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Intelligent transport systems — Vehicle/roadway warning and control systems — Report on standardisation for vehicle automated driving systems (RoVAS)/Beyond driver assistance systems

Systèmes intelligents de transport — Systèmes d'alerte et de commandes des véhicules/chaussées — Rapport sur la normalisation des systèmes de conduite automatisée des véhicules (RoVAS)/systèmes d'aide à la conduite

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Foreword

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

Introduction

In recent years, rapid progresses of sensing and computational technologies have promoted research and development on automated driving systems. Some systems have already been commercialized and have begun to be installed in production vehicles. Standardization activities for automated driving systems have been advanced as well. Amid ongoing practical implementation of the systems, standardization for automated driving systems should be stimulated.

In the future, various automated driving systems will be increasingly introduced in the automotive industry. For appropriate usage of these systems by general users, it is important for us to make a distinction between a vehicle's functions and the driver's role to avoid confusion. Therefore, several International Standards should be established that can be shared widely. However, from current perspective, it seems to be not clear which items should be standardized. Nevertheless, since more advanced systems for automated driving systems will be introduced in the near future, standardization will widely consider and assess candidates for standardization to ensure covering not only the functions of an automated driving system itself, but also contributing or enabling issues for each system.

Therefore, this document outlines potential standardization areas and items and marshal them in a systematic manner to distinguish potential standardization for various automated vehicle systems. It is also intended to cover the need for standardization on the usage of automated driving systems in a heterogeneous traffic condition (where not all vehicles are automated). This document does neither determine the area of standardization body, where the work should be performed, nor the recommendation of specific standardization.

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This document should be helpful for those who consider and/or develop standards for automated driving systems. Use case of this document may be as follows; to share common perceptions of standardization, to clarify perspectives of standardization, to take standardization items, to estimate coverages and priorities of items, and to consider feature of technologies or products.

Intelligent transport systems — Vehicle/roadway warning and control systems — Report on standardisation for vehicle automated driving systems (RoVAS)/Beyond driver assistance systems

1 Scope

This document provides the results of consideration on potential areas and items of standardization for automated driving systems. In this document, automated driving systems are defined as systems that control longitudinal and lateral motions of the vehicle at the same time.

Potential standardization areas and items are widely extracted and marshalled in a systematic manner to distinguish potential standardization for various automated vehicle systems. When, what, and by whom the standardization activities are actually done are discussed separately.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Extracting potential areas for standardization

4.1 Principles

4.1.1 General

This clause presents basic concepts for items related to automated driving systems for standardization. Examples of basic architectures have been considered and potential areas for standardization, based on these examples have been derived. Aside from this, items based on actual standardization activities and other important issues have been extracted.

4.1.2 Issues based on architectures

4.1.2.1 General

It is effective to extract areas for standardization based on architecture. This section suggests an example of notional architecture based on automated driving systems. This is not a proposal for a standard, but intended for use when for considering potential standardization items systematically.

It might be suggested that areas for standardization are standards for each entity and interface between entities. Functional transitions are especially important in the architecture of automated driving systems.

4.1.2.2 Functional architecture

An automated driving system as a whole is given as an example of the notional functional architecture of systems in Figure 1.

Under normal driving, a driver recognizes the driving environment (S1: on) and operates a vehicle (S5: on). Under automated driving, operation is entrusted to the in-vehicle system (S4: on). Additionally, the system shows its condition to the driver and he/she may adjust the system as needed (S2: on). The vehicle may be operated by the driver and the in-vehicle system also (S4: on and S5: on). Under fully automated driving, there is no need for the driver to be involved in operation. The driver does not need to recognize the environment (S1: off) nor monitor the in-vehicle systems (S2: off).

Alternatively, there are two types of automated driving modes: the non-connected (autonomous) type and the connected type. The non-connected type does not communicate with infrastructure and/or other vehicles (S3: off). The connected type communicates with infrastructure and/or other vehicles (S3: on). The connected type receives external information from infrastructure and/or other vehicles and transmits its own information to them also.

