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WELCOME



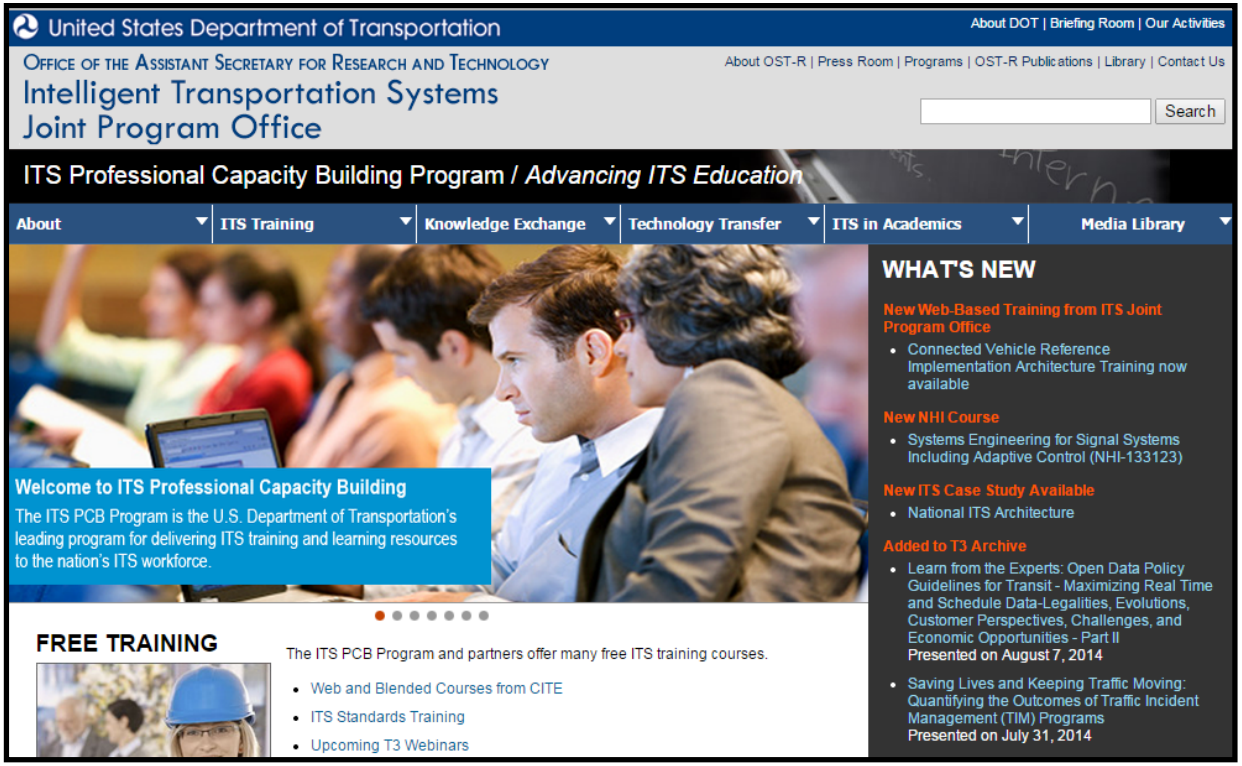
U.S. Department of Transportation

Office of the Assistant Secretary for
Research and Technology

Welcome



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www.pcb.its.dot.gov

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

Instructor



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Acknowledgements

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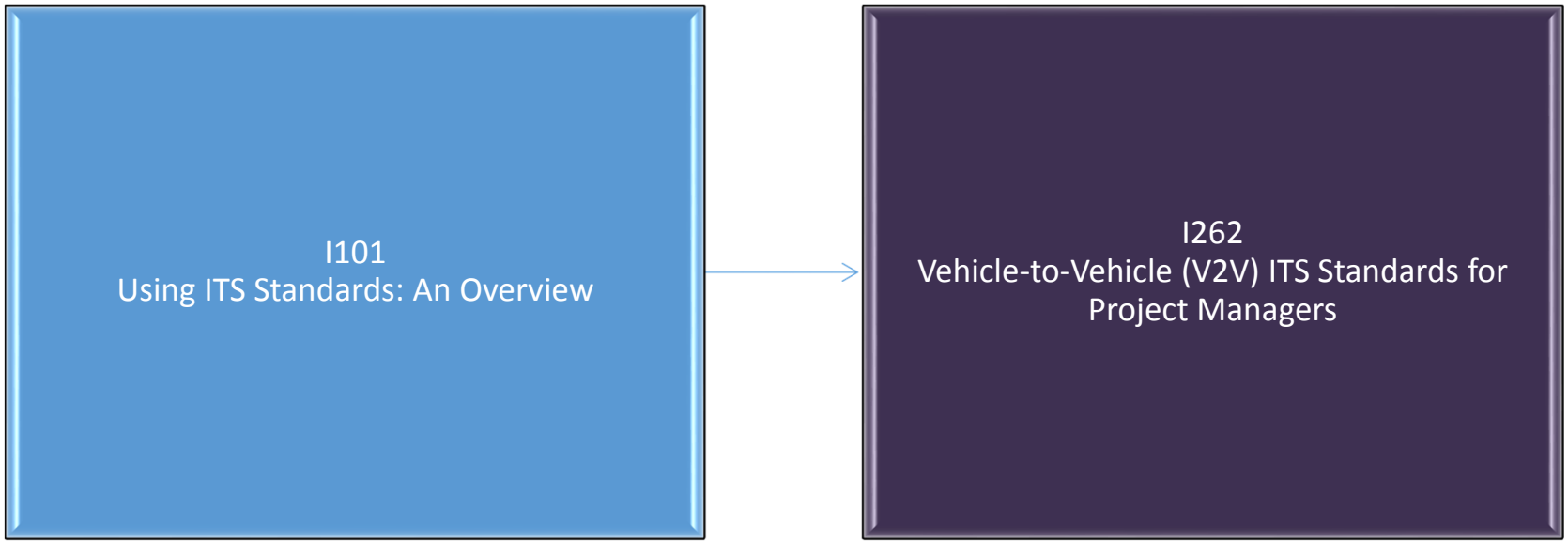
Target Audience

- Public sector managers of surface transportation systems and agencies
  - Understand and prepare for a connected vehicle environment, when it will happen and how it can address their transportation needs
- Procurement officials for surface transportation agencies
  - Understand how the standards can help design an implementation to address their transportation needs
- Decision makers
  - Understand the impacts of a V2V environment on the transportation system and how they do business
- Private and public sector users including automobile industry
  - Understand how they may benefit from a V2V environment

Recommended Prerequisite

- I101: Using ITS Standards: An Overview

Curriculum Path



Learning Objectives

1. Describe the connected vehicle environment
2. Discuss the V2V environment
3. Describe the roles of the standards in a connected vehicle environment
4. Identify and address high-level technical and institutional challenges to deploying a V2V environment
5. Describe the current status of the connected vehicle environment

Learning Objective #1:
Describe the Connected Vehicle Environment

- Identify the connected vehicle environment
- Define dedicated short range communications (DSRC)
- List the benefits of a V2V connected vehicle environment

Identify the Connected Vehicle Environment

Transportation Challenges in the United States

Safety
33,561 highway deaths in 2012
5,615,000 crashes in 2012
Leading cause of death for ages 4, 11-27



Mobility
5.5 billion hours of travel delay
$121 billion cost of urban congestion



Environment
2.9 billion gallons of wasted fuel
56 billion lbs. of additional CO_2



