

Transportation Digital Infrastructure and Cybersecurity for Safety and Mobility

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College of
Engineering

Civil, Construction and Environmental Engineering

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CAM Lab @ University of Alabama

Transportation Digital Infrastructure

New and Refurbished Transportation Infrastructure



Digital Infrastructure



Freeway



Bridge



Transit



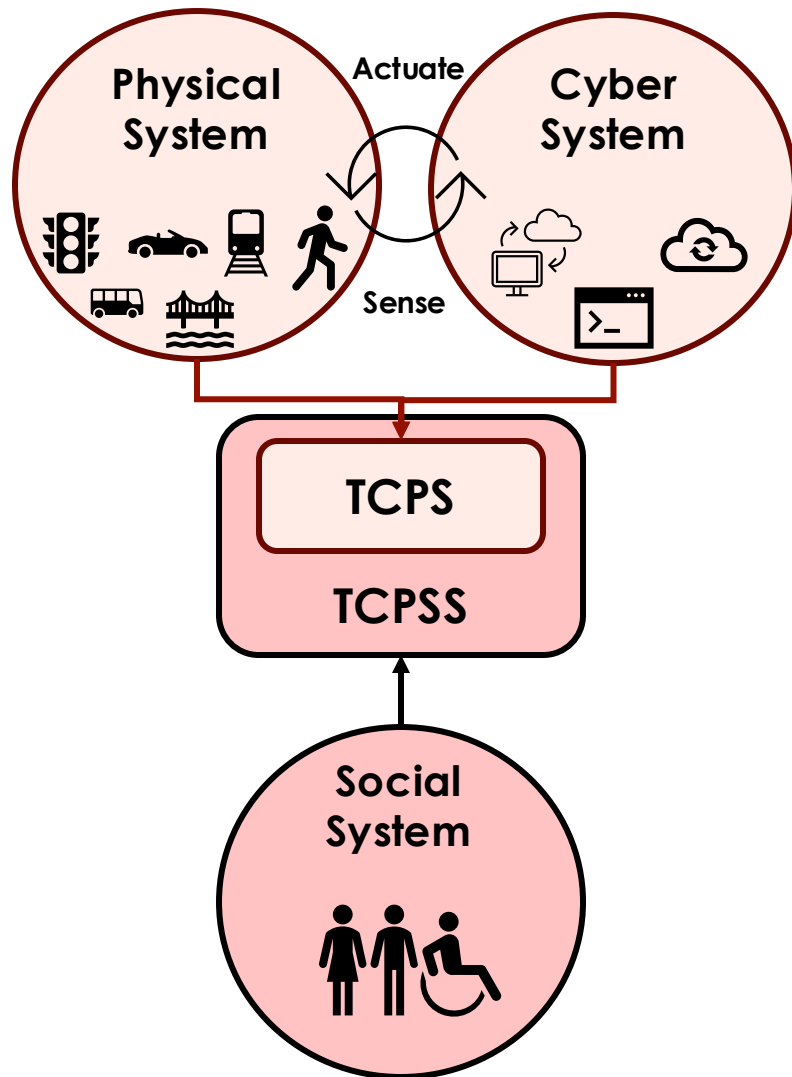
Port



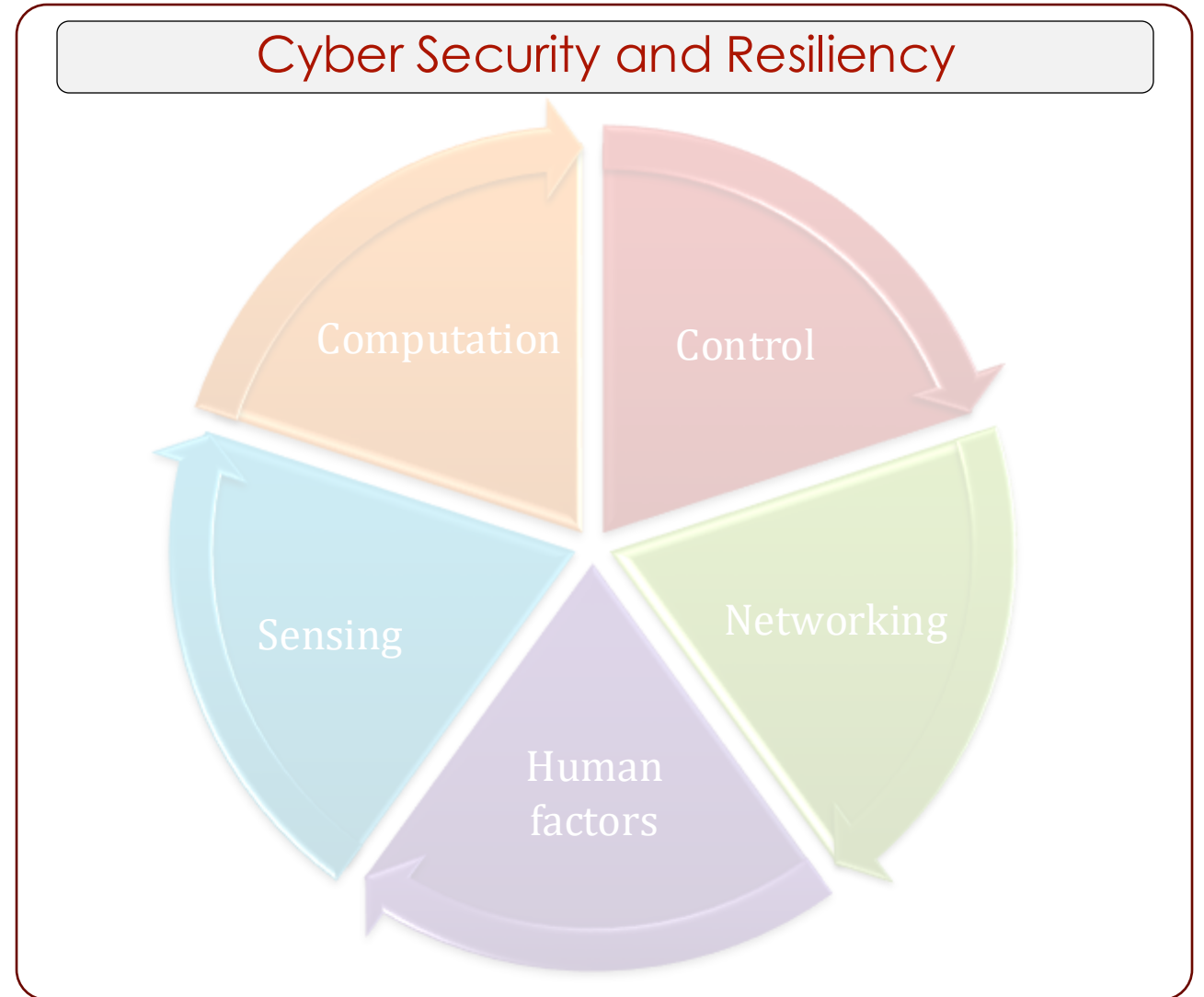
Street



Transportation Cyber-Physical Systems



TCPS = Transportation Cyber-Physical Systems



Digital Twin



Physical World

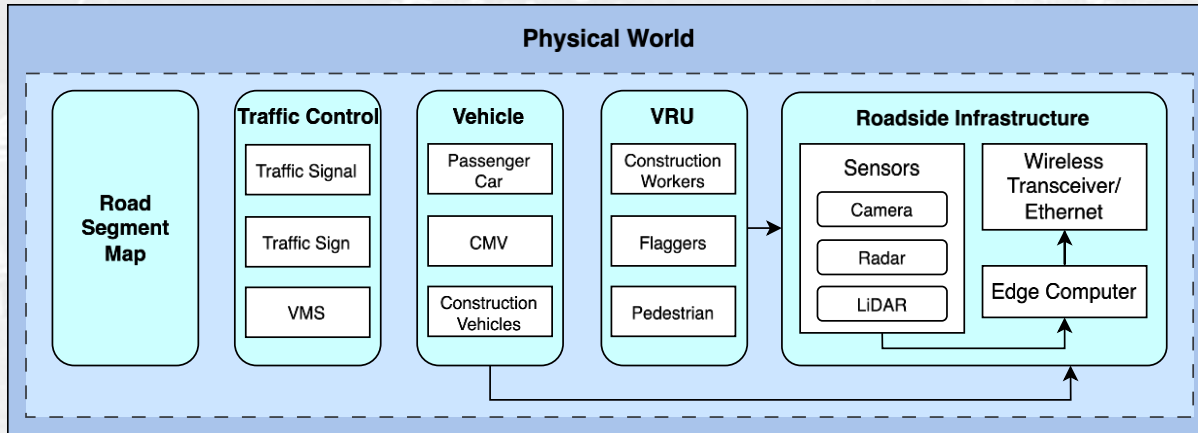


Digital Twin
(Real-Time Representation)