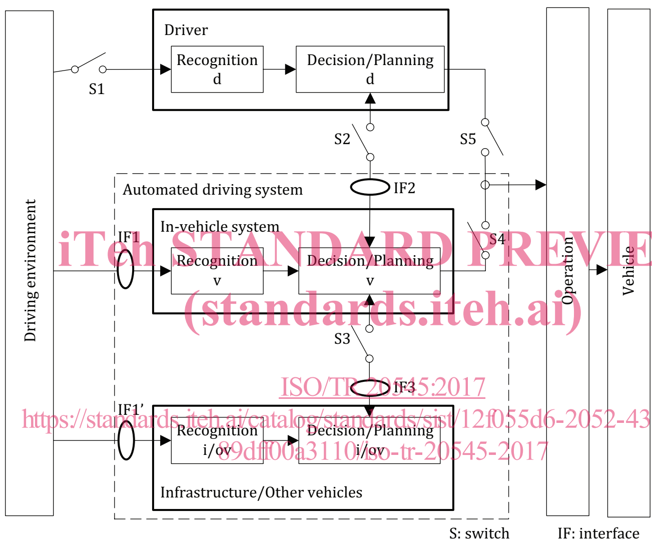

Figure 1 — Example of notional functional architecture

There might be a need to develop standards for the functional requirements of recognition, decision and planning, requirements for interfaces between elements, and standards for designing automated driving systems that can adapt to changes of switch positions. For future introduction, on behalf of users, of its design for systems that is widely shared, International Standards need to be established.

4.1.2.3 Physical architecture

An example of notional physical architecture is shown in Figure 2. This is not a proposal for a standard, but intended for use when for considering potential standardization items systematically.

Standards for each entity and interfaces between entities may be subjects of standardization. However, physical architecture and functions differ depending on the implementation of each system. Therefore, the specifications of physical elements and their standard are not discussed in this document, although those might be subject to international standards.

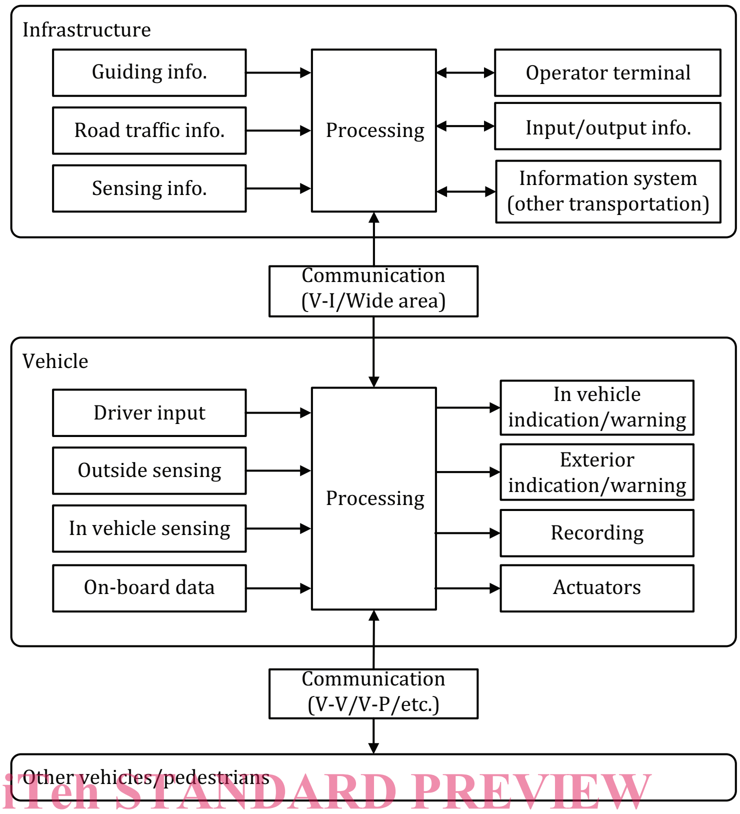

Figure 2 — Example of notional physical architecture

4.1.3 Issues based on activities

In addition, areas for standardization are extracted, considering the activities for standardizing automated driving systems as described in Annex A.

It is suggested that areas for standardization be definitions of levels of automated driving systems, terms, and testing issues.

4.1.4 Other important issues for automated driving systems

Several important potential standardization items that are not shown in the architecture are proposed.

For instance, standards might be developed for safety, reliability, security, recording (event data recorder), principle of privacy, test methods and distinguishing automated driving systems from non-automated driving systems.

4.2 Proposal of standardization items

4.2.1 Classification

Potential standardization areas and items are extracted in the previous section. In this section, potential areas of standardizations are classified in three categories: common items, basic functional requirements and other items.

NOTE Items are mapped and listed in Annex B.

