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

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Goal of this Talk (BLUF)

NSF CCRI

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

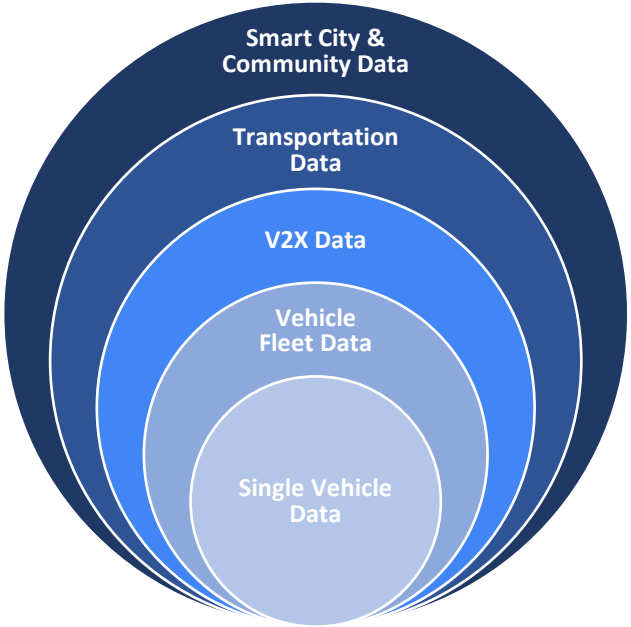
- High quality, real-life vehicle network datasets are needed by researchers who are advancing the state of the art in automotive and related systems

- 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

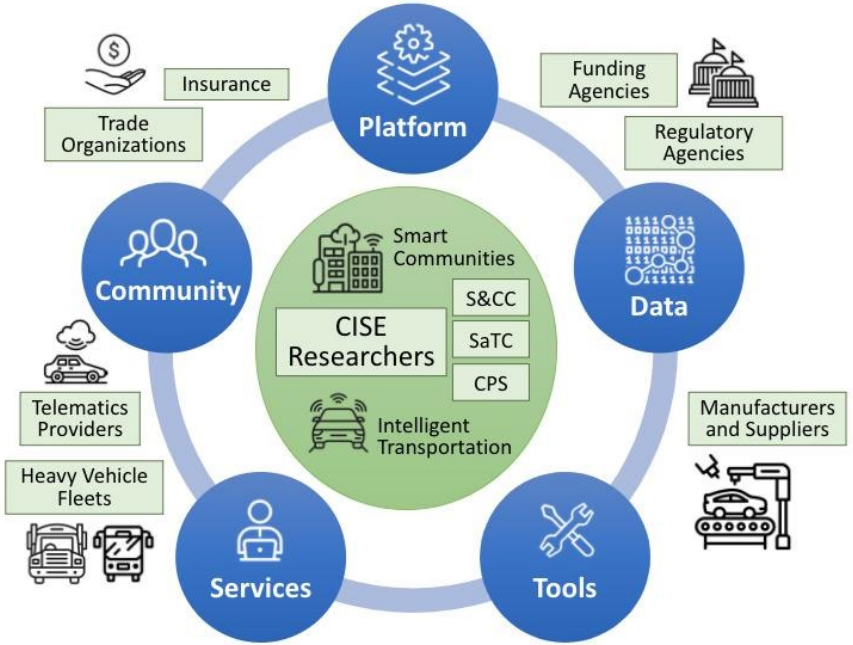
(1) Robust and reliable hardware/software platform upon which the system runs