Source: U.S. Department of Transportation

Identify the Connected Vehicle Environment

Vehicles



- Have safety devices and sensors
- Are a navigation device
- Are a multimedia center



In addition, millions of people carry mobile devices today that have Global Positioning System (GPS) and can access data…



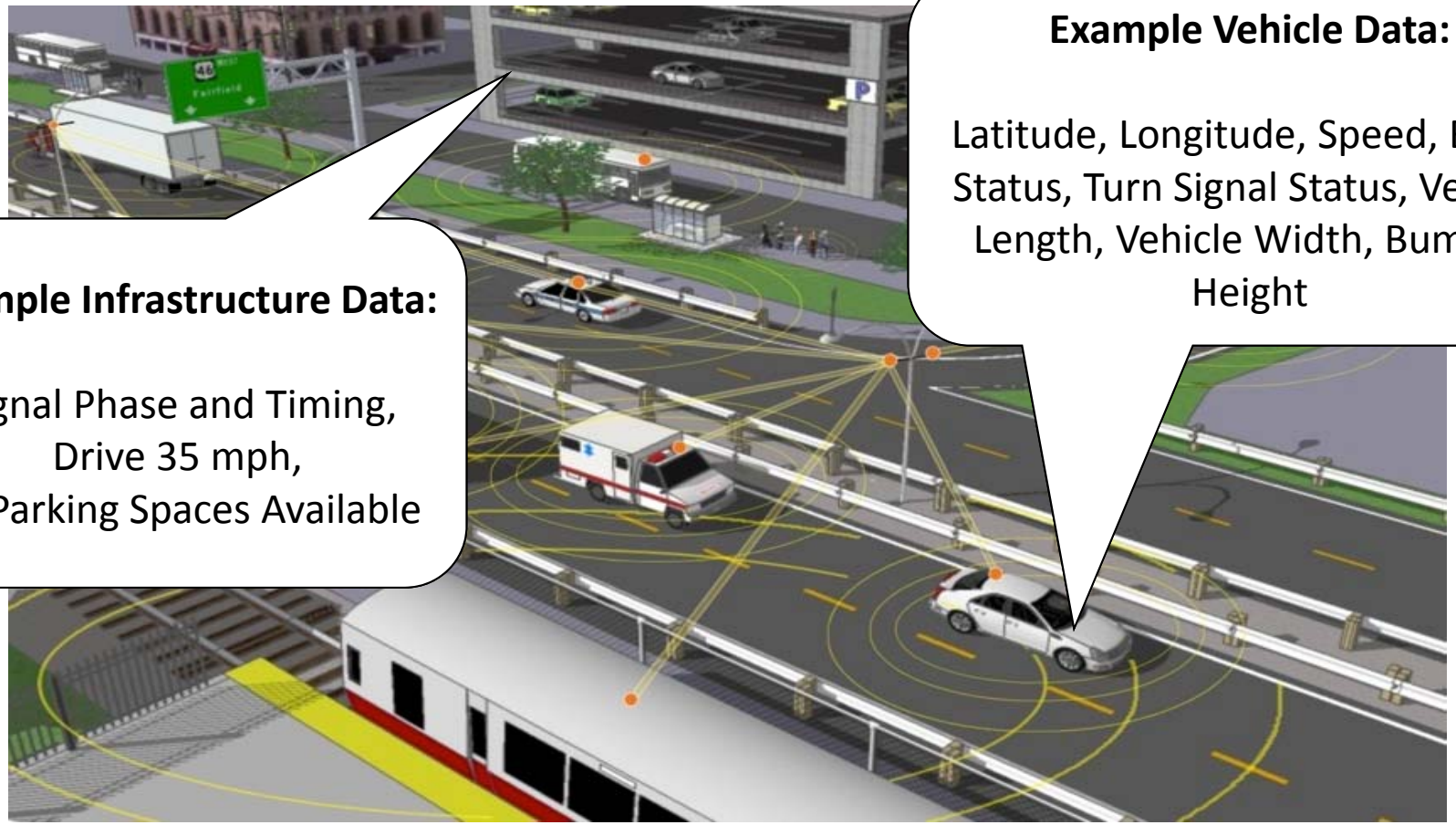
Identify the Connected Vehicle Environment

What if….

- Vehicles shared their sensor data with other vehicles and the roadway
- Vehicles shared their current position with other vehicles and the roadway
- Vehicles can receive data from the roadway that can reduce the likelihood of incidents
- Vehicles can receive data from the roadway to improve mobility (e.g., reduce delays)



Identify the Connected Vehicle Environment



Source: US Department of Transportation

Identify the Connected Vehicle Environment

What is the connected vehicle environment?

- A research program to explore how transportation connectivity can enable applications that provide safety, mobility and environmental benefits
- Transportation connectivity consists of
  - Vehicles wirelessly sending information about itself to other vehicles (vehicle-to-vehicle)
  - Vehicles wirelessly exchanging information with the infrastructure (vehicle-to-infrastructure)
  - Vehicles, infrastructure and other mobile devices wirelessly maintaining real-time connectivity
- Connected Vehicle Reference Implementation Architecture (CVRIA). http://iteris.com/cvria/

Identify the Connected Vehicle Environment

NHTSA ANPRM

- August 2014, National Highway Traffic Safety Administration (NHTSA) released an Advance Notice of Proposed Rulemaking (ANRPM) and a supporting research report
  - Federal Motor Vehicle Safety Standard (FMVSS) No. 150, to require vehicle-to-vehicle (V2V) communications capability for light vehicles and to create minimum performance requirements for V2V devices and messages
  - V2V and V2I systems could potentially address 81% of all vehicle crash types
- Notice of Proposed Rulemaking (NPRM) by 2016

Identify the Connected Vehicle Environment

In addition to safety, the connected vehicle environment:

- Can address mobility challenges – Address non-recurring congestion through V2V and V2I communications, including reducing crashes
- Can address environmental challenges – Increased fuel efficiency and reduced recurring congestion
- Can lead to a new class of vehicles – connected and possibly autonomous
  - May impact engineering analysis and design
- V2V will open the gates for V2X: V2I, V2P

Source: US Department of Transportation

Identify the Connected Vehicle Environment

This module focuses on the vehicle-to-vehicle (V2V) aspects!

- Module I261 focuses on the vehicle-to-infrastructure (V2I) aspects
- Introduces the standards (existing and under development) that will enable the V2V connectivity
- Allows project managers to begin planning how we manage and operate our transportation infrastructure to realize the benefits from V2V connectivity



Define Dedicated Short Range Communications (DSRC)

FCC Definition

- *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. DSRC systems may also transmit status and instructional messages related to the units involved.*
  - Note: An ASTM standard is incorporated into the FCC Rule

Source: Federal Communications Commission, Dedicated Short Range Communications of Intelligent Transportation Services – Final Rule, FR Doc No: 99-30591

Define Dedicated Short Range Communications (DSRC)

Frequencies

Frequencies vary in the U.S., Japan, and Europe

In the United States, only the 5.9 GHz band is being considered for V2V safety communications

- Original FCC spectrum allocation in 1999
- 75MHz of spectrum range in the 5.9 GHz band
- (7) 10MHz Channels (provides the necessary bandwidth)
  - Channel 178 is the control channel
  - Channel 172 service channel for safety data
  - Channel 184 service channel for high powered public safety eligible

Define Dedicated Short Range Communications (DSRC)

Advantages

- Low latency
  - Information can be transmitted at a high rate
  - Critical for V2V safety applications
  - Data can be transmitted 10 times per second
- Short to medium range (< 300 meters reliably)
  - Advantage - only interested in messages from nearby vehicles
  - Higher power permitted for emergency response vehicles (range can be 1 km)
- No subscription necessary

List the Benefits of a V2V Connected Vehicle Environment

Safety Benefits

- Increase situational awareness
  - A vehicle can alert other vehicles about roadway conditions – provides information a driver cannot see yet
  - 360-degree “visibility”
- Significantly reduce the number and severity of crashes
  - Driver advisories
  - Driver warnings
  - Vehicle control

List the Benefits of a V2V Connected Vehicle Environment

Mobility and Environmental Benefits

- Mobility Benefits
  - Reduced collisions
  - Minimizing time with blocked roadways
  - Optimized speed suggestions
- Environmental Benefits
  - Mobility benefits will result in less congestion, reducing emissions

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Which of the following is NOT a primary benefit in the connected vehicle environment according to USDOT?

