IEEE STANDARDS ASSOCIATION IEEE

IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services

IEEE Vehicular Technology Society

Sponsored by the
Intelligent Transportation Systems Committee



IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 1609.3™-2016
(Revision of
IEEE Std 1609.3-2010)

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

IEEE Std 1609.3™-2016
(Revision of
IEEE Std 1609.3-2010)

IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services

Sponsor

Intelligent Transportation Systems Committee
of the
IEEE Vehicular Technology Society

Approved 29 January 2016

IEEE-SA Standards Board

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

This is a Redline Document produced by Techstreet, a business of Thomson Reuters.

This document is intended to provide users with an indication of changes from one edition to the next. It includes a full-text version of the new document, plus an indication of changes from the previous version.

Redlines are designed to save time and improve efficiencies by using the latest software technology to find and highlight document changes. More professionals are using valuable new technologies like redlines, to help improve outcomes in a fastpaced global business world.

Because it may not be technically possible to capture all changes accurately, it is recommended that users consult previous editions as appropriate. In all cases, only the current base version of this publication is to be considered the official document.

Documents Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Redline Processing Notes:

1. ~~**Red Text**~~ - Red strikethrough text denotes deletions.

2. **Blue Text** - Blue underlined text denotes modifications and additions.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Abstract: Services to WAVE devices and systems are provided in IEEE Std 1609.3™, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services. Layer 3 and layer 4 of the open system interconnect (OSI) model and the Internet Protocol (IP), User Datagram Protocol (UDP), and Transmission Control Protocol (TCP) elements of the Internet model are represented. Management and data services within WAVE devices are provided.

Keywords: IEEE 1609.3™, Provider Service Identifier (PSID), WAVE Service Advertisement (WSA), WAVE Short Message (WSM), Wireless Access in Vehicular Environments (WAVE)

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2016 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 29 April 2016. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-1-5044-0763-2 STD20839
Print: ISBN 978-1-5044-0764-9 STDPD20839

IEEE prohibits discrimination, harassment, and bullying.
For more information, visit http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html.
No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Standards Documents."

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association ("IEEE-SA") Standards Board. IEEE ("the Institute") develops its standards through a consensus development process, approved by the American National Standards Institute ("ANSI"), which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE-SA Website at http://ieeexplore.ieee.org/xpl/standards.jsp or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE's standards development process, visit the IEEE-SA Website at http://standards.ieee.org.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: http://standards.ieee.org/findstds/errata/index.html. Users are encouraged to check this URL for errata periodically.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at http://standards.ieee.org/about/sasb/patcom/patents.html. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Participants

At the time this IEEE standard was completed, the P1609 Working Group had the following membership:

Thomas M. Kurihara, *Chair*
Justin McNew, John Moring, William Whyte, *Vice Chairs*

Mike Brown
Hanbyeog Cho
Hans-Joachim Fischer
Ramez Gerges
Aleksandar Gogic
Shubha Gopalakrishna
Gloria Gwynne
Ronald Hochnadel
Carl Kain
John Kenney
Bill Lattin
Jules Madey
Sean Maschue
Jim Misener
Frank Perry
Randy Roebuck
Richard Roy
Kevin Smith
Jasja Tijink
Michaela Venderveen
George Vlantis
Jason Wang
Aaron Weinfield

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Iwan Adicandra
Nobumitsu Amachi
Lee Armstrong
Harry Bims
William Byrd
Keith Chow
Sourav Dutta
Richard Edgar
Marc Emmelmann
Pedro Fernandes
Randall Groves
Gloria Gwynne
Ronald Hochnadel
Werner Hoelzl
David Hunter
Noriyuki Ikeuchi
Piotr Karocki
John Kenney
Stuart Kerry
Dmitri Khijniak
Thomas M. Kurihara
Paul Lambert
Jeremy Landt
Justin McNew
John Moring
Michael Newman
Alexandros Nikitas
Satoshi Oyama
Venkatesha Prasad
Alon Regev
Richard Roy
Osman Sakr
Bartien Sayogo
Kevin Smith
Rene Struik
Walter Struppler
Gerald Stueve
Jasja Tijink
Steven Tilden
Thomas Tullia
John Vergis
George Vlantis
Hung-Yu Wei
William Whyte
Oren Yuen

When the IEEE-SA Standards Board approved this standard on 29 January 2016, it had the following membership:

Jean-Philippe Faure, *Chair*
Vacant position, *Vice Chair*
John Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Chuck Adams
Masayuki Ariyoshi
Ted Burse
Stephen Dukes
Jianbin Fan
J. Travis Griffith
Gary Hoffman
Ronald W. Hotchkiss
Michael Janezic
Joseph L. Koepfinger*
Hung Ling
Kevin Lu
Annette D. Reilly
Gary Robinson
Mehmet Ulema
Yingli Wen
Philip Winston
Howard Wolfman
Don Wright
Yu Yuan
Daidi Zhong

*Member Emeritus

Copyright © 2016 IEEE. All rights reserved.
Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Introduction

This introduction is not part of IEEE Std 1609.3™-2016, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services.

A WAVE system is a radio communications system intended to provide seamless, interoperable services to transportation. These services include those recognized by the U.S. National Intelligent Transportation Systems (ITS) Architecture [B7][a] and many others contemplated by the automotive and transportation infrastructure industries. These services include vehicle-to-roadside communication, vehicle-to-vehicle communications, and potentially communication among other devices. Networking Services provides services to WAVE devices and systems. Layer 3 and layer 4 of the open system interconnect (OSI) model and the Internet Protocol (IP), User Datagram Protocol (UDP), and Transmission Control Protocol (TCP) elements of the Internet model are represented. Management and data services within WAVE devices are provided. Network Services is but one component in the overall WAVE architecture, which is described in IEEE Std 1609.0™.

[a] The numbers in brackets correspond to those of the bibliography in Annex A.

Copyright © 2016 IEEE. All rights reserved.
Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Contents

1. Overview 10
   1.1 Scope 10
   1.2 Purpose 11
   1.3 System overview 11
   1.4 Applicability 11
   1.5 Conformance 11
   1.6 Document conventions 12

2. Normative references 12

3. Definitions, acronyms, and abbreviations 13
   3.1 Definitions 13
   3.2 Acronyms and abbreviations 15

4. General description 17
   4.1 Overview 17
   4.2 Data services 18
   4.3 Management services 18

5. Data plane 19
   5.1 General 19
   5.2 Logical link control 20
   5.3 Internet Protocol version 6 20
   5.4 Other IP-based protocols 20
   5.5 WAVE Short Message Protocol (WSMP) 21

6. Management plane 22
   6.1 General 22
   6.2 Service requests and channel access assignment 22
   6.3 WAVE Service Advertisement monitoring 34
   6.4 IPv6 configuration 35
   6.5 MIB maintenance 36

7. Service primitives 36
   7.1 General 36
   7.2 Channel identification 38
   7.3 WSM SAP 38
   7.4 WME SAP 42
   7.5 WAVE LSAP 56
   7.6 MLME and MLMEX SAPs 57
   7.7 Sec SAP 58