(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

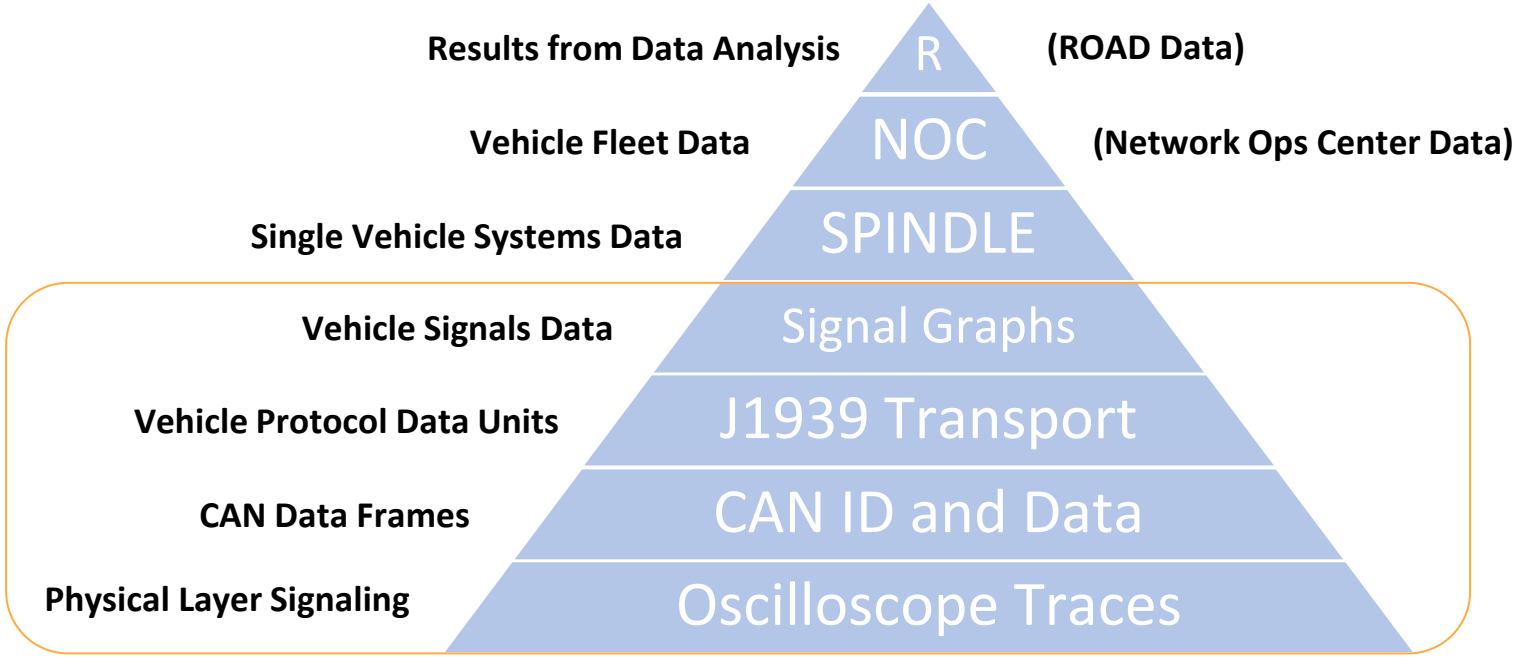
(3) PIVOT CAN loggers

- 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

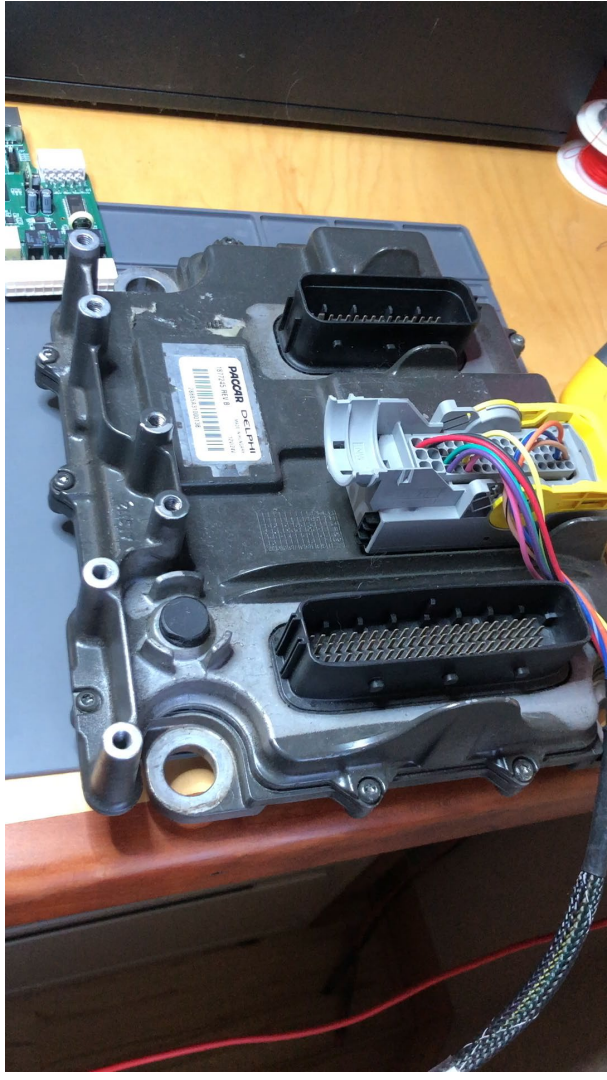


