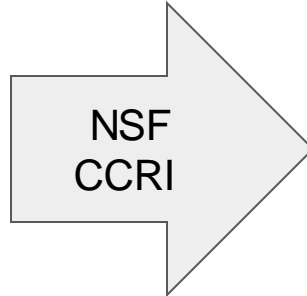




# Platform for Innovative Use of Vehicle Open Telematics

Presentation to Transport Canada's Virtual Vehicle  
Cybersecurity Conference  
Prof. Jeremy Daily, Colorado State University  
February 23, 2023

# Goal of this Talk (BLUF)



**PIVOT**

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

Provide overview of PIVOT project and how it will help educate the next generation of automotive cyber engineers; and

Talk about the related CyberAuto and CyberTruck Challenges

## Need for High Quality Automotive Datasets

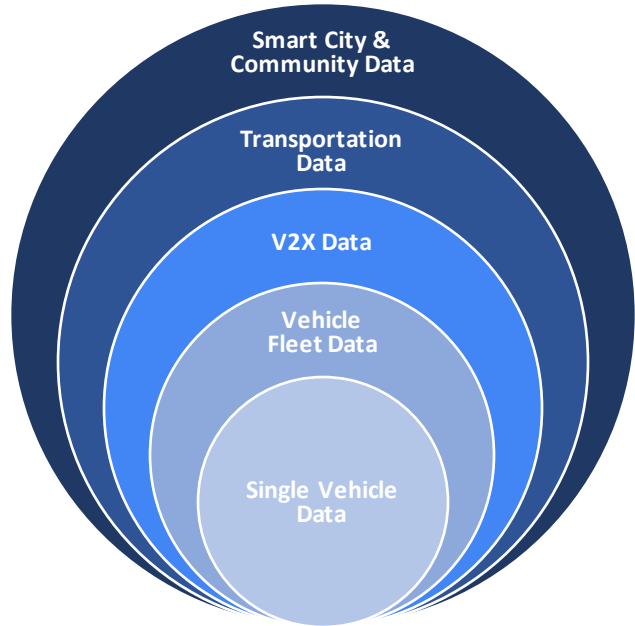
- High quality, real-life vehicle network datasets are needed by researchers who are advancing the state of the art in automotive and related systems
- Such datasets tend to be ad hoc, hard to obtain, and have limited utility, which prevents (or slows) the research community from growing the discipline

## 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



# Examples of Automotive Research Datasets



- Oak Ridge National Laboratory ROAD dataset
- Korea University HCRL Datasets
- Bosch SynCAN (for CANet)
- TU Eindhoven Lab Automotive CAN Bus Intrusion
- Heavy Truck Datasets from Jeremy Daily @ CSU
- Geotab telematics data and Altitude analytics platform
- US Department of Transportation Public Data Portal
- SmartColumbus Datasets Curated for Visualization
- Wyoming DOT CV Pilot

# Potential Applications of Automotive Datasets

- **Vehicles:** System monitoring and optimization, in-vehicle infotainment, predictive maintenance, route and trip planning, 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.
- **U.S. National Science Foundation research communities**



## Fleet Management Applications (from Geotab)

- **Productivity:** driver tracking, asset management and tracking, routing and dispatching, fleet management reports
- **Optimization:** keyless entry, fleet fuel management, fleet maintenance, fleet benchmarking
- **Safety:** driver safety reporting, driver coaching, dash cams
- **Sustainability:** EV fleet management, EV suitability assessment, EV battery degradation tool, temperature tool for EV range
- **Compliance:** DOT compliance (ELD), compliance management - Driver Vehicle Inspection Report (DVIR), International Fuel Tax Agreement (IFTA)
- **Expandability:** software integration, hardware integration



**GEOTAB**  
management by measurement

# The PIVOT Project

- Part of NSF's Computer and Information Science and Engineering (CISE) Community Research Infrastructure (CCRI) program
- Collaborative effort among:
  - University of Memphis
  - Colorado State University
  - USC Information Sciences Institute
  - Commercial telematics provider Geotab
- \$1.81M National Science Foundation grant
- Three-year project, from Oct 2022 to Sep 2025



