Standard Development Report for Roadside Unit (RSU) Standard v1.0

A connected intersection-ready Standard of AASHTO, ITE and NEMA

The following Standard Development Report (SDR) Is made in accordance with the Institute of Transportation Engineers (ITE) procedures for National Transportation Communications for ITS Protocols (NTCIP) standards.

Supported/Sponsored By: The United States Department of Transportation (USDOT)

U.S. Department
of Transportation

Foreword

This Roadside Unit (RSU) Standard v01 supersedes USDOT's Dedicated Short-Range Communications Roadside Unit Specifications v4.1. This RSU Standard v01 was developed by engaging with stakeholders representing the industry at large including but not limited to infrastructure owner operators, automobile original equipment manufacturers, RSU manufacturers, and the end users of data and services. The work was supported by the United States Department of Transportation (USDOT) Intelligent Transportation Systems (ITS) Joint Program Office (JPO). Several associations such as the American Association of State Highway Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), the National Electrical Manufacturers Associations (NEMA), and SAE International were involved in ensuring a balanced and effective stakeholder representation and adherence to standards development processes as Standards Development Organizations (SDOs).

This document establishes a non-proprietary, industry-based consensus Roadside Unit (RSU) Standard. An RSU is a transportation infrastructure communications device that is a part of a Cooperative Intelligent Transport Systems (C-ITS) transportation environment. The goal of such an environment is to reduce the number of fatalities and injuries on roadways, improve mobility and reduce environmental impacts. Commonly known as Connected Vehicles (CV) in the United States, terms such as Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) have been used to reflect the types of communications used. The vision for this technology has expanded to include all types of travelers including pedestrians, cyclists, and multimodal travelers and is referred to as Vehicle-to-Everything (V2X) technology and V2X communications.

More information on this standards effort can be found on the ITE Website.

The Standards Development Organizations (SDOs) supporting this standard include the following:

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Contents

1. Latest Version of the Draft Proposed Standard

Appendix I references the Recommended Standard (RS) Roadside Unit (RSU) Standard v1.0. The Roadside Unit (RSU) Standard v1.0, when Jointly Approved, will be a new ITE standard, and will be designated and cited as Roadside Unit (RSU) Standard v1.0. Jointly Approved means that the standard was balloted and approved separately by the three cooperating standard development organizations (SDOs): the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA).

2. Summary Status

RS Roadside Unit (RSU) Standard v1.0 was accepted as a Recommended Standard of the ITE Roadside Unit Standardization Working Group (WG). The Roadside Unit (RSU) Standard v1.0 document establishes a non-proprietary, industry-based consensus Roadside Unit (RSU) Standard. An RSU is a transportation infrastructure communications device that is a part of a Cooperative Intelligent Transport Systems (C-ITS) transportation environment. The goal of such an environment is to reduce the number of fatalities and injuries on roadways, improve mobility and reduce environmental impacts. Commonly known as Connected Vehicles (CV) in the United States, terms such as Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) have been used to reflect the types of communications used. The vision for this technology has expanded to include all types of travelers including pedestrians, cyclists, and multimodal travelers and is referred to as Vehicle-to-Everything (V2X) technology and V2X communications.

RS Roadside Unit (RSU) Standard v1.0 is distributed to the members of the Institute of Transportation Engineers (ITE), the American Association of State Highway and Transportation Officials (AASHTO), and the National Electrical Manufacturers Association (NEMA) for balloting and approval. After all three standards development organizations (SDOs) have individually approved RS Roadside Unit (RSU) Standard v1.0; it is a Jointly Approved Standard and published, with the designation (and to be cited as) Roadside Unit (RSU) Standard v1.0.

3. Status Report

RS Roadside Unit (RSU) Standard v1.0 was developed following a systems engineering process (SEP). At three development stages, Concept of Operations (ConOps), Functional Requirements (FR), and System Design Details (SDD), comments (written inputs) were submitted and addressed, a total of 370 comments were received and addressed (or deferred to the User Comment Draft (UCD) stage).

During (and subsequent to) the UCD stage, 213 comments (written inputs) were also submitted and addressed.

4. Comments Listing

The RSU Standardization WG comments received and addressed during SEP development stages (Concept of Operations (ConOps), Functional Requirements (FR), System Design Details (SDD), as well as during the User Comment Draft (UCD) stage and later) for Roadside Unit (RSU) Standard v1.0 are referenced in Appendix II (in the Excel worksheets named ConOps v1.05 by Section, FReqs v01.08, FReqs v01.11, FReqs v01.12, SDD v01.13d, UCD v1.15, UCD v1.15e, and pRS v1.16.

