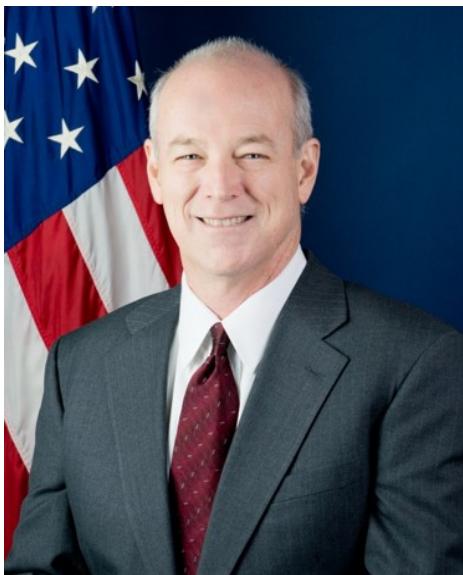**STANDARDS ITS TRAINING**

WELCOME

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

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…

8

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/stds_modules.aspx

Source: USDOT

Completed Modules on Connected Vehicle

- CV / I262: V2I ITS Standards for Project Managers

Over-the-Air Messages Transmitted
- SAE J2735 SPaT
- SAE J2735 MAP
- SAE J2735 TIM

Over-the-Air Messages Received
- SAE J2735 BSM

Traffic Signal Controller

Backhaul
- RSU Status
- Agency Data

USDOT V2I Hub ICD
- Current signal states
- Min countdown to change
- Max countdown to change

R S U

Available at PCB Website:
https://www.pcb.its.dot.gov/stds_modules.aspx

Source: USDOT

Key Concepts: On-Board Equipment (OBE)

Source: USDOT

Key Concepts: Roadside Equipment (RSE)

Roadside Unit (RSU)

GPS, Wireless Antenna

Wireless Communications Device
Receives and transmits data through an antennae

GPS Receiver
• Provides position and time
• Provides timekeeping signal for applications

CABINET

Controller Unit (CU)
Signal Applications Only
Current Active Phases
Countdown to Change

Memory
Stores security certificates, application data, and MAP File

Application Processing Unit
Processing unit that runs the applications

Backhaul Modem Device
Receives and transmits data with a center

Pole

Source: USDOT

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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
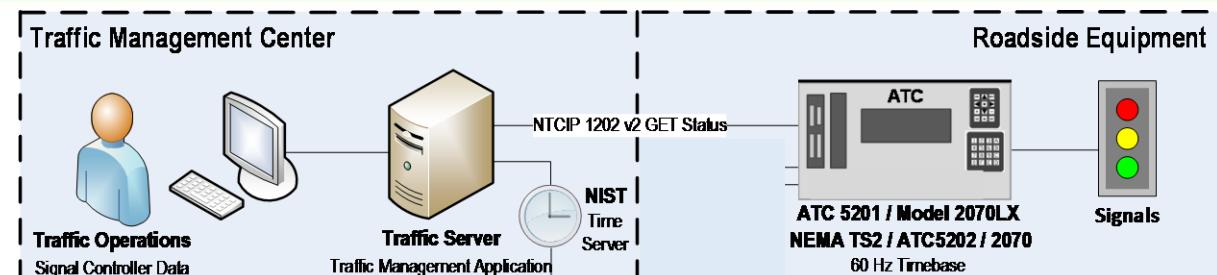
How do we trust each other?
IEEE 1609.2 enables it

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
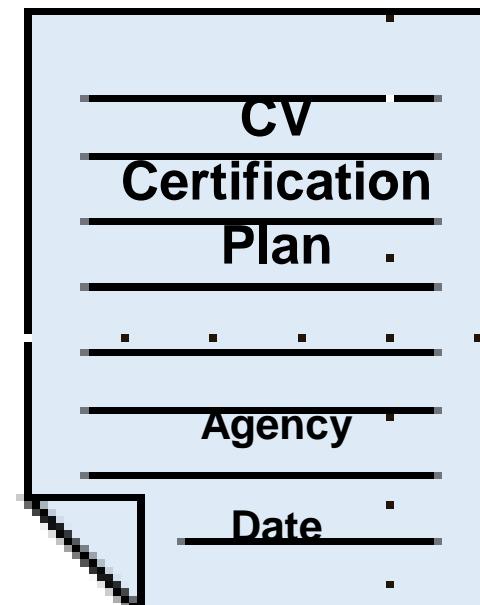
Connected Vehicle (CV) Terminology

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

Source: USDOT

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

Roadside Unit RSU

Source: Siemens Industry Inc.

Roadside Unit - RSU

Purpose of DSRC RSU

DSRC - Dedicated Short-Range Communications

- **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
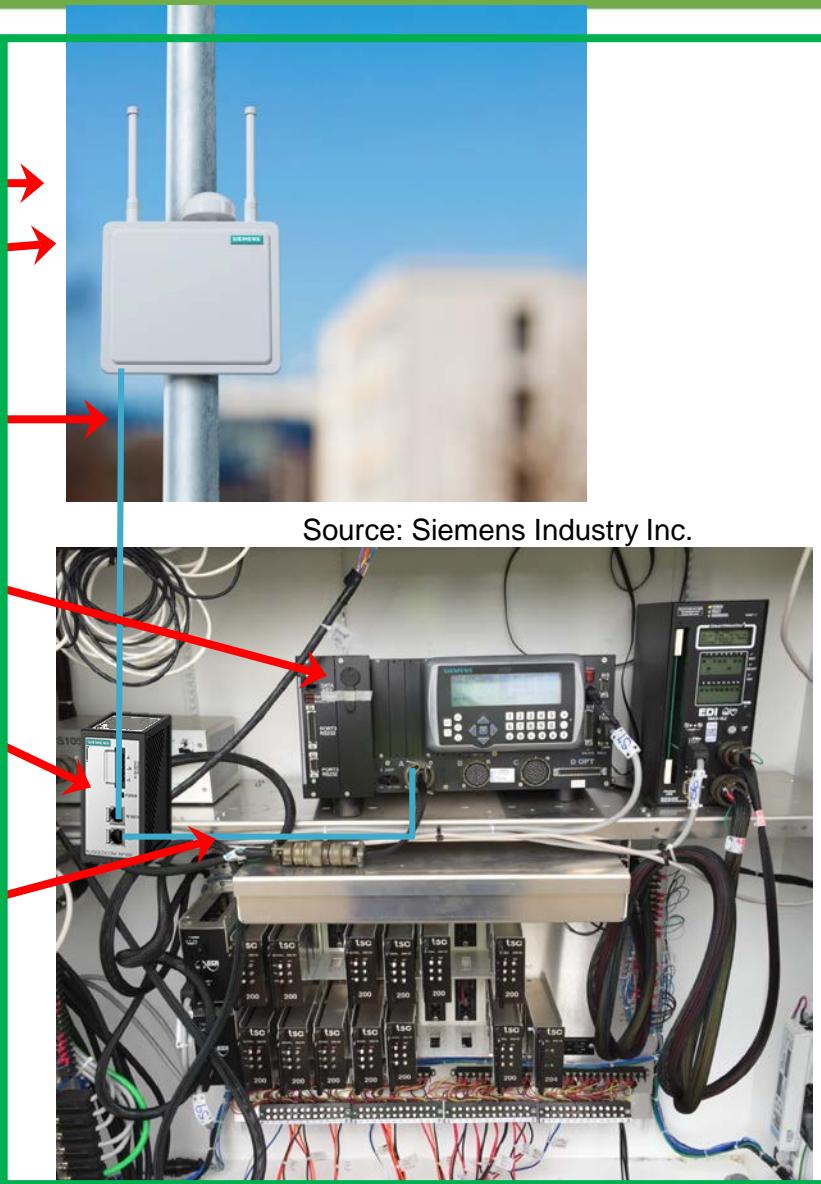
Infrastructure Roadside Equipment

(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

Source: Siemens Industry Inc.

Source: Siemens Industry Inc.
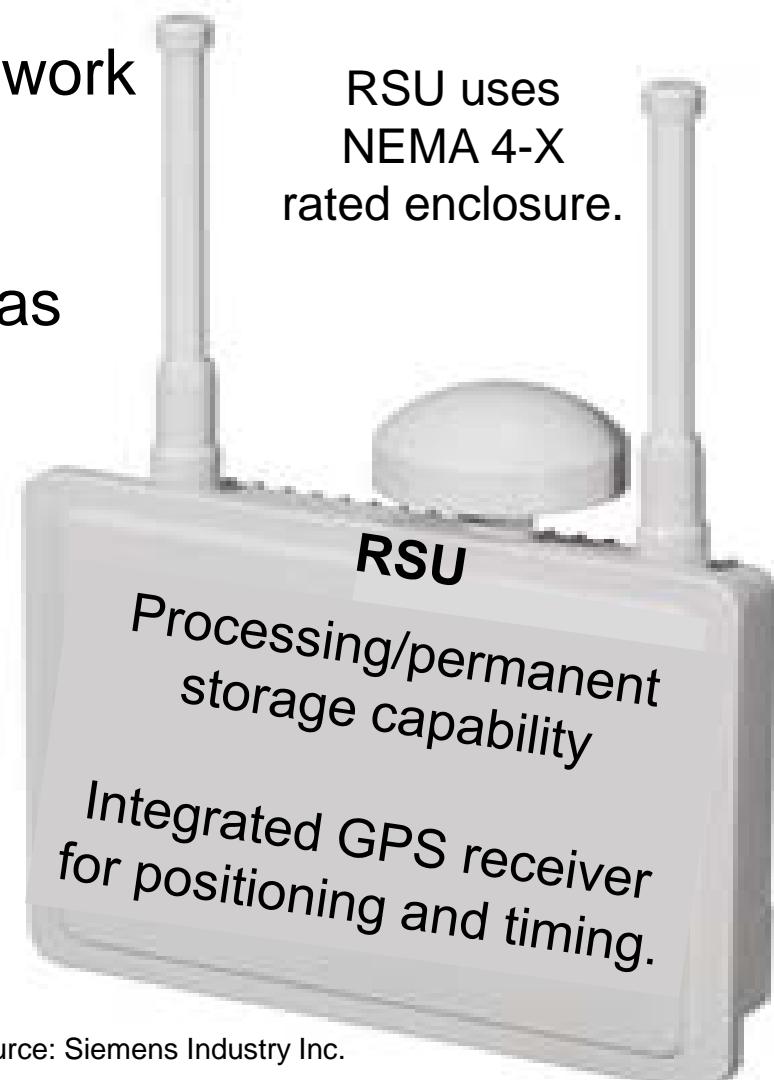
Roadside Unit - RSU

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.

RSU

Processing/permanent storage capability

Integrated GPS receiver for positioning and timing.

Source: Siemens Industry Inc.

