SIP-adus Workshop 2021 Breakout Workshop: Connected Vehicles

November 8, 2021

IEEE AND SAE V2X AND CAV STANDARDS

Presentation Summary

- IEEE 1609 Standards Overview
  - Communications Lower Layers
- SAE Standards Overview
  - V2X
  - Cooperative Automation

Standards Bodies Involved in V2X / CAV

Focus of this presentation
(North America)

IEEE

SAE INTERNATIONAL

NTCIP*

*Infrastructure Operations and Management

ISO

3GPP

ETSI

Introduction

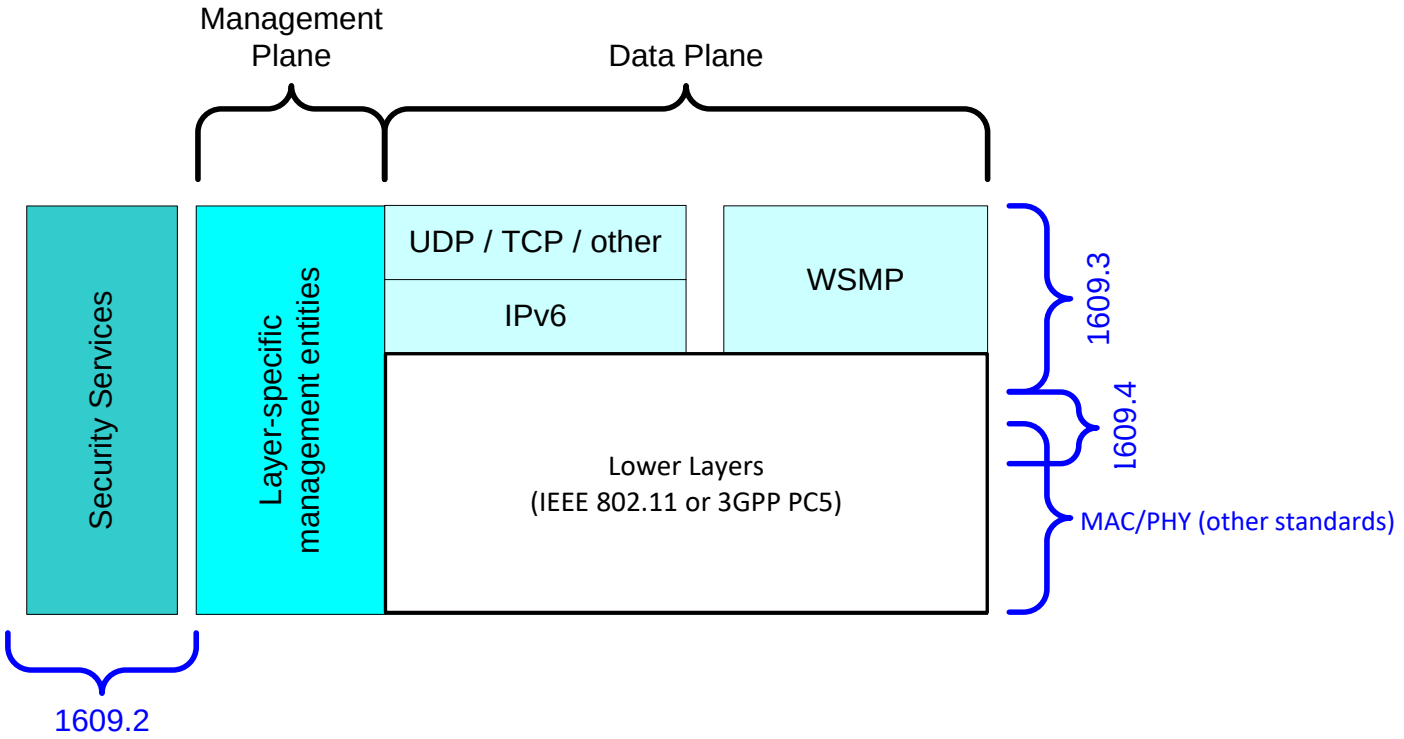
- Background
- IEEE Standards: Presentation focus is primarily on IEEE 1609
- SAE Standards: Presentation focus is on V2X applications and cooperative automation

