Welcome

Ken Leonard, Director
ITS Joint Program Office
Ken.Leonard@dot.gov

www.pcb.its.dot.gov
CV T160: Connected Vehicle Certification Testing

Introduction
Instructor

Dave Miller

Principal Systems Engineer
Siemens Industry Inc.
Austin, TX, USA
Learning Objectives

**Identify** Connected Vehicle (CV) **equipment** needed for a signalized intersection

**Review USDOT Requirements** Specifications for **RSU** hardware and software for procurement

**Understand** the **role of Certification Testing** within the context of a systems lifecycle

**Develop a Certification Plan**
Learning Objective 1

Identify Connected Vehicle (CV) equipment needed for a signalized intersection
What Is a Connected Vehicle (CV)?

**Safety System:** “Connected vehicles enable safe, interoperable networked wireless communications among vehicles, the infrastructure, and passengers’ personal communications devices.” –USDOT

**CV ≠ Autonomous**

- Automated Vehicles (AV)
- AV is Autopilot system
- CV is a Safety System
- CV predicts incidences
- Drivers use CV as input
- AV uses CV as input

Source: USDOT

Source: NYCDOT
Review of Previous Modules

A Paradigm Shift…

Source: USDOT
Completed Modules on Connected Vehicle

- **CV / I261: V2V ITS Standards for Project Managers**

  Location Service Inputs
  - GPS
  - Vehicle System Sensors
  - Dead Reckoning
  - Others

  Over-the-Air Messages Transmitted
  - SAE J2735 BSM

  Over-the-Air Messages Received
  - SAE J2735 BSM (From Private Vehicles)

Available at Professional Capacity Building (PCB)
Website: [https://www.pcb.its.dot.gov/standards_modules.aspx](https://www.pcb.its.dot.gov/standards_modules.aspx)

Source: USDOT
Review of Previous Modules

Completed Modules on Connected Vehicle

- CV / I262: V2I ITS Standards for Project Managers

Source: USDOT

Available at PCB Website:
Key Concepts: On-Board Equipment (OBE)

- On-Board Unit (OBU)
- Driver Interface

- GPS, DSRC antennae
- Dedicated Short Range Communications (DSRC) radio
  - Receives and transmits data through antennae
- GPS Receiver
  - Vehicle position input to Location Service, plus accurate time
- Memory
  - Stores security certificates, application data, and other information
- Safety application electronic control unit
  - Runs safety applications
- Driver-vehicle interface
  - Generates warning issued to driver
- Vehicle’s internal communications network
  - Existing network that interconnects components

Security system
- Provides and verifies V2V security certificates to ensure trust between vehicles

Source: USDOT
Review of Previous Modules

Key Concepts: Roadside Equipment (RSE)

Source: USDOT
Review of Previous Modules

Key Concepts: Communication and Standards

General Communications Requirements

How do we communicate?
IEEE 802.11, IEEE 1609.3

What language are we using?
SAE J2735, SAE J2945

How many people are talking in the room?
IEEE 1609.4

How do we trust each other?
IEEE 1609.2 enables it

Source: USDOT
Connected Vehicle (CV) Terminology

Architecture

- **Controller / Signals**
  - 60 Hz Time base
- **Backhaul to TMC**
  - WAN of Controllers
  - Optional for Solos
  - NIST Time Service

Source: Siemens Industry Inc.
Why Do We Need a CV Certification Testing Process?

- Certification testing process ensures that communications between vehicle and roadside equipment are **Private**, **Secure**, and **Interoperable**.

- Develop a **Certification Plan** based on relevant CV Environment:
  - Roadside Unit (**RSU**)  
  - On-Board Unit (**OBU**)  
  - IEEE 829-2008 Formats  
  - USDOT Requirements  

---

**CV Certification Plan**

Agency

Date
Connected Vehicle (CV) Terminology

Roadside Equipment - RSE

- Antennas
- Roadside Unit - RSU
- Lightning suppression
- Backhaul communication

Source: USDOT

Source: Siemens Industry Inc.
Purpose of DSRC RSU

- **RSU** facilitates **communication** between transportation infrastructure and vehicles and other mobile devices by **exchanging data over DSRC** in compliance with industry standards.