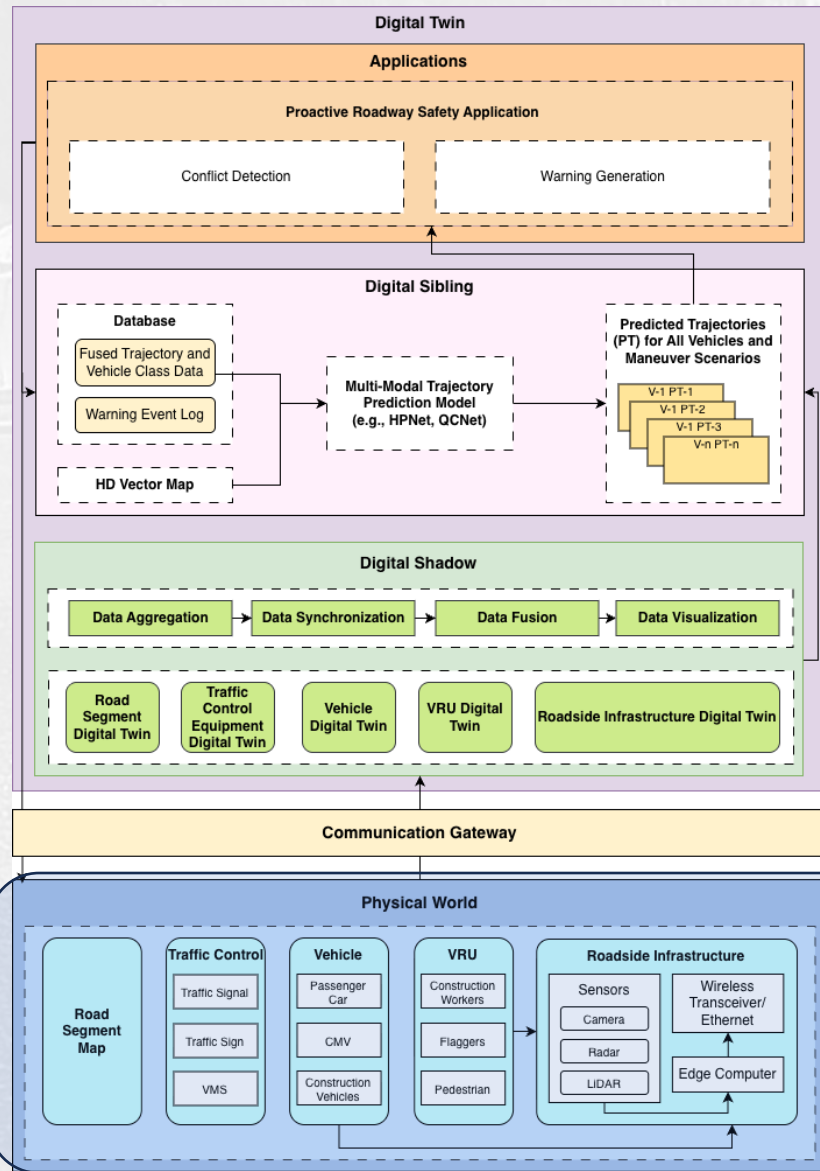


Predictive Digital Twin
(Predicted Representation)

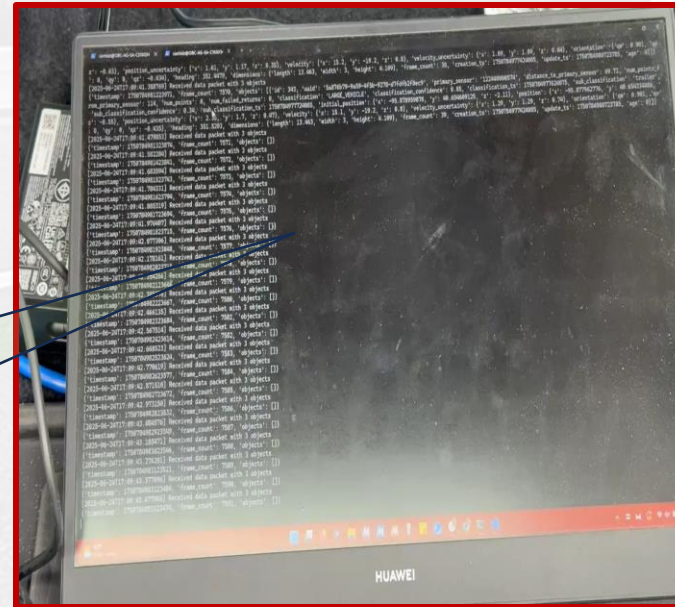
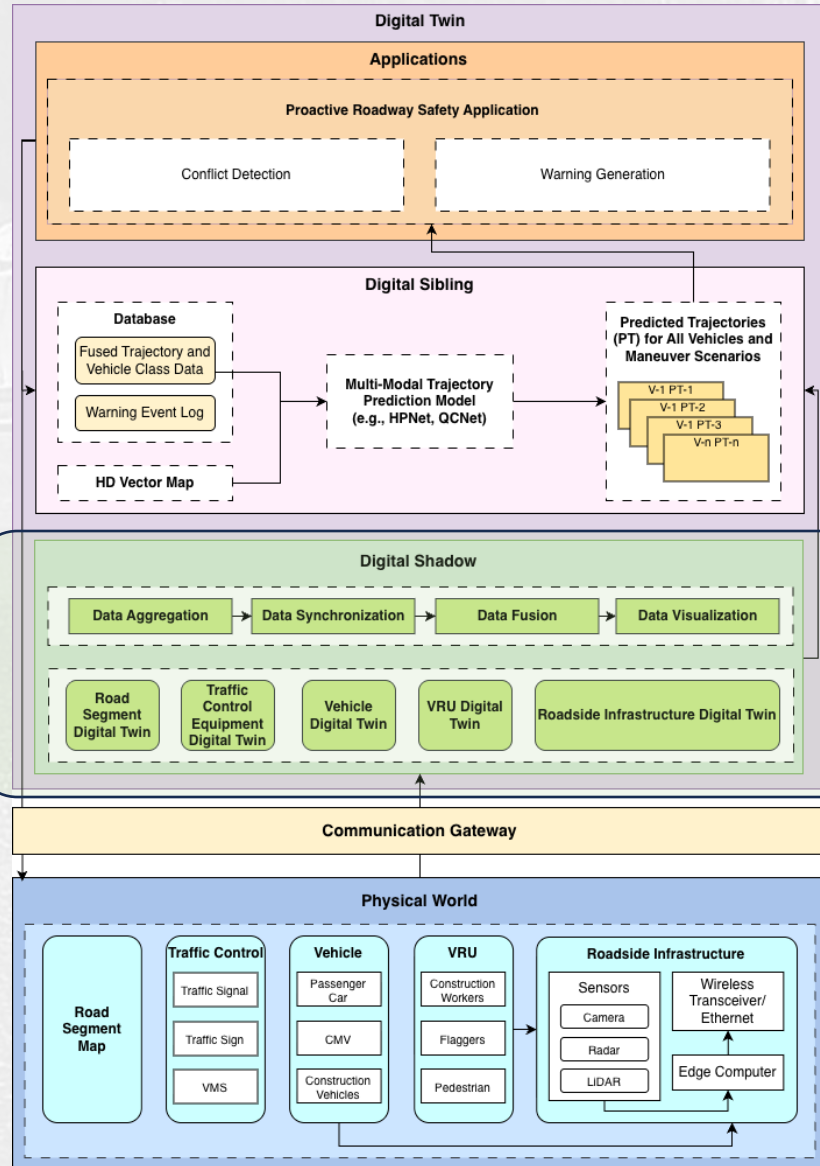
Components of Predictive Digital Twin



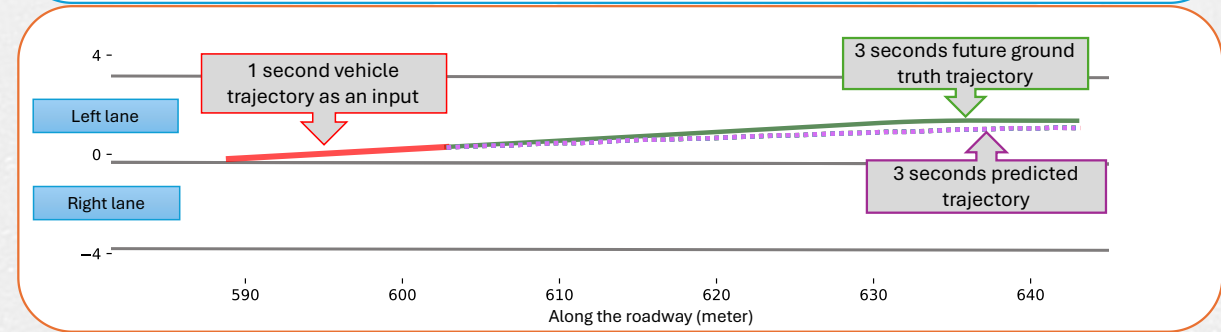
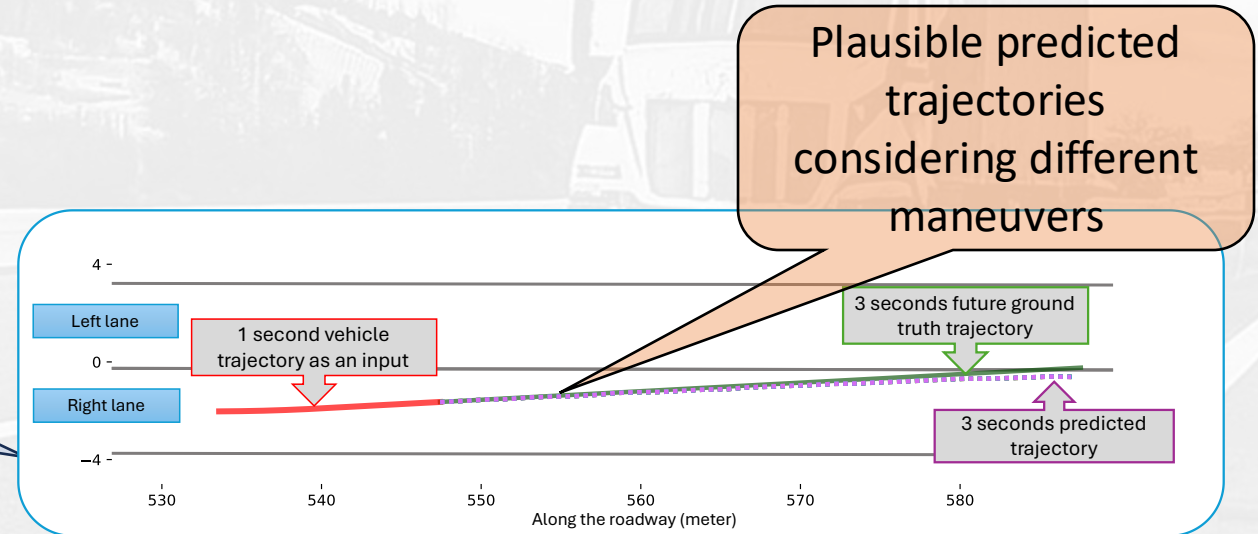
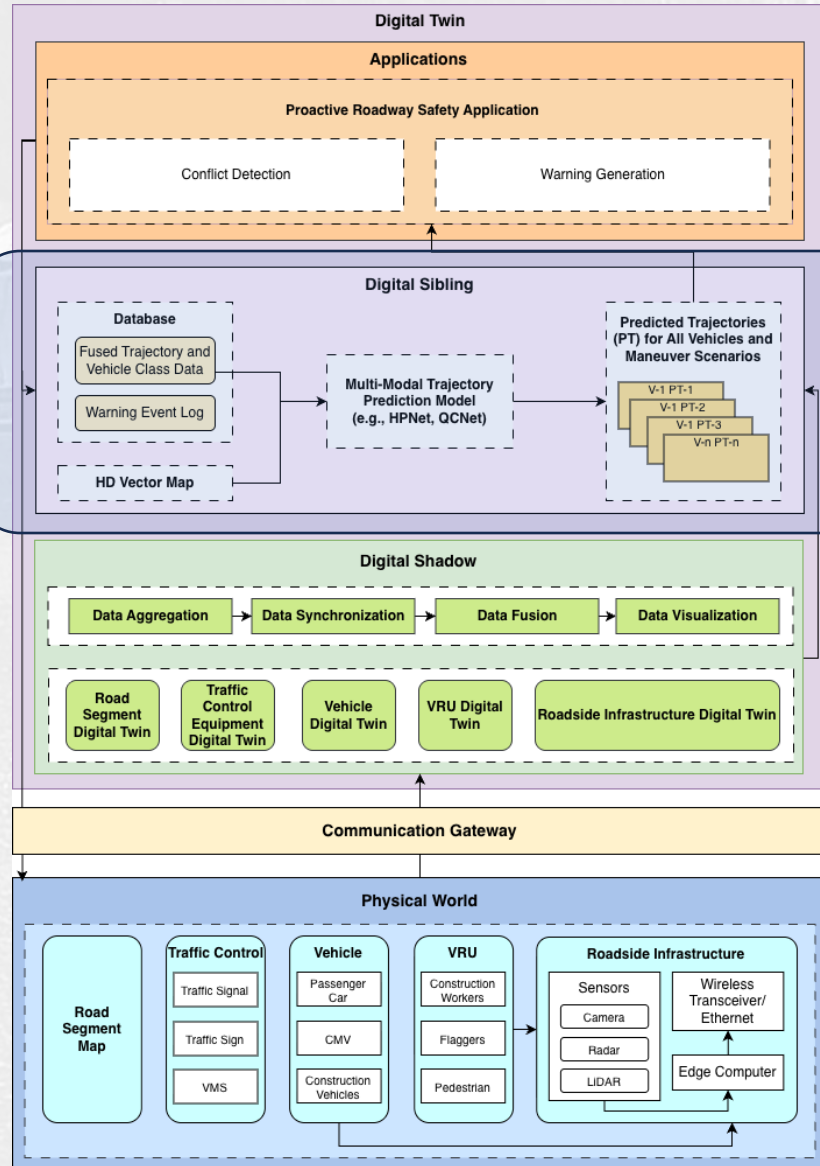
Predictive Digital Twin



