MARYLAND DEPARTMENT OF TRANSPORTATION

Maryland Connected & Automated Vehicles Working Group

December 4, 2024

Agenda

MOTOR VEHICLE ADMINISTRATION

Chrissy Nizer

Administrator

Maryland Department of Transportation

Motor Vehicle Administration

Governor's Highway Safety Representative

Co-Chair of the Maryland Connected & Automated Vehicles Working Group

MARYLAND DEPARTMENT OF TRANSPORTATION

2024 Accomplishments

Posted on the Maryland CAV Website.

https://cav.mdot.Maryland.gov

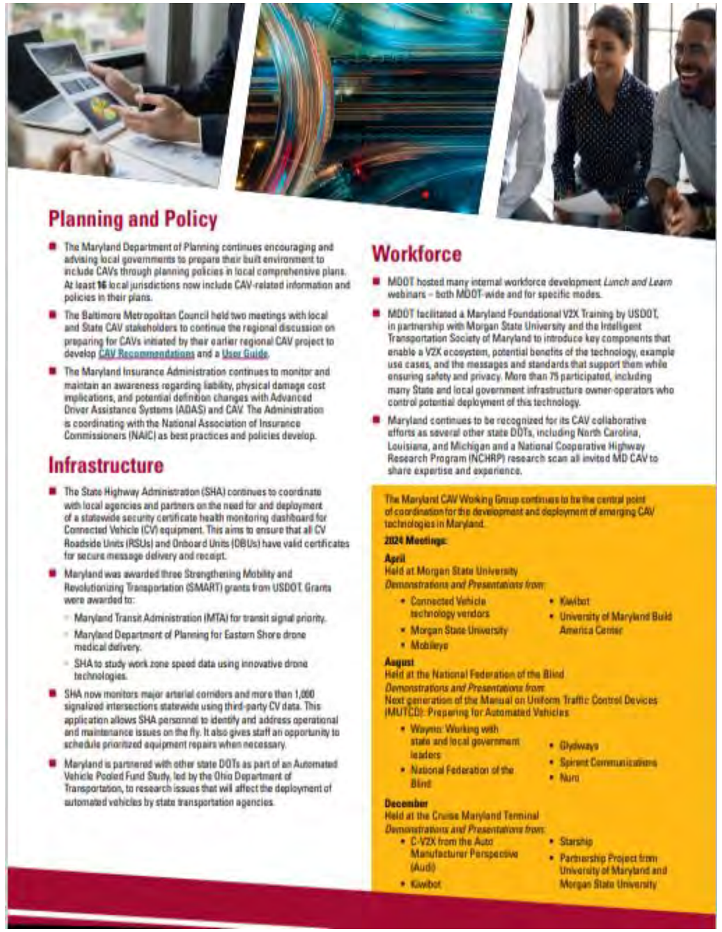
Maryland Accomplishments

in Connected and Automated Vehicle (CAV) Technology

2024

Public Outreach and Education

Early Deployment and Testing



Planning and Policy

- The Maryland Department of Planning continues encouraging and advising local governments to prepare their built environment to include CAVs through planning policies in local comprehensive plans. At least 16 local jurisdictions now include CAV-related information and policies in their plans.
- The Baltimore Metropolitan Council held two meetings with local and State CAV stakeholders to continue the regional discussion on preparing for CAVs initiated by their earlier regional CAV project to develop CAV Recommendations and a User Guide.
- The Maryland Insurance Administration continues to monitor and maintain an awareness regarding liability, physical damage cost implications, and potential definition changes with Advanced Driver Assistance Systems (ADAS) and CAV. The Administration is coordinating with the National Association of Insurance Commissioners (NAIC) as best practices and policies develop.

Infrastructure

- The State Highway Administration (SHA) continues to coordinate with local agencies and partners on the need for and deployment of a statewide security certificate health monitoring dashboard for Connected Vehicle (CV) equipment. This aims to ensure that all CV Roadside Units (RSUs) and Onboard Units (OBUs) have valid certificates for secure message delivery and receipt.
- Maryland was awarded three Strengthening Mobility and Revolutionizing Transportation (SMART) grants from USDOT. Grants were awarded to:
  - Maryland Transit Administration (MTA) for transit signal priority.
  - Maryland Department of Planning for Eastern Shore drone medical delivery.
  - SHA to study work zone speed data using innovative drone technologies.
- SHA now monitors major arterial corridors and more than 1,000 signalized intersections statewide using third-party CV data. This application allows SHA personnel to identify and address operational and maintenance issues on the fly. It also gives staff an opportunity to schedule prioritized equipment repairs when necessary.
- Maryland is partnered with other state DOTs as part of an Automated Vehicle Pooled Fund Study, led by the Ohio Department of Transportation, to research issues that will affect the deployment of automated vehicles by state transportation agencies.

Workforce

- MDOT hosted many internal workforce development *Lunch and Learn* webinars – both MDOT-wide and for specific modes.
- MDOT facilitated a Maryland Foundational V2X Training by USDOT, in partnership with Morgan State University and the Intelligent Transportation Society of Maryland to introduce key components that enable a V2X ecosystem, potential benefits of the technology, example use cases, and the messages and standards that support them while ensuring safety and privacy. More than 75 participated, including many State and local government infrastructure owner-operators who control potential deployment of this technology.
- Maryland continues to be recognized for its CAV collaborative efforts as several other state DOTs, including North Carolina, Louisiana, and Michigan and a National Cooperative Highway Research Program (NCHRP) research scan all invited MD CAV to share expertise and experience.

The Maryland CAV Working Group continues to be the central point of coordination for the development and deployment of emerging CAV technologies in Maryland.

2024 Meetings:

April
Held at Morgan State University
Demonstrations and Presentations from:
- Connected Vehicle technology vendors
- Morgan State University
- Mobileye
- Kiwibot
- University of Maryland Build America Center

August
Held at the National Federation of the Blind
Demonstrations and Presentations from:
Next generation of the Manual on Uniform Traffic Control Devices (MUTCD): Preparing for Automated Vehicles
- Waymo: Working with state and local government leaders
- National Federation of the Blind
- Glydways
- Spirent Communications
- Nuro

December
Held at the Cruise Maryland Terminal
Demonstrations and Presentations from:
- C-V2X from the Auto Manufacturer Perspective (Audi)
- Kiwibot
- Starship
- Partnership Project from University of Maryland and Morgan State University

MARYLAND DEPARTMENT OF TRANSPORTATION

Older Driver Safety Awareness Week

- Find more information at the National Highway Traffic Safety Administration.
- Advanced driver assistance systems, or ADAS, can detect dangers and provide warnings, steering, or braking support to all drivers, including older adults.
- Many mature drivers are unaware of ADAS, but can adapt to new technologies if they receive sufficient training and exposure opportunities.
- Education by dealers, government agencies, and the private sector – focused on mature drivers and their limitations – will be key to ensuring they not only accept technology but embrace it.

CAV Updates: AV Policies

- U.S. National Highway Traffic Safety Administration (NHTSA) and the United Nations Economic Commission for Europe (UNECE) issued regulations on ADAS.
- Locally, Pennsylvania DOT adopted new guidelines, called Publication 950, for the operation and testing of highly automated vehicles on Pennsylvania roadways.
- PennDOT's new guidelines define minimum requirements for the operation of driverless vehicles without a backup safety driver as well as for the remote operations of a vehicle.
- The European Union has included requirements for remote intervention operators and in the U.S., the Automated Vehicle Safety Consortium developed best practices for remote assistance.

MARYLAND PORT ADMINISTRATION

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MARYLAND DEPARTMENT OF TRANSPORTATION

AUDI AND PARTNERS FOR AUTOMATED VEHICLE EDUCATION (PAVE)

Brad Stertz

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Short Break

Agenda

MARYLAND DEPARTMENT OF TRANSPORTATION

PARTNERSHIP PROJECT – UNIVERSITY OF MARYLAND AND MORGAN STATE UNIVERSITY

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MARYLAND DEPARTMENT OF TRANSPORTATION

ADAS 101: Understanding Your Vehicle's Safety Features

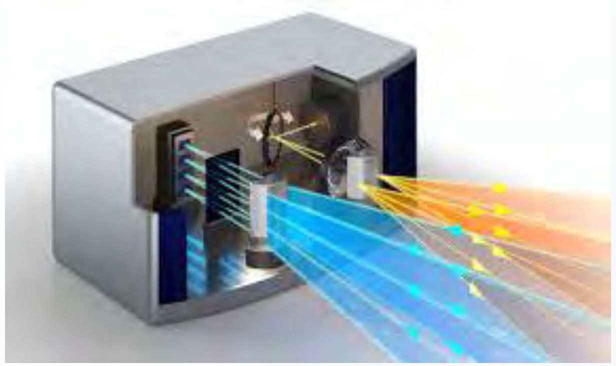
CAV Collaborative Research

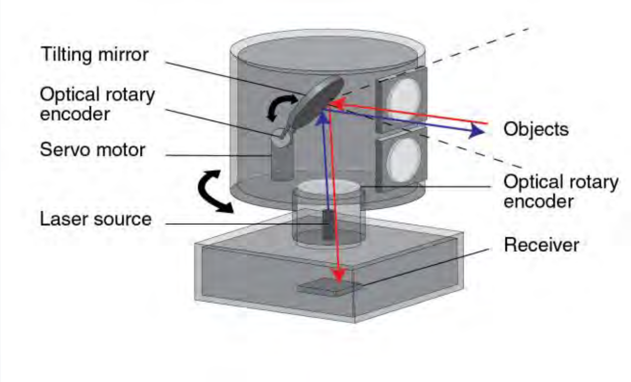
Terry Yang
University of Maryland

Mansoureh Jeihani, Di Yang
Morgan State University

Protecting Vulnerable Road Users Through Smart Infrastructure

What is LiDAR





LIDAR is a method for measuring distances (ranging) by illuminating the target with laser light and measuring the time the reflection of the light takes to return to the sensor. Two types:

- Mechanical LIDAR sensors: cove 360 degree
  - (16 lines ~128 lines)

- Quasi-solid-state LiDAR sensors: directional, no rotating parts
  - SCHOTT/Cepton/LSIS/HESAI, etc.
  - Very active market to meet the smart mobility needs

Cannot penetrate mental frame or human body

The point cloud will be bounced back.

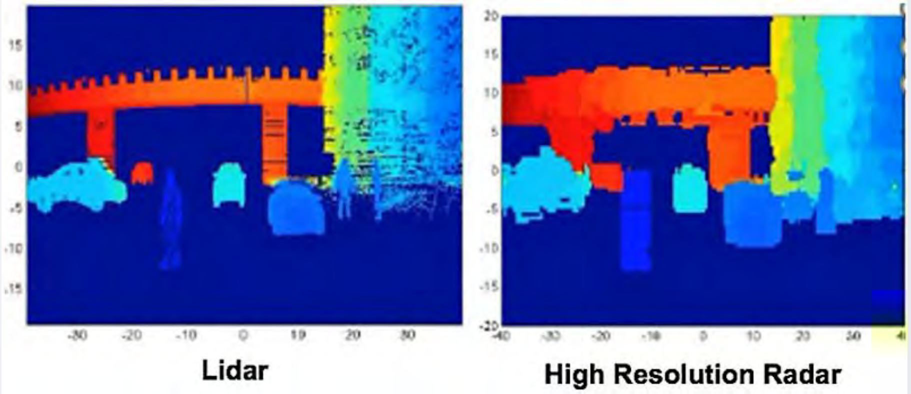
LIDAR sensors are “eyes”, not “brains”

LiDAR vs. Other Sensors

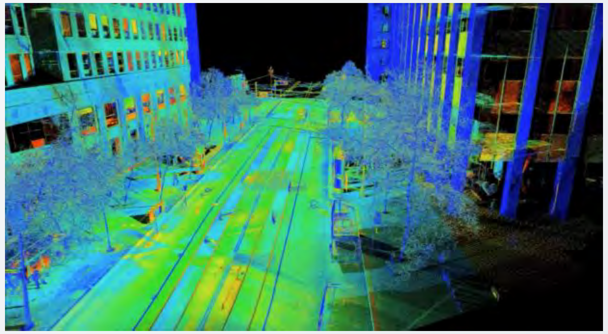
LIDAR's prominent performance in tracking in dark conditions

Source: Cepton Inc.