# PIVOT Five Pillars

- (1) Robust and reliable hardware/software platform upon which the system runs
- (2) 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 Datasets

## (1) Community datasets

- ORNL ROAD and future datasets
- HCRL CAN and other 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

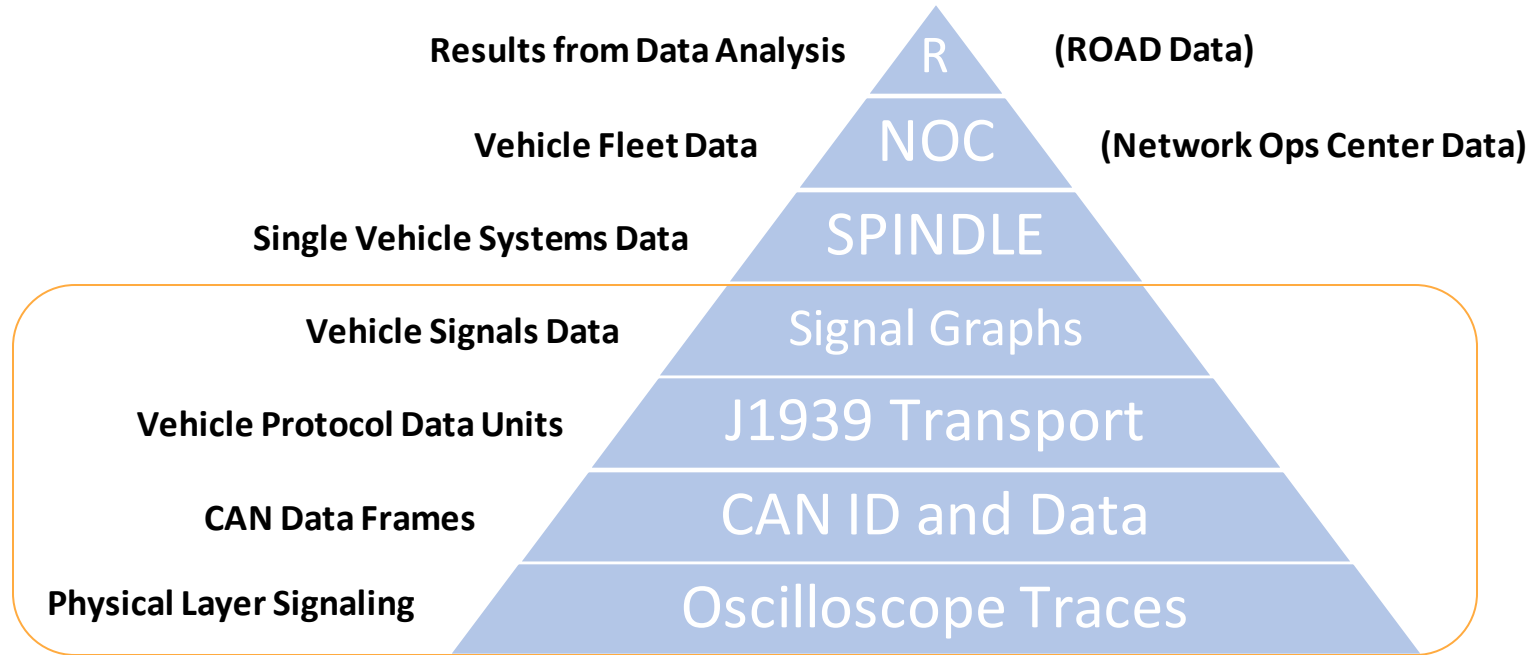
- Passenger cars
- Heavy trucks



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 of CAN Data

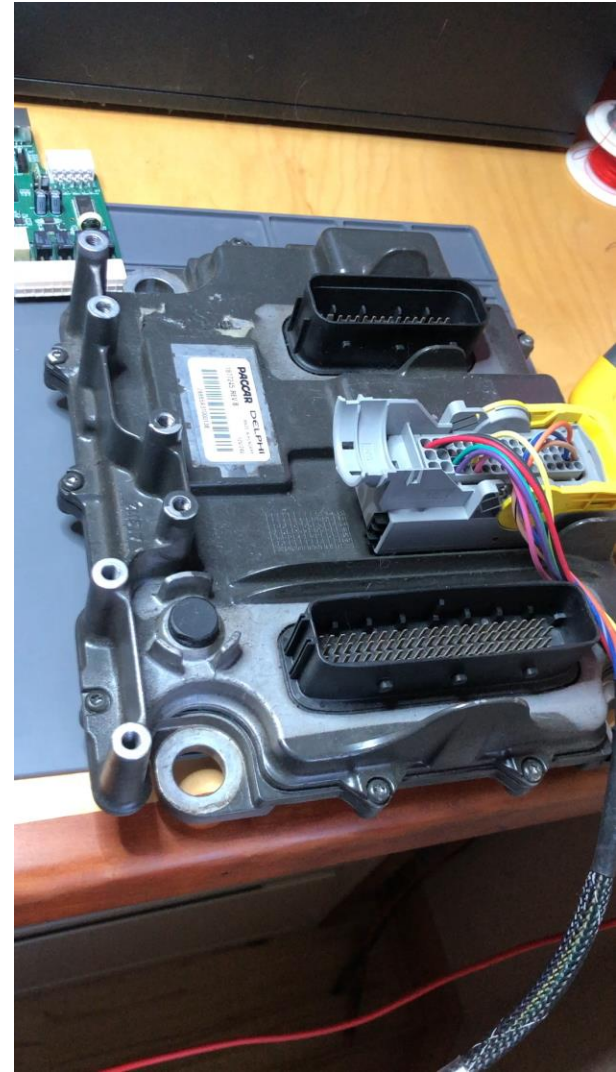


**We need tools to work with all these different layers**

# CAN Signaling: Measurement Example

- PACCAR MX Engine Control Module (ECM)
- Synercon Technologies Smart Sensor Simulator
