position accuracy:  $\pm 0.26$  m
- Speed accuracy:  $\pm 0.089$  m/s





# Position and Kinematic Applications: Insurance Pricing

- Telematics data to predict conflict measure and then ultimately predict collision rate





# Vehicle State Applications: Evaluate Vehicle Performance

- Initiatives of replacing ICE fleet with E-fleet
- Track E-fleet savings in energy consumption and emissions
- Track E-fleet services in combination with vehicle load



All-Electric Buses in City of Madison



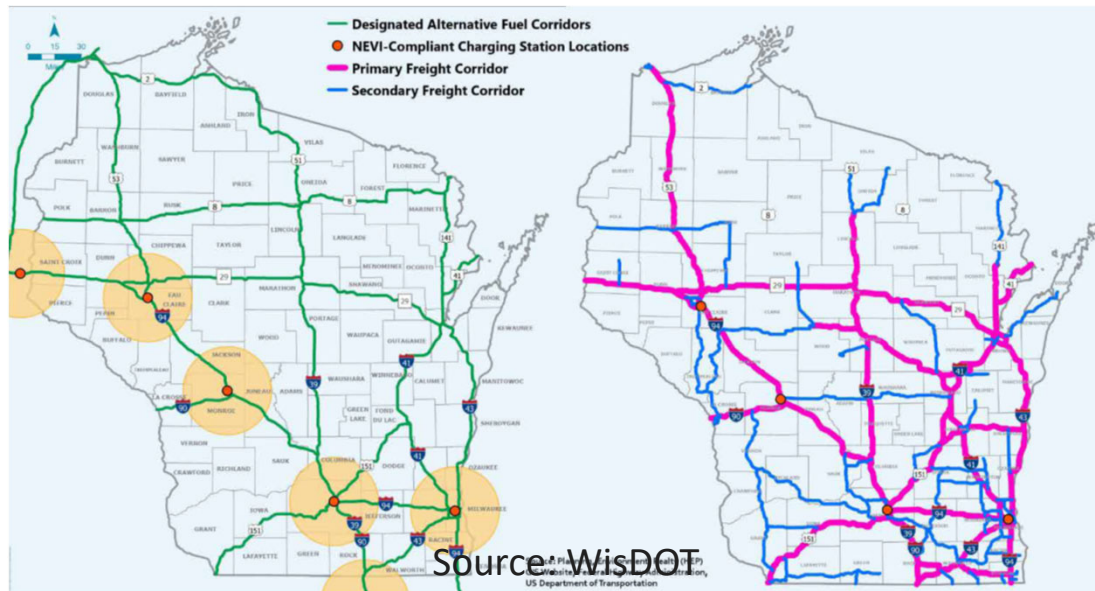
Battery-powered BRT buses begin service in Milwaukee County





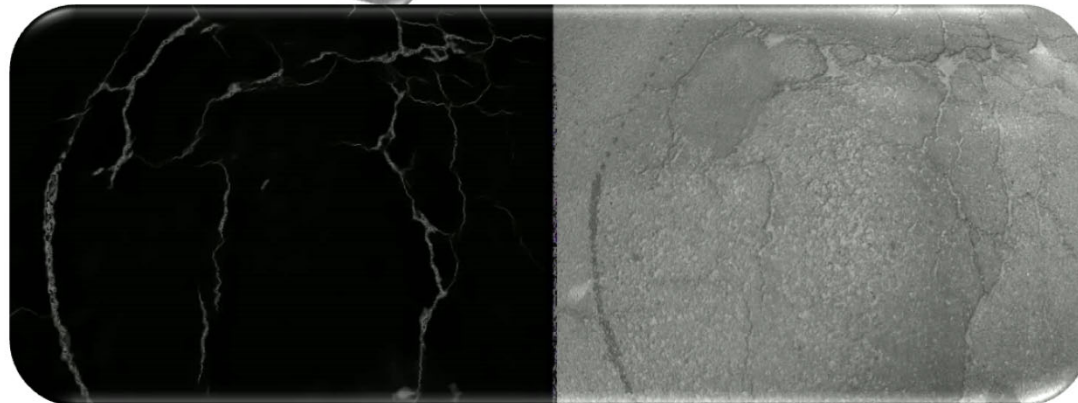
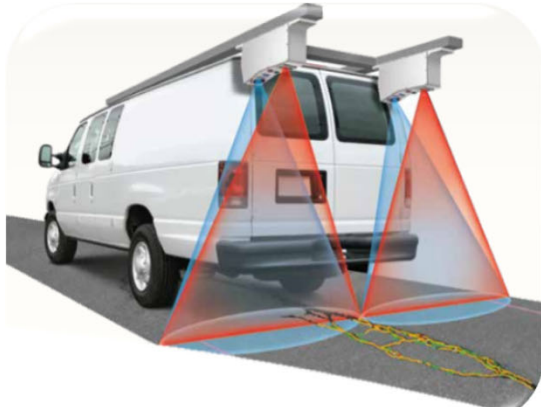
# Vehicle State Applications: Infrastructure Performance

