Revision to Dedicated Short-Range Communication Roadside Equipment Specification

RSU 4.1 Bench Test Plan

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16. Abstract

The document describes the overall process for evaluating Dedicated Short Range Communication (DSRC) Roadside Units (RSU) against USDOT RSU Specification 4.1 in preparation for field evaluation. The Test Cases contained in this document only evaluate basic RSU functionality. The results of this evaluation are intended to provide guidance to the vendors regarding implementations that may either not meet or only partially meet the requirements evaluated and are not intended to serve as official USDOT approval or certification. Official USDOT RSU Certification is performed under a separate USDOT effort.

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Test Plan Approvals

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Chapter 1. Introduction

The document describes the overall process for evaluating Dedicated Short Range Communication (DSRC) Roadside Units (RSU) against USDOT RSU Specification 4.1 in preparation for field evaluation. The Test Cases contained in this document only evaluate basic RSU functionality. The results of this evaluation are intended to provide guidance to the vendors regarding implementations that may either not meet or only partially meet the requirements evaluated and are not intended to serve as official USDOT approval or certification. Official USDOT RSU Certification is performed under a separate USDOT effort.

Test Scope

The Scope of the Test Cases contained in this document is to evaluate RSU hardware and firmware against core requirements defined in the USDOT RSU Specification 4.1. Evaluations will be performed on the Physical Requirements and as the following five functional areas:

1. Positioning and Timing
2. Log Files

System Interface
Interface Log Files

3. Message Processing

Store and Repeat-Encoded payload
Immediate Forward-Encoded payload
IPv6 Gateway

4. Security
5. Configuration

SNMPv3
Configuration Parameters
RSU Set (Multiple Radio Sets)

6. Health and Monitoring
7. Operation States

All Test Case numbers in this document will have the form BNCH-<test area>-<number>.

Provide Analysis and Report Findings

The Test Conductors will analyze the test results and prepare a Test Report for each vendor and submit the Report to the USDOT and the vendor. These Reports are intended to provide guidance to the vendors regarding implementations that may either not meet or only partially meet the

requirements evaluated as part of this test. These Reports shall not in any way serve as official approval, confirmation, or certification by the USDOT.

Upon request, the Test Conductors may also support briefings with USDOT and the vendor to explain the results. The Test Conductors may also support information exchange and collaboration with USDOT on the recommended next steps.

Test Objective

The primary objective of this plan is to evaluate DSRC RSUs against basic functionality described in the USDOT DSRC RSU Specification version 4.1 to provide additional guidance to RSU vendors to meet the specifications.

Chapter 2. Test Environment

Tests will be conducted at the Turner-Fairbank Highway Research Center (TFHRC) Saxton Transportation Operations Laboratory (STOL).

Test Environment Requirements

Each Test Environment must have the following configuration and equipment in order to conduct Tests based on the Test Cases listed in Chapter 4. Test Cases:

- AC Power to power the devices
- GPS to provide location and system time. GPS can be provided by:
  - Access to open sky
  - A GPS Repeater (license may be required)
  - A GPS Simulator
- IPv6 Backhaul connectivity to support back office service connections

Chapter 3. Test Schedule, Personnel, and Documentation

This section contains a high-level test schedule, personnel required to execute the tests, and a description of several documents that should be used to record test activities and results.

Test Schedule

Table 3-1 lists the activities anticipated for the evaluation process, once RSU 4.1 compliant hardware and firmware are available. These activities are required for each vendor under test.

Table 3-1. Test Activities

ID	Name	Estimated Duration
1	Initial hardware inspection	1 day
2	Initial configuration to operate in the applicable test environment	1 week
3	Full Evaluation	1 month
4	Document Results and submit Final Report	2-3 weeks

Personnel

The number and qualifications of staff required to complete testing activities will depend on the organization, but the following staff is anticipated to complete the activities in the estimated amount of time listed in Section 3.1 Test Schedule. Table 3-2 is a list of the general personnel required for compliance evaluation.

Table 3-2. Test Personnel

Title	Minimum Number
Test Director/Manager	1
Test Conductor	1
Test Operator	1-3
RSU Subject Matter Expert (SME)	1 per vendor
Test Observers	As desired

Test Director (Quality Assurance Manager)

The Test Director supervises and controls all tests, reviews and approves the test procedures, has the authority to direct all test activities, and is responsible for communicating test status to all

stakeholders. The test director will notify the USDOT and other key stakeholders of the test schedule in advance of the scheduled start.

Test Conductor

The Test Conductor is responsible for running the daily test activities and will stay in contact with the vendors as needed to communicate which tests are being run and to receive support input as the tests are conducted. The Test Conductor will distribute test scripts, forms and any other pertinent information and be available to answer questions.

Throughout the test day, the Test Conductor will verify the entrance criteria have been met for each test run, verify the readiness of test participants and equipment, and announce the start and end of each testing period. The Test Conductor will also ensure other participants execute tests according to the procedures. At all times, the Test Conductor will be responsible for judging how to proceed if incidents or exceptions occur as well as canceling and re-scheduling tests in the event of a failure that prevents a test from being executed.

At the end of the test period, the Test Conductor will write up the results of various test runs completed and any incidents or exceptions that occurred. The status report will be emailed to relevant stakeholders.

Test Operator

The Test Operator is responsible for defining and executing the test procedures to evaluate each device and recording the outputs and overall results of each test.

RSU Subject Matter Expert (SME)

The RSU subject matter expert is responsible for supporting the Test Conductors and Test Operators during all testing phases, as required.

Test Observers

Test observers witness test runs at the USDOTs discretion.

Note: Some roles can be combined such that a single person can assume up to two roles (i.e. the Test Conductor can also be the Test Operator).

Documentation

Test Records

Specific test information, including test environment, test execution, and attendees/ participants/ observers will be captured for each individual test. Each requirement evaluated will be marked with a P or an F, indicating success (Pass) or failure (Fail). All failures, as well as any deviations from the procedure or work-a-rounds, will be recorded in a comments section of the form. These entries will be entered electronically during test execution.

Chapter 4. Test Cases

This section contains information about, and provides brief introductions to, the individual Test Cases utilized to evaluate RSU Specification 4.1 Functionality.

Physical Requirements

The Test Cases listed in this section evaluate the Physical aspects of the RSU through visual inspection.

Table 4-1. Physical Assessment based on inspection

Test Case #	**BNCH-PHY-01**	
Test Case	**Physical Assessment based on inspection**	
Reference		
Objective	Assess RSU's weight, enclosure, connector, and power indications, through visual inspection	
Requirements verified	USDOT_RSU-Req_324-v001	Weight: The weight of the roadside unit, excluding antennas, mounting hardware and Power-over-Ethernet (PoE) Power Injector, **SHALL NOT** exceed fifteen (15) pounds
	USDOT_RSU-Req_325-v001	Enclosure: The roadside unit **SHALL** be housed in a corrosion-resistant enclosure that is compliant with the NEMA4X (IP66) rating.
	USDOT_RSU-Req_328-v001	Power over Ethernet Connector: The external Power-over-Ethernet (PoE) connector **SHALL** be compliant with the Outdoor IP66 rating.
	USDOT_RSU-Req_329-v001	Mounting: The roadside unit **SHALL** support installation on a shelf, wall, or pole (horizontal or vertical).
	USDOT_RSU-Req_331-v001	Power Indication: The roadside unit **SHALL** include an LED to indicate the power status of the device in accordance with the following protocol: Off - No Power Solid Green - Device is powered on
	USDOT_RSU-Req_359-v001	Status Indication: The roadside unit **SHALL** include an LED to indicate the operational status of the device in accordance with the following protocol: Off - No Power Blinking Green - Device Start-Up Solid Green - Device Operational Amber - Firmware Update In Progress Red-Fault

Test Case #	BNCH-PHY-01
Test Case	**Physical Assessment based on inspection**
Brief Description	RSU under test will be visually inspected and given an assessment of the device's potential to meet the Requirements listed. Ratings will be based on the housing material, connector placement in relation to the device's recommended mounting position, connector material, visible weather seal, etc. This rating is informational only and will be based on the evaluators' previous experience with outdoor grade electronic equipment.
Entrance Criteria	Production grade RSU hardware is available for visual inspection
Configuration	RSU Physical Configuration for production
Exit Criteria	Device inspected and results recorded
Data Outputs	Pictures of hardware and connectors and Test Operator Data Sheet

Positioning and Timing Requirements

The Test Cases listed in this section evaluate the Positioning and Timing functionality of the RSU.

