

TrafficCast BlueTOAD Spectra RSU System Evaluation Process Guidelines

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Acronyms and Abbreviations

Term	Meaning
AGL	Above Ground Level
AWS	Amazon Web Services
BlueARGUS	Web-based software to monitor BlueTOAD detectors
BlueTOAD	Bluetooth® Travel time Origin And Destination
BSM	Basic Safety Message—every 0.10 second, a connected vehicle (CV) broadcasts its vehicle type, speed, location, direction and approach relative to an intersection.
CAT-5 Cable	Category 5 cable, a twisted pair cable for computer networks. The cable standard provides performance of up to 100 MHz and is suitable for 1000BASE-T (Gigabit Ethernet). This is also called an “Ethernet Cable” or a “LAN Cable.”
CV / CAV	Connected Vehicle / Connected and Autonomous Vehicles
DIAM	DENSO International America, Inc.
Discoverable/ Non- Discoverable	Discoverable = Bluetooth device searching to Pair with another Bluetooth device Non-Discoverable = Two Paired Bluetooth devices
DNS UDP	Domain Name System—a hierarchical and decentralized naming system for resources connected to the Internet or a private network. User Datagram Protocol—an alternative comm protocol to TCP
DSRC	Dedicated Short Range Communications
Egress	Going out of (leaving) an intersection
EIRP	Effective Isotropic Radiated Power
EMAC	Ethernet Media Access Controller
FCC	Federal Communications Commission
GPS	Global Positioning System
HTML	Hypertext Markup Language
Ingress	Going into (entering) an intersection
IoT	Internet of Things
IP address	Internet Protocol address—host or network interface identification and location addressing
ITS	Intelligent Transportation System
LAN/WAN	Local Area Network/Wide Area Network
LED	Light Emitting Diode
MAP	Map Data Message—intersection geography and line definitions of the intersection or street. An RSU transmits one MAP message per second to OBUs.
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
NTCIP Support	ITS Standard NTCIP 1202 Object Definitions used for communication with Actuated Traffic Signal Controller (ASC) Units
NTP	Network Time Protocol
OBU	Onboard Unit
O/D	Origin/Destination
Omni- Directional	Receiving signals from or transmitting in all directions
PCB	Printed Circuit Board

PoE	Power over Ethernet
PuTTY	SSH Client terminal program for Microsoft Windows
RJ-45 Port	Registered Jack (RJ) is a standardized telecommunication network interface
RSU	Road Side Unit
RTCM	Radio Technical Commission for Maritime services. In the United States, the Federal Communications Commission uses RTCM standards to specify Differential GPS systems for DSRC.
SCMS	Security Certificate Management System—developed by a consortium of automakers and the United States Department of Transportation (USDOT) as a leading candidate for a vehicle-to-vehicle (V2V) security system in the United States.
SNMP	Simple Network Management Protocol—used to monitor and manage devices on networks. Typically, SNMP uses User Datagram Protocol (UDP) transport layer (layer 4) as its transport protocol.
SPaT	Signal Phase and Timing
SRM	Signal Request Message
SSH Client	A software program that uses the Secure Shell protocol to connect to a remote computer.
SYSLOG	A way for network devices to send event messages to a logging server, known as a Syslog server
TCP	Transmission Control Protocol
TIM	Traveler Information Message—delivered to Connected Vehicles and TravelSMART Mobile App —a personal message board about local conditions
TMC	Traffic Management Center
UPER	Unaligned Packed Encoding Rules
URL	Uniform Resource Locator
Users	Authorized access through secure login to a software application
Win SCP	File transfer application

System Evaluation Overview

This Evaluation Procedure is to address the requirement for minimum required evaluation and operations tests for the TrafficCast BlueTOAD Spectra RSU.

It is assumed that the BlueTOAD Spectra RSU under test has already gone through factory acceptance inspections and demonstrated full compliance with all project requirements and works “out of the box”, by visual inspection, setup and operation "on the bench", functional testing of the component including manufacturer’s recommended startup diagnostics and testing prior to any field installation of equipment or material.

This Evaluation Procedure will focus on SPaT, MAP, TIM and BSM Data Broadcasting verification which were not covered in initial product configuration and inspections. This Evaluation Procedure will confirm that the BlueTOAD Spectra RSU complies with USDOT Dedicated Short Range Communications (DSRC) standards, based on Society of Automotive Engineers SAE J2735 March 2016 standards-based message exchange between Roadside Units (RSU) and vehicle Onboard Units (OBU).