Roadside Unit - RSU

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
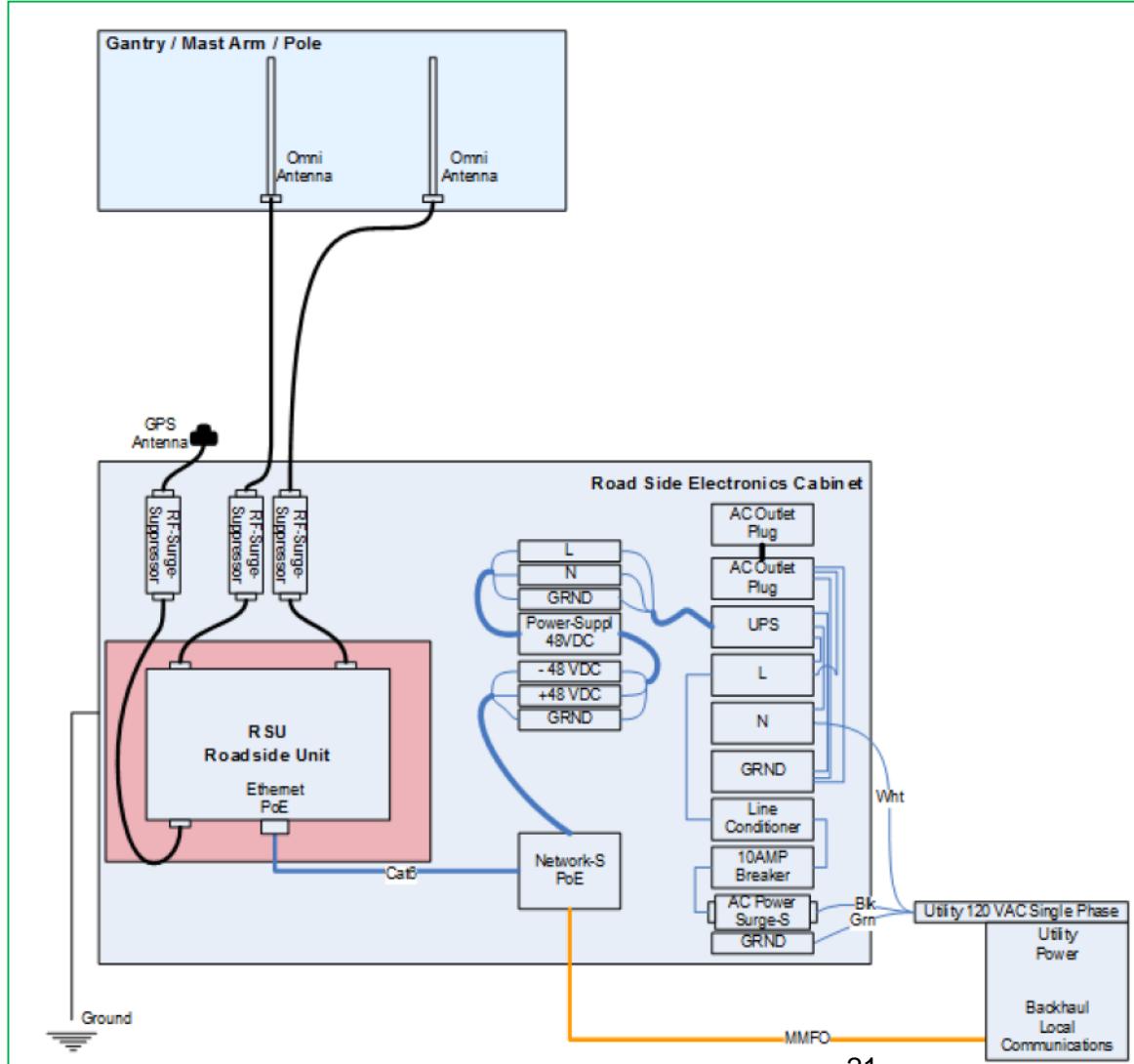
Source: Siemens Industry Inc.

Source: Siemens Industry Inc.

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Roadside Unit - RSU

Antennas and Cabling: RSU on Gantry
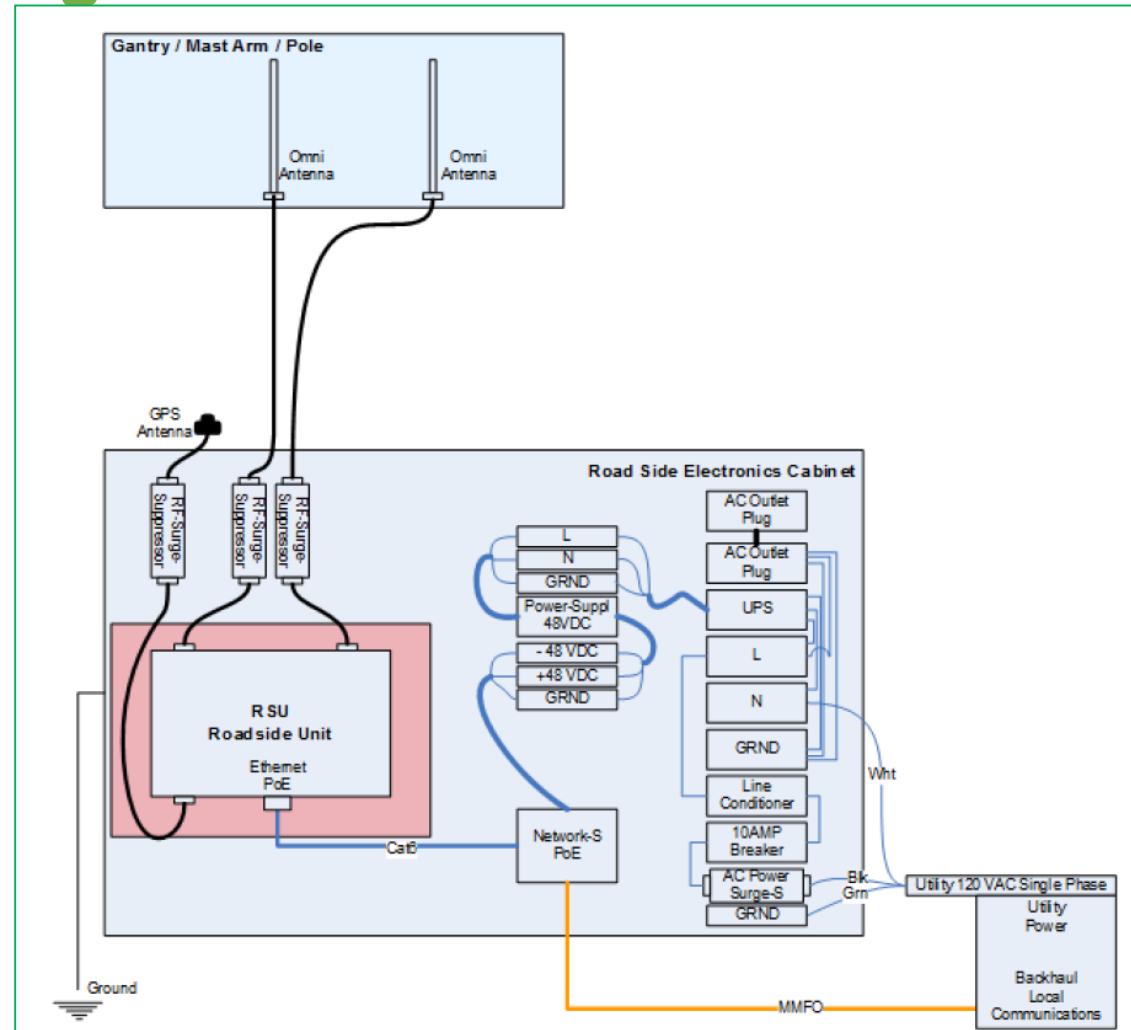
Source: USDOT

Roadside Unit - RSU

Antennas and Cabling: RSU in RSE Cabinet

Source: USDOT

RSU Installations

- Antennas have **line-of-sight** to vehicle lanes

RSU

Source: UMICH

Source: FDOT

RSU

Source: USDOT
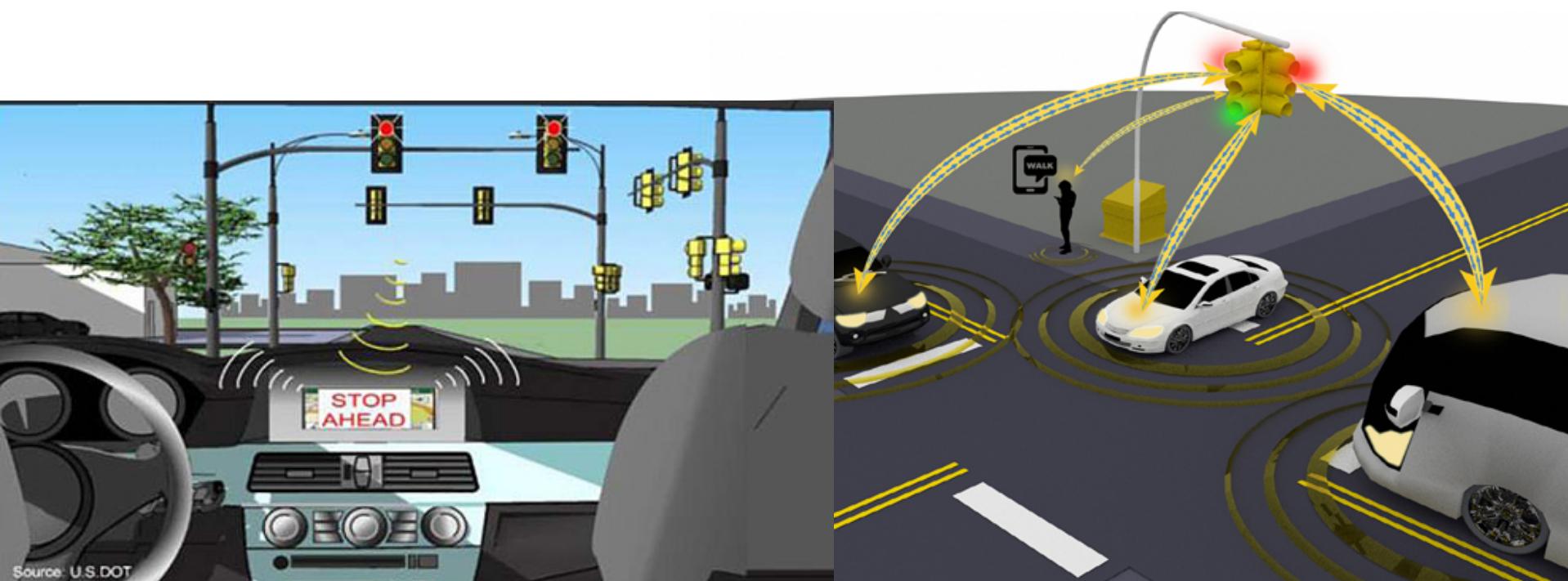
EXAMPLE

Roadside Unit - RSU

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

Source: U.S.DOT

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

OBU Integration

**Class 1 -
New Vehicles**
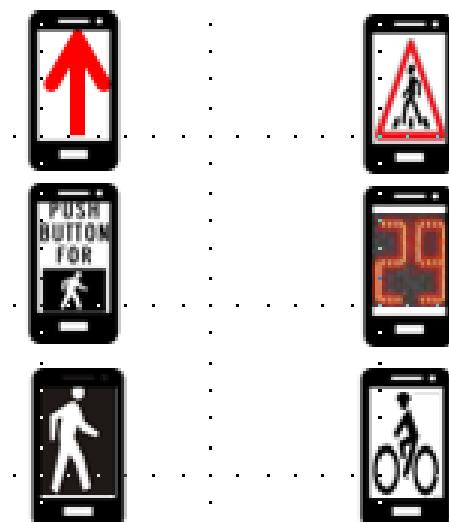
**Class 2 -
Existing Vehicles**

**Class 3 - Existing
Personnel Devices**

Source: Siemens Industry Inc.

