SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

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Requirements for Road Weather Applications

RATIONALE

Weather is a significant factor in the management and operation of transportation systems. Most, if not all, transportation agencies consider weather-related applications to be of critical importance in providing safe and efficient transportation systems to the travelling public. This standard defines interface requirements to support a weather applications interface in a connected vehicle environment, with a focus on information exchanges between the infrastructure and connected vehicles. This document specifies a new message, new data frames, and data elements associated with road weather applications.

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1. GENERAL

1.1 Scope

Inclement weather can have a significant impact on surface transportation systems. It can result in hazardous conditions for travelers due to poor visibility, or wet or icy roadways. Weather applications have the potential to provide additional data to surface transportation infrastructure owners and operators, allowing them to better assess the impacts of the weather environment on or around the roadway and to better manage the surface transportation system. Such weather applications can:

- Collect road weather data from connected vehicles and mobile devices, increasing the number of data sources available.
- Provide road weather related traveler information to travelers via connected vehicles and devices, such as when and where a hazardous condition exists.
- Provide the ability to manage road weather response on specific roadways.

This SAE Standard specifies interface requirements between vehicles and infrastructure for weather applications, including detailed systems engineering documentation (needs and requirements mapped to appropriate message exchanges). The purpose of this SAE Standard is to enable interoperability supporting these weather applications over a communications technology agnostic interface.

1.2 References

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

1.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J2540-2	ITIS Phrase Lists (International Traveler Information Systems)
SAE J2735	Dedicated Short Range Communications (DSRC) Message Set Dictionary
SAE J2945	Dedicated Short Range Communication (DSRC) Systems Engineering Process Guidance for SAE J2945/X Documents and Common Design Concepts™
SAE J2945/5	Service Specific Permissions and Security Guidelines for Connected Vehicle Applications

1.2.2 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE Std 1233-1998 (R2002)	IEEE Guide for Developing System Requirements Specifications (Replaced by ISO/IEC/IEEE 29148:2011 (https://www.iso.org/obp/ui/#iso:std:iso-iec-ieee:29148:ed-1:v1:en))
IEEE Std 1471-2000	IEEE Recommended Practice for Architectural Description for Software-Intensive Systems
IEEE Std 1609.2-2016	IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Security Services for Applications and Management Messages (as amended by IEEE Std 1609.2a™-2017 and IEEE Std 1609.2b™-2019)
IEEE Std 1609.3-2016	IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services

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IEEE Std 1609.4-2016 IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operation

IEEE Std 1609.12-2019 IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifiers

It should be noted that there are additional standards in the 1609 suite which are not directly referenced here but which may also be of assistance to implementers.

1.2.3 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO/IEC 8824-1:1998 Information Technology - Abstract Syntax Notation One (ASN.1): Specification of Basic Notation

ISO/IEC 8824-2:1998 Information Technology - Abstract Syntax Notation One (ASN.1): Information Object Specification

ISO/IEC 8824-3:1998 Information Technology - Abstract Syntax Notation One (ASN.1): Constraint Specification

ISO/IEC 8824-4:1998 Information Technology - Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 Specifications

ISO/TS 19091 Intelligent Transport Systems - Cooperative ITS - Using V2I and I2V Communications for Applications Related to Signalized Intersections

ISO/TS 21177 Intelligent Transport Systems - ITS Station Security Services for Secure Session Establishment and Authentication Between Trusted Devices

1.2.4 Other Publications

Noon, R.K, “Engineering Analysis of Vehicular Accidents,” February 23, 1994, ISBN: 9780849381041.

NTCIP 1204 v04 National Transportation Communications for ITS Protocol, Environmental Sensor Station (ESS) Interface Protocol, Version 4

1.2.5 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

1.2.5.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J3067 Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735] Using Systems Engineering Methods

1.2.5.2 NIST Publications

Available from NIST, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070, Tel: 301-975-6478, www.nist.gov.

NIST SP800-122 Guide to Protecting the Confidentiality of Personally Identifiable Information (PII)

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1.2.5.3 Other Publications

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT), U.S. DOT ITS JPO, 1200 New Jersey Avenue, SE, Washington, DC 20590, http://local.iteris.com/arc-it/.

Specification of the Bluetooth® System (Bluetooth Core Specification), Bluetooth SIG.

INCOSE Systems Engineering Handbook v4, available from INCOSE publications, http://www.incose.org.

FCC 412172 D01, "Guidelines for Determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of an RF Transmitting System," August 2015.

NTCIP 8002, "National Transportation Communications for ITS Protocol Content Outline for NTCIP 1200-Series Documents (for Standards Engineering Process (SEP) Content)," Annex B1 version v01, American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, N.W., Suite 249, Washington, D.C. 20001, September 2016.

U.S. DOT, "Concept of Operations for Road Weather Connected Vehicle Applications,"May 31, 2013, FHWA-JPO-13-047.

U.S. DOT, "Privacy Impact Assessment," National Highway Traffic Safety Administration Notice of Proposed Rulemaking (NPRM) on V2V Communications, December 2016.