V2X Standards

Note: other documents:
1609.0: System Architecture Guide
1609.11: EFC using 1609

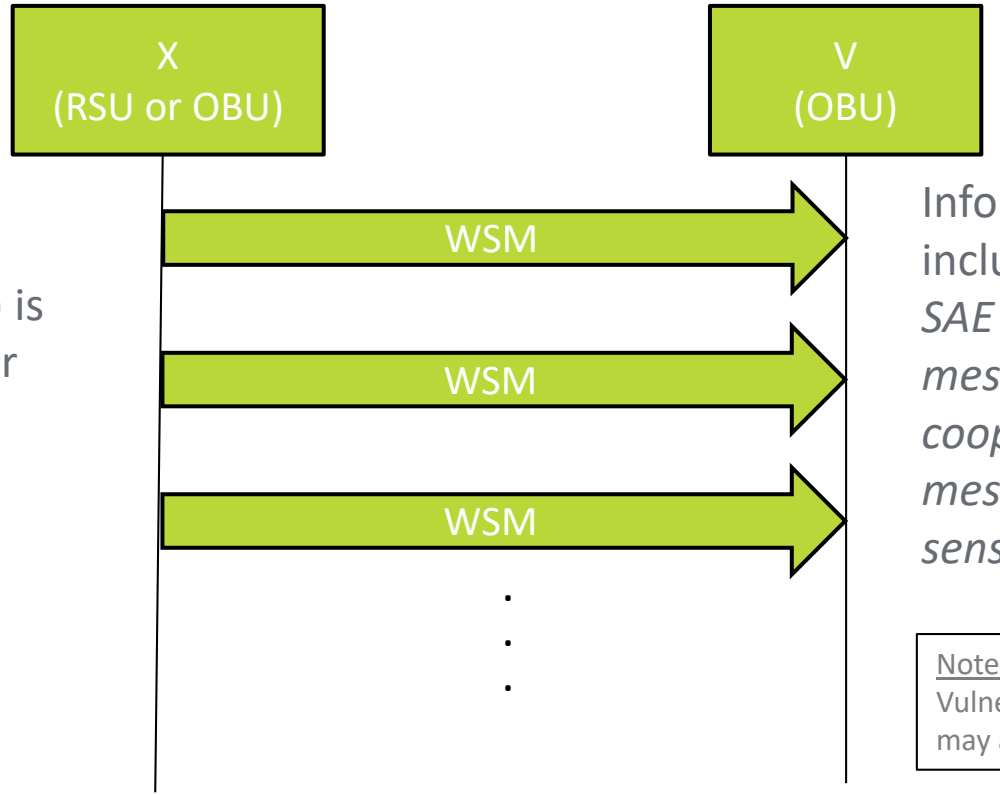
- 1609.2: Security Services for Applications and Management Messages
  - Signing/verification services, e.g. used for V2V broadcast messages
  - Encryption/decryption services (note: ISO 21177 can be used to support TLS over DSRC or PC5)
  - Amendments and revisions ongoing to add new features and support the certificate authority / SCMS
- 1609.3: Networking Service
  - WAVE Short Message Protocol (WSMP)
  - Internet-protocol based (IPv6)
  - Revision published in 2020 to add support for 3GPP PC5 (aka C-V2X and LTE-V2X)
- 1609.4: Multi-Channel Operation
  - May be obsoleted depending on direction of FCC rules
- 1609.12: Identifier Allocations