8. WAVE information formats 58
   8.1 General 58
   8.2 WAVE Service Advertisement (WSA) format 60
   8.3 WAVE Short Message (WSM) format 70

Annex A (informative) Bibliography 76

Annex B (informative) WME MIB table 77

Copyright © 2016 IEEE. All rights reserved.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

Annex C (normative) ASN.1 encoding of the WME MIB 80

Annex D (normative) Protocol Implementation Conformance Statement (PICS) proforma 118

Annex E (informative) Service usage examples 122
E.1 Provider service request 122
E.2 User service request with automatic channel assignment 122
E.3 User service request with notification 123
E.4 MIB monitoring by higher layer in support of user service request 124
E.5 Multi-PHY and multi-channel operation 125
E.6 Unconditional user service request 126

Annex F (normative) Allocated WAVE Information Element IDs 128

Annex G (informative) Packet format examples 129
G.1 WSA example 129
G.2 WSM example 134

Annex H (normative) IEEE Std 1609.2 security specification for WSA 135
H.1 WSA 135

Annex I (informative) General WSA security considerations 142

Annex J (informative) ASN.1 specifications for WAVE extension elements 143
J.1 General 143
J.2 ASN.1 module IEEE-1609-3-WEE 143
J.3 Explanations and further requirements 146

Annex K (informative) ASN.1 specifications for WSM 147
K.1 General 147
K.2 ASN.1 module IEEE-1609-3-WSM 147
K.3 Explanations and further requirements 152

Annex L (informative) ASN.1 specifications for WSA 154
L.1 General 154
L.2 ASN.1 module IEEE-1609-3-WSM 154
L.3 Explanations and further requirements 158

Copyright © 2016 IEEE. All rights reserved.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services

IMPORTANT NOTICE: ~~This standard is~~ IEEE Standards documents are not intended to ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers of ~~the standard~~ IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices ~~or regulatory requirements~~ and all applicable laws and regulations.

This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Documents." They can also be obtained on request from IEEE or viewed at htty://standards.ieee.ore/IPR/disclaimers.html.

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 1609.3-2016

1. Overview

~~1.1 General~~

A WAVE system is a radio communications system intended to provide interoperable services to transportation. These services include those recognized by the U.S. National Intelligent Transportation Systems (ITS) Architecture and many others contemplated by the automotive and transportation infrastructure industries. These services include communications between vehicles and roadside units, vehicles and other vehicles, and perhaps communications among other WAVE devices. WAVE Networking Services provide management services and data delivery services between WAVE devices. ~~This~~ Networking Services is but one component in the overall WAVE architecture, which includes IEEE ~~P1609.1™ [B1]~~[1], Std 1609.2™,[1] IEEE Std 1609.4™, ~~IEEE Std 802.11™~~ and IEEE Std 802.11™. The WAVE architecture is described in IEEE Std 1609.0™.

[1] Information on references can be found in Clause 2.

~~[1] The numbers in brackets correspond to those of the bibliography in Annex I.~~

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

1.1 Scope

The scope of this standard is to define services, operating at the ~~specification of~~ network and transport ~~layer protocols and services that~~ layers, in support ~~multi-channel~~ of wireless connectivity among vehicle-based devices, and between ~~IEEE 802.11~~ fixed roadside devices and vehicle-based devices using the 5.9 GHz Dedicated Short Range Communications/Wireless Access in Vehicular Environments (DSRC/WAVE) ~~devices~~ mode.

1.2 Purpose

WAVE Networking Services represent layer 3 (networking) and layer 4 (transport) of the open system interconnect (OSI) communications stack. The purpose of this standard is to provide addressing and ~~data delivery~~ routing services within a WAVE system, ~~providing~~ enabling multiple ~~higher layer entities access to~~ stacks of upper layers above WAVE ~~communication~~ Networking Services and multiple lower layers beneath WAVE Networking Services. Upper layer support includes in-vehicle applications offering safety and convenience to ~~their~~ users.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

1.3 System overview

The system described in this standard supports high-rate, low-latency communications between WAVE devices. Generic Internet Protocol version 6 (IPv6) traffic is supported (not Internet Protocol version 4), as well as a specialized WAVE Short Message service, although a given device might not support both protocols. A control channel provides a common channel for signaling. IP data is restricted to service channels; short message data may be sent on either type of channel. Higher layer entities benefiting from the WAVE communications can reside on the WAVE devices or reside on devices located on other networks connected to these devices. A more complete description of a WAVE system is provided in IEEE Std 1609.0.

1.4 Applicability

WAVE Networking Services support wireless communications between any and all WAVE devices. These devices may be mobile, portable, or stationary. The mobile devices include vehicles operating at high speeds on open highways. A common characteristic of WAVE systems is the need for extremely low communications latency (measured in milliseconds) from initially encountering a device that provides services to completing a set of data transfers.

This standard is consistent with the vehicle-to-roadside and vehicle-to-vehicle communications needs of various ITS architectures. Its intent is to enable interoperability and robust safety/public safety communications among these WAVE devices.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

1.5 Conformance

Per the *IEEE Style Manual* [~~B2~~ B1], this standard includes normative and informative information. Normative text may describe mandatory or optional features. A mandatory feature may have optional as well as mandatory components. For example, a mandatory message may have optional fields. An optional feature may have components that are mandatory if the feature is supported. For example, an optional message might require a certain field. Additionally, a feature may be conditional on support of another feature. For example, if A is supported, at least one of B or C must be supported.

In this standard, features are designated as mandatory, optional, or conditional in the introduction to the subclause specifying the feature. The designation applies to the requirements found in the subclause itself as well as any subordinate subclauses, unless otherwise indicated. The word *shall,* when applied to a component of an optional feature, indicates that the component is mandatory if the feature is supported, i.e., conditional on support for the feature. The protocol implementation conformance statement (PICS) in Annex D summarizes the features and their components.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

~~1.5 Document organization~~

~~Clause 1 provides an overview of the document. Clause 2 and Clause 3 contain references, definitions, and abbreviations, respectively. Clause 4 provides a general description of WAVE Networking Services. Clause 5 specifies the data plane elements of WAVE Networking Services, which carry higher layer data through the system. Clause 6 specifies the management plane functions that support system operations. Clause 7 defines the primitives used to communicate between WAVE Networking Services and other internal functional entities. Clause 8 specifies the format of WAVE Service Advertisements and Short Messages. Annex A and Annex B contain a description, and formal definition, of the management information employed by WAVE Networking Services. Annex C provides a PICS proforma. Annex D provides some examples of Networking Services usage. Annex E contains allocated *WAVE Element ID* values. Annex F specifies a supplement to the WAVE Short Message Protocol for safety applications. Annex G shows the contents of example WAVE packets. Annex H shows example Provider Service Identifiers. Annex I provides an informative bibliography and definitions.~~

1.6 Document conventions

Unless otherwise noted, conventions follow those in IEEE Std 802.11, including conventions for the ordering of information within data items as specified in Clause 8 of this standard.

