TECHNICAL REPORT

ISO/TR 10992

First edition
2011-12-15

Intelligent transport systems — Use of nomadic and portable devices to support ITS service and multimedia provision in vehicles

Systèmes intelligents de transport — Utilisation des dispositifs nomades et portables pour la prise en charge des services ITS et des provisions multimédia dans les véhicules

Reference number
ISO/TR 10992:2011(E)

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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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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.

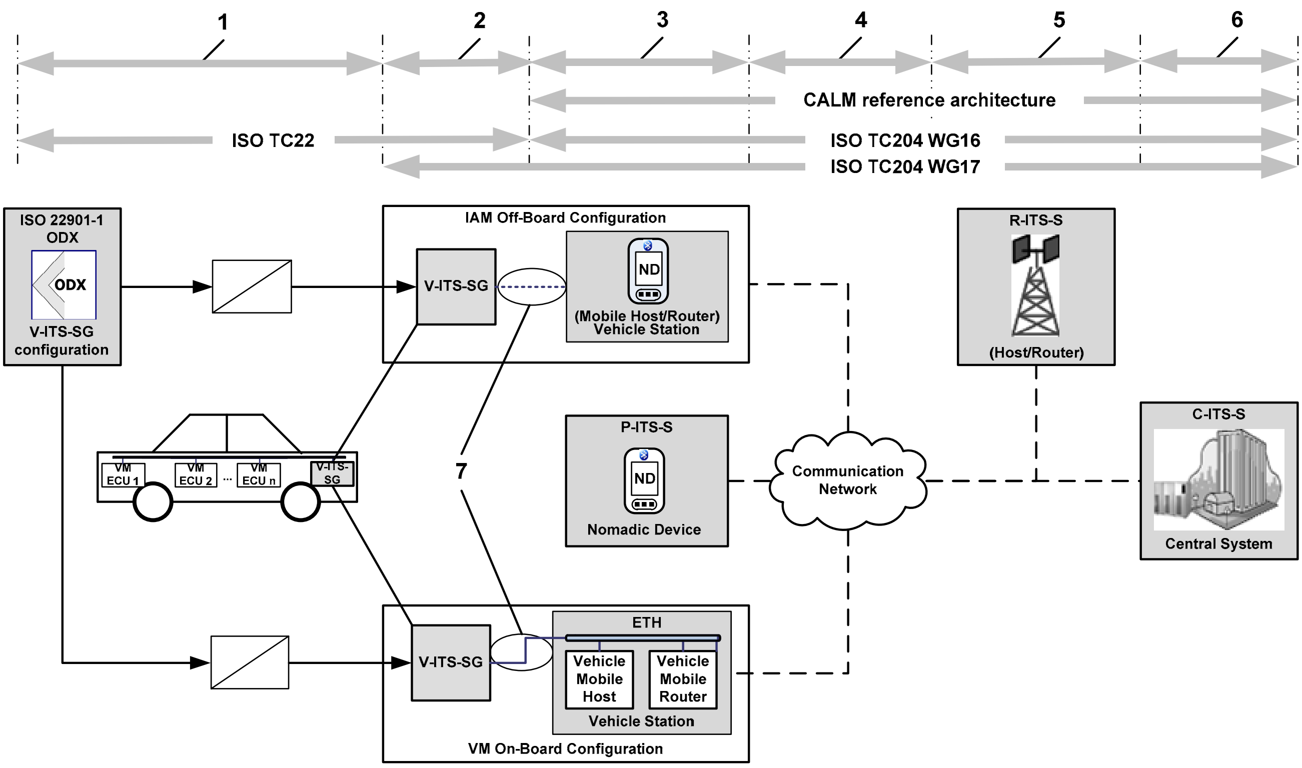
ISO/TR 10992 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Introduction

International Standards on nomadic and portable devices for intelligent transport systems (ITS) services are designed to facilitate the development, promotion and standardization of the use of nomadic and portable devices to support ITS service provisions and multimedia use such as passenger information, automotive information, driver advisory and warning systems, and entertainment system interfaces to ITS service providers and motor vehicle communication networks. This Technical Report fosters the introduction of multimedia and telematics nomadic devices in the public transport and automotive world.

These International Standards are developed for the communications architecture and generic requirements to enable the connectivity between the vehicle and the infrastructure or other vehicles by using nomadic links within the vehicle (e.g. Bluetooth) and devices introduced into the vehicle (e.g. music players, PDAs etc.) including the provision of connectivity via mobile devices (2G/3G/Mobile Wireless Broadband etc.) to the infrastructure; the support of application services within the vehicle; and integration within the CALM architecture and in vehicle gateways.

Conceptual aspects of the road vehicle to ITS technology chain are illustrated in Figure 1.



Key

1 Road vehicle technology
2 Vehicle interface technology
3 ITS host application & mobile routing technology
4 Short & wide range communication technology
5 ITS host application & mobile routing technology (Roadside-ITS-Station)
6 ITS back office technology (Central-ITS-Station)
7 Vehicle-ITS-Station Gateway protocol

Figure 1 — Road vehicle to ITS technology chain

Six different areas of competence are part of the technology chain.

