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Intelligent transport systems — Automated valet parking systems (AVPS) —

Part 1: System framework, requirements for automated driving and for communications interface

Systèmes de transport intelligents — Systèmes de parking avec voiturier automatisé (AVPS) —

Partie 1: Cadre du système, exigences relatives à la conduite automatisée et à l'interface de communication

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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 document 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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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

The aim of this document is to contribute to the realization of safe and reliable level 4 driverless operation of vehicles within parking facilities, and to support a fast and smooth market introduction by achieving interoperability among vehicles provided by different manufactures and within different parking facilities managed by different organizations.

An automated valet parking system (AVPS) will automatically operate unoccupied vehicles from the drop off area (where the driver and passengers leave the vehicle) to a parking destination, and will also send the vehicle to a pickup area upon the user's request.

An AVPS will not only provide enhanced user experiences, but is also expected to contribute to accident reduction, lowering energy consumption and CO_2 emissions of vehicles searching for available parking spaces, and effectively utilize land by densely parking vehicles in the available space.

An AVPS can be utilized in places such as the large-scale public parking facilities of shopping malls, airports, large apartment buildings, time-based small public parking lots, or fleet management carpools. By implementing the system in parking facilities, the service provider will gain the opportunity to add other related services such as moving electric vehicles to and from charging stations or providing access to the trunk for the delivery of goods. Rather than having fully-automated vehicles driving around and searching for space, the system allows the service provider to govern the vehicles for improved traffic management.

In order to contribute to the realization of safe and reliable level 4 driverless operation, the requirements specified in this document are based on the performance of state-of-the-art technologies that are available at the time of publication. Thus, this document will be revised in the future in accordance with relevant technology enhancement.

Within this document, specific technological solutions for the communications interface (e.g. communication method, message protocol) are intentionally left open due to differences in available and commonly-used technology (e.g. spectrum allocation) around the world. Therefore, it is recommended that the communications interface be further discussed at the national/regional level to ensure interoperability.

Intelligent transport systems — Automated valet parking systems (AVPS) —

Part 1:
System framework, requirements for automated driving and for communications interface

1 Scope

Automated valet parking systems (AVPSs) perform level 4 automated driving of individual or multiple unoccupied vehicles within a prescribed area of a parking facility. This document specifies performance requirements for the operation functions, the environmental conditions within parking facilities where automated vehicle operation is performed, and the test procedures to verify the performance requirements.

An AVPS is comprised of physically separated sub-systems distributed among vehicles, facility equipment and user domains. The functionalities of AVPSs are realized by cooperation of these sub-systems, which are, in many cases, provided by different organizations. This document defines the system architecture and the communication interfaces between the sub-systems at the logical level.

An AVPS manages its system participants (i.e. AVPS-compliant vehicles and parking facilities) and provides interfaces to other facility users and involved persons (e.g. system operators, facility managers). This document contains requirements for the management functions such as checking compatibility between vehicles and parking facilities, performing remote assistance and recovery when automated driving cannot be performed, and executing operation stop commands in response to the actions of other facility users.

AVPSs are intended for use by a service provider upon receiving authority over vehicles from individual service recipients. This document does not include parking automation technologies that are solely based on usage by an individual user. If the vehicle is put into driverless operation directly by the user, this is not considered to be part of the AVPS.

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 20900, *Intelligent transport systems — Partially-automated parking systems (PAPS) — Performance requirements and test procedures*

ISO 8608, *Mechanical vibration — Road surface profiles — Reporting of measured data*

ISO 19206-2, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 2: Requirements for pedestrian targets*

ISO 19206-3, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 3: Requirements for passenger vehicle 3D targets*

ISO 19206-4, *Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 4: Requirements for bicyclist targets*

ISO/SAE PAS 22736, *Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles*

IEC 61508 (all parts),, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

ISO 21448, *Road vehicles — Safety of the intended functionality*

ISO/SAE 21434, *Road vehicles — Cybersecurity engineering*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/SAE PAS 22736 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
service provider
organization that hands over or receives authority to or from users through an automated valet parking system (AVPS)

Note 1 to entry: See 5.5.2 for further information.

3.2
user
<of an automated valet parking system> individual service recipient that hands over or retrieves authority to or from service providers through an automated valet parking system (AVPS)

Note 1 to entry: Both the owner of a personal vehicle and a user of a car share service can be a user of an AVPS.

Note 2 to entry: Within ISO/SAE PAS 22736, the term “user” is defined as the human role specifically in relation to driving automation systems. An AVPS is a system that includes system participant management functions in addition to level 4 automated driving functions. Within this document, the term “system operator” (see 3.28 and 5.5.3) is used as a role which performs dispatching and remote assistance in relation to the level 4 automated driving functions of an AVPS. The term “user” is assigned to the individual service recipient, and not to the dispatcher or remote assistant.