We need tools to work with all these different layers

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

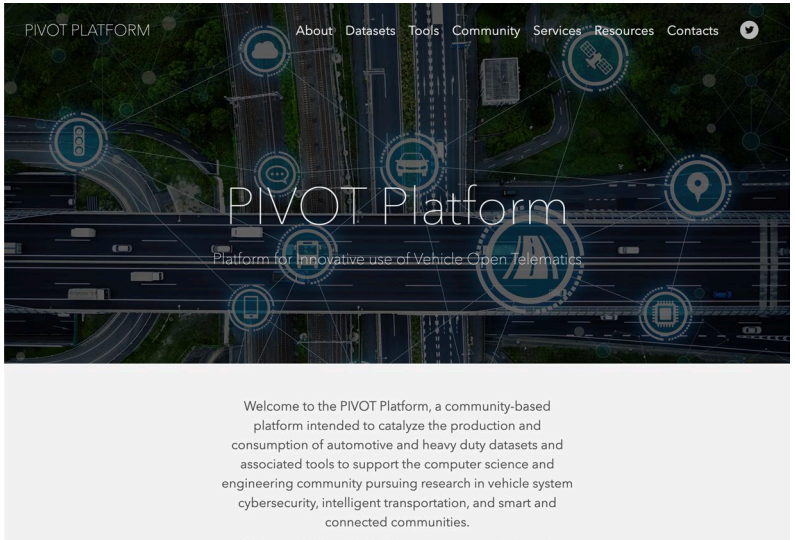
What is on the wire? Let's monitor the yellow CAN-H and green CAN-L lines.



