TECHNICAL REPORT

ISO/TR 5255-2

First edition

Intelligent transport systems — Low-speed automated driving system (LSADS) service —

Part 2: Gap analysis

Systèmes de transport intelligents — Service de système d'intégration de la mobilité pour la conduite automatisée à basse vitesse (LSAD) —

Partie 2: Architecture globale

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Reference number
ISO/TR 5255-2:2022(E)

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Foreword

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

A list of all parts in the ISO 5255 series can be found on the ISO website.

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.

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Introduction

Standardization of service role and functional model is necessary for the introduction of low-speed automated driving systems (LSADS) to support safe and efficient mobility used as a means of moving people, goods and services in urban and rural areas.

ISO 22737 and ISO 7856 describe vehicle driving supports and do not cover the requirements of service role and functional model covering infrastructure facilities. Many business use cases regarding low-speed automated driving system (LSADS) services are currently emerging and many more variations are coming to be deployed. Various role and functional model presentation methodologies are currently in use and there is therefore a need for a common understandable role and functional model presentation baseline standard.

ISO/TS 5255-1 defines a common LSAD system service role and functional model presentation guidelines. Future emerging business cases can refer to ISO/TS 5255-1 as a baseline document which does not hinder the development of future business cases, but instead assists them.

This document focuses on safety operation gap analysis and serves as a baseline document describing which supplemental roles need be considered to take a safe operation lead in addition to the roles described in ISO/TS 5255-1. The purpose of this document is to assist in the introduction of LSADS, including infrastructure facilities to support mobility in urban and rural areas.

Intelligent transport systems — Low-speed automated driving system (LSADS) service —

Part 2:
Gap analysis

1 Scope

This document:

— examines and analyses the safety environment for low-speed automated driving services (LSADS);

— describes the safety role supplement to the functional model described in ISO/TS 5255-1;

— describes the supplemental safety points for LSADS;

— describes role for the functional model of service applications for LSADS.

This document can contribute to the development of future automated driving system service safety requirement use cases, other than the one described in ISO/TS 5255-1.

This document is applicable to services using LSADS-equipped vehicles only.

In-vehicle control system is not in scope of this document.

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/

3.1
artificial intelligence
AI
<system> capability to acquire, process, create and apply knowledge, held in the form of a model, to conduct one or more given tasks

[SOURCE: ISO/IEC TR 24030:2021, 3.1]

4 Safety support function of LSADS service

4.1 General overview

The LSADS design safety is maintained through conformance to the requirements of related standards, such as UL4600, ISO 26262 series and ISO 21448.

4.2 LSADS cyber security protection

As described in ISO/TS 5255-1, the security credential management system is a valuable tool for cyber security issues. The LSADS vehicle needs to have such a system for safety operations. ISO/TS 21177 provides specifications for a set of ITS station security services required to ensure the authenticity of the source and integrity of information exchanged between trusted entities, such as:

— devices operated as bounded secured managed entities, i.e. "ITS Station Communication Units" (ITS-SCU) and "ITS station units" (ITS-SU) specified in ISO 21217; and

— ITS-SUs (composed of one or several ITS-SCUs) and external trusted entities such as sensor and control networks.

These services include authentication and secure session establishment which are required to exchange information in a trusted and secure manner.

These services are essential for many ITS applications and services, including time-critical safety applications, automated driving, remote management of ITS stations (ISO 24102-2), and roadside/infrastructure related services.

For the LSADS vehicle, the ISO/SAE 21434 specifies engineering requirements for cybersecurity risk management regarding the concept, product development, production, operation, maintenance and decommissioning of electrical and electronic (E/E) systems in road vehicles, including their components and interfaces.

4.3 LSADS safety environment using AI

The LSAD (low-speed automated driving) fleet safe operation function is maintained by using support from vehicle internal safety driving artificial intelligence (AI). This provides safe LSAD automated driving function and back-office (LSAD system service control centre) AI which remotely provides an overridden AI service function superseding the LSAD vehicle AI function when the vehicle AI requests supplemental support from back-office AI. Figure 1 shows the safety operation AI functions framework. For decision making by back-office AI, supplement infrastructure sensor data is necessary. Each vehicle's internal AI therefore sends a huge amount of data to back-office AI.