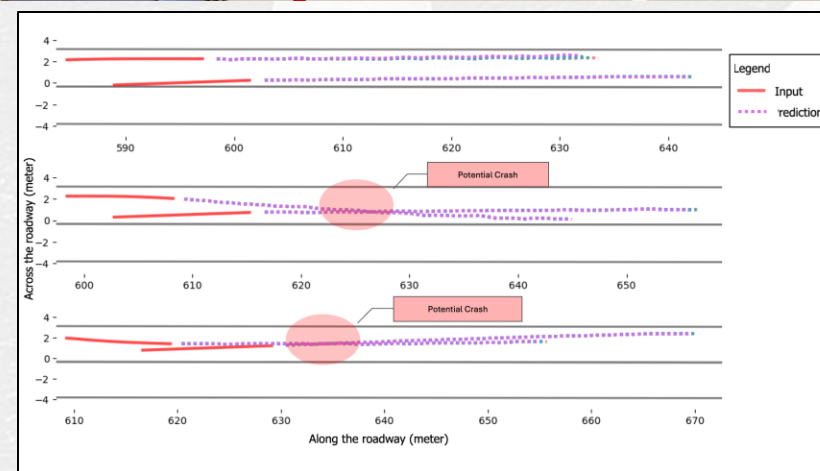
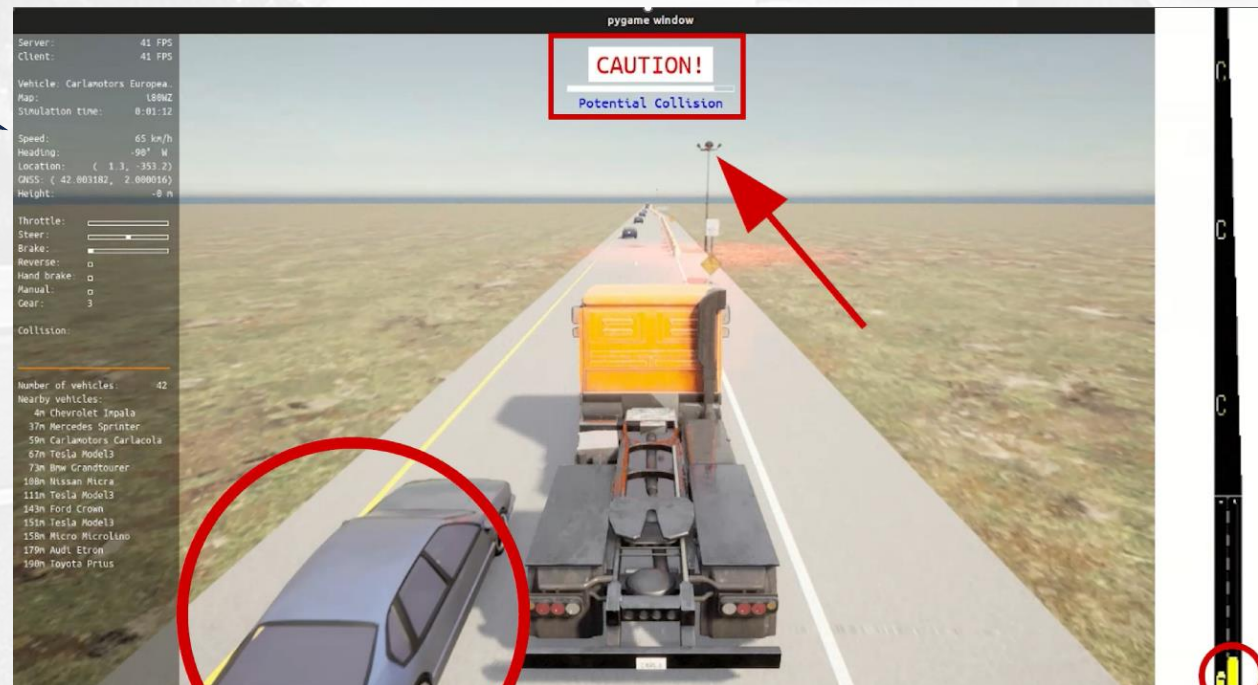
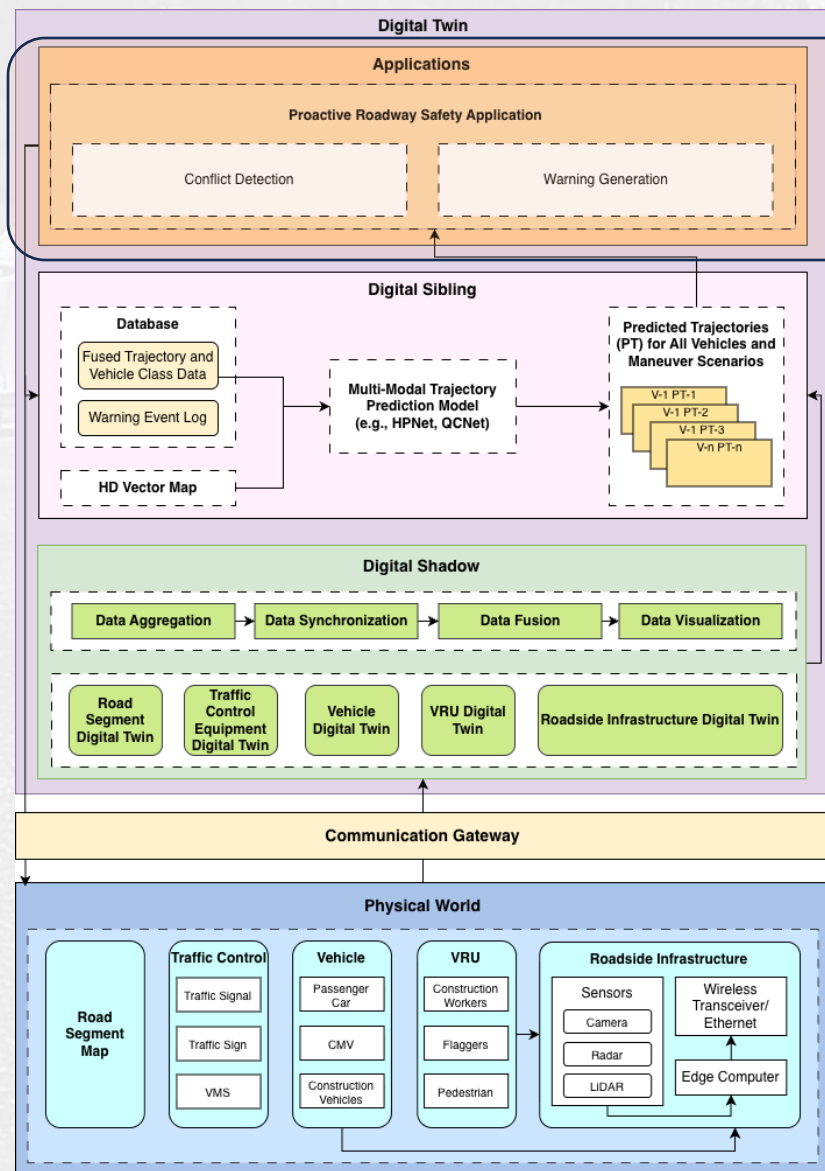
Predictive Digital Twin



