

IEEE Standard for Wireless Access in Vehicular Environments (WAVE)— Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS)

IEEE Vehicular Technology Society

Sponsored by the
Intelligent Transportation Systems (VT/ITS) Committee

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IEEE Standard for Wireless Access in Vehicular Environments (WAVE)— Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS)

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Intelligent Transportation Systems (VT/ITS) Committee
of the
IEEE Vehicular Technology Society

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Abstract: This standard specifies the electronic payment service layer and profile for Payment and Identity authentication, and Payment Data transfer for Dedicated Short Range Communication (DSRC) based applications in Wireless Access in Vehicular Environments. This standard defines a basic level of technical interoperability (vehicle-to-roadside) for electronic payment equipment, i.e., onboard unit (OBU) and roadside unit (RSU) using WAVE. It does not provide a full solution for interoperability, and it does not define other parts of the electronic payment system, other services, other technologies and non-technical elements of payment interoperability. This standard is not intended to define technology and processes to activate and store data into the OBU (personalization), nor the applications using the payment service.

Keywords: EFC, electronic fee collection, electronic payment service, EPS, WAVE, Wireless Access in Vehicular Environments

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Introduction

This introduction is not part of IEEE Std 1609.11-2010, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS).

This standard gives requirements for services for the handling of electronic payment information in WAVE systems, as described in the IEEE 1609 family of standards.

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1. Overview

1.1 Scope

This standard specifies the application service layer and profile for Payment and Identity authentication, and Payment Data transfer for Dedicated Short Range Communication (DSRC) based applications using IEEE Std 802.11™ and IEEE 1609 protocols in Wireless Access in Vehicular Environments. This standard defines a basic level of technical interoperability for electronic payment equipment, i.e., onboard unit (OBU) and roadside unit (RSU). It does not provide a full solution for interoperability, and it does not define other parts of the electronic payment-system, other services, other technologies, and non-technical elements of interoperability. This standard is not intended to define technology and processes to activate and store data into the OBU (personalization).

1.2 Purpose

This standard provides an open standard for the relevant interface in WAVE-based transaction systems, providing a common interoperable service for device identity and payment authentication, and payment data transfer. This allows for interoperability between systems of different vendors and/or operators.

1.3 Document organization

The body of this standard gives electronic payment service (EPS) requirements that are common to all payment systems. Clause 1 provides an overview of the document. Clause 2 and Clause 3 contain references, definitions, and abbreviations, respectively. Clause 4 contains a general description of payment systems. Clause 5 describes a Payment Service, which is the set of EPS functions used by applications. Clause 6 describes types of communication and approval of payment information.

Detailed requirements and profiles for various payment systems are given in annexes to this standard. Annex A contains a description of payment systems whose requirements are given in ISO 14906 and 15628. Annex B contains an example of a system per Annex A. Profiles for other payment systems may be added as annexes as requirements are identified.

Annex C contains the Protocol Implementation Conformance Statement (PICS) proforma.

2. Normative references

The following referenced documents 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.

FIPS Publication 197 (November 2001), Specification for the Advanced Encryption Standard (AES).¹

IEEE Std 802.11™, IEEE Standard for Local and Metropolitan Area Networks, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications.^{2, 3}

IEEE Std 802.11p™, IEEE Standard for Local and Metropolitan Area Networks, Amendment 7: Wireless Access in Vehicular Environments.

IEEE P1609.0™ (Draft 0.9, April 2010), Draft Standard for Wireless Access in Vehicular Environments (WAVE)—Architecture.⁴

IEEE P1609.2™ (Draft 5, June 2010), Draft Standard for Wireless Access in Vehicular Environments (WAVE)—Security Services for Applications and Management Messages.

IEEE Std 1609.3™-2010, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services.

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⁴ 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 Sponsor ballot/press. For information about obtaining drafts, contact the IEEE.

IEEE Std 1609.4™-2010, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)—Multi-channel Operation.

ISO 14906 Road transport and traffic telematics—Electronic fee collection—Application interface definition for dedicated short-range communication.⁵

ISO 15628 Road transport and traffic telematics—Dedicated short range communication (DSRC)—DSRC application layer.

