

Lightning Talk: PIVOT: An Open Community Platform for
Sharing Vehicle Telematics Data for Research and
Innovation

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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
- Currently, for passenger cars and heavy vehicles, such datasets are ad hoc, hard to obtain, and have limited utility, which prevents (or slows) the research community from growing the discipline

Need for PIVOT Infrastructure

- The PIVOT 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

Potential Applications of Automotive Datasets

- **Vehicle:** System monitoring and optimization, in-vehicle infotainment, predictive maintenance, route and trip planning, etc.; ADAS, CAVs, EVs, heavy trucks, etc.
- **Transportation and fleet management:** passenger safety, traffic management, ride sharing, multi-modal mobility, data-driven insurance
- **Smart cities:** infrastructure monitoring and mgmt, weather sensing and mapping, asset mgmt, etc.
- **Safety and cybersecurity:** CAN bus anomaly detection, sensor security, AI and MSF, etc.

The PIVOT Project

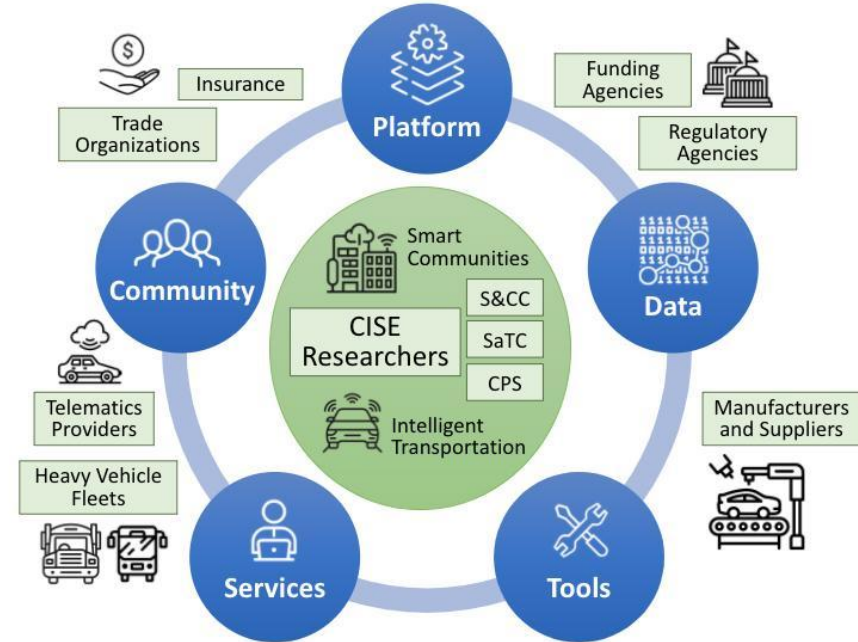
- Joint effort among:
 - University of Memphis (Christos Papadopoulos),
 - Colorado State University (Jeremy Daily),
 - USC Information Sciences Institute (David Balenson and Wes Hardaker), and
 - commercial telematics provider Geotab (Glenn Atkinson and Ted Guild)
- Three-year project, Oct 2022 - Sept 2025
- \$1.81M grant
- Supporting the CISE automotive and heavy duty vehicle research community