High-fidelity raw data (point cloud) create a high ceiling of detection accuracy



Source: https://www.fierceelectronics.com/components/lidar-vs-radar

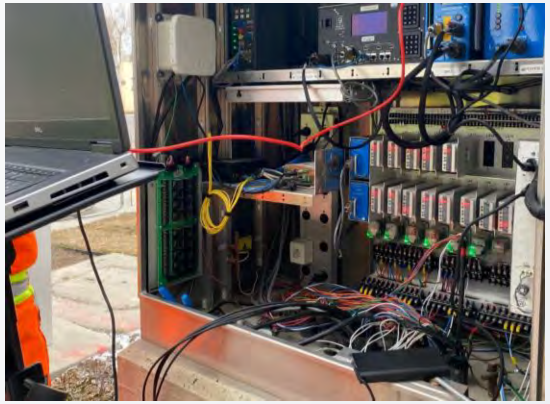


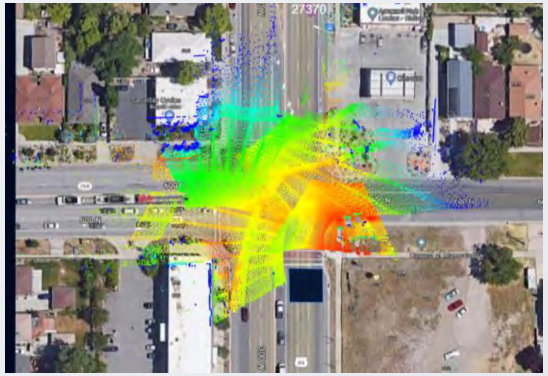
3-D measurement (length, width and height)

Utilizing LIDAR sensors to detect pedestrian movements at signalized intersections

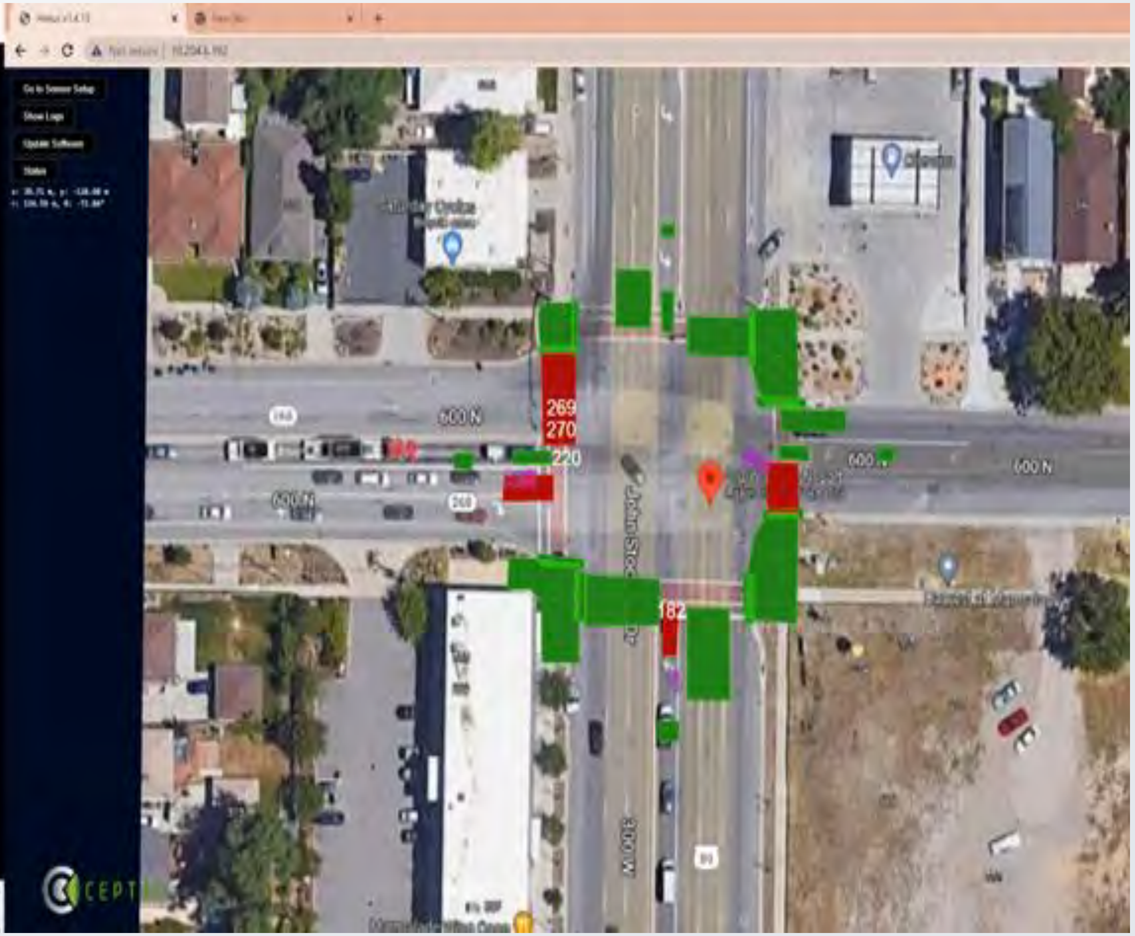
Four Steps

- Install and align sensors
- Draw Zones on the web interface
- Create config files for algorithms
- Set up central system for analytics



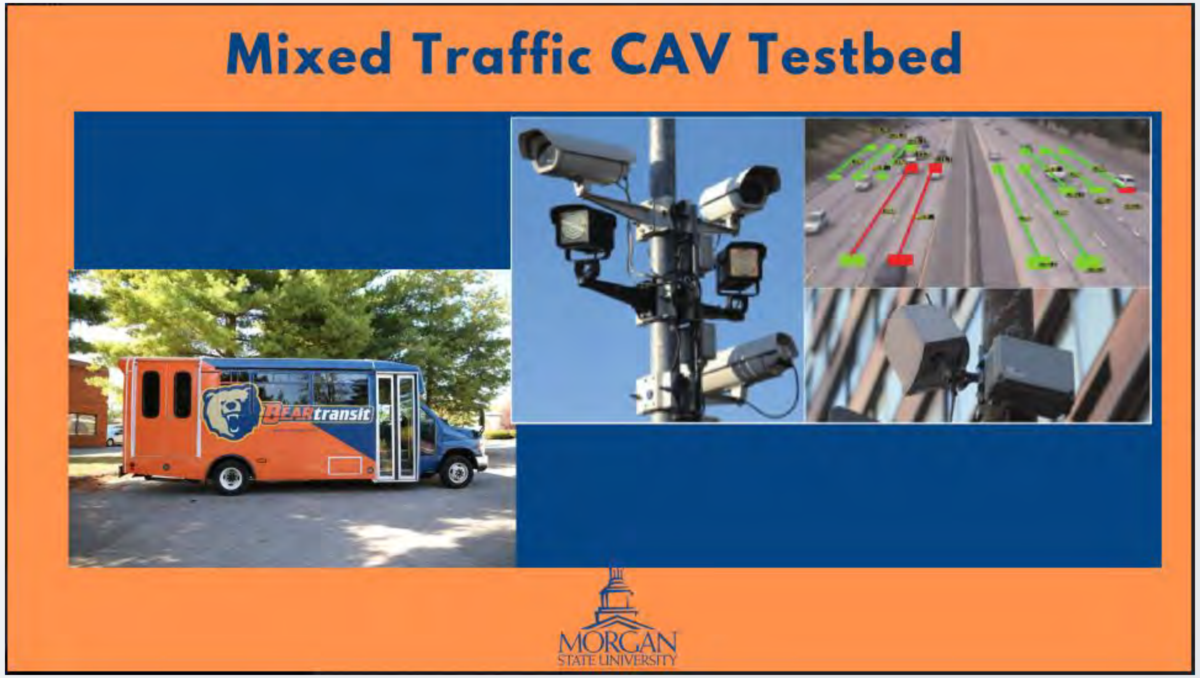



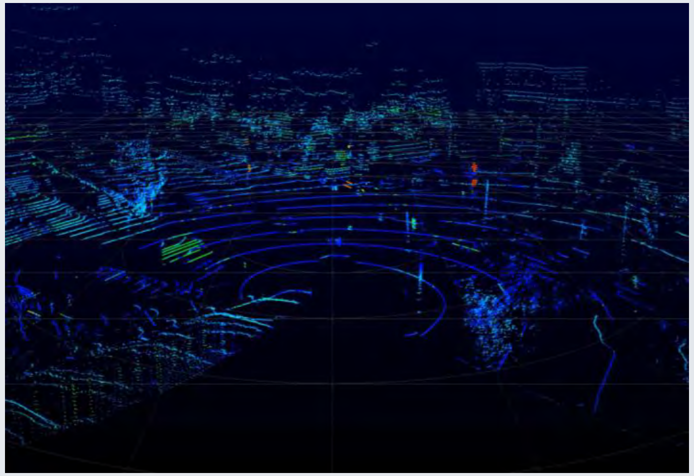

Visual verification



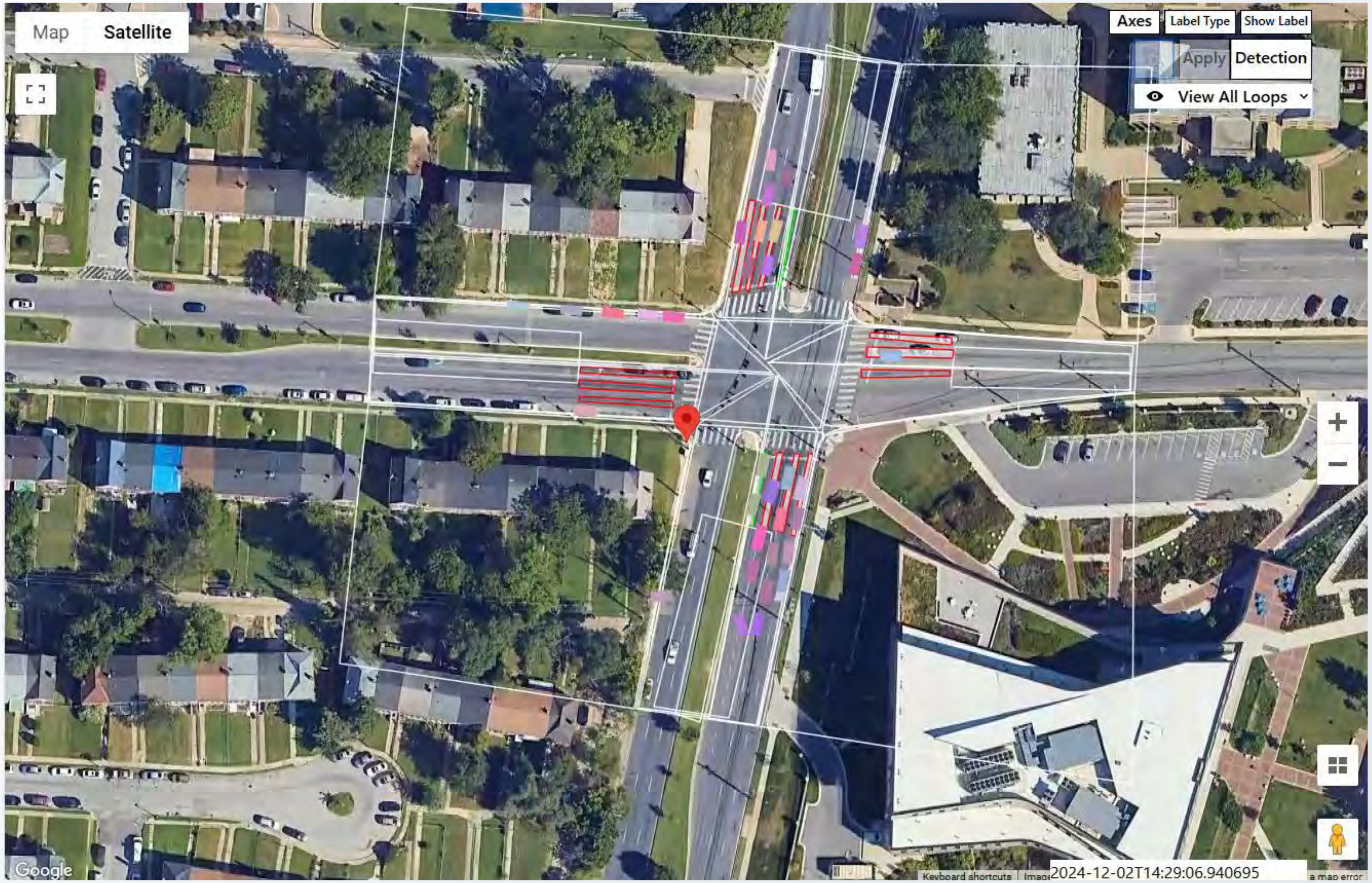
Connected Vehicle Testbed at Morgan State University

- **LiDAR sensors, Roadside Units, and CCTV cameras are installed on two signalized intersections at Morgan State University campus to develop a Connected Vehicle (CV) testbed**





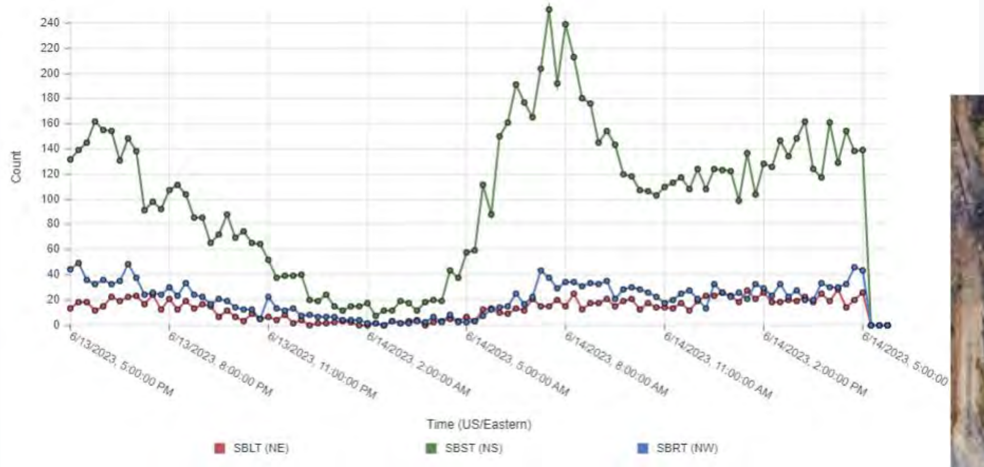
Object Tracking

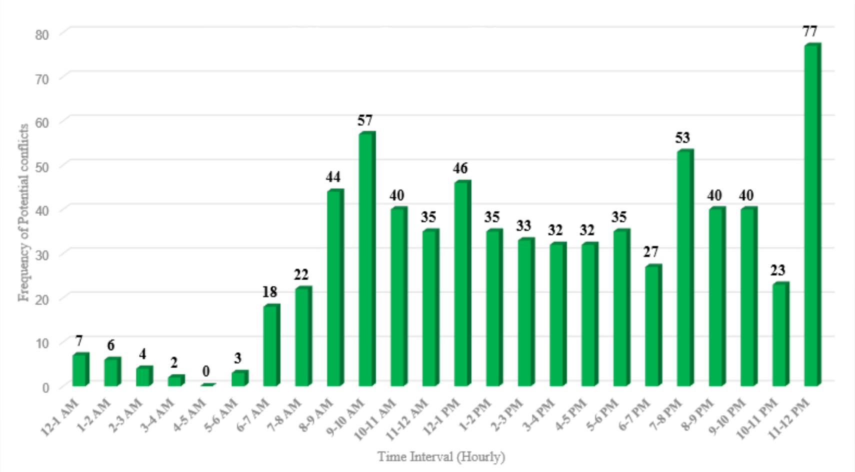


Traffic Measures

- **Traffic mobility and safety measures can be extracted directly from the testbed**

