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Intelligent transport systems — Mobility integration — Role model of ITS service application in smart cities

Systèmes de transport intelligents - Intégration de la mobilité - Schéma d'application des services ITS

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Currently, more than 70 % of the world's people live in cities. The proportion of people living in cities is rising around the world as civilisations develop and congregate around cities where there are more employment opportunities. Societies develop more innovatively and rapidly in cities, and they present better entertainment opportunities, adding to their attraction. *The Economist* magazine recently forecast that by 2045, an extra 2 billion people will live in urban areas[16]. The resulting concentration of population creates various issues such as road congestion due to an increase in vehicle population and environmental pollution due to exhaust gas and tyre erosion. These issues have been attributed to increases in the number of delivery trucks, taxis and town centre traffic and are further exacerbated by obstacles to the effective use of urban space due to the private ownership of cars (parking lots, street parking).

The pressures caused by scientific advice that significant action and change of behaviour is needed to ameliorate the adverse effects of climate change require a more environmentally friendly use of the transport system.

It is recognized that there is also road infrastructure deterioration, a lack of provision of information on the use of public transportation, driver shortages due to the increase in the number of elderly people and the inconvenience of multimodal fare payments, and action to improve the situation is urgently needed.

The International Data Corporation forecasts that of the USD 81 billion that will be spent on smart city technology in 2020, nearly a quarter will go into fixed visual surveillance, smart outdoor lighting and advanced public transit[17].

Eventually, this is likely to mean high speed trains and driverless cars. Consultancy McKinsey forecasts that up to 15 % of passenger vehicles sold globally in 2030 will be fully automated, while revenues in the automotive sector could nearly double to USD 6,7 trillion thanks to shared mobility (car-sharing, e-hailing) and data connectivity services (including apps and car software upgrades)[18].

Changing consumer tastes are also calling for new types of infrastructure. Today's city dwellers, for example, increasingly shop online and expect ever faster delivery times. To meet their needs, modern urban areas need the support of last-minute distribution centres, backed by out-of-town warehouses.

Therefore, in recent years, in Europe, studies on the development of mobility integration standards have been active to solve urban problems. There are various movements around the world making efforts to address these issues. In the United States, ITS technology is used to try to solve these urban problems, as in the Smart City Pilot Project. Columbus, Ohio has been selected as a smart city pilot project which is currently being designed in detail. Important key factors here are the core architectural elements of smart cities, and urban ITS sharing of probe data (also called sensor data), connected cars and automated driving. In addition, new issues have been recognized with the introduction of the connected car to the real world in respect of privacy protection, the need to strengthen security measures, big data collection and processing measures, which are becoming important considerations.

In terms of the effective use of urban space, it is hoped that the introduction of connected cars and automated driving can significantly reduce the requirements for urban parking lots (redistribution of road space). If technology can eliminate congestion, the city road area usage can also be minimized and reallocated (space utilization improvement) to improve the living environment of, and quality of life in, the city. In addition, the environment around the road will be improved by improving enforcement (e.g. overloaded vehicles). On the other hand, even in rural areas, it is possible to introduce automated driving robot taxis and other shared mobility that saves labour (and is therefore more affordable) and improves the mobility of elderly people.

To achieve this requires the realization of various issues, for example:

— cooperation with harmonization of de-jure standards such as ISO and industry de facto standards;

— recognition of the significance of international standardization (e.g. to reduce implementation costs);

— recognition of the significance of harmonization activities by countries around the world;

— cooperation and contribution between ISO/TC 22 for in-vehicle systems and ISO/TC 204 for ITS technology.

As mentioned above, automated driving mobility is expected to play an important role both in cities and in rural areas. The main effects are, as described above, the reduction of traffic accidents, reduction of environmental burden, elimination of traffic congestion, realization of effective use of urban space, etc.

ITS technology is an important element for realizing smart cities, and it is important to clearly understand the role model of ITS service applications when developing standards to achieve these objectives.

This document gives an important overview of the options for this objective. Considering the emerging direction of mobility electrification, automated driving and the direction of an environmentally friendly society, incorporating other urban data such as traffic management into the city management will improve the mobility of urban society. It is important to consider the creation of a common open role model for smart city data platforms (such as the ISO 15638 series service framework). Similar platforms will be necessary for the realization of the future mobility such as automated driving and electrification of vehicles. A common role model will be developed for all modes of vehicle, including public transport, general passenger vehicles and heavy vehicles. The incorporation of electronic regulation is especially important for automated vehicles and it is essential to incorporate it as a core element of urban ITS.