SUPPLEMENT
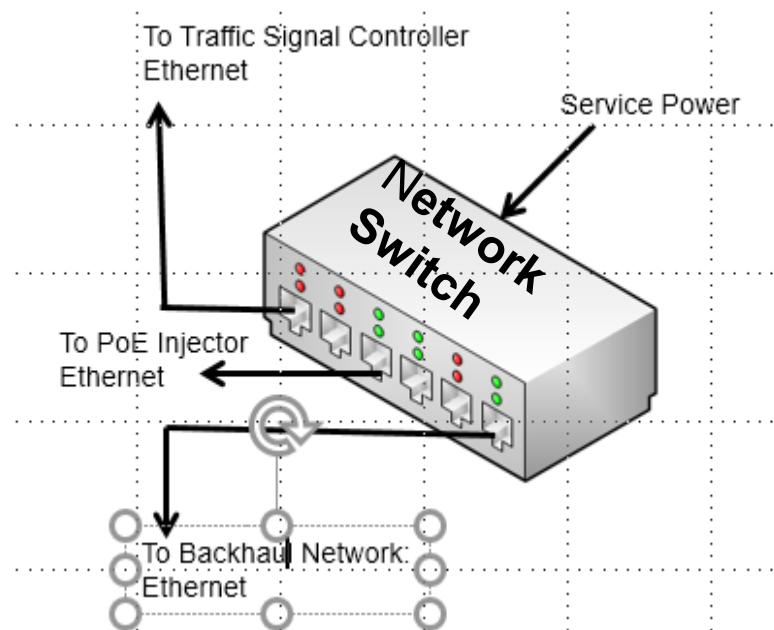
Roadside Unit - RSU
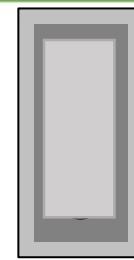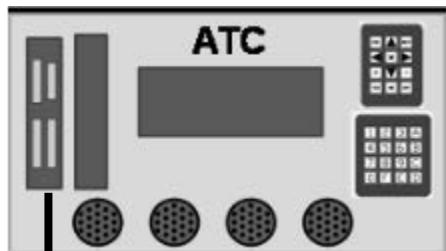
3 **DSRC RSU Supports (Interface and Protocols)**

- 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

ATC

Signals

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

Integrated Vehicle-to-Infrastructure Prototype (IVP)

V2I Hub Interface Control Document (ICD)

www.its.dot.gov/index.htm
Final Report — March 2017
FHWA-JPO-17-TBD

| Traffic Signal Controller | Roadside Unit (RSU) | GPS | Transportation Management Center (TMC) | Map Message | Signal Phase and Timing (SPAT) Message | Curve Speed Warning (CSW) |

V2I Hub

U.S. Department of Transportation

SPaT
MAP

RSU
MAP File
GPS Time

BSM
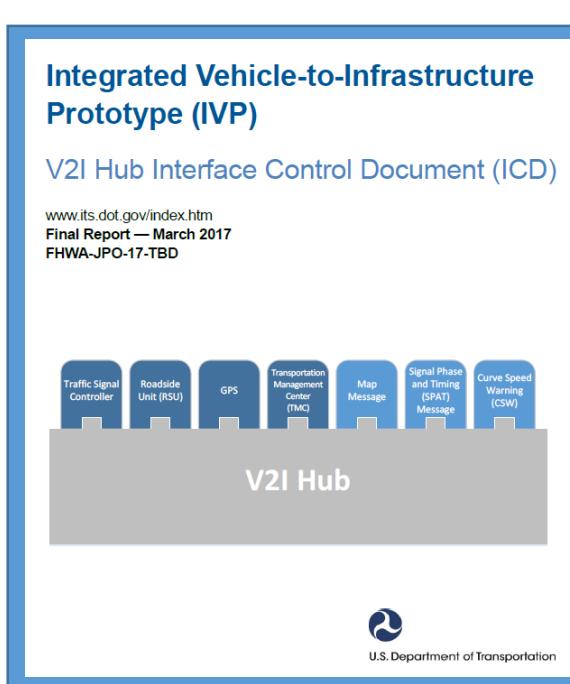
Vehicles

MAP and SPaT are available to vehicle during CU failure
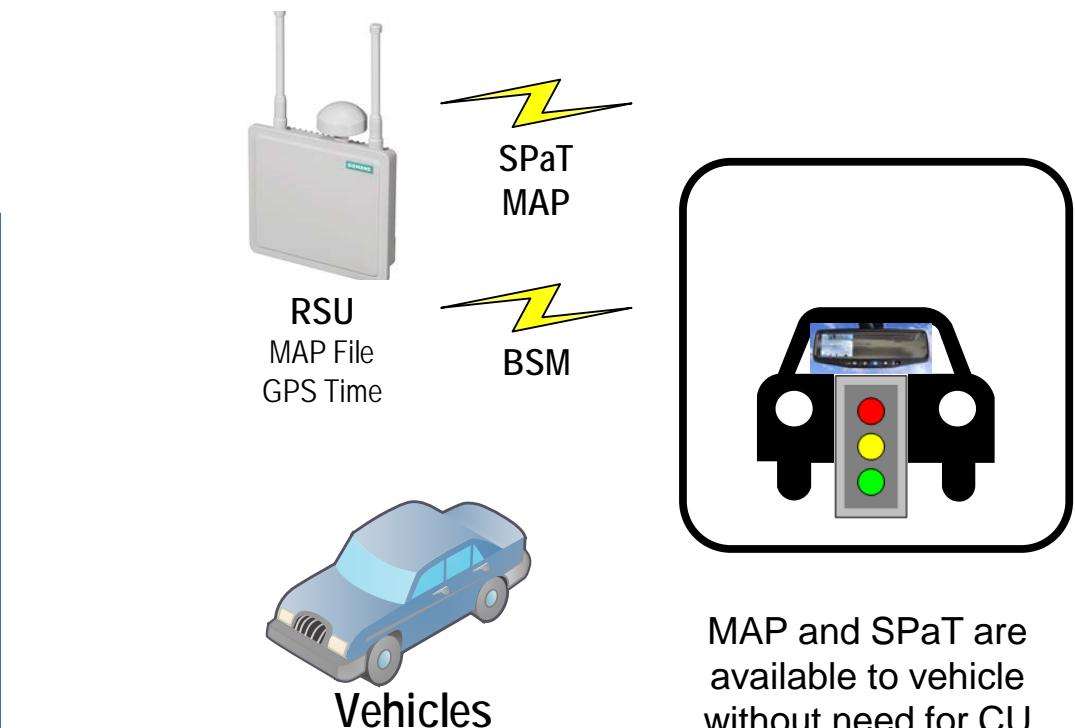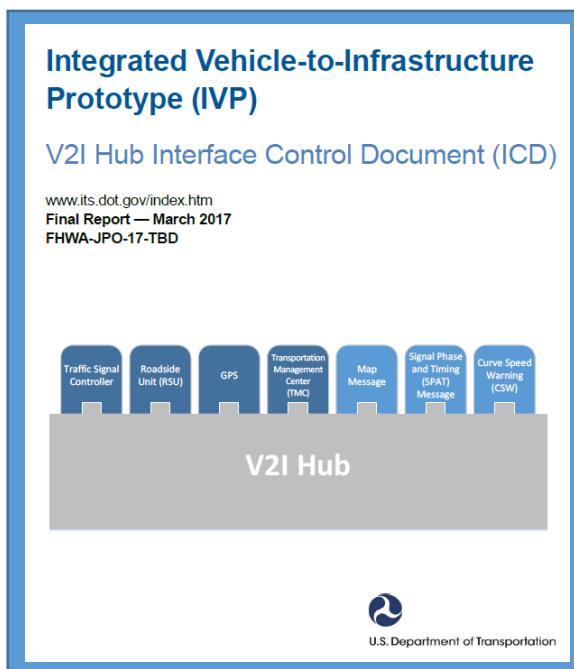
Source: USDOT

Source: Siemens Industry Inc.

Connected Vehicle (CV) Operation
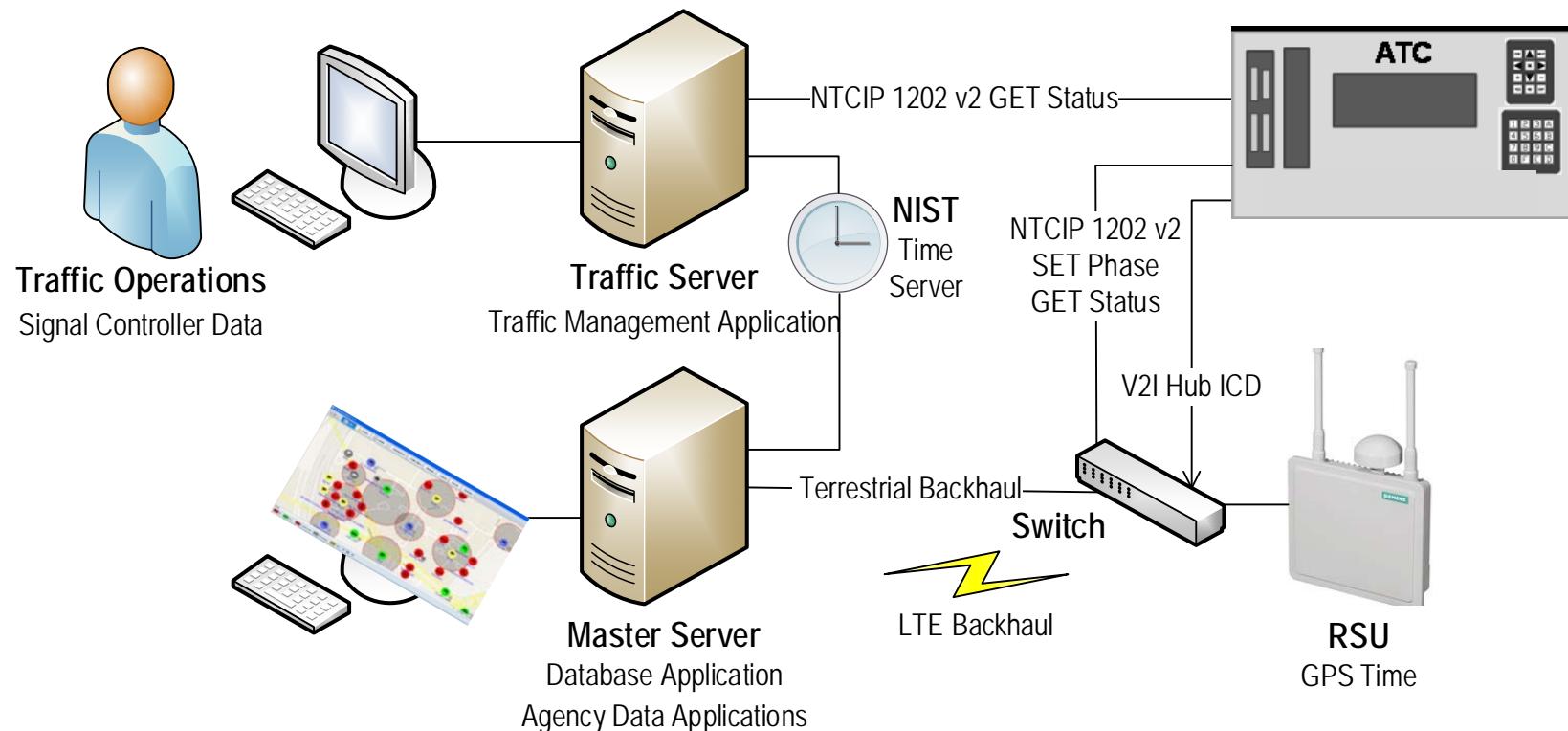
MAP and SPaT Without Signal Controller