IEEE 1609 Protocol Stack



How It Works (V2X) – Information Broadcasts

A WAVE Short Message (WSM) is typically used for information broadcasts

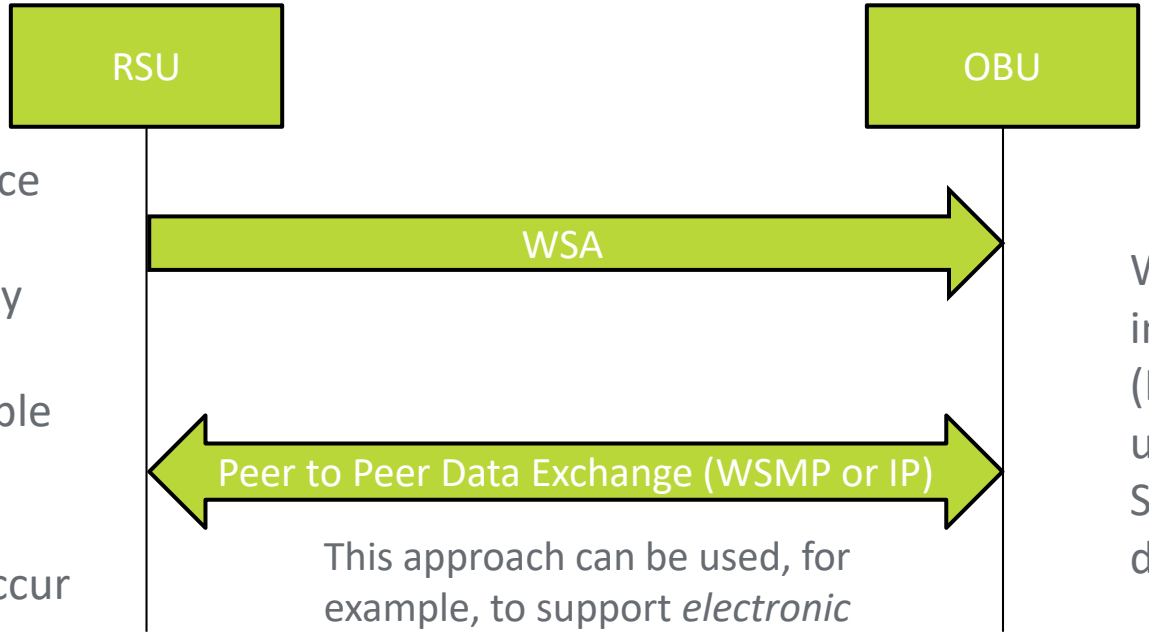


Information broadcasts include, for example, *SAE BSM & SPaT messages (and future cooperative automation messages, e.g., for sensor data sharing)*