- EV Charging Infrastructure Initiatives
  - NEVI, WEVI
- Aggregate vehicle states served by each station to track the station's performance
- Aggregate all stations' performance to evaluate the network performance



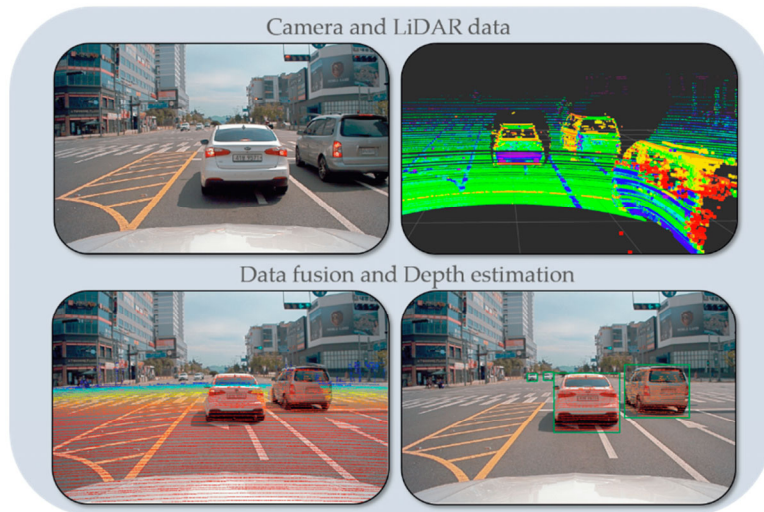
# Environmental Sensor Applications: Pavement Inspections

- Expensive professional vehicles → small portable sensors
- High-frequency inspection with crowd sourcing



# Environmental Sensor Applications: Work Zone Inspections

- Object detection
- Digital information: class, position, identified issues
- Automatic generation of the inspection report