Integrated Vehicle-to-Infrastructure Prototype (IVP)

V2I Hub Interface Control Document (ICD)

www.its.dot.gov/index.htm
Final Report — March 2017
FHWA-JPO-17-TBD

V2I Hub

U.S. Department of Transportation

Source: USDOT

RSU
MAP File
GPS Time

SPaT
MAP

BSM

Vehicles

MAP and SPaT are available to vehicle without need for CU

Source: Siemens Industry Inc.

Connected Vehicle (CV) Terminology

Backhaul Communications

Traffic Operations
Signal Controller Data

Traffic Server
Traffic Management Application

NIST Time Server

NTCIP 1202 v2 GET Status

ATC

NTCIP 1202 v2 SET Phase GET Status

V2I Hub ICD

Master Server
Database Application
Agency Data Applications

Terrestrial Backhaul

Switch

LTE Backhaul

RSU
GPS Time

Connected Vehicle (CV) Terminology

Test and Levels of Testing

Regional Architecture — Needs & Feasibility ← Project Stakeholders → Operate & Maintain — Change & Upgrade — Retire / Replace

Concept of Operations ← System Validation LTP → System Validation

Require-ments ← System Verification LTP → System Verification

High Level Design ← Subsystem LTP → Sub Systems

Detailed Design ← Unit/Device LTP → Units / Devices

Software / Hardware Development

Source: Siemens Industry Inc.

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

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

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

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

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

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

SUPPLEMENT

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Test and Certification Levels

Systems Engineering Process (SEP): Certification of software Units and hardware Devices
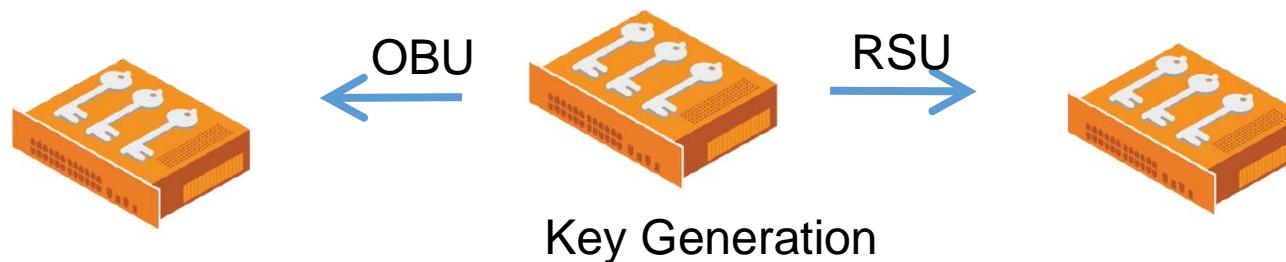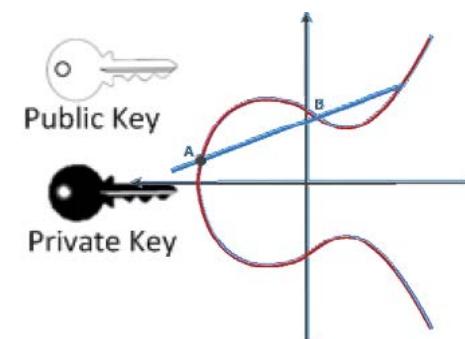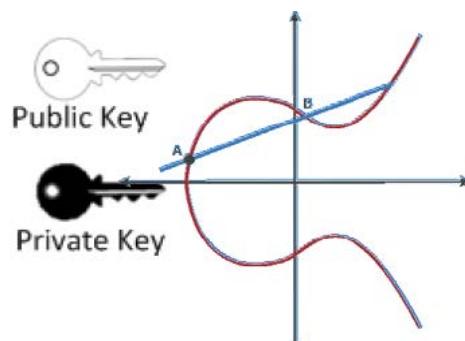
Source: Siemens Industry Inc.

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 **revokes** certificates

International Atomic Time (Temps Atomique International-TAI)

ACTIVITY

STANDARDS ITS TRAINING

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Question

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

DSRC RSU Specifications Document - USDOT

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

DSRC Roadside Unit (RSU) Specifications Document v4.1

FEDERAL HIGHWAY ADMINISTRATION'S TECHNICAL SUPPORT AND TASKS FOR THE

Saxton Transportation Operations Laboratory

Project Number: DTFH61-12-D-00020

Submitted: October 31, 2016

Version: 1

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

IEEE 1609.2	BSM: LAT LONG HEADING SPEED VEHICLE SIZE	
	IPv6	IPv6
	1609.3, 802.2, 802.11p	IEEE 802.2
	5.9 GHz wireless (802.11p), 1609.4	Backhaul PHY[2]
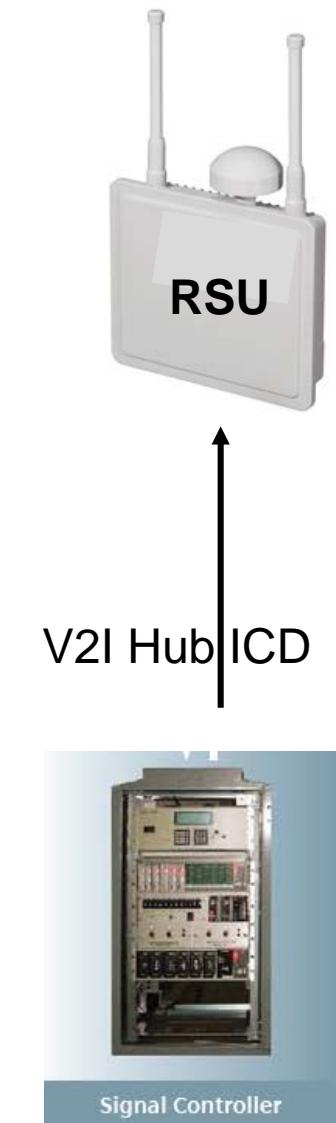
Basic Safety Message (BSM)

Understand the Messages for Certification
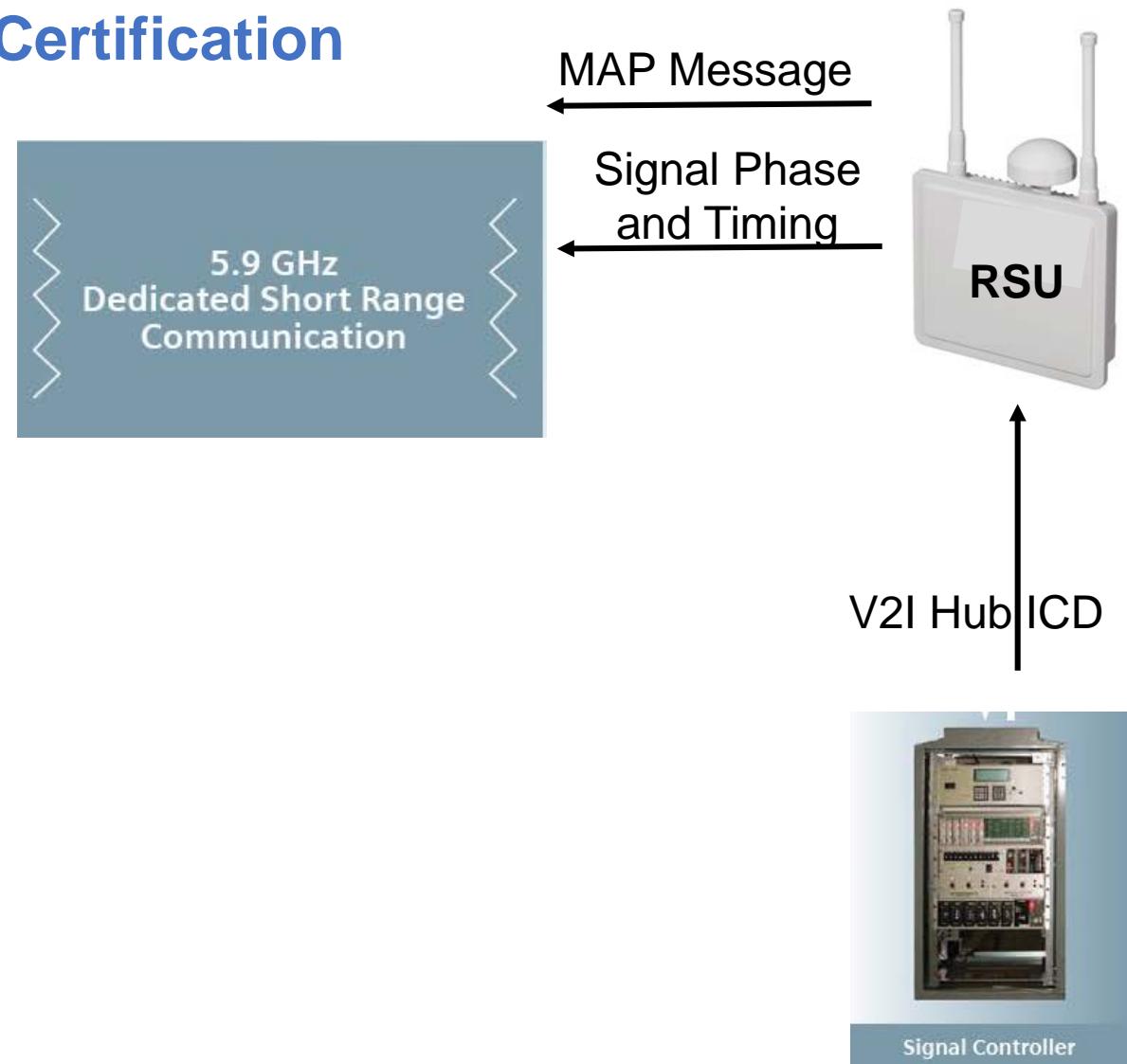
SAE J2735 Message Certification

RSU

V2I Hub ICD

Signal Controller

Source: Siemens Industry Inc.