Numbers are decimal unless otherwise noted, except Internet Protocol (IP) addresses, which are hexadecimal per the conventions defined in IETF RFC 2373. Numbers preceded by Ox indicate hexadecimal numbers, so that 0xFF is equivalent to "FF hexadecimal." Numbers preceded by 0b are binary. Numbers preceded by 0p are p-encoded (see IEEE Std 1609.12).

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Words ~~in italics refer~~ referring to data items that are defined as either a field in an interface primitive, a field in an over the air message, or a data item in the management information base (MIB) are written in italics.

Descriptive, informative information is generally found at the beginning of a clause or subclause, with normative text following. Figures are used for illustration and are informative unless otherwise noted. Refer to the *IEEE Style Manual* [~~B2~~ B1] for IEEE standards conventions.

Unless otherwise noted, references to a MIB refer to the WME MIB specified in Annex B.

2. Normative references

The following referenced documents~~ and URLs~~ are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 802®, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.[2,3,4]

[2] IEEE publications are available from The Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854,USA (http://standards.ieee.org/).

[3] The IEEE standards or products referred to in this clause are trademarks owned by The Institute of Electrical and Electronics Engineers, Incorporated.

[4]IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

IEEE Std 802.11™, 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 ~~P~~ Std 1609.0™, ~~/D0.9, April 2010,~~ IEEE ~~Draft~~ Standard for Wireless Access in Vehicular Environments (WAVE)— Architecture.

IEEE ~~P~~ Std 1609.2™, ~~/D5, June 2010~~ IEEE ~~Draft~~ Standard for Wireless Access in Vehicular Environments (WAVE)—Security Services for Applications and Management Messages.

IEEE Std 1609.4™, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Multi-Channel Operation.

IEEE Std 1609.12™, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Identifier Allocations.

IETF RFC 768, User Datagram Protocol.[5]

IETF RFC 793, Transmission Control Protocol.

IETF RFC 2460, Internet Protocol, Version 6 (IPv6) Specification.

[5] IETF publications are available from the Internet Engineering Task Force, IETF Secretariat, c/o Association Management Solutions, LLC (AMS), 48377 Fremont Boulevard, Suite 117, Fremont, CA 94538 (http://www.ietf.org).

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

IETF RFC ~~3513, Internet Protocol~~ 4291, IP Version 6 ~~(IPv6)~~ Addressing Architecture.

IETF RFC 4861, Neighbor Discovery for IP Version 6 (IPv6).

IETF RFC 4862, IPv6 Stateless Address Configuration.

ISO/IEC 8802-2 [IEEE Std 802.2™], IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 2: Logical Link Control.[6]

SAE J2735, Dedicated Short Range Communications (DSRC) Message Set Dictionary.[7]

The Unicode Standard, Unicode, Inc., http://www.unicode.org.

[6] ISO/IEC publications are available from the ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20,Switzerland (http://www.iso.org/). ISO/IEC publications are available in the United States from the American National StandardsInstitute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).

[7] SAE publications are available from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096, USA(http ://www. sae. org/).

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

IEEE P802.11REVmb™/D3.0, March 2010, IEEE Draft 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.[1]

IETF RFC 1042, Standard for the Transmission of IP Datagrams over IEEE 802 Networks.

IEEE Std 802.11kTM-2008, 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 Amendment 1: Radio Resource Measurement of Wireless LANs.

IEEE Std 802.11pTM, 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 Amendment 6: Wireless Access in Vehicular Environments.

[1] Numbers preceded by P are IEEE authorized standards projects that were not approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining drafts, contact the IEEE

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. ~~IEEE P1609.0 and~~ The *IEEE Standards Dictionary~~: Glossary of Terms & Definitions~~* *Online* should be consulted for terms not defined in this clause.[8]

application: A higher layer entity that may make use of WAVE communication facilities.

application-service: A service, involving an exchange of data, generally provided by a higher layer entity on one WAVE device to a similar entity on another WAVE device, using WAVE communications.

control channel (CCH): A ~~single~~ radio channel~~, not a service channel, intended for~~ limited by the WAVE standards to the exchange of management frames~~, including Wireless Access in Vehicular Environments (WAVE) Service Advertisements,~~ and WAVE Short Messages. *See also:* **service channel (SCH).**

[8] *IEEE Standards Dictionary* ~~*Glossary of Terms & Definitions*~~ *Online* subscription is available at: ~~http://shop.ieee.org/~~ http://ieeexplore.ieee.org/xpls/dictionary.isp.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

data plane: A ~~set of communication protocols defined to carry higher layer and management data. the data plane consists.of protocol stack(s) for the transfer of data through a device for transmission over the air~~ component of the abstract architecture containing entities that exchange user data.

EtherType: ~~The Ethernet Type field defined in IETF RFC 1042, used to identify the protocol above the Logical Link Control~~ A 2-octet value, assigned by the IEEE Registration Authority, which provides context for interpretation of a data field of a frame (protocol identification). (See IEEE Std 1609.12).

hexadecimal representation: The representation of a sequence of octet values in which the values of the individual octets are displayed in order from left to right, with each octet value represented as a two-digit hexadecimal numeral, and with the resulting pairs of hexadecimal digits separated by hyphens. The order of the hexadecimal digits in each pair, and the mapping between the hexadecimal digits and the bits of the octet value, are derived by interpreting the bits of the octet value as a binary numeral using the normal mathematical rules for digit significance. (From IEEE Std 802®)

higher layer entity: An entity, such as an application, that resides above the WAVE protocols in the protocol stack and may make use of WAVE communication services.

ITS port number: Transport layer protocol address element in Intelligent Transport Systems (ITS) used to identify source and destination of an entity above the OSI transport layer.

~~**higher layer:** A functionality (e.g., an application) residing in the context of the Open System Interconnection (OSI) protocol suite reference model, in the management or data plane above the services defined in this standard~~.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

managed Wireless Access in Vehicular Environments (WAVE) device: A WAVE device that supports management through the use of an IEEE 1609 standards-defined management information base (MIB).

management plane: A ~~collection of functions performed in support of the communication functions provided by the data plane but not directly involved in passing higher layer data. The management plane may employ lower layers of the data plane to transfer management information between devices~~ component of the abstract architecture containing functions that manage the entities in the data plane.

