



# I262: Vehicle-to-Vehicle (V2V) ITS Standards for Project Managers

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## Module Description

This module is an introduction to the connected vehicle environment, with a focus on a standards-based vehicle-to-vehicle communications. I101, Using ITS Standards – An Overview, is a recommended prerequisite for participants. A companion module is I261, Vehicle-to-Infrastructure (V2I) ITS Standards for Project Managers, which focuses on standards-based vehicle-to-infrastructure communications.

### 1. Introduction/Purpose

The connected vehicle environment has the potential to transform surface transportation systems such that vehicular crashes are significantly reduced, operators of the surface transportation systems have access to more accurate system performance data, travelers have access to specific traveler information, and allow the surface transportation systems to be optimized to minimize environmental impacts.

This module provides an introduction to the connected vehicle environment, a description of the vehicle-to-vehicle (V2V) environment, and its potential benefits to the operators of surface transportation systems. The module presents several V2V safety, mobility and environmental applications and discusses how these applications impact surface transportation operations. It also reviews the types of information that may be exchanged between the connected devices that make up the V2V environment.

The module then presents the ITS Standards that help support the deployment of the V2V environment and V2V applications. The module also introduces some of the challenges to implementing the V2V environment and how surface transportation systems can support the V2V environment.

It is essential that agencies use standards in deploying connected vehicle technologies to maximize the benefits from the connected vehicle environment. By taking this module, participants will learn what connected vehicle standards exist, where to find the standards, and how to use the connected vehicle standards to procure, implement and operate standards-based devices and equipment. Deploying these connected vehicle standards will support interoperability, minimize future integration costs, make procurements easier, and facilitate regional and national integration.

### 2. Reference to Other Standards

#### USDOT

- USDOT ITS Standards Program, <http://www.standards.its.dot.gov/>

#### ASTM

- ASTM E2213 – 03 (2010) – Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band Dedicated Short Range



Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications, ASTM, <http://www.astm.org/Standards/E2213.htm>

## IEEE

- Working Group Activities: IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE), IEEE, [http://standards.ieee.org/develop/wg/1609\\_WG.html](http://standards.ieee.org/develop/wg/1609_WG.html)
- IEEE 1609.0-2013 – IEEE Guide for Wireless Access in Vehicular Environments (WAVE) – Architecture, IEEE, <http://standards.ieee.org/findstds/standard/1609.0-2013.html>
- IEEE 1609.2-2013 - IEEE Standard for Wireless Access in Vehicular Environments — Security Services for Applications and Management Messages, IEEE, <http://standards.ieee.org/findstds/standard/1609.2-2013.html>
- IEEE 1609.3-2010 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services, IEEE, <http://standards.ieee.org/findstds/standard/1609.3-2010.html>
- IEEE 1609.3-2010/Cor 1-2012 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE)--Networking Services Corrigendum 1: Miscellaneous Corrections, IEEE, [http://standards.ieee.org/findstds/standard/1609.3-2010-Cor\\_1-2012.html](http://standards.ieee.org/findstds/standard/1609.3-2010-Cor_1-2012.html)
- IEEE 1609.4-2010 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE)--Multi-channel Operation, IEEE, <http://standards.ieee.org/findstds/standard/1609.4-2010.html>
- IEEE 1609.11-2010 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE)--Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS), IEEE, <http://standards.ieee.org/findstds/standard/1609.11-2010.html>
- IEEE 1609.12-2012 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations, IEEE, <http://standards.ieee.org/findstds/standard/1609.12-2012.html>
- IEEE 802.11-2012 – IEEE Standard for Information technology – Telecommunications and information exchange between systems. Local and metropolitan area networks – Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE, <http://standards.ieee.org/about/get/802/802.11.html>