Table 4-2. Positioning (GPS Reference and Corrections)

Test Case #	BNCH-PoS-02	
Test Case	**Positioning (GPS Reference and Corrections)**	
Reference		
Objective	Verify RSU can determine its position and maintains appropriate system logs relevant to positioning.	
Requirements verified	USDOT_RSU-Req_510-v002	Position Determination: The roadside unit **SHALL** utilize a local subsystem to determine its position on the surface of the earth using a sample rate of 1 Hz or better
	USDOT_RSU-Req_511-v001	Positioning Failure Log Entry: The roadside unit **SHALL** write a **CRITICAL** entry to the System Log if it is not able to acquire a minimum of 3 Satellites within 20 seconds after entering the **"Operate"** state
Brief Description	510 Appropriate command is entered on RSU under test to display the RSU's current position. Result is inspected to confirm the RSU positioning system reports the RSU's correct location, within reason. (Note: accuracy will not be tested, but the device should report a position "reasonably" close to the Test Site; i.e. on the TFHRC Campus or the USDOT MI Operations Center Campus). 511 RSU is powered up without a GPS antenna. 25 seconds after the RSU enters the "Operate State" the System log is inspected to verify a **CRITICAL** entry related to the RSU not being able to acquire a minimum of 3 GPS Satellites to determine its position.	

Test Case #	BNCH-PoS-02
Test Case	**Positioning (GPS Reference and Corrections)**
Entrance Criteria	1)RSU has access to open sky; or 2) GPS repeater or simulator is operational in the test environment
Configuration	• RSU under Test is configured for “normal” Operation
Exit Criteria	• RSU Under Test acquires position from test environment GPS information • RSU Under Test writes **CRITICAL** System log entry if it does not acquire a minimum of 3 GPS Satellites within 20 seconds for entering the “Operate” State.
Data Outputs	510: Snippet of RSU Positing System Result containing the correct Latitude, Longitude, and Elevation. 511: Snippet of RSU System Log File containing the **CRITICAL** Position log entry.

Table 4-3. GPS Output and System Time

Test Case #	BNCH-PoS-03	
Test Case	**GPS Output and System Time**	
Reference		
Objective	Verify the RSU outputs GPS and maintains system time.	
Requirements verified	USDOT_RSU-Req_438-v004	GPS Output: The roadside unit **SHALL** send the GPGGA NMEA String to a specified UDP port at a specified rate, upon acquisition of 3 or more Satellites, as configured in SNMPv3 MIB OID 1.0.15628.4.1.8, which contains the following data. -Destination IP Address -port (default is 5115) -sample period (default is 1 second, with a valid range of 1-18000 seconds, in increments of 1 second) See the SNMPv3 MIB OID 1.0.15628.4.1.8 in APPENDIX B [of the RSU 4.1 Spec] for more information
	USDOT_RSU-Req_513-v003	System Time: The roadside unit **SHALL** maintain a system clock based on timing information from a local positioning system that manages leap second corrections in accordance with IS-GPS-200H. Note: GPS is intended to serve as the primary time source and the NTP server is intended to be available as a secondary, backup time source in the event that the RSU loses GPS.
	USDOT_RSU-Req_514-v002	System Time Standard: The roadside unit SHALL conform to the Universal Time, Coordinated (UTC) standard with epoch 1 January 1970 00:00:00.
Brief Description	A Test Computer is connected to the RSU’s Ethernet port. The RSU is configured to send GPS data to the Test Computer. The Test Computer monitors the configured UDP port for GPGGA NMEA String at the configured rate.	

Test Case #	BNCH-PoS-03
Test Case	**GPS Output and System Time**
Entrance Criteria	RSU GPS receiver has 3 or more satellites acquired
Configuration	Test 1 RSU SNMPv3 MIB OID 1.0.15628.4.1.8 is configured with default parameters (IP=IP address of the external device, port=5115 and sample rate=1) Test 2 RSU SNMPv3 MIB OID 1.0.15628.4.1.8 is configured with the following parameters: (IP=IP address of the external device, port=5115 and sample rate=128) Test 3 RSU SNMPv3 MIB OID 1.0.15628.4.1.8 is configured with the following parameters: (IP=IP address of the external device, port=58000 and sample rate=9000)
Exit Criteria	RSU under test provides GPGGA NMEA String on the configured port at the configured rate, the RSU under test sends notifications to a remote host indicating that 1) a time source has been lost over a configurable period of time; 2) the value of a clock source deviates beyond a predefined skew rate; 3) the deviation between two or more time sources exceeds a predefined threshold.
Data Outputs	Data Log indicating Pass/Fail Test Computer Log File

Table 4-4. GPS Alerts

Test Case #	BNCH-PoS-03b	
Test Case	**GPS Alerts**	
Reference		
Objective	Verify the RSU outputs SNMP notifications to inform an operator of GPS status.	
Requirements verified	USDOT_RSU-Req_602-v001	GPS Reference: The roadside unit **SHALL** store a reference set of GPS coordinates for itself
	USDOT_RSU-Req_614-v002	The roadside unit **SHALL** notify a remote host via SNMPv3: • if its GPS position deviates from the stored reference by more than a configurable radius (OID 1.0.15628.4.1.100.0.11) • if a suspicious GPS signal is detected (OID 1.0.15628.4.1.100.0.10) • of its current NMEA GPGGA string at a configurable interval (OID 1.0.15628.4.1.100.0.12)

Test Case #	BNCH-PoS-03b	
Test Case	**GPS Alerts**	
	USDOT_RSU-Req_618-v002	The roadside unit **SHALL** notify a remote host via SNMPv3: • if a time source input has been lost for a configurable period of time or has failed after a configurable number of query attempts (note: the time source itself shall also be indicated) (OID 1.0.15628.4.1.100.0.7) • if the value of an internal clock drift (skew rate) has exceeded a configurable tolerance (OID 1.0.15628.4.1.100.0.8) • if the deviation between two or more time sources has exceeded a configurable threshold (OID 1.0.15628.4.1.100.0.9)
Brief Description	A Test Computer is connected to the RSU's Ethernet port and monitors the configured SNMP port for the notifications at the configured rate.	
Entrance Criteria	RSU GPS receiver has 3 or more satellites acquired SNMP is configurable	
Configuration	With a remote PC connected to the RSU under test, the test operator will watch incoming SNMP messages for the appropriate notifications. Test 1 The test operator will input a reference set of coordinates to the RSU with a radius that covers the current location. No position error messages should be sent. The test operator will input a reference set of coordinates to the RSU with a radius that does not include the current location. A position error message should be sent. Test 2 The test operator will input a time interval to the RSU for the GPGGA string to be sent by SNMPv3. The following intervals will be tested: 1 second 128 seconds 9000 seconds Test 3 The following parameters of the RSU under test are configured according to the manufacturer's suggested procedure: 1) The maximum allowable time duration that a time source can be lost 2) The maximum allowable skew rate for a clock source, 3) The maximum allowable deviation between two more time sources; After the RSU under test enters the "Operate" state, the GPS antenna of the RSU is removed. The test operators should confirm the RSU under test transmits appropriate notifications to the remote host.	
Exit Criteria	RSU under test sends an SNMP notification to the remote PC indicating a GPS error when the detected GPS signal does not match the reference coordinates RSU under test sends an SNMP notification with the GPGGA NMEA String on the configured port at the configured rate	
Data Outputs	Data Log indicating Pass/Fail Test Computer Log File	

Log Files

The Test Cases listed in this section evaluate the System Log and Interface Log File functionality of the RSU.