Answer Choices

a) Safety

b) Mobility

c) Environment

d) Entertainment experience

Review of Answers



a) Safety

Incorrect. The USDOT has identified that safety is the primary benefit for the connected vehicle environment.



b) Mobility

Incorrect. Mobility has also been identified as a primary benefit for connected vehicles.



c) Environmental

Incorrect. Environmental has also been identified as a primary benefit for connected vehicles.



d) Entertainment experience

Correct! The entertainment experience is not a primary benefit according to USDOT.

Summary of Learning Objective #1

Describe the Connected Vehicle Environment

- Identify what is a connected vehicle environment
- Define dedicated short-range communications (DSRC)
- List the benefits of a V2V connected vehicle environment

Learning Objective #2:
Discuss the V2V Environment

- List the components of a V2V environment
- Identify V2V applications
- Describe the information that needs to be exchanged between the components to support V2V applications

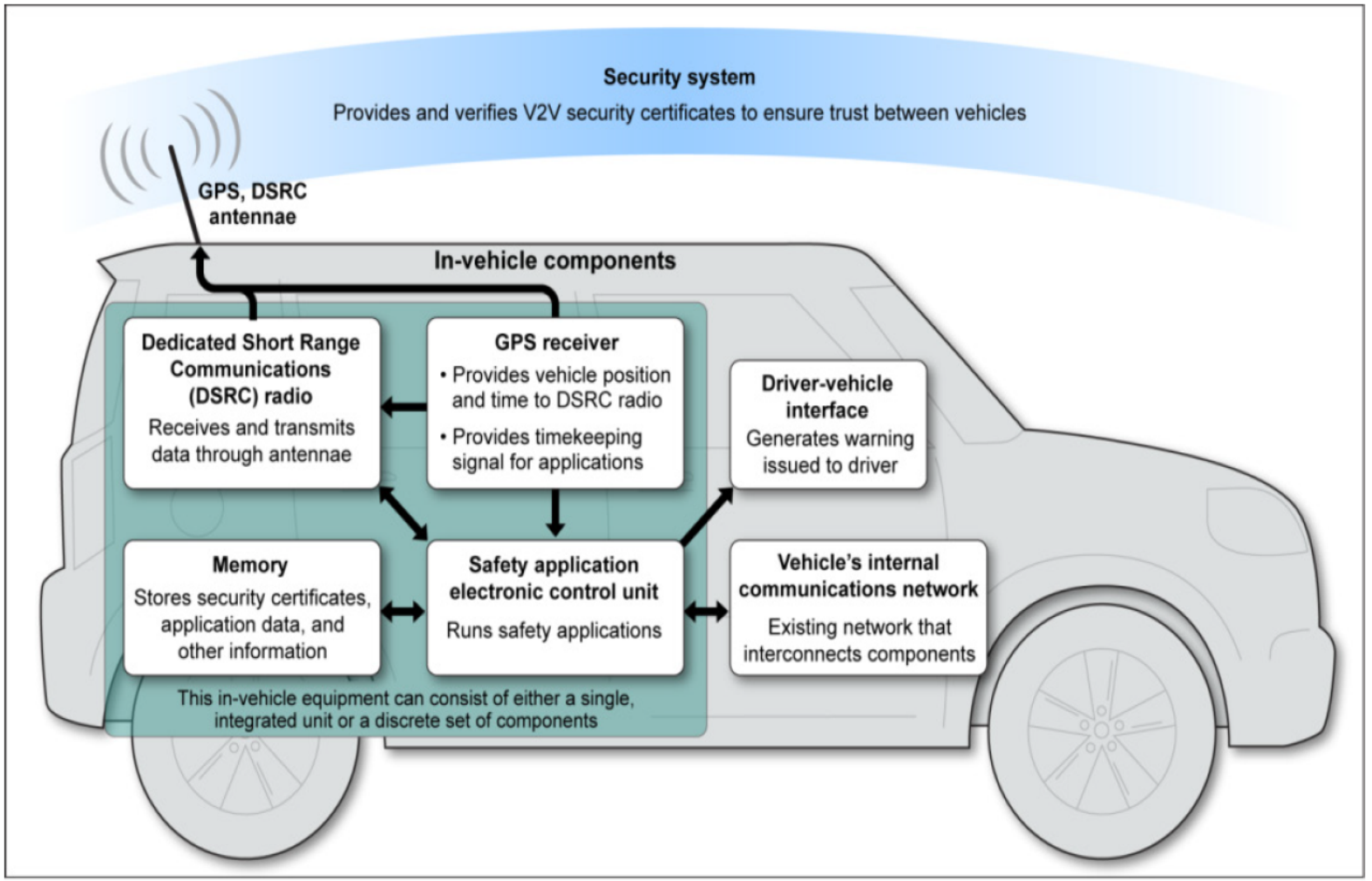
List the Components of a V2V Environment

The V2V environment consists of vehicles with on-board equipment (OBE). An OBE:

- Broadcasts a set of data, such as vehicle location, speed and direction of travel; AND/OR
- Receives the set of data from other vehicles



List the Components of a V2V Environment



Source: Crash Avoidance Metrics Partnership and GAO

List the Components of a V2V Environment

- **On-Board Units (OBUs) -** Represents the DSRC radio alone
- **Integrated Safety Devices (ISDs) -** Installed by the manufacturer, these devices integrate directly with the vehicle's computers, which can provide additional information
- **Aftermarket Safety Devices (ASDs) -** A portable unit with a driver interface, broadcasting basic safety information and receiving safety information from other vehicles
- **Retrofit Safety Devices (RSDs) -** A non-factory installed unit connected directly to a vehicle's data bus
- **Vehicle Awareness Devices (VADs) -** Only broadcasts basic safety information. Cannot receive information from other devices