Traffic Volume





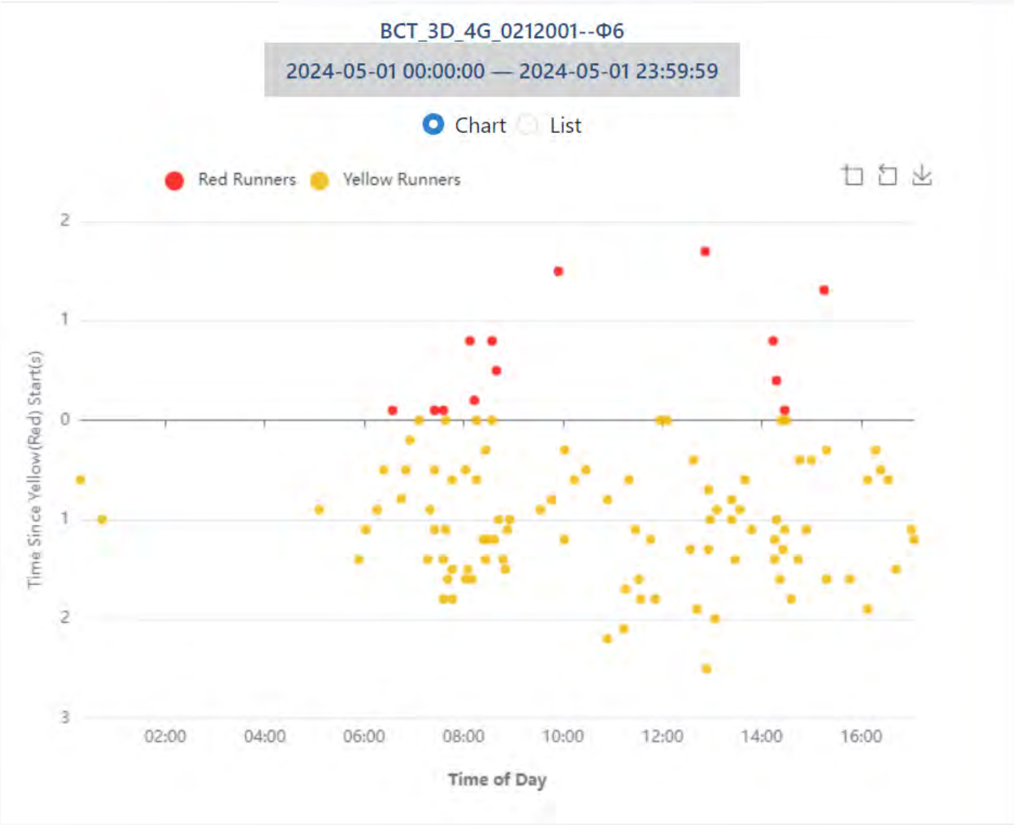
Pedestrian outside of the crosswalk

Traffic Conflict Examples

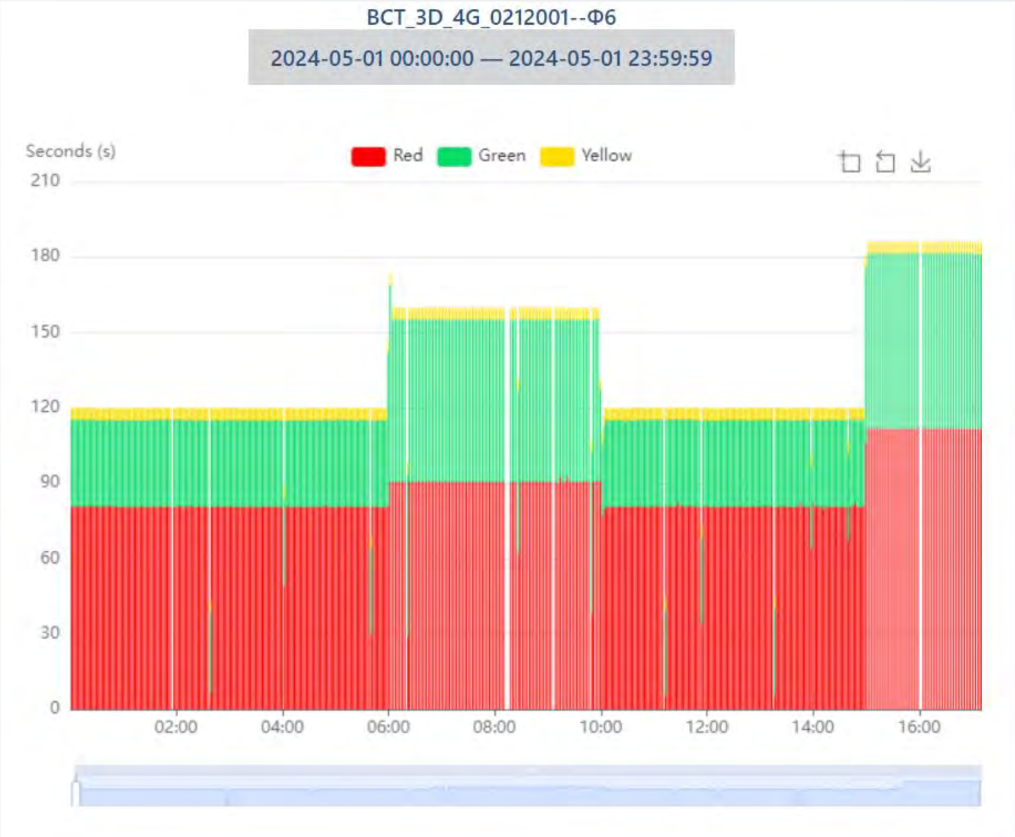
Traffic Measures

- **Traffic mobility and safety measures can be extracted directly from the testbed**

Red/Yellow Light Runners



Phase Interval



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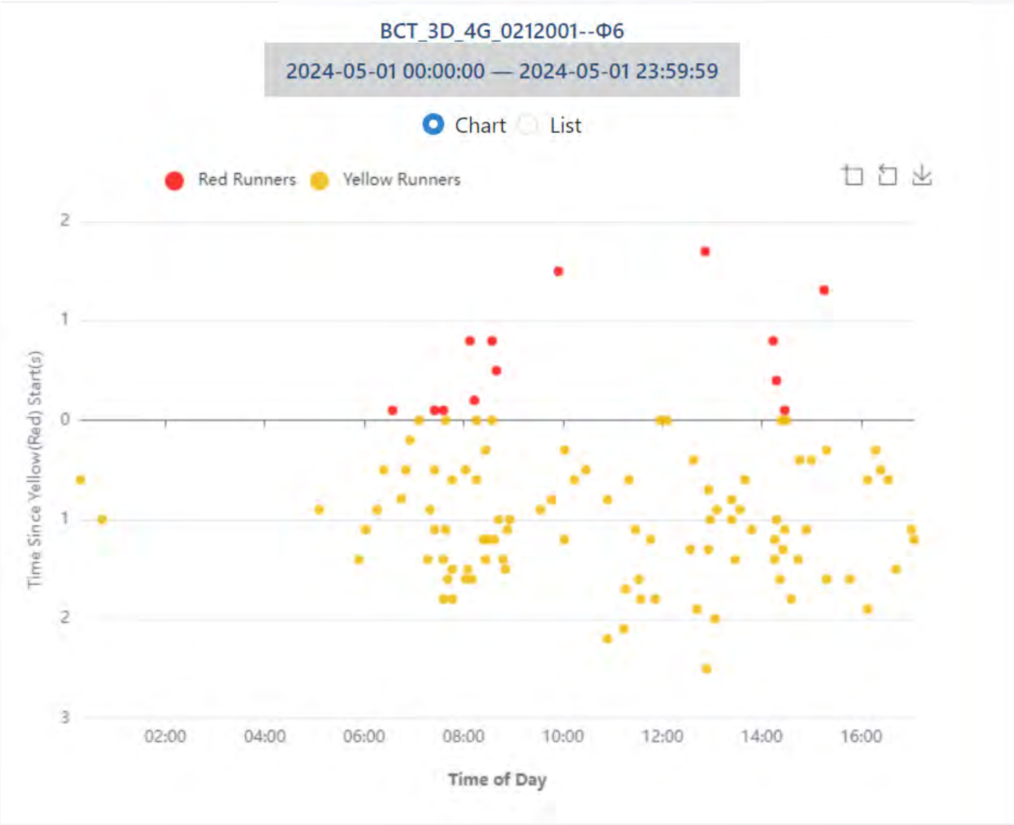
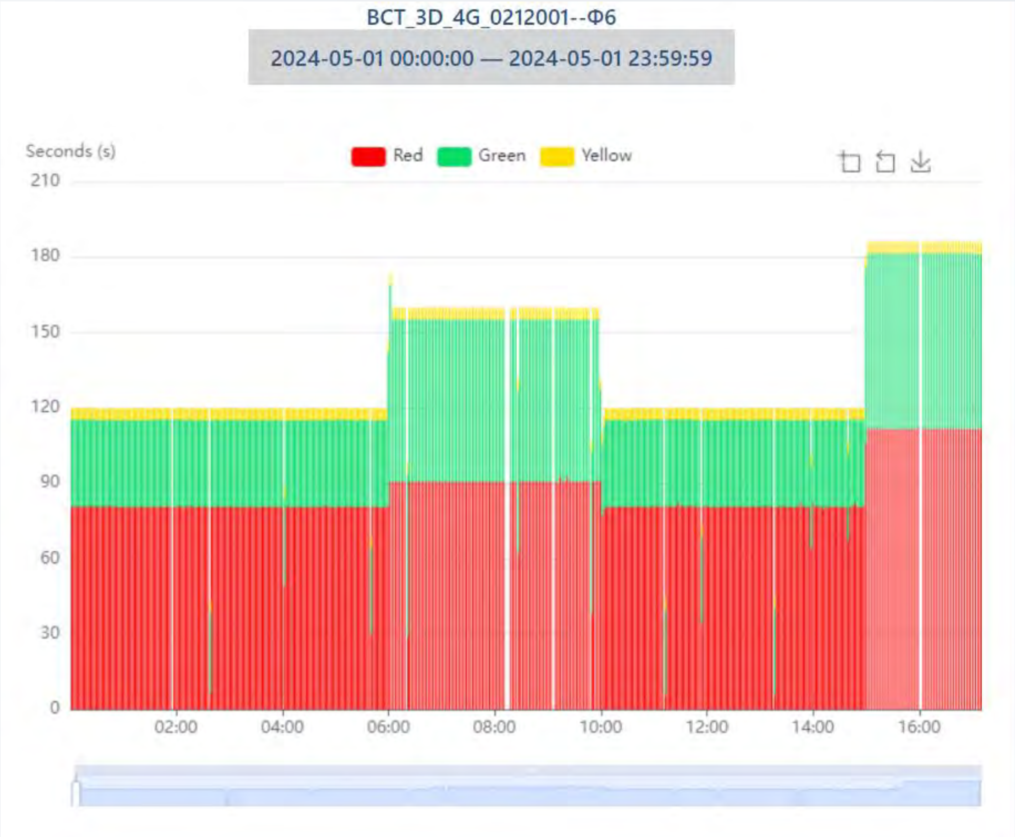


