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Road vehicles — Diagnostic communication over Internet Protocol (DoIP) —

Part 1: General information and use case definition

Véhicules routiers — Communication de diagnostic au travers du protocole internet (DoIP) —

Partie 1: Informations générales et définition de cas d'usage

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13400-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 13400 consists of the following parts, under the general title *Road vehicles — Diagnostic communication over Internet Protocol (DoIP)*:

— *Part 1: General information and use case definition*

— *Part 2: Transport protocol and network layer services*

— Part 3: *Wired vehicle interface based on IEEE 802.3*

The following parts are under preparation:

— *Part 4: Ethernet Diagnostic Connector*

— *Part 5: Conformance test specification*

Introduction

Vehicle diagnostic communication has been developed starting with the introduction of the first legislated emissions-related diagnostics and has evolved over the years, now covering various use cases ranging from emissions-related diagnostics to vehicle manufacturer specific applications like calibration or electronic component software updates.

With the introduction of new in-vehicle network communication technologies the interface between the vehicle's electronic control units and the external test equipment has been adapted several times to address the specific characteristics of each new network communication technology requiring optimized data link layer definitions and transport protocol developments in order to make the new in-vehicle networks usable for diagnostic communication.

With increasing memory size of electronic control units and the demand to update this increasing amount of software and an increasing number of functions provided by these control units, technology of the connecting network and buses has been driven to a level of complexity and speed similar to computer networks. New applications (x-by-wire, infotainment) require high band-width and real time networks (like FlexRay, MOST) which cannot be adapted to provide the direct interface to a vehicle. This requires gateways to route and convert messages between the in-vehicle networks and the vehicle interface to external test equipment.

The intent of ISO 13400 (all parts) is to describe a standardized vehicle interface which

— separates in-vehicle network technology from the external test equipment vehicle interface requirements to allow for a long-term stable external vehicle communication interface,

— utilizes existing industry standards to define a long-term stable state-of-the-art communication standard usable for legislated diagnostic communication as well as for manufacturer-specific use cases, and

— can be easily adapted to new physical and data link layers, including wired and wireless connections using existing adaptation layers.

To achieve this, all parts of ISO 13400 are based on the Open Systems Interconnection (OSI) Basic Reference Model specified in ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. Where mapped on this model, the services specified by ISO 14229-1, ISO 14229-2 and ISO 14229-5 are divided into

a) unified diagnostic services (layer 7), specified in ISO 14229-1, ISO 14229-5 and ISO 27145-3,

b) presentation (layer 6):

   1) for enhanced diagnostics, specified by the vehicle manufacturer;

   2) for WWH-OBD (World-Wide Harmonized On-Board Diagnostics), specified in ISO 27145-2, SAE J1930-DA, SAE J1939:2011, Appendix C (SPNs), and SAE J1939-73:2010, Appendix A (FMI), SAE J1979-DA, SAE J2012-DA,

c) session layer services (layer 5), specified in ISO 14229-2,

d) transport protocol (layer 4), specified in ISO 13400-2,

e) network layer (layer 3) services, specified in ISO 13400-2, and

f) physical and data link services (layers 1 and 2), specified in ISO 13400-3,

in accordance with Table 1.

Table 1 — Enhanced and legislated WWH-OBD diagnostic specifications applicable to the OSI layers

Applicability	OSI seven layers	Vehicle manufacturer enhanced diagnostics	WWH-OBD reference
Seven layers according to ISO/IEC 7498-1 and ISO/IEC 10731	Application (layer 7)	ISO 14229-1/ISO 14229-5	ISO 14229-1/ISO 27145-3
	Presentation (layer 6)	Vehicle manufacturer specific	ISO 27145-2, SAE J1930-DA, SAE J1939:2011, Appendix C (SPNs), SAE J1939-73:2010, Appendix A (FMIs), SAE J1979-DA, SAE J2012-DA
	Session (layer 5)	ISO 14229-2	ISO 14229-2
	Transport (layer 4)	ISO 13400-2	ISO 13400-2
	Network (layer 3)		
	Data link (layer 2)	ISO 13400-3	ISO 13400-3
	Physical (layer 1)		

The application layer services covered by ISO 14229-5 have been defined in compliance with diagnostic services established in ISO 14229-1, but are not limited to use only with them.

The transport and network layer services covered by ISO 13400-2 have been defined to be independent of the physical layer implemented.

For other application areas, ISO 13400-3 can be used with any Ethernet physical layer.

Road vehicles — Diagnostic communication over Internet Protocol (DoIP) —

Part 1: General information and use case definition

IMPORTANT — The electronic file of this part of ISO 13400 contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this part of ISO 13400 using a colour printer.