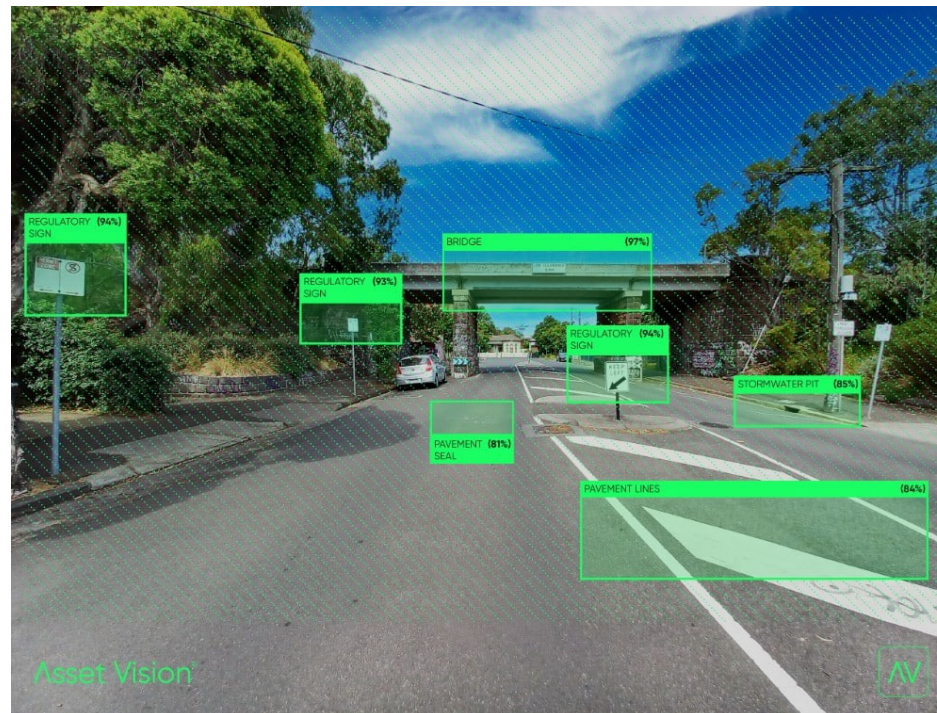






# Environmental Sensor Applications: Asset Inspection

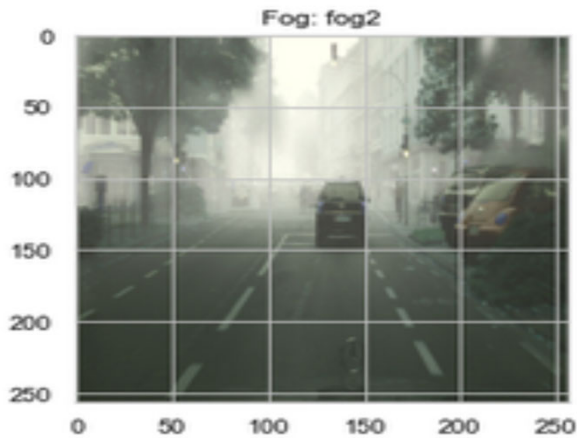
- Detect and classify various road assets
- Automatic damage report





# Environmental Sensor Applications: Weather Inspections

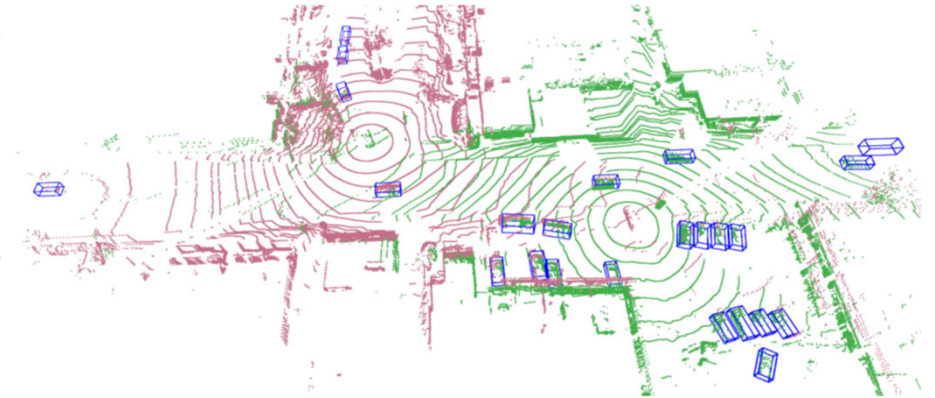
- Fog detection
- Wet pavement detection
- Ice/snow detection