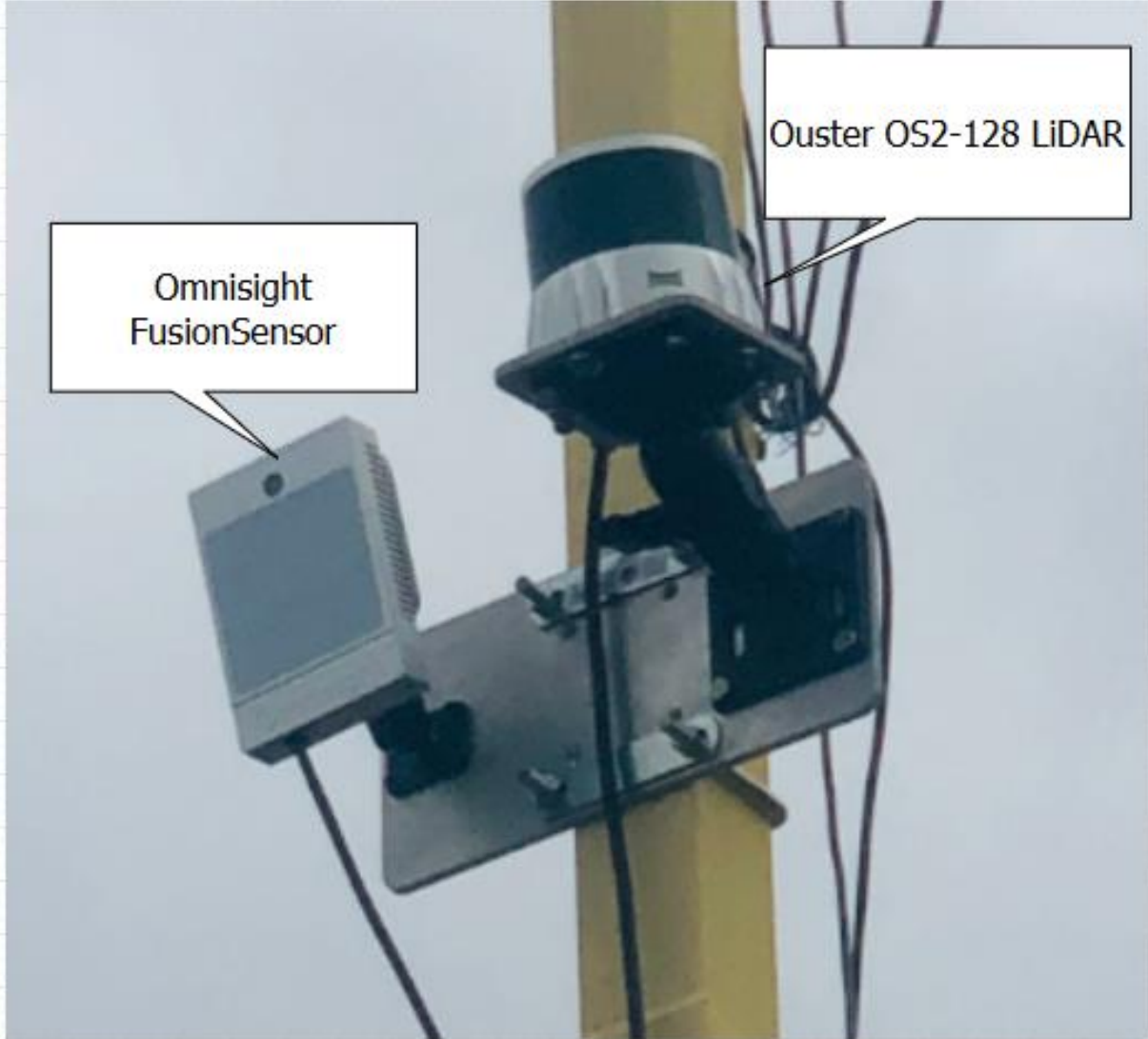
Predictive Digital Twin

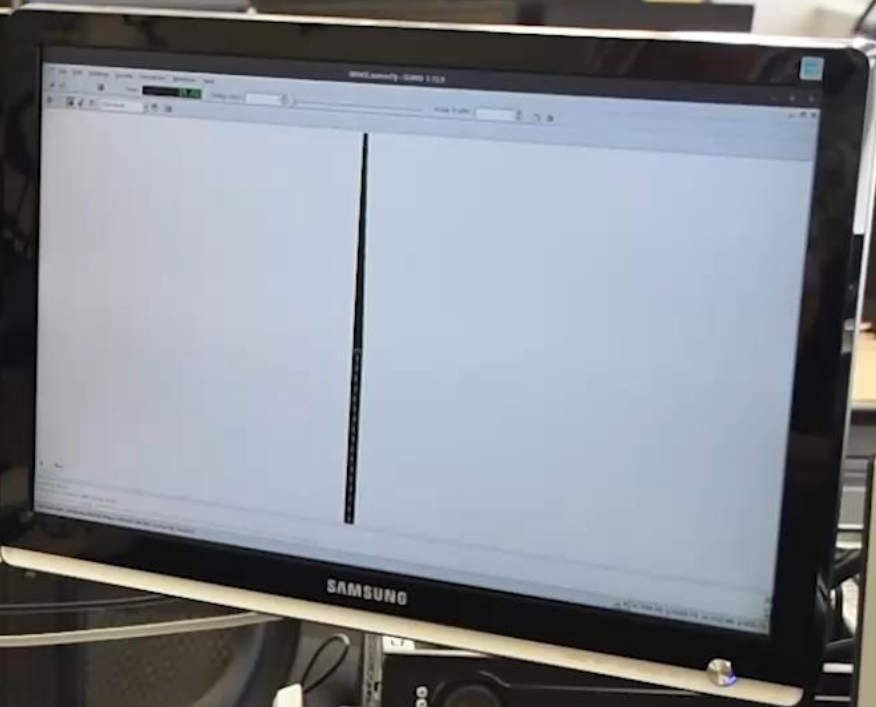
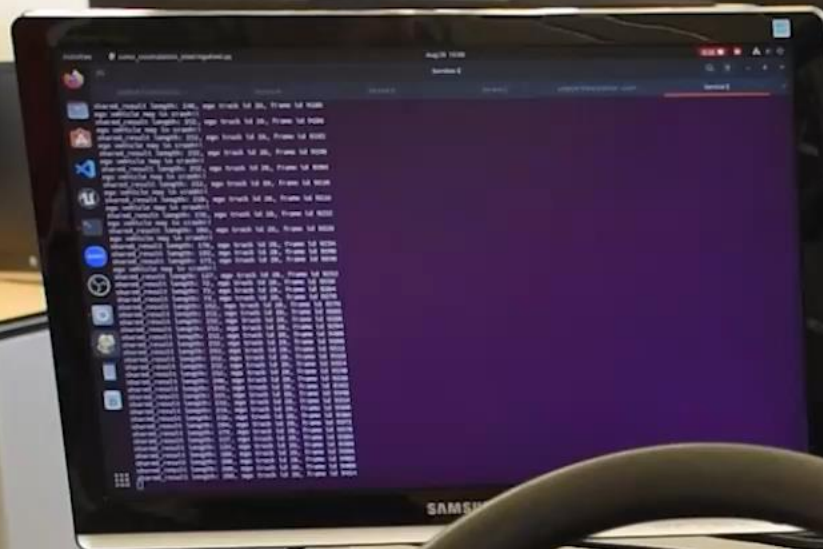


Predictive Digital Twin



Sensor Modalities





FMCSA Workshop

Help Shape the Future of Work Zone Safety

Proactive Technology Training & Evaluation Workshop

01 WHY THIS MATTERS

- Work zones are some of the most safety-critical places on our roads, especially for Commercial Motor Vehicle (CMV) drivers and highway construction workers.
- We are developing proactive warning technologies to alert drivers sooner, improve decision-making, and reduce crashes.
- Your participation will help ensure these tools work in real-world conditions.

DATE: September 10, 2025

TIME: 9 AM - 12 PM Central Time

LOCATION:
2200 Vine Street
Lincoln, NE 68583
Room 152

CONTACT:

Nathan Huynh (Principal Investigator)
nathan.huynh@uni.edu
(402) 472-3447

02 WHAT WE'RE DOING

We're conducting a workshop to:

- Present a proactive work zone warning system developed through a high-priority FMCSA research grant.
- Demonstrate how the system warns drivers and highway construction workers.
- Gather driver and stakeholder feedback to guide implementation strategies for technology providers, federal/state Department of Transportation (DOTs), and contractors.

03 WHO WE'RE LOOKING FOR

We welcome participation from:

- CMV drivers (long-haul and local)
- Road construction and maintenance professionals
- DOT staff and safety managers
- Driver training schools & instructors
- Industry and safety advocacy organizations

04 WHAT'S IN IT FOR YOU

- First look at cutting-edge safety technology
- Opportunity to shape future training programs
- Hands-on driving simulator experience
- Gift card for CMV drivers who attend in person and complete the training and feedback session

Your expertise can make work zones safer for everyone - join us and be part of the solution.



Transportation Digital Infrastructure

Project Title: Multi-Sensor Fusion for Proactive Commercial Motor Vehicle Safety at Work Zone [**Oct 2023**]

Goal and Impact: Develop a distributed multi-sensor system (i.e., distributed camera, LiDAR and RADAR sensors) and digital twin to ensure work zone safety.

Funded

Funding Status

\$1.08 M

Total Budget



Federal
Motor Carrier
Safety
Administration

Funding Agency

PI (UA)

My Role

2 Years

Project Duration



UNIVERSITY of NEBRASKA
LINCOLN



THE UNIVERSITY OF
ALABAMA

MITRE



Transportation Digital Infrastructure

Project Title: Roadside-to-Vehicle Crash Avoidance Warning System for Commercial Motor Vehicles on Rural Roads [**Sept 2024**]

Goal and Impact: Develop a Crash Avoidance Warning System (CAWS) for commercial motor vehicles to reduce the number of fatalities disproportionately occurring on rural roads, which have much lower vehicular volume.