- Road vehicle technology:

  This competence is provided by the vehicle manufacturers and their electronic system suppliers. They design vehicle's domain network architecture and connected ECUs. The diagnostic communication data of each ECU might be documented according to ISO 22901, the ODX standard, or traditionally in office type documents. The vehicle manufacturer is obliged to provide the ECU's diagnostic communication data in a non-discriminatory form to any interested party.

- Vehicle interface technology:

  This competence is provided by the diagnostic tool suppliers. The V-ITS-SG has a similar type of functionality compared to today's Vehicle Communication Interfaces (VCI). Many VCIs support a wireless interface to communicate with remote Human Machine Interface (HMI) devices e.g. Nomadic Devices.

- ITS Host Applications & Mobile Routing technology (Vehicle-ITS-Station):

  This competence is provided by the IT application and communication companies.

- Short and Wide Range Communication technology:

  This competence is provided by the IT communication companies.

- ITS Host Applications & Mobile Routing technology (Roadside-ITS-Station):

  This competence is provided by the IT application and communication companies.

- ITS Back Office technology (Central-ITS-Station):

  This competence is provided by the ITS service provider companies.

The vehicle interface technology connects the road vehicle technology with the ITS technology via the Vehicle Mobile Gateway (V-ITS-SG) protocol. The V-ITS-SG protocol provides a single solution access method via standardized XML vehicle data transfer services.

The V-ITS-SG provides vehicle manufacturer/V-ITS-SG supplier controlled access to vehicle data and functions. The ND (Vehicle Station) software applications have a similar functionality compared to an Internet browser.

Work on developing these International Standards includes the identification of exisiting International Standards for nomadic devices and existing vehicle communication network access International Standards.

- ISO 15031 defines emissions-related diagnostic data supported by vehicles in all countries requiring OBD compliance.

- ISO 27145 WWH-OBD defines diagnostic data (emissions-related systems, future safety related systems, etc.) to be supported by vehicles in all countries implementing the GTR (Global Technical Regulation) into their local legislation.

- ISO 22900-2 defines the Modular Vehicle Communication Interface (MVCI) D-PDU API to separate the protocol data unit (PDU) from the vehicle specific protocols.

- ISO 22901 defines the Open Diagnostic data eXchange (ODX) format which is an XML-based standard for describing diagnostic related ECU data. This International Standard is becoming the vehicle manufacturer's choice to document vehicle system diagnostic data and protocol information.

- ISO 22902 is a multimedia and telematics standard based on the AMI-C specification and reference documents for automotive industry. The important logical element of the architecture is a vehicle interface.
- ISO 22837 defines the reference architecture for probe vehicle systems and a basic data framework for probe data.
- ISO 29284 defines the standardization of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the ITS field.
- SAE J2534 defines a standardized system for programming of ECUs in a vehicle.
- SAE J2735 defines the support of interoperability among DSRC applications through the use of standardized message sets, data frames and data elements.

The work also includes identifying further standardization requirements to support the provision of specific ITS services where provisions using nomadic devices have additional or different requirements than those for inbuilt communications media.

It also includes the provision of updating information from the passenger and the vehicle via nomadic devices to external service providers, and updating the nomadic device and/or the vehicle data systems, such as map updates, etc., and ensures that nomadic devices introduced into vehicles can be used safely to support ITS and multimedia services.

Intelligent transport systems — Use of nomadic and portable devices to support ITS service and multimedia provision in vehicles

1 Scope

This Technical Report specifies the introduction of multimedia and telematics nomadic devices in the public transport and automotive world to support intelligent transport systems (ITS) service provisions and multimedia use such as passenger information, automotive information, driver advisory and warning systems, and entertainment system interfaces to ITS service providers and motor vehicle communication networks.

2 Terms, definitions, and abbreviated terms

2.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1.1
ALOHA
communication protocol developed at the University of Hawaii

NOTE Also known as ALOHAnet or the ALOHA system.

2.1.2
nomadic device
ND
device that provides communications connectivity via equipment such as cellular telephones, mobile wireless broadband (WIMAX, HC-SDMA etc.), Wi-Fi etc. and includes short range links, such as Bluetooth, Zigbee etc. to connect to the motor vehicle communications system network

2.1.3
STA
station
device that contains an IEEE 802.11 conformant medium access control (MAC) and physical layer (PHY) interface to the wireless medium (WM)

2.2 Abbreviated terms

ADSL asymmetric digital subscriber line

AMI-C Automotive Multimedia Information – Collaboration

CALM communication access for land mobile

CAN Controller Area Network

C-ITS-S central - intelligent transport systems - station

ETC electronic toll collection

DSRC dedicated short range communication

DMB digital multimedia broadcasting

D-PDU diagnostic protocol data unit

DSRC dedicated short range communication

DVB-H Digital Video Broadcasting – Handheld

ECU Electronic Control Unit

ETSI European Telecommunications Standards Institute

FCP Function Control Protocol

HC-SDMA High Capacity Spatial Division Multiple Access

IDB Intelligent Data Bus

IP Internet Protocol

IR Infra-red

ITS intelligent transport systems

ITU-R International Telecommunication Union Radio communication sector

LAN Local Area Network

L2CAP logical link control and adaptation protocol

M5 M5 Modem Remote Control Protocol

MAC media access control

MM Millimeter (Wave)