5. Committee Objectives

The scope of the RSU Standardization Working Group is to develop and publish a document that more clearly defines the key capabilities and interfaces an RSU supports to optimize interoperability among traffic management systems, RSUs, and road users (including vehicles, pedestrians, and other vulnerable road users).

Several associations such as American Association of State Highway Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE), National Electrical Manufacturers Associations (NEMA) and SAE International are involved in ensuring balanced and effective stakeholder representation and adherence to Standards Development Process as Standards Development Organizations (SDO).

The USDOT has made significant previous investments in defining the user needs, requirements and design elements of RSUs through the RSU Specification v4.1 and the development of National Transportation Communications for ITS Protocol (NTCIP) 1218 Object Definitions for Roadside Units. Additionally, there are multiple deployment efforts where real-world experience with RSUs is being gained, such as the Connected Vehicle (CV) Pilot programs and the Signal Phase and Timing (SPaT) Challenge. With the collective knowledge and experience gained from these efforts, it is the ideal time to standardize the key capabilities and interfaces that infrastructure owner operators (IOOs) expect in an RSU. The RSU Standard will focus on utilizing the existing USDOT investments to more rapidly develop and publish the standard utilizing a systems engineering (SE) process and ensuring the standard support future evolutionary updates.

The primary objectives of this project are to:

a) deliver, approve and publish a non-proprietary, industry-based consensus driven RSU Standard; and
b) provide manufacturer input based on actual product development.

6. Committee Members

RS Roadside Unit (RSU) Standard v1.0 was developed under the oversight of the RSU Standardization Working Group and Subject Matter Experts (SMEs), which is made up of representatives from the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA), and other stakeholders representing the industry at large including but not limited to Infrastructure, Original Equipment Manufacturers (OEM'S), RSU manufacturers and the end users of data and services.

RSU Standardization Working Group Co-chairs

Blaine Leonard, Utah Department of Transportation, AASHTO
Justin McNew, JMC Rota Inc., IEEE 1609/SAE

RSU Standardization Working Group (WG) Members

Alan Davis, Georgia Department of Transportation
Joe Gorman, Michigan Department of Transportation
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Aravind Kailas, Volvo Group
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Jay Parikh, CAMP
Robert Rausch, TransCore
Steve Sill, USDOT
Chris Stanley, Leidos
Alan Toppen, Kimley-Horn
Michaela Vanderveen, Still Waters Consulting Inc

7. Other Material of Interest

Normative and Other references in the RS Roadside Unit (RSU) Standard v1.0 are excerpted and follow.

7.1 Normative References

Normative references contain provisions that, through reference in this text, constitute provisions of this RSU Standard. Other references in this document might provide a complete understanding or provide additional information. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties using this RSU Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed.

Table 1. Normative References

Identifier	Title
3GPP TS 23.285	Architecture Enhancements for V2X Services, 3GPP.
CAMP CV Pilots Documentation	CAMP CV Pilots Documentation material. https://wiki.campllc.org/display/SCP/SCMS+CV+Pilots+Documentation **NOTE - TO BE UPDATED USING A USDOT LINK**
CAMP Platform Security Document	"Hardware, Software and OS Security Requirements", CAMP, April 11, 2018. https://wiki.campllc.org/display/CPD/CAMP+Public+Documents+Home?preview=%2F143491424%2F143491426%2FHardware+Software+and+OS+Security+Requirements-v106-20180411_1423.pdf **NOTE - TO BE UPDATED USING A USDOT LINK**
IEC 60529	Degrees Of protection provided by enclosures (IP Code), International Electrotechnical Commission, Ed. 2.2, 2013.
IEC 61000-4-2:2008	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test, International Electrotechnical Commission, Ed. 2.0, 2008.
IEC 61000-4-4:2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test, International Electrotechnical Commission, Ed. 3.0, 2012.
IEC 61000-4-5:2017	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test, International Electrotechnical Commission, Ed. 3.1, 2017.
IEC 61000-6-2:2016	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments, International Electrotechnical Commission, Ed. 3.0, 2016.
IEC 62368-1:2018	Audio/video, information and communication technology equipment - Part 1: Safety requirements, International Electrotechnical Commission, Ed 3.0, 2018.
IEEE Std 802.3™-2018	IEEE Standard for Ethernet, IEEE, 2018.
IEEE Std 802.11™-2020	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, 2020.
IEEE Std 1609.2™-2016	IEEE Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages, IEEE, 2016, with Amendments IEEE 1609.2a-2017 and IEEE 1609.2b-2019.
IEEE Std 1609.2b™-2019	IEEE Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages - Amendment 2--PDU Functional Types and Encryption Key Management, IEEE, 2019.
IEEE Std 1609.2.1™-2020	IEEE Standard for Wireless Access in Vehicular Environments--Certificate Management Interfaces for End-Entities, IEEE, 2020.
IEEE Std 1609.3™-2020	IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Networking Services, IEEE, 2020.
IEEE Std 1609.4™-2016	IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Multi-Channel Operation, IEEE, 2016.
IETF RFC 5905	Network Time Protocol Version 4: Protocol and Algorithms Specification, Internet Engineering Task Force (IETF), June 2010.
IETF RFC 6146	Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers, Internet Engineering Task Force (IETF), April 2011.
IETF RFC 8446	The Transport Layer Security (TLS) Protocol Version 1.3, Internet Engineering Task Force (IETF), August 2018.