- **Certification:**
  - DSRC Roadside Unit
  - DSRC Onboard Unit

Cooperative System (CoS)

- Integrated through RSU

Source: USDOT DSRC Requirements
1 Typical RSE

- Antennas, lightning suppression
- Roadside Unit (RSU)
  - Certification Required
- Backhaul communication
- Controller:
  - Signalized intersection CV apps
  - Not used midblock, exits, speed
- Power over Ethernet (PoE) injector
- V2I Hub Interface Control Document
  - USDOT Open Source Portal
  - Current signal Phase states
  - Min and Max countdown
  - No controller timestamp
DSRC RSU Performs Two Core Functions

1. Provide IPv6 **access** to remote network hosts

2. Broadcast and receive **messages** as defined in SAE J2735

RSU uses NEMA 4-X rated enclosure.

Source: Siemens Industry Inc.
RSU Mounting Details

- Housed inside cabinet or outside on pole
- Antennas have line-of-sight to vehicle lanes
- Outdoor CAT6 cable connected to PoE injector in RSE cabinet
- PoE Injector adds +48 VDC power on the Ethernet cable to power the RSU

Source: Siemens Industry Inc.
Roadside Unit - RSU

Antennas and Cabling: RSU on Gantry

Source: USDOT
Roadside Unit - RSU

Antennas and Cabling: RSU in RSE Cabinet

Source: USDOT
RSU Installations

- Antennas have **line-of-sight** to vehicle lanes
Signal Phase and Timing - SPaT

- Traffic signals are sharing messages between all nearby vehicles, infrastructure, and even pedestrian cell phones.
- SPaT in real-time: Matches visible signals within 50mS.
On-Board Unit - OBU

2 On-Board Unit (OBU)

- On Board Unit (OBU) - Mobile Component of CV Communications:
  - Class 1: Part of vehicle system
  - Class 2: Aftermarket device
  - Class 3: Nomadic device, e.g., smart phone

- Certification required

Source: USDOT-RITA
On-Board Unit (OBU)

OBU Integration

Class 1 - New Vehicles

Class 2 - Existing Vehicles

Class 3 - Existing Personnel Devices

Source: Siemens Industry Inc.
Roadside Unit - RSU

DSRC RSU Supports (Interface and Protocols)

- Single Channel Continuous and Dual Channel Alternating DSRC Channel Modes simultaneously per Requirements
- Power over Ethernet (PoE) compliant with 802.3at eliminates shock hazard and service power wiring

Source: USDOT
Connected Vehicle (CV) Operation

Vehicle “sees” digital representation of what the driver sees within 1/10 second

MAP and SPaT are available to vehicle during CU failure

Source: USDOT

Source: Siemens Industry Inc.
Connected Vehicle (CV) Operation

MAP and SPaT Without Signal Controller

MAP and SPaT are available to vehicle without need for CU

Source: USDOT

Source: Siemens Industry Inc.
Connected Vehicle (CV) Terminology

Backhaul Communications

- Traffic Operations
  - Signal Controller Data

- Traffic Server
  - Traffic Management Application
  - NTCIP 1202 v2 GET Status

- Master Server
  - Database Application
  - Agency Data Applications
  - Terrestrial Backhaul

- Switch
  - LTE Backhaul

- RSU
  - GPS Time

- ATC
  - NTCIP 1202 v2 SET Phase GET Status
  - V2I Hub ICD

Source: USDOT
**Test and Levels of Testing**

**Level 1:** 
*Procurement* of software objects and hardware objects

**Level 2:** 
*Test of software modules and hardware units*

**Level 3:** 
*Integration* test of software modules installed into hardware objects to form subsystems

**Level 4:** 
*Acceptance* test of system to fulfill Use Case requirements

**Level 5:** 
*Validation* of system installed in roadside equipment and vehicles

**Level 6:** 
*End to end system test*, operation and maintenance

Source: Siemens Industry Inc.
Connected Vehicle (CV) Terminology

Test and Certification Levels

Systems Engineering Process (SEP): Certification of software Units and hardware Devices

Source: Siemens Industry Inc.
Security Credential Management System (SCMS)

Role of SCMS

- SCMS provides DSRC devices with **digital certificates** that the devices use to sign (authenticate) and **encrypt** DSRC messages and **revoke** certificates.