Understand the Messages for Certification

SAE J2735 Message Certification

MAP Message

Signal Phase and Timing

RSU

5.9 GHz
Dedicated Short Range
Communication

V2I Hub ICD

Signal Controller

Source: Siemens Industry Inc.

Understand the Messages for Certification

SAE J2735 Message Certification

MAP Message

Signal Phase and Timing

RSU

5.9 GHz Dedicated Short Range Communication

Intersection Movement Assist Forward Collision Warning

MAP Message

Signal Phase and Timing

Basic Safety Message
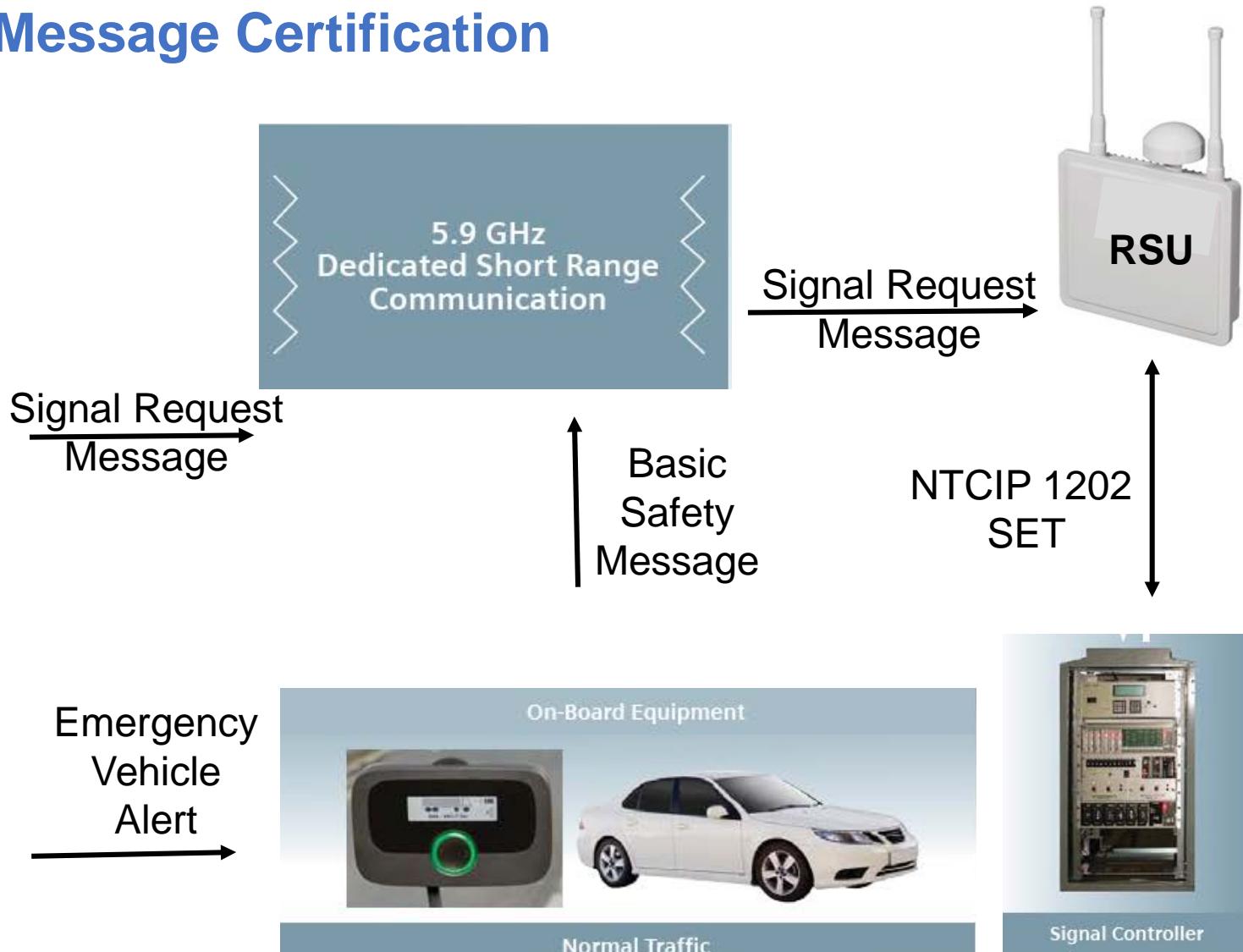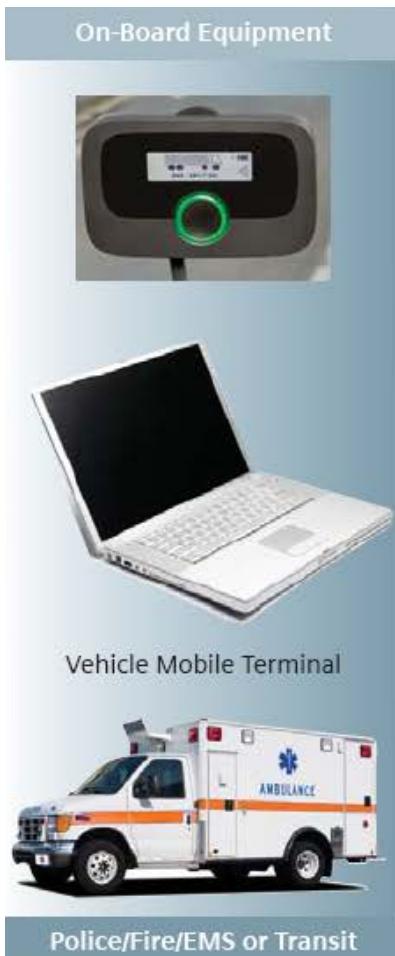
V2I Hub ICD

On-Board Equipment

Normal Traffic

Basic Safety Message

Signal Controller

Red Light Violation Warning

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SAE J2735 Message Certification

Source: Siemens Industry Inc.

SAE J2735 Message Certification

RSU

5.9 GHz
Dedicated Short Range
Communication

Signal Status
Message

Basic
Safety
Message

NTCIP 1202
GET

Signal Status
Message

Emergency
Vehicle
Alert

Source: Siemens Industry Inc.

SAE J2735 Message Certification

MAP Message

Signal Phase and Timing

RSU

5.9 GHz Dedicated Short Range Communication
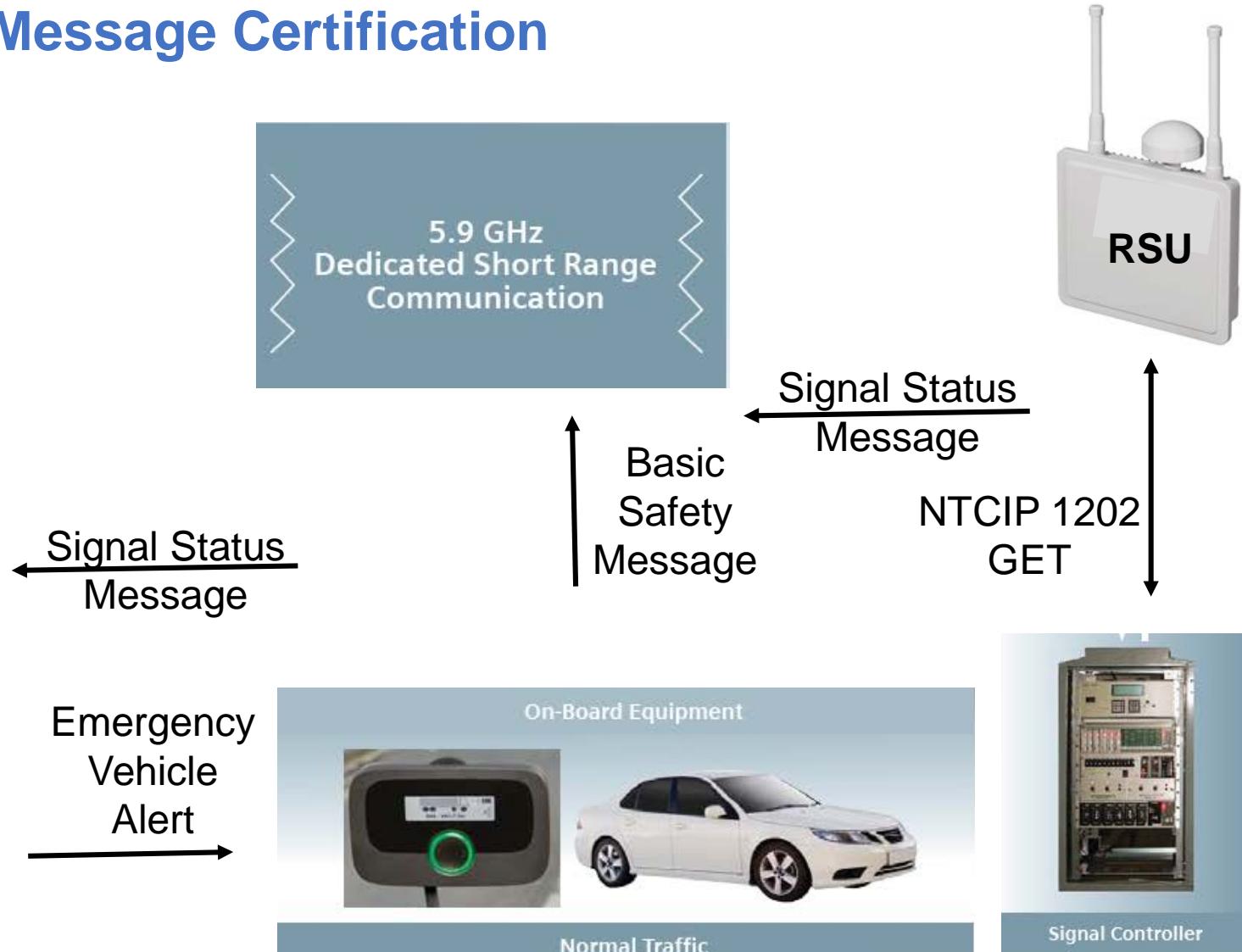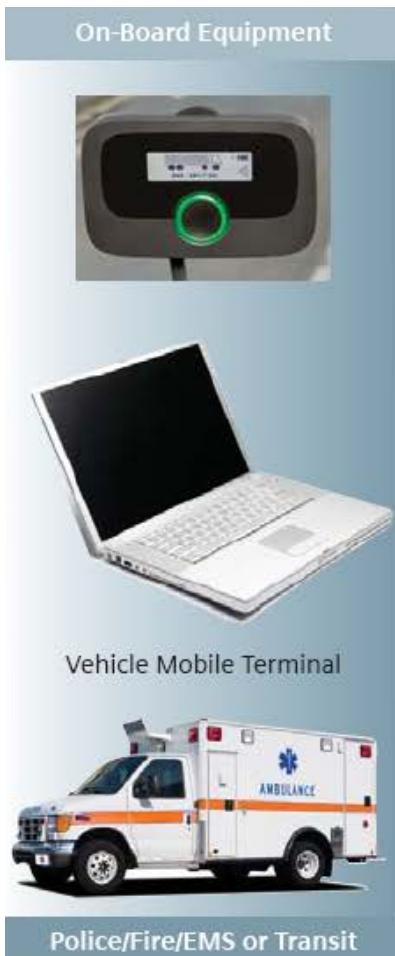
Curve Speed Warning