  - Completes the CAN network circuit
  - Provides connectivity for the ECM
- DG Technologies J1939 Breakout Box
- Raspberry Pi with a CAN-FD Hat
  - Runs embedded Linux with SocketCAN
  - Records CAN traffic using `can-utils candump` command
- Fluke Scope Meter as an Oscilloscope
  - Measures voltage traces between CAN High and CAN Low
- Saleae Logic Probe
  - Analog Voltage measurements (duplicating the oscilloscope)
  - Digital measurements from the CAN Transceiver
  - CAN signal decoding features
  - PC application interface

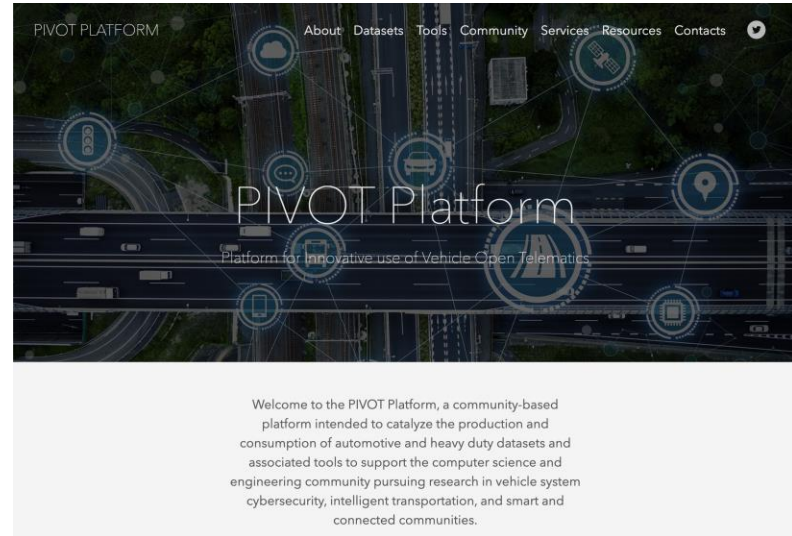
What is on the wire? Let's monitor the yellow CAN-H and green CAN-L lines.