![Diagram showing key generation process between OBU and RSU]

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International Atomic Time (Temps Atomique International-TAI)
What is the relationship between the RSE and RSU?

Answer Choices

a) RSE is the DSRC radio to the nearby vehicles
b) RSU includes the RSE
c) RSU is the DSRC radio that is part of the RSE
d) Backhaul connects the RSE with the RSU
Review of Answers

a) RSE is the DSRC radio to the nearby vehicles

Incorrect. RSE is all of the infrastructure equipment, such as signal controller, network equipment, signal monitor, etc.

b) RSU includes the RSE

Incorrect. RSE is not part of the RSU.

c) RSU is the DSRC radio that is part of the RSE

Correct! RSU is the DSRC radio that connects the signal controller, over the air, to vehicles using 5.9GH band.

d) Backhaul connects the RSE with the RSU

Incorrect. The backhaul is part of the communications network.
Learning Objectives

**Identify** Connected Vehicle (CV) **equipment** needed for a signalized intersection

**Review** USDOT **Requirements** Specifications for **RSU** hardware and software for procurement
Learning Objective 2

Review USDOT Requirements Specifications for RSU hardware and software for procurement
Relevant Standards to Insure Security, Privacy, and Interoperability

DSRC RSU Specifications Document - USDOT

- Includes DSRC RSU system requirements for:
  - Power
  - Environmental
  - Physical
  - Functional
  - Behavioral
  - Performance
  - Interface

Source: USDOT
Relevant Standards to Ensure Security, Privacy, and Interoperability

- **Standards for Security**
  - IEEE 1609.2 Security Services
  - IEEE 1609.3 MAC address change at intervals

- **Standards for Privacy**
  - SAE J2735 DSRC Message Set Dictionary
  - SAE J2945/1 for V2V safety (under development 2/2017)
  - SAE J2945/2 for safety and emergency vehicles
  - ISO TS 19091 for signalized Intersection Apps

- **Standards for Interoperability**
  - IEEE 1609.3 Networking Services
  - IEEE 802.11p Wireless LAN
  - IEEE 1609.4 Multi Channel Operation
  - IEEE 802.3at PoE
  - NEMA TS2 Traffic Signal Controller
  - NTCIP 1202 v2 plus USDOT V2I Hub ICD
## Elements of the CV Wireless Stack That Require Certification

### CV Wireless Stack Certification

<table>
<thead>
<tr>
<th>BSM: LAT LONG HEADING SPEED VEHICLE SIZE</th>
<th>IPv6</th>
<th>IPv6</th>
<th>IEEE 802.2</th>
<th>Backhaul PHY²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IEEE 1609.2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1609.3, 802.2, 802.11p</td>
<td></td>
<td></td>
<td>IEEE 802.2</td>
<td></td>
</tr>
<tr>
<td>5.9 GHz wireless (802.11p), 1609.4</td>
<td></td>
<td></td>
<td></td>
<td>Backhaul PHY²</td>
</tr>
</tbody>
</table>