Note:
Vulnerable road users (VRUs) may also receive messages

How It Works (V2I) – Localized Data Exchange

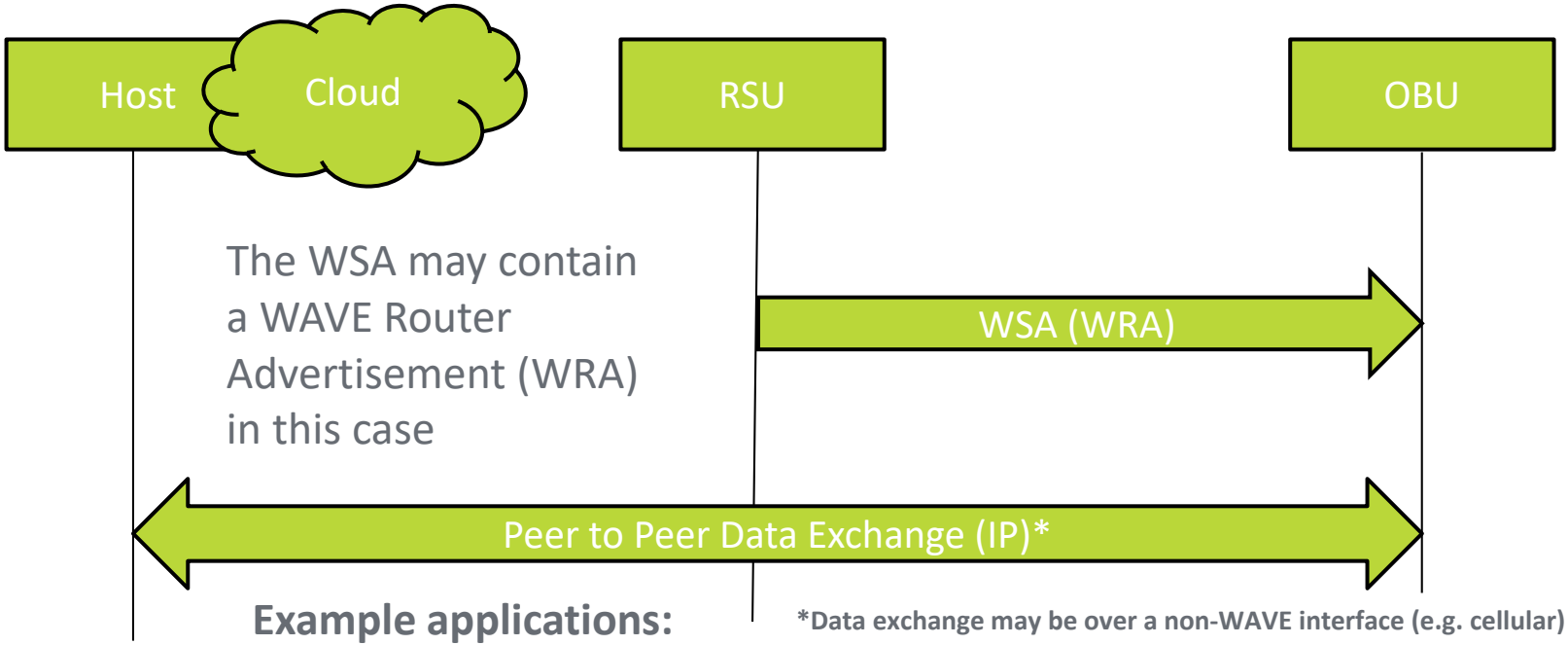
The WAVE Service Advertisement (WSA) is typically transmitted to advertise available applications or services. Data exchange can occur on another network.



This approach can be used, for example, to support *electronic fee collection*

WSMP and internet protocol (IP) can both be used to exchange SAE application data