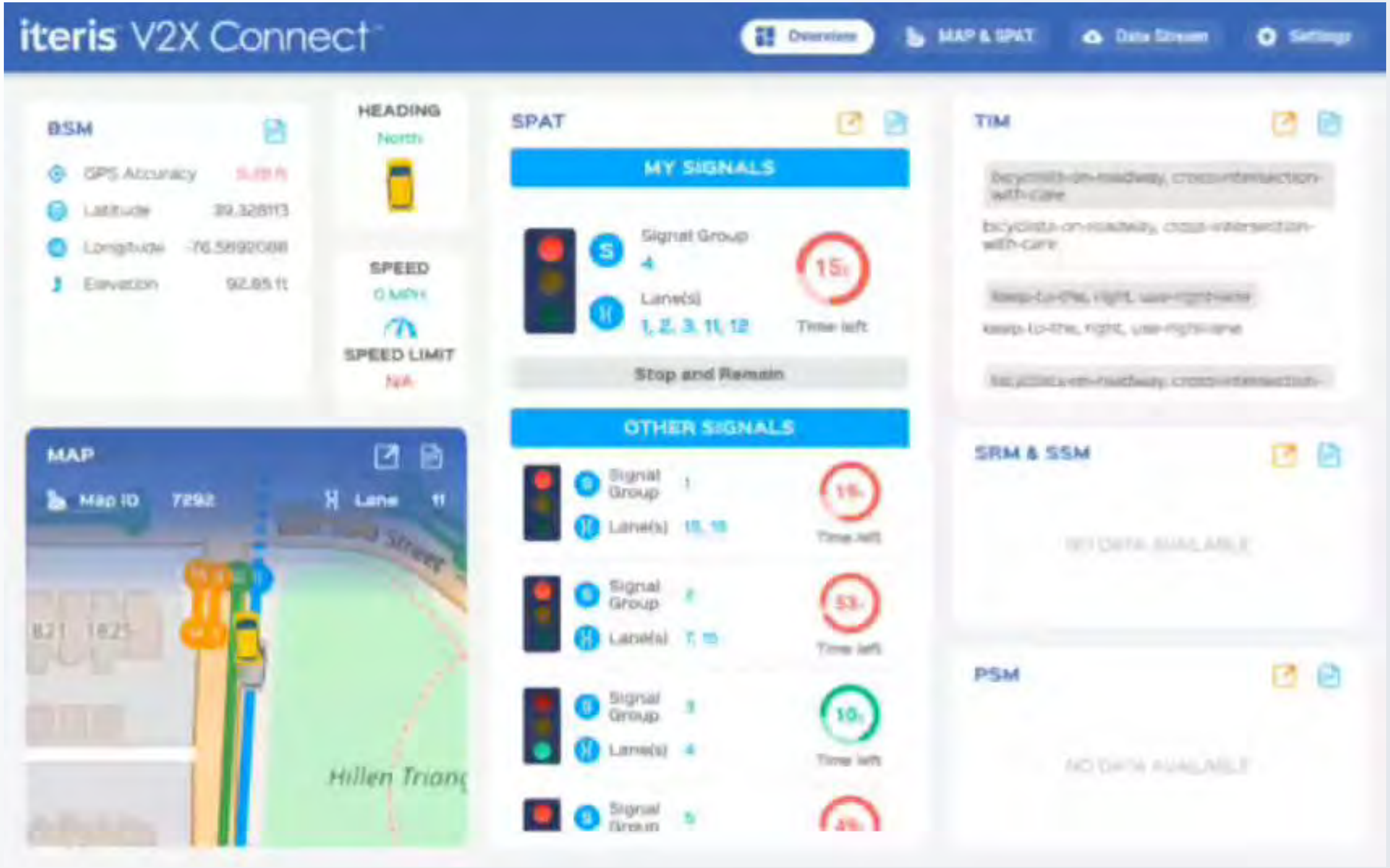
Phase Interval



Connected Vehicle Equipment

- **The Onboard Unit (OBU) enables cars to communicate with other vehicles (V2V communication) and infrastructure (V2I communication) in the surrounding environment.**

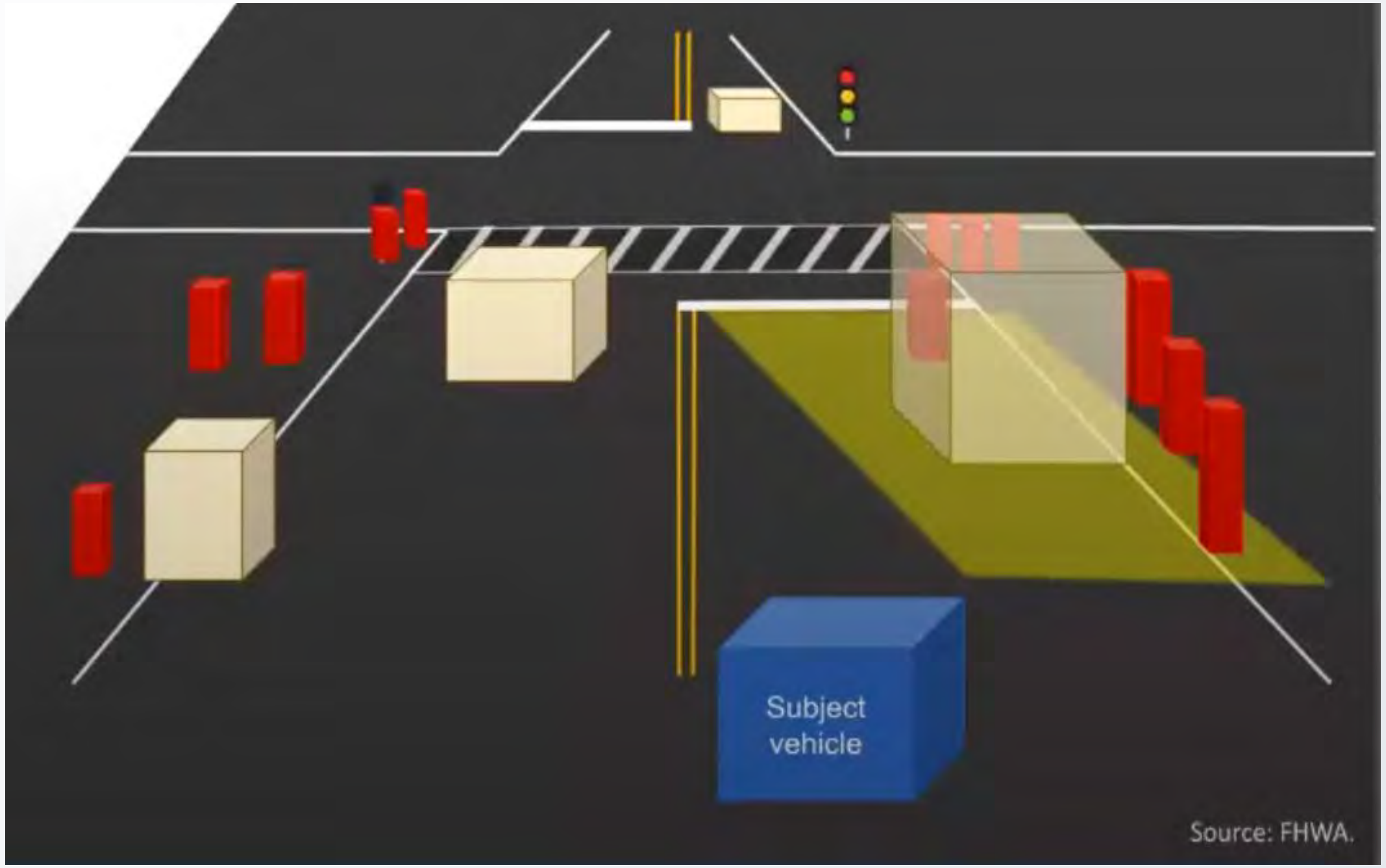
Connected Vehicle Equipment



Improving Safety Performance of CAVs with Cooperative Perception

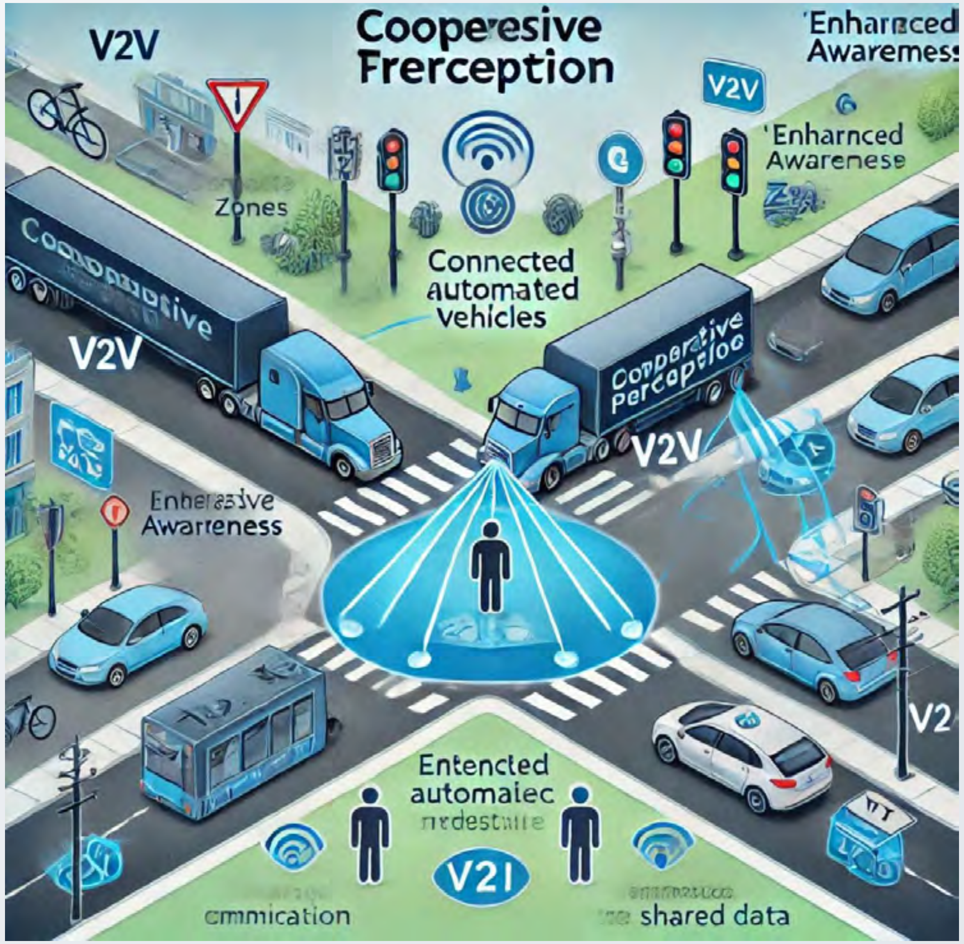
Tesla Robotaxi

Detection Challenges: "Blind Spot"