Source: US Department of Transportation

V2V Applications

Application

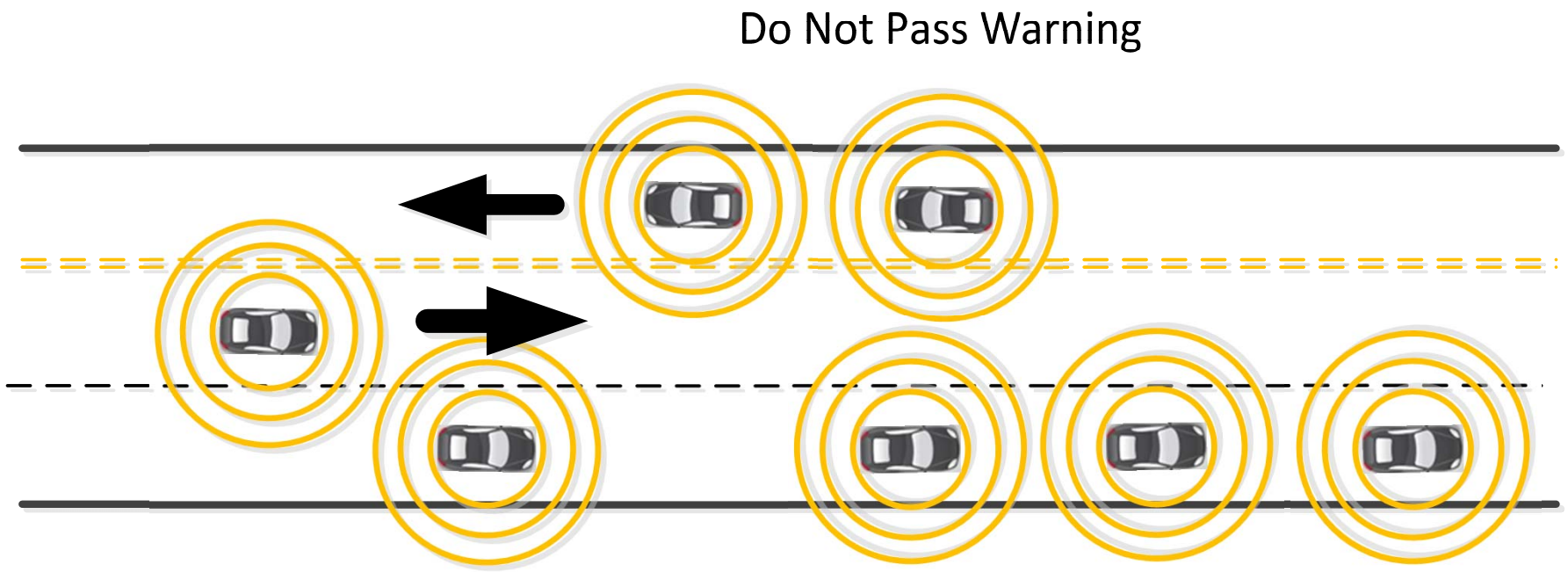
- A piece of software that processes inputs for a specific use or purpose.
- Could be burned on a chip
- It is through applications that we obtain the benefits of a V2V environment

The next several slides identify the most cited applications identified by USDOT for V2V

- Not all V2V applications are identified
- Most applications will use its own (device) sensor readings in addition to inputs from other vehicles

V2V Applications

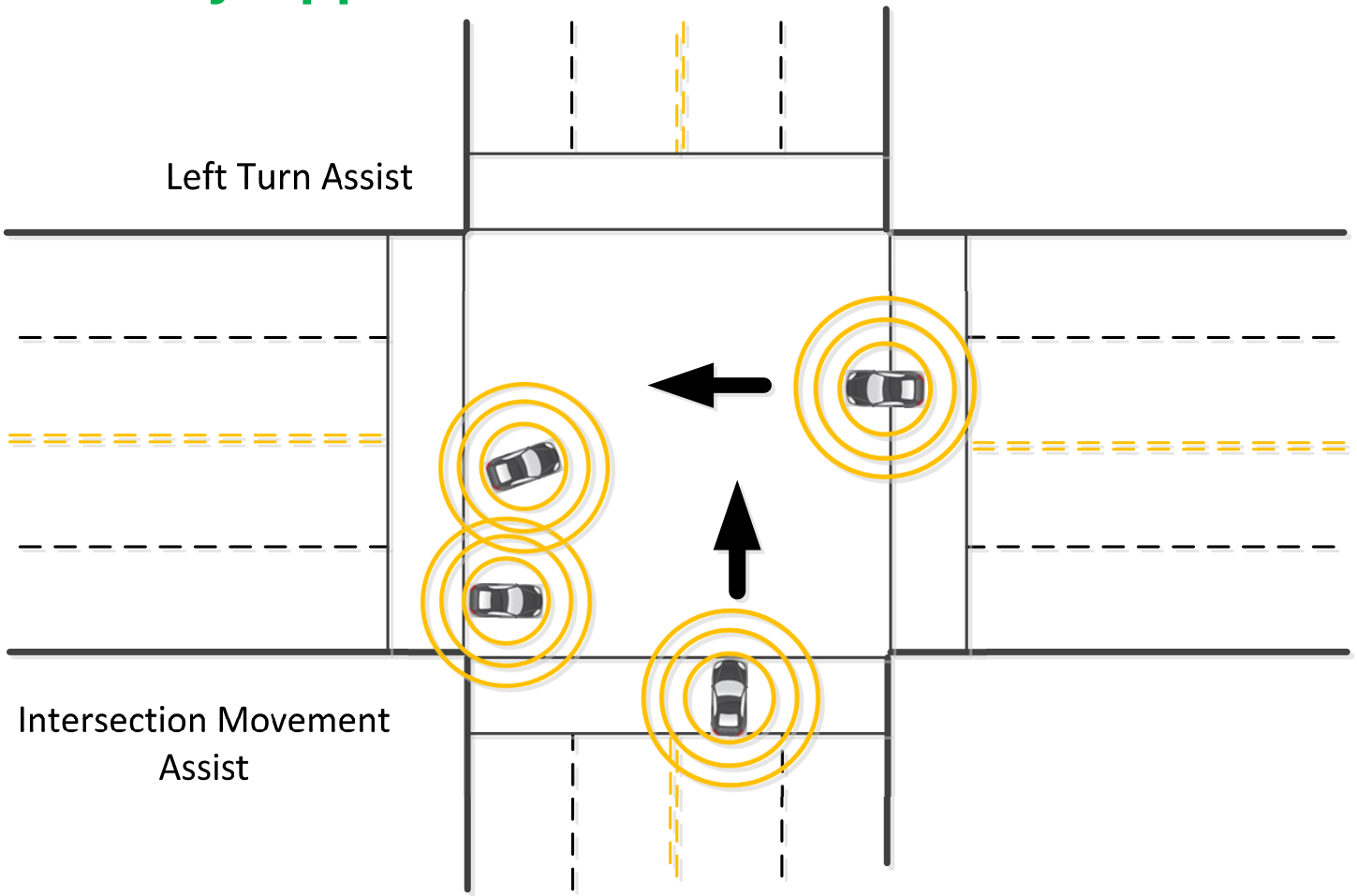
V2V Safety Applications



Source: Connected Vehicle Reference Implementation Architecture (CVRIA)

V2V Applications

V2V Safety Applications



Source: Connected Vehicle Reference Implementation Architecture (CVRIA)

V2V Applications

V2V Safety Applications (cont.)

- **Emergency Vehicle Alert (EVA)**
  - Warns driver about nearby public safety vehicles responding to an incident
- **Vehicle Emergency Response (VER)**
  - Provides public safety vehicles with information from connected vehicles involved in a crash
- **Transit Vehicle at Station/Stop Warnings**
  - Warns driver about transit vehicles that may be pulling into or out of a transit station or stop
- **Vehicle Turning Right in Front of a Transit Vehicle (VTRFTV)**
  - Warns the transit vehicle driver of a nearby vehicle pulling in front of the transit vehicle to make a right turn

Source: CVRIA

V2V Applications

V2V Mobility Applications

Each of these applications has a V2V component and a V2I component.