NIST Special Publication 800-38A 2001, Recommendation for Block Cipher Modes of Operation: Methods and Techniques, National Institute of Standards and Technology.⁶

NIST Special Publication 800-38B 2005 Edition, Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication, National Institute of Standards and Technology.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. *The IEEE Standards Dictionary: Glossary of Terms & Definitions* should be referenced for terms not defined in this clause.⁷ Additional WAVE definitions may be found in IEEE P1609.0/D0.9.

application: A higher-layer entity that requires electronic payment service (EPS) functions and communicates via the WAVE stack.

control channel (CCH): A single radio channel, not a service channel, intended for exchange of management information including WAVE service advertisements and WAVE short messages.

Electronic Fee Collection (EFC): A system that is a special case of an EPS system.

Electronic Payment Service (EPS): Pertains to the origination, communication, processing, storage, or retrieval of electronic payment information.

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

payee action pre-approval: The payee does not need to wait for approval before it takes further action.

payee action without pre-approval: The payee needs to wait for approval from an external entity before it may take further action.

payer action pre-approval: The payer does not need to wait for approval before taking further action.

payer action without approval: The payer must wait until it receives the payment information confirmation from the payee before taking further action.

⁵ ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/ Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁶ National Institute of Standards and Technology (NIST) publications are available from the Superintendent of Documents, U.S. Government Printing Office, Stop SSOP, Washington, DC, USA 20402-0001 (<http://bookstore.gpo.gov/>).

⁷ *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at <http://shop.ieee.org/>.

payer response pre-approval: The payer does not need to wait for approval before it may send the payment information response.

payer response without pre-approval: The payer needs to wait for approval from an external entity before it may send the payment information response.

provider: Advertiser of a WAVE service. *See also:* **user**, **WAVE service advertisement**.

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

Provider Service Identifier (PSID): An octet string that identifies a service provided by a higher layer entity.

service channel (SCH): Any channel that is not the control channel, intended for management frames and higher layer information exchanges (WSMs and IPv6 packets). There may be more than one service channel defined in a given spectrum.

user: One that acts on receipt of a WAVE service advertisement. *See also:* **provider**, **WAVE service advertisement**.

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 within the 1609 standards for carrying IEEE 1609 management information including WAVE service advertisements.

WAVE device: A device that is compliant to IEEE Std 1609.3-2010, IEEE Std 1609.4-2010, and IEEE Std 802.11, operating outside the context of a basic service set (see IEEE P1609.0/D0.9 and IEEE 802.11p).

WAVE management entity (WME): A set of management functions required to provide WAVE networking services. It is specified in IEEE Std 1609.3-2010.

WAVE service advertisement (WSA): A data structure specified in IEEE Std 1609.3-2010 containing information including the announcement of the availability of services

WAVE short message (WSM): A packet consisting of WSM data and a WSMP header.

WAVE short message protocol (WSMP): A protocol for rapid exchange of messages in a rapidly-varying radio frequency (RF) environment where low-latency is also an important objective.

3.2 Acronyms and abbreviations

BST	Beacon Service Table
CBC	cipher-block chaining
CCH	control channel
CMAC	cipher-based message authentication code
DSRC	Dedicated Short Range Communication
EFC	Electronic Fee Collection
EPS	Electronic Payment Service
FIPS	Federal Information Processing Standards

IP	Internet Protocol
IPv6	Internet Protocol version 6
ITS	Intelligent Transportation Systems
IV	initialization vector
LID	logical link control identifier
MAC	medium access control
MIB	management information base
MLME	MAC sublayer management entity
N/A	not applicable
NIST	National Institute of Standards and Technology
OBU	onboard unit NOTE—In some references, the term onboard equipment (OBE) is used instead of OBU. ⁸
PSC	Provider Service Context
PSID	Provider Service Identifier
RF	radio frequency
RSU	roadside unit NOTE—In some references, the term roadside equipment (RSE) is used instead of RSU.
SAP	service access point
SCH	service channel
T-ASDU	transfer-application data unit
UDP	User Datagram Protocol
VST	Vehicle Service Table
WAVE	Wireless Access in Vehicular Environments
WIAL	WAVE Interface Application Layer
WME	WAVE management entity
WSA	WAVE service advertisement
WSM	WAVE short message
WSMP	WAVE short message protocol

4. General description

This standard describes exchanges of electronic payment information between payment equipment units over WAVE. Examples of electronic payment information include the following:

- Account information
- Identity information
- Invoices
- Proof of payment (i.e., receipts)

⁸ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

Processing of electronic payment information requires electronic payment service (EPS) functions, which may include the origination, communication, processing, storage or retrieval of the information. EPS functions may also include security tasks such as the encryption or decryption of payment information.