**CISE RESEARCH
COMMUNITY**

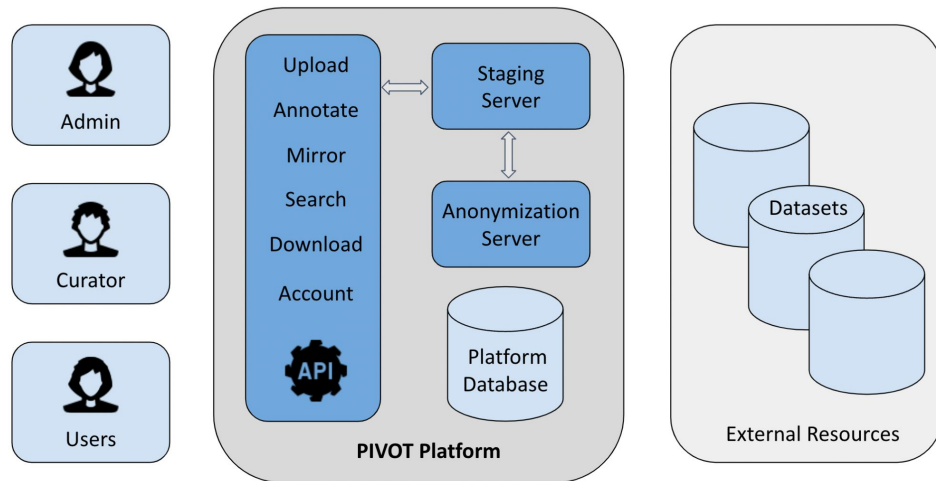
The PIVOT Five Pillars

- (1) Robust and reliable hardware/software platform upon which the system runs
- (2) Collection, curation and sharing of the data and contextual information
- (3) Researcher-centric services for sharing, securing, and evaluating datasets
- (4) Common software-based tools to collect, transform, combine, filter, and visualize the data
- (5) Extensive community outreach and engagement to improve the data utility using design feedback mechanisms



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



Services

- Access to datasets and tools
 - Links to community datasets and tools
 - Access to and/or mirroring of Geotab datasets and analytical tools
 - Access to and/or mirroring of PIVOT Spindle datasets
 - Collection, storage, and/or mirroring of PIVOT crowdsourced CAN logger datasets
 - Access to PIVOT tools
- Privacy support services and tools
- Institutional Review Board (IRB) support
- Community coordination and interaction

Datasets - Three Broad Categories

(1) Community datasets

- HCRL CAN and other datasets
- ORNL ROAD and future datasets
- Bosch and other CAN datasets
- Etc.

(2) Geotab telematics devices and fleet data

- Geotab telematics fleet data
- PIVOT Spindle high-fidelity telematics data for PIVOT researchers

(3) PIVOT CAN loggers

- Passenger cars
- Heavy trucks

(1) Community Datasets

- Produced by other researchers and/or laboratories
- Supports prior / ongoing research
- Available for use by others, but may not be widely known

PIVOT acts as a portal to increase awareness, make connections

- Examples
 - ORNL ROAD and potential future datasets
 - U. Korea / HCRL datasets
 - Heavy Truck Datasets from Jeremy Daily @ CSU
 - Bosch SynCAN (for CANet)
 - TU Eindhoven Lab Automotive CAN Bus Intrusion
 - CrySiS Lab CAN-Log Infector and Ambient CAN Traces
 - Cephas Baretto Dataset

(2) Geotab Telematics Fleet Data

- Geotab Altitude data
 - High-level, aggregated telematics data
 - From over 2.5M cars and trucks around the globe
 - Uses Geotab's GO9 telematics device and cloud services
- Two main Datasets
 - **Intersections** - characterize and improve intersection traffic flow
 - **Roads** - improve citywide transportation safety and mobility with individual and multi road analysis