## SAE

- Working Group Activities: SAE J2735\_2014 – Dedicated Short Range Communications (DSRC) Message Set Dictionary, SAE, <http://standards.sae.org/wip/j2735/>
- Dedicated Short Range Communications (DSRC) Support Page, SAE, <http://www.sae.org/standardsdev/dsrc/>
- SAE J2735\_2009– Dedicated Short Range Communications (DSRC) Message Set Dictionary, SAE, [http://standards.sae.org/j2735\\_200911/](http://standards.sae.org/j2735_200911/)
- SAE J2945 – Dedicated Short Range Communications (DSRC) Minimum Performance Requirements (Work in Progress), SAE, <http://standards.sae.org/wip/j2945/>
- SAE J3067 – Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735] Using Systems Engineering Methods, SAE, [http://standards.sae.org/j3067\\_201408/](http://standards.sae.org/j3067_201408/)



### 3. Glossary

Term	Definition
Aftermarket Safety Device (ASD)	A connected device in a vehicle that operates while the vehicle is mobile, but which is not connected to the data bus of the vehicle.
Application	A piece of software that processes inputs for a specific use or purpose
Basic Safety Message (BSM)	The core data set transmitted by the connected vehicle (vehicle size, position, speed, heading acceleration, brake system status) and transmitted approximately 10x per second. A secondary set is available depending upon events (e.g., ABS activated) and contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies). This would be transmitted less frequently. The BSM is tailored for low latency, localized broadcast required by V2V safety applications but can be used with many other types of applications.
Connected Device	Any device used to transmit to or receive messages from another device. A connected device can be sub-categorized as an OBE, ASD, VAD, or RSE. In many cases the connected device will be a DSRC device, but other types of communications can and are expected to be supported.
Connected Vehicle (CV)	A vehicle containing an OBU or ASD. Note that vehicles may alternatively include a Vehicle Awareness Device (VAD), which transmits the BSM but does not received broadcasts from other devices and cannot directly support vehicle-based applications.
Connected Vehicle Reference Implementation Architecture (CVRIA)	A set of system architecture views that describe the functions, physical and logical interfaces, enterprise/institutional relationships, and communications protocol dependencies within the connected vehicle environment. The CVRIA defines functionality and information exchanges needed to provide connected vehicle applications.
Dedicated Short Range Communications (DSRC)	<p>The use of non-voice radio techniques to transfer data over short distances between roadside and mobile radio units, between mobile units, and between portable and mobile units to perform operations related to the improvement of traffic flow, traffic safety and other intelligent transportation service applications in a variety of public and commercial environments. [FCC, Dedicated Short Range Communications of Intelligent Transportation Services – Final Rule, FR Doc No: 99-30591]</p> <p>A technology for the transmission of information between multiple vehicles (V2V) and between vehicles and the transportation infrastructure (V2I) using wireless technologies.</p>
Intelligent Transportation Systems (ITS)	Systems that apply data processing and data communications to surface transportation, to increase safety and efficiency. ITS systems will often integrate components and users from many domains, both public and private.
Interoperability	The ability of two or more systems or components to exchange information and to use the information that has been exchanged. The dependence of the CV Environment on successful exchange of data between independent components results in a requirement that all V2I deployments.