**Basic Safety Message (BSM)**

Source: USDOT
Understand the Messages for Certification

SAE J2735 Message Certification

Source: Siemens Industry Inc.
Understand the Messages for Certification

SAE J2735 Message Certification

Source: Siemens Industry Inc.
Understand the Messages for Certification

SAE J2735 Message Certification

5.9 GHz Dedicated Short Range Communication

MAP Message

Signal Phase and Timing

RSU

Intersection Movement Assist
Forward Collision Warning

Basic Safety Message

On-Board Equipment

Signal Controller

Normal Traffic

Source: Siemens Industry Inc.
Understand the Messages for Certification

SAE J2735 Message Certification

On-Board Equipment

Vehicle Mobile Terminal

Police/Fire/EMS or Transit

On-Board Equipment

5.9 GHz Dedicated Short Range Communication

Signal Request Message

NTCIP 1202 SET

Signal Controller

Source: Siemens Industry Inc.
Understand the Messages for Certification

SAE J2735 Message Certification

On-Board Equipment

Vehicle Mobile Terminal

Police/Fire/EMS or Transit

Source: Siemens Industry Inc.
Understand the Messages for Certification

SAE J2735 Message Certification

5.9 GHz Dedicated Short Range Communication

MAP Message
Signal Phase and Timing

RSU

Curve Speed Warning → Traveler Information Message → Work Zone Warning

Wrong Way

State Law

Stop for Pedestrians

Stop
Here for

On-Board Equipment

Normal Traffic

Source: Siemens Industry Inc.
Understand the Messages for Certification

SAE J2735 Message Certification

- Signal Phase and Timing
- Curve Speed Warning
- Traveler Information Message
- Basic Safety Message
- Signal Request Message
- Signal Status Message
- MAP Message

On-Board Equipment
Vehicle Mobile Terminal
Police/Fire/EMS or Transit

Source: Siemens Industry Inc.
Which is not a part of the RSU wireless stack?

**Answer Choices**

a) IPV6 device addresses
b) Basic Safety Message (BSM) of vehicle location, heading speed, elevation
c) 5.9 GHz wireless frequency band
d) IEEE 1609.2 security certificates
Review of Answers

a) IPV6 device addresses

Incorrect. IPV6 is the RSU Internet protocol address and included in the RSU Requirements Specification for the stack.

b) Basic Safety Message (BSM) of vehicle location, heading speed, elevation

Correct! BSM is a J2735 over-the-air message that is part of the RSU application made up of dialogs of messages.

c) 5.9 GHz wireless frequency band

Incorrect. The wireless frequency band is included in the RSU Requirements Specification for the stack.

d) IEEE 1609.2 security certificates

Incorrect. Mandatory uses of security certificates conforming to IEEE 1609.2 is part of the RSU Requirements Specification.
Learning Objectives

Identify Connected Vehicle (CV) equipment needed for a signalized intersection

Review USDOT Requirements Specifications for RSU hardware and software for procurement

Understand the role of Certification Testing within the context of a systems lifecycle
Learning Objective 3

Understand the role of Certification Testing within the context of a systems lifecycle
Create a Requirements to Test Case Traceability Matrix

What Are We Certifying?

- **Conformance** to RSU Requirements Specification
  - To ensure that all vehicles will work *correctly everywhere* within the CV network
  - Without certification, vehicles will not be able to receive *security certificates*

- RSU Requirements Specification includes:
  - Environmental
  - References to Relevant Standards
  - Minimum Security Requirements

Source: USDOT
## Develop a Requirements to Test Case Traceability Matrix (RTCTM)

### RTCTM for RSU

<table>
<thead>
<tr>
<th>ReqID</th>
<th>Description</th>
<th>Reference</th>
<th>Verification Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDOT_RSU-Req_312-v001</td>
<td>Ambient Temperature RSU: The roadside unit SHALL function as intended within the temperature range of -34 degrees C (-30 degrees F) to +74 degrees C (+165 degrees F).</td>
<td>NEMA TS 2-2003 v02.06</td>
<td>Test: A &quot;Pass&quot; indication contained in a Test Report from an accredited test facility</td>
</tr>
<tr>
<td>USDOT_RSU-Req_546-v001</td>
<td>Ambient Temperature Power Injector: The Power Injector unit SHALL function as intended within the temperature range of -34 degrees C (-30 degrees F) to +74 degrees C (+165 degrees F).</td>
<td>NEMA TS 2-2003 v02.06</td>
<td>Test: A &quot;Pass&quot; indication contained in a Test Report from an accredited test facility</td>
</tr>
<tr>
<td>USDOT_RSU-Req_313-v001</td>
<td>Ambient Temperature Rate of Change RSU: The roadside unit SHALL function as intended under changes in ambient temperature up to 17 degrees C (30 degrees F) per hour, throughout the required operational temperature range.</td>
<td>NEMA TS 2-2003 v02.06</td>
<td>Test: A &quot;Pass&quot; indication contained in a Test Report from an accredited test facility</td>
</tr>
</tbody>
</table>
Develop a Set of Test Cases for RSU Certification