MOST Media Oriented Systems Transport

MVCI modular vehicle communication interface

ND nomadic device

OBE on-board equipment

ODX	open diagnostic data exchange
OFDMA	Orthogonal Frequency-Division Multiple Access
OSGI	Open Services Gateway Initiative
OSI	open system interconnection
PDA	Personal Digital Assistant
PDU	Protocol Data Unit
P-ITS-S	personal - intelligent transport systems - station
PHY	physical layer of the OSI model
R-ITS-S	roadside - intelligent transport systems - station
RSE	roadside equipment
RSS	Really Simple Syndication
S-DMB	Satellite – Digital Multimedia Broadcasting
SWG	sub working group
TCP	transmission control protocol
TDD	time division duplex
T-DMB	Terrestrial – Digital Multimedia Broadcasting
TICS	transport information and control system
UDP	user datagram protocol
UDS	Unified Diagnostic Services
VEG	Vehicle Expert Group
V-ITS-SG	vehicle - intelligent transport systems - station gateway
WAVE	wireless access for vehicular environment
WiBro	Wireless Broadband
WiMax	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network

3 Purpose of standardization

The main purposes for developing International Standards on nomadic devices are to

a) identify which nomadic media are suitable to support ITS Services and multimedia use,

EXAMPLE 3G, WiBro/WiMax, Mobile Multimedia Broadcasting (T-DMB, S-DMB, DVB-H, MediaFlo, ETC), CALM, DSRC, etc.

b) identify the existing International Standards for nomadic devices and existing vehicle communication network access International Standards (for example those developed by ISO TC22, AMI-C etc.),

EXAMPLE Zigbee, Bluetooth, MOST, CAN, IDB 1394, OSGI, AMI-C, Standard Items in TC22.

c) identify additional work required to develop Standards by reference, and/or to develop Standards for additional protocol requirements, and

EXAMPLE Service items and related requirements.

d) identify the further standardization requirements to support the provision of specific ITS services where provision using nomadic devices has additional or different requirements than those for inbuilt depicts the Current status of related standards.communications media.

3.1 Communication media for nomadic and mobile devices

3.1.1 General

In order to identify which nomadic media are suitable to support ITS Services and multimedia use, current status of related standards is reviewed as shown in Figure 2.

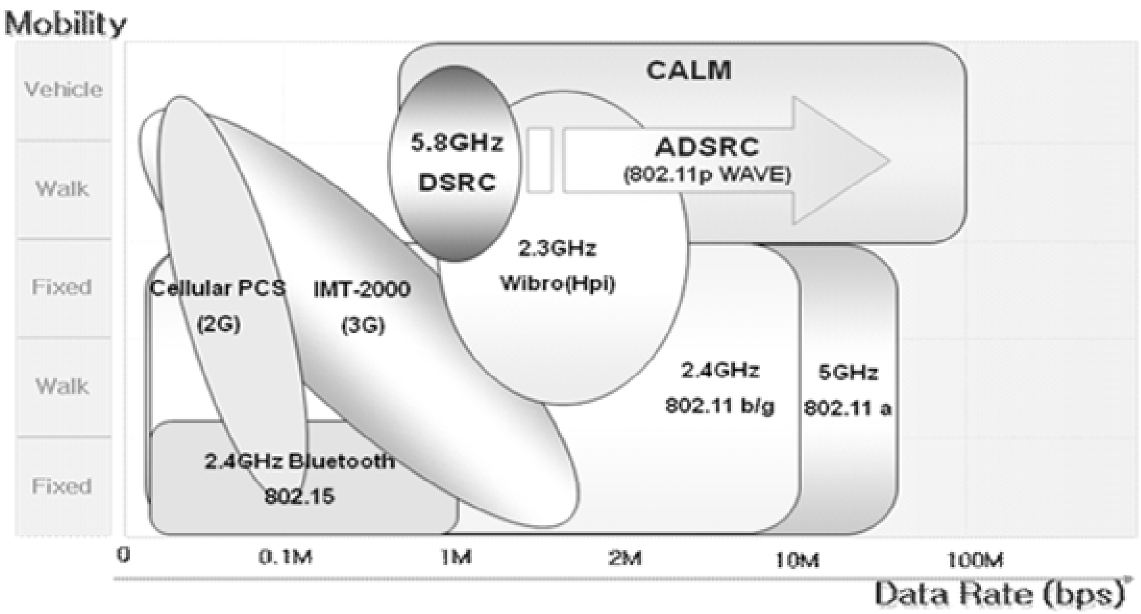


Figure 2 — Communication media

3.1.2 Dedicated short range communication (DSRC)

DSRC specifies the physical layer, data link layer and application layer of Dedicated Short Range Communication (DSRC) at 5.8 GHz for Intelligent Transport Systems (ITS) services, which is based on Open System Interconnection (OSI) reference model.