How It Works (V2I) – Cloud Based

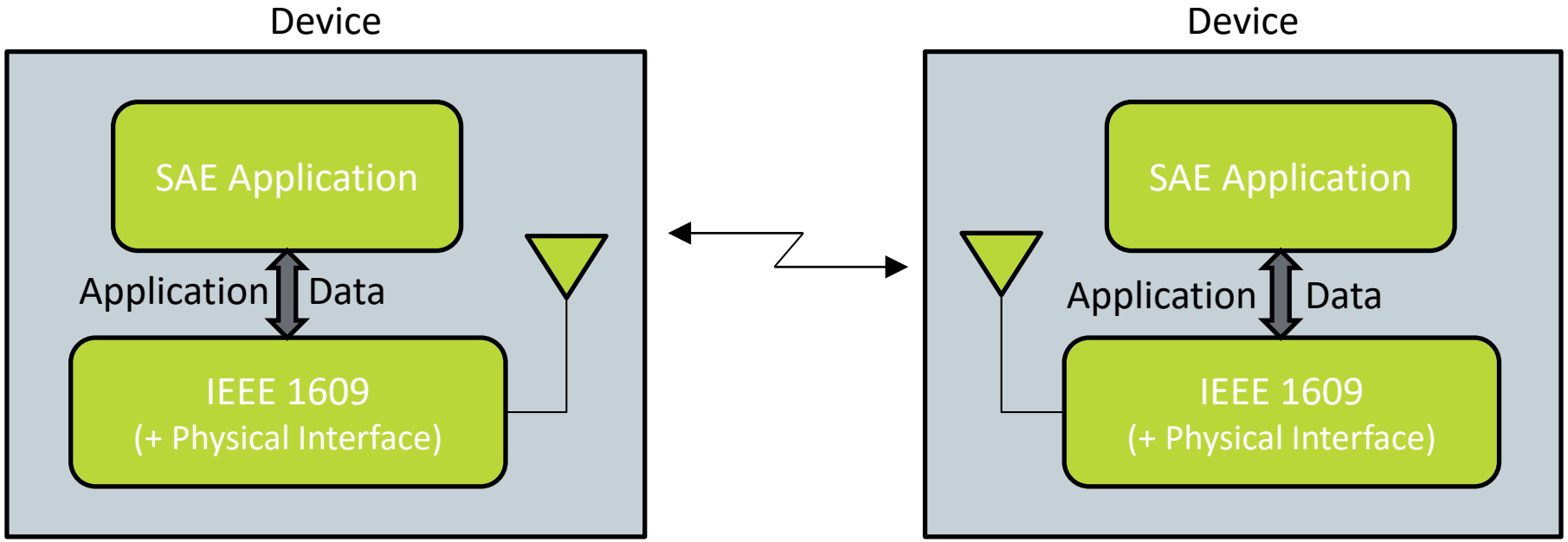


Example applications:

- *Probe probe data collection*
- *Road weather data collection and distribution*
- *Security Credential Management System (SCMS)*

***Data exchange may be over a non-WAVE interface (e.g. cellular)**

Relationship Between Standards



3GPP PC5 Mode 4 and 802.11 (DSRC) are currently supported physical interfaces

SAE Standards for V2X and CAVs

Key SAE V2X Standards / Documents

- J2735: Message Set Dictionary
  - Over the air messages used in DSRC and other systems
  - E.g. Basic Safety Message (BSM) and Signal Phase and Timing (SPaT) message

  Note: Messages are no longer directly added to J2735 without first being vetted through an application standard (e.g. J2945/3 creates the Road Weather Message, which may be incorporated in a later revision of J2735 if 2945/3 is not likely to be further revised)

- J2945/1: On Board System Requirements for V2V Safety Communications
  - Light vehicles only (FHWA classes 2 & 3)
  - Specifies functional and performance requirements for sending and receiving BSMs
  - Reference applications: EEBL, FCW, BSW/LCW, IMA, LTA, CLW
  - *Uses 802.11p for the physical interface; 3161/1 is in development and extends J2945/1 to support 3GPP PC5*

SAE V2X Standards / Documents Cont'd

- Published
  - J2945/2: V2V safety awareness *recommended practice* (builds on 2945/1)
  - J2945/9: Vulnerable road user *recommended practice*
  - J2945/3: Road weather applications
- In development
  - J2945/4: Road safety applications
  - J2945/5: Security guidelines for connected vehicle applications
  - J2945/6: Cooperative adaptive cruise control and platooning
  - J2945/7: Positioning enhancements
  - J2945/8: Cooperative perception system
  - J2945/A: Lane level and road furniture mapping
  - J2945/B: Signalized intersection applications applications
  - J2945/C: Probe data collection
  - J2945/D: Courteous communication
  - J3238: Infrastructure applications testing

SAE V2X Standards / Documents Cont'd

- Key documents still in development
  - **J2945/1B: On-Board V2V Safety Systems Requirements for Non-Light Duty Vehicles**
  - **J3161: C-V2X Deployment Profiles**
  - **J3161/1: On-Board System Requirements for LTE-V2X V2V Safety Communications**
    - **Uses LTE (3GPP PC5 mode 4) for the physical interface**
  - **J3161/1A: Test Procedures for J3161/1**

  - J3186: Maneuver Sharing and Coordinating
  - J3224: Sensor Sharing for Cooperative & Automated Driving

  - J3217: Toll Collection and Road User Charging

US DOT Reference Architecture

- Architecture Reference for Cooperative and Intelligent Transportation
  - https://local.iteris.com/arc-it/

