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Intelligent transport systems — Mobility integration — ITS data aggregation role and functional model

Systèmes de transport intelligents — Intégration de la mobilité — Rôle d'agrégation de données et modèle fonctionnel des systèmes de transport intelligents

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Foreword

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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. 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.

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).

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, intelligent transport systems (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 21177, i.e. exchange information with bi-directional protection.

Intelligent transport systems — Mobility integration — ITS data aggregation role and functional model

1 Scope

This document describes a basic role and functional model of the intelligent transport systems (ITS) data aggregation role, which is a basic role of ISO/TR 4445. It provides a paradigm describing:

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

b) a description of the concept of a role and functional model for such roles;

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

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, *Intelligent transport systems — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 14812 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

CONOPS	concept of operations
ITS	intelligent transport system
MaaS	mobility as a service
OBE	on-board equipment
OEM	original equipment manufacturer
SCMS	security credentials management system

5 Issues concerning data aggregation and sharing in smart city

5.1 General

ITS mobility service applications require open data aggregation of ITS data. The role and functional definition for this service is described in this document.

The ITS data aggregation role is required when combining internal data with the one externally inputted from other sources. The combining data requires a data sharing function, privacy protection and security controls.

5.2 Data sharing

ISO/TR 4286 describes the concept of data sharing in ITS service applications.

5.3 Open-source concept

For effective ITS data aggregation, utilising open source technology is key to success in developing smart mobility solutions. Deploying digital twins concept and data space platform is also a part of open source digital transformation.

Only technologies and methods standardized within an acknowledged global standards body are appropriate for consideration. Such technologies are considered to display some track record of sustainability and robustness to satisfy the global long-term deployment and operational nature of ITS.

5.4 Open-source API concept

Although the data API from external and sensor data is out of scope, open-source API concept is essential for effective data sharing and utilization.

Data API to service providers is out of scope of this document.

5.5 Privacy control and security controls

Procedures regulating privacy control and security controls are usually governed by national authorities.

5.6 Trustworthiness and data accountability

It is necessary to consider data trustworthiness and data accountability within all data flows.

6 General overview and framework

6.1 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), Kerb operations need structured data created from smart city big data through the effective use of AI (artificial intelligence) and support from digital infrastructure which is described in ISO/TR 7872 for secured and safety operations. And there are several independent related ongoing standardization work items within ISO/TC 204. Therefore, there is a need of a guidebook-style technical report that describe the basic role and functional model of the ITS data aggregation.

This will lead to digital twin operation for smart city; create digitality formed society twining real physical world to process big data and analyse to send out data stream to real world.

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

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

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

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

6.2 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.

6.3 Mandatory, optional, and cooperative issues

6.3.1 No mandated requirements

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 standardised sets of requirements descriptions for the exchange of data to enable consistent and cost efficient implementations where instantiated.

6.3.2 Common platform

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.

6.4 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.

6.5 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 will be 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 (much as we select an internet service provider today) or will be aftermarket 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.

7 Concept of operations

7.1 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 recognises that there will be variations between jurisdictions, a role in ISO/TR 4445. 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 standardised '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's deliverable (requiring it to specify in detail only the additional requirements of a jurisdiction).

A 'concept of operations' (CONOPS) evolves from a concept and is a description of how a set of capabilities will be employed to achieve desired objectives.

7.2 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.

7.3 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 authority to authority.

7.4 Organisations, activities, and interactions among participants and stakeholders

The classes, attributes and key relationships are described in Clause 8, and some elevated levels conceptual architectural detail is elaborated.

7.5 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 ISO/TR 4445.

7.6 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.

7.6.1 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 will 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.

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 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.

Wireless communications between a vehicle and its OEM (Commonly known as ExVe: extended vehicle) are separate and complementary to, and out of the scope of, this Document.

7.7 Appointment of an approval authority (regulatory)

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

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

The approval authority (regulatory) will, where appropriate, approve service providers (or delegate approval of service providers], and will provide audit, taking into consideration the requirements of the authority.

7.8 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 5616.

7.9 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 will also be between the RV/RVU and another transport system using entity, such as a vulnerable road user, micro mobility user, public transport service provider, MaaS service provider, etc.

7.10 Application service

An application service is provided on request or is cyclical to a pre-agreed cycle.

In an 'on request' implementation, an ITS trusted device, offering the appropriate credentials via the 'secure ITS interface' will request pre-specified information from the client OBE, which on confirmation of the credentials of the requestor for the requested information will provide it via the 'Secure ITS interface.'

An OBE will or will not be set up to deal with one or both cyclical and on request demands for information.

The nature and definition of the information supplied will be the subject of a specification or Regulation.

7.11 Big data management entity

7.11.1 Big data management

This big data will be connected to other smart city data entities and share the data for the efficient smart city operation in a manner approved and authorised by the authority. This role is needed to support privacy requirements and to fairly manage any business case issues.