Operating System Log Files

Table 4-5. Generation of System Log Files

Test Case #	**BNCH-SysLog-04**	
Test Case	**Generation of System Log Files**	
Reference		
Objective	Evaluate RSU System Log Functionality	
Requirements verified	USDOT_RSU-Req_500-v001	System Log File: The roadside unit **SHALL** log system events to a standard operating system's System Log (Syslog) File
	USDOT_RSU-Req_503-v001	System Log Default Event Priority: The roadside unit **SHALL** write an entry in the System Log file for INFO events and above, by default
	USDOT_RSU-Req_504-v002	System Log Time Period-Close: The roadside unit **SHALL** close open System Log files once per week at a configurable time.
	USDOT_RSU-Req_505-v002	System Log Time Period-Open: Upon closing a System Log file, the roadside unit **SHALL** open a new System Log file.
	USDOT_RSU-Req_506-v003	System Log File Storage: At a configurable time, the roadside unit **SHALL** delete system log files that are older than a configurable age (i.e. the length of time since the file was closed). See the SNMPv3 MIB OID 1.0.15628.4.1.18 in APPENDIX B of RSU Spec 4.1 for more information
	USDOT_RSU-Req_559-v001	System Log File Access: The roadside unit **SHALL** allow authorized users to view System Log Files stored in the System Log File directory on the device through an Ethernet interface.
Brief Description	Test Operator will log in to the RSU under test and perform the following: • Inspect appropriate file system directory for the presence of System Log Files • Inspect System Log Files for INFO and above Events Records • Configure a time to close the open System Log files and generate the new System Log files each week. Then, keep the RSU operational for a week and inspect System Log files for verification. • Configure a time through SNMPv3 (MIB OID 1.0.15628.4.1.18) to delete old system log files.	
Entrance Criteria	Test Operator receives the list of Priority Levels support by the RSU Operating System from the Manufacturer.	
Configuration	RSU is configured for "normal" operation	
Exit Criteria	RSU successfully generates System Log Files compliant with the listed requirements	
Data Outputs	• Snippets of System Log Files demonstrating compliance • Test Operator Data Sheet containing relevant notes.	

Table 4-6. System Log File Priority Level Configuration

Test Case #	**BNCH-SysLog-05**	
Test Case	**System Log File Priority Level Configuration**	
Reference		
Objective	Evaluation of System Log File Priority Level configuration.	
Requirements verified	USDOT_RSU-Req_501-v001	System Log Event Priorities: The Priority Level of events that are recorded in the roadside unit System Log file **SHALL** consist of all priorities available for the operating system
	USDOT_RSU-Req_502-v001	System Log Event Priority Configuration: The Priority Level of events that are recorded in the roadside unit System Log file **SHALL** be configurable by authorized users
Brief Description	Test Operator will log in to the RSU under test and perform the following operations: • Change the System Log Priority Level configuration to DEBUG (Level 8) in /etc/syslog.conf for Linux based systems or applicable file based on the Operating System, using the manufacturers recommended procedure • Inspect System Log Files for all Priority Levels' Records	
Entrance Criteria	If RSU operating system is not Linux, Test Operator has procedures for changing the System Log File Priority level configuration, supplied by the RSU Manufacturer	
Configuration	RSU is configured for "normal" operation	
Exit Criteria	System Log logging Priority Levels are successfully changed; and all Priority Levels' Records are logged within System Log Files.	
Data Outputs	• Snippets of System Log Files demonstrating the change is Priority Level logging and all Priority Levels' Records are logged. • Test Operator Data Sheet containing relevant notes.	

Table 4-7. Network Host Connection State Change Log Entries

Test Case #	**BNCH-SysLog-06**
Test Case	**Network Host Connection State Change Log Entries**
Reference	
Objective	Evaluation of RSU System Log Network Connection Change log entry.

Test Case #	BNCH-SysLog-06	
Test Case	**Network Host Connection State Change Log Entries**	
Requirements verified	USDOT_RSU-Req_450-v001	Network Host Connection State Change: The roadside unit **SHALL** write a WARNING entry to the System Log File when a non-DSRC network host connection changes state. The entry will contain the following data: -Date and Time -interface -new state (connected, not connected)
Brief Description	With the RSU under test in the "Operate" State and a Test Computer connected to the Ethernet port, the Test Operator will disconnect the Test Computer with the RSU, wait 5 minutes, reconnect the Test Computer to the RSU, and log into the RSU. Once Logged in, the Test Operator will inspect the System Log File for 2 WARNING level log entry: 1. An entry containing the date and time of when the Test Computer was disconnected, the interface is disconnected from, and a new state of "not connected," or similar. 2. An entry containing the date and time of when the Test Computer was connected, the interface (Ethernet) in which it was connected to, and a new state of "connected," or similar.	
Entrance Criteria	Operational RSU is available for testing.	
Configuration	RSU is configured for "normal" operation	
Exit Criteria	RSU successfully logs when the Test Computer is disconnected and re-connected	
Data Outputs	• Snippets of System Log Files depicting the WARNING level "not connected" and "connected" log entries • Test Operator Data Sheet containing relevant notes.	

Interface Log Files

Table 4-8. Interface Log File

Test Case #	BNCH-InfLog-07	
Test Case	**Interface Log File**	
Reference		
Objective	Evaluation of RSU Interface Log Files.	
Requirements verified	USDOT_RSU-Req_516-v001	Interface Log File: The roadside unit **SHALL** have the ability to log all transmitted and received packets across all enabled communication interfaces, while in the "Operate" State.
	USDOT_RSU-	Interface Log File-Separation by Interface: A separate and

Test Case #	BNCH-InfLog-07	
Test Case	**Interface Log File**	
	Req_518-v003	independent Interface log file **SHALL** be generated for each direction (transmit and receive) of a roadside unit communication interface when the SNMPv3 MIB OIB 1.0.15628.4.1.9 for that interface is set to "on." See the SNMPv3 MIB 1.0.15628.4.1.9 in Appendix B [of the RSU 4.1 Spec] for more information
	USDOT_RSU-Req_521-v003	Interface Log File Close-Max file size: The roadside unit **SHALL** close an active Interface Log File upon reaching the configured "Max file size" in SNMPv3 MIB OID 1.0.15628.4.1.9. See the SNMPv3 MIB 1.0.15628.4.1.9 in Appendix B [of the RSU 4.1 Spec] for more information.
	USDOT_RSU-Req_523-v003	Interface Log File Generation-Max file size: The roadside unit **SHALL** generate a new Interface Log File upon closing a previously active Interface Log File when the configured "Max file size" in SNMPv3 MIB OID 1.0.15628.4.1.9 is reached. See the SNMPv3 MIB 1.0.15628.4.1.9 in Appendix B [of the RSU 4.1 Spec] for more information
	USDOT_RSU-Req_524-v004	Interface Log File Name Convention: Each roadside unit Interface Log File **SHALL** be named according to the following convention: -RSU ID (see MIB OID 1.0.15628.4.1.17) -Interface ID -transmit, receive or both -date and time (UTC data and time when the file was created
	USDOT_RSU-Req_527-v002	Interface Log File Access: The roadside unit **SHALL** allow authorized users to view Interface Log Files stored in the Interface Log File directory on the device through an Ethernet interface.
	USDOT_RSU-Req_539-v003	Interface Log File Begin Generation: An Interface Log File **SHALL** be generated for a roadside unit communication interface upon setting the “generate” flag in SNMPv3 MIB OID 1.0.15628.4.1.9 for that interface to "on.” Note: when set to "on" both transmitted and received packets are logged. See the SNMPv3 MIB 1.0.15628.4.1.9 in APPENDIX B [of the RSU 4.1 Spec] for more information
	USDOT_RSU-Req_541-v002	Interface Log File format: Each Interface Log File **SHALL** be generated in the industry standard packet capture (pcap) format and contain the following data: -Date and Time (in UTC, when the packet was logged) -RSSI (for Packets Received over DSRC) -TxPower (for Packets Transmitted over DSRC) -packet (complete transmitted or received packet)