1.3 General Statements

The format of this document differs from the typical SAE document template for techncial specifications in order to comply with NTCIP format.[1]

1.4 Terms

For the purposes of this standard, the definitions, abbreviations, and acronyms found in SAE J2735 also apply. In the case of conflict, the following additional definitions, abbreviations, and acronyms supersede those found in SAE J2735. The definitions in SAE J2945 are incorporated by reference.

1.4.1 MONITORED PARTICIPATING VEHICLE

A participating vehicle that is being continuously monitored by the weather system. For the purposes of this document, monitored participating vehicles are agency owned or operated fleet vehicles.

1.4.2 NON-PARTICIPATING VEHICLE

A vehicle that is not participating in the uploading of weather data to a weather system (see 1.4.3).

1.4.3 PARTICIPATING VEHICLE

A vehicle that voluntarily provides data to a weather system. Vehicles may be owned or operated by a government agency or an infrastructure owner or operator, or vehicles may be privately owned.

1.4.4 TRANSPORTATION SYSTEM OPERATOR

The person or entity who interfaces with a weather system, typically located at a control center or traffic management center.

[1] "NTCIP format" is used throughout this document to refer to the document structure defined in NTCIP 8002 Annex B1 version v01.

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1.5 Abbreviations

The additional abbreviations and acronyms cited below are terms related to this standard (and of the other companion volumes and guides), unless specifically cited otherwise.

ASN	Abstract Syntax Notation Revision 1; Also: ASN.1
BSM	Basic Safety Message
ConOps	Concept of Operations
CRL	Certificate Revocation List
CV	Connected Vehicle
C-V2X	Cellular Vehicle-to-Everything
DE	Data Element
DF	Data Frame
DMS	Digital Message Sign
DSRC	Dedicated Short Range Communications
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
I2V	Infrastructure-to-Vehicle
ID	Identifier
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INCOSE	International Council on Systems Engineering
IP	Internet Protocol
IPv6	Internet Protocol Version 6
ITIS	International Traveler Information Systems
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
ITIS	International Traveler Information Systems
ITS	Intelligent Transportation System
JER	JSON Encoding Rules
JPO	Joint Program Office
JSON	Javascript Object Notation

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LAN	Local Area Network
MAC	Medium Access Control
MIB	Management Information Base
MSG	Message
NHTSA	National Highway Traffic Safety Administration
NIST	National Institute for Standards and Technology
NTCIP	National Transportation Communications for ITS Protocols
NRTM	Needs to Requirements Traceability Matrix
OBE	On-Board Equipment
OBU	On-Board Unit
PDU	Protocol Data Unit
PER	Packed Encoding Rules
PSC	Provider Service Context
PSID	Provider Service Identifier
RSU	Roadside Unit
RTM	Requirements Traceability Matrix
RWIS	Road Weather Information System
SCMS	Security Credential Management System
SP	Special Publication
SSP	Service Specific Permissions
Std	Standard
TCIP	Transit Communications Interface Profiles
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
U.S. DOT	United States Department of Transportation
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything Equipped Object

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VRU	Vulnerable Road User
WAVE	Wireless Access in Vehicular Environments
WDMS	Weather Data Management Subsystem
WSM	WAVE Short Message
WSMP	WAVE Short Message Protocol
XER	XML Encoding Rules
XML	eXtensible Markup Language

2. CONCEPT OF OPERATIONS [NORMATIVE]

Section 2 defines the user needs that SAE J2945/3 addresses in subsequent sections. Accepted system engineering processes detail that requirements should only be developed to fulfill well-defined user needs, in terms of the operations and maintenance of the system. The first stage in this process is to identify the ways in which the V2I and I2V weather-related data are likely to be used. For SAE J2945/3, this includes identifying what weather-related data from mobile sources may be used, and how weather applications may use this data, along with data collected from other sources, to improve transportation safety, mobility, and the environment. These weather applications may exist at a traffic management center, on transportation field devices, on vehicles, on mobile devices, or weather data centers.

This concept of operations provides:

a. A detailed description of the scope of SAE J2945/3.

b. An explanation of how weather applications fit into the larger context of a connected vehicle environment.

c. A starting point in developing specifications and the procurement process.

d. An understanding of the perspective of the designers of SAE J2945/3.

This section is intended for all users, including:

a. Transportation operations managers.

b. Transportation operations personnel, including transportation weather specialists.

c. Transportation engineers.

d. System integrators.

e. Application developers.

This section is intended to assist the first three categories of users in understanding how weather-related data from mobile sources, such as equipped vehicles or personal (VRU) devices, can be incorporated into a connected vehicle environment to support weather applications. For this audience, Section 2 serves as the starting point in the agency specification and procurement process. Users can become familiar with each feature addressed in SAE J2945/3 and determine whether or not a feature is appropriate for their agency-specific implementation. If a feature is appropriate, then an agency's procurement specification should be structured to require support for the feature and all of the mandatory requirements related to that feature.

The last two categories of users can gain a more thorough understanding as to why more detailed requirements exist later in SAE J2945/3.

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