It describes the communication mechanism and procedures between Road Side Equipment (RSE) and On-Board Equipment (OBE) which pass through RSE's communication zone, providing both point-to-point interactive communication and/or point-to-multipoint communication.

The communication mode is characterized by synchronous half duplex communication. For communication initiation from OBE, adaptive slotted ALOHA access scheme is used.

It covers Transport Information and Control System (TICS) service such as Electronic Toll Collection (ETC) service.

3.1.3 IEEE 802.11p, wireless access in vehicular environment (WAVE)

WAVE introduces enhancements to IEEE 802.11 in order to support:

- Extremely short latency, measured in tens of milliseconds
- Long range, up to 1000 meters (while still supporting short ranges of a few meters)
- Very mobile devices, with speeds while operating of up to 200 km/h
- Extreme multipath, such as what is encountered by STA mounted on a car travelling on a highway alongside other cars and trucks travelling by large buildings and bridges

To provide complete interoperability at the application level requires standardization of the entire communications stack, not just of the lowest layers of the MAC and PHY as defined in IEEE 802.11. Those layers above the PHY and MAC, outside the scope of IEEE 802.11 and are mentioned here only to provide a complete description of WAVE and how 11p fits into this larger picture. While these upper layers are part of the overall WAVE architecture, there is no intent to limit 11p operation to the use of these higher layers. As intended by the OSI model, the 11p specifications may be implemented by different higher layers, such as any other uses of IEEE 802.11 that have comparable requirements for these layers.

3.1.4 Communication access for land mobile (CALM)

CALM refers to the set of International Standards being developed to support this framework.

The CALM framework supports user transparent continuous communications across various interfaces and communication media such IEEE 802.11, 802.11p, 802.15, 802.16e, 802.20, 2G/3G/4G cellular systems, national ITS systems, etc.

Two main areas are being standardized:

a) CALM (Communications Air-Interface, Long and Medium Range), and

b) Probe Data and related areas.

Here are the list of the sub working groups and the fields they are working on:

- SWG 16.0 Architecture;
- SWG 16.1 Media;
- SWG 16.2 Networking;

- SWG 16.3 Probe Data;
- SWG 16.4 Application Management;
- SWG 16.5 Emergency Notifications;
- SWG 16.6 CALM ad-hoc subsystem.

The scope of CALM is to provide a standardized set of air interface protocols and parameters for medium and long range, high speed ITS communication using one or more of several media, with multipoint and networking protocols within each media, and upper layer protocols to enable transfer between media.

This service includes the following communication modes:

- Vehicle-Infrastructure: Multipoint communication parameters are automatically negotiated, and subsequent communication may be initiated by either roadside or vehicle.
- Infrastructure-Infrastructure: The communication system may also be used to link fixed points where traditional cabling is undesirable.
- Vehicle-Vehicle: A low latency peer-peer network with the capability to carry safety related data such as collision avoidance, and other vehicle-vehicle services such as ad-hoc networks linking multiple vehicles.

Table 1 defines the communication media and scope.

Table 1 — Communication media and scope

Medium	M5	IR	MM
Scope	— 5 ~ 6 GHz Microwave — support 3-27 Mbps — 6-54 Mbps — range 300 -1000m — support latencies and communication delays in the order of milliseconds	— 800 ~ 900 nm infrared — support 1-128 Mbps — range 300 – 1000 m — support latencies and communication delays in the order of milliseconds	— use 60-70 GHz Millimeter Wave — support latencies and communication delays in the order of milliseconds — support Multi-Subcarrier operations (DMB, DSRC, SDR, etc.
Current Issue	— cooperation with IEEE, ASTM and ETSI — adaptation of PHY/MAC in IEEE 802.11p WAVE	— cooperation with IRDA — FDIS Ballot Approval	— surveying the status of MM wave technology in Europe — reviewing international spectrum standardization — ETSI, ITU-R, etc.

3.1.5 WiBro and WiMax

WiBro (Wireless Broadband) is a wireless broadband Internet technology being developed by the South Korean telecoms industry. WiBro is the South Korean service name for IEEE 802.16e (mobile WiMAX) international standard.

WiBro adapts TDD for duplexing, OFDMA for multiple access and 8.75 MHz as a channel bandwidth. WiBro was devised to overcome the data rate limitation of mobile phones (for example ADSL or Wireless LAN).

WiBro base stations will offer an aggregate data throughput of 30 to 50 Mbit/s and cover a radius of 1-5 km allowing for the use of portable internet usage. In detail, it will provide mobility for moving devices up to 120 km/h (74.5 miles/h) compared to Wireless LAN having mobility up to walking speed and mobile phone having mobility up to 250 km/h.

WiMAX is a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to wired broadband like cable and DSL. WiMAX provides fixed, nomadic, portable and, soon, mobile wireless broadband connectivity without the need for direct line-of-sight with a base station. In a typical cell radius deployment of three to ten kilometers, WiMAX Forum Certified™ systems can be expected to deliver capacity of up to 40 Mbps per channel, for fixed and portable access applications.