Traveler Information Message
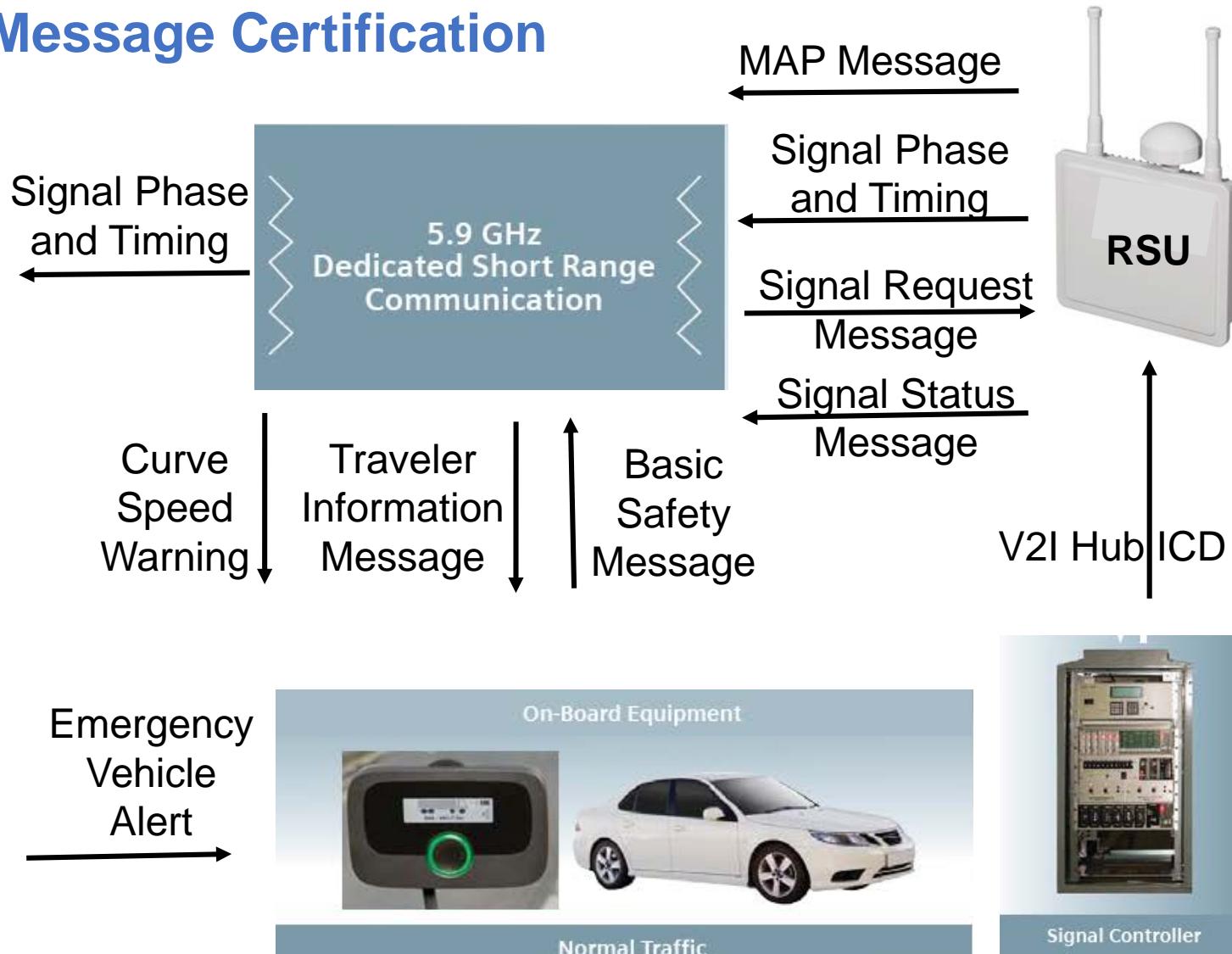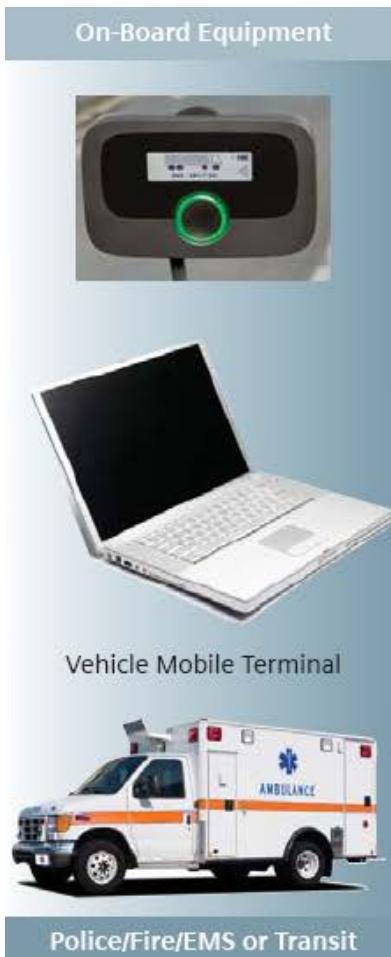
Work Zone Warning

On-Board Equipment

Normal Traffic

Source: Siemens Industry Inc.

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SAE J2735 Message Certification

Source: Siemens Industry Inc.

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ACTIVITY

STANDARDS ITS TRAINING

**U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology**

Question

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.

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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

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

DSRC Roadside Unit (RSU) Specifications Document v4.1

FEDERAL HIGHWAY ADMINISTRATION'S TECHNICAL SUPPORT AND TASKS FOR THE

Saxton Transportation Operations Laboratory

Project Number: DTFH61-12-D-00020

Submitted: October 31, 2016

Version: 1

Source: USDOT

Develop a Requirements to Test Case Traceability Matrix (RTCTM)
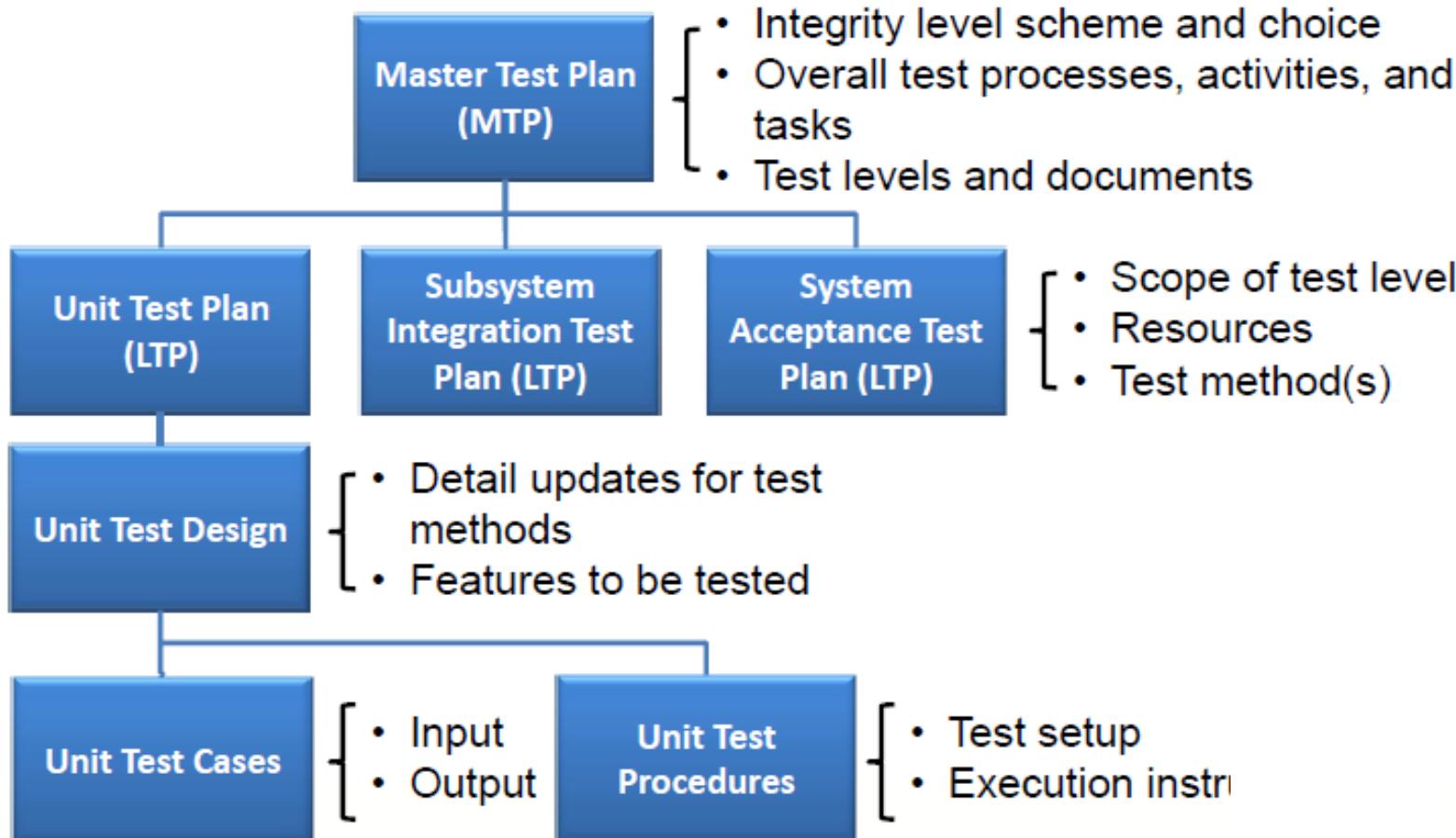
RTCTM for RSU

ReqID	Description	Reference	Verification Method
USDOT_RSU-Req_312-v001	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).	NEMA TS 2-2003 v02.06	Test: A "Pass" indication contained in a Test Report from an accredited test facility
USDOT_RSU-Req_546-v001	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).	NEMA TS 2-2003 v02.06	Test: A "Pass" indication contained in a Test Report from an accredited test facility
USDOT_RSU-Req_313-v001	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.	NEMA TS 2-2003 v02.06	Test: A "Pass" indication contained in a Test Report from an accredited test facility

