Open Community Platform for Sharing Vehicle Telematics Data for Research and Innovation

Christos Papadopoulos, University of Memphis
Jeremy Daily, Colorado State University
David Balenson, USC Information Sciences Institute

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PIVOT Summary

GOAL: Develop a community-based platform to catalyze the production and consumption of automotive and heavy-duty datasets and tools to support research in vehicle system cybersecurity, intelligent transportation, and smart and connected communities

FIVE PILLARS

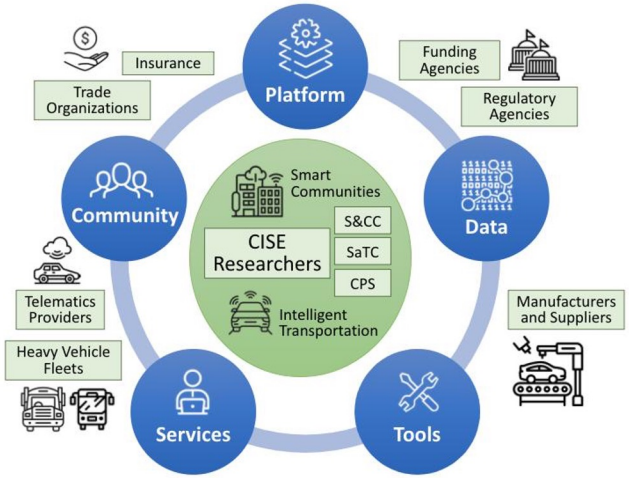
PLATFORM: Robust and reliable hardware and software upon which the system runs

DATA: Curation and sharing of data and contextual information

TOOLS: Common software-based tools to collect, transform, combine, filter, and visualize the data

SERVICES: Researcher-centric services for sharing, securing, and evaluating datasets, plus privacy services

COMMUNITY: Outreach and engagement to improve the data utility using design feedback mechanisms



EXAMPLE DATASETS

- ORNL ROAD dataset
- Korea University HCRL Datasets
- Bosch SynCAN (for CANet)
- CSU Heavy Truck Datasets
- Geotab telematics data and Altitude analytics platform
- US DOT Public Data Portal
- SmartColumbus Datasets
- Wyoming DOT CV Pilot

POTENTIAL APPLICATIONS

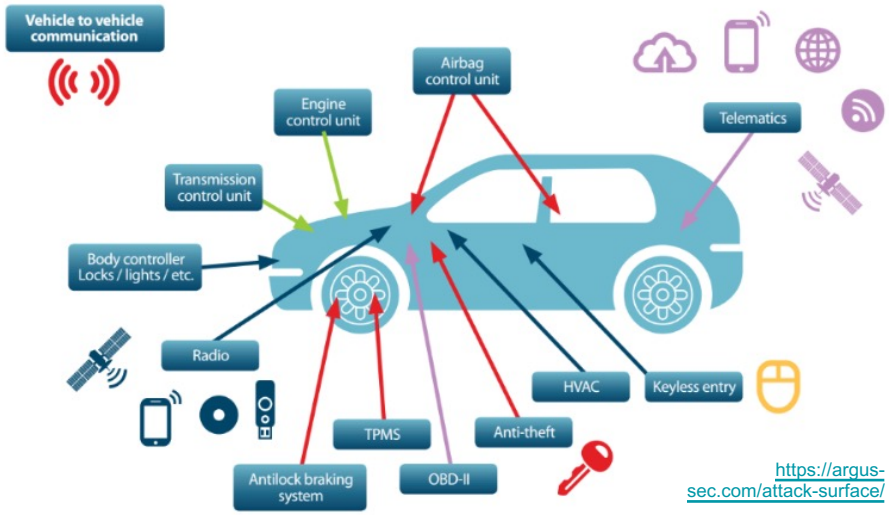
- Cybersecurity and safety
- Vehicle performance and maintenance
- Transportation and fleet management
- Smart cities and communities
- NSF research programs