Identifier	Title
ITU-R TF.460-6	Standard-frequency and time-signal emission, International Telecommunications Union, 2002.
MIL-STD-810H	Environmental Engineering Considerations and Laboratory Tests, Department of Defense, Test Method Standard, 31 January 2019.
NEMA TS 2-2016	NEMA Standards Publication TS 2-2016, Traffic Controller Assemblies with NTCIP Requirements, Version 3.07, NEMA, 2016.
NEMA TS 10-2020	Connected Vehicle Infrastructure - Roadside Equipment, NEMA, March 3, 2021.
NIST FIPS 140-2	Security Requirements for Cryptographic Modules, National Institute of Standards and Technology, March 22, 2019. https://doi.org/10.6028/NIST.FIPS.140-2
NTCIP 1218 v01	Object Definitions for Roadside Units (RSUs), AASHTO / ITE / NEMA, published September 2020.
SAE J3101_202002	Hardware Protected Security for Ground Vehicles, SAE International, 2020
TIA-607-D	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, Revision D, Telecommunications Industry Association (TIA), July 2019.
V2I Hub ICD	Integrated Vehicle-to-Infrastructure Prototype (IVP), V2I Hub Interface Control Document (ICD) - Final Report, FHWA JPO, March 2017. [https://usdot-carma.atlassian.net/l/c/qznaJ0DB]

7.2 Other References

The following documents and standards may provide the reader with a more complete understanding of RSU-related equipment and communications. However, these documents do not contain direct provisions that are required by the RSU Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on the RSU Standard are encouraged to investigate the possibility of applying the most recent editions of the standard listed.

Table 2. Other References

Identifier	Title
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT), USDOT.
ATC 5201 v06A	Advanced Transportation Controller (ATC) Standard Version 06A, ATC Joint Committee, July 2020.
ATC 5401 v02A	Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC) Version 02A, ATC Joint Committee, July 2020.
BS EN 50556:2018	Road traffic signal systems, British-Adopted European Standard, October 4, 2018.
CFR Title 47 – Telecommunication	Code of Federal Regulations, Title 47 – Telecommunication, Chapter 1 – Federal Communications Commission, Part 15 and Part 90 (Regulations Governing the Use of Frequencies in the 5850-5925 MHz Band).
CIS Controls Implementation Guide for Industrial Control Systems	CIS Controls Implementation Guide for Industrial Control Systems, Center for Internet Security, Version 7.1.
FHWA-JPO-17-589 (RSU Specification 4.1)	Dedicated Short-Range Communications Roadside Unit Specifications v4.1, USDOT, Saxton Transportation Operations Laboratory, published April 28, 2017. Note: Also referred to as RSU Specifications 4.1.