Test Case for RSU Certification
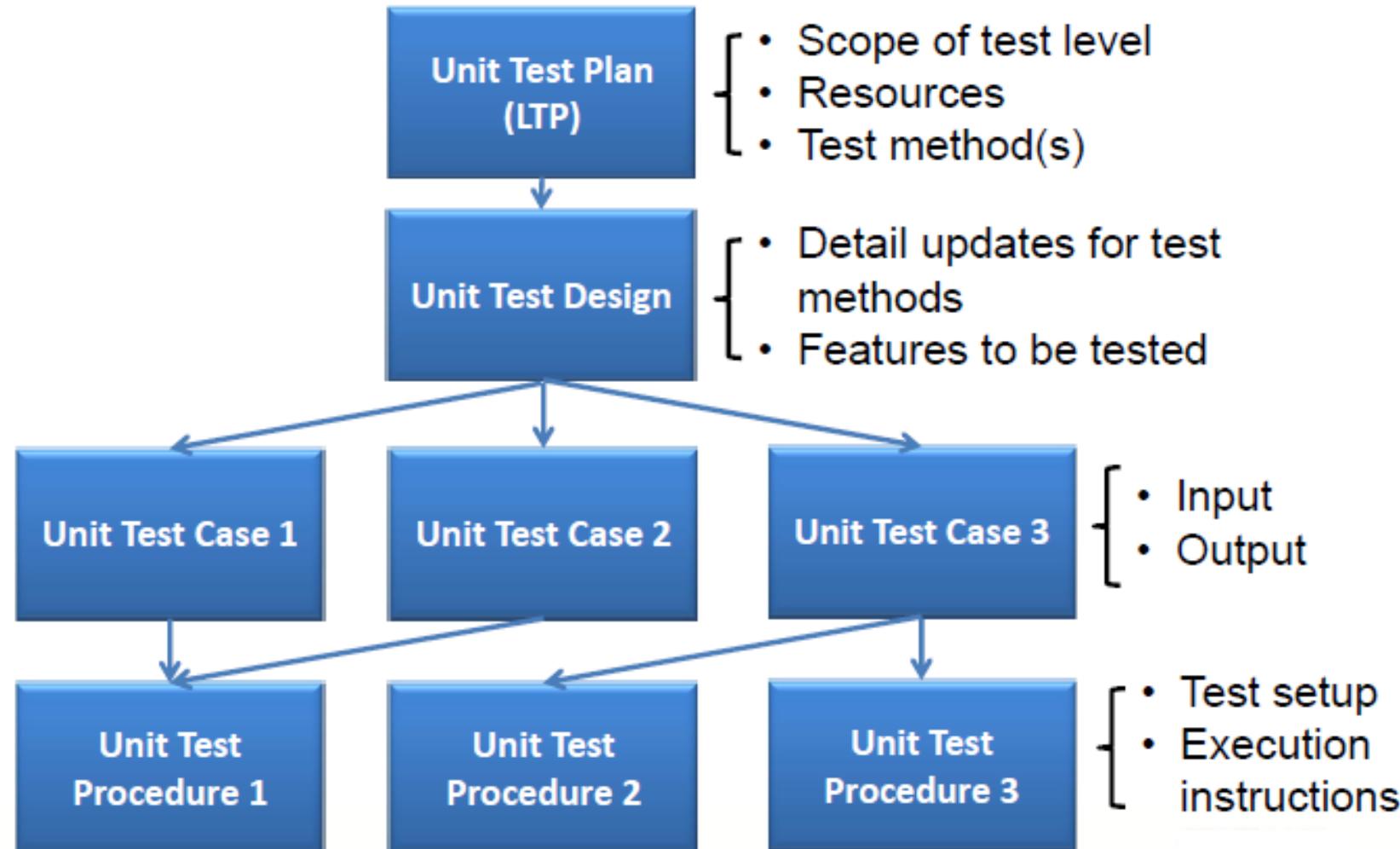
LTP-Level Test Plan

Source: USDOT Professional Capacity Building

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Develop a Set of Test Cases for RSU Certification

Unit Test Plan Workflow

Test Procedures for RSU Certification

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
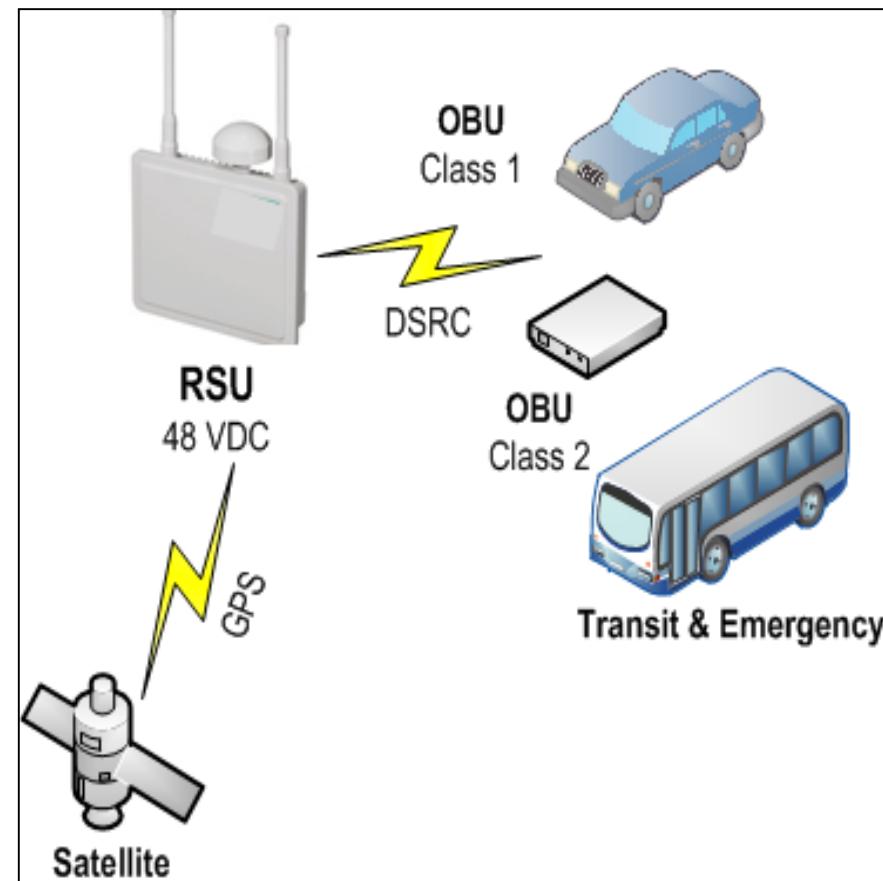
Addressing Local Needs

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.

EXAMPLE
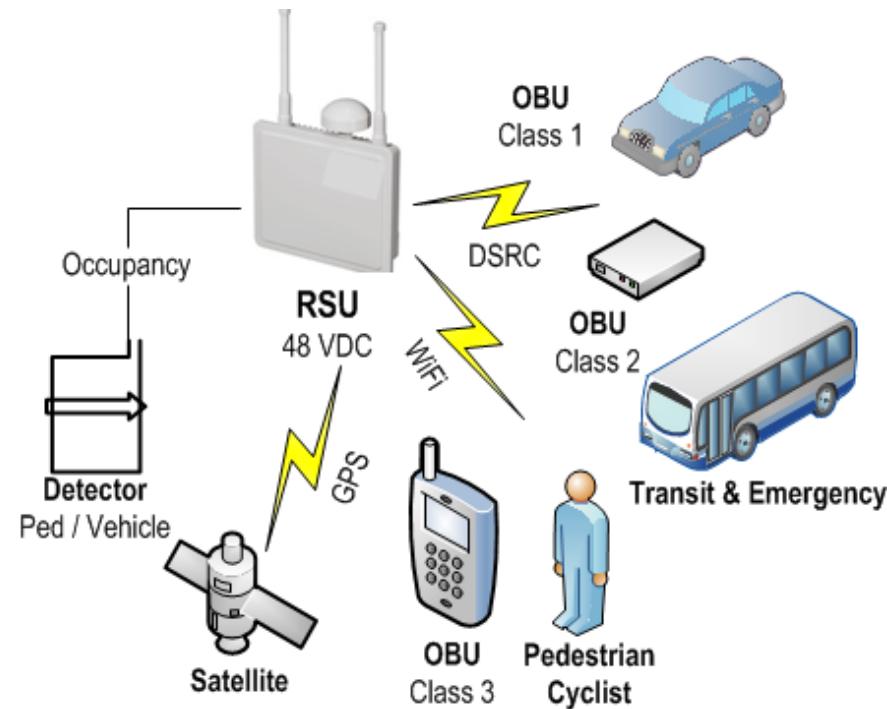
Addressing Local Needs

Pedestrian Safety:
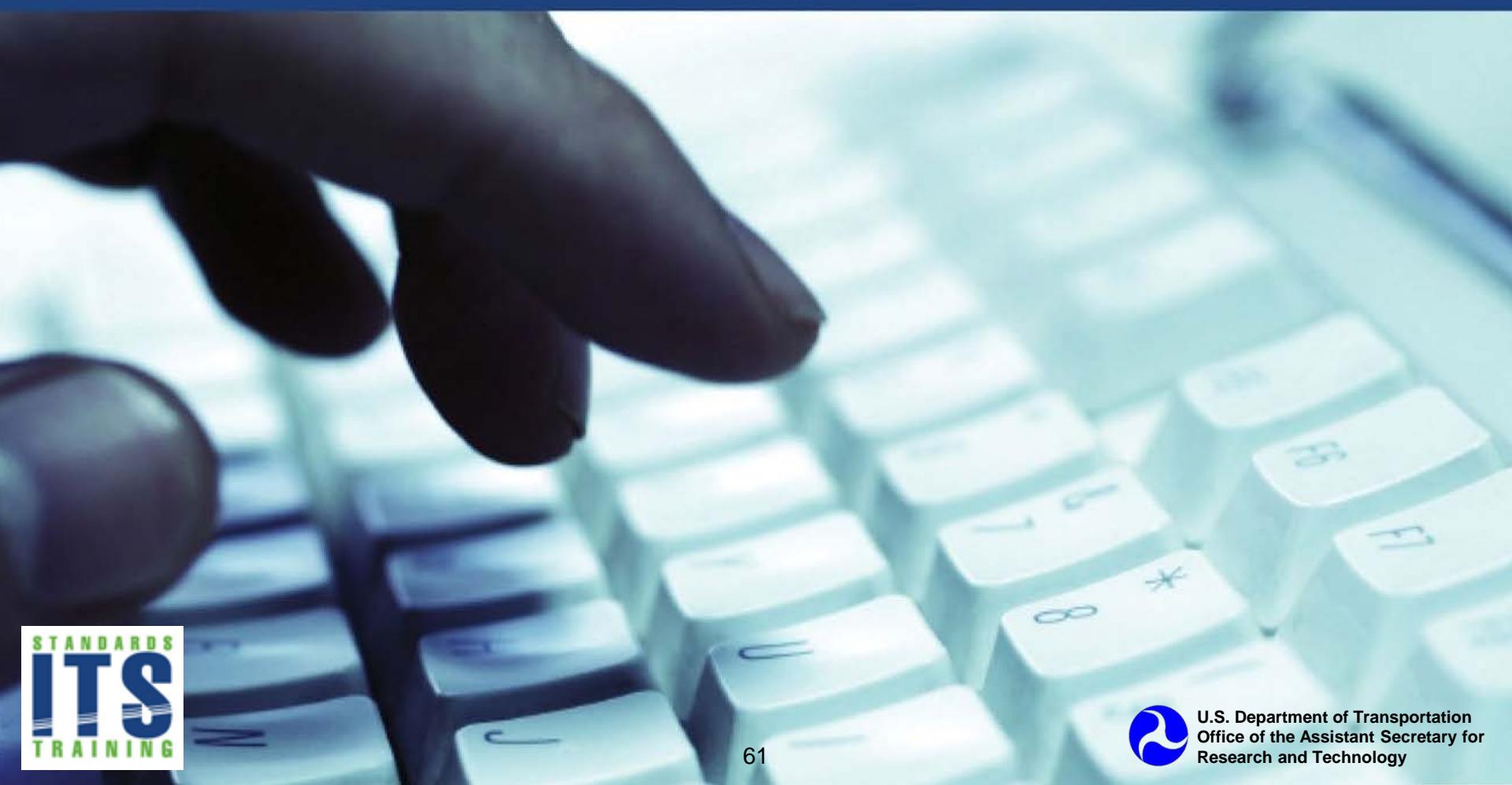
- Needs
  - Detect pedestrians
  - Avoid PED / vehicle conflicts

- 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.