For your convenience, we added an Evaluation Sign-Off Checklist form to this document for use as a guide for the evaluation procedure – see “Evaluation Sign-Off Checklist” section of this document.

Supporting Equipment

- Windows PC and Ethernet Cables
- BlueTOAD Spectra RSU Configuration Utility (Microsoft Windows 10 App)
- WinSCP or equivalent File Transfer Application
- PuTTY or equivalent SSH Client
- TrafficCast BlueTOAD Spectra RSU
- Traffic Controller with Power Cable or Similar ATC Controller
 - TrafficCast recommends any of the following Traffic Controllers as they are compatible with BlueTOAD Spectra RSU:
 - Econolite
 - Intelight
 - McCain
 - Siemens
 - Trafficware
- 7-Zip Archiving Utility
- Advanced IP Scanner (Optional)
- PoE Injector + Power Supply
- Shielded CAT-5 or CAT-6 Cable
- Mounting Bracket + Fasteners
- Cable Band
- Access to BlueARGUS Software

Visual Inspection

Verifying the BlueTOAD Spectra RSU is in good shape and not physically damaged.

- Check for damage to the:
- Antenna
- Ports
- LEDS
- Enclosure

BlueTOAD Spectra RSU Power Up

Before the RSU installation, confirm the following:

1. The network settings (for example, IP address, gateway, subnet mask, and DNS) are correctly set and that all ports (123, 8010, 10001) are open and set for outbound data traffic. Confirm all necessary inbound/outbound network ports have been set up.
 - a. IP Configuration Requirements
 - i. BlueTOAD Module assigned: IP Address, Subnet Mask and Gateway
 - ii. DSRC Module assigned: IP Address, Subnet Mask and Gateway
 - iii. In-Cabinet Processor assigned: IP Address, Subnet Mask and Gateway
 - b. Network Port Configuration:
 - i. Port 10001 needs to be open to 52.39.79.127 (Connected Vehicle specific data)
 - ii. Port 8010 needs to be open to btserver.trafficcast.com
 - iii. Port 123 needs to be open, only if using an external NTP server.
 - c. Required DNS entries for btserver.trafficcast.com:
 - i. 18.220.189.165
 - ii. 3.18.180.164
 - iii. 3.18.166.19
2. The IP addresses assigned to the Traffic Controller and to the RSU should be known. (**Note:** If there is a Processor (optional), it also has an IP address.).
3. Power ON (Connect Ethernet cable from RSU to PoE Injector) the RSU and confirm all LEDs are normal after the unit initializes:

TrafficCast RSU (Bottom View)



LED Indicators

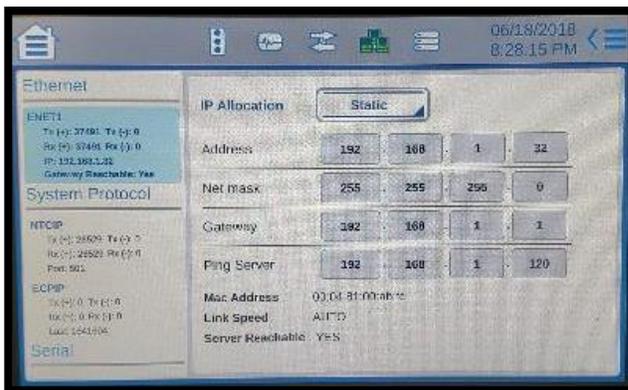
- Green – Device operational
- Amber – Device ON
- Red - Fault

How to Set Up the Traffic Controller

This example uses an Econolite **traffic controller**, model Cobalt Advanced Traffic Controller (ATC). However, you can use ATC controllers (preferred) from other manufacturers that have Ethernet and IP interfaces. Refer to the table on Page 1-2 for Compatible Traffic Controllers. Also, you can consult TrafficCast Support for models of traffic controllers supported; these include McCain (software Version 1.10.2.6705-2018-03-23), Siemens (software Version 3.59+), Trafficware (software Version 76.15N+) and Intelight (Maxtime CV).