(2) High-Fidelity Telematics Data

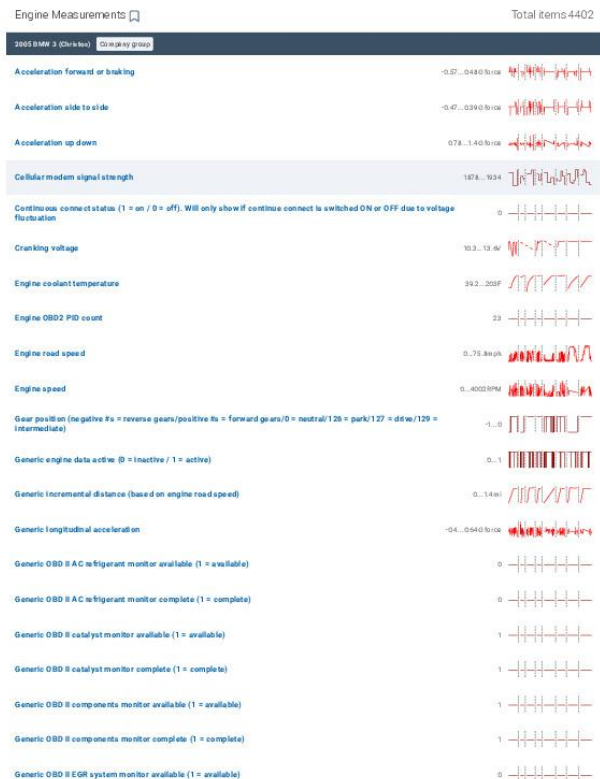
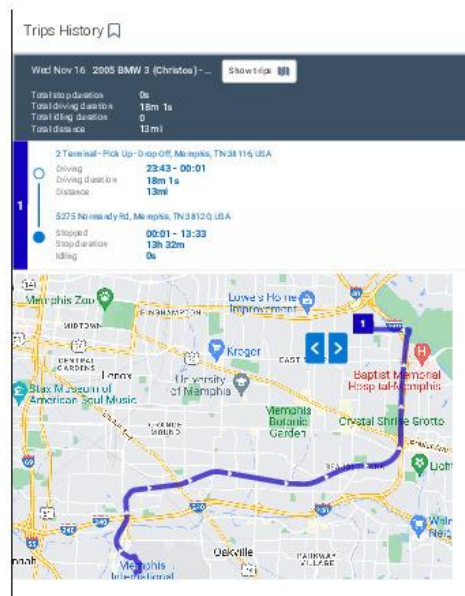
- PIVOT Spindle Program
 - Small “fleet” of PIVOT researchers w/ GO9 device installed in their vehicles
 - Agreed to contribute their data and make it available to other PIVOT Spindle researchers
 - Raw data accessible via Geotab SDK in .NET
 - Good example of data collected by commercial telematics devices
- PIVOT admins control the data
 - Intention is to provide data with as much detail as possible
 - Various levels of anonymization and user vetting possible
- Currently about 12 vehicles and growing!
 - Includes one EV and one heavy truck



GEOTAB
management by measurement

PIVOT Spindle Examples

- Trip maps
- Engine measurements
- Engine faults
- Fuel consumption
- Idling time
- Emissions report
- Speed reports
- Charging activity for EVs
- Much more!



(3) PIVOT CAN Loggers

Currently in progress for passenger cars and heavy trucks

Current Plan:

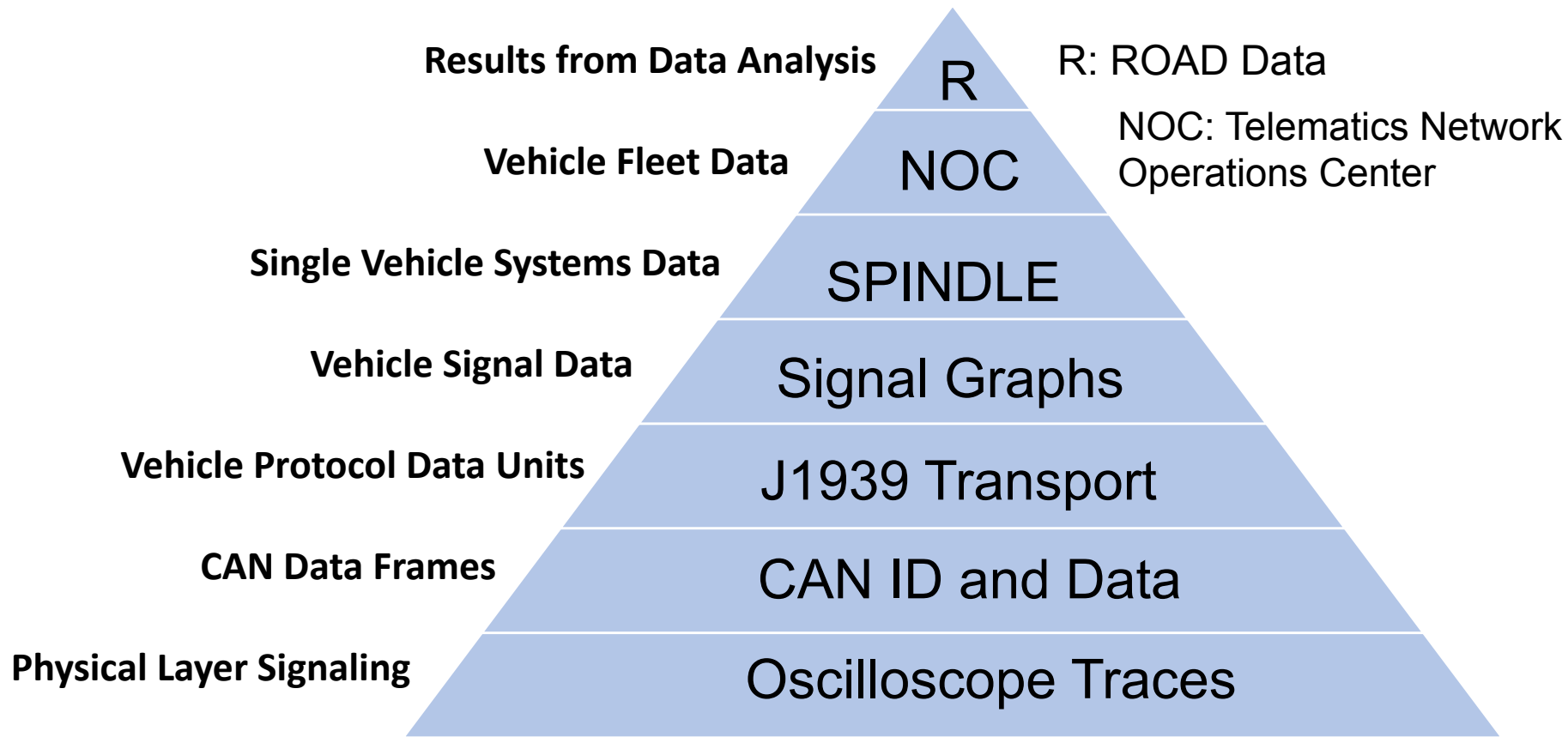
- Raspberry Pi or Arduino-based devices
- Open source software
- Distributed to volunteers
- Collect data, return to PIVOT
- Privacy controls
- 50-100 devices
- Deployment cycles and strategies (geography, make/model of vehicle, etc.)