# PIVOT Community

Community engagement and outreach activities to raise awareness, share initial plans, 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
- Cyber Challenge events



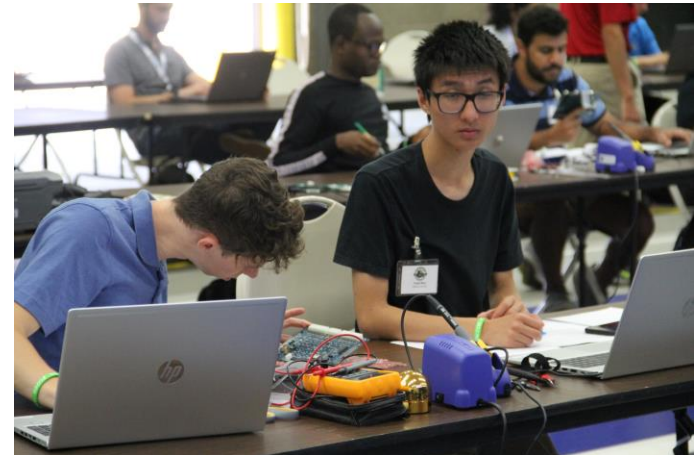
<https://www.pivot-auto.org/>

# 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 workshop – focus on datasets and applications
  - Brought together close to 70 people from academia, industry, and government
  - Materials: <https://bit.ly/auto-datasets-2021wkshp>
  - Report: <https://bit.ly/auto-datasets-2021wkshp-report>
- November 2022 workshop – focus on CAN loggers and data privacy / access
  - Similar number of people and organizations
  - Materials: <https://bit.ly/auto-datasets-2022wkshp>
  - Report: forthcoming

# 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 the Cyber Challenges





## Mission Statement

*Develop talent for the next generation workforce by bringing awareness, excitement, professional involvement, and practicum-based training to the heavy vehicle cybersecurity domain.*

*Establish community of interest for heavy vehicle cybersecurity that transcends individual companies or departments and reaches across disciplines and organizations to make a more universal and experienced base of engineers and managers.*