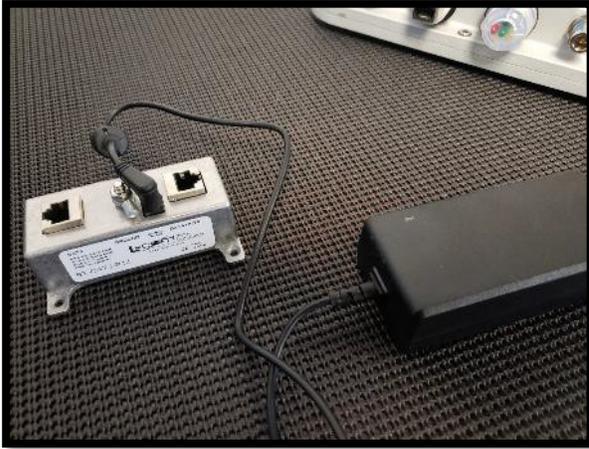


1. Attach the Traffic Controller “A” power cable to the “A” connector of the controller.
2. Plug the “A” power cable into an AC power source. The controller should power ON.
3. Using the assigned IP address of the BlueTOAD Spectra RSU, navigate to the Ethernet communications page of the controller.
4. Verify the controller IP address and Netmask. Set the Ping Server to the IP address of the RSU.

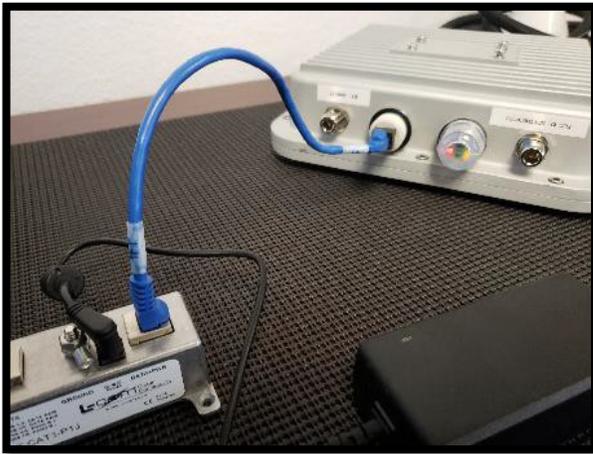


5. Plug the AC power cable of the POE injector AC adapter to an AC power source.

6. Plug the AC adapter output power cable into the POE injector. The AC adapter LED indicator should light up with power.



7. Connect the RSU to the Data+PWR port of the POE Injector with an Ethernet cable. The RSU Power LED indicator should light up with power.



8. Connect the POE Injector Data port to Port 1 of ENET-1 (WAN) of the controller with an Ethernet cable.



9. Connect the computer to Port 2 of ENET-1 (WAN) of the controller with an Ethernet cable.
10. Set the computer IP address to match the subnet of the RSU and controller.