Funded

Funding Status

\$1.34 M

Total Budget



Funding Agency

PI (UA)

My Role

2 Years

Project Duration



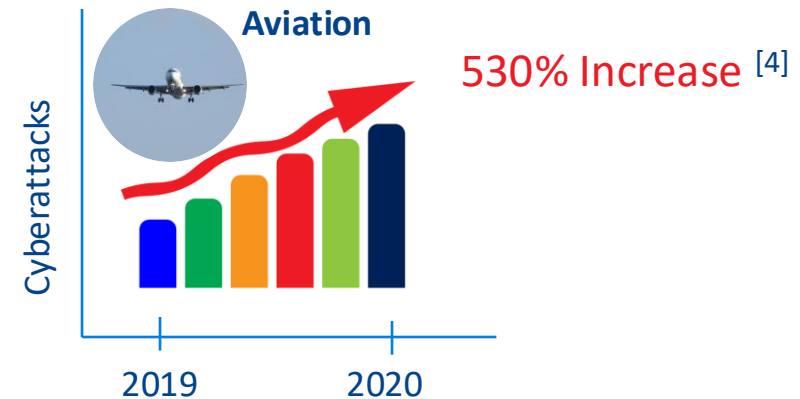
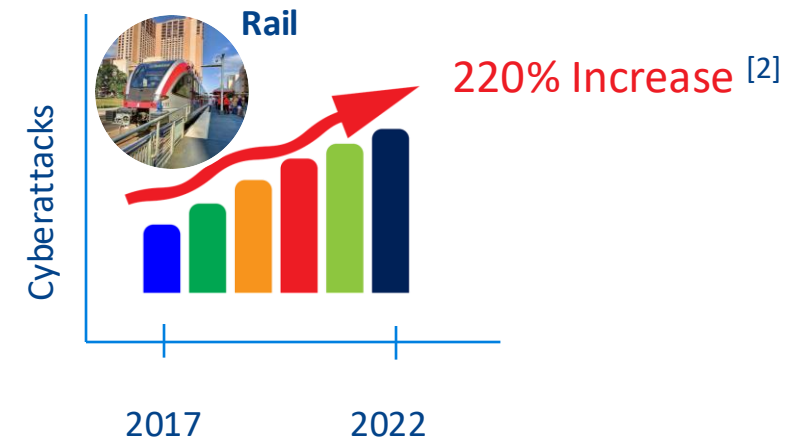
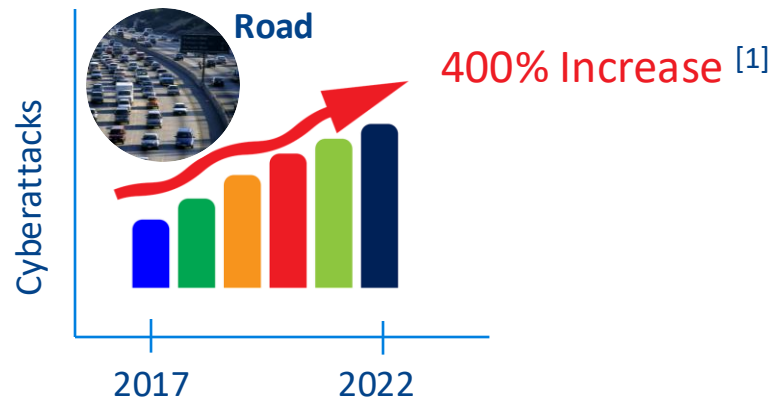
UNIVERSITY of NEBRASKA
LINCOLN



A satellite is shown in the upper right quadrant of the image, appearing to be in orbit. The satellite has a central body with various instruments and two large solar panel arrays extending outwards. The background is a light blue gradient with a prominent lens flare effect originating from a bright point of light near the center, creating several radiating lines and a soft glow. The overall aesthetic is clean and futuristic, typical of a presentation slide for a technology-related topic.

Transportation Cybersecurity

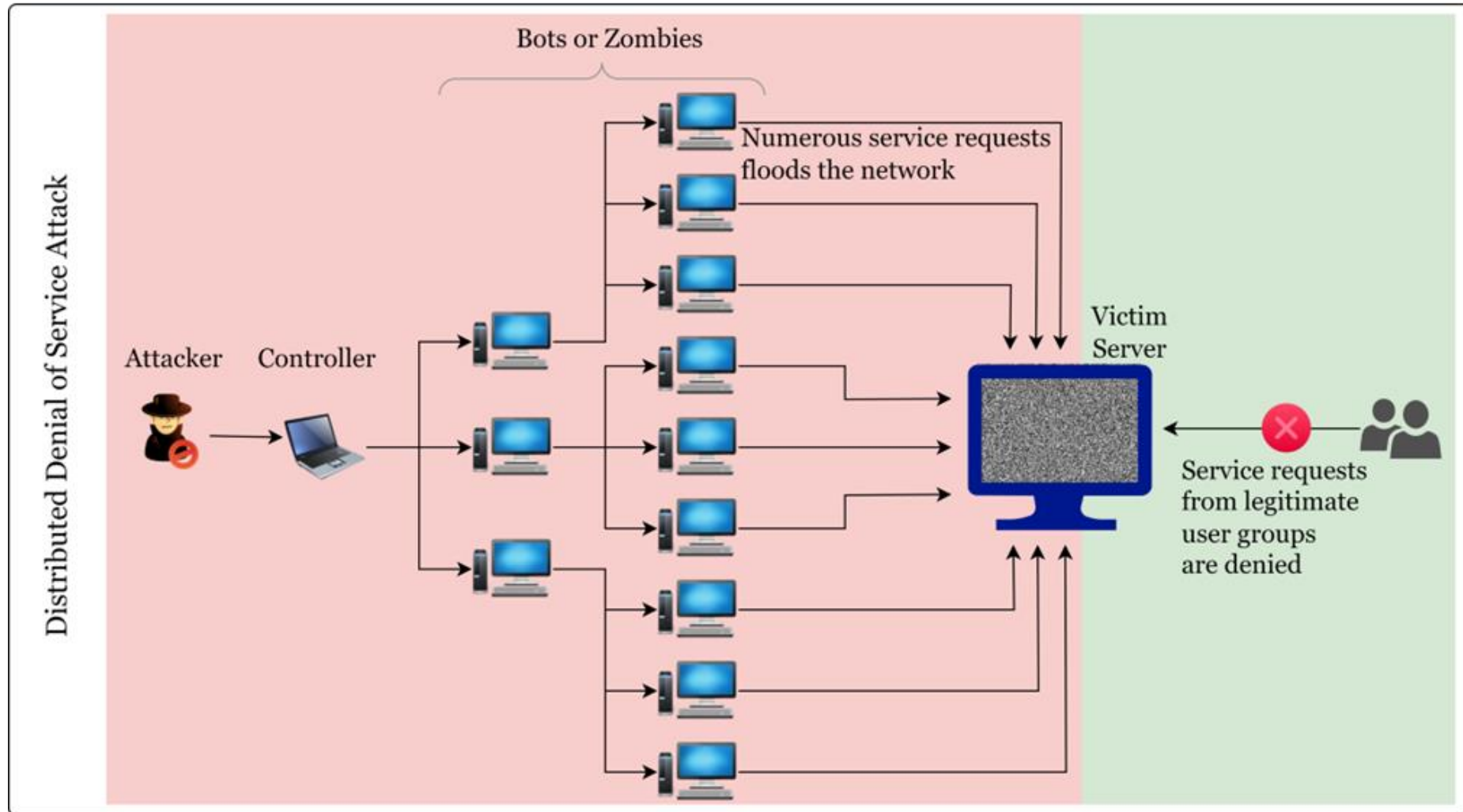
Cyberattacks Against Multimodal Transportation



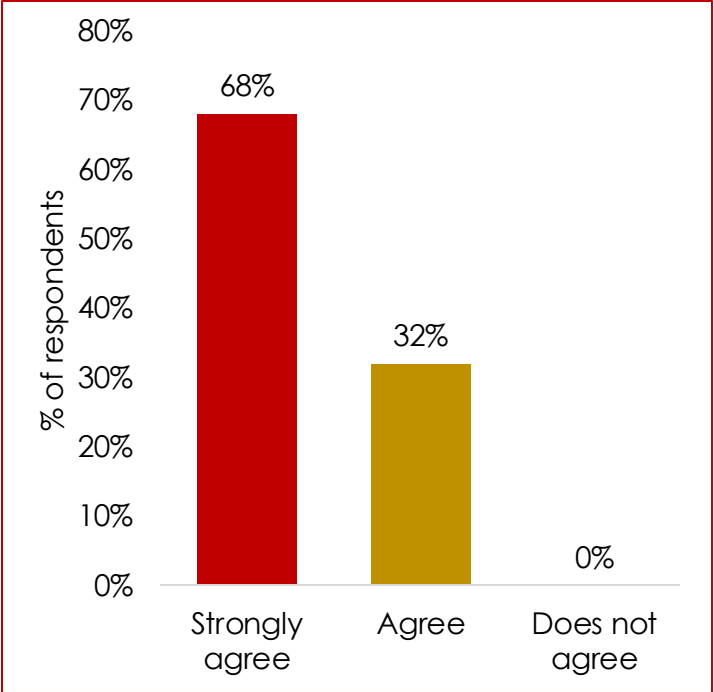
References:

1. Under Attack: Trucking Industry Increasingly at Risk of Cyberattacks. *Truck News*. <https://www.trucknews.com/features/under-attack-trucking-industry-increasingly-at-risk-of-cyberattacks/>. Accessed Aug. 5, 2024.
2. Rail Cybersecurity -How Railroads Can Harden Their Defenses and Get Ahead Of Cyber Threats in 2023. AppViewX, Aug 05, 2024.
3. IAPH Cybersecurity Guidelines for Ports and Port Facilities. 2021.
4. Aviation Is Facing a Rising Wave of Cyber-Attacks in the Wake of COVID. <https://www.shlegal.com/insights/aviation-is-facing-a-rising-wave-of-cyber-attacks-in-the-wake-of-covid?06082024160610>. Accessed Aug. 6, 2024.