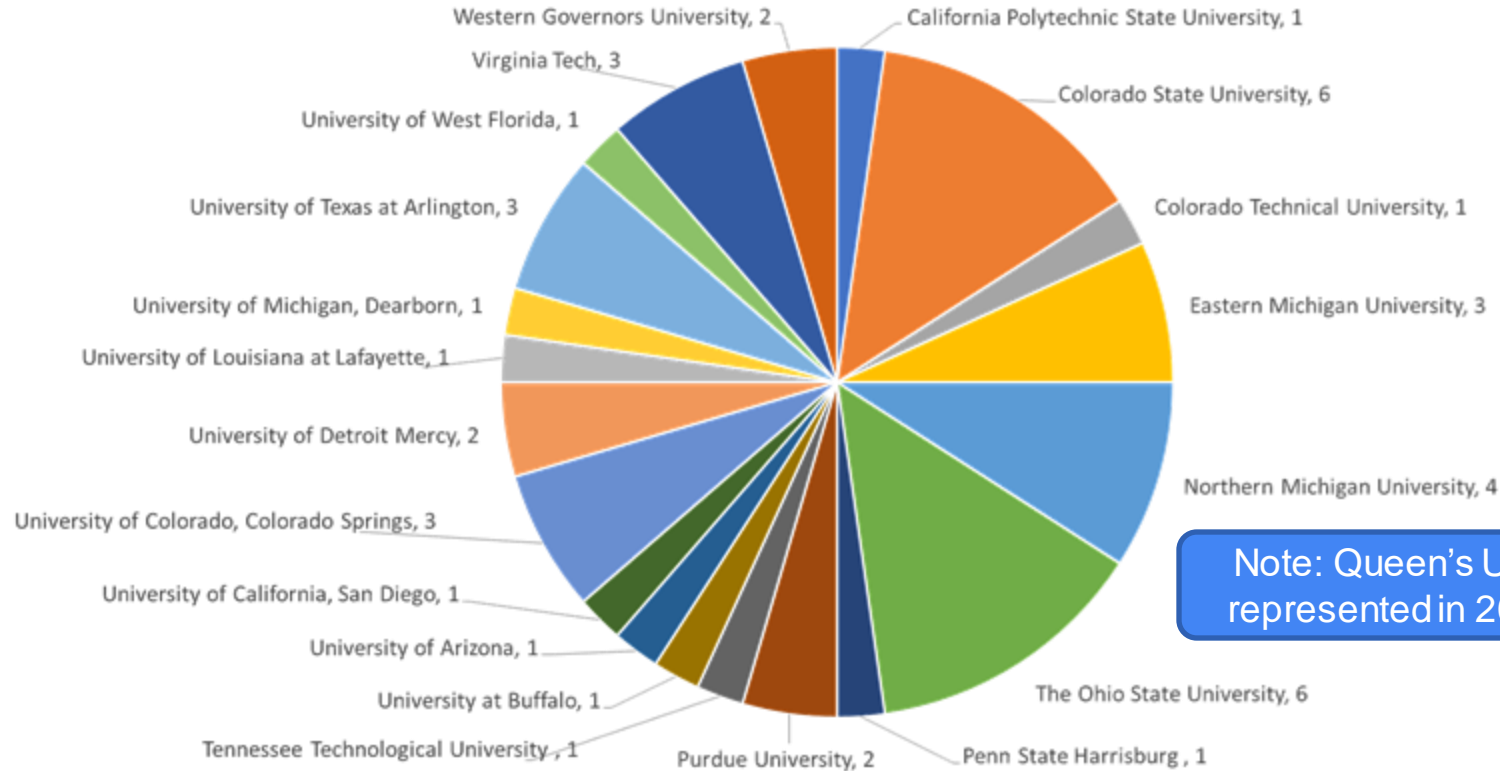
# Class of 2022



Photo taken on June 22, 2022 in the Sports and Expo Center of Macomb Community College, Warren, Michigan



# 2022 Student and University Participation: 44 students from 20 universities

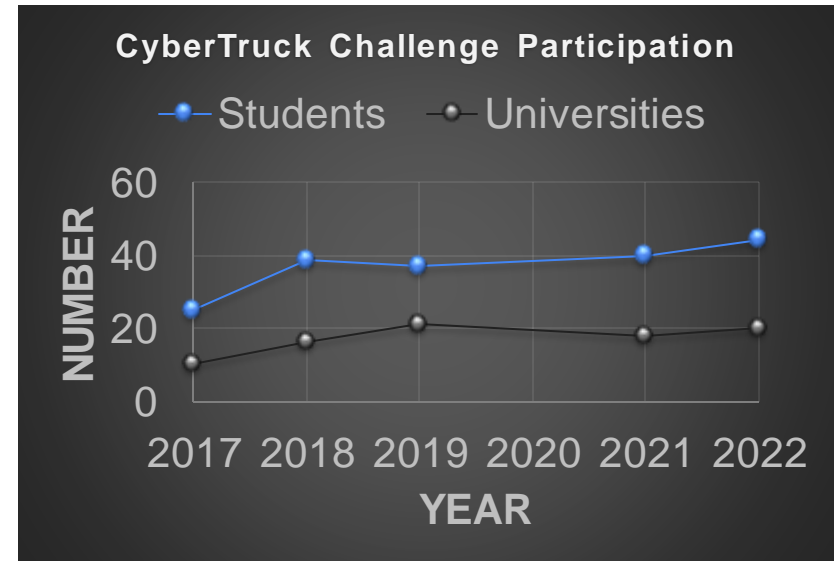


Note: Queen's University was represented in 2019 and 2021

# Student Participation Growth Over 5 Years



Year	Students	Universities
2017	25	10
2018	39	16
2019	37	21
2021	40	18
2022	44	20