Test Case #	**BNCH-InfLog-07**	
Test Case	**Interface Log File**	
	USDOT_RSU-Req_542-v002	Interface Log File Default Configurations: All Interface Log File configurations contained in SNMPv3 MIB OID 1.0.15628.4.1.9 **SHALL** have the following default values: -generate=off -Max file size=20MB -Max collection time=24 hr. See the SNMPv3 MIB 1.0.15628.4.1.9 in Appendix B [of the RSU 4.1 Spec] for more information
	USDOT_RSU-Req_543-v003	Interface Log File Close-Time Limit: The roadside unit **SHALL** close an active Interface Log File upon reaching the configured "Max collection time" in SNMPv3 MIB OID 1.0.15628.4.1.9. See the SNMPv3 MIB 1.0.15628.4.1.9 in Appendix B [of the RSU 4.1 Spec] for more information
	USDOT_RSU-Req_560-v002	Interface Log File Stop Generation: An Interface Log File **SHALL** stop being generated for a roadside unit communication interface upon setting the "generate" flag in SNMPv3 MIB OID 1.0.15628.4.1.9 for that interface to "off." See the SNMPv3 MIB 1.0.15628.4.1.9 in Appendix B [of the RSU 4.1 Spec] for more information
Brief Description	With the RSU under test in the "Operate" State, Test Operator performs the following: • Inspect appropriate file system directory for the presence of Interface Log Files with a pcap file format extension. • Confirm that Interface Log Files comply with the naming convention specified in Requirement USDOT_RSU-Req_524-v003 • View an Interface log File for each enabled interface to confirm compliance with Requirement USDOT_RSU-Req_518-v003 and USDOT_RSU-Req_541-v003 • Use SNMPv3 to confirm the default values of interface log files conform to Requirement USDOT_RSU-Req_542-v002. • Confirm that generation and close of interface log files conforms with Requirement USDOT_RSU-Req_521-v003, USDOT_RSU-Req_523-v003, USDOT_RSU-Req_539-v003, and USDOT_RSU-Req_543-v003, • Confirm that the RSU stops generating interface files as specified in Requirement USDOT_RSU-Req_560-v002	
Entrance Criteria	Test Operator knows the file system directory that contains Interface Logs.	
Configuration	• RSU is configured for "normal" operation • RSU SNMPv3 MIB OIB 1.0.15628.4.1.9 is set to "on." • Then RSU SNMPv3 MIB OIB 1.0.15628.4.1.9 is set to "off."	

Test Case #	BNCH-InfLog-07
Test Case	**Interface Log File**
Exit Criteria	RSU successfully generates properly named Interface Log Files per enabled interface
Data Outputs	• List of Interface Log Files contained in the appropriate directory • Snippets of Interface Log Files demonstrating compliance • Test Operator Data Sheet containing relevant notes.

Table 4-9. Interface Log File State Change

Test Case #	BNCH-InfLog-08	
Test Case	**Interface Log File State Change**	
Reference		
Objective	Confirm Interface Log Files close when the RSU enters the “standby” state.	
Requirements verified	USDOT_RSU-Req_522-v001	Interface Log File Close-transition to Standby: The roadside unit **SHALL** close all active Interface Log Files when transitioning to "standby" state.
Brief Description	With the RSU under test in the “Operate” State, Test Operator inspects the appropriate file system directory to confirm Interface Log Files are being generated by monitoring the size of the Log Files over a few minute period. The file size should increase. Once confirmed the Interface log Files are being generated, the Test Operator will force the RSU into the “Standby” State. Once in “Standby” State, Test Operator inspects the appropriate file system directory to confirm Interface Log Files are no longer being generated by monitoring the size of the Log Files over a few minute period. The files size should not change. Once Confirmed Interface Log Files are no longer being generated, the Test Operator forces the RSU back to the “Operate” State and confirms that new Interface Log Files are being generated, by inspecting the appropriate file system directory to confirm a new set of Interface Log Files are being generated.	
Entrance Criteria	Test Operator knows the procedure to force the RSU under test from the “Operate” State to the “Standby” State.	
Configuration	RSU is configured for “normal” operation	
Exit Criteria	Two sets of Interface Log Files are contained in the appropriate file system directory	
Data Outputs	• Snippet of RSU file system directory containing a list of Interface Log Files • Test Operator Data Sheet containing relevant notes.	

Message Processing

The Test Cases listed in this section evaluate the Message Processing functionality of the RSU.

Store and Repeat Messages

Table 4-10. Store and Repeat Message Transmission

Test Case #	**BNCH-MP_S&R-09**	
Test Case	**Store and Repeat Message Transmission**	
Reference		
Objective	Confirm the RSU under test sends WSMP messages on the appropriate channel (CCH or SCH) in the appropriate mode (alternating or continuous) according to transmission instructions and with the payload contained in a local file.	
Requirements verified	USDOT_RSU-Req_468-v001	Store & Repeat Message Start of Transmission: The roadside unit **SHALL** begin transmitting the payload of an Active Message text file over a DSRC interface, based on the transmission instructions contained in the Active Message text file, on or after the start time specified in the transmission instructions of the Active Message text file for each Active Message text file stored on the unit. Note: Appendix C [of the RSU 4.1 Spec] contains the message format
	USDOT_RSU-Req_470-v001	Store & Repeat Message End of transmission: The roadside unit **SHALL** stop transmitting the payload of an Active Message text file as a DSRC message at end time specified in the transmission instructions of the Active Message text file for each Active Message text file stored on the unit.
	USDOT_RSUReq_452- v002	Store & Repeat Message Storage: The roadside unit **SHALL** store at least 100 Active Message text files in an Active Message directory.
	USDOT_RSU-Req_453-v002	Store & Repeat Active Message file installation: The roadside unit **SHALL** allow authorized users to add/remove Active Message text files to/from the Active Message directory through SNMPv3 OID 1.0.15628.4.4.x.
	USDOT_RSU-Req_454-v003	Store & Repeat Active Message file removal: The roadside unit **SHALL** allow authorized users to remove Messages from the Active Message directory through SNMPv3 OID 1.0.15628.4.1.4.
	USDOT_RSU-Req_455-v003	Store & Repeat Active Message review: The roadside unit **SHALL** allow authorized users to view the contents of Active Messages in the Active Message directory through SNMPv3 1.0.15628.4.1.4.
	USDOT_RSU-Req_457-v003	Store & Repeat Active Message Modification: The roadside unit **SHALL** allow authorized users to modify an Active Message through SNMPv3 1.0.15628.4.1.4.

Test Case #	BNCH-MP_S&R-09	
Test Case	**Store and Repeat Message Transmission**	
	USDOT_RSU-Req_468-v001	Store & Repeat Message Start of Transmission: The roadside unit **SHALL** begin transmitting the payload of an Active Message text file over a DSRC interface, based on the transmission instructions contained in the Active Message text file, on or after the start time specified in the transmission instructions of the Active Message text file for each Active Message text file stored on the unit. Note: Appendix B [of the RSU 4.1 Spec] contains the message format
	USDOT_RSU-Req_459-v001	Store & Repeat Active Message Authorized Access Log Entry: The roadside unit **SHALL** write an INFO entry to the System Log File for each authorized access to an Active Message text file containing the following data: -Date and Time -File Name (name of the Active Message text file as stored in the Active Message directory) -Successful operation (installation, removal, or modification) -user ID
	USDOT_RSU-Req_462-v001	Store & Repeat Active Message Transmission Log Entry: The roadside unit **SHALL** write a **NOTICE** entry to the System Log File when an Active Message changes transmission status resulting from a user initiated device shut down, device boot up, message start time or message end time. Each entry will contain the following data: -Date and Time -File Name (name of the Active Message text file as stored in the Active Message directory) - Transmission Status (Start/Stop)
	USDOT_RSU-Req_469-v001	Store & Repeat Active Message Failed Access Log Entry: The roadside unit **SHALL** write a WARNING entry to the System Log File for each failed access attempt to an Active Message text file containing the following data: -Date and Time -File Name (name of the Active Message text file as stored in the Active Message directory) -Failed operation (install, remove, modify) -user ID