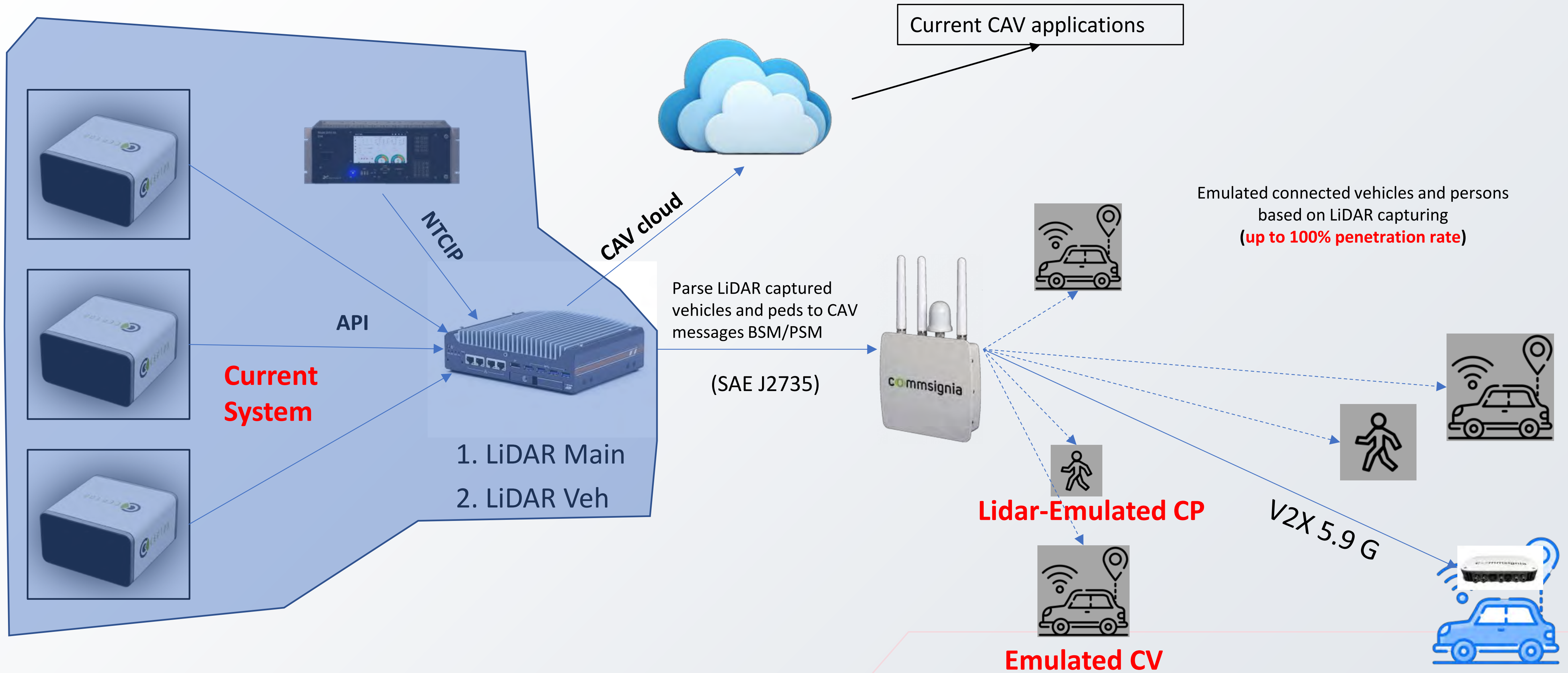


Cooperative Perception

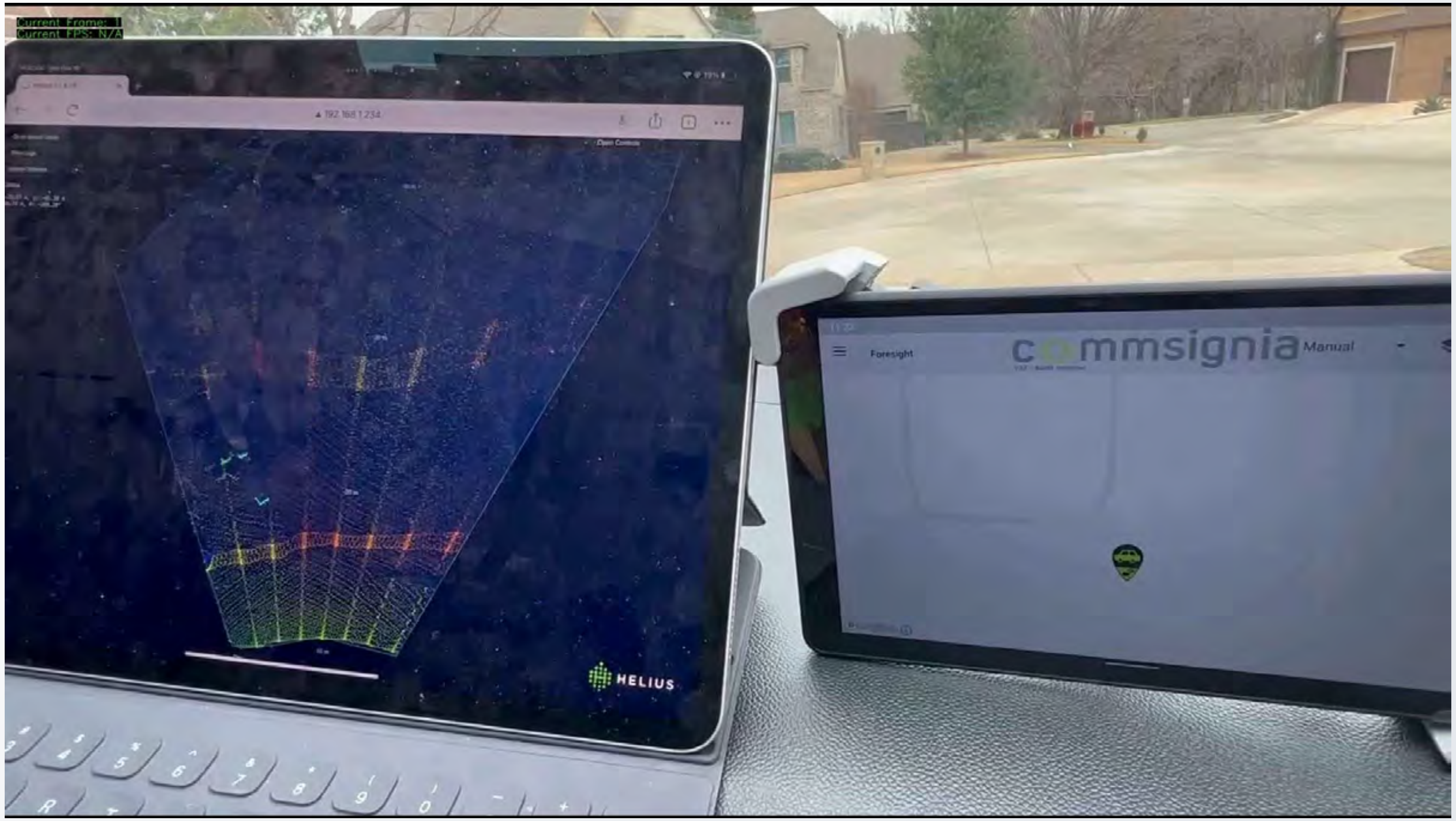
Cooperative Perception (also known as collective perception) refers to the concept where multiple connected vehicles and infrastructure (such as roadside sensors or cameras) share their real-time perception data to improve situational awareness and safety. This is particularly useful in situations where an individual vehicle's sensors may be obstructed or have limited range.



LiDAR + CV (C-V2X)

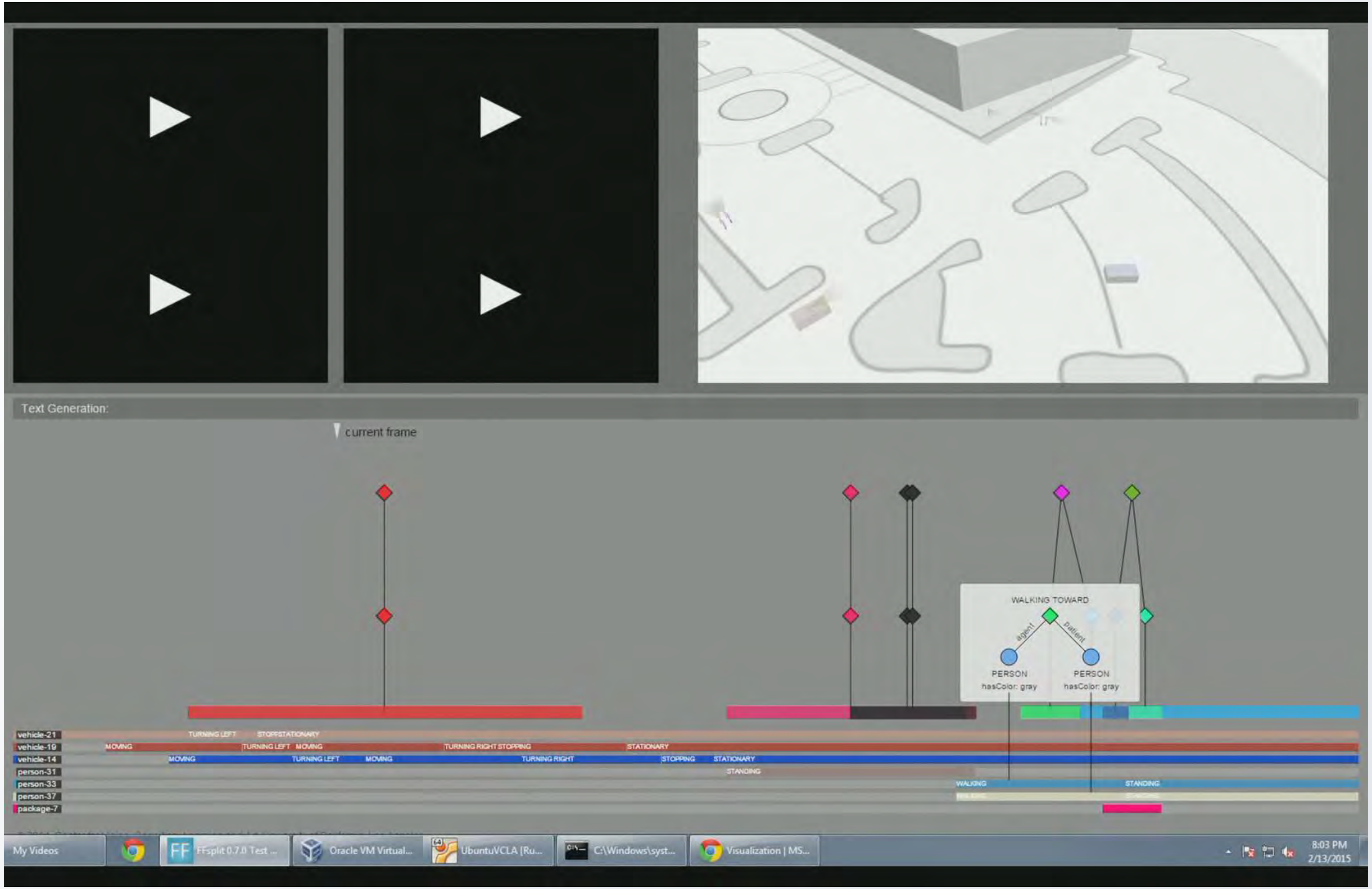


Ped Info via I2V (LiDAR → RSU → OBU)

