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Intelligent transport systems — Performance testing for connectivity and safety functions of automated driving buses in public transport —

Part 3: Service framework and use cases

Systèmes de transport intelligents — Essais de performance pour les fonctions de connectivité et de sécurité des bus à conduite automatisée dans les transports publics —

Partie 3: Cadre de service et cas d'usage

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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 21734 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.

Introduction

Automated vehicle technology has been developing rapidly in recent years as one of the measures for reducing automobile accidents caused by human errors and for promoting the automobile industry. The automated driving bus (ADB) is a new type of public transport mode embedded with automated vehicle technologies. The progress of development and deployment of ADBs has accelerated in recent years, exceeding that of automated passenger vehicles.

From the connectivity perspective, to ensure its effectiveness as a public transport mode, ADBs need to connect with:

— traffic signal networks both for vehicles and pedestrians;

— the monitoring and control centre for bus operation; and

— other relevant infrastructure.

In terms of safety, the ADB needs to:

— be embedded with automated vehicle functions to connect with the wireless signal control system; and

— be ready to respond to unexpected situations involving other road users such as pedestrians and bicyclists.

With secured connectivity and safety, ADBs can provide stable services.

Along with stable service provision, an ADB deviates its operational measures from conventional ones. This document describes basic components for providing transport services and service framework based on ADB. It also explains use-cases of ADB services, including structure of service components, operational route management, fare payment, emergency response, and provision of operational information along with service procedures for each service use-case.

Furthermore, public transport authorities need technical reference points to measure the service performance of ADB for enhancing public safety on roads.

This document provides the basis for the development of performance testing for connectivity and safety functions of ADB on a national and international level. It is intended to benefit public transport operators, relevant governing authorities and industrial stakeholders.

Intelligent transport systems — Performance testing for connectivity and safety functions of automated driving buses in public transport —

Part 3:
Service framework and use cases

1 Scope

This document specifies the general service framework and components for operating automated driving buses (ADBs) in public transport networks. It includes:

a) a description of the ADB service components which consist of ADBs, the monitoring and control (MC) centre, Internet of Things (IoT) infrastructure, the smart bus stations and the passengers.

b) a description of the use cases for the ADB service operation.

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 21734-1, *Intelligent transport systems — Performance testing for connectivity and safety functions of automated driving buses in public transport — Part 1: General framework*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21734-1 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 Terms and definitions

3.1.1
automated driving bus
ADB
bus designed for public transport and embedded with automated driving functions based on SAE level 4 or higher

Note 1 to entry: definitions of autonomous vehicle can be found in the SAE document SAE J3016.

3.1.2
automated driving bus service framework
ADB service framework
framework for transport services provided by the automated driving bus (ADB) system through interactions among the system components consisting of ADB, Internet of Things (IoT) infrastructure, passengers, smart bus stations and the monitoring and control centre

3.1.3
monitoring and control centre
MC centre
system that can ensure the safety of automated driving bus (ADB) operations by monitoring and controlling the fleet through the collection of data from the ADB system

3.1.4
IoT infrastructure
sensor-equipped transport infrastructure such as traffic signals at intersections and smart bus stations that recognize road traffic conditions and ADBs

3.1.5
smart bus station
facility where an automated driving bus (ADB) stops and passengers safely board, alight and wait for an ADB

Note 1 to entry: Smart bus stations include a station kiosk and Internet of Things (IoT) infrastructure to communicate with the monitoring and control (MC centre).

3.1.6
passenger
one of the automated driving bus (ADB) users provided with ADB transport services

3.1.7
operator
one of the users who is responsible for operating and managing automated driving bus (ADB) systems

3.1.8
on-demand operation
operating measure with a flexible schedule and route that responds to the passengers' demand within the delineated service area

Note 1 to entry: Passengers are only permitted to board and alight at a smart bus station.

3.1.9
station kiosk
device that is installed at a smart bus station and that provides boarding reservation, payment and billing services to passengers

3.1.10
mobile application
software program supporting automated driving bus (ADB) passengers in making their boarding reservation and payment with a mobile device

3.1.11
operation manager
person who is responsible for monitoring the operation of the automated driving bus (ADB) fleet and responding to emergencies in the MC centre

3.1.12
in-vehicle operation manager
individual who is responsible for monitoring automated driving bus (ADB) operation and responding to emergencies in an ADB while it is in operation

3.1.13
one-time boarding ticket
ticket used for one round trip

Note 1 to entry: Depending on reservation methods, tickets can be either paper or electronic.

3.2 Abbreviated terms and symbols

A	fare
ADM	automated driving message
ASM	automated driving service message
BIS	bus information system
BSM	basic safety message
EEM	emergency event message
IoT	Internet of Things
JPY	Japanese yen
KRW	South Korea won
MRT	mass rapid transit
N	deposit for the additional amount to pay when the reservation information differs from destination
NFC	near field communication
R	deposit of calculation of purchase cost of a one- time ticket
r_F	refund false
r_T	refund true
SGD	Singapore dollar
T	ticket

4 ADB service framework

4.1 ADB service components

4.1.1 General

The ADB service component consists of five components including the ADB, the MC centre, IoT infrastructure, the smart bus station and the ADB passenger. These components are shown in Figure 1.