- **Advanced Automatic Crash Notification Relay (AACNR)**
  - Enables a vehicle to automatically transmit an emergency message when the vehicle is disabled. Also enables another connected vehicle to relay the emergency message to a public safety vehicle. Also a V2I application
- **Cooperative Adaptive Cruise Control (CACC)**
  - Advises driver of a recommended cruise speed based on information from other connected vehicles within a platoon
- **Queue Warning (Q-WARN)**
  - Advises drivers of an impending queue

Source: CVRIA

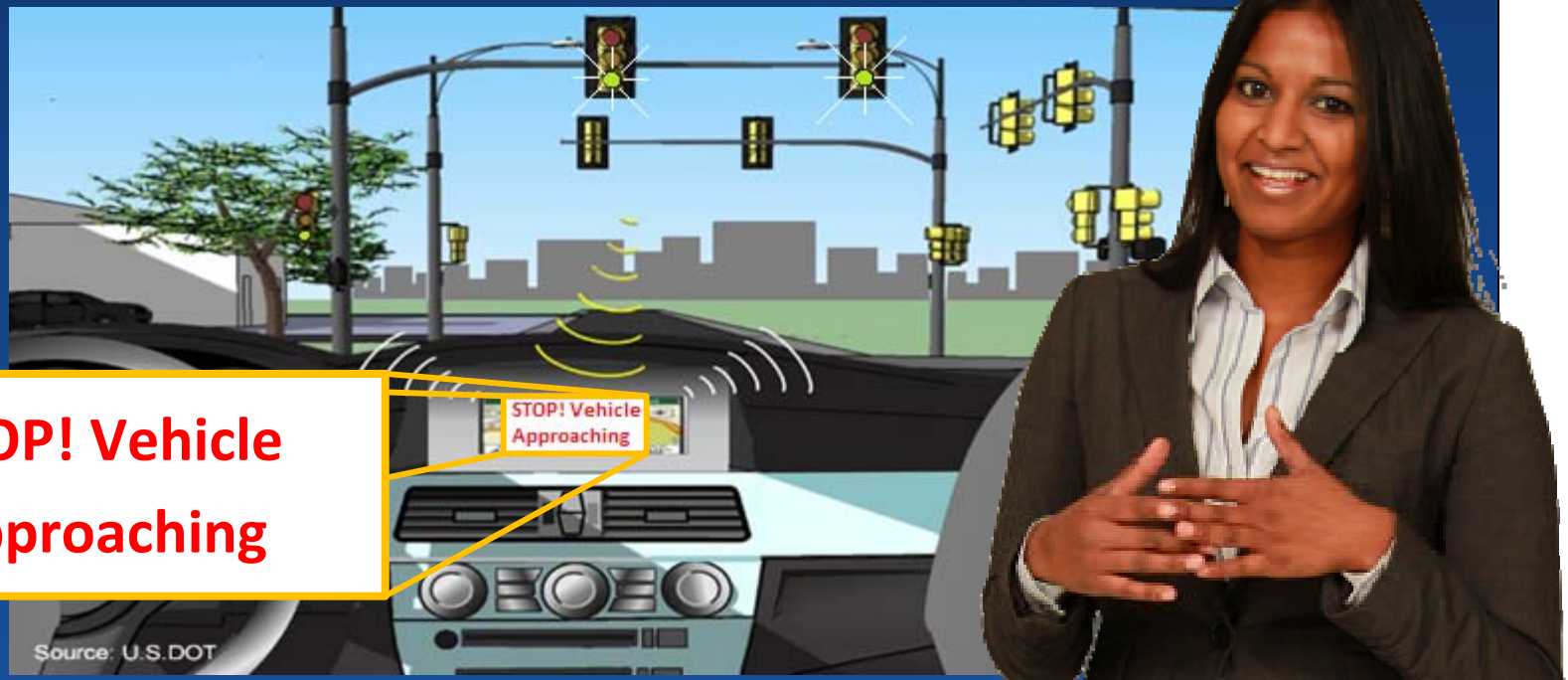
V2V Applications

V2V Environmental Applications

- **Connected Eco-Driving**
  - Advises driver to adjust their driving behavior to save fuel and reduce emissions
- **Eco-Cooperative Adaptive Cruise Control (Eco-CACC)**
  - Advises driver of a recommended cruise speed based on information from other connected vehicles within a platoon and eco-driving strategies. Also incorporates other information to determine the most environmentally efficient speed

Source: CVRIA

Lauren is driving home with her son after a day at school. She is stopped at a red light. When the light turns green, she is about to move through the intersection when she is warned of a vehicle crossing the path in front of her. She quickly brakes to avoid a T-bone crash.



STOP! Vehicle Approaching

Describe the Information That Needs to be Exchanged between the Components to Support V2V Applications

For this scenario, what data is needed for this application to work?

- Location (latitude, longitude, elevation) from the other vehicle
- Speed from the other vehicle
- Direction of travel from the other vehicle
- Acceleration rate from the other vehicle
- Brake status from the other vehicle
- Length and width from the other vehicle
- Steering wheel angle from the other vehicle

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Which of the following is NOT a component of the V2V environment?

Answer Choices

a) Vehicle powertrain

b) Safety application electronic control unit

c) GNSS (GPS) receiver

d) Memory for security certificates or application data

Review of Answers



a) Vehicle powertrain

Correct! While the vehicle powertrain is a component of the vehicle, it is not a component of the V2V environment.



b) Safety application electronic control unit

Incorrect. The electronic control unit includes the processor that runs the safety applications.



c) GNSS (GPS) receiver

Incorrect. The GNSS receiver provides the vehicle position and time for the vehicle.



d) Memory for security certificates or application data

Incorrect. The memory is needed to store security certificates and application data.

Summary of Learning Objective #2

Discuss the V2V Environment

- List the components of a V2V environment
- Identify V2V applications
- Describe the information that needs to be exchanged between the components to support V2V applications

Learning Objective #3: Describe the Roles of the Standards in a Connected Vehicle Environment

- Summarize the benefits of standards
- Identify the ITS standards to support communications between the components
- Identify the information and performance requirements that are supported by the ITS standards
- Identify the hardware specifications supported by USDOT

Summarize the Benefits of Standards

Standards are Essential!

- Supports interoperability to maximize potential benefits
  - Interoperability – The ability of two or more systems or components to exchange information and use the information that has been exchanged[1]
  - E.g., AM/FM radio broadcasts
- Makes testing easier
- Helps with the design and procurement of a system

[1] *IEEE Std. 610.12-1990: IEEE Standard Glossary of Software Engineering Terminology*