NSF CISE Community Research Infrastructure (CCRI)
Three-years, from Oct 2022 to Sep 2025

Attack Surface of a Connected Vehicle

Internal Components

- Telematics
- Infotainment
- Vehicle gateway
- OBD-II port
- Engine control unit
- Transmission control unit
- Body control unit
- Instrument cluster
- Steering control
- Brake control
- Airbag module
- Safety (wipers, headlights, horn)
- ADAS
- Sensors (camera, radar, lidar, ultrasonic)
- GNSS receiver)
- Anti-theft
- TPMS
- Keyless entry
- Bluetooth system
- Wi-Fi hotspot
- Radios
- V2X



https://argus-sec.com/attack-surface/

K. Koscher *et al.*, "Experimental Security Analysis of a Modern Automobile," *2010 IEEE Symposium on Security and Privacy*, 2010, pp. 447-462, doi: 10.1109/SP.2010.34.

Stephen Checkoway, *et al.*. Comprehensive Experimental Analyses of Automotive Attack Surfaces. In proceedings 20th USENIX Security Symposium, San Francisco, CA, August 2011. https://www.usenix.org/conference/usenix-security-11/comprehensive-experimental-analyses-automotive-attack-surfaces

Miller & Valasek, http://illmatics.com/car_hacking.pdf, http://illmatics.com/remote%20attack%20surfaces.pdf

Internal Busses

- Controller Area Network (CAN)
- Low Voltage Differential Signaling (LVDS)
- Local Interconnect Network (LIN)
- Media Oriented Systems Transport (MOST)
- FlexRay
- CAN FD
- Automotive Ethernet

Internal Interfaces

- Software, OSes
- Sensor interfaces
- Hardware interfaces

External Interfaces

- Bluetooth
- Cellular
- Wi-Fi
- Zigbee
- Radios (terrestrial, satellite, RFID, DSRC)

Recent Academic Research (~2017-2022)

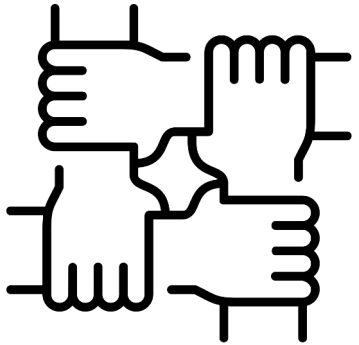
Institution	Professor	Topic	Link to Additional Information
U. Alabama	Mizanur Rahman	CRII: SaTC: Cyber Resilient Localization and Navigation for Autonomous Vehicles (NSF Grant #2104999)	https://eng.ua.edu/eng-directory/dr-mizanur-mizan-rahman/
U. Buffalo	Ziming Zhao	Hardware-assisted, system, and software security security; AutoSec workshop	https://zzm7000.github.io/
UC Berkeley	David Wagner	Computer security, systems security, and program analysis for security; AutoSec 2021 paper	https://people.eecs.berkeley.edu/~daw/
UC Colorado Springs	Gedare Bloom	Automotive cybersecurity	https://gedare.github.io/research.html
Colorado State	Jeremy Daily	Heavy truck forensics, CyberTruck and CyberAuto challenges	https://www.engr.colostate.edu/se/jeremy-daily/
Colorado State	Indrakshi Ray	GOALI: Detecting and Reconstructing Network Anomalies and Intrusions in Heavy Duty Vehicles (NSF Grant # 1715458)	https://rayscyberlab.org/home/projects/heavy-vehicle-security/
Ohio State	Qadeer Ahmed	Model-based intrusion detection	https://car.osu.edu/facilities/cybersecuritycar-lab
UC Irvine	Qi (Alfred) Chen	AI stack in autonomous driving and in multi-sensor fusion; AutoSec workshop	https://www.ics.uci.edu/~alfchen/
U. Michigan	Hafiz Malik	Linking2Source: Security of In-Vehicle Networks via Source Identification (NSF Grant #2035770)	http://www-personal.umd.umich.edu/~hafiz/;
U. Michigan	Kang Shin	S2CAN, LibreCAN	https://web.eecs.umich.edu/~kgshin/
U. Michigan	Z. Morley Mao	Trajectory prediction and drivable space detection; works with Mcity	https://web.eecs.umich.edu/~zmao/
U. Texas Dallas	Chung Hwan Kim	Cybersecurity and safety of autonomous vehicles	https://chungkim.gitlab.io/
U. Wisconsin-Madison	Xiaojin (Jerry) Zhu	ML, esp. machine teaching and adversarial sequential decision making; AutoSec 2021 paper	https://pages.cs.wisc.edu/~jerryzhu/
VATech	Wenjing Lou	S2GUARD: systems (real-time) security, in-vehicle network security, super-resolution sensing, safety enforcement (NSF Grant #1837519)	https://www.cnsr.ictas.vt.edu/WJLou.html