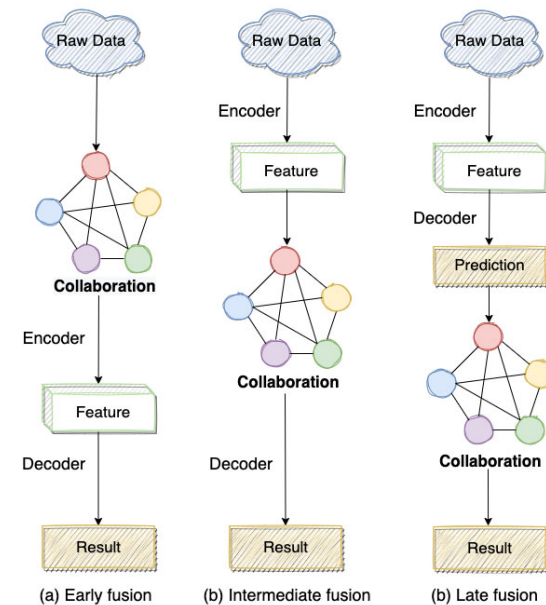


# Challenges - Cooperative Perception

- How to fuse data from different vehicles/sensors



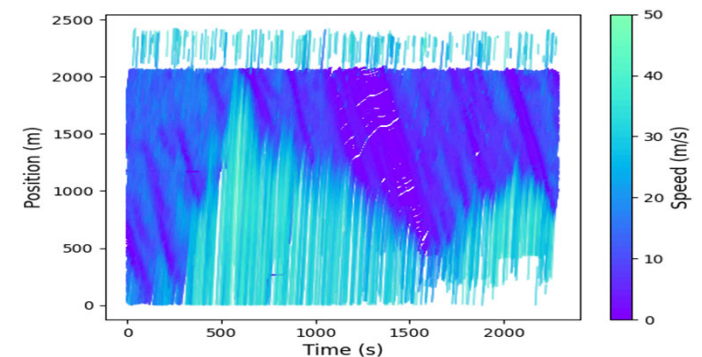
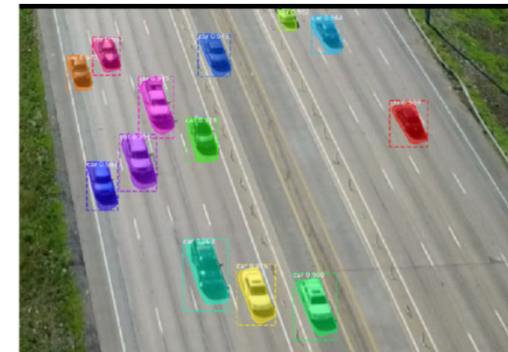
- Sensor fusion
  - Raw data
  - Intermediate feature fusion
  - Detection outcome fusion



Source: Xu et al., 2023

# Challenges - Low Penetration Rate

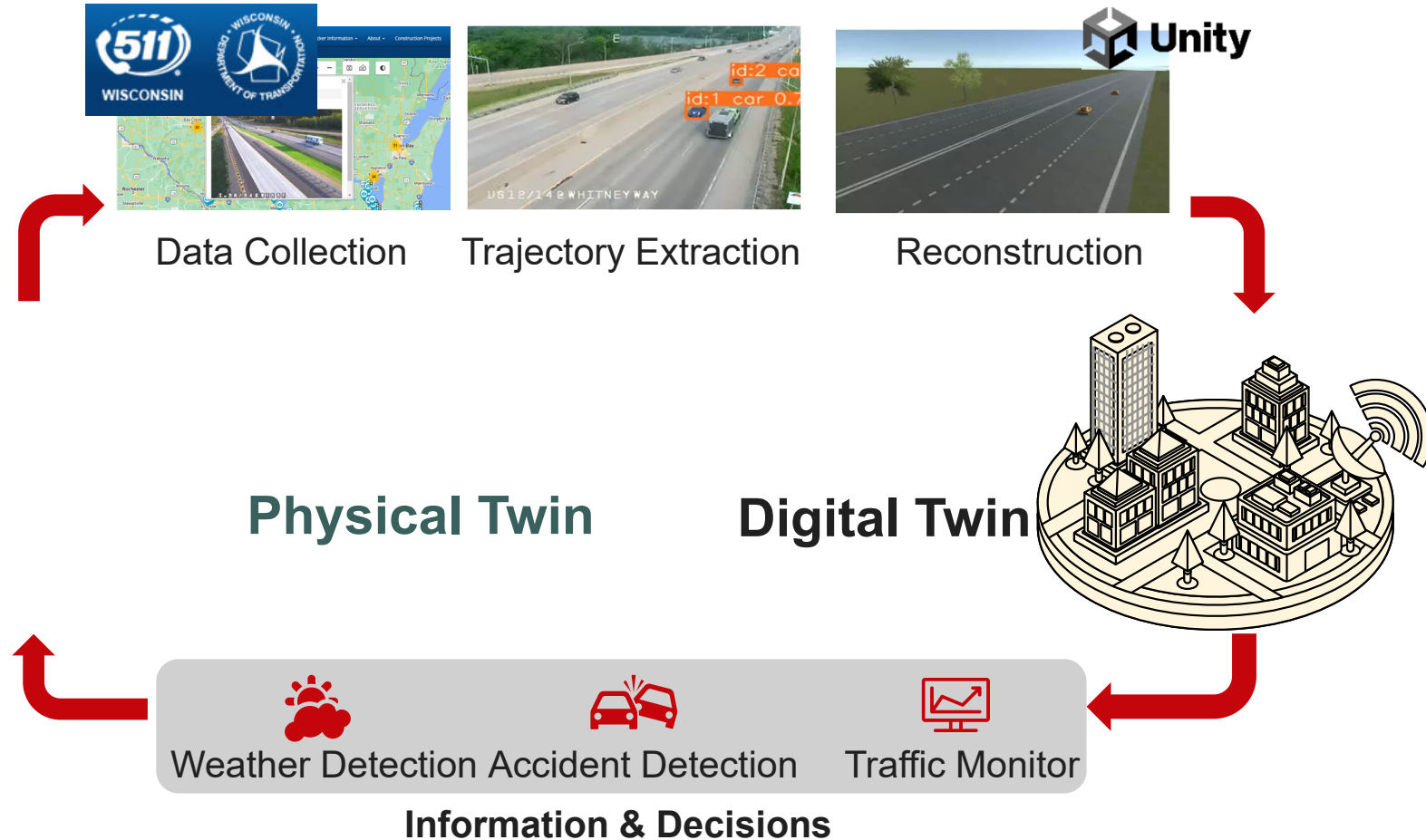
- Not every vehicle can or wants to share its telematics information
- Incentives for crowd sourcing
- Proxy telematics data obtained by external sensors