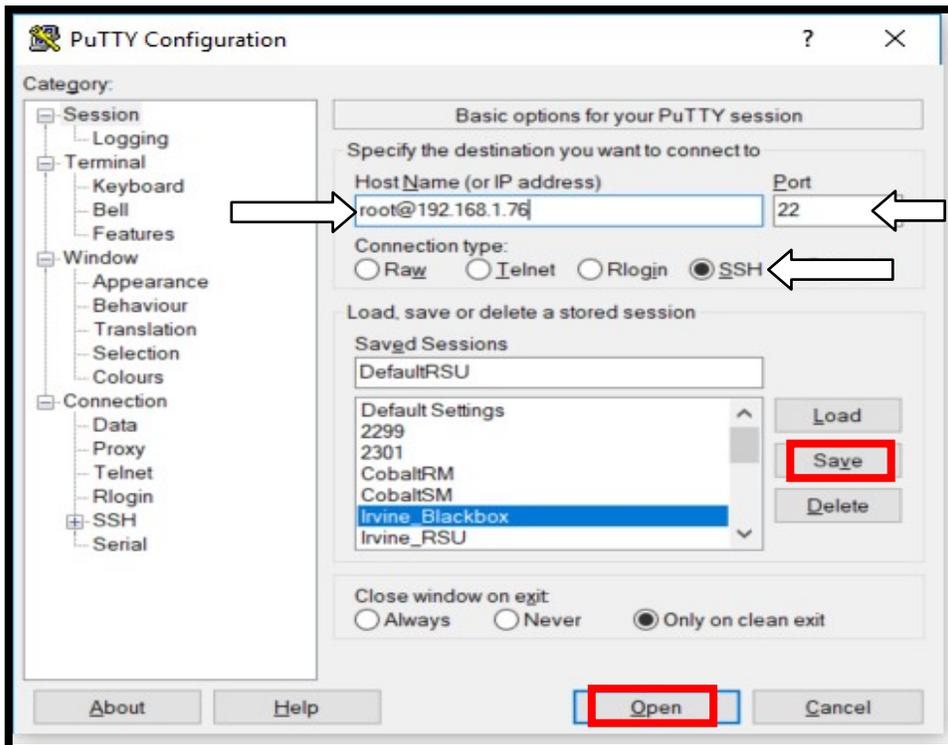


System Evaluation Procedure

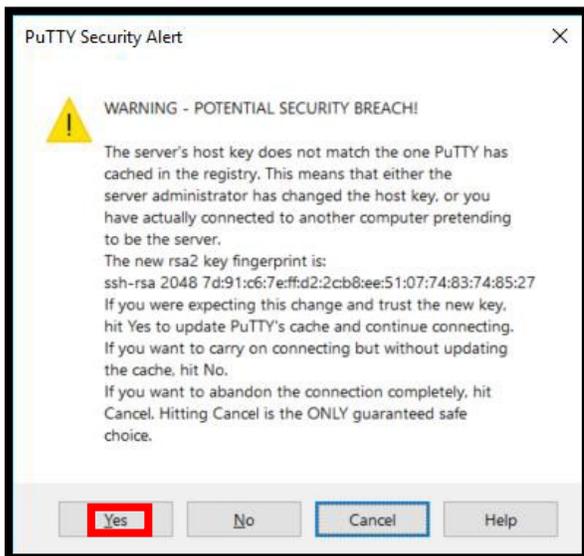
SPaT, MAP and BSM Data Broadcasting Verification

It is assumed that the BlueTOAD Spectra RSU under test has been installed in the field and already setup and configured. For TrafficCast’s Recommended Network Configuration Implementation and setup procedure refer to system documentation provided by TrafficCast.

1. Open PuTTY to start an SSH session into the RSU. Set the Host Name to root@192.168.1.76, Port to 22, Connection Type to SSH, and save the session as “DefaultRSU” for future use.



2. If prompted to accept the RSA key of the RSU click **Yes**.



3. After you connect to the RSU, verify the GPS (GNSS Fix) functionality:
 - a. Run **“tpstestapp”**
 - b. Press **Enter**

```

---Terminating syslogd
---Executing /rwflash/configs/shutdown.sh
---Terminating Radio Stack (Radio_ns)
---Terminating ssh sessions
Using username "root".
# tpstestapp
TPS Test Application. Enter 'h' for help.'
->
    
```

4. To query the GPS status:
 - a. Press **q**
 - b. Press **Enter**
5. Check that the Average Position is being reported.
 - a. Press **x**
 - b. Press **Enter**
 - c. The BASH prompt is shown.

```

# tpstestapp
TPS Test Application. Enter 'h' for help.'
-> q
->
Type: TPS_DATA_CFM
-----
valid: 1
source_msg_type: ???
fixquality: 1
fix-mode: 3
date: 190618
time: 221315.70
latitude: 33.6513093
longitude: -117.7369565
altitude: 30.50
groundspeed: 0.300
course: 0.0
hdop: 0.95
pdop: 1.62
laterr: 4.20
lonerr: 3.20
alterr: 5.10
semi-major_err: 11.00
semi-minor_err: 7.70
semi-major_orient: 17.0000
numsats: 8
diffage: 0.00
leap_seconds: 0
coming_ls_change: 0
secs_to_lschange: 0
ubx_fix_type: 0 (0=None, 1=DR, 2=2D, 3=3D, 4=GNSS+DR, 5=TimeOnly)
diff_corrections: 0

Secs Passed: 1529446395
Average Position: Lat:33.6513093, Long: -117.7369565, Alt:30.50
    
```