Networking Services: ~~A~~ The collection of management plane and data plane functions at the network ~~layer~~ and transport ~~layer, as~~ layers specified in this standard, supporting Wireless Access in Vehicular Environments (WAVE) communications.

notification: An indication of an event of interest, sent from a management entity to a higher layer entity.

null-networking: A network layer protocol that does not utilize network layer addresses.

provider: Advertiser of a Wireless Access in Vehicular Environments (WAVE) application-service. *See also:* **user; Wireless Access in Vehicular Environments (WAVE) Service Advertisement.**

Provider Service Context (PSC): A field associated with a Provider Service Identifier (PSID) containing supplementary information related to the application-service. The internal format of the PSC is PSID dependent.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Provider Service Identifier (PSID): An ~~octet string that identifies a service provided by a higher layer entity~~ identifier of an application area. (See IEEE Std 1609.12).

pseudonymity: A property ~~of a pseudonymous entity. A pseudonymous entity has the property that its~~ wherein an entity's permanent or long-lived identities, and its long-term patterns of behavior, cannot be deduced from its network traffic and are only ~~available to~~ observable by appropriately authorized parties.

service channel (SCH): Any channel that is not the control channel~~, intended for management frames and higher layer information exchanges (Wireless Access in Vehicular Environments (WAVE) Short Message [WSMs] and Internet Protocol version 6 [IPv6] packets). There may be more than one service channel defined in a given spectrum~~. *See also:* **control channel (CCH).**

sync interval: A repeating time interval comprised of one time slot 0 interval followed by one time slot 1 interval. *See also:* **time slot 0; time slot 1.** (See IEEE Std 1609.4)

time slot 0: A recurring time interval during which a device using alternating channel access will tune to one channel (nominally the CCH) and outside of which the device will tune to another channel (nominally an SCH). *See also:* **time slot 1; sync interval.** (See IEEE Std 1609.4)

time slot 1: A recurring time interval during which a device using alternating channel access will tune to one channel (nominally an SCH) and outside of which the device will tune to another channel (nominally the CCH). *See also:* **time slot 0; sync interval.** (See IEEE Std 1609.4)

Timing Advertisement frame: A specific management frame ~~specified in~~ used to carry timing information. (See IEEE Std 802.11)

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Transport Protocol Identifier (TPH>): Identifier contained in the WSMP-N-Header, which selects a WSMP-T-Header type.

user: ~~One~~ A WAVE device that ~~acts on receipt of a~~ monitors received WAVE Service Advertisements (WSAs) for an advertised application-service opportunity of interest. *See also:* **provider; Wireless Access in Vehicular Environments (WAVE) Service Advertisement.**

user priority: A ~~priority level~~ value assigned to a packet that is ready for transmission, which determines its treatment at the medium access control (MAC) layer. (See IEEE Std 802.11)

Wireless Access in Vehicular Environments (WAVE) device: A device that is compliant ~~to~~ with IEEE ~~P~~ Std 1609.3, IEEE Std 1609.4, and IEEE Std 802.11~~, operating~~ communicating outside the context of a basic service set. ~~(See IEEE P1609.0 and IEEE Std 802.11p.)~~

Wireless Access in Vehicular Environments (WAVE) medium access control (MAC): A WAVE MAC is a medium access control sublayer conformant to IEEE Std 1609.4.

Wireless Access in Vehicular Environments (WAVE) Management Entity (WME): A set of management functions required to provide WAVE Networking Services.

Wireless Access in Vehicular Environments (WAVE) Routing Advertisement (WRA): IPv6 network configuration information broadcast as part of a WAVE Service Advertisement.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Wireless Access in Vehicular Environments (WAVE) Service Advertisement (WSA): A data structure ~~containing information including~~ that may include the announcement of the availability of ~~a service~~ application services.

Wireless Access in Vehicular Environments (WAVE) Short Message (WSM): A packet consisting of a ~~WAVE Short Message Protocol (~~WSMP~~)~~ header and WSM Data.

Wireless Access in Vehicular Environments (WAVE) Short Message Protocol (WSMP): ~~A~~ The protocol ~~for rapid exchange of messages~~ specified in ~~a rapidly varying radio frequency (RF) environment where low latency is also an important objective~~ this standard that minimizes communications overhead.

~~**air interface:** A radio frequency communication interface, from the physical layer of one device to that of a remote device, such as the interface defined by Wireless Access in Vehicular Environments (WAVE).~~

~~**management ID:** Identifier of an IEEE 1609 management entity used to indicate the source and destination of management information. The values are specified in IEEE P1609.0.~~

~~**service priority:** A priority level associated with a service request that determines which service requests are given precedence by the WAVE Management Entity (WME) when assigning channels.~~

~~**Vendor Specific Action frame:** A management frame specified in IEEE Std 802.11. Despite the name, when the first 36 bits of the *Organization Identifier* are equal to 0x0050C24A4, the contents are specified for use in carrying IEEE 1609 management information including Wireless Access in Vehicular Environments (WAVE) Service Advertisements.~~

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

3.2 Acronyms and abbreviations

ACI	access category index
ACM	admission control mandatory
AIFSN	arbitration interframe space number
ASCII	American Standard Code for Information Interchange
ASN	Abstract Syntax Notation
CCH	control channel
~~CW~~	~~contention window~~
DNS	domain name system
EDCA	enhanced distributed channel access
EIRP	effective isotropic radiated power

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

EPD	EtherType protocol discrimination
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPv6	Internet Protocol version 6
ITS	Intelligent Transportation Systems
LLC	Logical Link Control
LSAP	link service access point
MAC	medium access control
MIB	management information base
MLME	MAC sublayer management entity
OSI	open system interconnect
PHY	physical layer

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

PICS	protocol implementation conformance statement
PSC	Provider Service Context
PSID	Provider Service Identifier
RCPI	received channel power indicator
RF	radio frequency
RFC	Request for Comments
SAE	Society of Automotive Engineers
SAP	service access point
SCH	service channel
~~SNAP~~	~~Subnetwork Access Protocol~~
STA	station
TA	Timing Advertisement (frame)

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

TCP	Transmission Control Protocol
TXOP	transmission opportunity
TPID	Transport Protocol Identifier
UDP	User Datagram Protocol
~~VSA~~	~~Vendor Specific Action (frame)~~
WAVE	Wireless Access in Vehicular Environments
WGS	world geodetic system
WME	WAVE Management Entity
WRA	WAVE Routing Advertisement
WSA	WAVE Service Advertisement
WSM	WAVE Short Message
~~WSMP~~	~~WAVE Short Message Protocol~~