7.12 Data aggregator

The data aggregator will provide timely and value-added data to service provider for its ITS service application provisioning. Data collected for sharing is not forwarded in the same formats or data timing so there is a need to have an entity that can provide standardized data to service provider in a standard data format and data timing. This role is like ISO/TS 21184 role between ITS entities, but in this case is between ITS entities and smart city entities. AI can be deployed to create such structured value-added data for service providers.

(This report does not attempt to describe general role of big data/data aggregation in smart cities [out of scope of ISO TC 204]).

7.13 Map Service providers

The open architecture platform map data will be assumed as "Map data that anyone can use for free", "Map data that is charged but has no usage restrictions", "Map data that anyone can modify and re-provide", etc.

The map service will provide an open architecture platform map data and it receives probe data, OEM cloud data, etc. from data aggregator. It combines such data into map and provides map data (such as HD map) cluster in a standard format such as GDF, NDS, etc. to digital infrastructure service provider for ITS application services.

Other map formats and systems such as those being developed under ISO/TC 211 Geographic Information/Geomatics is a possible candidate for the open architecture platform map data.

7.14 Digital infrastructure service provider

The digital infrastructure service provider will receive map data cluster in a standard format from map service provider and receive public infrastructure and enforcing regulation data, such as METR (management for electronic traffic regulations), GDD (graphic data dictionary), etc. from jurisdictions/road authority/municipals. It combines such data into map as data cluster, digital infrastructure data which are consist of dynamic and static data. Digital infrastructure service provider provides those to service provider who performs provisioning of ITS services such as CAV, parking (AVPS), Kerbside management, etc. Service provider will utilize AI/edge computing tools in some use cases for low latency safety service applications.

8 Conceptual architecture framework

8.1 General

Clause 7 above provided the generic concept of operations which these actors and classes enact to provide the application service(s). To specify a generic framework standard of the ITS service platform exchange of data with smart cities, this framework standardisation deliverable identifies core actors and classes as described in 8.2 to 8.4 below, which are described as elements that are independent of any specific application. Example of use case is listed in Annex A for reference only.

8.2 Actors

ISO/TR 4445 defines a role model where the roles and responsibilities of three key actor classes are defined to provide an entity known as an ‘application service’:

a) the ‘Service Users.’

b) the ‘Service Provider(s).’

and, for any regulated applications, will involve:

c) the ‘Jurisdiction(s).’

The ISO/TR 4445 ‘role model’ provides the general attributes and the responsibilities of the parties. These aspects are described within this document. Figure 1 illustrates a conceptual role model architecture) for application service provision.

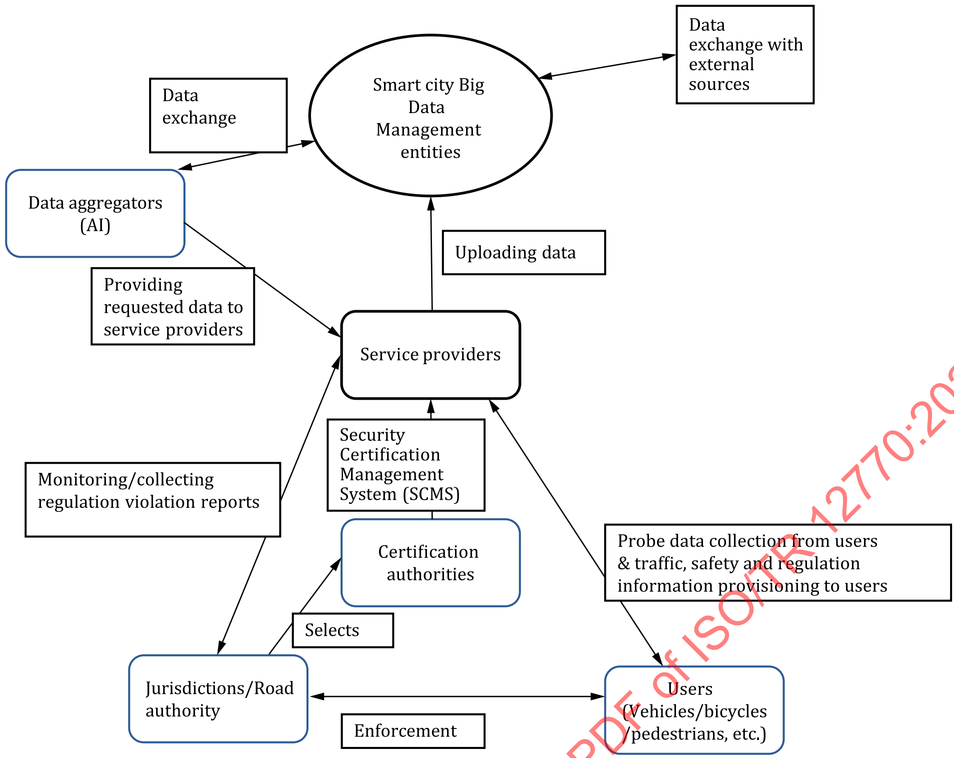

Figure 1 — Role model conceptual architecture: Smart city ITS application service taken from ISO/TR 4445