Identifier	Title
IEC 60068-2-64:2008	Environmental Testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance, International Electrotechnical Commission, Ed. 2.0, 2008.
IETF RFC 3414	User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3), Internet Engineering Task Force (IETF), December 2002.
IETF RFC 5246	The Transport Layer Security (TLS) Protocol Version 1.2, Internet Engineering Task Force (IETF), August 2008.
IETF RFC 5424	The Syslog Protocol, Internet Engineering Task Force (IETF), June 2010.
IETF RFC 5590	Transport Subsystem for the Simple Network Management Protocol (SNMP), Internet Engineering Task Force (IETF), June 2009.
IETF RFC 5591	Transport Security Model for the Simple Network Management Protocol (SNMP), Internet Engineering Task Force (IETF), June 2009.
IETF RFC 6353	Transport Layer Security (TLS) Transport Model for the Simple Network Management Protocol (SNMP), Internet Engineering Task Force (IETF), June 2009.
ISO/IEC/IEEE 24765:2017	ISO/IEC/IEEE International Standard – Systems and Software Engineering – Vocabulary, 2017. https://pascal.computer.org/
ISO/TS 21177:2019	Intelligent transport systems - ITS station security services for secure session establishment and authentication between trusted devices. ISO, 2019.
LRFDLTS-1	AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 1st Edition, 2015.
NIST FIPS PUB 197	Announcing the Advanced Encryption Standard (AES), National Institute of Standards and Technology (NIST), November 26, 2001. https://doi.org/10.6028/NIST.FIPS.197
NIST 800-63B	NIST Special Publication 80-63-3, Digital Identity Guidelines, National Institute of Standards and Technology (NIST), June 2017. https://doi.org/10.6028/NIST.SP.800-63B
NTCIP 1202 v03A	Object Definitions for Actuated Signal Controllers (ASC) Interface. AASHTO/ITE/NEMA, published May 2019.
SAE J2735_202007	V2X Communications Message Set Dictionary™, SAE International, 2020.
SAE J2945/3_202003	Requirements for Road Weather Applications, SAE International, 2020.
SAE J2945_201712	Dedicated Short Range Communication (DSRC) Systems Engineering Process Guidance for SAE J2945/X Documents and Common Design Concepts, SAE International, 2017.
SAE J3161	C-V2X Deployment Profiles, SAE International, 2021.
SCMS EE Certificate Rollover (Re-enrollment) Technical Standard v01	EE Certificate Rollover (Re-enrollment) Technical Standard, v1.0, SCMS Manager LLC, October 8, 2020; https://www.scmsmanager.org/wp-content/uploads/2020/10/SCMS-Manager-EE-Re-Enrollment-Technical-Specification-v1.0.pdf

7.3 Contact Information

7.3.1 3GPP Documents

Copies of 3GPP documents may be obtained electronically from:

http://www.3gpp.org/

7.3.2 Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

The Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) may be viewed online at:

http://local.iteris.com/arc-it/

ARC-IT is the US ITS reference architecture and includes all content from the (now deprecated) National ITS Architecture v7.1 and the Connected Vehicle Reference Implementation Architecture (CVRIA) v2.2.

7.3.3 Advanced Transportation Controller (ATC) Standards

Copies of Advanced Transportation Controller (ATC) Standards may be obtained electronically from:

https://www.ite.org/technical-resources/standards/

7.3.4 International Electrotechnical Commission (IEC)

International Electrotechnical Commission (IEC) standards can be purchased on-line in electronic format or printed copy from:

Techstreet
6300 Interfirst Dr.
Ann Arbor, MI 48108
(800) 699-9277
www.techstreet.com

7.3.5 IEEE

IEEE standards can be purchased on-line in electronic format or printed copy from:

Techstreet
6300 Interfirst Dr.
Ann Arbor, MI 48108
(800) 699-9277
www.techstreet.com/ieee

7.3.6 Internet Documents

Obtain Request for Comment (RFC) electronic documents from several repositories on the World Wide Web, or by “anonymous” File Transfer Protocol (FTP) with several hosts. Browse or FTP to:

www.rfc-editor.org
www.rfc-editor.org/repositories.html
for FTP sites, read ftp://ftp.isi.edu/in-notes/rfc-retrieval

7.3.7 International Telecommunications Union (ITU)

International Telecommunications Union (ITU) standards can be purchased on-line in electronic format or printed copy from:

Techstreet
6300 Interfirst Dr.
Ann Arbor, MI 48108
(800) 699-9277
www.techstreet.com

7.3.8 National Transportation Communications for ITS Protocol (NTCIP)

Copies of NTCIP standards may be obtained from:

NTCIP Coordinator
National Electrical Manufacturers Association

1300 N.17th Street, Suite 900
Rosslyn, Virginia 22209-3801
www.ntcip.org
e-mail: ntcip@nema.org

7.3.9 National Electrical Manufacturers Association (NEMA)

National Electrical Manufacturers Association (NEMA) standards can be purchased on-line in electronic format or printed copy from:

Techstreet
6300 Interfirst Dr.
Ann Arbor, MI 48108
(800) 699-9277
www.techstreet.com/nema

7.3.10 SAE International

Copies of SAE International documents may be obtained from:

SAE International
400 Commonwealth Drive
Warrendale, PA 15096
www.sae.org

7.3.11 USDOT/FHWA

U.S. Department of Transportation Federal Highway Administration (FHWA) documents (with designations FHWA-JPO-…) are available at the U.S. Department of Transportation National Transportation Library, Repository and Open Science Access Portal (ROSA P):

https://rosap.ntl.bts.gov/

8. Declaration Regarding Other Known National and International Standards

This statement confirms that other known national and international standards have been examined with regard to harmonization and duplication of content, and no significant conflicts with other known standards have been identified.

9. Abstract of the Standard

9.1 Purpose

This document establishes a non-proprietary, industry-consensus Roadside Unit (RSU) Standard. An RSU is a transportation infrastructure communications device that is a part of a Cooperative Intelligent Transportation Systems (C-ITS) transportation environment. The goal of such an environment is to reduce the number of fatalities

and injuries on roadways, improve mobility, and reduce environmental impacts of transportation systems. Commonly known as the Connected Vehicle (CV) environment in the United States, it includes both connected human-driven vehicles and connected automated vehicles (CAVs). The terms Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) are used to reflect the exchanges of messages within the CV environment. The vision for this technology has expanded to include all types of travelers including pedestrians, cyclists, multimodal travelers, and other vulnerable road users, and is referred to as Vehicle-to-Everything (V2X) technology and V2X communications.

Services to the traveler are carried out through on-board units (OBUs) that are installed in vehicles or mobile units (MUs) that are used for other modes of transportation. A vehicle can receive traffic signal timing information and warn the driver of a potential red-light violation. A bus can receive traffic signal priority. A pedestrian can activate a crosswalk without the push of a button. These examples require an interface between the OBUs/MUs and the transportation infrastructure. An RSU provides this interface by connecting wirelessly to OBUs/MUs and through Ethernet connections to traffic control devices, traffic management systems (TMSs) and back-office systems. The RSU communicates wirelessly with OBUs/MUs via its V2X interface.

The United States Department of Transportation (USDOT) has made significant previous investments in defining the user needs, requirements, and design elements of RSUs through FHWA-JPO-17-589, Dedicated Short-Range Communications Roadside Unit Specifications v4.1 (see Section 1.2.2, also referred to as RSU Specifications 4.1) and the development of National Transportation Communications for ITS Protocol (NTCIP) 1218 v01 Object Definitions for Roadside Units (see Section 1.2.1). Additionally, there are multiple deployment efforts where real-world experience with RSUs is being gained, such as the USDOT's Connected Vehicle Pilot programs and Signal Phase and Timing (SPaT) Challenge projects. This standard has been developed by incorporating knowledge gained from these previous documents and pilot programs and using a systems engineering (SE) approach with multidisciplinary stakeholders.

9.2 Overview

Vehicle-to-everything (V2X) technology has been designed to help mitigate various transportation related issues (e.g., crashes, congestion, delays, pollution). Using V2X communications, OBUs/MUs and RSUs can exchange critical information to improve safety and mobility for vehicles, vulnerable road users (e.g., cyclists, pedestrians, motorcycles), and other road users. By receiving real-time infrastructure information (e.g., traffic signal phasing and timing, details about the intersection geometry), road users can more efficiently travel on roadways with reduced delays, improved fuel efficiency, and reduced emissions. In addition, after obtaining real-time status information from OBUs/MUs, active or proactive traffic management strategies can be implemented by operators in traffic management centers (TMCs) in order to reduce congestion and improve mobility.