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

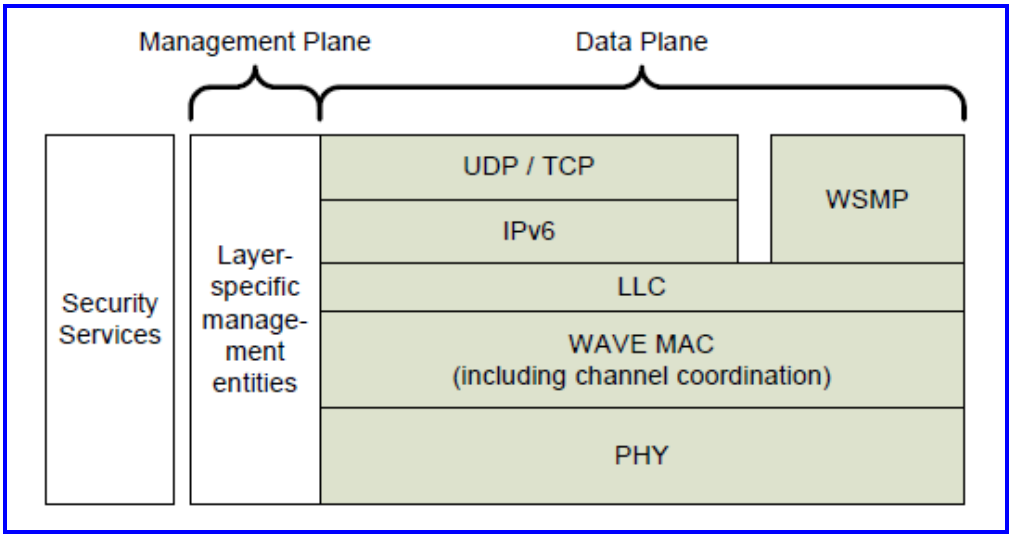
~~WSMP-I~~ ~~WAVE identity supplement~~

~~WSMP-S~~ ~~WSMP safety supplement~~

4. General description

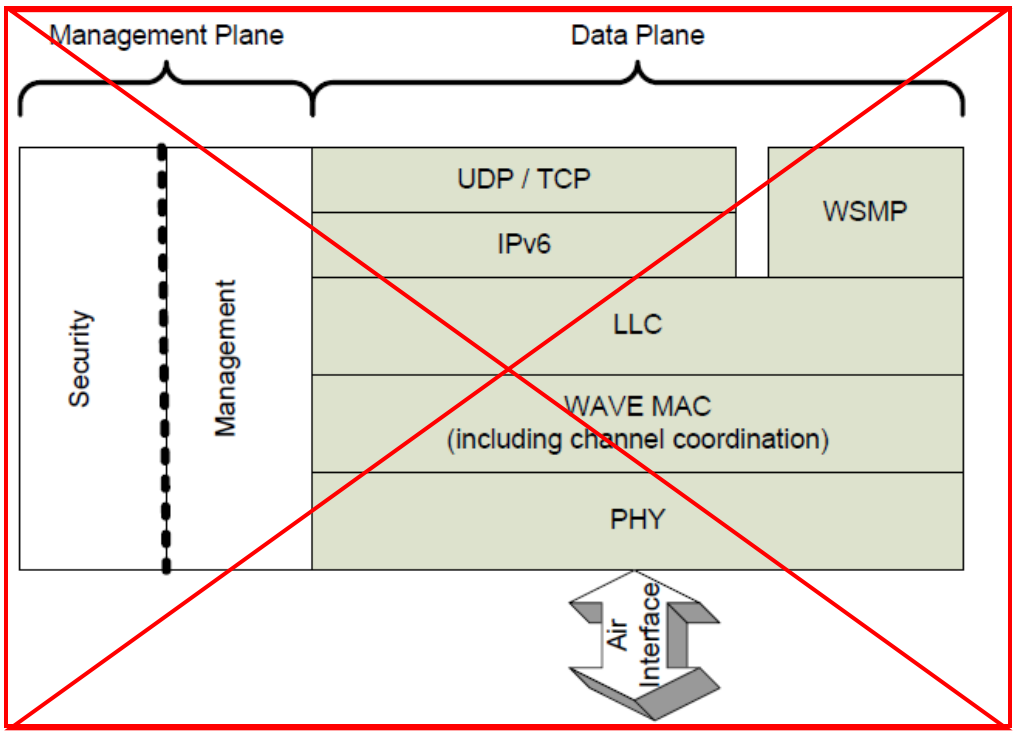
4.1 Overview

WAVE provides a communication protocol stack optimized for the vehicular environment, employing both customized and general-purpose elements as shown in Figure 1 and Figure 2. IEEE ~~P~~ Std 1609.0 provides a description of the WAVE system architecture and operations.



(New)