Thank you to the CyberTruck Challenge sponsors



Premier Sponsor



**KEYSIGHT**  
TECHNOLOGIES

**GEO TAB**  
management by measurement

Platinum  
Sponsors

Gold Sponsors

DAIMLER

PACCAR



BOSCH



U.S. Department of Transportation  
Federal Motor Carrier Safety Administration



SYSTEMS ENGINEERING  
COLORADO STATE UNIVERSITY

Silver  
Sponsors



# Description of Activities



## Real Vehicles

*Sponsors bring new vehicles as assessment targets. Company engineers work with students and mentors.*



## Real Hackers

*Experienced mentors from professional security firms help coach students through exercises and security related assessments.*



## Real Fun!

*Students have a unique opportunity to solve challenging problems, learn from experts and experience engineering in the heavy-duty industry.*

# CyberTruck Challenge 2022 Schedule

Version:20220619

	Sunday, 19 June	Monday, 20 June	Tuesday, 21 June	Wednesday, 22 June	Thursday, 23 June	Friday, 24 June	Time																			
		Group A	Group B	Group A	Group B																					
Before 0700	Site Closed	Site Closed						Before 0700																		
0700-0730		Breakfast					Breakfast	0700-0730																		
0730-0800							Student Team Briefs (30 minutes each group)	0730-0800																		
0800-0830		Welcome // NDA		Vehicle Network Security	<i>Ghidra</i>	Legal Briefing		Assessment	0800-0830																	
0830-0900		Safety and Orientation				<i>Cryptography</i>			Vehicle Network Security	Assessment	0830-0900															
0900-0930		<i>Software RE</i>	Truck Systems and J1939	Assessment	Assessment						0900-0930															
0930-1000						Site Closed			Site Closed		Assessment	Assessment	0930-1000													
1000-1030		Site Closed	Site Closed										Assessment	Assessment	1000-1030											
1030-1100															Site Closed	Site Closed	Assessment	Assessment	1030-1100							
1100-1130							Site Closed												Site Closed	Assessment	Assessment	1100-1130				
1130-1200								Site Closed														Site Closed	Assessment	Assessment	1130-1200	
1200-1230										Site Closed															Site Closed	Assessment
1230-1300				Site Closed	Site Closed																					
1300-1330						Site Closed			Site Closed		Assessment	Assessment														
1330-1400		Site Closed	Site Closed										Assessment	Assessment												
1400-1430															Site Closed	Site Closed	Assessment	Assessment								
1430-1500							Site Closed												Site Closed	Assessment	Assessment					
1500-1530								Site Closed														Site Closed	Assessment	Assessment		
1530-1600										Site Closed															Site Closed	Assessment
1600-1630	Site Closed			Site Closed	Assessment																					
1630-1700						Site Closed			Site Closed		Assessment	Assessment														
1700-1730		Site Closed	Site Closed										Assessment	Assessment												
1730-1800															Site Closed	Site Closed	Assessment	Assessment								
1800-1830							Site Closed												Site Closed	Assessment	Assessment					
1830-1900								Site Closed														Site Closed	Assessment	Assessment		
1900-1930										Site Closed															Site Closed	Assessment
1930-2000	Site Closed			Site Closed	Assessment																					
2000-2030						Site Closed			Site Closed		Assessment	Assessment														
2030-2100		Site Closed	Site Closed										Assessment	Assessment												
2100-2130															Site Closed	Site Closed	Assessment	Assessment								
2130-2200							Site Closed												Site Closed	Assessment	Assessment					
After 2200								Site Closed														Site Closed	Assessment	Assessment		

Snacks will be served each afternoon.