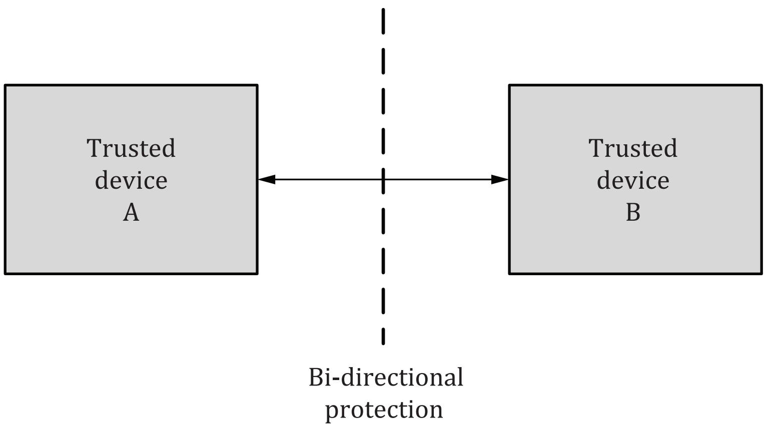
This document describes how ITS data can be presented, interchanged and used by smart cities. This document does not describe smart city use cases for ITS data in any detail nor does it describe in detail any specific ITS use cases. It is focused on the generic role model for data exchange between ITS and smart cities.

The necessary security and data exchange protocols have now been finalized to provide a secure ITS interface, with the approval of ISO/TS 21177[5], i.e. exchange information with bi-directional protection.

The trust relation between two devices is illustrated in Figure 1.

The relation enables two devices to cooperate in a trusted way, i.e. to exchange information in secure application sessions, and thus only access data or request data that they have the appropriate credentials to access.

This document provides the framework within which these transactions can be undertaken.



NOTE Source: ISO/TS 21177:2019[5], Figure 1.

Figure 1 — Interconnection of trusted devices

Intelligent transport systems — Mobility integration — Role model of ITS service application in smart cities

1 Scope

This document describes a basic role model of smart city intelligent transport systems (ITS) service applications as a common platform for smart city instantiation, directly communicating via secure ITS interfaces. It provides a paradigm describing:

a) a framework for the provision of a cooperative ITS service application;

b) a description of the concept of operations, regulatory aspects and options, and the role models;

c) a conceptual architecture between actors involved in the provision/receipt of ITS service applications;

d) references for the key documents on which the architecture is based;

e) a taxonomy of the organization of generic procedures.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/TS 14812,[1] *Intelligent transport systems — Vocabulary*

ISO 15638-1, *Intelligent transport systems — Framework for collaborative Telematics Applications for Regulated commercial freight Vehicles (TARV) — Part 1: Framework and architecture*

ISO 15638-3, *Intelligent transport systems — Framework for collaborative telematics applications for regulated commercial freight vehicles (TARV) — Part 3: Operating requirements, 'Approval Authority' procedures, and enforcement provisions for the providers of regulated services*

ISO/TS 15638-4, *Intelligent transport systems — Framework for cooperative telematics applications for regulated commercial freight vehicles (TARV) — Part 4: System security requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 14812, ISO 15638-1, ISO 15638-3 and ISO/TS 15638-4 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

1) Under preparation. Stage at the time of publication: ISO/DTS 14812:2020.

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

API	application programming interface
app	application programme
APDU	application protocol data unit
ASD	alcohol screening device
CA	certificate authority
CAN	controller area network
CCAM	cooperative, connected and automated mobility
C-ITS	cooperative intelligent transport system
CONOPS	concept of operations
ECU	engine control unit
ExVe	extended vehicle (see the ISO 20078 series[4])
GNSS	global navigation satellite system
ITS	intelligent transport system
ITS-S	intelligent transport system station
ITS-SCU	intelligent transport system station communication unit
ITS-SU	intelligent transport system station unit
MaaS	mobility as a service
OBE	on-board equipment
OEM	original equipment manufacturer
PKC	public key certificate
PKI	public key infrastructure
RA	registration authority
RAM	random access memory
RSE	road-side equipment
RV	road vehicle
RVU	road vehicle user
Rx	receive
SAPDU	service access point data unit
SCMS	security credential management system

SSP	secure service provider
TARV	telematics applications for ITS service applications
Tx	transmit
TLS	transport layer security
UML	Unified Modelling Language (see ISO/IEC 19501[3])
V2I	vehicle-to-infrastructure (communication)
V2V	vehicle-to-vehicle (communication)
VRU	vulnerable road user

5 General overview and framework

5.1 Objective

This clause describes a generic framework for the provision of cooperative telematics application services for ITS service applications.

Clause 6 provides the general CONOPS for which this architecture is designed. Clause 7 provides a framework, role definition and summary of the architecture at a conceptual level. Clause 8 describes the communications architecture.

5.2 National variations

The instantiation of interoperable on-board platforms for ITS service applications with common features is expected to vary from country to country, as will the provision of regulated, or supported, services.

5.3 Mandatory, optional and cooperative issues

5.3.1 This document does not impose any requirements on nations in respect of which services for ITS service applications countries will require, or which they will support as an option, but provides a generic common framework architecture within which countries can achieve their own objectives in respect of application services for ITS-supported service applications in cities, and provide standardized sets of requirements descriptions for the exchange of data to enable consistent and cost-efficient implementations where instantiated.

5.3.2 Cooperative ITS application, in this context, is the use of a common platform to meet both regulated and commercial service provision, providing collaboration between transport systems and smart cities.