Test Case for RSU Certification

LTP-Level Test Plan

Master Test Plan (MTP)
- Integrity level scheme and choice
- Overall test processes, activities, and tasks
- Test levels and documents

Unit Test Plan (LTP)

Subsystem Integration Test Plan (LTP)

System Acceptance Test Plan (LTP)
- Scope of test level
- Resources
- Test method(s)

Unit Test Design
- Detail updates for test methods
- Features to be tested

Unit Test Cases
- Input
- Output

Unit Test Procedures
- Test setup
- Execution instructions

Source: USDOT Professional Capacity Building
Develop a Set of Test Cases for RSU Certification

Unit Test Plan Workflow

- Unit Test Plan (LTP)
  - Scope of test level
  - Resources
  - Test method(s)

- Unit Test Design
  - Detail updates for test methods
  - Features to be tested

- Unit Test Case 1
- Unit Test Case 2
- Unit Test Case 3

- Unit Test Procedure 1
- Unit Test Procedure 2
- Unit Test Procedure 3

- Input
- Output

- Test setup
- Execution instructions
Test Procedures for RSU Certification by an Independent Laboratory

- **Vehicle to Vehicle (V2V)** Safety Test Specifications exist now
  - Stack (802.11, 1609.2, 1609.3, 1609.4)
  - V2V safety (J2945/1)

- Additional applications planned for certification for the CV pilots

- Certification operating council with support of USDOT
Addressing Local Needs

Typical Example: Pedestrian Safety

- **Needs**
  - Detect pedestrians
  - Avoid PED / vehicle conflicts

- **Requirements**
  - Transmit PED location to OBU
  - Receive PED location by OBU
  - Warn driver of crash trajectory

Source: Siemens Industry Inc.
Test Procedures for RSU Certification

Addressing Local Needs

Pedestrian Safety:

- **Needs**
  - Detect pedestrians
  - Avoid PED / vehicle conflicts

- **Requirements**
  - Transmit PED location to OBU
  - Receive PED location by OBU
  - Warn driver of crash trajectory

- **Design**
  - Dialog of BSM & PSM between car and PED
  - Calculate crash trajectories
  - Issue driver warnings

- **Test**
  - Master Test Plan
  - Level Test Plans

Source: Siemens Industry Inc.
ACTIVITY
Which of the following applies to Agencies requiring RSU certification process?

**Answer Choices**

a) Develop RSU Test Cases per each agency  
b) Specify independent certification test report per Certification Test Specification, with special provisions for local needs  
c) Purchase RSUs without contract requirements  
d) None of the above
Review of Answers

a) Develop RSU Test Cases per agency

Incorrect. RSU Test Cases should be uniform throughout North America for interoperability with vehicles.

b) Specify independent certification test report per Certification Test Specification, with special provisions for local needs

Correct! Specify the Certification Test Procedure to ensure compatibility with vehicles, and then add special provisions for local needs, such as Wi-Fi connection to smart phones.

c) Purchase RSUs without contract requirements

Incorrect. Without contract requirements, older revision of RSU specification can be substituted, or delivery without security.

d) None of the above

Incorrect.
Learning Objectives

Identify Connected Vehicle (CV) equipment needed for a signalized intersection

Review USDOT Requirements Specifications for RSU hardware and software for procurement