This is enough bandwidth to simultaneously support hundreds of businesses with T-1 speed connectivity and thousands of residences with DSL speed connectivity. Mobile network deployments are expected to provide up to 15 Mbps of capacity within a typical cell radius deployment of up to three kilometers. It is expected that WiMAX technology will be incorporated in notebook computers and PDAs by 2007, allowing for urban areas and cities to become “metro zones” for portable outdoor broadband wireless access.

3.1.6 Digital Multimedia Broadcasting (DMB)

Digital multimedia broadcasting (DMB) is a method of multicasting multimedia content to mobile and portable devices, such as cell phones, by satellite or terrestrial services, or a combination of the two. Some DMB-capable receiving devices can render content that is individualized to the location or subscriber.

Common examples of multimedia broadcast content include

— text and audio,

— text, audio, and still or animated graphics,

— audio and full-motion video,

— text, audio, and full-motion video, and

— multiple, concurrent display areas, images, or programs.

The most popular application of DMB is mobile television. Movies, video clips, music, RSS feeds, and text messages can also be transmitted. Most existing and proposed DMB services operate on a fee-based subscription basis, although advertising has been suggested as a revenue source. A free state-operated DMB service is available in South Korea.

3.1.7 Cellular (3G)

3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide-area wireless voice telephony and broadband wireless data, all in a mobile environment. Typically, they provide service at 5-10 Mb per second.

Unlike IEEE 802.11 networks, 3G networks are wide area cellular telephone networks which evolved to incorporate high-speed internet access and video telephony. IEEE 802.11 (common names Wi-Fi or WLAN) networks are short range, high-bandwidth networks primarily developed for data.

3.1.8 Wi-Fi (IEEE 802.11)

A wireless network uses radio waves, just like cell phones, televisions and radios do. In fact, communication across a wireless network is a lot like two-way radio communication. Here's what happens:

- A computer's wireless adapter translates data into a radio signal and transmits it using an antenna.

- A wireless router receives the signal and decodes it. It sends the information to the Internet using a physical, wired Ethernet connection.

The process also works in reverse, with the router receiving information from the Internet, translating it into a radio signal and sending it to the computer's wireless adapter.

The radios used for Wi-Fi communication are very similar to the radios used for walkie-talkies, cell phones and other devices. They can transmit and receive radio waves, and they can convert 1s and 0s into radio waves and convert the radio waves back into 1s and 0s. But Wi-Fi radios have a few notable differences from other radios:

- They transmit at frequencies of 2.4 GHz or 5 GHz. This frequency is considerably higher than the frequencies used for cell phones, walkie-talkies and televisions. The higher frequency allows the signal to carry more data.

- They use IEEE 802.11 networking standards, which come in several flavours:

  - **IEEE 802.11a** transmits at 5 GHz and can move up to 54 megabits of data per second. It also uses orthogonal frequency-division multiplexing (OFDM), a more efficient coding technique that splits the radio signals into several sub-signals before they reach a receiver.

  - **IEEE 802.11b** is the slowest and least expensive standard. For a while, its cost made it popular, but now it's becoming less common as faster standards become less expensive. 802.11b transmits in the 2.4 GHz frequency band of the radio spectrum. It can handle up to 11 megabits of data per second, and it uses complimentary code keying (CCK) coding.

  - **IEEE 802.11g** transmits at 2.4 GHz like 802.11b, but it's a lot faster -- it can handle up to 54 megabits of data per second. 802.11g is faster because it uses the same OFDM coding as 802.11a.

  - **IEEE 802.11n** is the standard that significantly improves speed and range for being widely available. For instance, although 802.11g theoretically moves 54 megabits of data per second, it only achieves real-world speeds of about 24 megabits of data per second because of network congestion. 802.11n, however, reportedly can achieve speeds as high as 140 megabits per second.

  - **IEEE 802.11p** <u>is the newest standard</u> that provides the set of specifications required to ensure interoperability between wireless devices attempting to communicate in potentially rapidly changing in communications environments and in situations where transactions must be completed in time frames much shorter than the minimum possible with infrastructure or ad hoc IEEE 801.11 networks.

Table 2 provides an overview of communication technology and frequency.

Table 2 — Overview of communication technology and frequency

Type	cellular	DMB	WiBro	Wi-Fi	DSRC	WAVE
FrequencyGHz)	0.8-1.7	0.2/2.6	2.3	2.4/5.8	5.8	5.9
Radio Range(Km)	20	100	3	0.1	0.1	1
Transmit speed(Mbps)	0.3	0.1	1	0.3-54	1	2-54
Mobility (Km/H)	5	60	60	-	160	200
Access time unit	S	-	S	s	ms	ms
Duplex	Full duplex	Half duplex	Full duplex	Full duplex	Full duplex	Full duplex

3.2 Vehicle communication network for nomadic & mobile devices

3.2.1 ISO/TC22/SC3/WG1 data communication

3.2.1.1 Overview

ISO TC22/SC3/WG1 is responsible for studies relating to data communication including diagnostic communication, data transmission between road vehicles and off-board diagnostic devices and related data management issues (e.g., definitions, security, and open interface for embedded software). WG1 works on the items as described in 3.2.1.2 - 3.2.1.4.