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

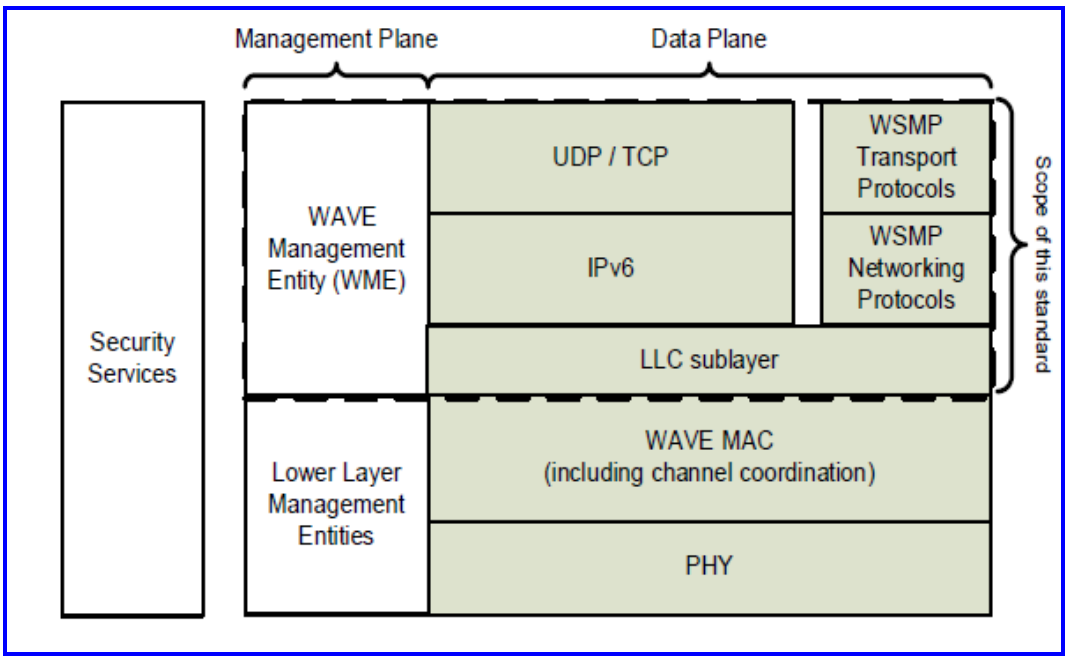


~~(Deleted)~~

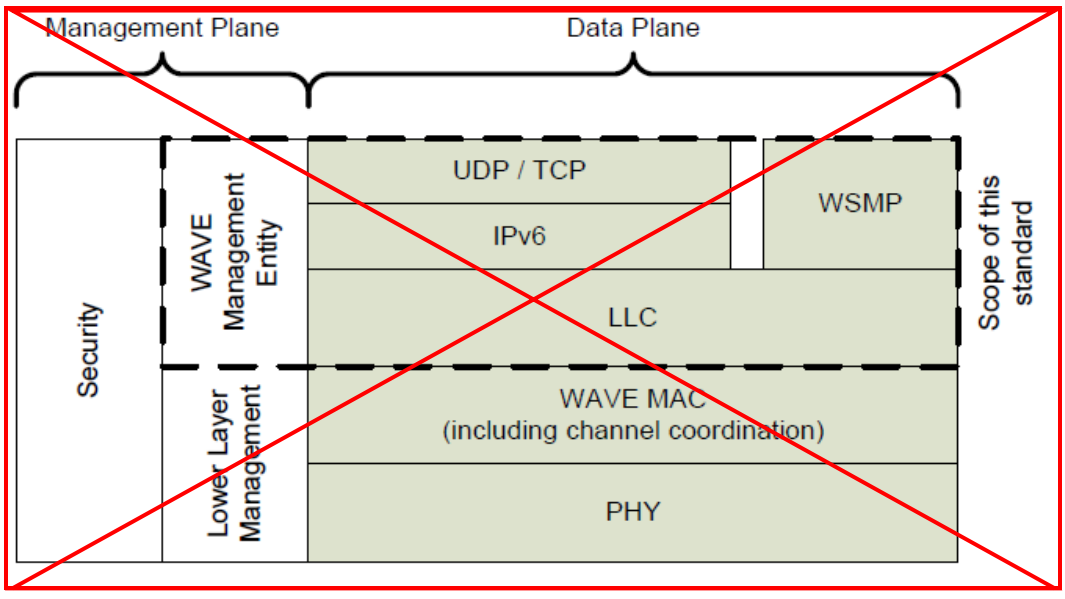
Figure 1—WAVE ~~protocol stack~~ reference model

WAVE Networking Services is specified in this standard and consists of ~~data plane layers~~ network and transport layer services and the associated management plane entity [WAVE Management Entity (WME)] as shown by the dashed lines in Figure 2. These are introduced in 4.2 and 4.3 and specified in Clause 5 and Clause 6.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016



(New)



~~(Deleted)~~

Figure 2—Scope of this standard

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

At minimum, a WAVE device implements at least the following features specified in this standard (see Annex D).

— LLC sublayer

— IPv6 or WSMP, or both

— Transmit or receive, or both

4.2 Data services

Data plane components of WAVE Networking Services are specified in Clause 5 and consist of the following, not all of which may be present in a given device:

— Logical Link Control (LLC)

  Networking Services includes the LLC sublayer, for both IPv6 and WSMP traffic.

— ~~Internet Protocol version~~ IPv6, and ~~higher layers~~ transport layer protocols such as User Datagram Protocol (UDP) and Transmission Control Protocol (TCP)

  Networking Services accepts data from higher layers for transmission over the ~~Internet Protocol~~ IP stack and delivers received ~~Internet Protocol~~ IP data to higher layers.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

— WSMP

Networking Services accepts data from higher layers for transmission over the WAVE Short Message Protocol (WSMP) and delivers received WSM data to higher layers. WSMP is designed to provide both network and transport layer protocols.

WSMP is used to transport WAVE Service Advertisements (WSAs) as requested by the WAVE Management Entity (WME).

4.3 Management services

Management plane components of WAVE Networking Services are specified in Clause 6 and consist of the following functions performed by the WAVE Management Entity, not all of which may be present in a given device:

— Service requests and channel access assignment

The WME processes service requests from higher ~~layers~~ layer entities, provides service channel access to satisfy service requests, and causes WAVE Service Advertisements and Timing Advertisements~~, and general management data~~ to be transmitted.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

— ~~Management data delivery~~

~~The WME accepts management data received over the air, and either processes it or passes it to a designated management entity.~~

— WAVE Service Advertisement monitoring

The WME monitors and verifies services advertised by other WAVE devices for use by higher ~~layers~~ layer entities and management functions.

— IPv6 configuration

The WME configures the local IP protocol stack using data received from other WAVE devices.

— MIB maintenance

The WME maintains a MIB containing configuration and status information~~.~~

~~Other device management functions may be accessed directly, i.e., not via the Networking Services specified in this standard, via the primitives specified in IEEE Std 802.11 or the MLMEX-SendPrimitive.request specified in IEEE Std 1609.4.~~

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

5. Data plane

5.1 General

This clause specifies the components of the Networking Services data plane, which are optimized for air interface efficiency and low latency in support of vehicular applications. WSMP is specified in this standard. For WSMs, the channel, time slot, transmit power, data rate and ~~are~~ channel load may be set by higher layers on a per-message basis. Networking Services also specifies the use of the Internet Protocol IPv6 and supports transport protocols such as UDP and TCP. For IP datagrams, the channel, transmit power, and data rate to be used are stored in a transmitter profile. A Networking Services implementation shall support either IPv6 or WSMP or both. WSMP and IPv6 are each selected by registered EtherType values.

WSMP uses subtyping to distinguish various features related to networking. WSMP provides networking protocol functions via the WSMP-N-Header. Different networking protocol features are indicated by different values of the *Subtype* field (see Table 22). WSMP provides transport protocol functions via the WSMP-T-Header. Different transport protocol features are indicated by different values of the *TPID* field (see Table 23).

Figure 3 and Figure 4 illustrate the flow of information associated with IP and ~~WSM data~~ WSMP, respectively. The primitives defined for exchanging information between the data plane components are described in Clause 7.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