6. Run “mk5stats” to verify the operation of the DSRC radio:
7. Each row indicates the number of DSRC messages received and sent per second. Verify that the **output** column is sending an average of **11** messages per second. (10 SPaT messages plus 1 MAP message generated by the RSU).

```

# mk5stats
[A2]  input  output  RxFail  TxFail  CBR%  CBR%2  RxInd  TxValid
      12698  52012   453    0,    0    0    0    12698  52012
      3     10     0     0,    0    0    0    12701  52022
      3     12     0     0,    0    0    0    12704  52034
      3     11     0     0,    0    0    0    12707  52045
      2     11     0     0,    0    0    0    12709  52056
      3     11     0     0,    0    0    0    12712  52067
      2     11     0     0,    0    0    0    12714  52078
      2     11     0     0,    0    0    0    12716  52089
      3     11     0     0,    0    0    0    12719  52100
RecvFromLLC: POLL error 4 'Interrupted function call'
#
  
```

8. Press **Ctrl-C** to stop the **mk5stats** stream and return to the BASH prompt.
9. Run “i2vmonitor” to verify the decoding of the controller timing messages:

```

# i2vmonitor
  
```

10. To view the SPaT message:
 - a. Press **1**
 - b. Press **Enter**
 - c. The **Current Signal Phase** and **Time to Next Phase** fields should be counting down.

```

SPaT STATUS DISPLAY Tue Jun 26 22:35:36 GMT 2018
-----
Number of Movement States: 8
-----
Movement State ID  Current Signal Phase  Confidence  Time to Next Phase  Yellow Duration
-----
01  0x00000001           0x 1           185                30
02  0x00000004           0x 1           225                30
03  0x00000004           0x 1           725                30
04  0x00000004           0x 1           770                30
05  0x00000001           0x 1           185                30
06  0x00000004           0x 1           225                30
07  0x00000004           0x 1           725                30
08  0x00000004           0x 1           780                30
-----
NOTES:
1. Confidence is two separate nibbles - upper nibble is confidence for time to next phase; lower is for yellow duration.
   If the value is zero, the corresponding SPaT field should be ignored.
2. See J2735 spec for the list of signal phase values - basic definitions: 0x00000001 = Green; 0x00000002 = Yellow; and
   0x00000004 = Red.
-----
Options  1: Display SPaT Stats  2: Reserved  3: Reserved
         4: Reserved  9: To Exit (or Ctrl-C)
Enter the option then press "Enter"
#
  
```

11. Press **Ctrl-C** to stop the **i2vmonitor** stream.
12. When you have completed the confirmations, remove power (Ethernet cable) from the RSU.

OBU DSRC Message Verification Instructions

Objective

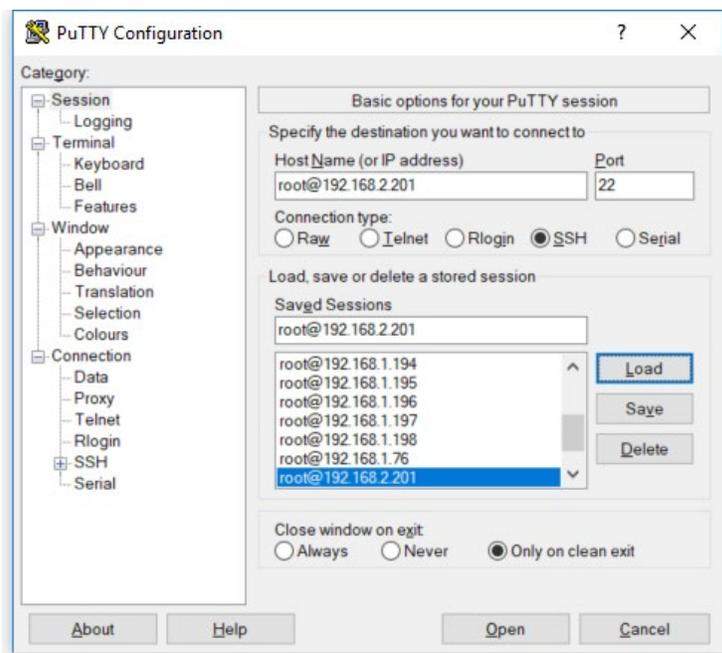
This procedure outlines the steps taken to capture WSMs received by the DENSO Onboard Unit (OBU) for packet analysis. J2735 messages are encoded using unaligned packed encoding (UPER) rules when transmitted from the roadside unit based on the 2016 standard's requirements. Due to this encoding scheme, any messages received must be decoded using the USDOT Connected Vehicles Tools Message Validator utility. This procedure assumes user familiarity with the OBU and Roadside Unit (RSU) as well as the WAVE short message protocol (WSMP).