8.3 An image of role model and functional model of ITS data aggregation

This document defines a role and functional model where the roles and responsibilities of key actor class is defined to provide an entity known as an 'ITS data aggregation':

This document 'role and functional model of ITS data aggregation' provides the general attributes and the responsibilities of the party. These aspects are described within this document. Figure 2 illustrates a conceptual role model architecture for ITS data aggregation.

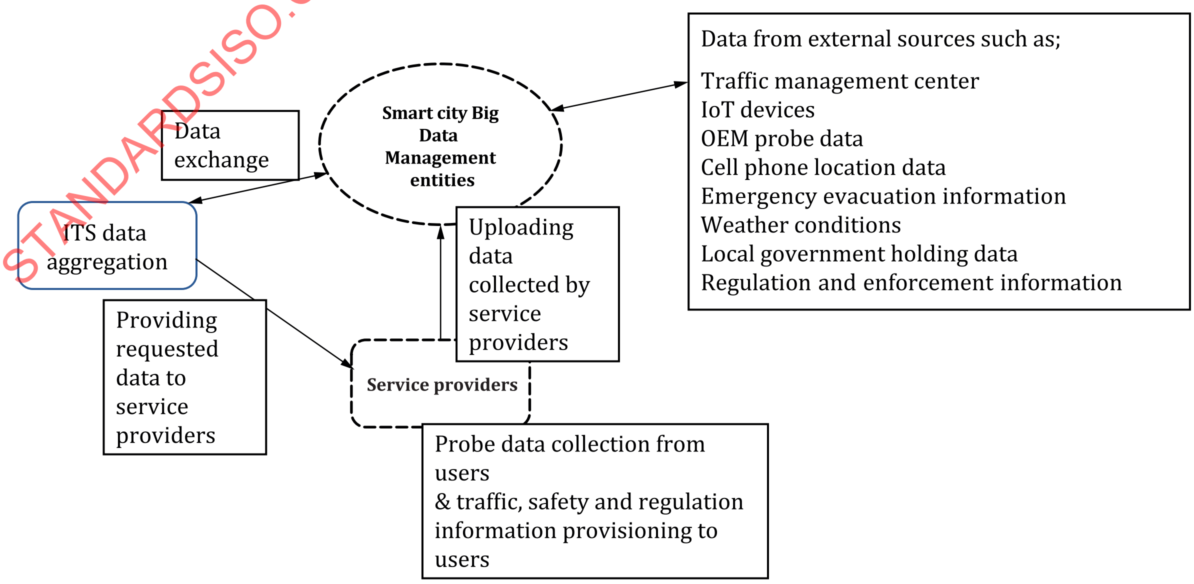

Figure 2 — An image of role model and functional model of ITS data aggregation servicer

8.4 Service definition

The service definition for each application service comprises:

a) a clear description of the service provided and its inputs, outputs and results.

b) basic vehicle data content and quality that an OBE must deliver.

c) core application data content to meet the requirements of the service and meet any requirements of the authority.

d) any additional application specific data content for the provision of that service.

e) service elements (such as “retrieve data from OBE,” “map data to a map with access conditions,” “report non-compliance,” etc.).

f) rules for the approval of OBEs and ‘application services.’

8.5 Role model architecture

8.5.1 General

This clause considers the roles of the actors and their interrelationship in greater detail, and their relationship to the provision of the applications service(s).

8.5.2 Application service actors

Application services, whether or commercial or regulated, therefore need clear definition in terms of the requirements on the OBE.

It also falls to the service provider to provide accurate enough specification of what is required from the vehicle to enable the OEM, or aftermarket provider, to design the OBE.

Application services can be architecturally described as involving seven further classes/subclasses of actors in addition to the authority:

— the authority;

— the SCMS;

— the certificate issuer;

— the OBE;

— equipment installer (subclass);

— the OBE equipment maintainer (subclass);

— the approval authority (regulatory);

— the service user.

Single entities will perform the roles of multiple classes of actor. (e.g., The SCMS and the certificate authority will be the same actor) Other actors will also be embraced within these key roles (such as a communications provider), but these will be regarded as additional subclasses that support one of the key actor roles.

8.5.3 Service provider(s)

A service provider, within the context of this deliverable, can be described as a party which is providing safety, commercial or regulated ITS or smart city services. Application services will be certified by the certification authority (regulatory) as suitable.