Test Case #	**BNCH-MP_S&R-09**	
Test Case	**Store and Repeat Message Transmission**	
	USDOT_RSU-Req_571-v001	WSA Configuration_S&R Messages: The roadside unit WAVE Service Advertisement (WSA) **SHALL** include DSRC Service Channel (SCH) Services based on the Store and Repeat messages contained in MIB OID 1.0.15628.4.1.4
	USDOT_RSU-Req_573-v002	Control Channel Store & Repeat Messages: Store & Repeat messages transmitted on the DSRC Control Channel (CCH), 178 **SHALL NOT** be included in the WAVE Service Advertisement
Brief Description	Several files, formatted according to Appendix C of RSU Specification v4.1 are prepared and stored on the RSU under test using SNMPv3. The RSU transmits the payload of each file in a separate WSMP message according to the transmission instructions contained within that file. All messages are transmitted from "DeliveryStart" to "DeliveryStop" and transmitted with a predetermined rate of "TxInterval," as specified in their respective file. Transmission duration and rate will be varied across all messages. The files and all transmitted WSMP packets are captured and recorded. A sample number of WSMP packets pertaining to each file are decoded to confirm the sent payload matches the payload contained in the corresponding file. Each configuration listed below will be evaluated separately. The Active Message List will be replaced, 1 file will be removed from the Active Message List, 1 file will be added to the Active Message List, 1 file on the Active Message List will be modified, and the Active Message List will be reviewed during configuration changes to confirm the proper management of the Active Message List. The test operator deliberately configures a message incorrectly in order to confirm the RSU conforms to Requirement USDOT_RSU-Req_469-v001. The test operator prepares more than 100 messages to confirm the RSU conforms to Requirement USDOT_RSU-Req_452-v002.	
Entrance Criteria	Production grade RSU hardware and software capable of the Store and Repeat Message functionality on both the CCH and SCH is available for evaluation.	
Configuration 1 (Alternating CCH)	3 messages on the Active Message List are configured to transmit on the CCH with different DeliveryStart, DeliveryStop, and TxInterval values using SNMPv3. (Note: WSA should NOT advertise the PSIDs for messages transmitting on the CCH; USDOT_RSU-Req_573-v002). 1 message of these 3 messages will be modified using SNMPv3 and the modified message will be reviewed to confirm the modification and the System Status log file will be examined to confirm an appropriate entry was made.	

Test Case #	BNCH-MP_S&R-09
Test Case	**Store and Repeat Message Transmission**
Configuration 2 (Alternating SCH; replace 1 message on Active Message List)	3 messages on the Active Message List are configured using SNMPv3 to broadcast on the default SCH with different DeliveryStart, DeliveryStop, and TxInterval values. (Note: WSA should advertise the PSIDs for messages transmitting on a SCH: USDOT_RSU-Req_571-v001). 1 message of these 3 messages will be replaced using SNMPv3, the Active Message List will be reviewed to confirm the modification, and the System Status log file will be examined to confirm an appropriate entry was made.
Configuration 3 (Continuous SCH)	1 message on the Active Message List is configured using SNMPv3 to broadcast on SCH 172 (Continuous Mode). (Note: WSA should advertise the PSIDs for messages transmitting on a SCH: USDOT_RSU-Req_571-v001).
Exit Criteria	RSU transmits the payload of files stored locally as WSMP messages according to the transmission instructions and generates appropriate log messages when the Active Message list and Messages are modified, added, or removed.
Data Outputs	• DSRC Protocol analyzer cap file • System Log files • Test Operator Data Sheet with relevant notes

Immediate Forward Messages

Table 4-11. Immediate Forward Message Management

Test Case #	BNCH-MP_IF-10	
Test Case	**Immediate Forward Message Management**	
Reference		
Objective	Confirm the RSU under test transmits WSMP messages on the appropriate channel (CCH or SCH) in the appropriate mode (alternating or continuous) according to transmission instructions upon receiving a properly formatted text file, containing instructions and payload, from an external source through the Local System Interface.	
Requirements verified	USDOT_RSU-Req_554-v001	Immediate Forward Message Receive: The roadside unit **SHALL** receive messages for Immediate Forward from network hosts on default UDP port 1516 Note: Appendix C [of the RSU 4.1 Spec] contains the Immediate Forward message format

Test Case #	BNCH-MP_IF-10	
Test Case	**Immediate Forward Message Management**	
	USDOT_RSU-Req_471-v003	Immediate Forward Message Transmission: The roadside unit **SHALL** transmit over a DSRC interface each message payload received from a network host upon receipt of the message and according to the transmission instructions contained in the message header. Note: Appendix C [of the RSU 4.1 Spec] contains the Immediate Forward message format
	USDOT_RSU-Req_572-v001	WSA Configuration_IF Messages: The roadside unit WAVE Service Advertisement (WSA) **SHALL** include DSRC Service Channel (SCH) Services based on Immediate Forward messages received on non-DSRC interfaces as listed in MIB OID 1.0.15628.4.1.5
	USDOT_RSU-Req_574-v001	Control Channel Immediate Forward Messages: Immediate Forward messages transmitted on the DSRC Control Channel (CCH), 178 **SHALL NOT** be included in the WAVE Service Advertisement
Brief Description	Two files, formatted according to Appendix C of RSU Specification v4.1, are sent to the Local System Interface of the RSU under test at a rate of 10 times per second (representing a SPaT message) and 1 time per second (representing a Map message) for 10 minutes. The RSU transmits the payload of each file as a separate WSMP message according to the transmission instructions contained within that file. The files, the number of times the files are sent to the RSU, and all transmitted WSMP packets, are captured and recorded. A sample number of WSMP packets containing both payloads are decoded to confirm the transmitted payload matches the payload contained in the file sent to the RSU. The same two text files will be utilized throughout the evaluation, 1 representing a SPaT message sent 10 times per second and 1 representing a MAP message sent 1 time per second. Each configuration listed below will be evaluated separately. After all applicable configurations have been evaluated, the connection to the external source sending the text files to the RSU will be removed abruptly, and the system status log file will be examined to confirm an entry was made recording the time of the event.	
Entrance Criteria	Production grade RSU hardware and software capable of the Immediate Forward functionality on the CCH (Optional) and SCH (Mandatory) and in both continuous and alternating modes is available for evaluation. 2 text files formatted according to Appendix C of RSU Specification v4.1 are available.	
Configuration 1 (Alternating SCH)	WSMP messages are transmitted on the default SCH based on files received through a Local System Interface. (Note: WSA should advertise the PSID contained in the received file: USDOT_RSU-Req_572-v001)	

Test Case #	BNCH-MP_IF-10
Test Case	**Immediate Forward Message Management**
Configuration 2 (Alternating CCH)	WSMP messages are transmitted on the CCH based on files received through a Local System Interface. (Note: WSA should NOT advertise the PSID contained in the received file: USDOT_RSU-Req_574-v001)
Configuration 3 (Continuous SCH)	WSMP messages are transmitted on SCH 172 based on files received through a Local System Interface. (Note: WSA should advertise the PSID contained in the received file: USDOT_RSU-Req_572-v001)
Exit Criteria	RSU transmits WSMP messages according to the transmission instructions and payload sent to the local system interface of RSU for as long as the files are sent.
Data Outputs	• DSRC Protocol analyzer cap file • Test Operator Data Sheet with relevant notes

Table 4-12. DSRC Message Forwarding

Test Case #	BNCH-MP_MF-11	
Test Case	**DSRC Message Forwarding**	
Reference		
Objective	Confirm RSU forwards received DSRC messages to an external network host, based on SNMPv3 MIB configurations.	
Requirements verified	USDOT_RSU-Req_437-v005	DSRC Message Forwarding: The roadside unit **SHALL** forward WSMP messages received on any DSRC interface, containing a specified PSID, to a specified network host, as configured in SNMPv3 MIB OID 1.0.15628.4.1.7. Note: The WSMP Message Forwarding SNMPv3 MIB Object contains the following information: -PSID -Dest_IP Address -Dest_Port -TransPort_Protocol -RSSI -MsgForwardInterval (RSU forwards every nth message received)-DeliveryStart -DeliveryStop See the SNMPv3 MIB OID 1.0.15628.4.1.7 in Appendix B [of the RSU 4.1 Spec] for more information

Test Case #	BNCH-MP_MF-11
Test Case	**DSRC Message Forwarding**
Brief Description	A DSRC Vehicle OBU is broadcasting SAE J2735 Basic Safety Messages (BSM) within communication range of the RSU Under test. A second RSU is broadcasting SAE Traveler Information Messages within communication range of the RSU Under test. Once the RSU under test is in the "operate" state, the Test Operator will monitor the External Network Host for BSMs and TIMs from the RSU Under test.
Entrance Criteria	• External Network Host is available during evaluation
Configuration	• RSU Under test is configured to forward BSMs (PSID 0x20) and TIMs (PSID 0x8003) to an external Network Host. • DSRC OBU is configured for "normal" operation, broadcasting BSMs • Secondary RSU is configured to broadcast Store and Repeat TIMs
Exit Criteria	RSU successfully forwards BSMs and TIMs received over DSRC to a specified External Network Host.
Data Outputs	• Screen Captures of External Network Host depicting BSMs and TIMs received from the RSU under test • Test Operator Data Sheet with relevant notes

Security

The Test Cases listed in this section evaluate the Security functionality of the RSU.