Material Requirements

1. Windows laptop with PuTTY, WinSCP, Wireshark and web browser (Chrome or Firefox)
2. DENSO On Board Unit (OBU)
3. Preconfigured TrafficCast Roadside Unit (RSU)

Message Capture and Validation

1. Power up and connect the RSU.
2. Power up and connect the OBU.
3. Connect the laptop to the OBU WiFi network, denoted with the **#OBU** SSID.
4. Open PuTTY and connect to the OBU at the default OBU IP address **192.168.2.201**.



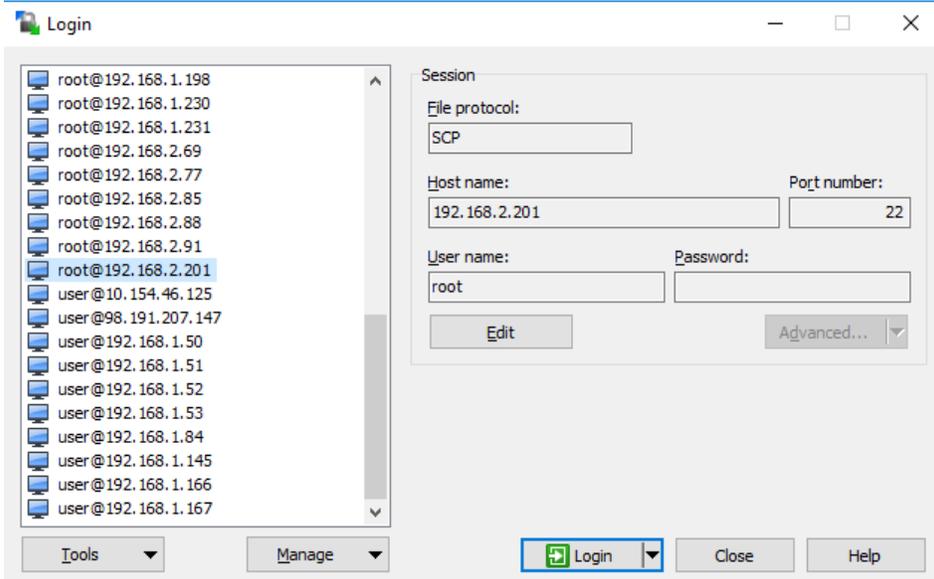
5. Change the working directory to that of the MicroSD card with “`cd /mnt/microsd/`”.

```
192.168.2.201 - PuTTY
Using username "root".
# cd /mnt/microsd/
#
```

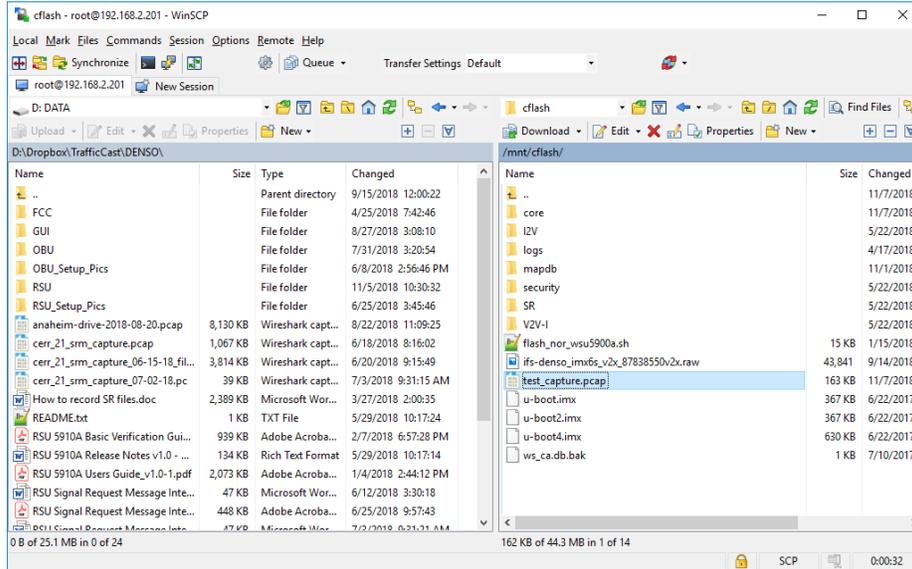
6. Enter the following command to start the packet capture “`SOCK=/llc tcpdump -i llc0 -s 0 -w filename.pcap`” (note, earlier OBU software builds use “llc0” instead of “cw-llc00”), replacing “filename” with any preferred name. Press **Ctrl-C** to stop capturing data when finished.

```
192.168.2.201 - PuTTY
# SOCK=/llc tcpdump -i llc0 -s 0 -w test_capture.pcap
tcpdump: WARNING: llc0: no IPv4 address assigned
tcpdump: listening on llc0, link-type EN10MB (Ethernet), capture size 65535 bytes
801 packets captured
876 packets received by filter
0 packets dropped by kernel
#
```