WAVE communications on a payment equipment unit is done using the WAVE protocol stack, as described in IEEE Std 1609.3-2010 and IEEE Std 1609.4-2010. In this standard, an *application* is defined as a higher-layer entity that requires EPS functions and communicates via the WAVE stack.

More than one application on a payment equipment unit may use the same set of EPS functions. For example, a group of applications may be tied to the same account and therefore require common identical payment processing functions.

The set of EPS functions that are used by one or more applications is called the *Payment Service* that serves the application(s).

Figure 1 illustrates the relationships among two applications, which wish to exchange payment information on WAVE, on different equipment units and their respective Payment Services and WAVE stacks.

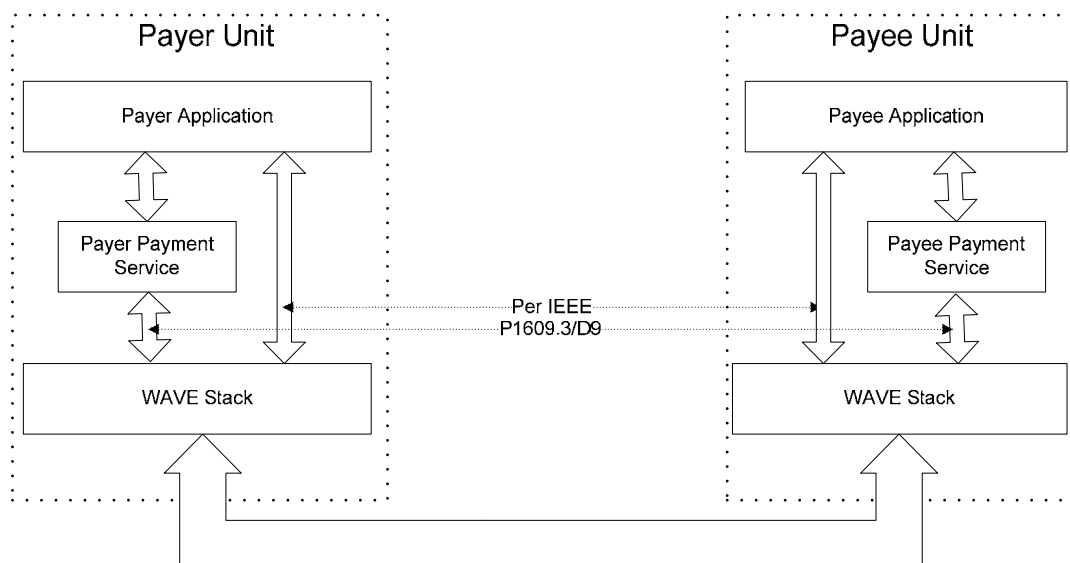


Figure 1—Relationships among applications on different units and their respective Payment Services and WAVE stacks

A payer or payee application may be modeled as shown in Figure 2. The Application Core performs application-specific processing. The WAVE Interface Application Layer (WIAL) processes and transmits information between the Application Core and the WAVE stack. The WIAL and, in some systems, the Payment Service interact with the WAVE stack via the WME SAP and WSM SAP, which are described in IEEE Std 1609.3-2010. Depending on the type of payment system, the Payment Service may provide functions to either the Application Core or the WIAL.

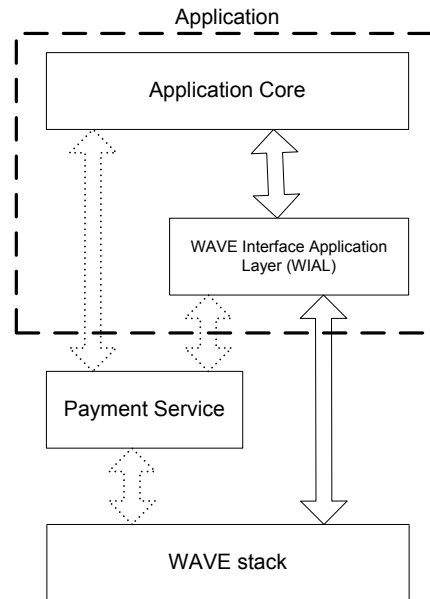


Figure 2—Relationships among application components and Payment Service and WAVE stack

An application transmits and receives payment information either in WAVE short message protocol (WSMP), as defined in IEEE Std 1609.3-2010, or Internet Protocol version 6 (IPv6). Non-payment information may be sent in the same message as payment information.