Table 4-13. Authentication - Passwords

Test Case #	BNCH-Sec_A&A-12	
Test Case	**Authentication - Passwords**	
Reference	FIPS 140-2 Section 4.3.3	
Objective	To assess the RSU's authentication control enforcements	
Requirements verified	USDOT_RSU-Req_344-v002	Authentication: The roadside unit **SHALL** be protected by a password compliant with either local operator security policies or a policy based on existing standards (e.g., FIPS 140- Level 3 and 4 in Section 4.3.3)
	USDOT_RSU-Req_346-v002	Authentication: The roadside unit **SHALL** support password recovery for the RSU User Accounts that cannot be violated by physical access alone.
Brief Description	This test verifies conformance to the password uniqueness capabilities of the RSU and the RSU's ability to support a password reset.	

Test Case #	BNCH-Sec_A&A-12
Test Case	**Authentication - Passwords**
Entrance Criteria	RSU is accessible via Ethernet interface. RSU has only been configured with manufacturer default authenticators, as appropriate. RSU password policy enforcement mechanism and user instructions are provided in RSU vendor documentation.
Configuration	RSU under test is configured initially with only default password authenticator from manufacturer. Tester establishes password policy (length, special character requirements, etc.) Tester attempts to create a custom password inconsistent with the established password policy Tester sets a password that is consistent with the established password policy Tester initiates a password reset/recovery function and inspects the security properties of this mechanism and its potential for misuse (e.g., out of band information verification, secure channel). Tester verifies that external physical access to the RSU provides no interfaces from which to initiate a password reset.
Exit Criteria	RSU provides password policy selection mechanism RSU successfully enforces minimum requirement on passwords RSU supports password reset mechanism
Data Outputs	Test Operator Data Notes

Table 4-14. Authentication - SNMP

Test Case #	BNCH-Sec_A&A-13	
Test Case	**Authentication - SNMP**	
Reference		
Objective	To assess the RSU's SNMP authentication control enforcements	
Requirements verified	USDOT_RSU-Req_467-v001	SNMPv3 Authentication: The roadside unit **SHALL** support multiple SNMPv3 users each with an individual password
Brief Description	This test verifies the RSU supports multiple SNMPv3 users with unique passwords. 1. A roadside unit will be connected to a network and configured with appropriate password policies and passwords. The Test Operator will verify that access is granted only after submitting the proper password. 2. SMNPv3 Users will be created, each with different access levels. The Test Operator will log into the RSU under test using the credentials for each user separately and confirm that applicable restrictions apply to each user.	

Test Case #	BNCH-Sec_A&A-13
Test Case	**Authentication - SNMP**
Entrance Criteria	• RSU SNMPv3 username and passwords can be configured • An SNMPv3 capable host is available on the network segment
Configuration	• RSU Under test will be configured with a policy to enforce an 8 character SNMP password for each SNMP user, with one Uppercase and one special symbol. • RSU Under test will be configured with two SNMPv3 users • RSU Under test will be configured with different passwords for each SNMPv3 user
Exit Criteria	RSU supports more than one SNMPv3 user RSU supports different SNMPv3 passwords for each user
Data Outputs	Test Operator Data Notes

Table 4-15. Access Control: Remote Access

Test Case #	BNCH-Sec_A&A-14	
Test Case	**Access Control: Remote Access**	
Reference		
Objective	To assess the RSU's remote access controls	
Requirements verified	USDOT_RSU-Req_348-v001	Access Control: The roadside unit **SHALL** restrict remote network access based on an IP Address Access Control List (ACL) Note: The RSU can only be accessed from the IP Addresses contain in the ACL.
	USDOT_RSU-Req_351-v002	Interfaces: Each roadside unit Ethernet interface **SHALL** be protected by a configurable firewall with a default to be closed.
	USDOT_RSU-Req_356-v003	Network Access Control: The roadside unit **SHALL** only be accessible through the following network protocols: • Secure Shell version 2 (SSHv2) • SNMPv3 • SCP • TLS (HTTPS)
	USDOT_RSU-Req_440-v002	Access Control: If so equipped, Web-Based access to the roadside unit **SHALL** only be through Hypertext Transfer Protocol Secure (HTTPS)
Brief Description	The RSU is verified to restrict remote access	

Test Case #	BNCH-Sec_A&A-14
Test Case	**Access Control: Remote Access**
Entrance Criteria	• RSU Security documentation is available and indicates TLS interface properties • RSU is reachable over Ethernet connection • RSU firewall and ACL are configurable • RSU management software is operational and has network connectivity to the RSU • RSU ACL is configured to accept only one IP address or a range of IP addresses from which to allow remote access. • RSU SSH and/or TLS server certificates are installed.
Configuration	Tester verifies that firewall/ACL default settings is that all remote access is restricted (no IPs, ports, protocols, by default are available). RSU ACL is configured to accept only one IP address or a range of IP addresses from which to allow remote access. RSU manager host IP is changed to an address inconsistent with ACL requirements on board RSU Tester initiates RSU manager connectivity to RSU (attempt should be made using SSH, SCP SNMPv3 and if available, TLS) and verifies RSU rejects the connection Tester initiates RSU manager connectivity to the RSU using a valid IP or IP range and verifies remote access is accepted. Tester verifies that other protocols other than SSH, SNMPv3, SCP, and TLS are not available for remote accessing the RSU.
Exit Criteria	Remote access is restricted to specific TLS configuration traversing a selected firewall configuration
Data Outputs	Test Operator Data Notes, including ACL settings chosen and, optionally, VPN mechanism observed.

Table 4-16. Access Control: Roles and Services

Test Case #	**BNCH-Sec_A&A-15**	
Test Case	**Access Control: Roles and Services**	
Reference		
Objective	Demonstrate clear identification of roles, services (authenticated and unauthenticated) and access controls in the RSU. Roles may be human or machine-level (including external applications); services may be system or application-level.	
Requirements verified	USDOT_RSU-Req_619-v001	Access Control: The roadside unit **SHALL** enforce clear associations between roles, services and the distinct authentication and authorizations required to access those services.
	USDOT_RSU-Req_620-v001	Access Control: Access to sensitive services **SHALL** require an authenticated, authorized role.
	USDOT_RSU-Req_621-v001	Access Control: Access to sensitive data **SHALL** require an authenticated, authorized role.
Brief Description	The RSU operator and machine roles are identified, including: • Local and remote, administrative and general users (SSH, TLS and SNMP users) • SNMP users • External application roles (traffic signal controller applications) • Other vendor or system operator mandated roles Sensitive services (e.g., configuration accesses, cryptographic management, and sensitive application settings) are identified and mapped to each role that is authorized to access the service. The method of authenticating the role is identified and indicates whether it is a role-based or identity-based authentication. Services that do not require role or identity-based authentication to access are identified along with a clear rationale as to why the service is not sensitive.	
Entrance Criteria	• Vendor documentation provided	
Configuration	Tester reviews the access control matrix mapping all RSU services provided to external operators/systems. Operator verifies that all sensitive services are accessible only by an authenticated, authorized role	
Exit Criteria	The RSU maintains clear role/service/access controls on all sensitive services. Unauthenticated services are verified as not sensitive	
Data Outputs	Tester data notes	