Need for High Quality Automotive Datasets

- High quality, real-life vehicle network datasets are needed by researchers who are advancing the state of the art in automotive and related systems
- Such datasets tend to be ad hoc, hard to obtain, and have limited utility, which prevents (or slows) the research community from growing the discipline

Need for Community Infrastructure

- Community infrastructure is needed to transform the ad-hoc, small-group endeavors for vehicle data curation into a scientific body of work done by a larger synergistic community



PIVOT Five Pillars

Platform: Robust and reliable hardware and software upon which the system runs

Data: Curation and sharing of data and contextual information

Tools: Common software-based tools to collect, transform, combine, filter, and visualize the data

Services: Researcher-centric services for sharing, securing, and evaluating datasets, plus privacy services

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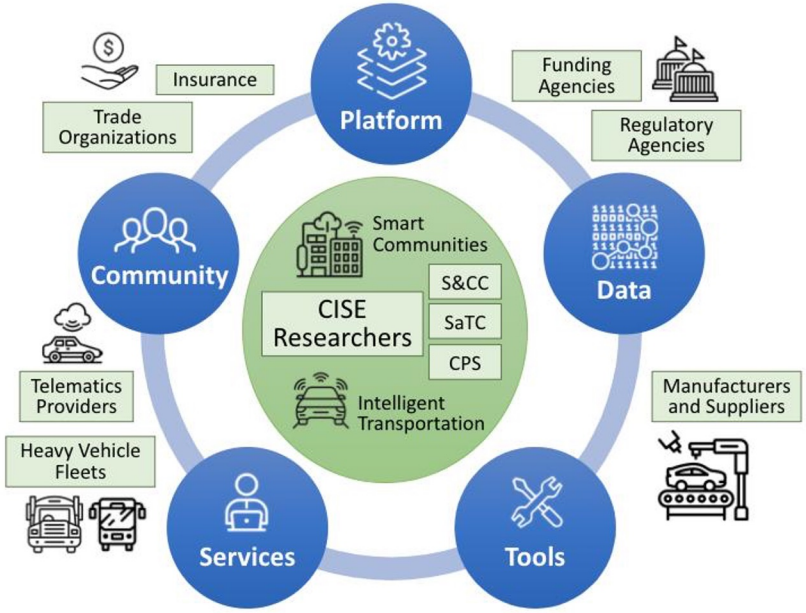
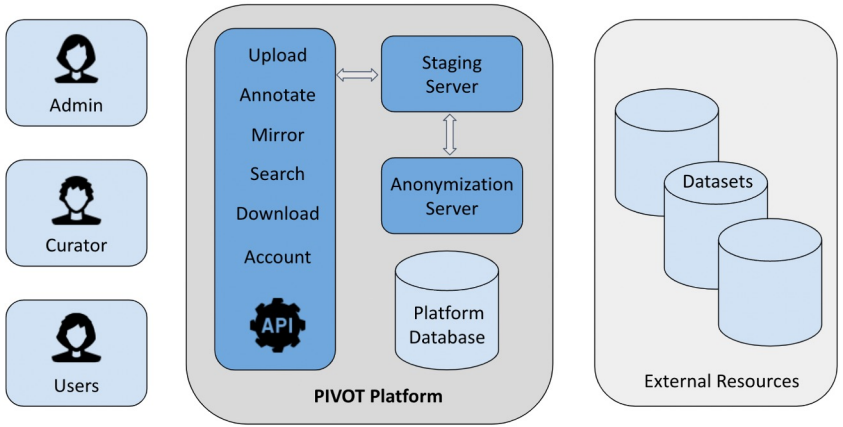