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



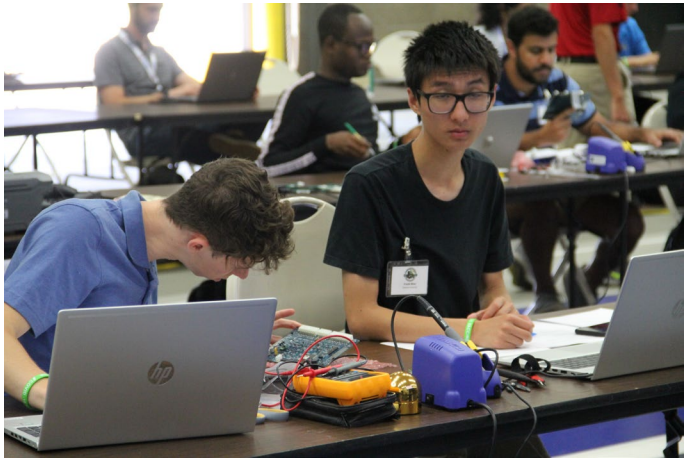
https://www.pivot-auto.org/

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

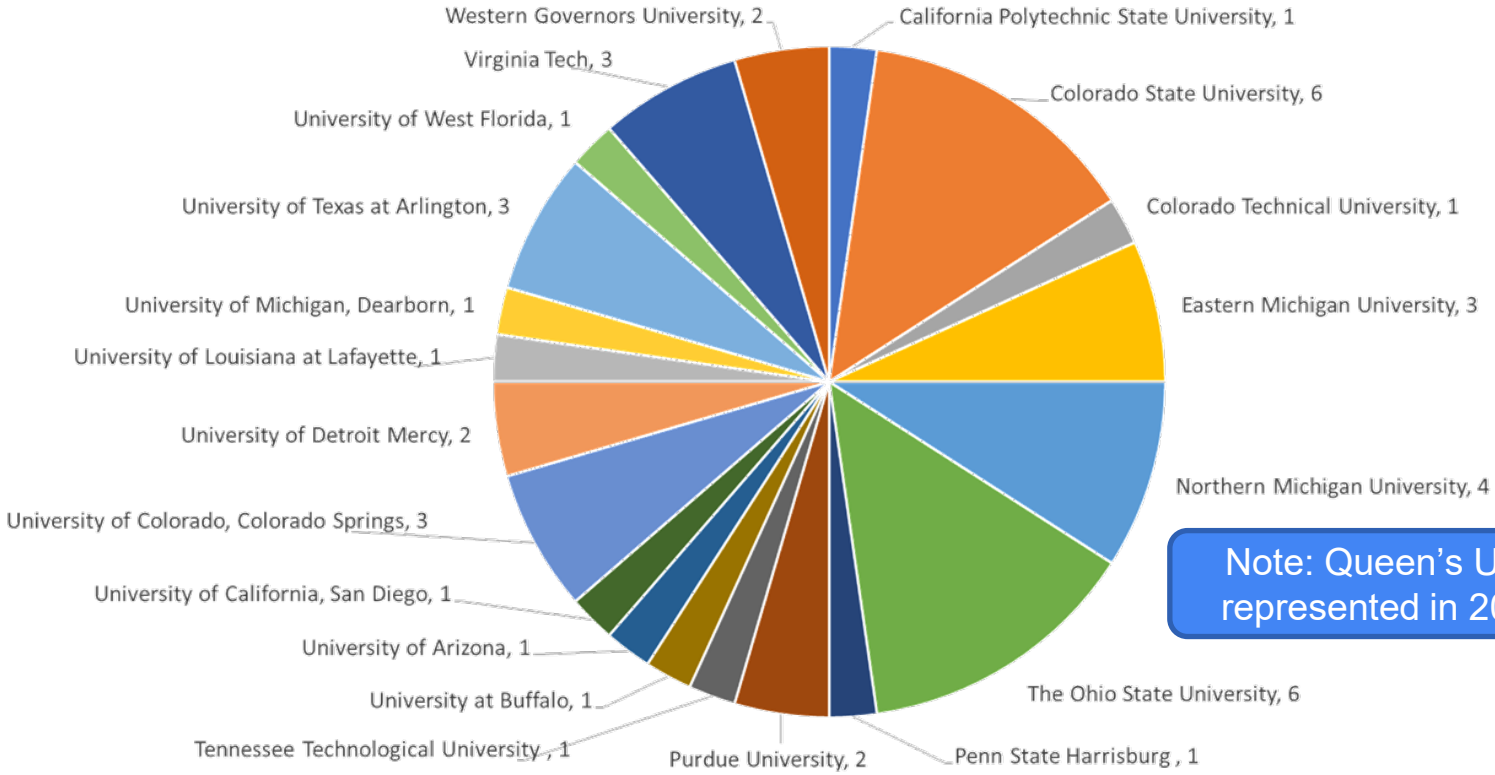
Develop talent *for the next generation workforce by bringing awareness, excitement, professional involvement, and practicum-based training to the heavy vehicle cybersecurity domain.*

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

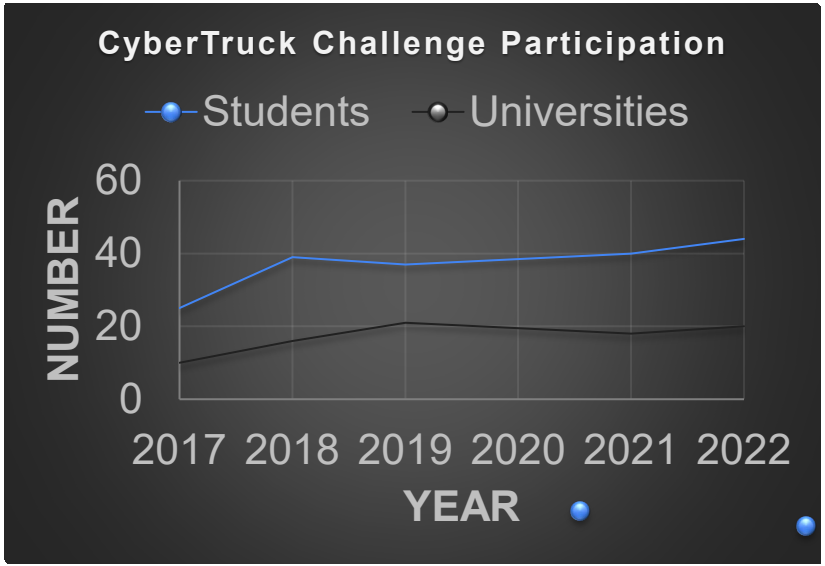
2022 Student and University Participation: 44 students from 20 universities