1 Scope

This part of ISO 13400 describes the general use cases and communication scenarios which are covered by an Internet Protocol-based vehicle communication standard. Each use case drives specific communication capabilities of the vehicle communication interface, for instance in order to be interoperable in an existing computer network.

The diagnostic communication over Internet Protocol (DoIP) protocol supports the standardized service primitive interface as specified in ISO 14229-2.

The descriptions in this part of ISO 13400 cover different application layer implementations, such as:

— enhanced vehicle diagnostics (system diagnostics beyond legislated functionality, non-emissions-related system diagnostics);

— WWH-OBD as specified in ISO 27145-2 and ISO 27145-3.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14229-1, *Road vehicles — Unified diagnostic services (UDS) — Part 1: Specification and requirements*

ISO/IEC 7498-1, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*

ISO/IEC 10731, *Information technology — Open Systems Interconnection — Basic Reference Model — Conventions for the definition of OSI services*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14229-1 and the following apply.

3.1.1
controller area network
CAN
network with ECUs exchanging data frames

3.1.2
DoIP entity
host that implements the DoIP-protocol

NOTE A DoIP entity is either a DoIP node or a DoIP gateway.

3.1.3
DoIP gateway
host inside the vehicle which implements the DoIP-protocol and thereby provides access to itself and the ECUs of its connected vehicle subnetworks

3.1.4
DoIP node
host inside the vehicle which implements the DoIP-protocol to provide access to itself but does not route DoIP protocol data to the vehicle subnetworks

3.1.5
external programming equipment
off-vehicle device which is used to programme vehicle subsystem ECUs with changed software; a subset of external test equipment

3.1.6
external test equipment
off-vehicle device which is used to obtain information from vehicle subsystems during the act of performing manufacturing, maintenance, diagnostics and repair

3.1.7
Internet Protocol
IP
protocol for packet-switched end-to-end data communication over various transport media

3.1.8
network address translation
NAT
process of modifying network addresses in IP datagram headers while routing

3.1.9
transport control protocol
TCP
transport protocol for connection-oriented data communication via an IP network

3.1.10
user datagram protocol
UDP
transport protocol for connectionless data communication via an IP network

3.2 Abbreviated terms

CAN	controller area network
ECU	electronic control unit
FMI	failure mode indicator
IP	Internet Protocol
NAT	network address translation
OSI	Open Systems Interconnection
PC	personal computer

SAP	service access point
SPN	suspect parameter number
TCP	transmission control protocol
UDP	user datagram protocol
WLAN	wireless local area network

4 Conventions

ISO 13400 is based on the conventions discussed in the OSI Service Conventions (as specified in ISO/IEC 10731) as they apply to diagnostic services.

5 Document overview

5.1 General

All parts of ISO 13400 are applicable to vehicle diagnostic systems implemented on an IP communication network.

ISO 13400 has been established in order to define common requirements for vehicle diagnostic systems implemented on an IP communication link.

Although primarily intended for diagnostic systems, ISO 13400 has been developed to also meet requirements from other IP-based systems needing a transport protocol and network layer services.

Figure 1 illustrates the most applicable application implementations utilizing DoIP.