CAN Logger 3, rev 3e

By Duy, Secure CAN Logging and Data Analysis,
Colorado State University, Fall 2020.
<https://www.engr.colostate.edu/~jdaily/J1939%2FSecureCANLoggingPresentationDuyVan.pdf>

Types and Examples of Collected CAN Data



Community Outreach and Engagement

Community engagement and outreach activities to raise awareness, share initial plans, encourage contributions and use, elicit input and requirements from the broader community are a critical element of any NSF CCRI and of PIVOT

- Publications
- Technical Review Articles
- Webinars
- Website
- Social media such as Twitter
- Conferences and workshops
- Hands-on Events
- PIVOT Community Workshops
- CyberAuto & CyberTruck Challenge Events

Engaging a diverse community, including activities targeting faculty, researchers, and students at minority institutions and from underrepresented groups is also important!

Benefits of PIVOT

- Help coordinate existing isolated efforts
- Facilitate exchange of knowledge and resources
- Encourage, nurture, and sustain ongoing conversations
- Stimulate research collaborations among users and producers of datasets
- Engage industry, including OEMs, suppliers, and other important partners
- Engage relevant standards bodies and applicable government organizations

Community Impact

- Create robust ecosystem that works to develop, share, and exploit community resources, including automotive research datasets and tools
- Enable research community to address important problems, define high quality research initiatives, and develop new, innovative applications to benefit society

Benefits to AGL Community and NSF Researchers

Benefits to AGL Community

- Introduce AGL in the academic automotive research community
- Help adoption of AGL and explore new AGL use cases
- Gain new code contributors
- Gain access to PIVOT platform resources and access to the advisory board
- Use PIVOT as an outlet to solicit and distribute new automotive datasets
- Gain quick access to publications from PIVOT researchers
- Get notifications for workshops, webinars, meetings, and other outreach events organized by PIVOT

Benefits to NSF Researchers

- Better understanding and appreciation of the AGL ecosystem
- Educate researchers on the design of AGL
- Improve researcher understanding about needs and requirements that necessitate AGL
- Guidance to researchers in defining real-life problems addressed by AGL
- Code and feature support

Contact Us



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