Summarize the Benefits of Standards

General Communications Requirements



Required for Deployment:
Different manufacturers

How do we trust each other?
Authentication

How do we communicate?
Wireless on the same frequency

What language are we using?
Agree on the grammar and dictionary

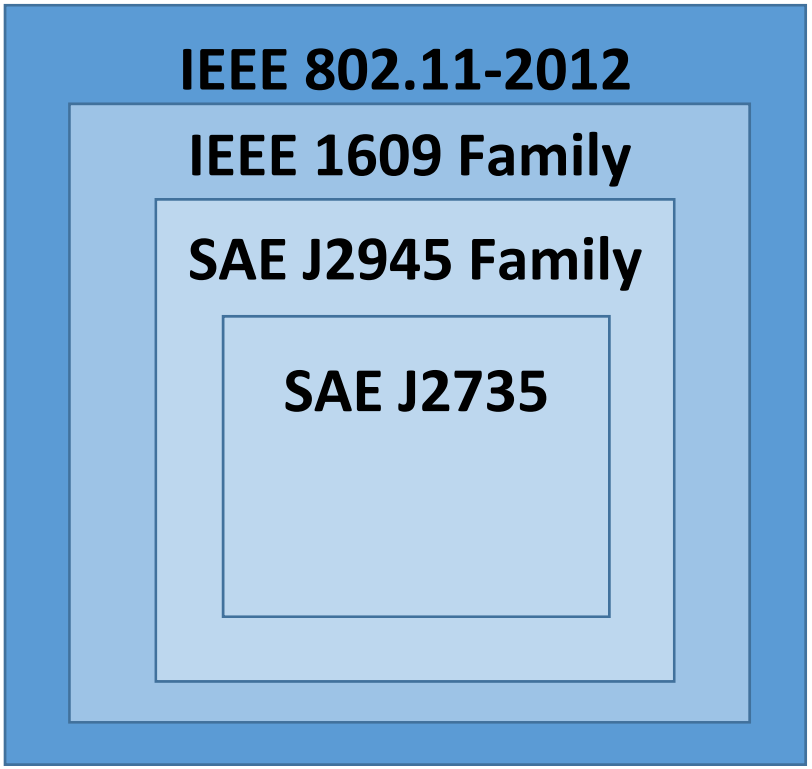
How many people are talking in the room?
Talk louder or softer or change rooms or channels



Identify the ITS Standards to Support Communications between the Components

Communications Standards

- **Transmission Standards**
  - ASTM 2213-03
  - IEEE 802.11-2012
  - IEEE 1609 Family
- **Interface Standard**
  - SAE J2945 Family
- **Data Standard**
  - SAE J2735



Identify the ITS Standards to Support Communications between the Components

ASTM 2213-03

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

- Describes a MAC and PHY specification for wireless connectivity using DSRC services
  - PHY: the radio chips and the intervening environment in-between
  - MAC: the message protocols that allows applications to 'connect' to the PHY
- Basis for IEEE 802.11p amendment

Identify the ITS Standards to Support Communications between the Components

IEEE 802.11-2012

IEEE Standard for Information Technology – Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Network-Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

- Provides wireless connectivity among fixed, portable, and moving stations (STAs) within a local area
- Supports wireless connectivity in vehicular environments
- Specifies channel bandwidths, operating classes, transmit power classification, transmission masks, and alternate channel requirements in the 5.9 GHz spectrum
- IEEE 802.11p amendment is included in IEEE 802.11-2012

Identify the ITS Standards to Support Communications between the Components

IEEE 1609.x Family

IEEE 1609.0™-2013, Architecture (Guide)

- Describes the architecture and operation of a Wireless Access in Vehicular Environments (WAVE) system based on IEEE 1609 standards and IEEE Std 802.11-2012
- Enables the development of interoperable low-latency, low overhead WAVE devices that can provide communications in support of transportation safety, efficiency and sustainability, and that can enhance user comfort and convenience

Identify the ITS Standards to Support Communications between the Components

IEEE 1609.x Family (cont.)

IEEE Std 1609.2™-2013, Security Services for Applications and Management Messages

- Specifies security processing requirements and message sets for secure WAVE radio system operation
- Specifies communications security for WAVE Service Advertisements and WAVE Short Messages and additional security services that may be provided to higher layers

Identify the ITS Standards to Support Communications between the Components

IEEE 1609.x Family (cont.)

IEEE Std 1609.3™-2010, Networking Services

- Specifies networking services required for operation of a WAVE system that employs standard IPv6 protocol, introduces a WAVE Short Message Protocol (WSMP), and provides a collection of management functions supporting WAVE services

Identify the ITS Standards to Support Communications between the Components

IEEE 1609.x Family (cont.)

IEEE Std 1609.4™-2010, Multi-Channel Operation

- Specifies extensions to IEEE Std 802.11-2012 MAC layer for multichannel operations, i.e., operating alternately on the control channel and one of several service channels
- Includes the following features:
  - Channel timing and switching
  - MAC-layer readdressing in support of pseudonymity

Identify the ITS Standards to Support Communications between the Components

IEEE 1609.x Family (cont.)

IEEE Std 1609.11™-2010, Over-the-air Electronic Payment Data Exchange Protocol for ITS

- Application-level IEEE 1609 standard, communication technology independent, specifies a payment over-the-air protocol referencing ISO standards

IEEE P1609.12™, WAVE - Provider Service Identifier Allocation (PSID)

- Specifies allocations of WAVE identifiers defined in the IEEE 1609™ series of standards
- Records the Provider Service Identifier (PSID) allocation decisions made by the IEEE 1609 working group, and other identifiers used by the WAVE standards

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

Dedicated Short Range Communications (DSRC) Message Set Dictionary

- Defines messages and data elements

Basic Safety Message (BSM)

- Primary message set for V2V communications
- Part I contains data elements that are necessary for safety applications and are expected to be broadcasted frequently
- Part II data elements are broadcasted less frequently as needed or as requested

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

BSM Part I includes:

- **Location** (longitude, latitude, elevation) – where it is
- **Positional Accuracy** - how accurate is the position
- **Speed** - the rate at which the vehicle is moving
- **Transmission** - the status of the transmission gears
- **Heading** - the direction the vehicle is facing
- **Steering Wheel Angle** – the rate for change of direction
- **Acceleration** - the rate the vehicle speed is changing
- **Brake System Status** – if brakes are being applied
- **Vehicle Size** – for collision calculations

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

BSM Part I also includes:

- **Message Count** – counter to track sequence of messages
- **Temporary ID** – a transient identifier for the vehicle to track its movement and status
- **Time** – when the message was broadcasted

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

BSM Part II:

- Part II data elements are broadcasted as needed or as requested
- Below are some examples of Part II data elements:
- **Event Flags** – indicates an unusual event has occurred. Includes hazard lights, anti-lock brake system activated, traction control system activated, stability control activated, hard braking, stop line violation, external lights changed, wipers changed, flat tire, vehicle disabled, air bag deployment
  - Also indicates if the vehicle is an emergency vehicle on a service call, or a vehicle placarded for and carrying hazardous materials

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

BSM Part II:

- **Path History** – representation of the actual path history of the vehicle
- **Path Prediction** – predicted vehicle path trajectory
- **Exterior Lights** – status of lights for environmental purposes or to determine the driver's intent
- **Brake Pressure** – pressure on the brakes applied by the driver
- **Vehicle weight and height** (including trailer weight)
- **Vehicle Bus** (J1939) – information from a vehicle bus
- **Vehicle Identification** – includes a VIN number and vehicle type

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

BSM Part II:

- **Wipers** – rate of wipes
- **Environmental Data**
  - Air temperature
  - Sun sensor
  - Air pressure
  - Rain sensor
  - Coefficient of Friction
- **Obstacles** – based on vehicle sensors or sudden vehicle movements to avoid a potential obstacle

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

Other V2V Messages

- **Common Safety Request (CSR)** – A request from a vehicle to nearby vehicles for additional information for safety applications it is running
- **Emergency Vehicle Alert (EVA)** – Broadcasted warning message that a public safety vehicle is operating in the vicinity

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2735

Other Messages

- MAP Data (MAP)
- Signal Phase and Timing (SPaT)
- Probe Messages
- Signal Request (SRM) / Signal Status Message (SSM)
- Traveler Information Message (TIM)
- Roadside Alert (RSA)
- National Marine Electronics Association (NMEA) Corrections
- Radio Technical Commission for Maritime Services (RTCM) Corrections