3.2.1.2 ISO 22900 MVCI (Modular Vehicle Communication Interface)

The ISO 22900 MVCI is proposed to specify a standardized hardware device and generic software interface adapting a “plug and play” concept to access OEM proprietary in-vehicle network from after-market applications. This International Standard consists of three parts as follows.

— Part 1: Hardware design requirements

— Part 2: D-PDU API (Diagnostic Protocol Data Unit Application Programmers Interface)

— Part 3: D-Server API (Diagnostic Server Application Programmers Interface)

Part 1 specifies design requirements including hardware configuration, protocol module usage and protocol module interface/API according to three different levels of conformance levels such as software compliance, electrical compliance and mechanical compliance. Basically, vehicle communication protocol applied to MVCI will be selected by tool suppliers and has close relationship with D-PDU and Server API defined in Part 2 ~3. The part 1 suggests the data link connector and pin assignment based on the industry standard, 26-pin and HD (High Density D-Sub) connector (cf. OBD II connector is defined as 16 pins).

Part 2 specifies the protocol independent API used as a VCI software interface for diagnostic and ECU reprogramming software applications. The D-PDU API provides a standardized set of API function calls to enable a host system controlling bidirectional communication of the Modular VCI with the vehicle's electronic systems. The document covers the description of the API functions, the principles of VCI communication, as well as functional mapping of D-PDU with existing standards such as SAE J2534-1 and RP1210a. The description of the API functions defines type, behaviour, parameters, return values, data structures and message structures exchanged between sender and receiver.

Part 3 was proposed to specify the diagnostic server API. The D-Server API converts diagnostic response messages retrieved from the MVCI Protocol Module back to symbolic information and provides it to the application.

3.2.1.3 ISO 14229 UDS (Unified Diagnostic Services)

The ISO 14229 UDS is developed to specify the data link independent application layer protocol used for diagnostic services. Diagnostic functions such as an electronic fuel injection, automatic gear box, anti-lock braking system, etc. embedded in an on-vehicle ECUs are controlled by the diagnostic tester(client) using UDS. ISO 14229-1 specifies generic requirements and services needed to transmit diagnostic message. Part 1 was released in 2005 and specified the following items.

- Application Layer Services (6 Primitives are defined for each diagnostic service)
- Application Layer Protocol (PDU format, Control Information, Implementation rules)
- Service description (Request, Positive Response, Negative Response)
- Functional Units (Diagnostic and Communication Management, Data Transmission, Stored Data Transmission, Input-output control, Remote Activation of Routine)

Based on ISO 14229, the common diagnostic services defined in Part 1 can be applied to telematics services and vehicle safety applications by using a number of remote functions.

The following is an overview of different parts of ISO 14229 UDS:

- Part 2: Session layer services
- Part 3: Unified diagnostic services on CAN implementation (UDSonCAN)
- Part 4: Unified diagnostic services on FlexRay implementation (UDSonFR)
- Part 5: Unified diagnostic services on Internet Protocol implementation (UDSonIP)
- Part 6: Unified diagnostic services on K-Line implementation (UDSonK-Line)

3.2.1.4 ISO 22902

ISO 22902 is an International Standard developed to specify common in-vehicle communication architecture for mobile information and entertainment systems. It consists of seven parts, as follows:

- Part 1: General technical overview
- Part 2: Use cases
- Part 3: System requirements
- Part 4: Network protocol requirements for vehicle interface access
- Part 5: Common message set
- Part 6: Vehicle interface requirements
- Part 7: Physical specification

ISO 22902-1 explains the AMI-C system from the structural, functional, and application point of views. From a structural point of view, the AMI-C architecture consists of three main components: vehicle interface, network, and host.

The vehicle interface, a mandatory component of the AMI-C system, acts as a bridge between manufacturer-specific parts and non-specific parts of a vehicle. A vehicle contains one or more vehicle interfaces. They provide a standardized common interface to information and service of manufacturer's specific parts so that no component and application has to communicate with manufacturer-specific ECUs or devices directly. The common interface is realized with three main mechanisms: Request, Command, and Subscription. ISO 22902-6 defines the vehicle service interface as the logical collection of vehicle services implemented by all vehicle interfaces in the vehicle.

The vehicle service interface is categorized into four groups: vehicle services, power management services, Human-Machine Interface (HMI) services, and audio services. Vehicle services must be implemented in the vehicle interfaces and provide the functions to control vehicle operations such as door locking/unlocking, data related to the vehicle itself such as diagnostic information, or a system signal indicating vehicle status such as vehicle speed or fuel level. Power management services control the power states of the multimedia system and orderly startup and shutdown of system components. They also must be implemented in a vehicle interface. HMI services provide a standard interface to displays and/or audible interfaces intended for occupants of the vehicle. Audio services provide a method for devices to access audio resources.