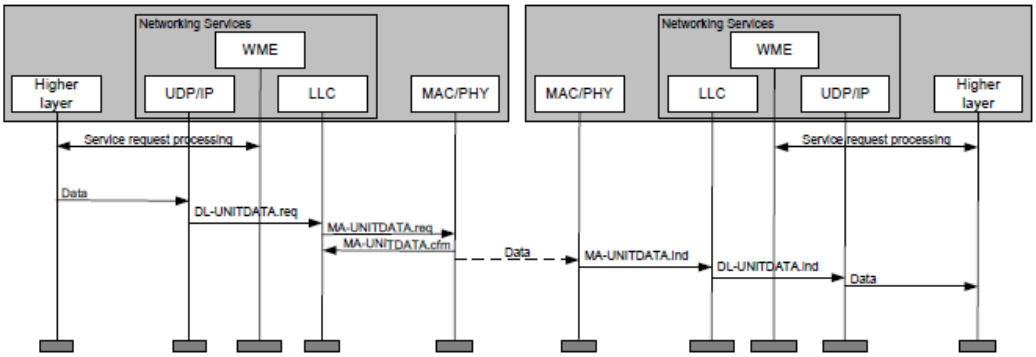


Figure 3—IP data flow

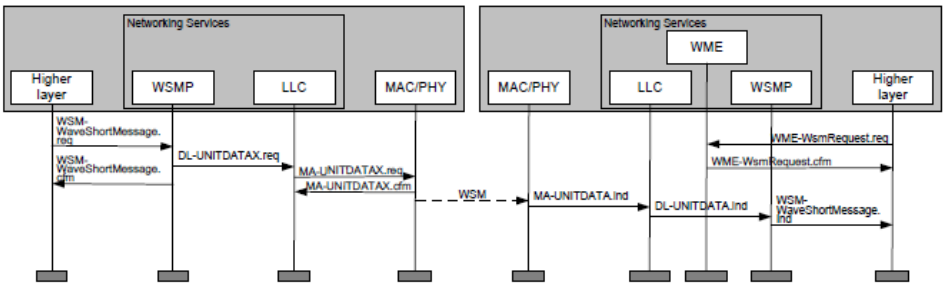


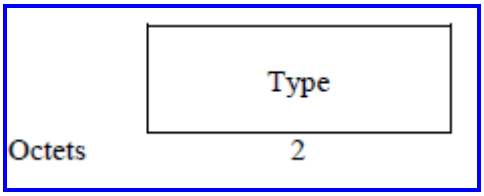
Figure 4—~~WSM~~ WSMP flow

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

5.2 Logical link control

5.2.1 General

A Networking Services implementation shall ~~support the connectionless unacknowledged Type 1 Operation of the LLC as specified in ISO/IEC 8802-2 [IEEE Std 802.2™], the Subnetwork Access Protocol (SNAP) specified in IEEE Std 802, and the standard for transmission of IP datagrams over IEEE 802 networks specified in IETF RFC 1042. Different Ethernet Type (*Ethertype*) values identify the different network layer protocols used in WAVE~~ use EPD in the LLC sublayer as described in IEEE Std 802, using an EtherType in the LLC sublayer header *Type*[9] field (see Figure 5 and Figure 28). The LLC sublayer header consists solely of a 2-octet field that contains an EtherType that identifies the higher layer protocol. To allow higher layer control of WSM transmit parameters, the link service access point (LSAP) has been extended for WSM as specified in 7.5.



(New)

Figure 5—LLC sublayer header type field

[9] The Type field specified herein is one of the options for the Length/Type field described in IEEE Std 802.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

5.2.2 Processing on transmit

When IPv6 requests transmission of a packet (via DL-UMTDATA. re quest), the LLC sublayer sets the *Type* field to EtherType value 0x86DD, and passes the data to the lower layers using the MA-UNITDATA.request primitive. Similarly, when WSMP requests transmission of a packet (via DL-UNITDATAX.request), the LLC sublayer sets the *Type* field to EtherType value 0x88DC and passes the data to the lower layers using the MA-UNITDATAX.request primitive.

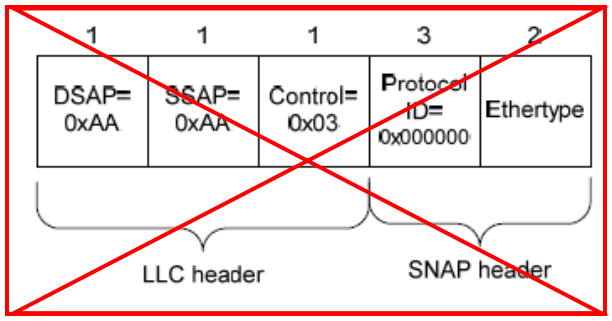
5.2.3 Processing on receive

When the LLC sublayer receives ~~an~~ a MAC service data unit (MSDU) via an ~~IEEE 802.2~~ MA-UNITDATA.indication primitive, it ~~checks~~ reads the ~~in~~ *Type* field containing the ~~SNAP header~~ EtherType and extracts the packet. If the EtherType value is 0x86DD, the LLC sublayer delivers the packet to IPv6. If the EtherType value is 0x88DC, the LLC sublayer delivers the packet to WSMP. In either case, the packet is delivered to the higher layer via the ~~IEEE 802.2~~ DL-UNITDAT A. indication ~~primitive~~.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

~~When IPv6 uses an IEEE 802.2 DL-UNITDATA.request primitive to request transmission of a packet, the LLC protocol shall set the *Ethertype* to 0x86DD. It will encapsulate the packet in LLC and SNAP headers and pass the data to the lower layers using an IEEE 802.11 MA-UNITDATA.request primitive. Similarly, when WSMP uses a DL-UNITDATAX.request primitive (see 7.5) to request transmission of a packet, the LLC protocol shall set the *Ethertype* to 0x88DC. It will encapsulate the packet in LLC and SNAP headers and pass the data to the lower layers using an IEEE 1609.4 MA-UNITDATAX.request primitive. An example of the LLC and SNAP headers is shown in Figure 5.~~

~~To allow higher layer control of WAVE Short Message transmit parameters, the LLC service access point has been extended for WAVE Short Messages as specified in 7.5.~~



~~(Deleted)~~

~~Figure 5—LLC and SNAP headers~~

5.3 Internet Protocol version 6

Support for IPv6 is conditionally mandatory as specified in 5.1. An IPv6 implementation shall comply with IETF RFC 2460. Related features defined in other RFCs are specified in 6.4. IP traffic is sent and received through the LLC sublayer as specified in 5.2.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

5.4 Other IP-based protocols

WAVE devices may implement any Internet Engineering Task Force (IETF) protocol~~, but care should be taken not to compromise interoperability with other WAVE devices~~. Examples of IETF protocols are UDP (IETF RFC 768) and TCP (IETF RFC 793).

5.5 WAVE Short Message Protocol (WSMP)

5.5.1 General

Support for WSMP is conditionally mandatory as specified in 5.1. ~~Acceptance~~ Delivery of a received ~~frame at the MAC layer is determined by the destination address; delivery of a received WAVE Short Message~~ WSM to a higher layer entity is determined by the WSMP header *Address Info* field. In this version of the standard, the *Address Info* field shall contain a *Provider Service Identifier (PSID)*, see 8.1.4. Future versions of this standard may support other types of addressing methods such as ports, see 8.3.2.2 and 8.3.3.2. A WSM may be accepted by one or more destination devices, depending on the type of MAC-level addressing used (e.g., individual or group). Note that MAC addresses may be changed for pseudonymity as specified in IEEE Std 1609.4.

Within a receiving device, the message will be delivered by WSMP to any higher layer entities with interest in the application-service opportunity associated with the *PSID*. Interest is indicated via the WSM service request procedure specified in 6.2.2.1.4. Higher layer entities take responsibility for message signing and authentication (per IEEE ~~P~~ Std 1609.2) and for providing the channel information for transmission. The ~~WSMP header~~ WSM format is specified in 8.3.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

WSMP is also used to send and receive WSAs. From the standpoint of WSMP, the WME may be considered as a higher layer entity.

5.5.2 WSM transmission

On receipt of a WSM-WaveShortMessage.request from a higher layer entity, WSMP shall calculate the length of the WSMP header and verify that the length of that WSMP header combined with the accompanying *WSM Data* is less than the value of the WME MIB parameter *WsmMaxLength.* Upon successful verification of *WsmMaxLength,* WSMP shall generate the WSMP header per the format specified in 8.3 for inclusion in ~~an LLC~~ a DL-UNITDATAX.request ~~(see 7.5.2)~~. Upon failed verification of *WsmMaxLength,* the WSM is not passed and the failure is indicated ~~in~~ via the ~~resulting~~ WSM-WaveShortMessage.confirm.