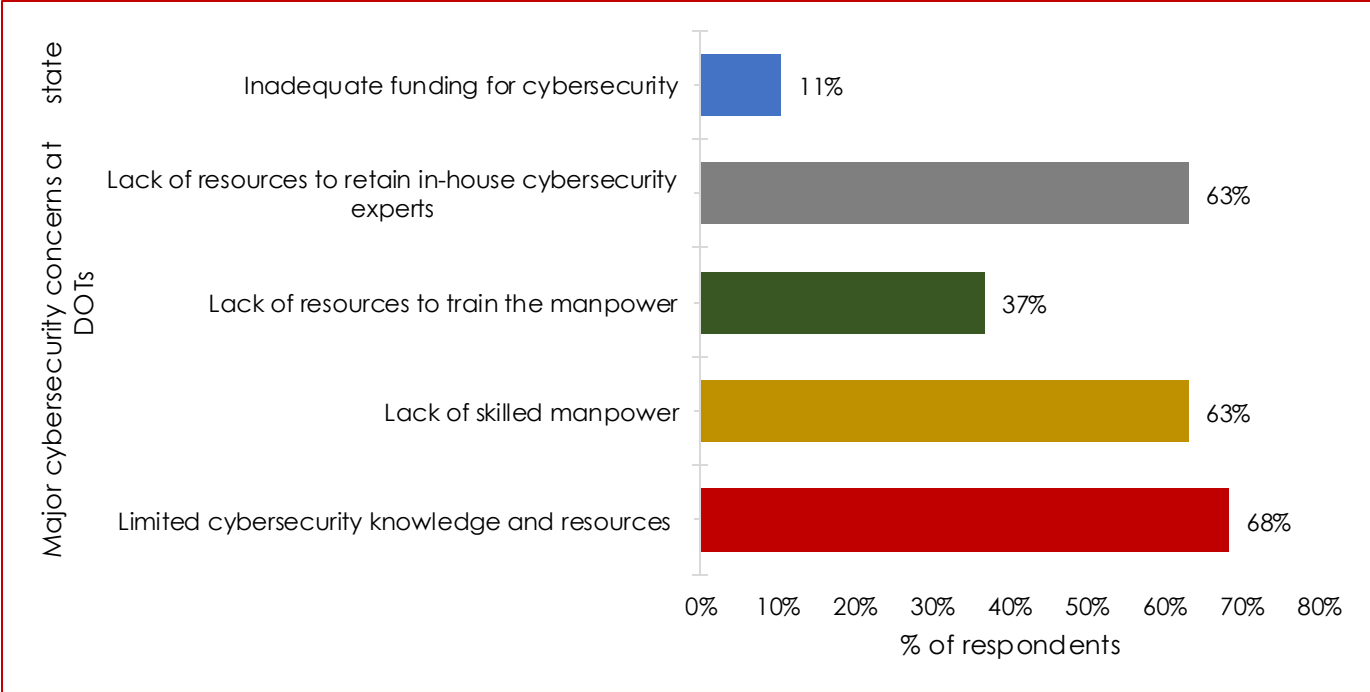
Unavailability of service like this can occur due to cyberattacks, such as **Denial of Service (DoS)** and **Distributed Denial of Service (DDoS)**



Survey Results to Understand Existing Limitations of State DOTs



Survey results related to whether transportation cybersecurity a concern



Survey results related to the major cybersecurity concerns

Why is Cybersecurity of Transportation Systems Becoming a Pressing Issue?

Increased Attack Surfaces



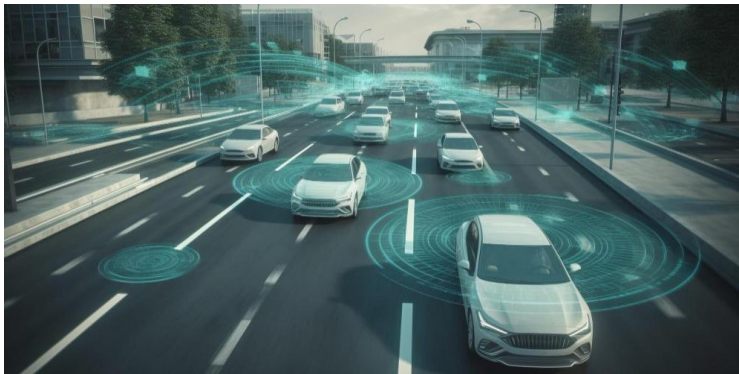
Insufficient Security in Legacy Systems



Weak Supply Chain Security



Increased Dependence on Digital Assets



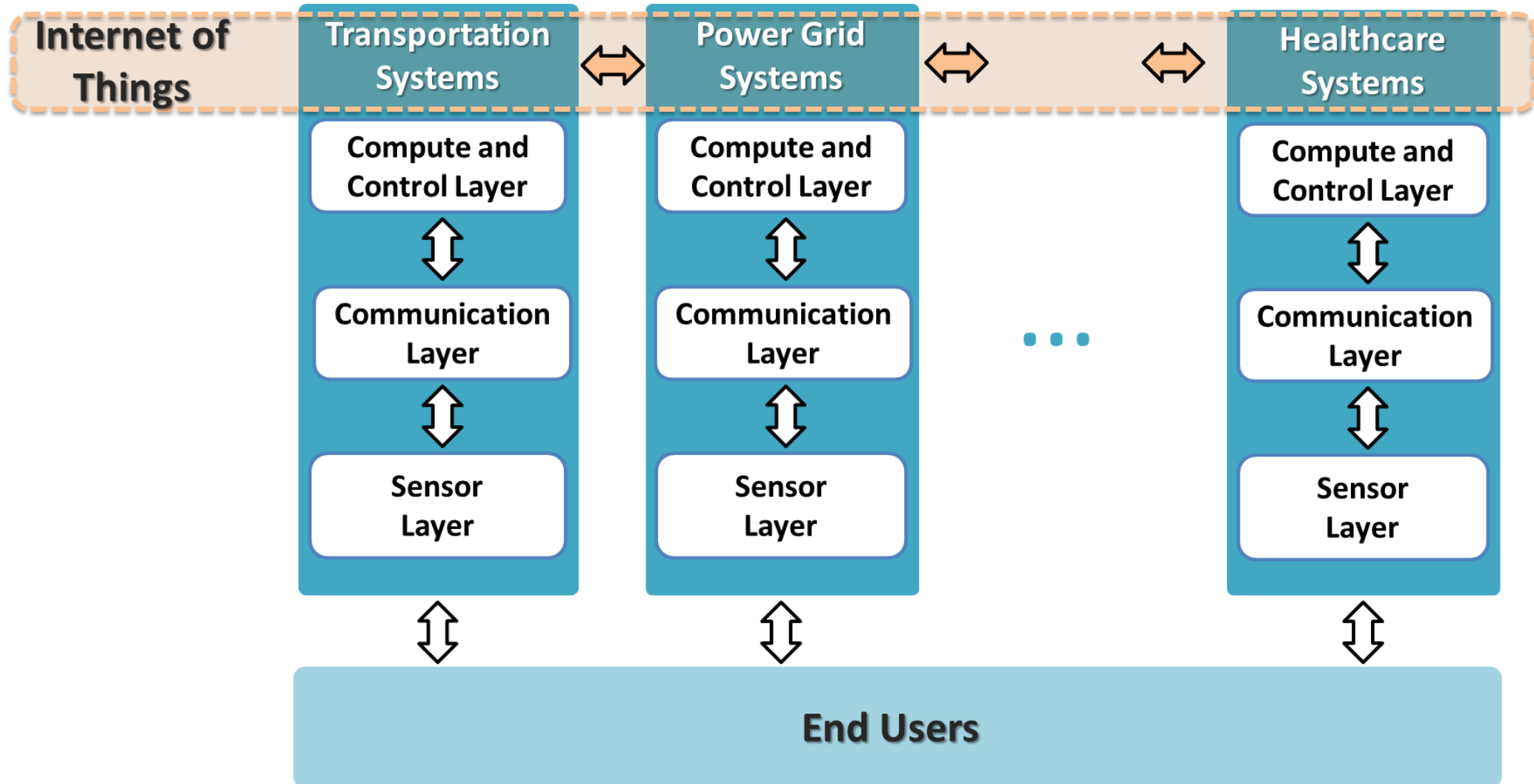
Operation, Maintenance, and Training



Lack of Standardization and Policies



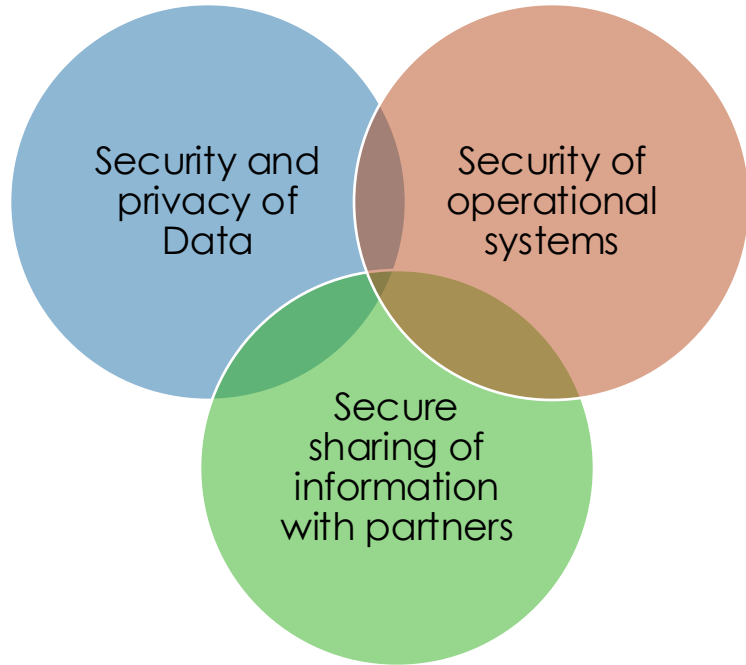
Threat Propagation Across Internet-of-Things





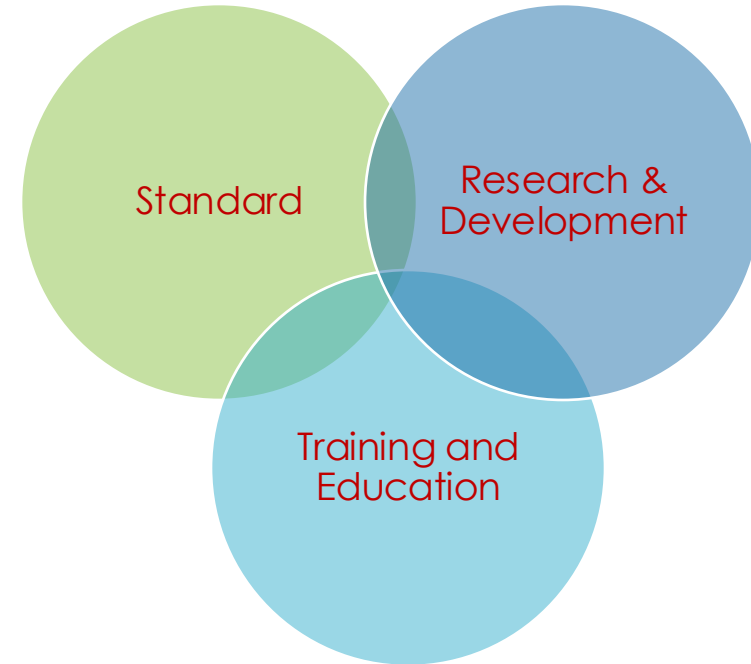
What work or exploration is needed?

Achieve their mobility, safety, and security goals.