3.3
authority
rights and ability to perform certain tasks on the subject vehicle

Note 1 to entry: Within this document, authority is transferred between the user and the service provider, and does not exist among the two at the same time. One always has priority regarding the management and operation of the subject vehicle (SV).

Note 2 to entry: See 5.1.2.2 for further information.

3.4
subject vehicle
SV
light vehicle[1] which is equipped with the vehicle operation sub-system of an automated valet parking system (AVPS)

3.5
parking facility
public or private car park in which an automated valet parking system (AVPS) is available

Note 1 to entry: An AVPS does not necessarily have to be available in the entire facility in order to achieve conformance to this document. For example, it is possible for only a certain floor within a multi-story parking facility to be dedicated to an AVPS.

Note 2 to entry: Within ISO/TS 5206-1, a parking facility is defined by different elements of the place hierarchy depending on the configuration of the place hierarchy. Typically, in ISO/TS 5206-1 conformant data, a parking facility can be characterized as a "place" with associated characterizing attributes.

3.6
operation zone
single or multiple geographical area(s) within a parking facility where automated driving can be performed by an automated valet parking system (AVPS)

Note 1 to entry: An operation zone can contain information other than the two-dimensional geographical area, such as ceiling height or floor level information.

Note 2 to entry: Within ISO/TS 5206-1, an operation zone can be defined by different elements of the place hierarchy depending on the configuration of the place hierarchy. Depending on the configuration of the parking facility, in ISO/TS 5206-1 conformant data, an operation zone can either be characterized as a "place" or as an "identified area" with associated characterizing attributes.

Note 3 to entry: Multiple areas may overlap.

3.7
drop-off area
location within the operation zone where the user leaves the subject vehicle (SV) and hands over authority to the service provider

Note 1 to entry: The drop-off area may be for a single vehicle or a larger area (e.g. the entire operation zone).

Note 2 to entry: Within ISO/TS 5206-1, this term is defined as a “specific area” which is a sub-class of “identified area”.

3.8
pick-up area
location within the operation zone where the service provider sends the subject vehicle (SV) to the user for boarding, and hands over authority

Note 1 to entry: The pick-up area may be for a single vehicle or a larger area (e.g. the entire operation zone).

Note 2 to entry: Within ISO/TS 5206-1, this term is defined as a “specific area” which is a sub-class of “identified area”.

3.9
parking spot
area within the parking facility where a single vehicle can be parked

Note 1 to entry: Parking spots are typically delineated by line markers, curbs or other identification markings on the floor.

Note 2 to entry: Within ISO/TS 5206-1, this term is defined as a “space”.

3.10
parking area
area within the operation zone consisting of multiple parking spots

Note 1 to entry: Within ISO/TS 5206-1, this term is defined as a "specified area" with associated characterizing attributes.

3.11
destination
location within the operation zone to which the subject vehicle is transferred

Note 1 to entry: The destination is determined by the automated valet parking system (AVPS). Parking spots, service bays (e.g. location beside an electric vehicle charging station) and pick-up area are examples of a destination.

3.12
route
planned traversal of a subject vehicle (SV) from the point of origin to a destination

Note 1 to entry: When way point(s) are given, a route will be created to pass these way point(s).

3.13
path
planned sequence of way points for a subject vehicle (SV) to follow

Note 1 to entry: A path is determined based on the physical size and moving capabilities (e.g. turning radius) of the SV.

3.14
trajectory
planned path with dynamic information (e.g. time, speed, acceleration)

3.15
automated valet parking facility equipment
PFE
physical equipment installed in the parking facility for supporting automated valet parking system (AVPS)

EXAMPLE Communication devices and detection sensors.

3.16
coded marker
physical indication with a unique ID installed in the parking facility, which is detectable by the SV for the purpose of assisting localization

Note 1 to entry: The number of unique IDs may be limited depending on the area of application.

Note 2 to entry: “Marker” includes all kinds of localization indicators such as radio-based technologies and those explained in Annex D.

3.17
anonymous marker
physical indication without a unique ID installed in the parking facility that is detectable by the subject vehicle (SV) for the purpose of assisting localization

3.18
designed speed
situation-specific speed for travel under given circumstances (e.g. traffic conditions, environmental conditions) which is determined by an automated valet parking system (AVPS) and which is designated to the subject vehicle (SV) by that system

Note 1 to entry: Designed speed is a variable and not a fixed value. An AVPS will operate the SV based on the designed speed, resulting in dynamic changes of the actual speed of the SV during its operation.

Note 2 to entry: Different manufacturers can provide different designed speeds under the same circumstances.