Table 4-17. Authentication and Access Control Errors and Enforcement

Test Case #	**BNCH-Sec_A&A-16**	
Test Case	**Authentication and Access Control Errors and Enforcement**	
Reference		
Objective	Demonstrate RSU indications of authentication and access control failures/errors	
Requirements verified	USDOT_RSU-Req_615-v001 (PARTIAL)	Notification: The roadside unit **SHALL** notify a remote host via SNMPv3: • if an Active Message fails an Integrity check • if a configurable number of consecutive authentication attempts have failed • if the signature of a signed DSRC message has failed verification • of any access control errors and rejections
	USDOT_RSU-Req_622-v001	Authentication: The roadside unit **SHALL** be configurable to limit the number of repeated authentication attempts for services requiring authentication.
Brief Description	The RSU is verified to indicate to the operator failed authentication attempts and access control errors over SNMPv3	
Entrance Criteria	• RSU is accessible via Ethernet interface • RSU Management software is active with a SNMPv3 connection established with the RSU • Authorized roles have been established on the RSU (minimum of one high level privilege and one low level privilege access role) • Services and file system entries have been set with access permissions specific to the established roles	
Configuration	AUTHENTICATION ERRORS: • Tester has configured a threshold authentication attempt limit at which the RSU will indicate an error (typically 3 to 10 attempts) • Tester has configured the RSU's policy-conforming SSH and TLS certificates, passwords or other authenticators. • For each Authentication method (incl. SSH, TLS, Password and multi-factor attempts): o Enter the threshold limit of authentication requests using the incorrect authenticator (e.g., mismatching certificates or incorrect passwords) o Observe and record the RSU SNMP indication of the authentication error AUTHORIZATION ERRORS: • For a sampling of executable services and non-executable files: o Log in normally to a low privilege, authorized role o Attempt to initiate a service to which the role does not have access o Observe and record the RSU SNMP indication of the authorization error o Attempt to open a file to which the role does not have access o Observe and record the RSU SNMP indication of the authorization error	
Exit Criteria	The RSU under test indicates authentication errors The RSU under test indicates authorization errors	

Test Case #	BNCH-Sec_A&A-16
Test Case	**Authentication and Access Control Errors and Enforcement**
Data Outputs	Tester data notes, including services, permissions and role attributes attempted

Table 4-18. DSRC Message Signature Verification Duty Cycle

Test Case #	BNCH-Sec_Config-17	
Test Case	**DSRC message signature verification duty cycle**	
Reference	Section 3.4.4 and Section 3.4.5	
Objective	Demonstrate the RSU can be configured to perform digital signature verification on a smaller proportion of received DSRC transmissions.	
Requirements verified	USDOT_RSU-Req_635-v001	Configuration: The roadside unit **SHALL** be configurable regarding the maximum frequency (number per second) or ratio (percentage) of DSRC message digital signatures to verify based on PSID.
Brief Description	The RSU is verified to be configurable to digitally verify either the quantity per second or the percentage of received DSRC messages	
Entrance Criteria	• Vendor RSU documentation available that indicates the instructions for establishing message verification thresholds • RSU connected to Ethernet • RSU Manager session established with RSU • A DSRC message emulator is available that can generate and transmit signed DSRC messages at an adjustable rate according to application-specific PSIDs.	
Configuration	The tester initiates the DSRC message emulator at an upper bound message rate for each PSID. The tester initiates the RSU signature verification threshold to a value equal to or greater than the receive rate for a selected PSID and verifies (e.g., in logs or another method) that the RSU has verified all messages sent in a set time window (for the given PSID) The tester configures the RSU at a low signature verification rate/threshold and performs the test again, verifying that the RSU verified no more DSRC message signatures than configured for the given PSID.	
Exit Criteria	The RSU successfully indicates to the operator any pending or expired certificates and discontinues using expired certificates.	
Data Outputs	Test Operator Data Notes	

Configuration

The Test Cases listed in this section evaluate the configurability of the RSU.

SNMP

Table 4-19. SNMP Walk

Test Case #	**BNCH-SNMP_Walk-18**	
Test Case	**SNMP Walk**	
Reference	*SNMPv3*	
Objective	Confirm RSU can be configured using SNMPv3	
Requirements verified	USDOT_RSU-Req_435-v001	SNMPv3: roadside unit configuration, Management, and Status information **SHALL** be provided through SNMPv3. The RSU Management Information Base (MIB) is contained in APPENDIX B [of the RSU 4.1 Spec].
	USDOT_RSU-Req_490-v001	SNMPv3 MIB Walk: The roadside unit **SHALL** allow an authorized user to perform a MIB walk on the SNMPv3 MIB to produce a complete list of all supported MIBs and OIDs and the current setting for each Object.
Brief Description	Test Operator will log into the RSU under test and run an SNMP Walk Command	
Entrance Criteria	• RSU is accessible via an Ethernet interface • Production grade RSU software capable of supporting the SNMPv3 requirements.	
Configuration	• SNMPv3 username and password configured to allow SNMP access.	
Exit Criteria	• SNMPv3 can be “walked” by the Test Operator.	
Data Outputs	Test Operator Data Sheet with relevant notes	

Table 4-20. SNMP MIB Operation and Management

Test Case #	**BNCH-SNMP_O&M-19**	
Test Case	**SNMP MIB Operation and Management**	
Reference	*SNMPv3*	
Objective	Confirm RSU can be configured using SNMPv3	
Requirements verified	USDOT_RSU-Req_487-v001	SMNPv3 MIB Configurations: The roadside unit **SHALL** operate based on parameters contained in the SNMPv3 MIB stored on the device.
	USDOT_RSU-Req_489-v001	SMNPv3 MIB Configuration Default Parameters: The roadside unit **SHALL** have default values for each configuration parameter in the SNMPv3 MIB.

Test Case #	BNCH-SNMP_O&M-19	
Test Case	**SNMP MIB Operation and Management**	
	USDOT_RSU-Req_491-v002	SMNPv3 MIB Parameter Modification: The roadside unit **SHALL** allow an authorized user to modify the value of any writeable SNMPv3 MIB Object within its valid range.
	USDOT_RSU-Req_493-v001	SNMPv3 MIB installation: The roadside unit **SHALL** allow authorized users to copy/move a SNMPv3 MIB from a network host to the SMNPv3 MIB directory on the device through an Ethernet Interface.
	USDOT_RSU-Req_494-v001	SNMPv3 MIB copy: The roadside unit **SHALL** allow authorized users to copy the SNMPv3 MIB from the SNMPv3 MIB directory to a network host through an Ethernet Interface
Brief Description	Test Operator will perform the following steps: 1. Copy the existing MIB file from the RSU under test to a Laptop through the Ethernet Interface 2. Modify parameters contained in the following MIB Objects in the file on the laptop: • MsgForwarding_x • GPS_Output_Status • DSRC Channel Model_x • WSA Service_x_Configuration • WRA_Configuration 3. Install the modified MIB file to the appropriate directory on the RSU under test 4. Verify the RSU operates based on the new MIB	
Entrance Criteria	• RSU is accessible via an Ethernet interface • Production grade RSU software capable of supporting the SNMPv3 requirements.	
Configuration	• SNMPv3 username and password configured to allow SNMP access.	
Exit Criteria	• A MIB file can be copied from the RSU under test to a network host • A MIB file can be installed on the RSU under test from a network host. • RSU operates based on the parameters contained in the SNMP MIB	
Data Outputs	Test Operator Data Sheet with relevant notes	

Configuration Parameters

Table 4-21. Configuration Updates

Test Case #	BNCH-Config-20
Test Case	**Configuration Updates**
Reference	

Test Case #	BNCH-Config-20	
Test Case	**Configuration Updates**	
Objective	Verify general behavioral requirements: • updateconfig command • SNMPv3 update	
Requirements verified	USDOT_RSU-Req_496-v002	Configuration Updates-updateconfig command: The roadside unit SHALL update all configuration parameters upon receiving an "updateconfig" command from an authorized user
	USDOT_RSU-Req_497-v002	Configuration Updates-SNMPv3 MIB: The roadside unit SHALL update all configuration parameters upon receiving changes to any writable SNMPv3 MIB objects from an authorized user
Brief Description	496 Several configuration parameters should be changed within the configuration files according to the manufacturer's instructions. The 'updateconfig' command is issued. The appropriate changes are verified. 497 A configuration parameter is read by SNMPv3. The same parameter is changed using SNMPv3. The same parameter is read by SNMPv3 and the change is verified.	
Entrance Criteria	Ethernet connection is active and user is authorized to make configuration changes.	
Configuration	• RSU under test is configured for "normal" Operation	
Exit Criteria	• RSU under test is able to be configured using the 'updateconfig' command • RSU under test is able to be configured using SNMPv3	
Data Outputs	Screenshot of configuration parameters before and after change	

RSU Set

Table 4-22. RSU Set Configuration (Multiple Radio Sets)

Test Case #	BNCH-RSU_Set-21	
Test Case	**RSU Set Configuration (Multiple Radio Sets)**	
Reference		
Objective	Confirm multiple radio sets can operate as a single functional unit	
Requirements verified	USDOT_RSU-Req_361-v002	RSU Set: At installation locations that require multiple roadside units to provide the required DSRC coverage, all RSUs **SHALL** be configured to operate as a single functional unit.
	USDOT_RSU-Req_576-v001	RSU Set Master: 1 roadside unit in the RSU Set **SHALL** be configured as the Set "Master" which will be the basis for the configuration of the other RSUs in the Set.