4.2.2 Common items

a) Terminology

Today, automated driving systems are being discussed in various countries and regions. However, there is no common International Standard for definitions of terms of automated driving systems. As a result, different groups use terms in different ways. For instance, one word may have different meanings, or several words may be used to express the same idea.

To prevent confusion among users and to share a common understanding among stakeholders, terms for automated driving systems might be potential standardization areas.

For instance, the concept of automated driving systems might be a potential standardization item because it has a wide range of meanings.

b) Levels of automation

As shown in A.6, several institutions, including SAE, NHTSA and BASt, define automation levels. However, their definitions differ in terms of descriptions and criteria.

There is a need to standardize automation levels to prevent misunderstandings among users and to have a shared understanding among stakeholders.

The name of each level, which is easy to understand, and description of each level including examples of use, are needed.

The definitions of automation levels in A.6 are based on the following elements:

— the subject of control by systems;

— division of authority between driver and systems [driver's presence, response to faults and failures (override, etc.) transition time, driver's position, monitoring environment, monitoring systems, control operations, start/stop];

— operating environment (time, place, weather, road conditions, road structures, traffic conditions, speed, etc.).

c) Automated driving system reference architecture

There are many systems that can be used for automated driving systems. Having a common understanding of systems might be a potential standardization area. To define reference architecture would be useful to discuss and consider functions for automated driving systems.

For example, the communication protocol field has reference architectures such as the OSI model to promote a common understanding by everyone. It is a layered model of communication functions, which provides a common understanding when discussing communication protocols and systems.

4.2.3 Basic functional requirements

a) System requirements of each automation level

Requirements for automated driving systems at each automation level may include recognition, decision and planning of automated driving system's area and requirements of on/off switching conditions of S1, S2 and S3, which are connections of interfaces under the notional functional architecture in Figure 1.

For instance, standardizing recognition of driving status (positioning, static or dynamic condition of status such as maps and traffic jam information), sensing targets and area, control performance (responsive and control area), checks of status and information to driver might be considered.

b) Functional allocation between system and driver at each automation level

Requirements for functional allocation between system and driver at each automation level may be considered. They relate interface IF2 between driver and in-vehicle system under the notional functional architecture in Figure 1.

For instance, standardization of requirements for monitoring/estimating driving state and system operation, requirements for driver to recover driving might be considered.

c) Requirements regarding transition of functions between system and driver at each automation level

Requirements regarding transition of functions between system and driver of each automation level may be considered. They include transition of on/off switching condition of S1, S2, S4 and S5, and interface IF2 under the notional functional architecture in Figure 1.

For instance, for standardizing information provided by a system, time requirements for control change, interaction with driver, and HMI might be considered.

d) Requirements regarding system transition between automation levels

Requirements regarding system transition between levels may be considered. They include transition of on/off switching conditions of S1, S2, S4 and S5, and interface IF2 under the notional functional architecture in Figure 1.

For instance, for standardizing information provided by a system, time requirements for control change, interaction with driver, and HMI might be considered.

e) Requirements in case of system malfunction at each automation level

Requirements of system operation in case of system malfunctions (recognition and decision/planning) at each level may be considered.

They include interface IF2 between driver and in-vehicle system on/off switching conditions of S1 and S2, on/off switching and transition conditions of S4 and S5 under the notional functional architecture in Figure 1.

For instance, standardizing requirements for system operation (processing principle in case of system malfunctions at each automation level) might be considered.

f) Elements of V2X communication requirements under cooperative systems

Requirements for a driver under cooperative systems may include interface IF3 between in-vehicle system and infrastructure/other vehicles if S3 is "on", then a vehicle cooperates with infrastructure or other vehicles under the notional functional architecture Figure 1. V2X communication is required for automated parking known as "Automated valet parking system", which does not need a vehicle to be driven by a human driver but may offer operating and monitoring from outside the vehicle.

For instance, standardization of requirements for message sets, data (contents, accuracy, etc.), latency, capacity, V2X communication range and security if a vehicle communicates with infrastructure or other vehicles might be considered.

g) Basic concepts regarding using combinations of information from in-vehicle sensors and V2X communications

Requirements for external information from infrastructure or other vehicles obtained from cooperative systems should be considered. A vehicle cooperates with infrastructure or other vehicles under the notional functional architecture in Figure 1, when S3 is "on".

In case there are inconsistencies between the information received from in-vehicle sensors and V2X communications, data fusion approaches should be considered, weighing the different information based on the level of confidence in the accuracy of each. Basic concepts or requirements on these issues may be considered for standardization.