- **Security and privacy of Data**
Example: Analytics, AI, Data quality/timeliness/accuracy
- **Secure sharing of information with partners**
Examples: Between TMCs, Digital Infrastructure
- **Security of operational systems**
Examples: Cyber-physical systems, systems of systems

What resources, references, or ongoing efforts are available



- **Standard**
Example: NIST Cybersecurity Framework [ITS Profile - RSU, CCTV, Traffic Signal]
- **Training and Education**
Example: JPO DOT Senior Executive Cyber Training – Summer 2026
- **Research & Development**
Example: Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

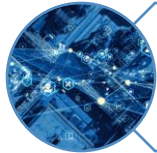
What current challenges, gaps, or opportunities exist in this area?



Cybersecurity testing strategies
(Networks and devices; Test case generation; pen testing/testing scenarios)



Insufficient security in legacy systems



Weak supply chain



Programmatic and policy domain



Workforce development

National Center for Cyber Security and Resiliency

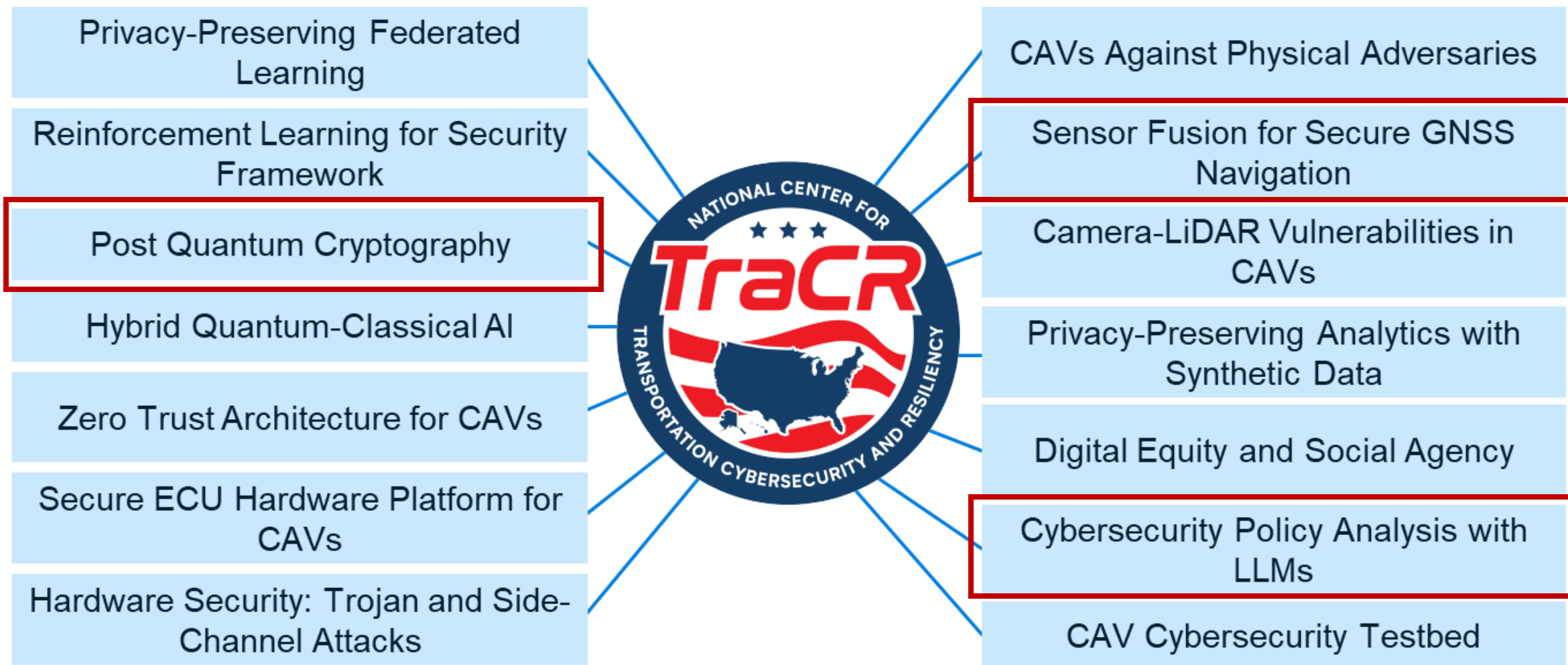
Project Title: National Center for Transportation Cyber Security and Resiliency (TraCR)
[February 2023]

Goal and Impact: Pioneer cybersecurity and resiliency to defend transportation systems and infrastructures against the threats of today and tomorrow.

Funded Funding Status	\$20 M Total Budget	 USDOT Funding Agency	Co-PI (UA) My Role	5 Years Project Duration
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Funded Project Categories



CAV: Connected autonomous vehicle; GNSS: Global navigation satellite system; LLM: Large language model

Outdoor Technology Demonstration Securing GNSS-based Autonomous Vehicle Navigation

USDOT Future of Transportation Summit 2024, August 2024, US DOT Headquarters, Washington DC

Vehicle Tracker

localhost:3000

THE UNIVERSITY OF ALABAMA

Cyber Resilient Navigation

CAM Lab @ UA
Connected and Automated Mobility Laboratory

TracR

Legend:
● Ground Truth
● Estimated
● Spoofed

Desired route

Transportation landmark

Starts here

End

Sensor Data: Accelerometer (Left) and Gyroscope (Right)

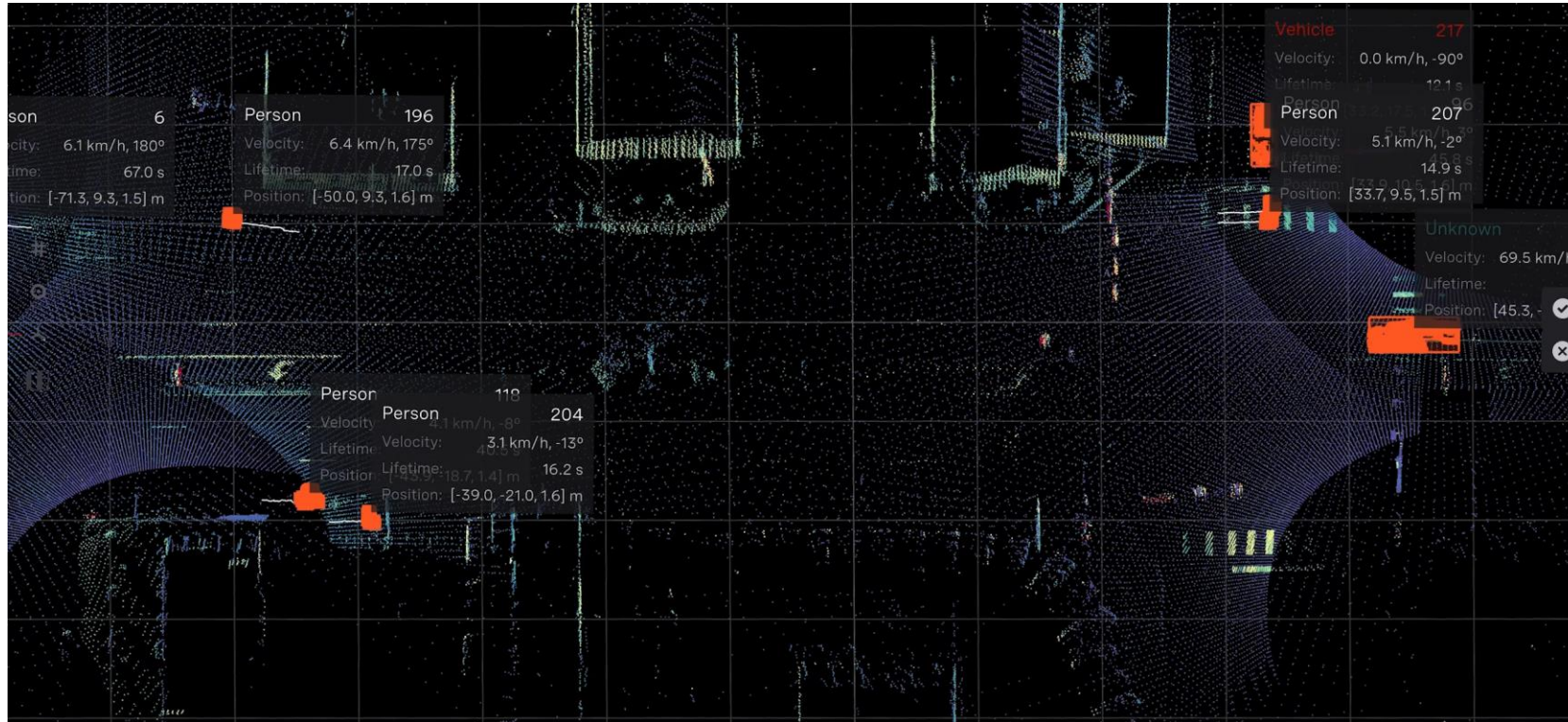
Speed
04
mph

Attack Status: No Attack

A satellite is shown in space, positioned in the upper right quadrant. It has a central body with various instruments and two large solar panel arrays extending outwards. A bright light source, likely the sun, is positioned behind the satellite, creating a prominent lens flare that radiates across the center of the image. The background is a light, hazy blue, suggesting the Earth's atmosphere or space.

