SYSTEMS ENGINEERING
COLORADO STATE UNIVERSITY

Student CyberTruck Experience Manual

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Learning Outcomes and Program Mission

To develop the talent necessary to improve the cybersecurity posture of the heavy vehicle.

Assessments

Assessments are formative hands-on exercises where students

1 Introduction to Trucking

1.1 Objectives

What is the trucking industry?

What is a truck?

Who makes trucks

1.2 Assessments

2 Overview of Heavy Vehicles

Weight Classes

3 Building Hardware

The purpose of this chapter is to give students skills necessary to work with modern electronics and build their own hardware tools.

3.1 Recommended Hardware Kit

Each student should have access to the parts in the basic kit. These items are minimum to successfully accomplish the programming and learning exercises.

3.1.1 Basic Kit

Qty	Label	Description	Supplier	Supplier Part Number
1	A	Teensy 4.0 Development Board	PJRC	TEENSY40_PINS[1]
2	B	MPC2562 CAN Transceiver	Digi-Key	MCP2562FD-E/P-ND[2]
1	C	Solderless Breadboard	Digi-Key	BKGS-830-ND[3]
5	D	120 Ohm Axial Resistors	Digi-Key	
1	E	Wiz850IO Ethernet Expansion Board	Digi-Key	1278-1043-ND[4]
1	F	Pack of breadboard wires	Sparkfun	PRT-12795[5]
1	G	Ethernet Cat6 Cable, 3 ft.	Sparkfun	CAB-08915[6]
1	H	USB micro Cable, 6 inch	Sparkfun	CAB-13244[7]
1	K	ATECC608A Crypto Authentication Module	Digi-Key	ATECC608A-SSHDA-TCT-ND[8]
1	L	ATECC608 Crypto Co-Processor Breakout	Sparkfun	SPX-15838[9]
1	M	Trimpot 10K Ohm with Knob	Sparkfun	COM-09806[10]
1	N	SOIC8 to DIP Converter Board	Sparkfun	BOB-13655[11]
1	P	Break Away Headers - Straight	Sparkfun	PRT-00116[12]
1	Q	One-Wire Ambient Temperature Sensor - MAX31820	Sparkfun	SEN-14049[13]
1	R	Conductive Organizer		

Table 3.1.1: Basic Hardware Kit

Qty	Description	Supplier	Supplier Part Number	URL
1	Teensy 4.1	PJRC	TEENSY41	[14]
1	Beagle Bone Black			
1	Quadrature Encoder with breakout board. Bournes PEC09			

Table 3.2.1: Advanced Hardware Kit

Newer laptop computers may not have a physical Ethernet port, so a USB to Ethernet adapter may be necessary.

3.1.2 Basic Tools

Multimeter Any modern digital multimeter is acceptable to get started. There are many on Amazon that are suitable.

Soldering Iron A

Tweezers

Wire Cutters

Wire Strippers

Exercise 3.1. Write a program to send CAN messages from one node to another.

Hints:

1. Check the continuity of each hookup wire before using it. They can be fragile and break easily.

3.2 Advanced Hardware Kits

[1] https://www.pjrc.com/store/teensy40_pins.html
[2] https://www.digikey.com/product-detail/en/microchip-technology/MCP2562FD-E-P/MCP2562FD-E-P-ND/4842807
[3] https://www.digikey.com/products/en?keywords=BKGS-830-ND
[4] https://www.digikey.com/products/en?keywords=Wiz%20850
[5] https://www.sparkfun.com/products/12795
[6] https://www.sparkfun.com/products/8915
[7] https://www.sparkfun.com/products/13244
[8] https://www.digikey.com/products/en?keywords=ATECC608A-SSHDA-TCT-ND
[9] https://www.sparkfun.com/products/15838
[10] https://www.sparkfun.com/products/9806
[11] https://www.sparkfun.com/products/13655
[12] https://www.sparkfun.com/products/116
[13] https://www.sparkfun.com/products/14049
[14] https://www.pjrc.com/store/teensy41.html
[15] https://www.pjrc.com/store/teensy41.html

Qty	Description	Supplier	Supplier Part Number	URL
1	Smart Sensor Simulator 2	DG Technologies	TEENSY41	[15]
1	Beagle Bone Black			
1	Quadrature Encoder with breakout board. Bournes PEC09			

Table 3.2.2: Vehicle ECU Testing Kit

4 Networking Fundamentals

4.1 Problems of Networking

4.1.1 Encoding

4.1.2 Framing

4.1.3 Data Transmission

Link Access

Media Access Control

Collision Avoidance

4.1.4 Flow Control

4.1.5 Routing

switching

4.1.6 Reliable Delivery

4.1.7 Fault Tolerance

error detection

error correction - Hamming Codes

4.2 OSI Layered Model

4.3 Ethernet

4.3.1 TCP/IP

4.3.2 UDP

4.3.3 Automotive Ethernet

4.4 Wireless Protocols

4.4.1 Wifi

Krack

4.4.2 Cellular

4.4.3 Bluetooth

Blueman

Blueborne

4.4.4 Zigbee

4.4.5 Iridium Satelite

4.4.6 Other Communications

4.5 In-vehicle Networking

4.5.1 Contoller Area Networks

4.5.2 J1708 Serial Communications

Figure 4.5.1: Title

5 Truck Systems for Computer Scientists

6 Computer Programming for Engineers

7 Initial Heavy Vehicle Serial Protocols

8 High speed communication with SAE J1939 and CAN Bus

Exercise 8.1. CAN Frame Decoding

Capture a CAN Frame using an oscilloscpope on a J1939 network and decode it according to SAE J1939.

9 Princples of Cybersecurity

10 Introduction to Cryptography

11 Message Authentication

12 Encryption on CAN

13 Heavy Vehicle Digital Forensics