4.4 Fail safe

The LSAD entire service system (including infrastructure support facilities) is generally designed based upon a fail-safe concept. Even when back-office AI overrides the vehicle's internal AI, the vehicle's internal AI is expected to be designed to operate as per this concept. When re-starting an LSAD vehicle after the occurrence of an unexperienced situation, resuming operation of the entire LSAD service system is generally designed to re-start the service at minimum manoeuvring speed (whilst being prepared for sudden unexpected service interruptions meaning service stoppage). All the safety sensor data from the entire LSAD service system and other smart city infrastructure sensors are also generally designed to be used by the entire AI families of the LSAD system for safety-service-provisioning decision making.

4.5 Safety design standards

The ISO 26262 series and UL 4600 contain requirements for achieving the safest operation of the entire LSADS system. As always, safety first is important concept, and it gains top priority.

4.6 Safety operational concept using AI

Figure 1 shows the image of LSADS system safety operational concept.

The back-office AI contributes safety operational support for the entire LSAD fleet. For decision making by back-office AI, the supplemental infrastructure sensor data are used. Vehicle internal AI for LSAD usually takes control of safety operations and receives support from back-office AI when needed. See Annex A for use cases.

The AI learns safety operation decision making by consuming rich safety operation driving data. AI does not have the thinking ability to make decisions without external support. Therefore, when AI encounters a new situation experience, it needs external support from matured AI or other decision-making ability role entities.

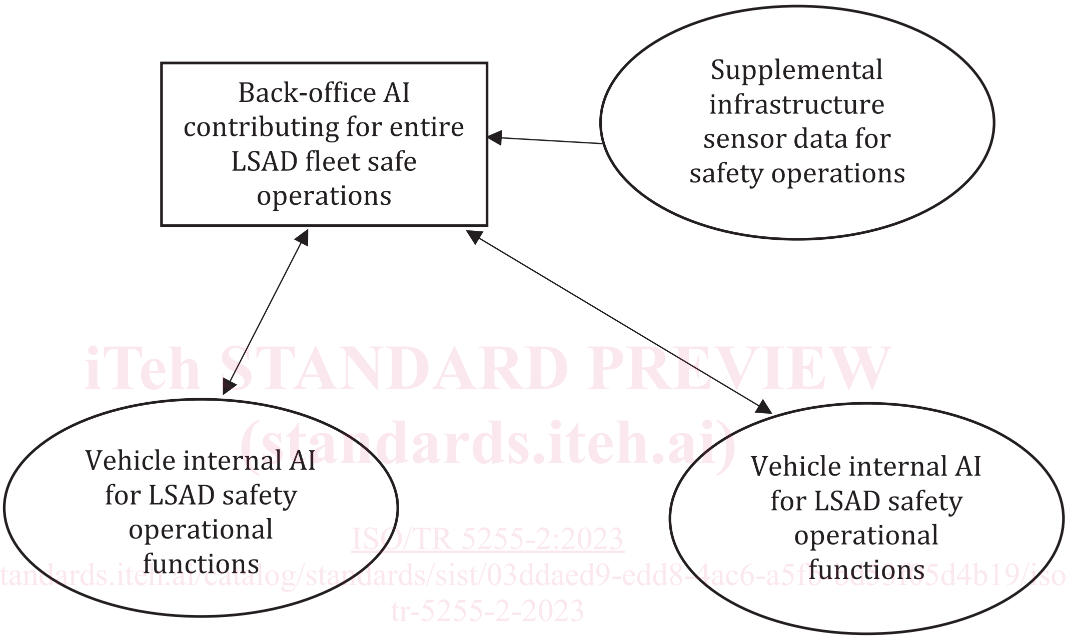

Figure 1 — LSADS safety operational framework using AI functions

4.7 AI education on safety function

AI is expected to be designed to be educated constantly by rich and properly structured big data provided by smart city infrastructure sensors and real time automated driving records. But pre-matured AI sometimes need supplemental support from matured AI. In this manner, pre-matured AI is expected to be able to be become more matured AI. For this reason, AI supporting automated driving need experiences to meet new situations where first first-hand safety decision making is taking place, so the necessary, proper and correct decision making becomes possible.