Cooperative Automation

- ***SAE J3216: Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles***

- Cooperative Driving Automation Technical Committee formed to further address cooperative automation applications and architecture
  - SAE International Ground Vehicle Standards staff are leading a Federal Highway Administration funded project to advance and accelerate the development of Cooperative Driving Automation (CDA) standards for automated vehicles. The focus of the project includes initiatives to:
    - Develop a taxonomy for the role of communications and relationship to automation
    - Identify cooperation and automation factors suitable for standardization to support integration of CDA and Automated Driving Systems (ADS) with the infrastructure
    - Develop new and augment existing standards to support CDA and ADS integration using the System Engineering Management Process (SEMP) process
    - Foster development of Intelligent Transportation System (ITS) standards including: V2V, V2I, V2P, V2X using the SEMP process

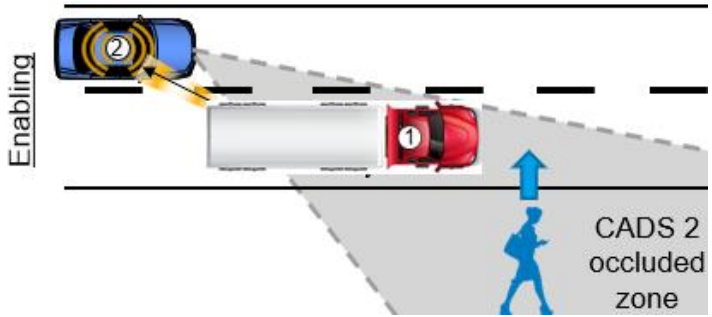
What is *Cooperative Driving Automation*?

- Cooperative Driving Automation
  - Driving automation that includes machine-to-machine (M2M) communication to enable cooperation between entities with capable communications technology and is intended to support or enable performance of the Dynamic Driving Task (DDT) for a subject vehicle with driving automation feature(s) engaged, for the purposes of facilitating the safer, more efficient movement of road users.

- Why is it useful?
  - Enables larger field of view that sensors like cameras and LIDAR may not provide
  - Provides an interface to infrastructure, e.g. traffic signals and road condition information
  - Supports self-organizing groups of vehicles for purposes such as platooning
  - Allows participation of other types of transportation system users, e.g. pedestrians, cyclists, etc.

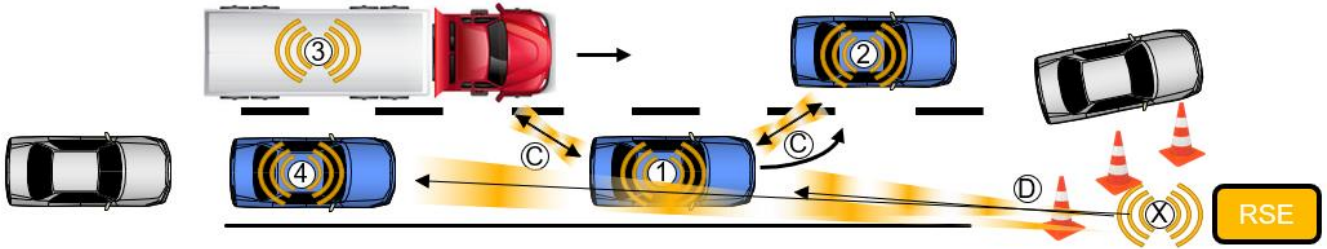
Cooperative Driving Automation

- Documents in development
  - J3251: Cooperative perception CDA feature: Jaywalking pedestrian collision avoidance



  - J3252: Framework for Interoperable CDA Use Case Testing

  - J3256: Infrastructure-based prescriptive cooperative merge



Thank You!

Justin McNew

- IEEE 1609 Working Group Chair
- ITE Roadside Unit Standard Working Group Co-Chair
- SAE Infrastructure Applications Technical Committee Vice Chair
- SAE J2735 Sponsor/editor
- SAE J2945/1 Sponsor/editor
- SAE J2945/1B Sponsor/editor
- SAE J2945/C Sponsor
- SAE J3217 Editor
- SAE J3242 Sponsor/editor
- SAE Cooperative Driving Automation Technical Committee Vice Chair

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