EXAMPLE

ACTIVITY

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Question

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

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

Certification

Certification Scope

4 - Overall Application Abilities		Applications
3 - **Interface Abilities**		
1 - Environmental Abilities	2 - **Communication Protocol Abilities**	Basic Device

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

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Certification

Technical Standards

DSRC-WSMP			
Vehicle location and motion . →			
Remote Vehicle OBE			**Transit Vehicle OBE**
ITS Application Information Layer SAE J2735	Security Plane IEEE 1609.2		**ITS Application Information Layer** SAE J2735
Application Layer Undefined			**Application Layer** Undefined
Presentation Layer ISO ASN.1			**Presentation Layer** ISO ASN.1
Session Layer Undefined			**Session Layer** Undefined
Transportation Layer IEEE 1609.3 WSMP	Security Plane Undefined		**Transportation Layer** IEEE 1609.3 WSMP
Network Layer IEEE 1609.3 WSMP			**Network Layer** IEEE 1609.3 WSMP
Data Link Layer IEEE 1609.4, 802.11			**Data Link Layer** IEEE 1609.4, 802.11
Physical Layer IEEE 802.11			**Physical Layer** IEEE 802.11

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)
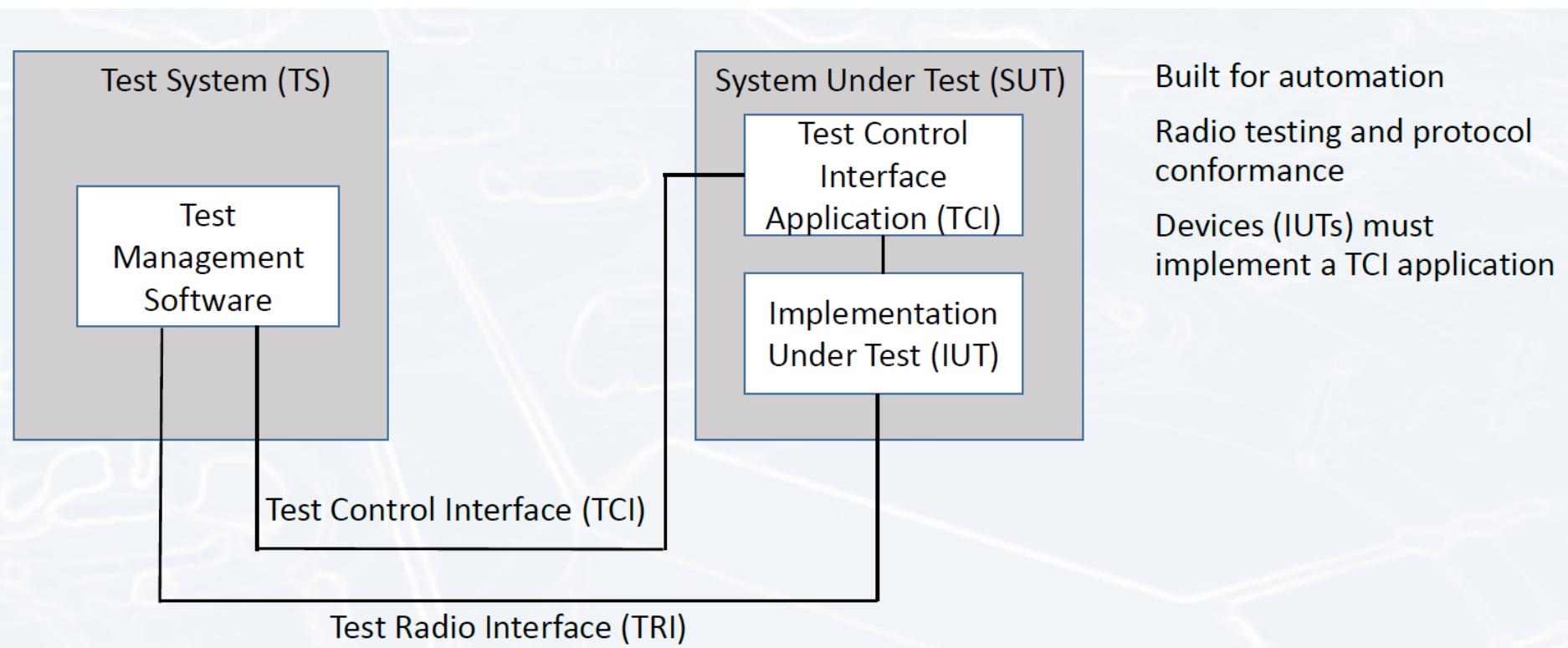
Device Profiles

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

System Under Test (SUT)

Test Control Interface Application (TCI)

Implementation Under Test (IUT)

Test Control Interface (TCI)

Test Radio Interface (TRI)

Built for automation

Radio testing and protocol conformance

Devices (IUTs) must implement a TCI application

Source: USDOT

Certification

Test Specifications

Applications	
SAE J2735 & J2945/1 Messaging	IEEE 1609.2
IEEE1609.3	
IEEE 1609.4	
IEEE 802.11	

Test Specification	Title/Scope
Test System Interface	Test Command Interface Protocol Specification
J2945.1-TSS&TP	Test Suite Structure and Test Purposes for SAE J2945/1
WAVESEC-TSS&TP	Test Suite Structure and Test Purposes for Security Services (IEEE 1609.2)
WAVENS-TSS&TP	Test Suite Structure and Test Purposes for Network Services (IEEE 1609.3)
WAVEMCO-TSS&TP	Test Suite Structure and Test Purposes for Multi-Channel Operation (IEEE 1609.4)
WAVE802.11-TSS&TP	Test Suite Structure and Test Purposes for IEEE802.11 (Scope of DSRC)

Source: USDOT

Example Test

Test Purpose Id	TP-16094-RXT-MDE-BV-01			
Summary	Transmit WSMs in continuous channel mode (non-switching) and verify IUT receives the transmitted messages.			
Test Configuration	TC1			
Reference:	[2] 5.2, 6.3.1, 5.2.1, 5.2.3			
PICS Selection	M2, M2.1, M3, M3.1			
Pre-test conditions				
• The IUT is in initial state as per sec 4.3.1				
Test Sequence				
Step	Type	Description		Verdict
1	Configure	IUT to receive WSM messages in continuous channel mode on 'vChannel'		
2	Configure	Test Equipment to transmit WSMs in continuous channel mode on 'vChannel' with 'vDataRate' at 'vWSMRepeatRate'.		
3	Stimulus	Test Equipment to continuously transmit WSM messages		
4	Verify	IUT receives WSM messages available on 'vChannel' at every 'vWSMRepeatRate'.		PASS / FAIL
5	Procedure	Repeat steps 1-4 for each supported value of 'vDataRate' in Table 4-2		
6	Procedure	Repeat steps 1-5 for each supported value of 'vChannel' in Table 4-1		
7	Configure	The IUT to initial state		

Source: USDOT

EXAMPLE

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

Have device

↓

Contact Certification Organization

↓

Device tested by an authorized testing laboratory

↓

Report submitted to Certification Organization

↓

Device listed as certified

Source: USDOT

Certification

Device Certification Progression

Source: USDOT

SAE J2735 Message Dialogs to Realize Applications

V2I Safety
Red Light Violation Warning
Curve Speed Warning
Stop Sign Gap Assist
Spot Weather Impact Warning
Reduced Speed/Work Zone Warning
Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety
Emergency Electronic Brake Lights (EEBL)
Forward Collision Warning (FCW)
Intersection Movement Assist (IMA)
Left Turn Assist (LTA)
Blind Spot/Lane Change Warning (BSW/LCW)
Do Not Pass Warning (DNPW)
Vehicle Turning Right in Front of Bus Warning (Transit)

Agency Data
Probe-based Pavement Maintenance
Probe-enabled Traffic Monitoring
Vehicle Classification-based Traffic Studies
CV-enabled Turning Movement & Intersection Analysis
CV-enabled Origin-Destination Studies
Work Zone Traveler Information

Environment
Eco-Approach and Departure at Signalized Intersections
Eco-Traffic Signal Timing
Eco-Traffic Signal Priority
Connected Eco-Driving
Wireless Inductive/Resonance Charging
Eco-Lanes Management
Eco-Speed Harmonization
Eco-Cooperative Adaptive Cruise Control
Eco-Traveler Information
Eco-Ramp Metering
Low Emissions Zone Management
AFV Charging / Fueling Information
Eco-Smart Parking
Dynamic Eco-Routing (light vehicle, transit, freight)
Eco-ICM Decision Support System

Road Weather
Motorist Advisories and Warnings (MAW)
Enhanced MDSS
Vehicle Data Translator (VDT)
Weather Response Traffic Information (WxTINFO)

Mobility
Advanced Traveler Information System
Intelligent Traffic Signal System (I-SIG)
Signal Priority (transit, freight)
Mobile Accessible Pedestrian Signal System (PED-SIG)
Emergency Vehicle Preemption (PREEMPT)
Dynamic Speed Harmonization (SPD-HARM)
Queue Warning (Q-WARN)
Cooperative Adaptive Cruise Control (CACC)
Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
Emergency Communications and Evacuation (EVAC)
Connection Protection (T-CONNECT)
Dynamic Transit Operations (T-DISP)
Dynamic Ridesharing (D-RIDE)
Freight-Specific Dynamic Travel Planning and Performance
Drayage Optimization

Smart Roadside
Wireless Inspection
Smart Truck Parking

Source: USDOT

ACTIVITY

STANDARDS
ITS
TRAINING

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Question

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

U.S. Department of Transportation
ITS Joint Program Office
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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!