Figure 1 shows the high-level structure of a V2X system. Roadside units (RSUs) are the key element of the system since they exchange data with OBUs/MUs and other infrastructure elements. RSUs can receive messages from OBUs/MUs and forward these messages to transportation infrastructure elements (e.g., traffic management systems, traffic signal controllers (TSCs), back-office data storage) to provide information about real-time traffic conditions. Similarly, RSUs broadcast real-time critical infrastructure information, such as Signal Phase and Timing (SPaT), information about the intersection's geometry (MAP), and Traveler Information (TIM), over the air to OBUs/MUs to inform travelers of current and upcoming traffic management strategies, conditions, and incidents. Any transportation infrastructure device capable of signing messages has a direct connection to the SCMS (Security Credentials Management System). Although Figure 1 shows that the OBUs/MUs communicate to the SCMS via the RSU, OBUs/MUs may have their own connection to the SCMS e.g., via cellular or Wi-Fi or other wireless technologies.

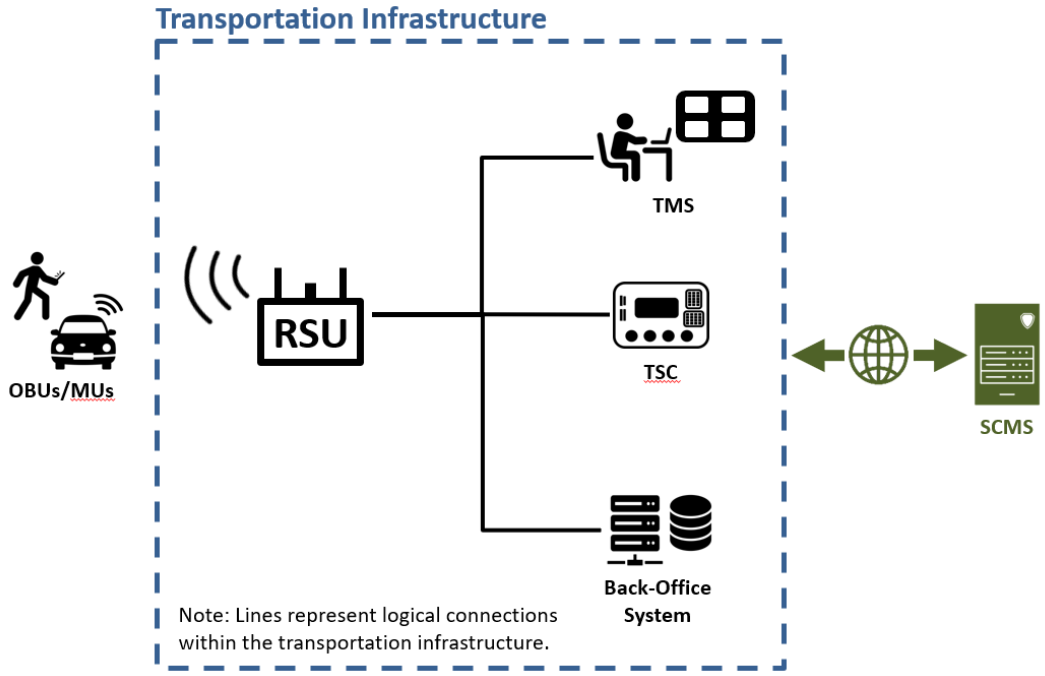

Figure 1. V2X System

Because of the crucial role of RSUs in the V2X communications, its functionalities and performance have significant impacts on the safety and operation of the entire V2X ecosystem, including cooperative automation systems that may use V2X. A growing number of transportation agencies have started to invest resources to include V2X technology in their transportation systems by deploying RSUs, since V2X technology brings significant benefits to their operations. Transportation agencies may use different models or different manufacturers of RSUs in order to deploy V2X technology. For this reason, interoperability of RSUs becomes critical for maximizing the benefits of V2X technology regionally and nationally. The goal of this standard is to facilitate V2X interoperability by defining the required functionality to be provided by RSU manufacturers.

In 2017, the USDOT published RSU Specifications 4.1 which incorporated input from industry, including device vendors, users, and early deployers, to define the minimum performance requirements of RSUs. It specified power requirements, environmental requirements, physical requirements, functional requirements, behavioral requirements, performance requirements, and interface requirements of RSUs. RSU Specifications 4.1 required the use of Simple Network Management Protocol (SNMP) Version 3 (SNMPv3) communications to configure and operate RSUs, as well as various health and status monitoring features, to support the secure management of RSUs network-wide.