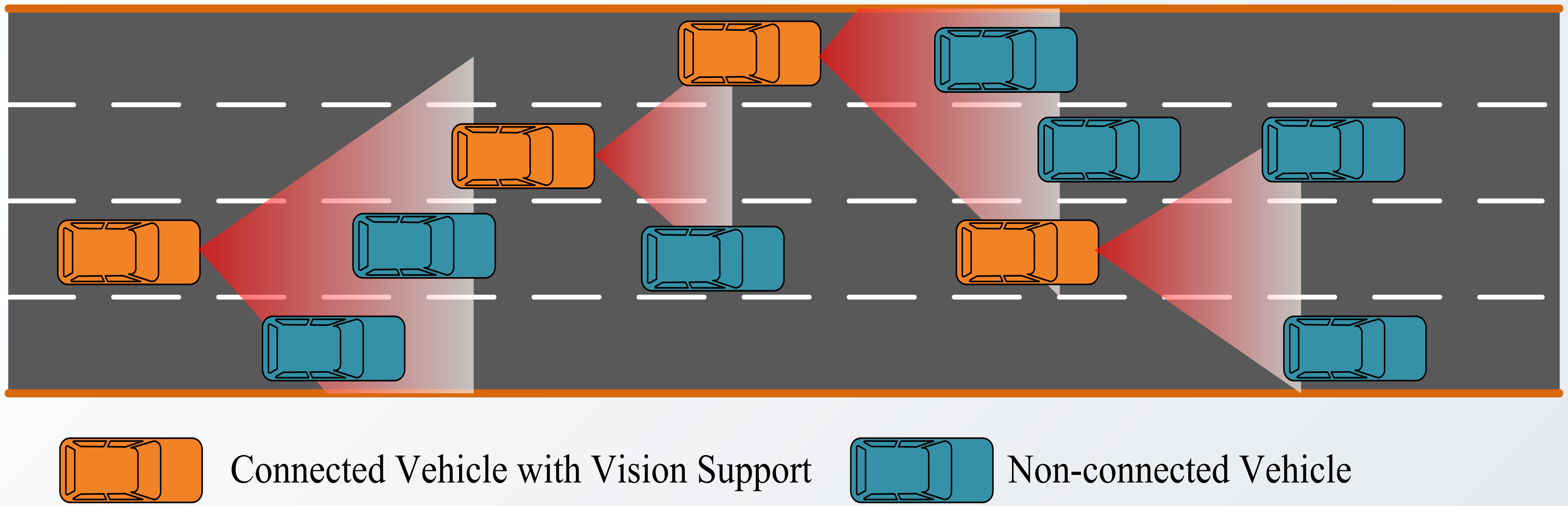


https://www.youtube.com/watch?v=yaLPUo2RWIQ

Video based CP with V2I



CP with V2V Communications

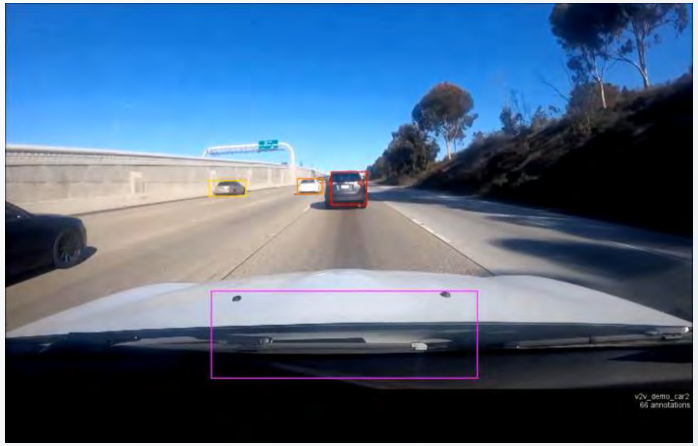


Step 1: Video Processing on each connected vehicle

Step 2: Construction of dynamic Ad-Hoc Sensor Network

Car D

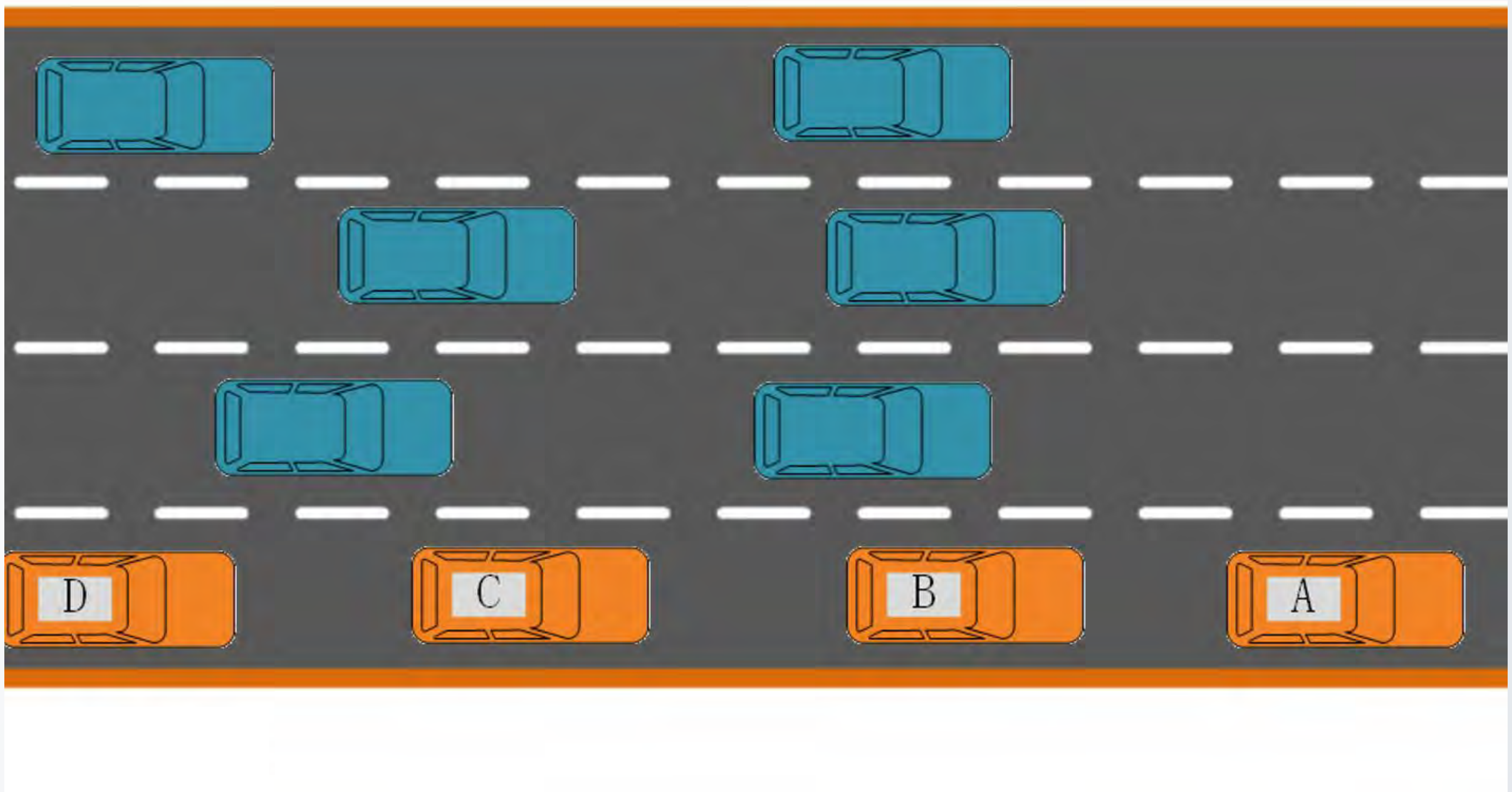
Car C



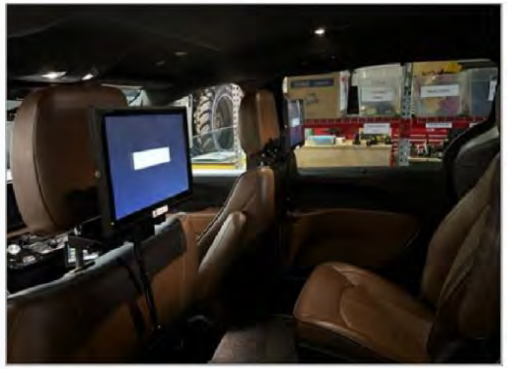
Car B

Car A

Step 2: Construction of dynamic Ad-Hoc Sensor Network



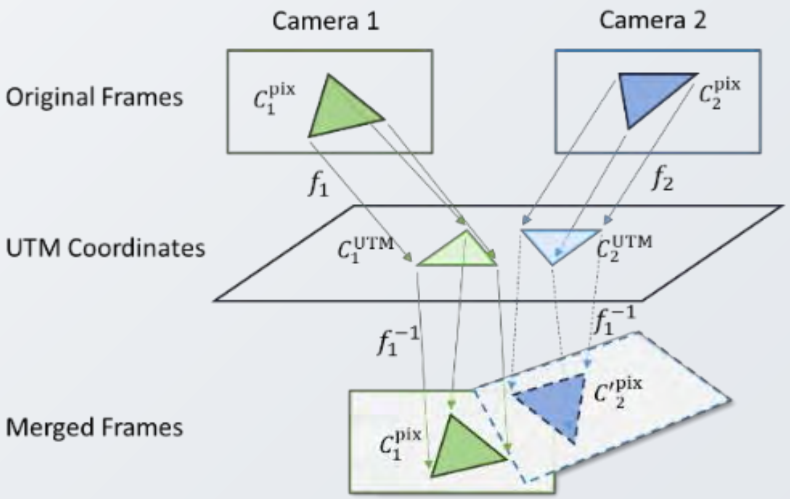
UMD In-house CAV



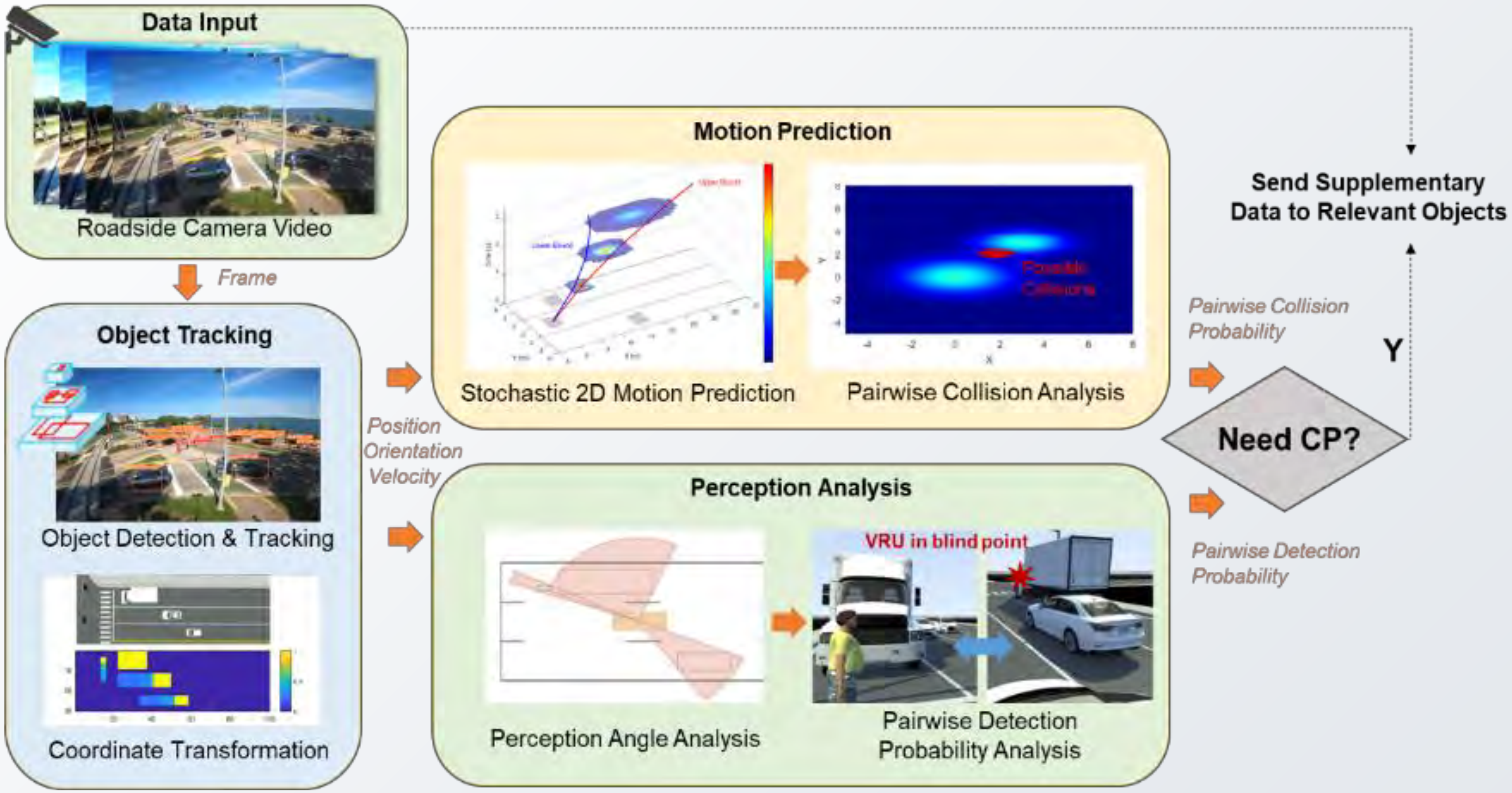
Metrics for Evaluations

Impact Category	Metric	Description
Safety	Vehicle-to-Vehicle Crash rate	Compare collision rates before and after CP implementation.
	Vehicle-to-VRU collision frequency	Assess the reduction in accidents involving pedestrians or cyclists.
	Time to Collision (TTC) improvement	Measure improvements in TTC for potentially hazardous situations.
	Near-miss frequency	Count reductions in incidents where collisions are narrowly avoided.
	Emergency braking activations	Quantify the decrease in last-moment emergency braking events.
Efficiency	Average vehicle speed	Evaluate whether CP allows for consistent speeds, reducing unnecessary deceleration.
	Traffic throughput at intersections	Measure vehicle throughput in occluded or complex intersection scenarios.
	Frequency of deadlock occurrences	Count how often mutual occlusions cause deadlocks and the impact of CP in resolving them.
	Fuel consumption or energy efficiency	Assess energy savings through smoother driving enabled by CP.
Cost	Communication bandwidth usage	Measure the amount of data transmitted under different fusion strategies.
	Computational load	Evaluate the processing power required for early vs. late fusion.
	Scalability	Determine the system's ability to handle an increasing number of agents or data streams effectively.

Spatial and Temporal Synchronization



Communicate Only Necessary Information



CP Scenarios

Application	Scenario	Description
VRU Protection	#1: VRU awareness	Using CP to inform vehicles about VRUs at mid-block crossings or intersections.
	#2: VRUs jaywalking	Using CP to alert vehicles when jaywalking VRUs is detected.
	#3: VRU in “blind spots”	Using CP to detect VRUs when they are occluded by large vehicles (e.g., buses).
Collision Avoidance	#4: WWD warning	Using CP to inform vehicles about wrong-way driving (WWD).
	#5: Car-following alert	Using CP to inform vehicles about a sudden braking event downstream by a non-connected agent.
Conflict Avoidance	#6: RLR warning	Using CP to respond to potential red-light running (RLR) proactively.
	#7: Permissive left-turn	Using CP to have CAV conduct permissive left-turn at signalized intersections.
Enhanced Situational Awareness	#8: Line-of-sight assist	Using CP to navigate difficult geometric conditions that may affect line-of-sight.
	#9: Adverse weather assist	Using CP to assist in adverse weather limiting line-of-sight.
	#10: Work zones assist	Using CP to assist vehicles in navigating work zones.

PARTNERSHIP PROJECT – UNIVERSITY OF MARYLAND AND MORGAN STATE UNIVERSITY

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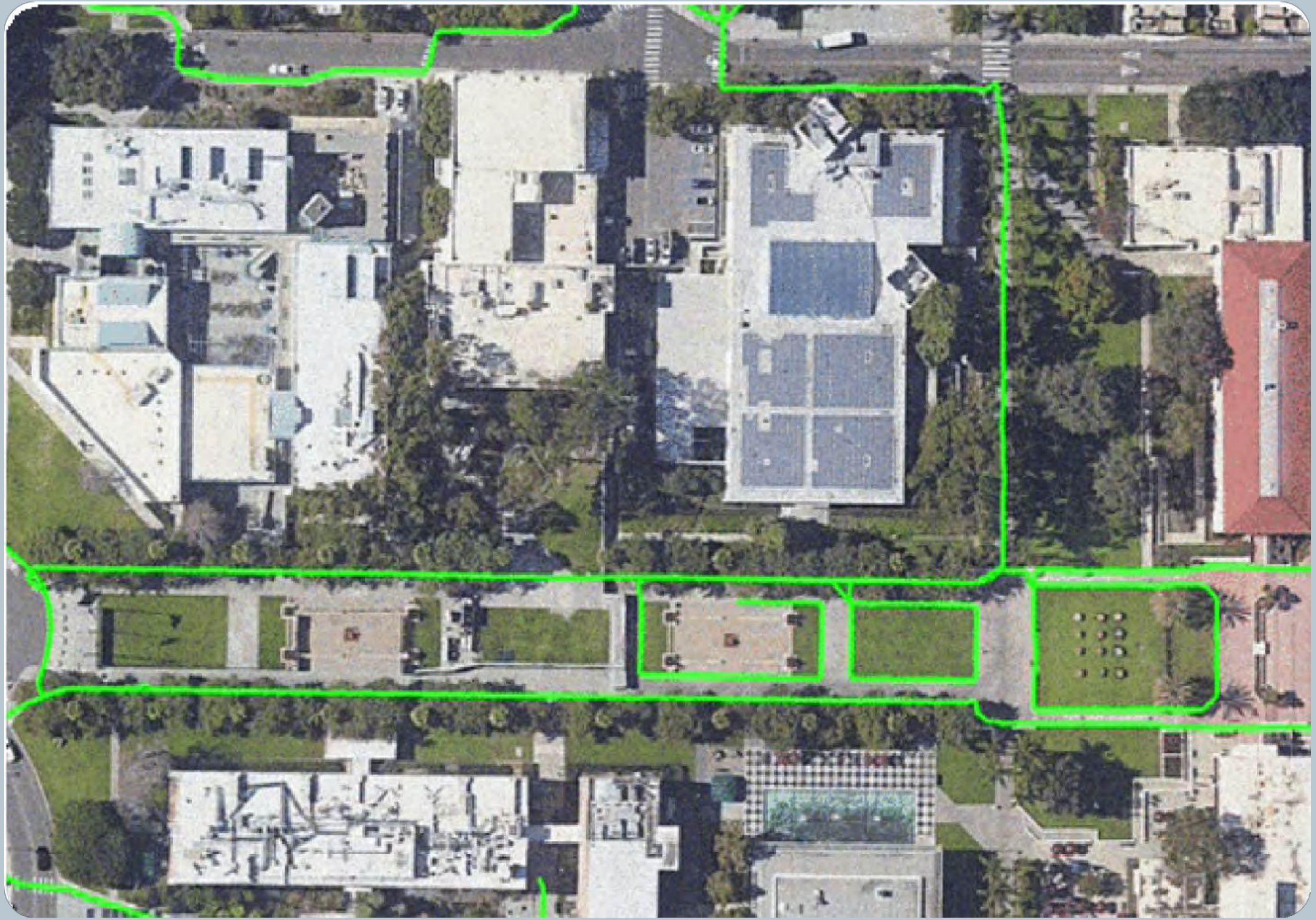
Urban Infrastructure