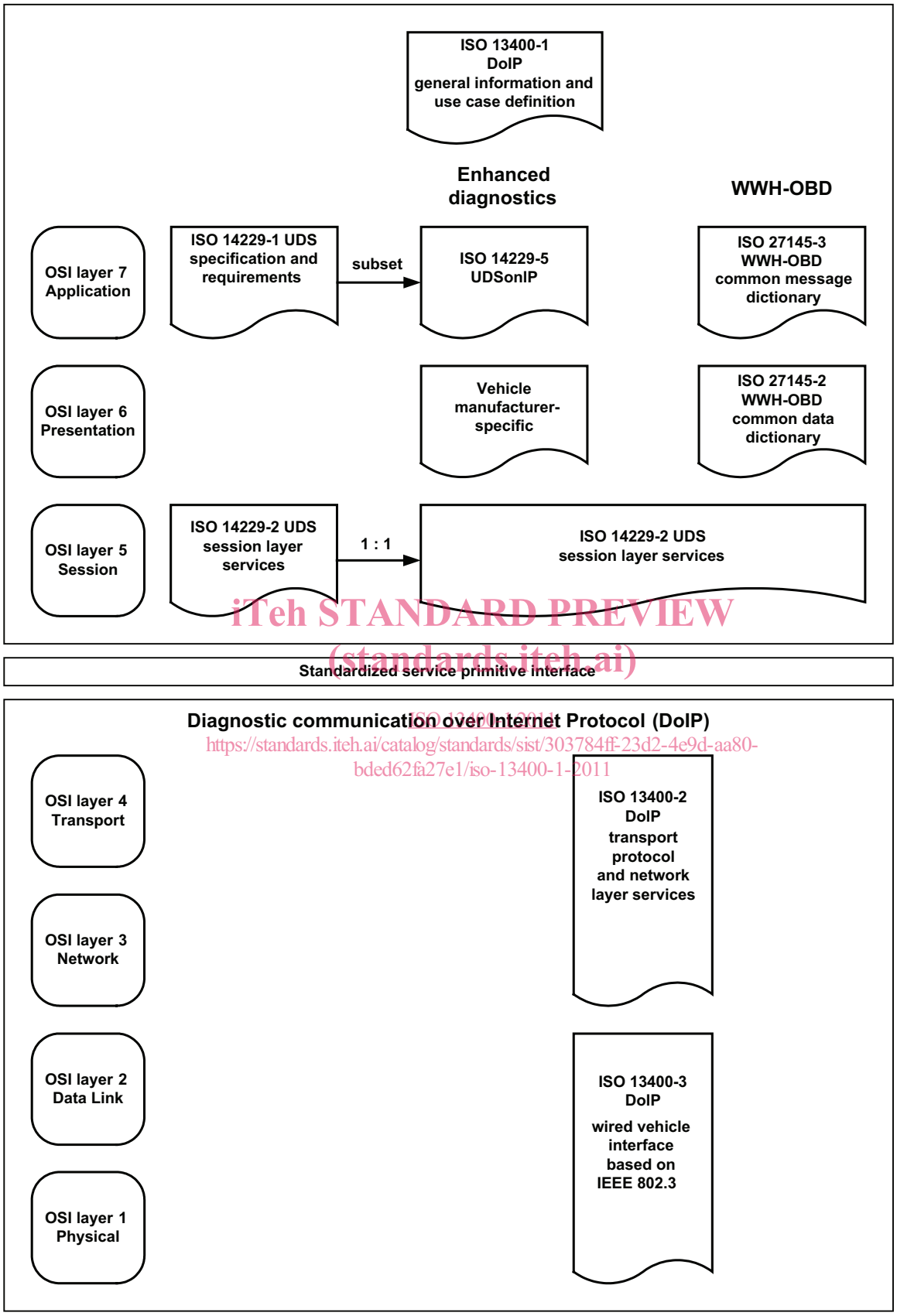

Figure 1 — DoIP document reference according to OSI model

5.2 OSI model

All parts of ISO 13400 are based on the OSI Basic Reference Model, as specified in ISO/IEC 7498-1, which structures communication systems into seven layers.

ISO 13400 is guided by the OSI service conventions, as specified in ISO/IEC 10731, to the extent that they are applicable to diagnostic services. These conventions define the interaction between the service user and the service provider through service primitives.

The aim of this subclause is to give an overview of the OSI model and show how it has been used as a guideline for this part of ISO 13400. It also shows how the OSI service conventions have been applied to ISO 13400.

The OSI model structures data communication into seven layers called (from top down) Application layer (layer 7), Presentation layer, Session layer, Transport layer, Network layer, Data Link layer and Physical layer (layer 1). A subset of these layers is used in ISO 13400.

ISO 13400 specifies the Transport layer, Network layer, Data Link layer and Physical layer for DoIP.

The purpose of each layer is to provide services to the layer above it. The application layer provides services to the diagnostic application. The active parts of each layer, implemented in software, hardware or any combination of software and hardware, are called entities. In the OSI model, communication takes place between entities of the same layer in different nodes. Such communicating entities of the same layer are called peer entities.

The services provided by one layer are available at the SAP of that layer. The layer above can use them by exchanging data parameters.

ISO 13400 distinguishes between the services provided by a layer to the layer above it and the protocol used by the layer to send a message between the peer entities of that layer. The reason for this distinction is to make the services, especially the application layer services and the transport layer services, reusable also for other types of networks than the IP, e.g. CAN. In this way, the protocol is hidden from the service user and it is possible to change the protocol if special system requirements demand it.

6 Diagnostic network architecture

6.1 Diagnostic network

The diagnostic network contains all DoIP entities as well as any external test equipment.

A diagnostic network can range from a simple point-to-point connection between external test equipment and a single DoIP entity to a complex distributed network architecture with several test equipment hosts, multiple vehicles, each with multiple DoIP entities and vehicle subnetworks connected via DoIP gateways.

6.2 Vehicle subnetwork

A vehicle subnetwork is an in-vehicle network which is not directly connected to the IP-based network.

NOTE Data to and from this vehicle subnetwork can only be sent through the connecting DoIP gateway.

6.3 Diagnostic gateway

A diagnostic gateway is a node in the network that is physically connected to two (or more) subnetworks and has the ability to transfer diagnostic messages between the subnetworks.

Connecting individual subnetworks via diagnostic gateways creates larger diagnostic network architectures.