V2X technology has developed rapidly in the last three years and the functionality defined in RSU Specifications 4.1 needs to evolve to meet current needs. New standards have been developed, including NTCIP 1218 v01, which defines an RSU management interface and NEMA TS 10-2020, which describes desired operational situations for RSU standards. This comprehensive RSU Standard addresses current needs by:

- Helping IOOs procure RSUs that are conformant with national standards and that address their use cases;
- Facilitating RSU compatibility and interoperability with OBUs and MUs from different manufacturers;
- Facilitating RSU compatibility and interoperability with traffic control devices from different manufacturers;

- Facilitating the interchangeability of RSUs from different manufacturers;
- Providing for the use of emerging wireless technologies that may be introduced in the RSU's service life;
- Providing security for the RSU and its communication interfaces; and
- Defining the functionality of RSUs that will exchange standardized V2X messages to improve safety and mobility.

This standard satisfies the needs summarized above by defining functional requirements, behavioral requirements, performance requirements, and interface requirements in order to support deployment of V2X technology in North America.

9.3 Document Organization

Roadside Unit (RSU) Standard v1.0 consists of the following sections and annexes (appendices):

- Section 1 General [Informative]
- Section 2 Concept of Operations [Normative]
- Section 3 Functional Requirements [Normative]
- Section 4 System Design Details [Normative]
- Annex A Additional Notes [Informative]
- Annex B IEEE Std 1609 PICS [Normative]
- Annex C User Requests [Informative]

10. Appendices

A.1 Recommended Standard (RS) Roadside Unit (RSU) Standard v1.0

RS Roadside Unit (RSU) Standard v1.0 is attached as RSU_Std_v01_0117.pdf (both with and without Revs versions).

A.2 Adjudicated Working Group Comments on (RS) Roadside Unit (RSU) Standard v1.0

The RSU WG comments received and addressed during SEP development stages (ConOps, FR, SDD and UCD) of Roadside Unit (RSU) Standard v1.0 are referenced in RSU_Std_v01_Comments_210517.xlsx (in the Excel worksheets named ConOps v1.05 by Section, FReqs v01.08, FReqs v01.11, FReqs v01.12, SDD v01.13d, UCD v1.15, UCD v1.15e, and pRS v1.16. (See Attachment)

A.3 Development Milestones

ITE Standards Development Milestone	Date, Description of Action Taken and Other Background Information
1. Submit request and initiate standards activity	This project was initiated September 18, 2019, under the oversight of the National Transportation Communications for ITS Protocol (NTCIP) Joint Committee (JC) and Roadside Unit (RSU) Working Group. A Kick-off meeting

ITE Standards Development Milestone	Date, Description of Action Taken and Other Background Information
	was held on October 8, 2019 and a Project and Working Group Scope were delivered on April 23, 2020.
2. JC (Joint Committee) votes to form WG (Working Group)	Not applicable
3. WG formed	The RSU WG was finalized on March 3, 2020. Beginning April 2020, the RSU WG followed SEP, conducting three walkthroughs (ConOps, FR, and SDD), receiving and addressing RSU WG input, through December, 2020, yielding Roadside Unit (RSU) Standard System Design Details (SDD) Document on January 25, 2021.
4. WG develops WG Draft for informal review	The RSU WG reviewed comments received during the SDD walkthrough and delivered pUCD Roadside Unit (RSU) Standard v01 on February 5, 2021.
5. WG prepares User Comment Draft (UDC)	The RSU WG reviewed pUCD Roadside Unit (RSU) Standard v1.0 for the period of February 5-March 19, 2021.
6. JC votes on distribution of UCD	Not applicable
7. WG distributes UCD through SDOs and receives comments	UCD Roadside Unit (RSU) Standard v1.0 was prepared and circulated for user comment for the period February 5-March 19, 2021.
8. WG resolves user comments	The RSU WG met on March 9, 2021 to address comments received to date.
9. WG decides to submit a “resolved” version as a Recommended Standard	The RSU WG voted to accept pRS Roadside Unit (RSU) Standard v1.0 on May 3, 2021.
10. WG prepares a Draft Recommended Standard	The RSU WG reviewed pRS Roadside Unit (RSU) Standard v1.0 during the period May 3-May 17, 2021.
11. WG votes on submission of Recommended Standard to SDOs	The RSU WG voted to accept as Recommended Standard (RS) Roadside Unit (RSU) Standard on May 17-21, 2021.
12. WG forwards Recommended Standard to SDOs	*In process.*
13. SDOs approve the Recommended Standard and thereby create the Standard	*In process.*
14. SDOs maintain the Standard	*SDOs maintain the Standard on a five-year review cycle.*

NOTE: Steps above in italics refer to future milestones.