CAM Lab Facilities

Roadside Sensors



LiDAR System



Radar and Camera System

Weather Sensors

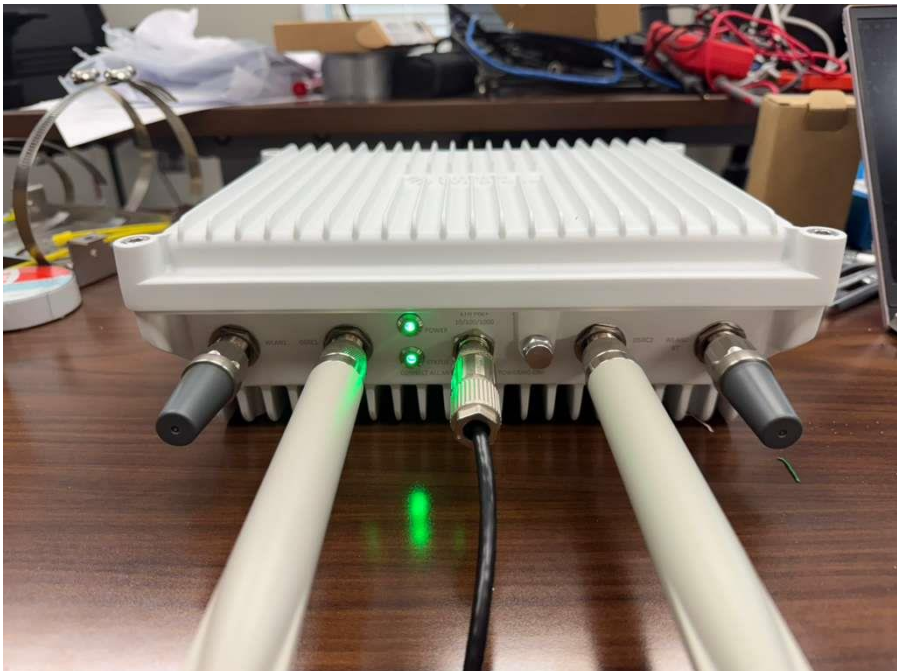


Visibility Sensor

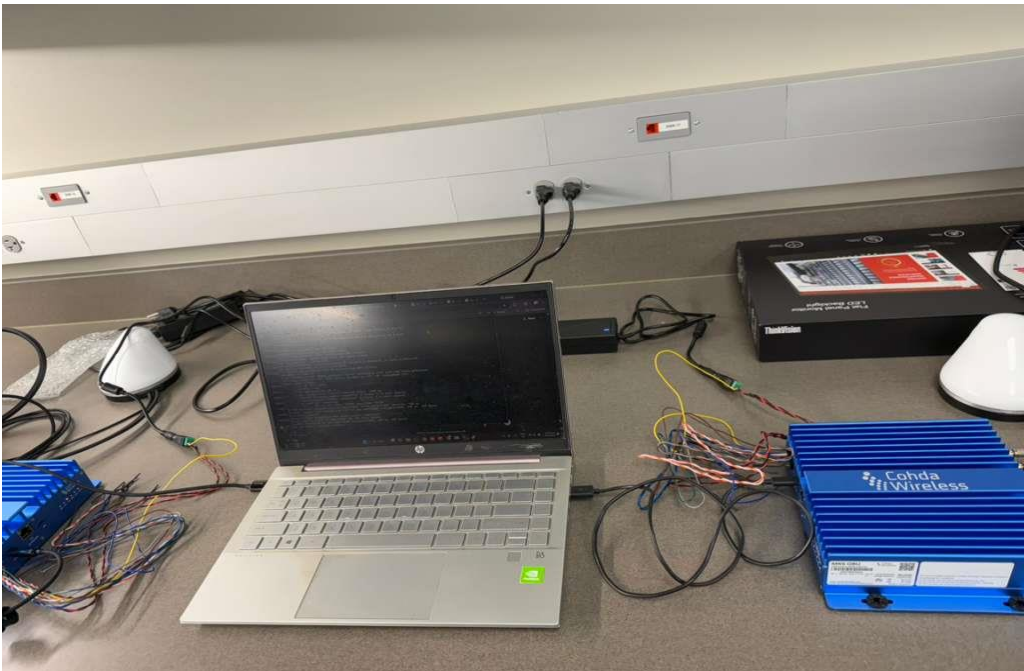


Non-invasive Road Sensor

Cellular Vehicle-Everything (C-V2X) Communication



C-V2X Roadside Unit



C-V2X Onboard Unit

CAM Lab Facilities



Vehicle equipped with RTK-GNSS receiver, inertial sensors, ZED 2i stereo camera and onboard computing platform



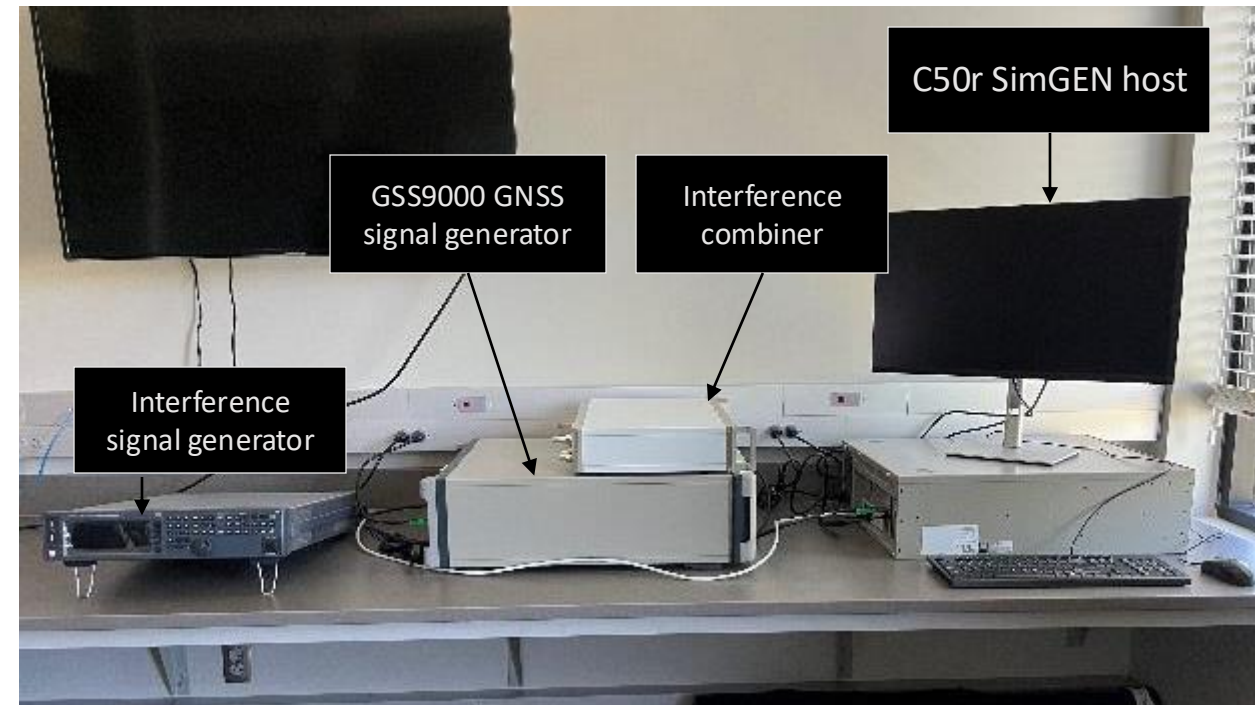
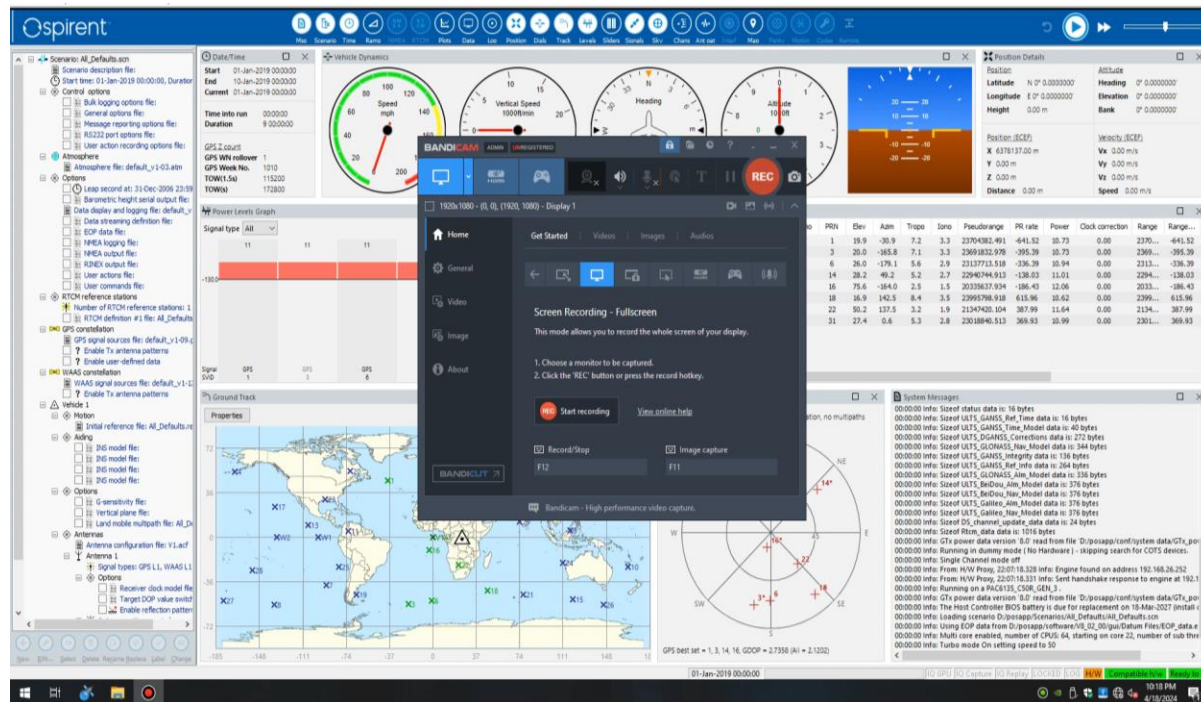
Hexagon/NovAtel RTK-GNSS CPT7700



Software Defined Radios (SDR) for cyber attack generation

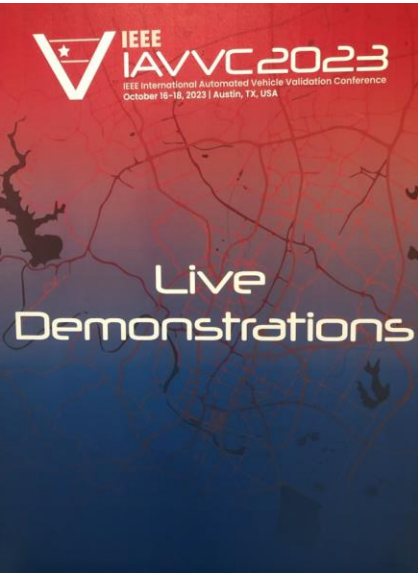
CAM Lab Facilities

State-of-the-art Hardware-in-the-loop Simulation Platform Global Navigation Satellite Systems (GNSS) and Autonomous Systems



Spirent GNSS signal simulator

Technology Demonstration



A satellite is shown in the upper right quadrant of the image, oriented diagonally. It has a central body with various instruments and two large solar panel arrays extending outwards. The background is a light blue-grey gradient, and a bright light source is positioned behind the satellite, creating a prominent lens flare with multiple rays of light extending across the frame.

Thank you!