7. Open WinSCP and connect to the OBU.



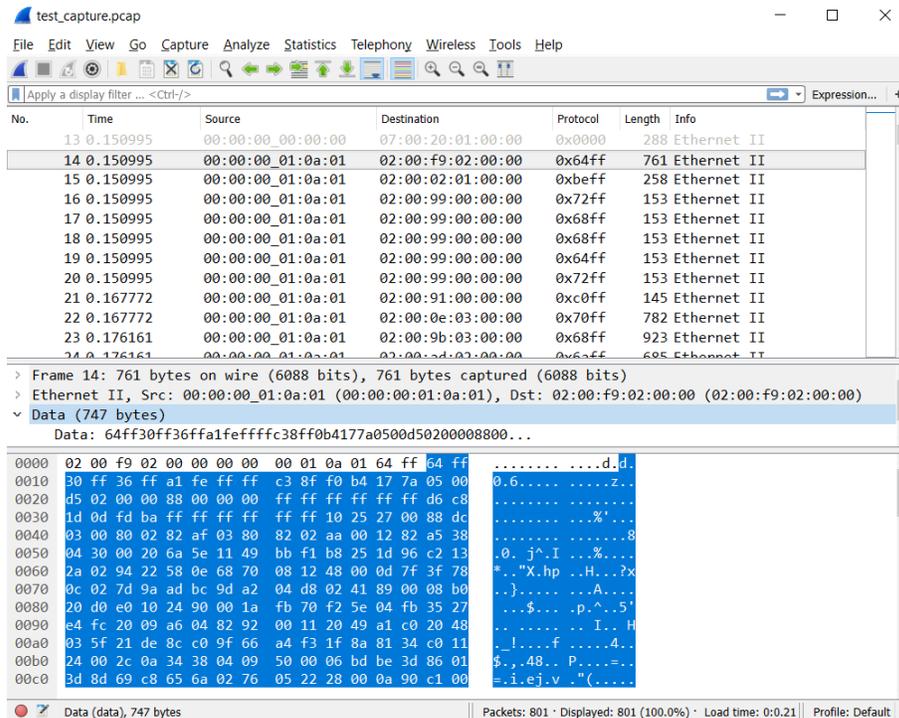
8. Navigate to the MicroSD card's directory in WinSCP.



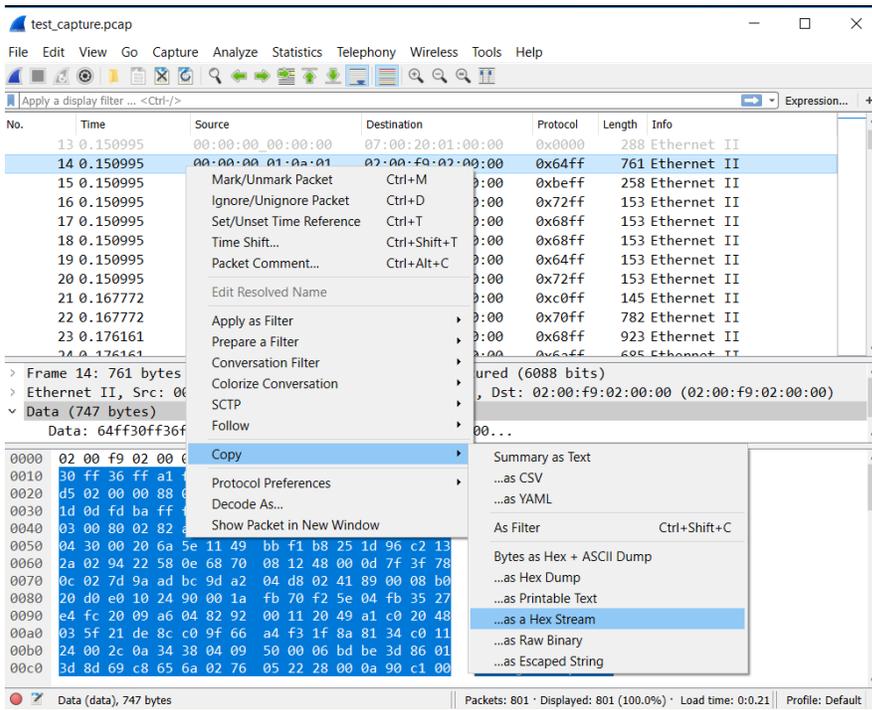
9. Left click and drag the PCAP file with captured data onto the local directory.