4.8 Education sharing among AIs

Education provided by back-office AI to one vehicle AI is expected to be shared by all other vehicle AI's so that entire LASD service system fleet vehicle AIs are kept on similar and/or same matured levels.

5 Supplemental safety support function of LSAD system service

5.1 General

It has been understood in recent years that the most appropriate teacher for educating premature AI to matured level is the human brain. A safety support hierarchy model employing this human-on-top concept is expected to be the most reasonable solution. Figure 2 describes this concept.

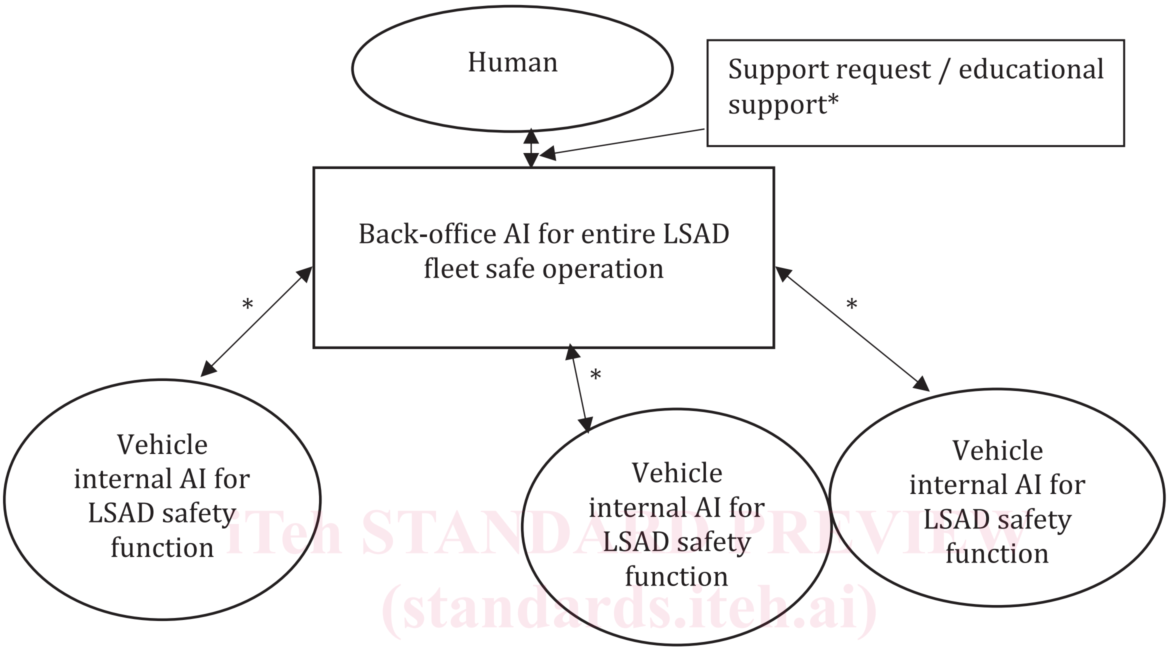

Figure 2 — LSADS supplement safety operational support functions

5.2 Role of humans

The LSADS discussed in this document is designed to conform to operational design domain levels 4 and 5 (SAE J3016). Various dynamic human interventions are assumed to occur on an on-demand basis depending on the maturity of the AI mounted on the LSADS vehicle.

The role of the human is expected to be initiated only when back-office AI is unable to make a safe and suitable decision. The back-office AI needs some level of human education when expected necessary support is assumed. For decision-making by humans, various sensor data from the entire LSAD service system and surrounding smart city infrastructure facility sensors are to be used. Such supplemental data is essential for safe decision making.

6 Connected vehicle environment

6.1 Latency

The safety function is accomplished through the provision of minimum communication latency created by the entire application system including the steps in various stages (A/D conversion, compression, decompression). Latency in the communication link is a crucial factor. Current fourth generation mobile network used as major cellular network is not favourable for safety applications. The 5G technology and emerging 6G cellular communication/low earth orbit (LEO) satellite communication system can be a favourable selection. Inter-LEO satellite communication using laser communications can cut latency in half because laser travels at twice the speed in a vacuum compared to travel through an optical fibre on the ground level. The selection of communication media is important when deploying an entire

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