Electronic payment information may require different processing and handling depending on the type of payment system. For example, after receiving account or identity information from a payer application, a payee application might respond directly with an electronic receipt. In another type of system, the payee might need to send an electronic invoice and receive approval information before it sends the receipt to the payer.

5. Payment Service overview

5.1 Payment Service functions

The functions of a Payment Service can be grouped into the following two categories:

- *General EPS functions:* These may include functions for the origination, communication, processing, storage or retrieval of EPS information. Requirements for these functions are system dependent and are described in the appropriate annex to this standard.
- *Security functions:* These may include functions for encryption and decryption or authentication of EPS information for over-the-air transmission or application-specific purposes. Some systems may use security methods offered by the Payment Service while others may use security methods accessed outside the Payment Service, for example by the application using services described in IEEE P1609.2/D5. Requirements for these functions are system dependent and are described in the appropriate annex to this standard.

5.2 MIB maintenance

In this version of the standard no management information base (MIB) functions are defined since there are no requirements defined in this revision that require specific MIB attributes for Payment Services.

6. Types of systems using EPS

6.1 Modes of EPS information exchange

6.1.1 Introduction

An EPS system may exchange EPS information between Payment Services in either *Direct* or *Indirect EPS communication* mode.

These modes are discussed in the following subclauses.

6.1.2 Direct EPS communication mode

In a system operating in Direct EPS communication mode, EPS information is directly exchanged between Payment Services via their respective WAVE stacks.

On the sending unit, an application makes a request to its Payment Service for EPS information to be sent. The sending Payment Service then prepares and secures the EPS information before sending it via its WAVE stack. On the receiving unit, the Payment Service extracts the message and sends an appropriate indication to its application.

This mode is illustrated in Figure 3.

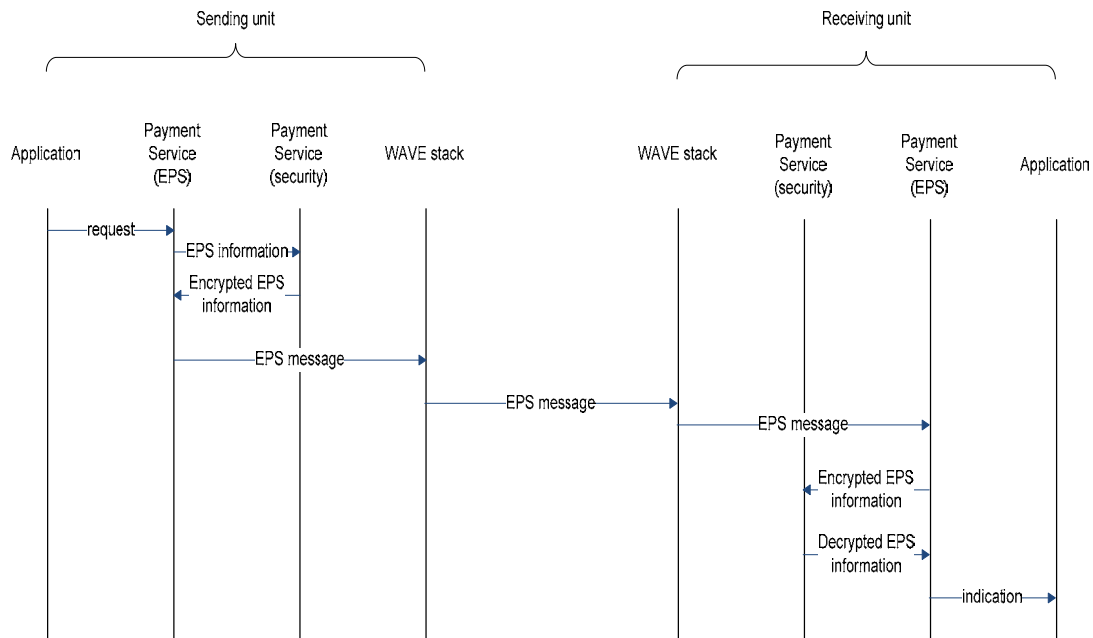


Figure 3—Information flow in Direct EPS communication mode

6.1.3 Indirect EPS communication mode

In a system operating in Indirect EPS communication mode, EPS information is exchanged between Payment Services through their respective applications.