PIVOT Platform

Scalable, interactive platform to provide user services and access to data and tools

- The platform will host a web server, database, and microservices
- Robust security including firewall
- Hosted at Memphis
- Mirrored at partner institutions (e.g., Colorado State) for backup, redundancy, and seamless recovery



PIVOT Datasets

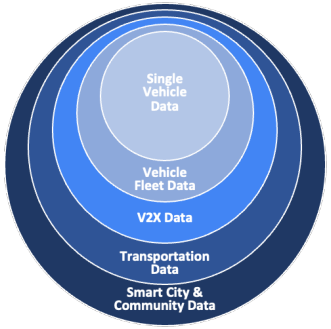
Community Datasets

Produced by others

Not widely known

PIVOT acts as clearinghouse

E.g., ORNL ROAD, HCRL datasets, Bosch SynCAN, CSU heavy truck datasets



Geotab Telematics Devices and Fleet Data

Spindle: Small "fleet" for collecting high-fidelity telematics data for PIVOT researchers

Altitude: Geotab global telematics network and analytics platform

GEOTAB

management by measurement

PIVOT CAN Loggers

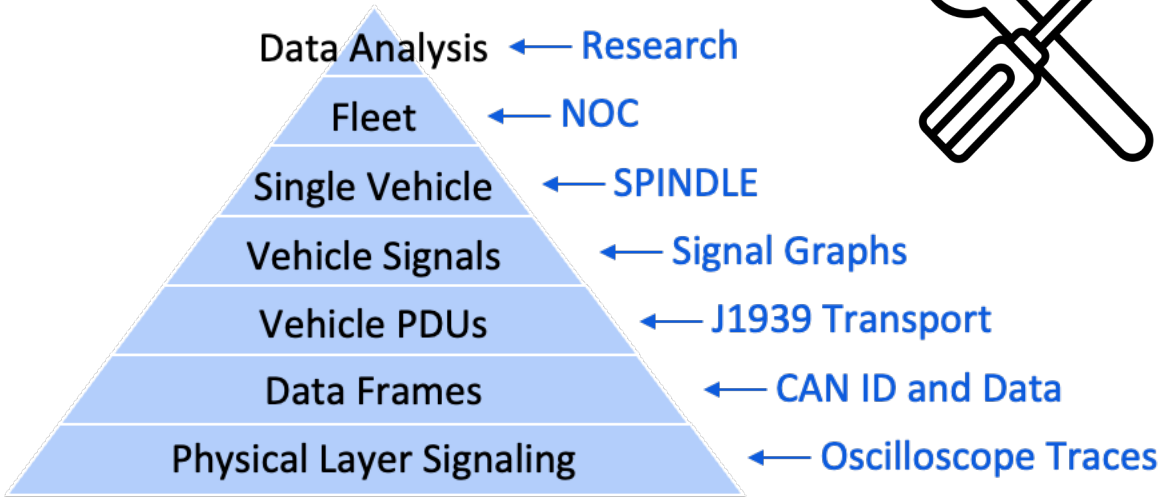
Collect and store crowdsourced datasets from passenger cars and heavy trucks