Understand the role of Certification Testing within the context of a systems lifecycle

Develop a Certification Plan
Learning Objective 4

Develop a Certification Plan
Independent Testing Laboratories

Independent Laboratory Test Options

OmniAir

7layers

DANLAW

SwRI
 Certification

Certification Scope

<table>
<thead>
<tr>
<th>1 - Environmental Abilities</th>
<th>2 - Communication Protocol Abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - Interface Abilities</td>
<td></td>
</tr>
<tr>
<td>4 - Overall Application Abilities</td>
<td>Applications</td>
</tr>
<tr>
<td>Applications</td>
<td>Basic Device</td>
</tr>
</tbody>
</table>

Certification Levels

1. Environmental Abilities including Physical Security
2. Communication Protocol Abilities
3. Interface Abilities (both the syntax and contents of the message payload transmitted over the communications medium)
4. Overall Application Abilities

Source: USDOT
## Certification

### Technical Standards

<table>
<thead>
<tr>
<th>DSRC-WSMP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Remote Vehicle OBE</strong></td>
</tr>
<tr>
<td>ITS Application Information Layer</td>
</tr>
<tr>
<td>SAE J2735</td>
</tr>
<tr>
<td>Application Layer</td>
</tr>
<tr>
<td>Undefined</td>
</tr>
<tr>
<td>Presentation Layer</td>
</tr>
<tr>
<td>ISO ASN.1</td>
</tr>
<tr>
<td>Session Layer</td>
</tr>
<tr>
<td>Undefined</td>
</tr>
<tr>
<td>Transportation Layer</td>
</tr>
<tr>
<td>IEEE 1609.3 WSMP</td>
</tr>
<tr>
<td>Network Layer</td>
</tr>
<tr>
<td>IEEE 1609.3 WSMP</td>
</tr>
<tr>
<td>Data Link Layer</td>
</tr>
<tr>
<td>IEEE 1609.4, 802.11</td>
</tr>
<tr>
<td>Physical Layer</td>
</tr>
<tr>
<td>IEEE 802.11</td>
</tr>
</tbody>
</table>

### Data Messages

- SAE J2945/1 Requirements for V2V
- Encoding (ISO ASN.1 UPER)
- Process Information (SAEJ2735)

### Data Transmission

- Transport (IEEE1609.3 WSMP, IPv6)
- Security (IEEE 1609.2)
- Link (IEEE 1609.4)
- Physical (IEEE 802.11)

### Device Profiles

- **V2V** per SAE J2945/1
- **V2V + SCMS** per SAE J2945/1
- **CV Pilot OBU**
- **CV Pilot RSU** per USDOT RSU 4.1 spec

**Source:** USDOT
Certification

Test System Architecture

Test System (TS)
- Test Management Software

Test Control Interface (TCI)

System Under Test (SUT)
- Test Control Interface Application (TCI)
- Implementation Under Test (IUT)

Built for automation
Radio testing and protocol conformance
Devices (IUTs) must implement a TCI application

Test Radio Interface (TRI)

Source: USDOT
## Test Specifications

<table>
<thead>
<tr>
<th>Applications</th>
<th>Test Specification</th>
<th>Title/Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAE J2735 &amp; J2945/1 Messaging</td>
<td>Test System Interface</td>
<td>Test Command Interface Protocol Specification</td>
</tr>
<tr>
<td>IEEE1609.3</td>
<td>J2945.1-TSS&amp;TP</td>
<td>Test Suite Structure and Test Purposes for SAE J2945/1</td>
</tr>
<tr>
<td></td>
<td>WAVESEC-TSS&amp;TP</td>
<td>Test Suite Structure and Test Purposes for Security Services (IEEE 1609.2)</td>
</tr>
<tr>
<td></td>
<td>WAVENS-TSS&amp;TP</td>
<td>Test Suite Structure and Test Purposes for Network Services (IEEE 1609.3)</td>
</tr>
<tr>
<td></td>
<td>WAVEMCO-TSS&amp;TP</td>
<td>Test Suite Structure and Test Purposes for Multi-Channel Operation (IEEE 1609.4)</td>
</tr>
<tr>
<td></td>
<td>WAVE802.11-TSS&amp;TP</td>
<td>Test Suite Structure and Test Purposes for IEEE802.11 (Scope of DSRC)</td>
</tr>
</tbody>
</table>