10. Open Wireshark and open the PCAP file.

11. Search through the PCAP and select a packet to be decoded.



12. Right-click and select **Copy ...As a Hex Stream** to copy the packet hex data.



13. Open the USDOT Connected Vehicles Tools website: <https://webapp.connectedvcs.com/>

14. Click on **View Tool** to open the Message Validator.



Message Validator for SDC/SDW messages

Use this tool to check versions of messages for accuracy against the specifications and standards prior to depositing into a warehouse.

[View Tool](#)

15. Set the Message Type to **Message Frame**.



- Click on Validate to decode the hex data. Green filled area text indicates the message meets the latest USDOT standard message format. If an error appears, re-evaluate the hex data based on the error. Observe...



BlueTOAD Spectra RSU Site Requirements Form

This form must be printed for each RSU along with the Sign-Off Checklist below.

SPECTRA RSU SITE REQUIREMENTS

Thank you for choosing the Spectra RSU. To ensure the best possible field deployment experience, please provide the information below. All fields are required and must be complete prior to scheduling your installation.

CONTACT INFORMATION

Agency Name

Agency Phone Number

Agency E-mail

INTERSECTION INFORMATION

The Spectra RSU requires a supported ATC 5.2b (or higher) compliant traffic controller with compatible software to generate Signal Phase and Timing messages. Intersection diagrams are required to generate MAP messages. FCC site licenses are required by law (47 C.F.R, Parts 90 and 95). Intersection latitude and longitude shall be in Decimal Degrees.

Intersection Location

Intersection Latitude Intersection Longitude

Intersection Diagram Provided Intersection Timing Plan Provided

Traffic Controller Brand Traffic Controller Model

Traffic Controller Software Version

Traffic Controller IP Address

Traffic Controller Subnet Mask

Traffic Controller Gateway

ATMS Software Version

FCC Site License Registered FCC Call Sign

FCC File Number

SPECTRA RSU INFORMATION

The Spectra RSU requires two IP addresses for Bluetooth and DSRC functionality. Serial numbers are found on device or packaging. Serial numbers may be left blank if unknown.

Bluetooth Module Serial Number

Bluetooth Module IP Address

Bluetooth Module Subnet Mask

Bluetooth Module Gateway

DSRC Module Serial Number

DSRC Module IP Address

DSRC Module Subnet Mask

DSRC Module Gateway

TRAFFICCAST SERVER ACCESS

The Spectra RSU requires internet access to the TrafficCast servers for collection and processing of Bluetooth data. Refer to Tech Bulletin TCI-FSB-ET-2011-01 (available on request) for more information.

Port 69 Opened

Port 123 Opened

Port 8010 Opened

Port 10001 Opened

System Evaluation Checklist

This form must be printed for each RSU along with the BlueTOAD Spectra RSU Site Requirements form.

Date:

RSU Number:

Serial Number:

RSU IP Address:

Category	Items tested	Date & Time	Pass	Signature of Evaluator
Visual Inspection	Confirm condition of hardware enclosure: - Antennas with Connectors - Enclosure Ports - LEDs - Enclosure			
Confirm Network Configuration Settings	Confirm ports 123, 8010 and 10001 are open and set for outbound data traffic. Contact TrafficCast Support for assistance			
Confirm Power Up	Power up unit and confirm all LEDs are normal after the unit initializes. LED Indicators: Green – Device operational Amber – Device ON Red - Fault			
Confirm Operation	1. GPS Functionality Verified			
	2. SPaT, MAP, TIM and BSM Data Broadcasting Verification: Verified 11 messages per second (generated by the RSU). - 10 SPaT messages - 1 MAP message			
	3. SPaT, MAP, TIM and BSM Data DSRC Message Verification USDOT / SAE J2735 (March2016)			