Based on CSU's CAN Logger 3

CAN Logger 3, rev 3e

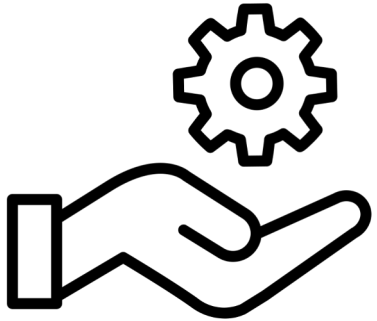
PIVOT Tools

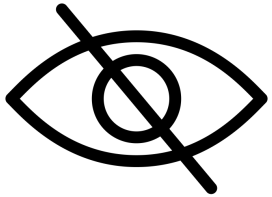
- CAN log format converters
- Convert raw CAN into protocol data units
- Data decoding
- CAN data log slicing and filtering
- Others TBD based on community needs



PIVOT Services

- Access to datasets and tools
  - Links to community datasets and tools
  - Access to and/or mirroring of PIVOT Spindle datasets
  - Access to Geotab datasets and analytical tools
  - Collection, storage, and mirroring of PIVOT crowdsourced CAN logger datasets
  - Access to PIVOT tools
- Privacy support services and tools
  - E.g., using anonymization or privacy-enhanced technologies
- Internal Review Board (IRB) support





PIVOT Community Engagement

Community engagement and outreach activities to raise awareness, encourage contributions and use, elicit input and requirements from the broader community

- Publications
- Technical review articles
- Webinars
- Website content
- Social media
- Conferences and workshops
- PIVOT community workshops
- CyberAuto & CyberTruck challenges

https://www.pivot-auto.org/

PIVOT Annual Community Workshops

Bring together the community around development and sharing of robust automotive and heavy-duty datasets to support open research in areas with strong societal impact

- **November 2021:** focus on datasets and applications
  - Brought together close to 70 people from academia, industry, and govt
  - Materials: https://bit.ly/auto-datasets-2021wkshp
  - Report: https://bit.ly/auto-datasets-2021wkshp-report

- **November 2022:** focus on CAN loggers and data privacy / access
  - Similar number of people and organizations
  - Materials: https://bit.ly/auto-datasets-2022wkshp
  - Report: forthcoming

- **February 2024:** focus on beyond CAN

PIVOT Educational Opportunities

- U. Memphis and Colorado State U. students are directly supporting PIVOT
- PIVOT will provide artifacts and resources to educate the next generation of automotive cyber engineers
  - Classes in computer science and engineering (networking, security, machine learning, digital forensics) as well as classes in transportation and smart and connected communities
- PIVOT will emphasize diversity through efforts targeting minority institutions and underrepresented groups
- PIVOT will engage and promote students from CyberTruck, CyberAuto, CyberBoat, and CyberTractor Challenges

PIVOT Benefits

- Help coordinate existing isolated efforts
- Provide new crowdsourced CAN datasets
- Facilitate exchange of knowledge and resources
- Encourage, nurture, and sustain ongoing conversations
- Stimulate pre-competitive research collaborations
- Provide resources to educate the next generation of automotive cyber engineers
- Engage industry, including OEMs, suppliers, and other important partners
- Engage relevant standards bodies and applicable government organizations

IMPACT: Create robust ecosystem that works to develop and share community resources, including automotive research datasets and tools

➔ Enable researchers to address important problems, define high-quality research initiatives, and develop new, innovative applications

PIVOT Team and Contact

Christos Papadopoulos
Professor of Computer Science, University of Memphis

Spiros Thanasoulas
Research Associate, University of Memphis

Jeremy Daily
Associate Professor of Systems Engineering, Colorado State University

David Balenson
Assoc Director, NCD, USC Information Sciences Institute

Wes Hardaker
Sr Computer Scientist, USC Information Sciences Institute

Glenn Atkinson
Vice President, Product Safety Geotab, Inc.

Ted Guild
Connectivity Standards Lead, Geotab, Inc.

For more information or to participate in PIVOT, please contact us!

Email: info@pivot-auto.org Web: https://www.pivot-auto.org/