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2945 Family

- Currently titled Dedicated Short Range Communications (DSRC) Minimum Performance Requirements
- Defines the operational and performance requirements for specific applications
  - What, when and how often a message is sent (minimum, typical, maximum)
  - Minimum quality requirements
- Each standard (J2945/n) may contain a Concept of Operations, requirements, information level dialog definitions, and the design content in the form of messages and data elements (defined in SAE J2735) for a specific set of applications

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J2945 Family

- J2945/0 will define common requirements for DSRC
  - Includes systems engineering content (Concept of Operations, requirements, message exchanges, and message content)
- J2945/1 will define the minimum performance requirements for V2V safety applications
  - Standards Compliance (IEEE, SAE, FCC)
  - BSM Transmission
  - Security and Privacy
- J2945/2 will define other requirements for V2V safety
  - Includes systems engineering content (Concept of Operations, requirements, message exchanges, and message content)
- Work in Progress (Target: end of 2015)

Identify the Information and Performance Requirements that are Supported by the ITS Standards

SAE J3067

Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735] Using Systems Engineering Methods

- An informational report with systems engineering content
- Includes a concept of operations (user needs), requirements content (including performance content), and design content
- Includes traceability matrices between user needs, requirements and design
- To be used as a template for developing SAE J2945 family and the next revision of SAE J2735

Identify the Information and Performance Requirements that are Supported by the ITS Standards

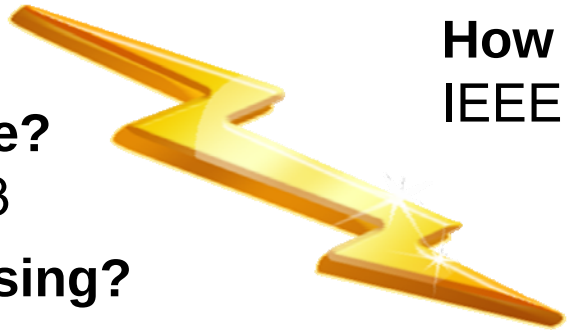
General Communications Requirements



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



Identify the Hardware Specifications Supported by USDOT

Research Qualified Products List

Hardware specifications being used in the Southeast Michigan Test Bed

- Each specification is based on the standards
- 5.9 GHz DSRC Vehicle Awareness Device Specification v3.8
  - http://www.its.dot.gov/testbed/PDF/Vehicle_Awareness_Device_Specification-r3-8%2020140322.pdf
- 5.9 GHz DSRC Aftermarket Safety Device Specification v3.1
  - http://www.its.dot.gov/testbed/PDF/ASD_Device_Design_Specification_3_1%2020140322.pdf

Identify the Hardware Specifications Supported by USDOT

Compliance Testing Program / Certification

- Certification process
  - Goal: verify and validate off-the-shelf interoperability of devices
- Certification Services were developed for testing programs to certify the Vehicle Awareness Device (VAD) for USDOT's Safety Pilot
- Testing programs were developed for the Aftermarket Safety Device (ASD)

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Which is NOT a benefit of using ITS Standards?

Answer Choices

a) Supports interoperability

b) Eliminates institutional issues

c) Makes testing easier

d) Makes procurements easier

Review of Answers



a) Supports interoperability

Incorrect. Interoperability is a key benefit of standards.



b) Eliminates institutional issues

Correct! Standards alone cannot eliminate institutional issues.



c) Makes testing easier

Incorrect. Standards can make testing easier.



d) Makes procurements easier

Incorrect. Standards can help with the design and procurement of a system.

Which of the following is a data standard?

Answer Choices

a) IEEE 802.11-2012

b) IEEE 1609.x Family of Standards

c) SAE J2735

d) USDOT FHWA Vehicle Awareness Device Specification

Review of Answers

a) IEEE 802.11-2012
Incorrect. IEEE 802.11 is a communications and transmission standard.

b) IEEE 1609.x Family of Standards
Incorrect. IEEE 1609.x Family of Standards are communications and transmission standards.

c) SAE J2735
Correct! SAE J2735 is a data standard that describe both messages sets and the data dictionary used by the message sets.

d) USDOT FHWA Vehicle Awareness Device Specification
Incorrect. USDOT FHWA DSRC RSU Specifications Document v4.0 is a specification.

Summary of Learning Objective #3

Describe the roles of standards in a Connected Vehicle Environment

- Summarize the benefits of standards
- Identify the ITS standards to support communications between the components
- Identify the information and performance requirements that are supported by the ITS standards
- Identify the hardware specifications supported by USDOT

Learning Objective #4: Identify and Address High-Level Technical and Institutional Challenges to Deploying a V2V Environment

- Describe technical challenges to deploying V2V
- Describe institutional challenges to deploying V2V
- Describe how transportation systems support the V2V environment

Describe Technical Challenges To Deploying V2V

NHTSA ANPRM

- The August 2014 ANPRM included a supporting research report
  - SAE and IEEE standards need refinement with improved security, inclusion of minimum performance requirements and associated improvements in message protocols
  - V2V applications show substantial ability to mitigate crashes, injuries or fatalities
  - NHTSA has the legal authority to mandate V2V devices in new light vehicles and require installation in commercial vehicles
  - Additional research areas include V2V device certification, test procedures and performance requirements

Describe Technical Challenges To Deploying V2V

Standards are Still Evolving

- Align with NHTSA regulatory decision on V2V deployment and research needs
  - Guidance provided to SDOs to have stable, approved and published standards by September 2015
- Updates to standards based on prototypes and field tests
  - For example, there is a “wish list” for Part II data elements from stakeholders
- Harmonization of protocols and standards with each other and international efforts

Describe Technical Challenges To Deploying V2V

Standards Implementation

- Basic Safety Message Part II is optional
  - Event flags, path history and path prediction are proposed to be mandatory for V2V safety
- Channel congestion on radio systems
- Currently very few guidance documents on deploying these standards

Describe Technical Challenges To Deploying V2V

Implementation Issues

- Two vehicles need to be equipped to gain benefits
  - One vehicle must broadcast and another vehicle must receive at the same time
- Managing the environment and the challenges during the "roll out"
  - Few vehicles will be "fully" equipped
  - Managing the entire range of capabilities – different vehicles have different devices and different capabilities
- Near-field tracking is possible

Describe Technical Challenges To Deploying V2V

Testing and Certification

- Define testing program and certification
  - Conformance testing (to standards)
  - Compliance testing (with regulations or legal requirements)
  - Dependent on the implementation's requirements and applications
- Degree of maturity of current standards for certification testing (self-testing, third-party testing, establishing accredited laboratories for device testing and certification)

Describe Technical Challenges To Deploying V2V

Regulatory Issues

- Requirement for coexistence if band sharing with unlicensed users is required by FCC (75 MHz allocation in 5.9 GHz band for safety applications in vehicular environments)
  - December 17, 2003 FCC Report and Order – safety applications have primary status over non-safety applications

Describe Institutional Challenges To Deploying V2V

Privacy

- Privacy between users and 3rd parties
- Can't track a vehicle to its source and destination without appropriate authorization (e.g., electronic payments)
- IEEE 1609.3 describes the use of changing MAC address at random intervals
- SAE J2945 standards address this by assigning and changing an identifier on a frequent basis

Describe Institutional Challenges To Deploying V2V

Security

- Exchange of trusted and authenticated data between users and applications
- Message validity
- Designing a security certificate management system
  - Based on IEEE 1609.2, which defines how to use, revoke and refresh certificates

Describe how Transportation Systems Support the V2V Environment

Support the Security Credential Management System

- Infrastructure needed to support renewing security credentials/certificates
  - Security credentials/certificates on vehicles need to be updated on a periodic basis
  - Create, manage, store, distribute and revoke security certificates that accompany and validate each BSM
- Infrastructure consists of:
  - Certificate authority to issue and verify certificates
  - Registration authority to verify a certificate authority
  - A certificate distribution and management system which includes the communications system

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What is a current challenge to deploying connected vehicles?