www.kiwibot.com

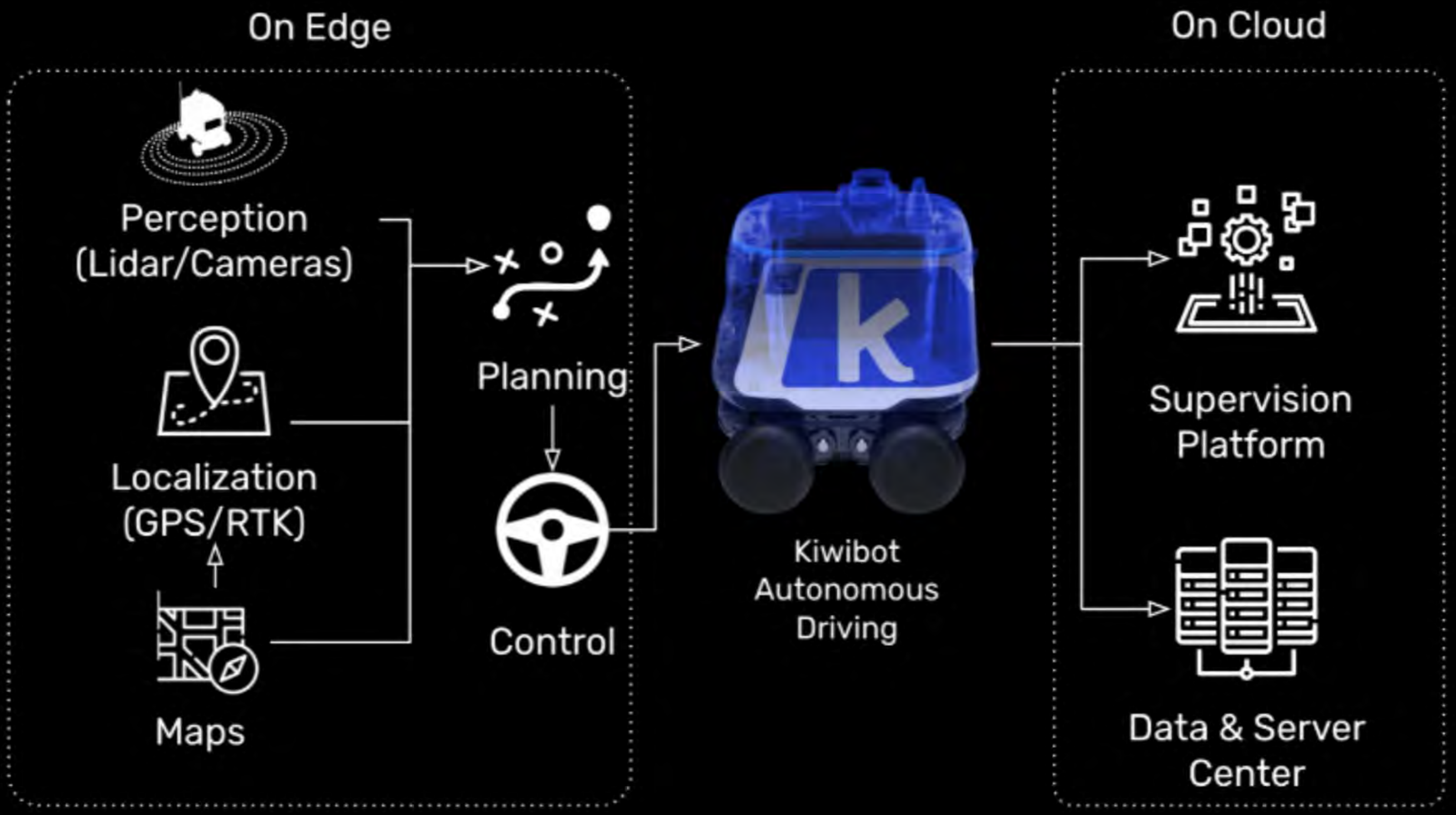
Past, Present and Future

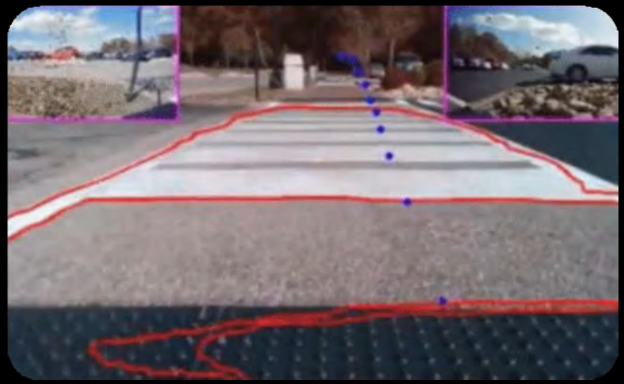
Since its inception at the UC Berkeley Skydeck accelerator program in 2017, Kiwibot has deeply integrated into communities, where robots are now an accepted part of daily life. By 2024, Kiwibot is present on 20 college campuses in the US, partnering with major vendors like Sodexo and Grubhub. Kiwibot’s applications extend to hospitals, corporate campuses, malls, smart cities, and any last-mile environment. The company is capable of manufacturing, adapting, and implementing both customized and third-party robots.



kiwibot

Autonomous Process



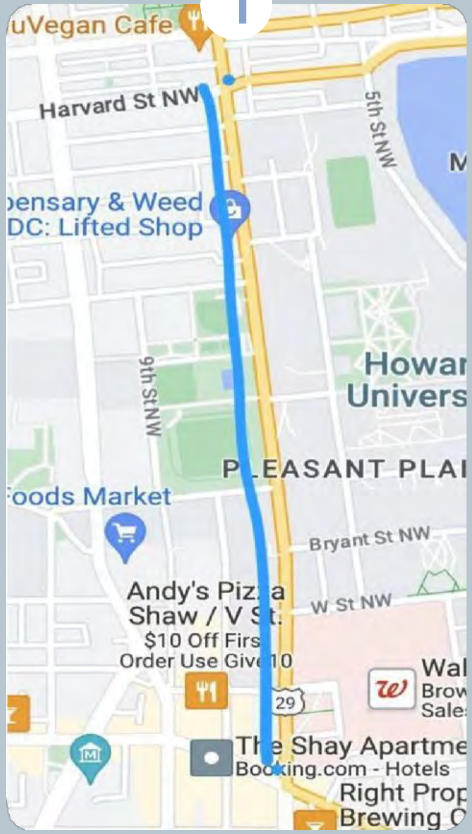


Kiwibot urban inspection and autonomous mapping

Kiwibot's urban inspection and autonomous mapping process enables the government to address the complex challenges of modern governance by incorporating data collection on sidewalk risks and hazards. Monitoring and tracking these potential risks allow for the identification and mitigation of hazards, helping to prevent economic disruptions caused by public demands and safety violations. Demonstrating a commitment to hazard tracking and management helps build public trust in the government and its ability to protect and serve the community.

Project stages

1



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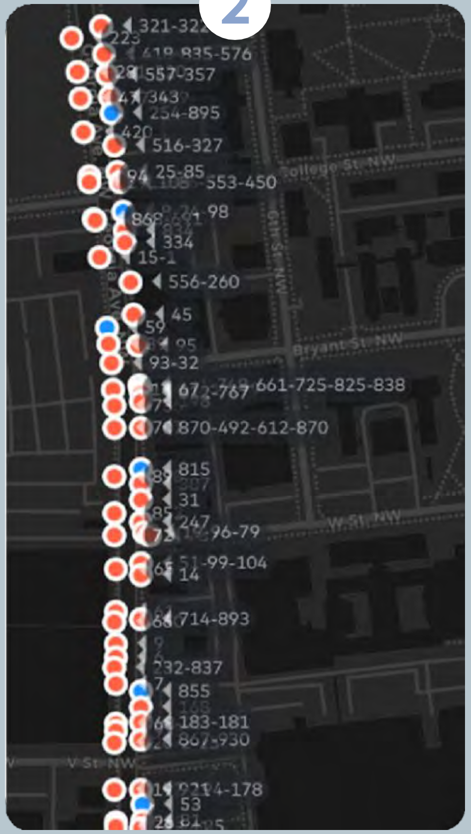

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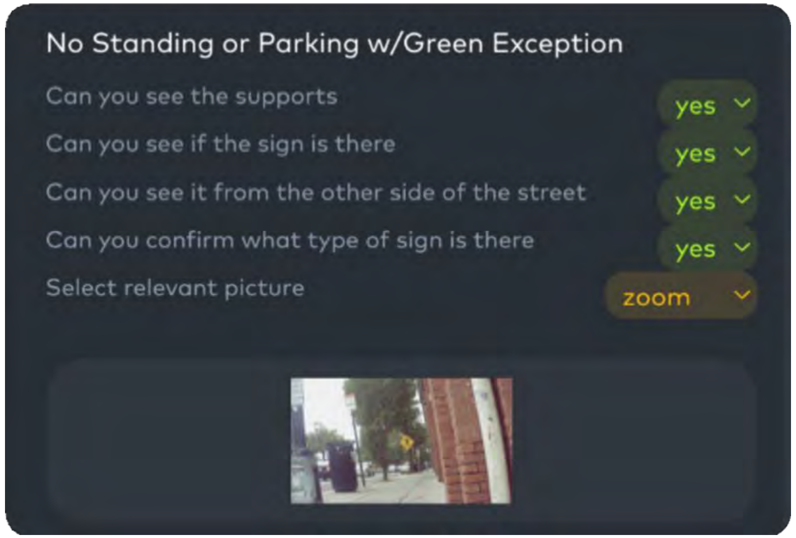
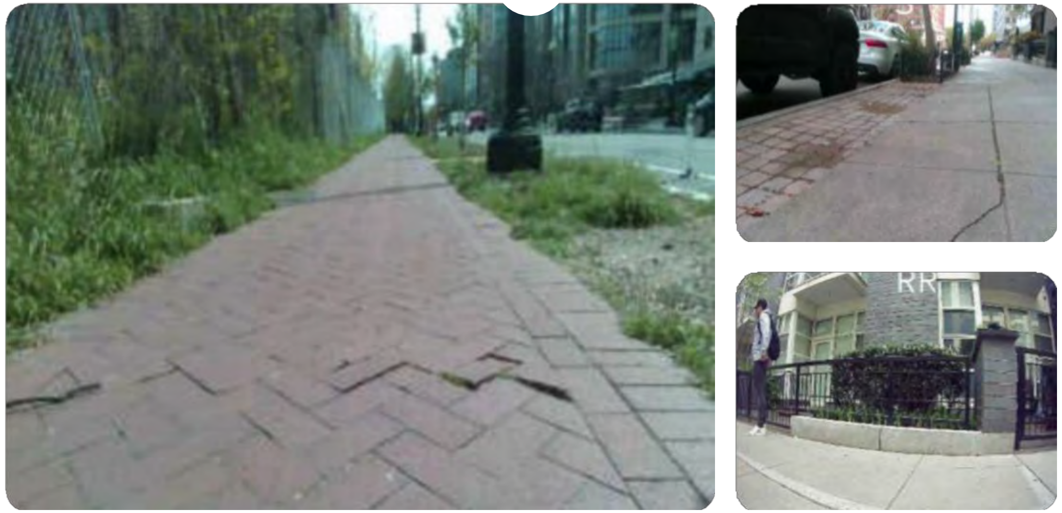


1. Define the area
Select the area to be analyzed and delimited the project

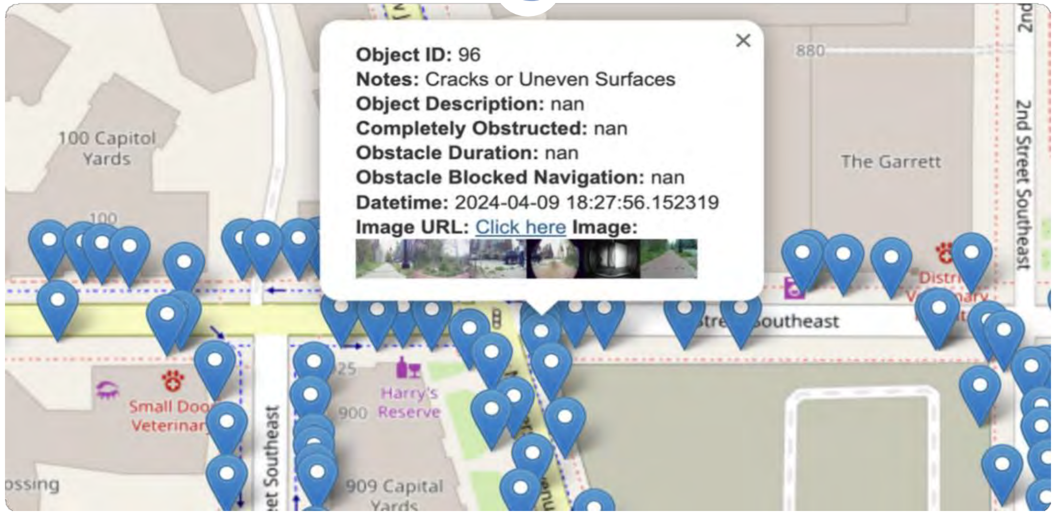
2. Mapping the area
Mark the points and save the coordinates

3. Data Collection
Check and audit the hazards or risks

Project stages



4. Data evidence
Save the pictures to track the hazards and risks



5. Mapping and data analytics
Save the data of the hazards and risks

Business Case

Kiwibot firmly believes that smart cities are strongly dedicated to the seamless technological integration of robots within secure ecosystems operating 24/7.