Test Case #	BNCH-RSU_Set-21	
Test Case	**RSU Set Configuration (Multiple Radio Sets)**	
	USDOT_RSU-Req_577-v001	RSU Set Configuration: All non-Master RSUs in the RSU Set **SHALL** be automatically configured based on the configuration of the Set "Master" RSU
	USDOT_RSU-Req_580-v002	RSU Set Backhaul: If the RSU Set has a backhaul connection, all data between the Back Office and the RSU Set **SHALL** route through a single device connecting the RSU Set Master to the other roadside units in the backhaul.
Brief Description	Up to 4 RSUs will be configured as a single functional unit Broadcasting 1609.3 WAVE Service Advertisements, SPaT and Map, and Traveler Information Messages. 1 RSU will have a backhaul connection and act as the “master” device.	
Entrance Criteria	• RSUs support master/slave, or similar mechanism such that multiple devices can be configured to operate as a single functional unit	
Configuration	Test operator will perform the following steps: • 1 RSU is configured as the location “master”, or similar, device • Up to 3 RSUs are configured as “slave” , or similar, devices • Change configurations of the “master” RSU; confirm corresponding configurations of all “slave” RSUs are changed automatically • Confirm the RSU set can work as a single functional unit to broadcast WSA, SPAT, MAP, and TIM messages • Confirm the RSU set conforms with Requirement USDOT_RSU-Req_580-v002	
Exit Criteria	Up to 4 RSUs act as a single functional unit with 1 “master” and 3 “slaves” or similar.	
Data Outputs	Test Operator Data Sheet with relevant notes	

Health and Status Monitoring

The Test Cases listed in this section evaluate the Health and Status Monitoring functionality of the RSU.

Table 4-23. Health and Status Monitoring

Test Case #	BNCH-Health&Status-22	
Test Case	**Health and Status Monitoring**	
Reference		
Objective	Verify reported Health and Status data	
Requirements verified	USDOT_RSU-Req_592-v002	The roadside unit **SHALL** report over SNMPv3: • status of its memory (OID ucdavis.4) • status of its CPU load • status of its non-volatile storage • standard system load average values • time elapsed since it entered the "Operate" state • time elapsed since it was first powered on • last user to log in

Test Case #	BNCH-Health&Status-22	
Test Case	**Health and Status Monitoring**	
		• time the last user logged in • source IP address of the last user to log in • number of messages transmitted and received over DSRC, sorted by Alternating or Continuous, SCH or CCH, and Sent or Received • number of messages transmitted over DSRC, sorted by PSID
Brief Description	The RSU under test will be interrogated via SNMPv3 in accordance with the MIB to verify that each data element is available. The test operator will perform the following steps: • From a remote host connected by Ethernet to the RSU under test, send the SNMP Get command to view the status of the following: o status of its memory (OID ucdavis.4) o status of its CPU load o status of its non-volatile storage o standard system load average values o time elapsed since it entered the "Operate" state o time elapsed since it was first powered on o last user to log in o time the last user logged in o source IP address of the last user to log in • Configure the RSU under test to transmit the following: o MAP on ALTSCH o TIM on CONT 172 • Configure a secondary DSRC device (RSU or OBU) to transmit the following: o MAP on ALTSCH (SCH same as RSU under test) o TIM on CONT 172 • Verify that the transmitted and received messages are counted in the appropriate OID	
Entrance Criteria	• SNMPv3 is operational • RSU is in run mode and capable of receiving and transmitting DSRC messages	
Configuration	• 1 RSU is connected to a host PC and configured to send and receive messages • Secondary DSRC device is configured to send messages	
Exit Criteria	Data are reported in the appropriate OIDs.	
Data Outputs	Test Operator Data with relevant notes	

Operation States

The Test Cases listed in this section evaluate the functionality of the RSU to transition between operation states.

Table 4-24. Operation States

Test Case #	**BNCH-Op_States-23**	
Test Case	**Operation States**	
Reference		
Objective	Confirm RSU can be configured for different operation states.	
Requirements verified	USDOT_RSU-Req_475-v002	State Transition - Initial to Standby: The roadside unit SHALL transition from the "Initial" State to the "Standby State" upon power on. Note: Transition from the "initial" state to the "standby" state only happens the first time the device is powered on after manufacturing or after factory reset. The device will only return to the "initial" state if a factory reset is initiated.
	USDOT_RSU-Req_476-v002	State Transition - Operate to Standby: The roadside unit SHALL transition from the "Operate" State to the "Standby" State upon receiving a "standby" command from an authorized user
	USDOT_RSU-Req_479-v002	State Transition - Standby to Operate: The roadside unit SHALL transition from the "Standby" State to the "Operate" state upon receiving a "run" command from an authorized user
	USDOT_RSU-Req_480-v002	State Transition - Current to No Power: The roadside unit SHALL transition from its current State to the "No Power" State upon loss of power or user initiated shut down without corrupting or damaging the file system or files contained on the unit.
	USDOT_RSU-Req_575-v001	State Transition - No Power to Previous State: When power is restored, the roadside unit SHALL transition from the “No Power” state to the State (“Standby” or “Operate”) the roadside unit was in when power was lost.
	USDOT_RSU-Req_568-v002	Factory Reset: The roadside unit SHALL support a "Factory Reset" mechanism (command, button, etc.) for authenticated, authorized local users to remove all configuration parameters and operator installed files, returning the device to its original Factory Settings and “Initial” State
Brief Description	The RSU under test will be configured for different operation states, using the manufacturers recommended procedures.	
Entrance Criteria	The RSU under test supports different operation states (“Initial,” “Standby,” “Operate,” and “No Power”) and factory reset.	

Test Case #	BNCH-Op_States-23
Test Case	**Operation States**
Configuration	• Backup all configurations and critical files of the RSU under test; after that, the RSU will be conducted a “Factory Reset”, using the manufacturer’s recommended procedure; • When the RSU is powered up, confirm the RSU’s state changes from “Initial” to “Standby”; • Confirm the RSU’s state changes from “Standby” to “Operate”, using the manufacturer’s recommended command; • Confirm the RSU’s state changes from “Operate” to “Standby”, using the manufacturer’s recommended command; • Remove the power of the RSU under test, confirm that RSU’s state changes from current state (“Standby” or “Operate”) to “ No Power”; • Reconnect the power of the RSU under test, confirm that RSU’s state changes from “ No Power” to previous state (“Standby” or “Operate”).
Exit Criteria	The RSU under test is successfully configured for different operation states.
Data Outputs	Test Operator Data Sheet with relevant notes; Relevant System Log Files.

APPENDIX A. List of Acronyms

DSRC	Dedicated Short Range Communication: Vehicle-to-Vehicle and Vehicle-to-Roadside communication Protocols
IEEE 1609	Suite of Institute of Electrical and Electronics Engineers Standards defining DSRC Security, Network, Upper MAC, etc., protocol stack layers
Map	SAE J2735 defined message containing a vector map of an intersection identifying Lane, and allowed movements for each Lane.
RSU	Roadside Unit: Infrastructure device that facilitates Vehicle-to-Roadside communications over DSRC
SAE J2735	Society of Automotive Engineers standard containing vehicle-to-vehicle and vehicle-to-roadside messages, frames, and data definitions
SPaT	Signal Phase and Timing: SAE J2735 defined message containing information related to the current phase and when the phase will change for a given signalized intersection
TIM	Traveler Information Message: SAE J2735 defined message containing traveler information vehicle drivers may be interested in
WAVE	Wireless Access in Vehicular Environments
WRA	WAVE Routing Advisement: Data Frame contained in a WSA that provides IPv6 address and routing information for the subject RSU
WSA	WAVE Service Advertisement: 1609.3 defined management packet containing services provided by the subject RSU
WSMP	WAVE Short Message Protocol: IEEE 1609.3 defined message types

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