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

U.S. Department of Transportation

Federal Motor Carrier Safety Administration

SYSTEMS ENGINEERING

COLORADO STATE UNIVERSITY


Munich RE


NAVISTAR


BATTELLE
It can be done


Macomb
Community College
Education • Enrichment • Economic Development
Discover. Connect. Advance.


Bendix


DG TECHNOLOGIES
Vehicle Network Solutions


AUTO-ISAC
Automotive Information Sharing and Analysis Center


UNIVERSITY OF
DETROIT MERCY
COLLEGE OF ENGINEERING & SCIENCE


ais


CALSTART

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	***Ghidra***	Legal Briefing	Assessment		0800-0830
0830-0900		Safey and Orientation				Assessment			0830-0900
0900-0930		***Software RE***	Truck Systems and J1939						0900-0930
0930-1000									0930-1000
1000-1030				***Cryptography***	Vehicle Network Security				1000-1030
1030-1100									1030-1100
1100-1130									1100-1130
1130-1200								Awards	1130-1200
1200-1230		Lunch						Lunch	1200-1230
1230-1300									1230-1300
1300-1330		Truck Systems and J1939	***Software RE***	***Android***	Embedded Firmware Patching	Assessment	Assessment	Site Closed	1300-1330
1330-1400									1330-1400
1400-1430									1400-1430
1430-1500									1430-1500
1500-1530									1500-1530
1530-1600									1530-1600
1600-1630		***Trucking Industry***	Cryptography	Embedded Firmware Patching	***Android***				1600-1630
1630-1700									1630-1700
1700-1730		***Ghidra***							1700-1730
1730-1800									1730-1800
1800-1830	Informal Welcome Reception (offsite)		Trucking Industry						1800-1830
1830-1900									1830-1900
1900-1930		Dinner							1900-1930
1930-2000									1930-2000
2000-2030		Introduction to Learning Platforms		**Assessment Preparation**		Assessment	Free		2000-2030
2030-2100									2030-2100
2100-2130	Site Closed	Free		Free					2100-2130
2130-2200									2130-2200
After 2200		Site Closed							After 2200

Snacks will be served each afternoon. *Survey *Survey

Legend	
Lecture / Demo	All participants
Volvo Side	Interactive lecture and activities
Cummins Side	Interactive lecture and activities
Meals	Meals will be catered on-site
"Hacking"	On vehicle assessments
Free	Can hack, study, rest, leave, etc.
Site Closed	No access the facility
Off Site	Limelight Grill on VanDyke Ave

Topic	Instructor, Affiliation	Verified
Welcome and Review	Karl Heimer [MEDC] & Sponsor Representatives	Yes
Embedded Firmware Patching	Ang Cui, Edward Larson [Red Balloon Security]	Yes
Decompilation with Ghidra	Justin "Ozzie" Osborn [JHU-APL]	Yes
Software Reverse Engineering	Erin Cornelius [GRIMM]	Yes
Truck Systems and J1939	Jeremy Daily [Colorado State University]	Yes
Android	Eduardo Novella [Now Secure]	Yes
Cryptography	Ben Gardiner [NMFTA]	Yes
Vehicle Network Security	Hannah Silva [Leviathan Security]	Yes
Trucking Industry	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