The network is a set of manufacturer-proprietary networks and non-proprietary networks including Bluetooth and IEEE 1394 automotive. Each network consists of a set of components connected to the network and a protocol that provides a set of common interfaces for accessing vehicle devices and their function through the vehicle interface. ISO 22902-4 describes the network protocol requirement for vehicle interface access and ISO 22902-5 describes a set of common application layer messages, called Common Message Set (CMS), exchanged by the network components across the various networks. ISO 22902-4 defines a common communication model to access a vehicle interface over a variety of network transport protocols including TCP(UDP)/IP, FCP over 1394 automotive, and L2CAP over Bluetooth. In this model, the vehicle interface is considered as a kind of AMI-C network component and each network component contains a Vehicle Interface Protocol (VIP), a common access protocol to the vehicle interface independent of the transport layer technologies.

A network component has one or more functional modules that perform the main function of the component. This specification describes the addressing scheme of functional modules and the frame format of the messages exchanged by functional modules, which are used for initialization, address resolution, and service discovery of the functional modules. Whereas the network protocol requirements deal with the support of access to vehicle services, the CMS contains general and semantic requirements for audio and visual messages, phone messages, HMI messages, etc. as well as vehicle services. According to ISO 22902-5, CMS can be classified into six types of messages: Inquire, Report, Set, Confirm, Command, and Warning. The message classes are defined as follows:

- Management – network device and audio/video stream management, and service discovery
- Core – information that is originally inherent in a vehicle
- Body Module – control and status related with body module
- Powertrain – status related with powertrain
- Vehicle Diagnostics – message for vehicle diagnostics
- Amplifier – control related with amplifier and codec
- General Player – common functions for disk and tape player
- Disk Media – audio/video player for disk media
- Tape Media – audio/video player for tape media
- Tuner – audio/video broadcast tuner
- General Phone – basic phone functionality

— Advanced Phone – advanced phone functionality

— Text Display – command to display simple texts and input texts

The host provides a common software execution environment based on the capability of Java, which enables generic application software to operate on any platform of the vehicle. This software execution environment includes OSGi framework which run on the Java runtime environment.

From a functional point of view, the AMI-C provides primary functions categorized into four types: service discovery, security, system management, and HMI. The service discovery function provides a mechanism to query for particular services and determine service information or other characteristics. The security function provides a mechanism to authenticate and authorize devices and applications and encrypt data exchanged among them. The system management is used for controlling the network components. The HMI function defines the interface between the vehicle user interface devices and the host applications based on XML.

From an application point of view, the AMI-C architecture identifies the relationship between the use cases and the applications that meet the requirements implicit in the use cases. ISO 22902-2 describes the use cases in categories of commerce (abbreviated as COMM), customer relationship management (CUST), emergency (EMER), entertainment (ENTE), fleet management (FLEE), guidance (GUID), home automation (HOME), information (INFO), messaging (MESS), mobile devices (MOBI), customer preferences (PREF), productivity (PROD), security (SECU), service and maintenance (SERV), user interface (USER), safety (SAFE), Bluetooth (BLUE), intelligent transportation systems (ITS) and combination use cases (COMB). In each use case, several information indicating required devises, required services, prior conditions, flow of events, actors, and so on, are described.

In addition to the elements of the AMI-C architecture mentioned above, ISO 22902-3 describes the general and architectural requirements of the AMI-C system and ISO 22902-7 specifies environmental conditions and tests to be applied to AMI-C compliant electrical and electronic equipment and some subcomponents directly mounted in or on the vehicle.

3.2.2 OSGi VEG Vehicle Interface

The OSGi Alliance is an independent non-profit corporation comprised of technology innovators and developers and focused on the interoperability of applications and services based on its component integration platform. OSGi technology is the dynamic module system for Java and Universal Middleware.

In OSGi, five expert groups were approved such as Core Platform Expert Group, Vehicle Expert Group, Mobile Expert Group, subject to sufficient participatory interest within the membership and an acceptable charter. Among these experts group, Vehicle Expert Group has focused on automotive, transport and telematics related issues.

Working items selected by Vehicle Expert Group based on the automotive industry's input are as follows.

— Vehicle API

— Navigation API

— Communication Manager

— Integration with AUTOSAR

— Persistence

— HMI

Vehicle API defines a vehicle interface to provide an application to access (query and/or write data) vehicle related status information such as VIN, vehicle speed, etc. Several issues were raised by car manufacturers because currently the information is secret and guarded. Car manufacturers require the function of security and authorization when they develop the standard. The Vehicle Expert Group expects the vehicle information can be accessed in a controlled environment to protect car manufacturer specific in-vehicle network design concept.

Navigation API defines an API for location based services, POI, positioning, routing, guidance, map handling (update/extend the map), traffic information.

Communication Manager enables application to choose a communication link. The communication manager should manage the communication for applications depending on what is available (e.g. DSRC, GSM) or specific bandwidth is required. Applications do not have to be aware of the intricacies of protocol stacks and mobile session management.

Integration with AUTOSAR deals with the method how to communicate between an AUTOSAR defined system and OSGi based applications. The group wants to examine whether the OSGi interface can interact with AUTOSAR tools.

Persistence is a simple embedded database or interface to a database. This item defines the standardized mechanisms to store data and the standardized ways to synchronize data with backend systems.