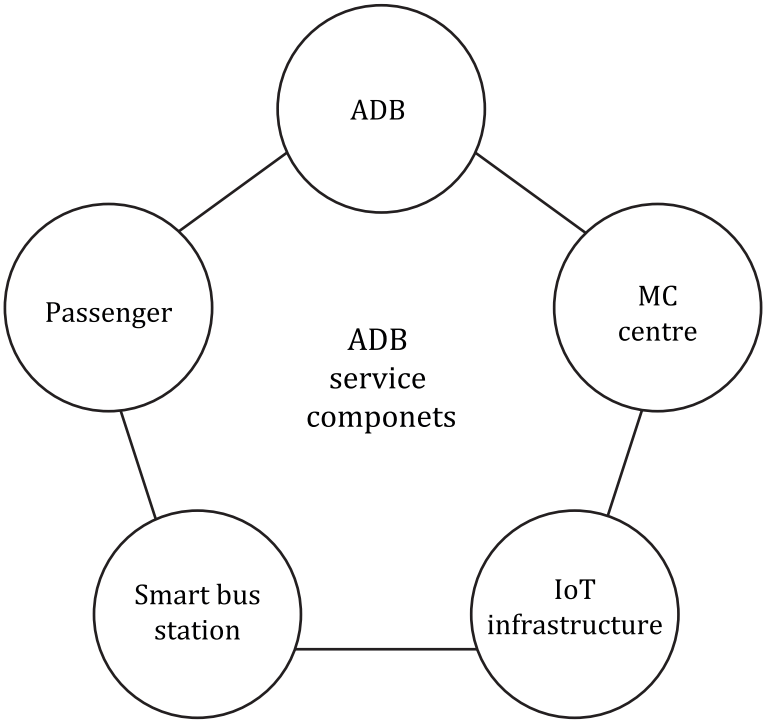

Figure 1 — Five components of ADB service

4.1.2 Automated driving bus (ADB)

An ADB is a vehicle designed for the carriage of passengers with a capacity of more than 9 persons. It can provide safe transport services by communicating with traffic signals and IoT infrastructure that are installed on the roadside and can transmit messages to the MC centre. An ADB can also allow the MC centre to manage its driving functions when necessary.

The messages an ADB provides to the MC centre include its real time locations, the number of empty seats, its expected arrival time at a smart bus station, the number of boarding passengers, passengers' identities, and traffic conditions. Additionally, an ADB provides the MC centre with emergency messages with the occurrence of an event such as system errors or accidents. Furthermore, information protection policies and technologies are applied for operating an ADB.

4.1.3 Monitoring and control centre

The functions of the MC centre component consist of delivering ADB mobility services, managing information for reservations and fare payments, and responding to emergencies.

For delivering the ADB mobility services, the functions of the MC centre include the provision of information for facilitating bus operations and serving passengers. The provision of information includes the number of boarding/alighting passengers at the next station, optimum paths to their destinations, traffic conditions and signal phases along their routes, and weather and road conditions. The passenger service information includes an ADB's current location, its expected arrival time, and the number of remaining seats.

Additionally, the MC centre manages information for the passengers' boarding reservations and payments through in-vehicle equipment, station kiosks and passengers' mobile applications. A station kiosk and a mobile application identify passengers' intentions to board on an ADB along with their designated stations for boarding and alighting, fares for their trips, and their payment status information. It further manages the issuance of a one-time ticket and the refunding of deposits upon return, and imposes a penalty fare if necessary.

For responding to emergencies, the MC centre operation manager is informed of emergency situations by ADBs, passengers or IoT infrastructure. The MC centre operation manager is responsible for communicating

with first responders including hospitals, police and the fire stations, if necessary, based on information on the emergency type, time and location, and emergency handling procedures.

When collecting and utilizing passengers' personal information for the delivery of these functions, the MC centre complies with regulations for protecting privacy.

4.1.4 IoT infrastructure

The IoT infrastructure directly detects road and traffic conditions in real time, collects real-time operational data from ADBs, and transmits the collected data to ADBs and the MC centre. The data that IoT infrastructure collects includes traffic, road and weather conditions, along with information for ADBs to identify safety gaps when passing through intersections within a scheduled time.

4.1.5 Smart bus station

The smart bus station provides passengers with shelters while waiting for their ADBs. It also provides operational information concerning the ADBs through devices such as bus information system (BIS) monitors and kiosks at the station. The operational messages of an ADB include route information, current locations, the number of remaining empty seats, and the remaining time for arrival at the station. The smart bus station also identifies passengers' boarding intentions through kiosks installed at the station and provides the MC centre with the messages including the number of passengers who intend to board and ADBs' arrival and departure time at a stop lot.

4.1.6 ADB passenger

The ADB passenger is a person using an ADB by making their boarding reservations at a station kiosk or with their own mobile application before boarding an ADB and paying the fare for their trip. When making a reservation, an ADB passenger provides a station kiosk or a mobile application with the messages designating their departure and destination stations, the number of accompanying passengers and the boarding time. An ADB passenger touches one-time boarding ticket on the tagging devices installed in the vehicle upon boarding and before alighting or at a smart bus station to provide boarding information. Passengers can respond to in-vehicle information in case of emergency.

4.1.7 Summary

Table 1 provides a summary of the roles of each ADB service component.