5.4 Specification of service provision

Cooperative ITS applications for ITS service applications (both commercial services and regulated services) are specified in terms of the service provision, and not in terms of the hardware and software.

5.5 Architecture options

Architecturally, it needs to be possible for a vehicle user/OBE to use the services of different application services. The in-vehicle system is a vehicle original equipment specification option, inbuilt at the time of manufacture of the vehicle, with service provider selection being a subsequent service-user choice (e.g. like selecting an internet service provider) or is aftermarket equipment that has access rights to the required data. An ITS application service is based in the infrastructure. Other options are possible and can be supported within the conceptual architecture. The objective of this role model is the accessibility of the use of ITS data generated in ITS application services in smart city application services.

6 Concept of operations

6.1 General

This clause describes the characteristics of a proposed system from the viewpoint of an individual who uses that system. Its objective is to communicate the quantitative and qualitative system characteristics to all stakeholders.

This document describes the roles and responsibilities of the classes and actors involved in the provision of ITS services for ITS service applications using a secure vehicle interface.

This document recognizes that there are variations between jurisdictions. It does not attempt, nor recommend, homogeneity between jurisdictions. It is designed to provide common standard features to enable equipment of common specification, that supports a standardized secure ITS interface to be used, and the common features of service provision to be able to be referenced simply by reference to an International Standard (requiring it to specify in detail only the additional requirements of a jurisdiction).

A CONOPS generally evolves from a concept and is a description of how a set of capabilities is employed to achieve desired objectives.

6.2 Statement of the goals and objectives of the system

The overall objective of the ITS service application in smart cities is the seamless exchange of data between transport applications and smart city service applications.

These services are provided to meet the smart city requirements using common secure ITS interface communications between ITS systems (including in-vehicle systems, infrastructure-based systems and personal ITS stations) and smart city applications.

6.3 Strategies, tactics, policies, and constraints affecting the system

Strategies, tactics, policies and constraints, and indeed the services that are regulated as mandatory or optionally supported, vary from jurisdiction to jurisdiction. Clause 7 provides details of the options of such aspects.

6.4 Organizations, activities and interactions among participants and stakeholders

The classes, attributes and key relationships are described in this clause. Some high-level conceptual architectural details are elaborated in Clause 7. Clause 8 provides the taxonomy of the architecture. Clause 9 defines the communications architecture. Clause 10 defines the facilities layer and its interoperability.

6.5 Clear statement of responsibilities and authorities delegated

Clause 5 describes the high-level options and issues. The actors, their responsibilities and authorities are described in Clause 7. The roles are described in this clause and in Clause 7.

6.6 Operational processes for the system

6.6.1 General

The description given in 6.6.2 of operational processes is at a high abstracted level (above that of any application service). Specific services have additional requirements not described herein.

6.6.2 Service requirements definition

A smart city application service provides a "service" (a benefit that a service user receives or a duty that a service user provides) to a service user using exchanges of data, in this case using a secure ITS interface. (Smart cities also use other communications means appropriate to the context of their use.) The interface is wired or wireless, but is likely to be the latter, in which case the latency of the system limits the ability to provide/capabilities of the application service.

An ITS application service provides an ITS "service" (a benefit that a service user receives or a duty that a user provides) to a service user using a secure ITS interface. The interface is wired or wireless, but is likely to be the latter, in which case the latency of the system limits the ability to provide/capabilities of the application service.

Wireless communications between a vehicle and its OEM (commonly known as "ExVe") are separate and complementary to, and out of the scope of, this document.

6.7 Appointment of an approval authority (regulatory)

This document is based on the premise that a smart city develops its own regulation base (in consort with national government and other smart cities). The term used in this document to describe this organization and its regulation base is the "jurisdiction", and this body creates or appoints an authority to approve and audit the process. The "process" in this context is a smart city application service, and the assumption is made that there is some form of approval process to control smart city application services and their cybersecurity (at a minimum to protect privacy and avoid fraud, and to minimize risks of terrorism or other disruption). The structure of that authority or authorities is a matter for the jurisdiction, and it is a separate appointed organization or a department of the jurisdiction. Within the context of this document, it is the actor role of the approval authority that is important, not its structure, ownership or business model.

An approval authority (regulatory) only presides over the instantiation and operation of one application service or presides over the instantiation and operation of many application services (at the discretion of the jurisdiction).

The approval authority (regulatory), where appropriate, approves service providers (or delegate the approval of service providers), and provides an audit as described in Clause 5, in accordance with the requirements of the jurisdiction.

6.8 In-vehicle system

In ITS service applications, the OBE that provides the application service is an ITS trusted device that meets the requirements of ISO/TS 5616[1].

6.9 User

An ITS application service provides a service to a service user using a secure ITS interface. Within the context of mobility integration, while most of ITS services are being provided to/from a road vehicle/road vehicle user (RV/RVU) to another RV/RVU, or between an RV/RVU and a service provider or service receiver, the application service is also between the RV/RVU and another transport system using entity, such as a VRU, micro mobility user, public transport service provider, MaaS service provider, etc.