DL-UNITDATAX.request parameters are set as follows:

source_address	Set to the IEEE 802.11 *dot11StationID* for the WAVE interface.
destination_address	Set to the *Peer MAC address* from the WSM-WaveShortMessage.request.
data	Set as described in the subsequent discussion.
priority	Set to the *User Priority* from the WSM-WaveShortMessage.request.
service class	May be set to QoSAck or QoSNoAck per IEEE Std 802.11.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Channel Identifier	Set to the *Channel Identifier from* the WSM-WaveShortMessage.request.
Time Slot	Set to the *Time Slot from* the WSM-WaveShortMessage.request.
Data Rate	Set to the *Data Rate* from the WSM-WaveShortMessage.request.
TxPwr_Level	Set as described in the subsequent discussion.
Channel Load	Set to the *Chanel Load* from the WSM-WaveShortMessage.request.
~~*Wsm* *Expiry Time*~~	Set to the ~~*Wsm*~~ *Expiry Time* from the WSM-WaveShortMessage.request.

The *data* parameter consists of a ~~WAVE Short Message~~ WSM, which is formed from the WSMP header ~~described earlier in this subclause~~ (which includes the WSMP-N-Header and the WSMP-T-Header) and the *WSM Data* from the WSM-WaveShortMessage.request, as described in 7.3.2.

Transmit Power Level, received in the WSM-WaveShortMessage.request, is converted to *TxPwrJLevel* in the DL-UNITDATAX.request as follows. *TxPwrJLevel* is set to the index of the highest value of IEEE 802.11 MIB *Dotl lPhyTxPowerEntry* that does not exceed *Transmit Power Level.* If there is no such value, then the WSM-WaveShortMessage.request should be rejected.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

5.5.3 WSM reception

On receipt of a DL-UNITDATA.indication from ~~with~~ the ~~*WAVE Element ID*~~ LLC sublayer, WSMP evaluates the *WSMP Version* field in the WSMP ~~indicating WAVE Short Message, WSMP shall pass~~ -N-Header. If a WAVE device receives a WSM with *WSMP Version* set to an unsupported value, no further processing is required (see 8.3.2.1).

WSMP then evaluates the WSMP-N-Header *Subtype* field and processes the WSMP-N-Header as indicated in 8.3.2. WSMP then evaluates the *TPID* field and processes the WSMP-T-Header as indicated in 8.3.3. After the headers have been processed, WSMP delivers the received ~~information~~ *WSM Data* to the destination higher layer entity or entities, with the destination entity determined ~~from~~ by the ~~WSMP header *ProviderServiceIdentifier*~~ *PSID* and the MIB *WsmServiceRequestTable*. ~~On receipt of DL-UNITDATA.indication from LLC with the *WAVE Element ID* in the WSMP Header indicating a WSMP WAVE element besides WAVE Short Message (e.g., WSMP safety supplement [WSMP-S]), WSMP shall pass the received information to the appropriate entity, as indicated by the reference listed in Annex E. In either case,~~ Higher layer entities are notified via the WSM-WaveShortMessage.indication primitive ~~is used to deliver WSM information to higher layer entities. Annex E specifies WSMP WAVE *Element ID*~~ (see 7.3.4).

If a WAVE device receives a WSM in which the *Subtype* equals any value other than 0, or in which *TPID* equals any values~~; Annex F specifies functionality for WSMP-S. A *WsmVersion* value higher than that specified in 8.2.5.8.3 may cause WSMP to fail to parse~~ other than 0 or 1, then no further processing of the message is required.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

6. Management plane

6.1 General

The following subclauses specify the networking functions associated with the management plane. The primitives for exchanging information between the WME and other internal functional entities are described in Clause 7. Use of the WME-Notification.indication primitive (e.g., notifying a higher layer entity that a service request has been matched to an ~~available~~ application-service opportunity, or that ~~an SCH~~ a channel has been assigned) is not explicitly specified, but it is left as a choice for implementers.

Networking Services management functions provide the means to control transmit parameters (e.g., data rate and power) of data plane traffic; the data rates and power levels for transmitting management frames are specified in EEE Std 1609.4.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

6.2 Service requests and channel access assignment

6.2.1 General

The WME accepts service requests of several types from higher layer entities. Channel access allows higher layers to exchange data on a designated channel. Channel access options include continuous access (on CCH or SCH), alternating access (between CCH and SCH, or two SCHs), and immediate SCH access (see IEEE Std 1609.4). To satisfy service requests, the WME may provide access to ~~SCHs~~ channels and may cause ~~management~~ WSAs and Timing Advertisement messages to be periodically transmitted. Providing ~~SCH~~ channel access entails causing the device transceiver to be tuned to a specific channel during one or more ~~channel intervals~~ time slots, via requests to the MAC sublayer management entity (MLME).

For convenience, two WAVE device roles are defined. The provider role is assumed by a device transmitting WAVE Service Advertisements (WSAs) indicating its availability for data exchange on one or more ~~SCHs~~ channels. The user role is assumed by a device monitoring for received WSAs, with the potential to participate in ~~the SCH~~ a data exchange on any channel. A WAVE device may assume one, both, or neither role.

The various service request types, ~~the resulting~~ an indication of whether or not a channel ~~access assignments~~ assignment occurs, and the messages automatically generated are summarized in Table 1.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016

Service request type	Reference	Primary purpose	Results in channel assignment?	Message generation
Provider	7.4.2.2	WAVE service advertisement/SCH participation	yes	WSM containing WSA
User	7.4.2.4	Service availability notification/SCH participation	yes	none
WSM	7.4.2.6	Received message delivery	no	none
Channel	7.4.2.8	Channel participation	yes	none
Timing Advertisement	7.4.2.10	Time distribution	yes	Timing Advertisement (TA) frame

(New)

~~Service request type~~	Reference	Primary purpose	Resulting channel/interval assignment	Message generation
Provider	7.4.2.2	Service advertisement/ SCH participation	SCH in SCH interval, or SCH in SCH and CCH intervals	VSA frame containing WSA
User	7.4.2.4	Service availability notification/ SCH participation	SCH in SCH interval, plus optionally SCH in CCH interval	none
WSM	7.4.2.6	Received message delivery	none	none
CCH	7.4.2.8	Control channel participation	CCH in CCH or SCH interval or both	none
Management data	7.4.2.10	Management data distribution	CCH or SCH; CCH or SCH interval or both	VSA frame
Timing advertisement	7.4.2.13	Time distribution	CCH or SCH; CCH or SCH interval or both	Timing Advertisement (TA) frame

~~(Deleted)~~

Table 1—Service request summary

To facilitate the specification, a distinction is made between single-physical layer (PHY) devices and multi-PHY devices (see IEEE Std 1609.4). A single-PHY device is a WAVE device not capable of simultaneous operation on multiple radio channels. A multi-PHY device is a WAVE device capable of simultaneous operation on multiple radio channels. A switching device has at least one PHY that is capable of switching between channels (e.g., SCH and CCH). Depending on the characteristics and usage of the WAVE device at a given time, it might support any ~~number~~ of several channel usage models, including the following:

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on March 05,2026 at 16:19:05 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 1609.3-2016