Answer Choices

a) Security

b) Privacy

c) Evolving standards

d) All of the above

Review of Answers



a) Security

Incorrect. The exchange of trusted, authenticated, and valid data is a current challenge to the connected vehicle environment.



b) Privacy

Incorrect. The protection of the identity of the driver and the vehicle is a current change to the connected vehicle environment.



c) Evolving standards

Incorrect. The evolving standards is a current challenge to implementing and testing the connected vehicle environment.



d) All of the above

Correct! Security, privacy and evolving standards are all current challenges to the connected vehicle environment.

Summary of Learning Objective #4

Identify and Address Technical and Institutional Challenges to Deploying a V2V Environment

- Describe technical challenges to deploying V2V
- Describe institutional challenges to deploying V2V
- Describe how transportation systems support the V2V environment

Learning Objective #5: Describe the Current Status of the Connected Vehicle Environment

- Introduce standards and research activities underway
- Provide key schedule milestones for the connected vehicle environment
- List resources for further reading and information
- Note: as of March 2015

Introduce Standards and Research Activities Underway

Review

- Introduced what the connected vehicle environment and V2V environment are and what benefits they bring
- Described the V2V environment and identified potential applications
- Identified the standards that support the V2V environment
- Described some of the challenges to deploying the V2V environment

Introduce Standards and Research Activities Underway

IEEE 802.11-2012

- 802.11RevMc scheduled for review and comment in March 2016
  - Assess potential changes needed for alignment to any NHTSA proposed rulemaking

Introduce Standards and Research Activities Underway

IEEE 1609 Family

- P1609.2 – Converting to use ASN.1 for next revision (2015)
- P1609.3 – Miscellaneous Corrections (2015)
- P1609.11 – Plan revisions if needed following publication of referenced ISO standards revisions
- P1609.12 – May consider revision before 4Q2015 - essential for operation of DSRC radio system

Introduce Standards and Research Activities Underway

SAE DSRC Technical Committee

- Acceleration of standards to support NHTSA V2V Rulemaking Activities
  - Possible reconsideration of BSM elements
- SAE J2735
  - Support for other modes/stakeholders
    - Emergency vehicles - stemming from emerging message set requirements based on research
    - Heavy duty truck – inclusion of trailers in BSM
- SAE J2945
  - Application of systems engineering content
  - J2945/1 – Minimum performance requirements for V2V as a result of CAMP's work
  - J2945/2 – Systems engineering content and other requirements to enable interoperability for V2V safety awareness
  - Other J2945/n as efforts warrant

Introduce Standards and Research Activities Underway

Security Credential Management System (SCMS)

- October 2014, NHTSA released a Request For Information seeking information related to the security system to support V2V operations
  - Noted that the security system will not be established by NHTSA regulation
  - Envision a V2V SCMS to support trusted, safe/secure V2V communications and to protect driver privacy appropriately
  - A SCMS Manager for managing Certificate Management Entities (CME)
- Designed to protect the security and privacy of data exchanges in the CV environment
- Will reference IEEE 1609.2

Introduce Standards and Research Activities Underway

Certification Testing

- USDOT released a Request For Applications (RFA) in June 2014 to establish a certification environment for connected vehicle devices and applications
  - Intent to enter a cooperative agreement with one or more existing facilities to conduct qualification and certification testing for connected devices
- Proposed device and application certification that includes:
  - Environmental Capabilities (e.g., temperature, vibration, weather);
  - Communication Protocol Capabilities (e.g., DSRC interoperability);
  - Interface Abilities (e.g., message syntax and content)
  - Overall Application Abilities (i.e., verifies the system level function)
  - SCMS

Source: US Department of Transportation

Introduce Standards and Research Activities Underway

Connected Vehicles Research

- Southeast Michigan Test Bed. Real-world, operational conditions to test applications, services and components using the latest standards and architecture
- CAMP (Collision Avoidance Metrics Partnership)
  - Developing minimum performance requirements based on careful analysis as input to SAE J2945/1 and SAE J2735
  - Quantifying and providing technical approaches for congestion control methods as inputs to SAE J2945/1
  - Defining security system as inputs to IEEE 1609.2
- USDOT Connected Vehicle PlugFests. Events where devices can be tested for interoperability using standards
- http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm

Provide Key Schedule Milestones for the Connected Vehicle Environment

NHTSA

- February 3rd, 2014 – Decision to move forward with V2V communications for light vehicles
- August 18, 2014 – USDOT issues Advance Notice of Proposed Rulemaking to Begin Implementation of Vehicle-to-Vehicle Communications Technology
- Decision on heavy vehicles was expected by the end of 2014
- Sent letters to IEEE and SAE asking that these standards be updated and mature by the end of 2015 for deployment purposes

List Resources for Further Reading and Information

Connected Vehicle Reference Implementation Architecture (CVRIA)

- A reference framework that spans all ITS standards activities and provides a means of detecting gaps, overlaps and inconsistencies between the standards
- Can be used as a resource for planning or deployment
  - Includes an application list, which will include emerging application requirements and standards to be considered for deployment for each application
- Will be migrated to the next major revision of the US National ITS Architecture

List Resources for Further Reading and Information

ITS Standards

- 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 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
- IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE), IEEE, http://standards.ieee.org/develop/wg/1609_WG.html

List Resources for Further Reading and Information (cont.)

ITS Standards

- SAE J2735_2014 – Dedicated Short Range Communications (DSRC) Message Set Dictionary, SAE, http://standards.sae.org/wip/j2735/, http://www.sae.org/standardsdev/dsrc/, 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/
- See Student Supplement for additional resources

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Which of the following is not a current connected vehicle activity?

Answer Choices

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

Review of Answers

a) Revising ITS standards based on lessons learned

Incorrect. The standards are currently being revised based on lessons learned.

b) USDOT will be operating new certification laboratories for connected devices

Correct! USDOT plans to develop a cooperative agreement with one or more existing facilities to conduct certification testing for connected devices.

c) Developing a security system to authenticate messages

Incorrect. USDOT is seeking to establish a SCMS manager and certificate management entities.

d) Revising the CVRIA for emerging application requirements

Incorrect. The CVRIA is a living document and will be revised to include emerging application requirements.

Summary of Learning Objective #5

Describe the Current Status of the Connected Vehicle Environment

- Introduce standards and research activities underway
- Provide key schedule milestones for the connected vehicle environment
- List resources for further reading and information

What We Have Learned

1) The connected vehicle environment involves a vehicle wirelessly broadcasting ___data___ about itself.
2) The V2V environment consists of on-board units broadcasting information to support:
   a) ___safety___ applications
   b) ___mobility___ applications
   c) and ___environmental___ applications

What We Have Learned

3) Connected vehicle standards are critical to support interoperability .

4) Some of the institutional issues are:

   a) security

   b) privacy

   c) and data ownership

5) Standards maintenance is continuing to include new requirements and to incorporate lessons learned .

QUESTIONS?



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