\*Survey

\*Survey

Legend	Topic	Instructor, Affiliation	Verified
Lecture / Demo	All participants		Yes
Volvo Side	Interactive lecture and activities	Karl Heimer [MEDC] & Sponsor Representatives	Yes
Cummins Side	Interactive lecture and activities	Ang Cui, Edward Larson [Red Balloon Security]	Yes
Meals	Meals will be catered on-site	Justin "Ozzie" Osborn [JHU-APL]	Yes
"Hacking"	On vehicle assessments	Erin Cornelius [GRIMM]	Yes
Free	Can hack, study, rest, leave, etc.	Jeremy Daily [Colorado State University]	Yes
Site Closed	No access the facility	Eduardo Novella [Now Secure]	Yes
Off Site	Limelight Grill on VanDyke Ave	Ben Gardiner [NMFTA]	Yes
		Hannah Silva [Leviathan Security]	Yes
		Urban Jonson [Serjon]	Yes

# Truck Systems and SAE J1939

By Jeremy Daily  
 Associate Professor of Systems  
 Engineering at Colorado State



**SYSTEMS ENGINEERING**  
 COLORADO STATE UNIVERSITY





# Software Reverse Engineering

By Erin Cornelius  
Senior Security Researcher



# Trucking Industry

By Urban Jonson  
SVP Information Technology and  
Cybersecurity



# Cryptography

By Ben Gardiner  
 Researcher, National Motor Freight  
 Traffic Association, Inc.



# Heavy Vehicle Network Security

By Hannah Silva  
Security Researcher



# Using the Ghidra Decompiler

By Justin “Ozzie” Osborne  
Security Researcher



JOHNS HOPKINS  
APPLIED PHYSICS LABORATORY



# Android Security

By Eduardo Novella  
Mobile Security Researcher



NowSecure™



# Patching Embedded Systems

By Wyatt Ford and Andrés Hernández  
Software Engineers at Red Balloon  
Security



**Red Balloon  
Security**



# Assessment Period: Applying Hands-on Lecture Content





# Assessment Period: Students Explore with Mentors



# Student Presentations

- Results from the assessment are presented to the other participants
- This is a **CLOSED** event; only participants who have agreed to the non-disclosure agreement can attend
- Student reports are not archived or available to be released
- Results from the assessment are communicated to the equipment engineers



# Industry Perspective of CyberTruck

Students learned

Students had fun



# Typical Assessment Team & Project



# CyberTruck Challenge Industry Perspective

Action items, redacted



- 1 [Redacted]
- 2 [Redacted]
- 3 [Redacted]
- 4 [Redacted]
- 5 [Redacted]
- 6 [Redacted]
- 7 [Redacted]
- 8 [Redacted]
- 9 [Redacted]
- 10 [Redacted]
- 11 [Redacted]
- 12 [Redacted]

Students learned...  
Students had fun ...  
Industry left with action items

# Why Participate?



Workforce Development



Demonstrate high-tech nature of commercial vehicles



Attract top students to the industry



Improve Current Workforce



Continuous Product Improvement

# Save the Date

CyberTruck Challenge 2023  
June 12 – 16, 2023  
Macomb Community College  
Warren, Michigan

[www.cybertruckchallenge.org](http://www.cybertruckchallenge.org)

# Additional Cyber Challenge Events

- CyberBoat Challenge 2022
  - First-time offering in Houghton, MI
  - 14 students from five universities
  - Next event: Fall 2023
  
- CyberAuto Challenge 2022
  - 32 of students from US, UK, and Germany
  - Sponsored by Ford, GM, and Toyota
  - Next event: 24-28 July 2023
  
- CyberTractor 2022
  - First-time offering in Des Moines, IA
  - Sponsored by John Deere
  - Next Event: 26-30 June 2023



<https://www.deere.com/en/stories/featured/seeking-the-next-generation-of-cyber-security-talent/>



# 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
- Provide artifacts and 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

# 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

# Contact Us



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University of Memphis



[Jeremy Daily](#)  
Associate Professor of  
Systems Engineering  
Colorado State University



[David Balenson](#)  
Sr Computer Scientist  
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](mailto:info@pivot-auto.org)

Web: <https://www.pivot-auto.org/>

Twitter: [@PIVOT\\_Auto](https://twitter.com/PIVOT_Auto)