Term	Definition
Latency	A measure of time delay experienced in a system, the precise definition of which depends on the system and the time being measured. For a data element in this context, latency is the time difference between the time that data value is acquired by the source and the time the message is transmitted.
On-Board Equipment (OBE)	This term refers to the complement of equipment located in the vehicle for the purpose of supporting the vehicle side of the applications. It is likely to include the DSRC radios, other radio equipment, message processing, driver interface, and other applications to support the use cases described herein. It is also referred to as the Vehicle ITS Station. When referring to the DSRC radio alone, the correct term is OBU (see below).
On-Board Unit (OBU)	A vehicle mounted device used to transmit and receive a variety of message traffic to and from other connected devices (other OBUs and RSUs). Among the message types and applications supported by this device are vehicle safety messages, a primary subject of this standard, used to exchange information on each vehicle's dynamic movements for coordination and safety.
Original Equipment Manufacturer (OEM)	An original equipment manufacturer refers to the entity that originally manufactures and item that may be branded and sold by others. In the Connected Vehicle Environment, it is commonly used to refer to automobile manufacturers.
Security Certificate Management System (SCMS)	A public key infrastructure approach to security involving the management of digital certificates that are used to sign and authenticate messages among legitimate but unknown vehicles and/or equipment and/or other points of connection.
Vehicle	A self-propelled transport device, along with any attachments (e.g., trailers), that is a legal user of the transportation network.
V2V	Short for vehicle-to-vehicle communications: a system designed to transmit basic safety information between vehicles to facilitate warnings to drivers concerning impending crashes.
WAVE	Wireless Access in Vehicular Environments. A WAVE system is a radio communications system intended to provide seamless, interoperable services to transportation.

## 4. Acronyms

AACNR	Advanced Automatic Crash Notification Relay
AASHTO	American Association of State Highway and Transportation Officials
ANPRM	Advance Notice of Proposed Rulemaking
ASD	Aftermarket Safety Devices
ASTM	American Society for Testing and Materials
BSM	Basic Safety Message
BSW	Blind Spot Warning
CACC	Cooperative Adaptive Cruise Control
CAMP	Collision Avoidance Metrics Partnership
CLW	Control Loss Warning
CME	Certificate Management Entities



CSR	Common Safety Request
CVRIA	Connected Vehicles Reference Implementation Architecture
DNPW	Do Not Pass Warning
DSRC	Dedicated Short Range Communications
Eco-CACC	Eco-Cooperative Adaptive Cruise Control
EEBL	Emergency Electronic Brake Light
EVA	Emergency Vehicle Alert
FCC	Federal Communications Commission
FCW	Forward Collision Warning
GPS	Global Positioning System
ICA	Intersection Collision Avoidance
IEEE	Institute of Electrical and Electronic Engineers
IMA	Intersection Movement Assist
ISD	Integrated Safety Devices
ISO	International Standards Organization
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
LCW	Lane Change Warning
MAC	Medium Access Control
NEMA	National Electrical Manufacturers Association
NHTSA	National Highway Traffic Safety Administration
NMEA	National Marine Electronics Association
NPRM	Notice of Proposed Rulemaking
NTCIP	National Transportation Communications for ITS Protocol
OBE	On-Board Equipment
OBU	On-Board Units
PCA	Pre-Crash Actions
PHY	PHYSical layer
PSID	Provider Service IDentifier
Q-WARN	Queue Warning
RFA	Request for Applications
RSD	Retrofit Safety Devices
RSE	RoadSide Equipment
RSU	RoadSide Unit
RTCM	Radio Technical Commission for Maritime Services
SA	Situational Awareness
SAE	Society of Automotive Engineers
SCMS	Security Credential Management System
SDO	Standards Development Organization
SPaT	Signal Phase and Timing
SRM	Signal Request Message
SSM	Signal Status Message
TA	Tailgating Advisory
TIM	Traveler Information Message
USDOT	United States Department of Transportation
VAD	Vehicle Awareness Device
VER	Vehicle Emergency Response



VTRFTV	Vehicle Turning Right in Front of a Transit Vehicle
WAVE	Wireless Access in Vehicular Environments
WSMP	WAVE Short Message Protocol
V2I	Vehicle-to-Infrastructure
V2P	Vehicle-to-Pedestrian
V2V	Vehicle-to-Vehicle
VIN	Vehicle Identification Number