SERJON

Cryptography

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

Heavy Vehicle Network Security

By Hannah Silva
Security Researcher

leviathan security group

Using the Ghidra Decompiler

By Justin “Ozzie” Osborne
Security Researcher

Android Security

By Eduardo Novella
Mobile Security Researcher

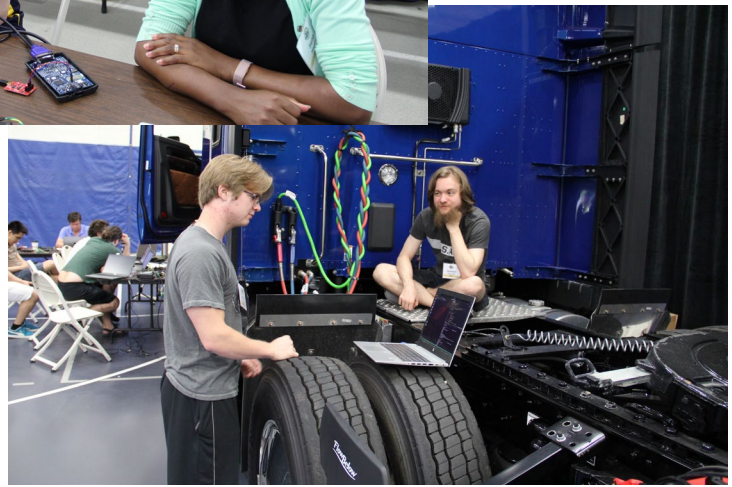
NowSecure™

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

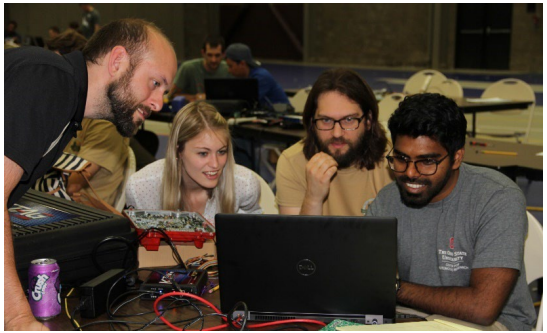
Student Presentations

- 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

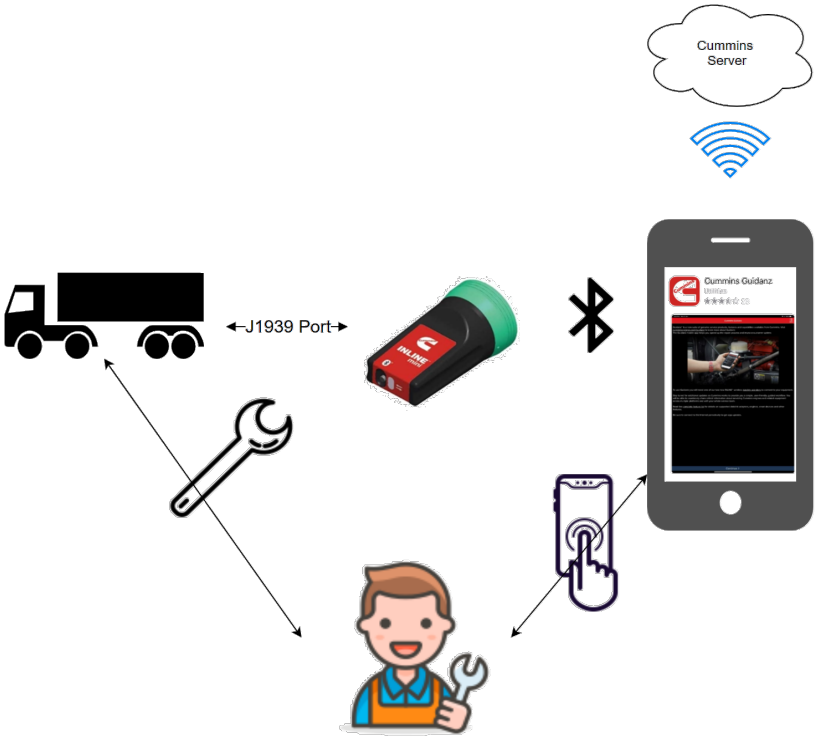
Industry Perspective of CyberTruck

Students learned

Students had fun



Typical Assessment Team & Project



CyberTruck Challege Industry Perspective

Action items, redacted

1. [redacted]
2. [redacted]
3. [redacted]
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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

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

Christos Papadopoulos
Professor of
Computer Science
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 Web: https://www.pivot-auto.org/ Twitter: @PIVOT_Auto