Source: USDOT
### Example Test

<table>
<thead>
<tr>
<th>Test Purpose Id</th>
<th>TP-16094-RXT-MDE-BV-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>Transmit WSMs in continuous channel mode (non-switching) and verify IUT receives the transmitted messages.</td>
</tr>
<tr>
<td>Test Configuration</td>
<td>TC1</td>
</tr>
<tr>
<td>Reference:</td>
<td>[2] 5.2, 6.3.1, 5.2.1, 5.2.3</td>
</tr>
<tr>
<td>PICS Selection</td>
<td>M2, M2.1, M3, M3.1</td>
</tr>
</tbody>
</table>

#### Pre-test conditions
- The IUT is in initial state as per sec 4.3.1

#### Test Sequence

<table>
<thead>
<tr>
<th>Step</th>
<th>Type</th>
<th>Description</th>
<th>Verdict</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Configure</td>
<td>IUT to receive WSM messages in continuous channel mode on ‘vChannel’</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Configure</td>
<td>Test Equipment to transmit WSMs in continuous channel mode on ‘vChannel’ with ‘vDataRate’ at ‘vWSMRepeatRate’.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Stimulus</td>
<td>Test Equipment to continuously transmit WSM messages</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Verify</td>
<td>IUT receives WSM messages available on ‘vChannel’ at every ‘vWSMRepeatRate’.</td>
<td>PASS / FAIL</td>
</tr>
<tr>
<td>5</td>
<td>Procedure</td>
<td>Repeat steps 1-4 for each supported value of ‘vDataRate’ in Table 4-2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Procedure</td>
<td>Repeat steps 1-5 for each supported value of ‘vChannel’ in Table 4-1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Configure</td>
<td>The IUT to initial state</td>
<td></td>
</tr>
</tbody>
</table>

Source: USDOT
Certification

Certification Process

- Certification is similar to other certification schemes
- Certification applies to
  - in-vehicle modules (for OEM integration)
  - roadside devices
  - aftermarket devices
- Device manufacturers pay for certification

Source: USDOT
Device Certification Progression

Pre-commercial phase (2016-2017)
- Managed by the Certification Operating Council (USDOT project)
- Test specifications available
- 1st USDOT PlugFest for device interoperability in Nov 2016, Novi MI

Commercial certification phase (after 2017)
- Industry certification managed by an industry trade association - OmniAir

Source: USDOT
ACTIVITY
Which of the following is not a CV application group?

**Answer Choices**

a) V2V Safety  
b) V2I Mobility  
c) Road and Weather  
d) Autopilot for self-driving vehicle
Review of Answers

a) V2V Safety

Incorrect. V2V Safety is an application group.

b) V2I Mobility

Incorrect. V2I Mobility is an application group.

c) Road and Weather

Incorrect. Road and Weather is an application group.

d) Autopilot for self-driving vehicle

Correct! Self-driving vehicle is an Autopilot system, not part of Connected Vehicle applications.
Module Summary

**Identify** Connected Vehicle (CV) **equipment** needed for a signalized intersection

**Review** USDOT **Requirements** Specifications for **RSU** hardware and software for procurement

**Understand** the **role of Certification Testing** within the context of a systems lifecycle

**Develop a** Certification Plan
We Have Now Completed the CV Curriculum

**Module CV I261**: V2V ITS Standards for Project Managers

**Module CV I262**: V2I ITS Standards for Project Managers

**Module CV T160**: Connected Vehicle Certification Testing Introduction
Thank you for completing this module.

Feedback
Please use the Feedback link below to provide us with your thoughts and comments about the value of the training.

Thank you!