EXAMPLE An AVPS will adjust the SV’s operating speed when the SV is travelling towards a corner with limited visibility due to occlusion by a wall. The exact operating speed depends on the system design in this circumstance. Therefore, most of the test procedures in this document do not specify a specific value for the speed but only refer to the designed speed.

3.19
designed distance
situation-specific physical distance to other facility users, objects or structures, which an automated valet parking system (AVPS) intends to maintain under given circumstances while performing automated driving, and which is designated to the subject vehicle (SV) by the system

Note 1 to entry: Different manufacturers can provide different designed distances towards the same object.

3.20
pause
braking activity performed by an automated valet parking system (AVPS) which either leads the subject vehicle (SV) to a standstill or maintains a stationary condition that occurs during automated driving and in which the SV remains ready to resume automated driving

Note 1 to entry: Situations such as coming to a standstill to give way to other traffic and coming to a standstill to avoid a collision can be considered as a pause provided the AVPS is able to continue operating the SV towards the destination after the situation that led to the pause has been cleared.

Note 2 to entry: When automated driving cannot be continued by the AVPS without human confirmation, the braking activity is described as an emergency stop as defined in 6.3.

3.21
sub-system
component of an automated valet parking system (AVPS) at a logical level which includes one or more functions

Note 1 to entry: See 5.2.1 for details.

3.22
function
ability of automated valet parking system (AVPS) to process inputs to the system and contribute to conversion of the inputs into appropriate outputs

3.23
reservation
<automated valet parking service> basic agreement between the user and the service provider regarding the operation and management of the subject vehicle (SV) within a specific parking facility

Note 1 to entry: A single reservation may be valid for a certain period of time or dedicated to a single session.

Note 2 to entry: A reservation may include information such as the right to use a parking spot during a certain period of time, agreement to hand over authority or agreement for additional services (e.g. charging electric vehicle).

3.24
session
<automated valet parking service> sequence of interactions for a given subject vehicle (SV) between a check-in (see 9.3.3.1) and a check-out (see 9.3.3.2)

Note 1 to entry: There may be more than one session during one valid reservation period, but multiple sessions are not carried out simultaneously for one SV.

Note 2 to entry: Typically, a wireless connection is established on the operation interface (see 5.2.3) during a session, leaving the possibility of suspending the connection during the sleep sub-state (see 9.3.2.3.3).

Note 3 to entry: Under certain conditions, the user may have authority while a session is established. See 9.3.2.2 for additional information.

3.25
mission
<automated valet parking service> sequence of interactions under which the subject vehicle (SV) is being operated automatically by an automated valet parking system (AVPS) from its parked location to the destination for a particular purpose

Note 1 to entry: There may be more than one mission during one valid session period, but multiple missions are not carried out simultaneously for one SV.

3.26
scenario
<test> description of a complete traversal from the point of origin to a destination, to be performed for testing

3.27
scene
<test> description of a specific event to be performed for testing that does not include a point of origin or destination

Note 1 to entry: Test scenes may become part of a test scenario. Multiple test scenes may be implemented in a single test scenario.

3.28
system operator
role within an organization which manages vehicle operation in the parking facility, and which involves tasks which are either monitored while being performed automatically, or performed manually by individuals from a remote location.

Note 1 to entry: See 5.5.3 for further information.

3.29
facility manager
role within an organization which involves tasks which are to be performed by individuals and which require physical access to objects and events within the facility

Note 1 to entry: See 5.5.4 for further information.

4 Symbols and abbreviated terms

4.1 Symbols

Symbols and their meanings.

$V_{\text{des,sv}}$	designed speed of an SV
$V_{\text{max,sv}}$	maximum designed speed of an SV
$D_{\text{des,fu}}$	designed distance to other facility users (e.g. vulnerable road users) and dynamic non-AVPS vehicles
$D_{\text{des,ob}}$	designed distance to fixed structures or objects other than facility users (e.g. parked vehicles)
$D_{\text{des,gap}}$	designed longitudinal distance to the preceding vehicle during automated vehicle operation

4.2 Abbreviated terms

4.2.1 Terms defined in ISO/SAE PAS 22736

ADS automated driving system

DDT dynamic driving task

OEDR object and event detection and response

ODD operational design domain

4.2.2 Terms relating to names of system and sub-systems

AVPS automated valet parking system

OB operator backend (sub-system)

P automated valet parking facility management (sub-system)

R remote vehicle operation (sub-system)

U user frontend (sub-system)

UB user backend (sub-system)

V on-board vehicle operation (sub-system)

VB vehicle backend (sub-system)

4.2.3 Other terms

CRC cyclic redundancy check

DSRC dedicated short range communication

FV forward vehicle

PFE automated valet parking facility equipment (see 3.11)

SV subject vehicle (see 3.3)

VMC vehicle motion control

VRU vulnerable road user

NDS Navigation Data Standard