HMI is considered to provide a way for applications to interact with the end user using an HMI present in the vehicle. Applications should be able to integrate seamlessly with the existing HMI, which might mean using controls that are not on display.

All working items are currently under development in OSGi VEG.

4 Nomadic and portable devices for ITS services

4.1 General

Nomadic devices are the devices that provide communications connectivity via equipment such as cellular telephones, mobile wireless broadband (WIMAX, HC-SDMA etc.), WiFi etc. and include short range links, such as Bluetooth, Zigbee etc. to connect nomadic devices to the motor vehicle communications system network.

4.2 Service items

To develop International Standards for the communications architecture and generic protocols to provide and maintain ITS services to travellers including drivers, passengers, bicyclers, pedestrians, and service providers using the following nomadic and portable devices:

- Device Discovery in the CALM in-vehicle environment
- Service Discovery in the CALM in-vehicle environment
- The mobile device in the role as mobile router
- The definition of single access method to vehicle data elements to support the ITS Services
- Augmentation of the capabilities of the nomadic device using information from in-vehicle systems
- Nomadic device acting as a key to personalise the vehicle configuration
- Using capabilities in a nomadic or mobile device to augment functionality within the vehicle
- The use of portable nomadic devices within commercial vehicles and public transport
- Optimising the use of the capabilities in nomadic and mobile devices in the provision of ITS services

4.3 Standardization requirements

4.3.1 General

This subclause identifies further standardization requirements to support the provision of specific ITS services where provision using nomadic devices has additional or different requirements than those for inbuilt communications media.

4.3.2 Communication requirements on nomadic devices

The nomadic devices may exchange a wide variety of information as described below, which could be collected within the vehicles or infrastructure and could be used by either vehicle or infrastructure based systems.

- Communication channel and Frequency
- Transmit power management
- Radio Range: 1 Km
- Transmit speed: 10 Mbps
- Mobility: 100 km/h
- Continuous, Seamless (Service, Media, Place)
- IME interface Manager (media manager)
- Support of short Message transmit protocol
- Plug-and-play networking
- Network Manager (IPv4/6 manager, routing manager, media switch)
- Location information service
- Support of V2V and V2I
- Support of multi-hop in ad-hoc mode
- Support of broadcast, multicast and unicast
- Access of heterogeneous media: Select media according to application, channel routing
- Access internet: support of IPv6 and non-IP
- System power management

4.3.3 Information requirements on nomadic devices

The nomadic devices may exchange a wide variety of information as described below, which could be collected within the vehicles or infrastructure and could be used by either vehicle or infrastructure based systems.

a) Roadway & Traffic Conditions

b) Vehicle Conditions

c) Environmental Conditions

d) Public Transport Conditions

e) Interconnectivity and/or Transfer Center Conditions

Current sensors in the vehicle, plus information from the navigation system, plus good real-time traffic information, possibly plus some probe data can provide a pretty good idea of how demanding the current driving environment is.

For example:

— Is traffic heavy?

— Is a complicated turning maneuver about to start?

— How is visibility?

— How many other passengers are in the car?

— What on-board devices (radio, CD player, navigation system) are currently in use?

— What nomadic devices (mobile phone, MP3 player, etc.) are currently being used in the vehicle?

— How alert and how capable is the driver?

It should be possible to rank the level of demand on (for example) a scale of 1-10, and to make the current level of demand known to nomadic devices.

There could be rules associated with various kinds of nomadic devices that say: If the demand level is above a certain threshold, then some or all of the nomadic device's functionality should be suppressed. For example, in a high demand situation mobile phone calls might automatically be put on hold until the demand got lower. Both the driver and the person on the other end of the call might hear a message that says "Call temporarily put on hold due to complex driving situation – Please wait").

Then the International Standards would

a) characterize the level of demand on the driver, based on the current driving situation and the driver's personal situation,

b) characterize the demands that a particular kind of device makes on the driver; if a device has many different functions, each function and combination of functions might have a different level, and

c) prescribe how the nomadic device should respond to various levels of driver demand.

The messages shown in the following examples would be included in describing the interfaces not only between vehicle and nomadic device but also between nomadic device and infrastructure.

Table 3 defines the message update interval and urgency.

Table 3 — Message update interval and urgency

Class	Update Interval	Urgency
A	< 100 ms	Emergency – ASAP
B	100 ms – 1 s	High Priority, Safety Critical
C	1 – 10 s	Priority, Safety-Influencing
D	> 10 s	Background update information

Table 4 defines the message length (including headers, error checks).

Table 4 — Message length (including headers, error checks)

Category	Length	Description
I	< 10 bytes	Single data element
II	10 – 100 bytes	Simple real-time condition update
III	100 – 1000 bytes	Extended real-time condition update
IV	> 1000 bytes	Background data update

Table 5 defines the message addressing.

Table 5 — Message addressing

Type	Source and Recipient	Addressing
1	V2V	Broadcast
2	V2V	Addressed to specific recipient(s)
3	I2V	Broadcast
4	I2V	Addressed to specific recipient(s)
5	V2I	Broadcast

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1) Under preparation.

ICS 35.240.60; 43.040.15
Price based on 17 pages