TECHNICAL REPORT

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Intelligent transport systems — Mobility integration — Digital infrastructure service role and functional model for urban ITS service applications

Systèmes de transport intelligents - Intégration de la mobilité - Rôle des services d'infrastructure numérique et modèle fonctionnel pour les applications de services ITS urbains

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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).

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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 civilizations develop and congregate around the areas where employment opportunity most arises. Societies develop more innovatively and more rapidly in cities, adding to their attraction. Finally, cities present better entertainment opportunities. These points all add to their attraction and popularity, hence the continuing trend. It has recently been forecast that by 2045, an additional 2 billion people will live in urban areas.[4] Due to the concentration of the population that this causes, various issues arise, such as road congestion due to increases in vehicle population and environmental pollution due to exhaust gas and tyre erosion. This has been attributed to increases in the amount of delivery trucks, taxis and town centre traffic and is further exacerbated by obstacles to effective use of urban space due to private ownership of cars (parking lots, street parking).

In line with scientific advice that significant action and change of behaviour is needed to ameliorate the adverse effects of climate change, more environmentally-friendly use of the transport system is required.

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

Therefore, in recent years, in Europe, studies on the development of mobility integration standards have been active in solving urban problems. There are also various movements around the world making efforts to address such issues. In the United States, for example, intelligent transport system (ITS) technology is used to try to solve urban problems in the Smart City Pilot Project. 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 regarding privacy protection, the need to strengthen security measures, big data collection and processing measures, which are becoming important considerations.

In terms of 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, city road area usage can also be minimized or reallocated (space utilization improvement) to improve the living environment and quality of life in the city. In addition, the environment around the road will be improved by improving enforcement (e.g. overloaded vehicles). It is possible, even in rural areas, 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, the following points will need to be achieved:

— cooperation in the harmonization of International Standards and other industry standards;

— recognition of the significance of international standardization (for example, in reducing 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.

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.

ISO/TR 4445 is already an important resource for this objective, providing consideration of the emerging direction of mobility electrification, automated driving and the direction of an environmentally friendly society, whilst also incorporating other urban data such as traffic management into city management within the context of improving the mobility of urban society.

This document, ISO/TR 7872, describes how ITS sensor data can be integrated into a valuable data cluster presented on map data, so that ITS service providers can provide services such as automated driving, parking, kerb operations, etc.

This document does not describe smart city use cases for ITS data in detail, nor does it describe in detail any specific ITS use-cases; it is instead focussed on the generic role model for digital infrastructure service.

Intelligent transport systems — Mobility integration — Digital infrastructure service role and functional model for urban ITS service applications

1 Scope

This document describes a basic role and functional model of digital infrastructure service for urban intelligent transport system (ITS) service applications. It provides an extension of the information given in ISO/TR 4445. It lays out a paradigm describing:

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

b) a description of the concept of roles and functional models for such services;

c) a conceptual architecture between actors involved in the provision/receipt of digital infrastructure services;

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

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, *Intelligent transport systems — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 14812 and the following 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 https://www.electropedia.org/

4 Abbreviated terms

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

AI	artificial intelligence
AVPS	automated valet parking system
AV	automated vehicle
CAV	connected and automated vehicle
CONOPS	concept of operations

EFC electronic fee collection

EV electric vehicles

ExVe extended vehicle

FCV fuel cell vehicles

GDD graphic data dictionary

GDF geographic data files

HD high definition

ITS intelligent transport system

LSAD low-speed automated driving

MaaS mobility as a service

METR management for electronic traffic regulations

NDS Navigation Data Standard

OBE on-board equipment

OEM original equipment manufacturer

QoS quality of service

RV road vehicle

RVU road vehicle user

SCMS security credentials management system

SPaT-MAP signal phase and timing (SPaT) and map (MAP)

WIM weigh in motion

5 General overview and framework

5.1 Objective

Emerging ITS service applications such as parking (including AVPS: automated valet parking systems), CAV (connected and automated vehicle, including LSAD: low-speed automated driving) and kerb operations require infrastructure supports for secured and safety operations. Several ongoing standardization work items exist within ISO/TC 204, including:

— high definition (HD) maps,

— management for electronic traffic regulations (METR), and

— graphic data dictionary (GDD).

There is a need for the creation of a document describing how these standardization items fit into a prospected digital infrastructure service role and functional model for smart city ITS service applications.

This will lead to a digital twin operation for smart cities: creation of a digitality formed society connecting real (physical world) society to processing and analysing big data and sending out a data stream to the real world.

In actual deployment, distributed security technology such as block chain will be introduced for efficient and speedy transactions.

This document suggests investigating ITS as a component of a smart city and that the ITS data can focus on data originating from ITS components and available for sharing with other smart city services and commercial interests.

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

(Clause 6 provides the general concept of operations for which this architecture is designed. Clause 7 provides a framework, role definition and summary of the architecture at a conceptual level.)

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 can 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/on-board equipment (OBE) to use the services of different application services. The in-vehicle system can be a vehicle-original equipment specification option, in-built at the time of manufacture of the vehicle, with the service provider selection being a subsequent service-user choice. Alternatively, it can be after-market equipment that has access rights to the required data. An ITS application service will be 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 will use that system. Its objective is to communicate the quantitative and qualitative system characteristics to all stakeholders.

ISO/TR 4445 describes the roles and responsibilities of the classes and actors involved in the provision of digital infrastructure for ITS services for ITS service applications using a secure vehicle interface.

This document recognizes that there will be variations between jurisdictions, a role in ISO/TR 4445. It does not attempt, nor recommend, homogeneity between jurisdictions. It is simply designed to provide common standard features to enable equipment of common specification, that supports a standardized 'Secure ITS Interface', to be used, and to enable the common features of service provision to be able to be referenced simply by reference to an ISO deliverable (requiring detailed specification of only the additional requirements of a jurisdiction).

A 'concept of operations' (CONOPS) generally evolves from a concept and is a description of how a set of capabilities will be 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, will vary from jurisdiction to jurisdiction. Clause 7 provides detail 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 Clause 7. High-level conceptual architectural detail is elaborated in Clause 8.

6.5 Clear statement of responsibilities and authorities delegated

Clause 6 describes the high-level options and issues. The actors, their responsibilities and authorities are described in Clause 7.

6.6 Operational processes for the system

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

6.6.1 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 can also use other communications means appropriate to the context of their use. The interface will be wired or wireless, but is likely to be the latter, in which case the latency of the system will limit the ability to provide/capabilities of the application service.