# Challenges - Visualization and Interface with Human

- Digital Twin







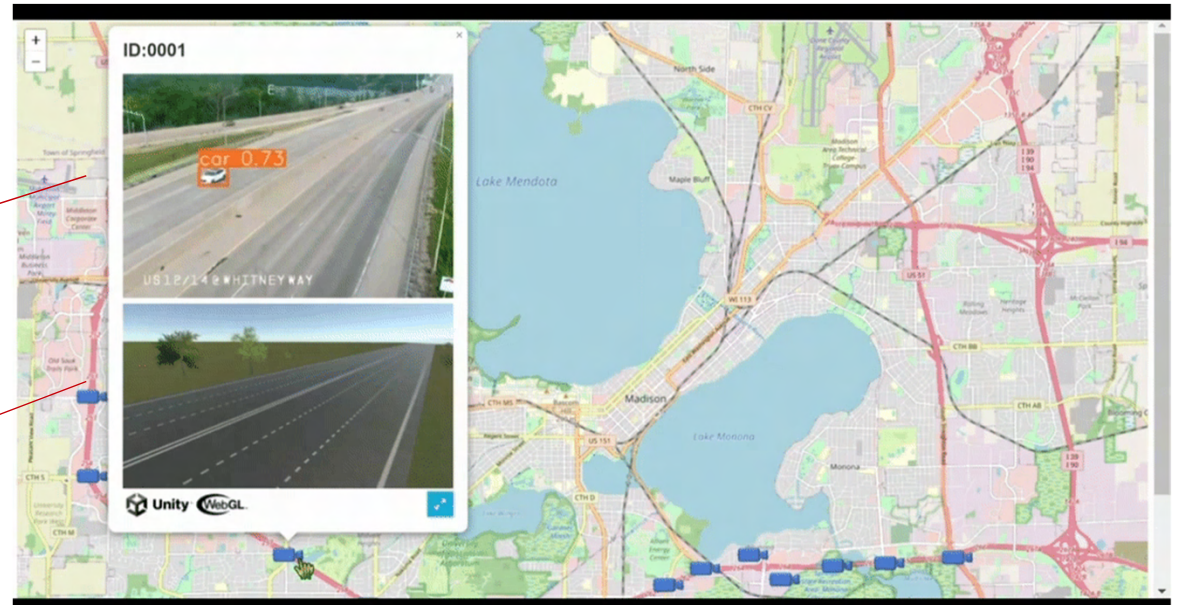
# Challenges - Visualization and Interface with Human

## Digital Twin System on the web interface

- Digital Twin

Current traffic states

Digital Twin Model



## Application I: Weather Detection

>85% accuracy



## Application II: Accident Alert

1-minute accident detection  
can save **148 lives** in  
Wisconsin per year





# Thank You



Camera



Industrial computer



DSRC device



LIDAR



Radar



OBD II scanner



Drone



Mobileye



U-Blox navigation unit



NovAtel navigation unit