The project focuses on gathering information about sign locations, sign statuses, and pathway quality.

Mapping urban landscapes is a complex task that requires precision and efficiency. Utilizing robots for this purpose presents a modern solution, offering a range of benefits:

Continuous Operation
Safety
Advanced Operation
Cost-Efficiency
Accuracy
Navigational Abilities

Business Case

Thanks!

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kiwibot

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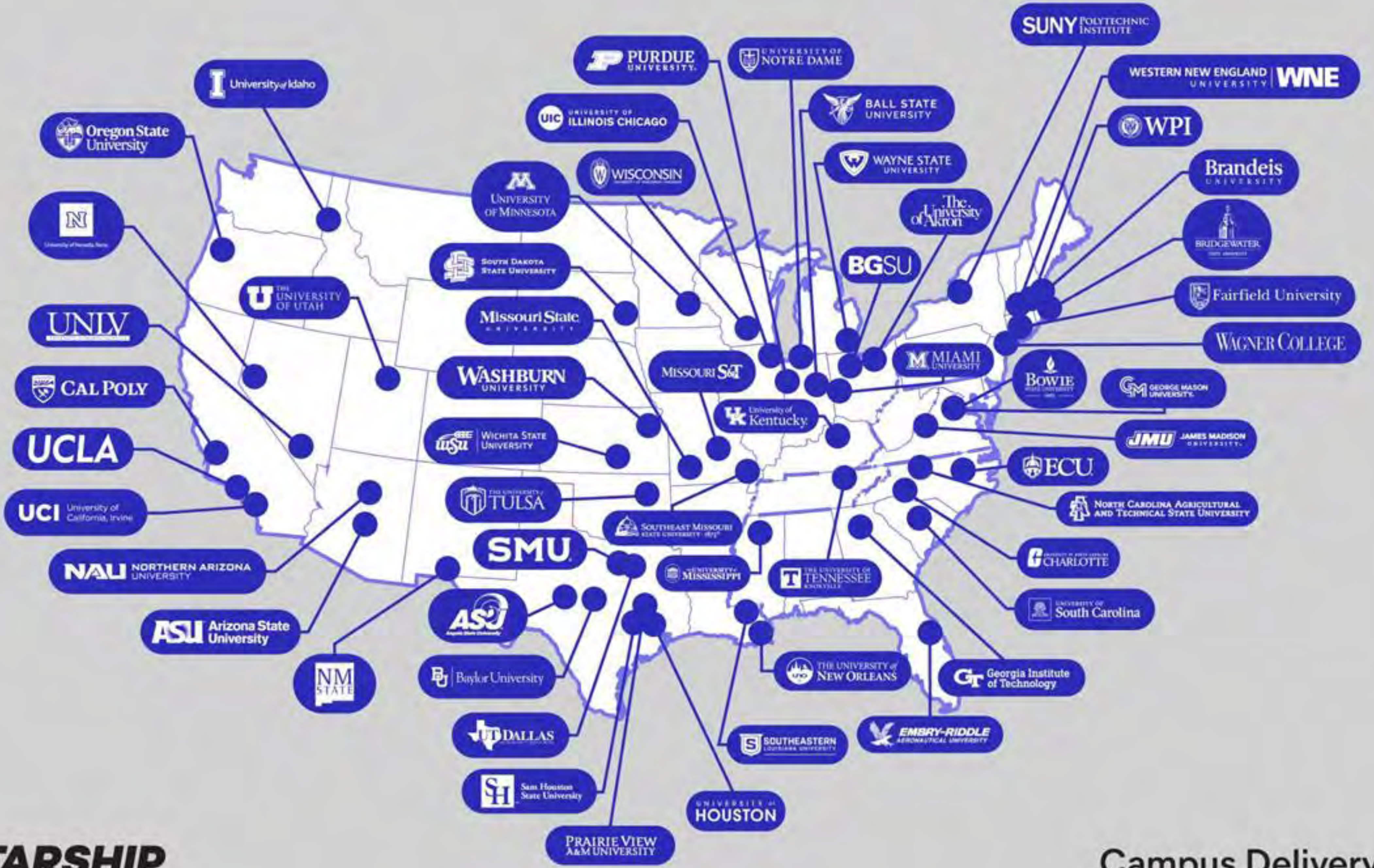
MARYLAND DEPARTMENT OF TRANSPORTATION

STARSHIP

Maryland Connected & Automated Vehicles Working Group

December 4,2024



STARSHIP

Campus Delivery

We’re revolutionising last-mile delivery on a global scale

Global Service Areas

+100

Cities, campuses, industrial sites

Miles driven

8 million

14m + kms

Deliveries Completed

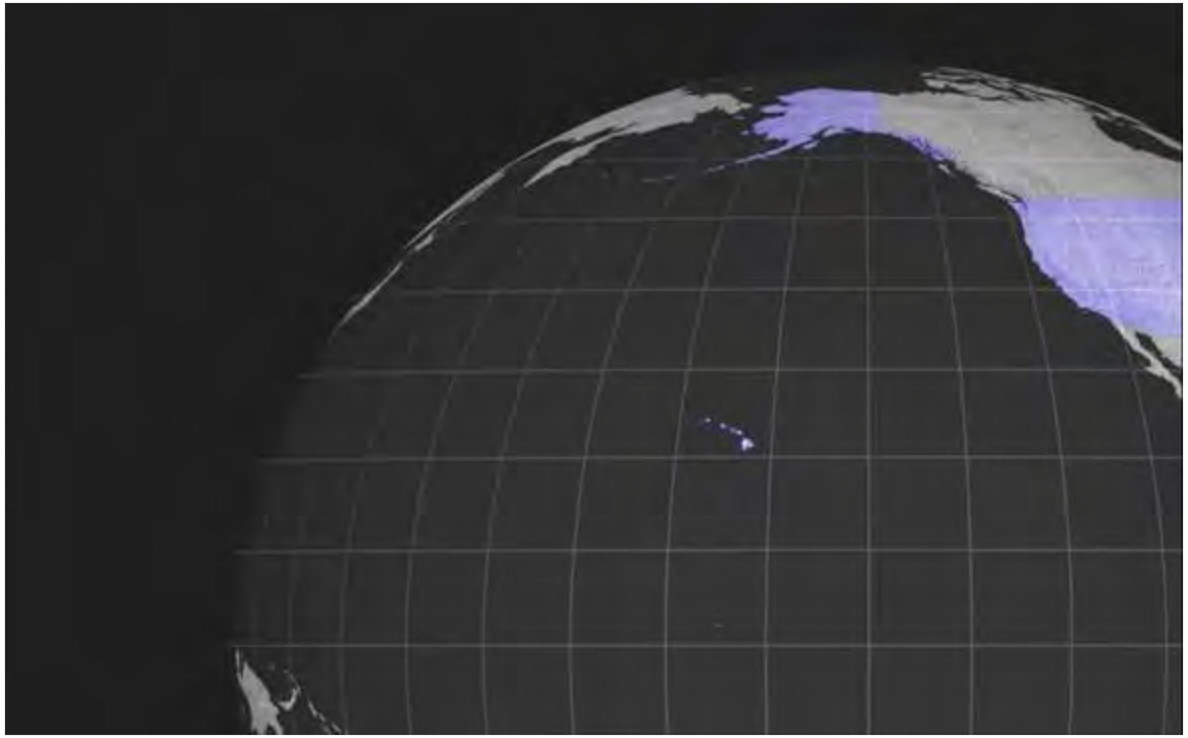
7 million

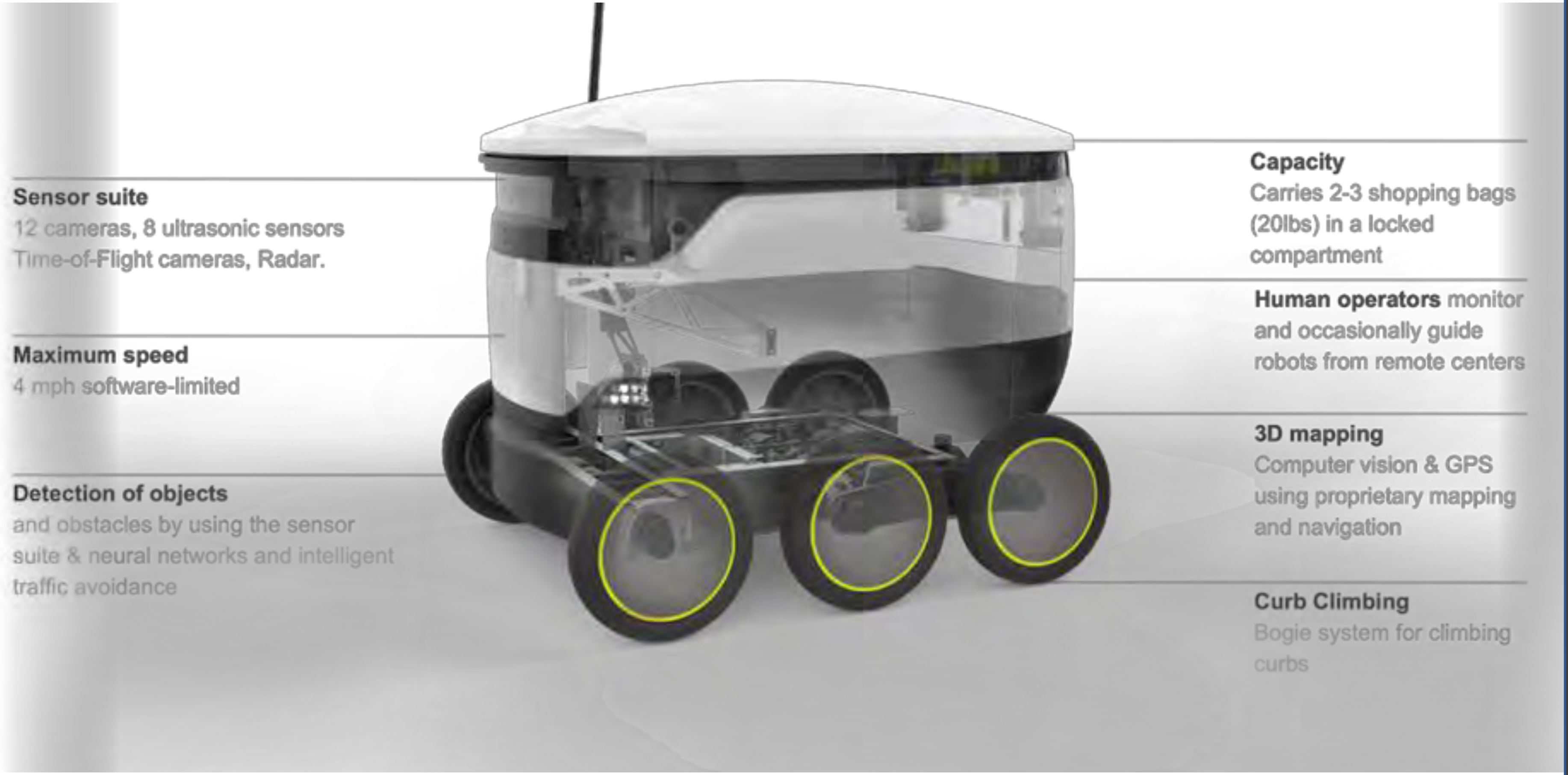
Hot food, groceries, industrial supplies

Road Crossings Per Day

150,000

x3 road crossing per second





A 'Bubble of Awareness': developed over 7 years

- High level of autonomy
- Human operator back up

Low speed and weight

BOWIE STATE

- Fall 2024 launch
- Delivery with meal plans
- Events with the university

STARSHIP

STARSHIP

Juan Canahui

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Adjourn

Remember to visit with UMD, MSU, Kiwibot, and Starship just outside and see their demonstrations!

Reach out anytime with ideas and questions!

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MARYLAND DEPARTMENT OF TRANSPORTATION