## 5. References

### Connected Vehicle Basics

- ITS ePrimer – Module 13: Connected Vehicles.  
<http://www.pcb.its.dot.gov/eprimer/module13.aspx>
- Research and Innovative Technology Administration, “T3 Webinar: Connected Vehicle Basics.” [http://www.pcb.its.dot.gov/t3/s140424\\_cv\\_basics.asp](http://www.pcb.its.dot.gov/t3/s140424_cv_basics.asp)
- Federal Highway Administration, “Connected Vehicles Environment Fundamentals 101”, [http://stsmo.transportation.org/Documents/ConnectedVehiclesToInfrastructure101\\_PresentationRev7.pdf](http://stsmo.transportation.org/Documents/ConnectedVehiclesToInfrastructure101_PresentationRev7.pdf)
- Research and Innovative Technology Administration, “Vehicle-to-Vehicle Communication: A New Generation of Driver Assistance and Safety (Video)”, July 9, 2013.  
[http://www.its.dot.gov/library/media/v2v\\_video.htm](http://www.its.dot.gov/library/media/v2v_video.htm)

### Federal Register and Requests

- Federal Communications Commission, 47 CFR Parts 2 and 90, “Dedicated Short Range Communications of Intelligent Transportation Services – Final Rule, FR Doc No: 99-30591” Federal Register Volume 64, Issue 227 (November 26, 1999).
- National Highway Traffic Safety Administration, 49 CFR 571, “Federal Motor Vehicle Safety Standards: Vehicle-to-Vehicle (V2V) Communications, Docket No. NHTSA-2014-0022”, Federal Register, August 20, 2014.  
<http://www.nhtsa.gov/About+NHTSA/Press+Releases/NHTSA-issues-advanced-notice-of-proposed-rulemaking-on-V2V-communications>
- National Highway Traffic Safety Administration, “Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application, Report No. DOT HS 812 014”, August, 2014.
- National Highway Traffic Safety Administration, “Vehicle-to-Vehicle Security Credential Management System; Request for Information”, October 10, 2014.  
<http://www.safercar.gov/v2v/pdf/V2V-SCMS-RFI-Oct-2014.pdf>
- Federal Highway Administration, “Request for Application - Connected Vehicle - Next Stage Certification Environment”, DTFH6114RA00014, June 18, 2014.  
<http://www.grants.gov/web/grants/view-opportunity.html?oppId=258008>

### Deployment

- Research and Innovative Technology Administration, Connected Vehicle Research, [http://www.its.dot.gov/connected\\_vehicle/connected\\_vehicle.htm](http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm)
- Connected Vehicle Reference Implementation Architecture (CVRIA). <http://iteris.com/cvria/>



- Research and Innovative Technology Administration, DSRC Fact Sheet, [http://www.its.dot.gov/factsheets/dsrc\\_factsheet.htm](http://www.its.dot.gov/factsheets/dsrc_factsheet.htm)
- ITE Connected Vehicle Support Project, <http://www.ite.org/connectedvehicle/>

## 6. Study Questions

1. **Which of the following is NOT a primary benefit in the connected vehicle environment according to USDOT?**
  - a) Safety
  - b) Mobility
  - c) Environment
  - d) Entertainment experience
2. **Which of the following is not a component of the V2V environment?**
  - a) Vehicle powertrain
  - b) Safety application electronic control unit
  - c) GNSS (GPS) receiver
  - d) Memory for security certificates or application data
3. **Which is NOT a benefit of using ITS Standards?**
  - a) Supports interoperability
  - b) Eliminates institutional issues
  - c) Makes testing easier
  - d) Makes procurements easier
4. **Which of the following is a data standard?**
  - a) IEEE 802.11-2012
  - b) IEEE 1609.x Family of Standards
  - c) SAE J2735
  - d) USDOT FHWA Vehicle Awareness Device Specification
5. **What is a current challenge to deploying connected vehicles?**
  - a) Security
  - b) Privacy



- c) Evolving standards
- d) All of the above

6. **Which of the following is not a current connected vehicle activity**

- a) Revising ITS standards based on lessons learned
- b) USDOT will be operating new certification laboratories for connected devices
- c) Developing a security system to authenticate messages
- d) Revising the CVRIA for emerging application requirements