On the sending unit, an application may make a request to its Payment Service for EPS information. The sending Payment Service then prepares the EPS information that is then returned to the application in a confirmation. For example, the preparation of EPS data may involve payment security, such as encryption. The application's WIAL then encapsulates the EPS information and/or a request for EPS information to the receiving unit, along with application-specific information if desired, into a message that is sent over the air via the WAVE stack.

On the receiving unit, the application separates the message into the EPS information and/or requests for EPS information, which is sent to the Payment Service in an indication, and any application information. The Payment Service may then process the EPS information and send a response to the application. The processing of EPS data may involve payment security, such as decryption.

This mode is illustrated in Figure 4.

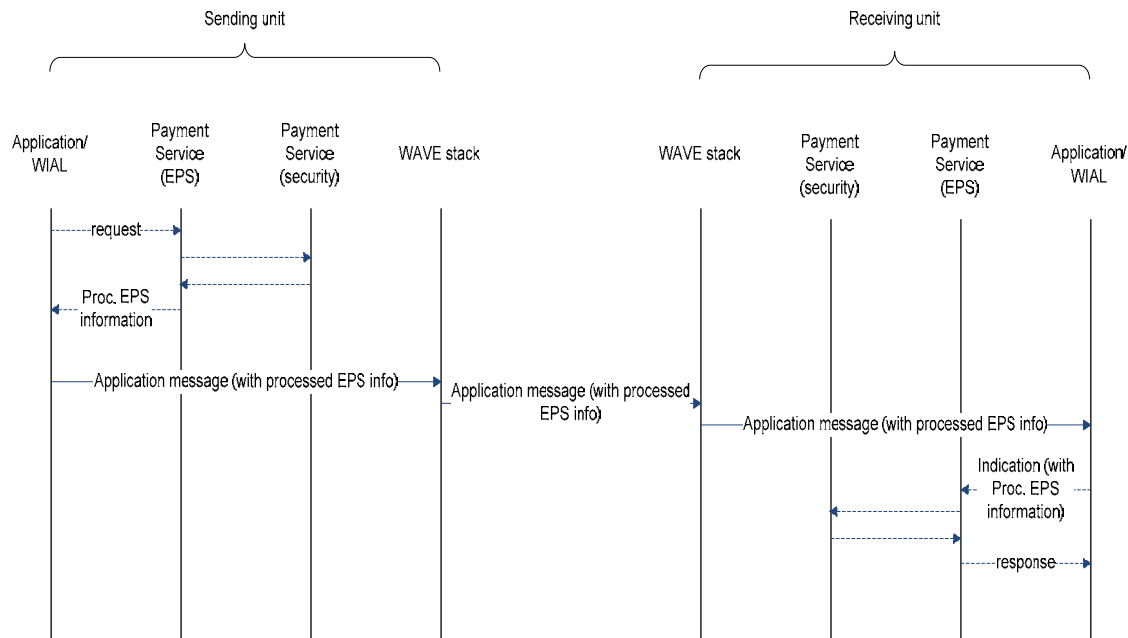


Figure 4—Information flow in Indirect EPS communication mode

6.2 Payer and payee approval types

6.2.1 Introduction

On over-the-air receipt of Payment information and validation/verification, a payer or payee may be required to wait to obtain approval from another entity before it can perform other actions or send a response, or if pre-approved, it would not need to wait.

The types of approval, including examples of situations where they may be required, are defined in 6.2.2 through 6.2.4.

Note that the details of validation/verification and approval, and the circumstances and consequences of disapproval are system-dependent and are out of scope for 6.2.2 through 6.2.4.

6.2.2 Payer response approval types

On over-the-air receipt and validation/verification of a Payment information request from the payee, the payer may require approval (e.g., from a human-machine interface) to reply with a Payment information response. For example, for a financial transaction, the Payment information request may contain an invoice and the Payment information response may contain the account information from which the payment is to be made. For another example, for an identity transaction (i.e., payer authentication without payment), the Payment information request may contain a request for identification and the Payment information response may contain the identity of the payer.

The *Payer response approval types* are defined as follows: