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This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 12768-1

Intelligent transport systems — Automated Valet Driving Systems (AVDS) —

Part 1: Requirements, System Framework, Communication Interfaces and Test Procedures

*Systèmes de transport intelligents — Systèmes automatisés de
service de voiturier (AVDS) —*

*Partie 1: Exigences, cadre du système, interfaces de
communication et procédures d'essai*

ICS: 35.240.60; 43.040.15

ISO/TC 204

Secretariat: **ANSI**

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This document is circulated as received from the committee secretariat.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 23374 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

The aim of this document is a use case and ODD extension of ISO 23374-1 Automated Valet Parking System (AVPS). It aims to contribute to the realization of safe and reliable low-speed level 4 (L4) driverless operation of vehicles and to facilitate a fast and smooth market introduction of future L4 systems based on the experience gained with AVDS at low speed in a well-defined ODD.

Automated valet driving systems (AVDS) perform L4 automated driving of individual or multiple unoccupied vehicles within a prescribed operation zone and predominantly at low speed.

Automated Valet Driving Systems (AVDS) provide vehicle owners an automated valet driving service at low speed which is not restricted to driverless manoeuvring within dedicated parking facilities but in addition allows driverless manoeuvring on prescribed outdoor areas. Basically, both AVPS and AVDS describe a trip from point A to point B.

One exemplary use case addressed by AVDS is valet parking at airport terminals. While AVPS describes SAE L4 driving in a dedicated parking facility AVDS will expand the drop off zone to an area which is outside of the parking facility. After the driver has left the AVDS drop off zone at a designated area, the system will automatically direct the vehicle on a public road to the entrance of a parking facility and from there to a vacant parking space or, if required, to another space of interest. The space of interest may be e.g. an electric charging station or a car cleaning station. Other use cases covered by AVDS are e.g. driving on company premises for logistics purposes.

AVDS is expected to achieve end user benefits regarding timesaving, stress reduction, lower energy consumption of vehicles and to fulfil user expectations for many low-speed manoeuvring functions. It supports e.g. the automated charging process of electric vehicles without the driver investing any time and optimizing the utilization of a limited amount of available charging stations. AVDS on company premises will enable driverless vehicle manoeuvring systems to save labour costs.

For contributing to the realization of safe and reliable driverless AVDS 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 part will be revised in the future upon technology enhancement.

This document intends to leave specific technological solutions for the communication interface (e.g. communication method, message protocol) open, due to the difference in available and commonly used technology (e.g. spectrum allocation) around the globe. Therefore, it is recommended that the communication interface is further discussed at the national/regional level to ensure interoperability.

Intelligent transport systems — Automated Valet Driving Systems (AVDS) —

Part 1: Requirements, System Framework, Communication Interfaces and Test Procedures

1 Scope

This document specifies system framework, operation sequences and communication interfaces, as well as performance requirements for sub-systems, operation and management functions, environmental conditions within the operation zone, and test procedures to verify the minimum performance requirements of AVDS.

This document defines the system architecture with the sub-systems and the communication interfaces between the sub-systems at the logical level but not the assignment of the sub-systems to business entities.

This document contains requirements for the management functions such as checking compatibility between vehicles and 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.

AVDS is restricted to cars (M1) and light commercial vehicles with a weight below 3,5 t (N1) according to ECE/TRANS/WP.29/78/Rev.3 and is not intended to be utilized for transportation of people.

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 23374-1, *Intelligent transport systems — Automated valet parking systems (AVPS) — Part 1: System framework, requirements for automated driving and for communications interface*

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 19206-4, *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 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*

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 terminological 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

User (of AVDS)

Individual service recipient that hands over *authorization* (3.3) to or retrieves authorization from system operator through AVDS.

Note 1 to entry: The owner/user of a personal vehicle, the management system of a car rental company or a marshalling system in a manufacturing plant can be a user of AVDS

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. AVDS is a system that includes system participant management functions in addition to L4 automated driving functions. Within this document, the term “system operator” (see 3.36 and 5.3.3.3) is used as a role which performs dispatching and remote assistance in relation to the L4 automated driving functions of AVDS. The term “user” is assigned to the individual service recipient, and not to the dispatcher or remote assistant

3.2

(Other) road user

All non-AVDS traffic participants like e.g. manually driven vehicles, pedestrians and bicyclists being present in the OZ of AVDS.

3.3

Authorization

Authorization to perform certain tasks on the SV including especially L4 operation e.g. driving from point A to point B.

Note 1 to entry: Within this document, authorization is transferred between the user and system operator and does not exist among the two at the same time. One always has priority regarding the management and operation of the SV

Note 2 to entry: Refer to 5.1.2 for further information

Note 3 to entry: Having the authorization does not only mean being responsible for safe driving but also for e.g. taking care of avoiding damage, collisions, vandalism, minimized energy consumption, etc.

3.4

Subject vehicle - SV

a vehicle which is equipped with the vehicle operation sub-system of AVDS.

3.5

Facility

public or access-controlled area in parts or completely capable of AVDS

Note 1 to entry: The entire facility or parts of it may be outdoor and subject to different weather conditions

3.6

Parking facility

public or access-controlled car park capable of AVPS

Note 1 to entry: The entire facility does not necessarily have to be capable of AVDS in being compliant to this document. For example, only a certain floor within a multi-story parking facility may be dedicated to AVDS.

Note 2 to entry: Within ISO/TS 5206-1, the term is defined as a “Place” with related attributes

3.7

Operation zone - OZ

geographical area within an AVDS compliant facility where L4 automated driving can be performed.

Note 1 to entry: OZ may 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, the term is defined as a “Place” using hierarchy elements

3.8

Drop-off area

location within the OZ where the user leaves the SV and hands over authorization to the system operator.

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

Note 2 to entry: Within ISO/TS 5206-1, the term is defined as a “Specific area” which is a sub-class of “Identified area”

3.9

Pick-up area

location within the OZ where the system operator sends the SV to the user for boarding, and hands over the authorization back to the user.

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

Note 2 to entry: Within ISO/TS 5206-1, the term is defined as a “Specific area” which is a sub-class of “Identified area”

3.10

Parking spot

destination within the OZ where a single vehicle can be parked or temporarily stored.

Note 1 to entry: Parking spots are typically marked by lines, curb stones, or other identification markings on the floor. (see ISO 20900)

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

Note 3 to entry: in AVDS all destinations in general are considered as parking spot where the mission ends in standby state with conditions of SV as defined in ISO 23374 (AVPS) e.g. in standstill, doors locked, windows closed. This includes also places e.g. at a charging station where the SV is parked for a certain length of time

3.11

Service spot

destination within the OZ where the SV is stopped and left in service state condition.

Note 1 to entry: the service state conditions at a service spot can differ from the fixed conditions at a parking spot (standby state) and are set according to the considered use case. These conditions include e.g. engine/motor on or off, gear in parking or neutral position, parking brake on or off

Note 2 to entry: examples for a service spot are a car wash station and a testing area with engine on and gear in N position

3.12

Parking area

area within the OZ consisting of multiple parking spots.

Note 1 to entry: Within ISO/TS 5206-1, the term is defined as an “Identified area”

3.13

Destination

location within the OZ to which the SV is transferred to.

Note 1 to entry: The destination is determined by AVDS. Parking spots, service spots (e.g. location at the entrance of a car wash station), and pick-up area are examples of a destination

3.14

Starting point

location within the OZ where an AVDS mission starts.

3.15

Route

planned traversal of an 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)

3.16

Path

planned sequence of static way points for the 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

3.17

Trajectory

planned path with dynamic information like time, direction, speed and acceleration.

3.18

Automated valet parking facility equipment - PFE

physical equipment installed in the parking facility by the system supplier and operated by the system operator (SO) for supporting AVPS in the respective AVPS garage.

Note 1 to entry: For example, communication devices and detection sensors are PFEs

3.19

Automated valet driving facility equipment - DFE

equipment installed by the system supplier and operated by the system operator (SO) for controlling AVDS in the respective AVDS facility.

Note 1 to entry: DFE can be physically installed in the AVDS facility or e.g. parts of it virtually in the cloud

Note 2 to entry: DFE includes PFE if not otherwise mentioned

3.20

Mating space

Three-dimensional volume with specified range of orientations at a conductive charging station where mating of the SV inlet and a charging plug handled by a manipulator is possible. (see IEC 61851-27)

3.21

Designed speed

situation specific speed by design of an SV to travel under the given circumstances (e.g. traffic conditions, environmental conditions) determined by AVDS

Note 1 to entry: Designed speed is a variable and not a fixed value. AVDS 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 may provide different designed speeds under the same circumstances

Note 3 to entry: For example, AVDS will adjust the SV's operating speed when the SV is traveling towards a corner with limited visibility due to occlusion by a wall. The exact operating speed depends on the system design under 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

3.22

Designed distances

situation specific physical distance by design from the SV to other road users, objects, or structures, which AVDS intends to maintain under the given circumstances while performing automated driving.

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

3.23

Safe standstill

condition where the SV is secured to avoid inadvertent rolling.

3.24

(Automated valet driving service) reservation

basic agreement between the user and the system operator regarding the operation and management of the SV within specific facility.

Note 1 to entry: Within this document, the term is shortened to “reservation”

Note 2 to entry: A single reservation may be valid for a certain period of time or dedicated to a single session

Note 3 to entry: a reservation used to be applied to automated valet parking and additional services like e.g. car wash. In this document it is also used for the planning of AVDS drives in manufacturing plants, logistic yards or car rental facilities by a management system

Note 4 to entry: depending on the organization and responsibilities of a facility the parking operator may be included in the reservation process

3.25

(Automated valet driving) session

sequence of interactions for a given SV between a check-in (see 8.2.3.1) and a check-out (see 8.2.3.2) where the permission to operate the SV or functions of the SV is handed over to the system operator.

Note 1 to entry: Within this document, the term is shortened to “session”

Note 2 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 3 to entry: Typically, wireless connection is established on the operation interface (see [5.2.4](#)) during a session, leaving the possibility of suspending the connection during the sleep sub-state

Note 4 to entry: There are conditions under which the user may have the authorization while a session is established e.g. to open the SV and store luggage in the vehicle trunk

Note 5 to entry: SV operation includes SV driving and conducting other SV related operations like unlocking and opening of windows or doors

3.26

(Automated valet driving) mission

sequence of interactions under which the SV is being operated automatically by AVDS from its starting point to the destination for a particular purpose.

Note 1 to entry: Within this document, the term is shortened to “mission”

Note 2 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

Note 3 to entry: a mission ends with a safe standstill at the destination

3.27

(test) scenario

description of a complete traversal from the point of origin to a destination, to be performed for testing

3.28

(test) scene

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

3.29

Sub-system

component of AVDS at a logical level which includes one or more functions, and which directly contributes to the AVDS operation.

Note 1 to entry: See [5.3](#) for details

3.30

Facility operator - FO

the role of an organization which is responsible for the activities in the whole facility including AVDS operation.

3.31

Safety management System - SMS

the role of an organization or person to approve a drivable and safe OZ in the facility according to the AVDS requirements.

3.32

Incident manager - IM

the role of an organization or a person that handles situations with incapacitated AVDS vehicles either manually or through the AVDS to maintain proper AVDS operation.

3.33

Orchestration system - OS

a system that orchestrates optional value-added services and breaks down a session into several missions and arranges an executable and optimized sequence of these missions.

Note 1 to entry: OS is mandatory if one or several VAS are used

3.34

Value added service system - VAS

the role of an optional service system which provides management of a dedicated AVDS use case and the communication interface to AVDS.

Note 1 to entry: Examples for VAS are EV charging, car wash, vehicle maintenance and parcel delivery

3.35

System supplier (of AVDS) - SS

role of an organization that supplies and installs AVDS equipment in the facility to enable safe operation of AVDS vehicles.

3.36

System operator - SO

receives/hands over authorization from and to users through AVDS and manages AVDS vehicle operation in the facility considering the user requests like reservation and VAS.

3.37

Parking operator - PO

the role of an organization which manages reservation, access control and payment for AVDS and non-AVDS vehicles.

Note 1 to entry: relevant only for access-controlled parking

3.38

Access-control

an area where anybody who wants to enter needs to pass a check. Entrance to the area via a gate, where conditions are checked.

4 Symbols and abbreviated terms

4.1 Symbols

Table 1 — Symbols and their meanings

Symbol	Meaning
V_{des_sv}	Designed speed of an SV (a variable) depending on the current situation
V_{max_sv}	Maximum designed speed of an SV (a fixed value)
D_{des_fu}	Designed distance to other figure road users (e.g. vulnerable road users) and dynamic non-AVDS vehicles (a variable)
D_{des_ob}	Designed distance to fixed structures or objects other than road users (e.g. parked vehicles) (a variable)
D_{des_gap}	Designed longitudinal distance to the preceding vehicle during automated vehicle operation (a variable)

4.2 Abbreviated terms

ADS	Automated Driving System [1]
aEVSE	automatic Electric Vehicle Supply Equipment
DDT	Dynamic Driving Task [1]
DFE	automated valet Driving Facility Equipment
FO	Facility Operator
FV	Forward Vehicle
IM	Incident Manager
L4	Level 4 (see SAE J3016™)
MRC	Minimal Risk Condition
MRM	Minimal Risk Manoeuvre
OB	Operator Backend (sub-system)
ODD	Operational Design Domain [1]
OEDR	Object and Event Detection and Response [1]
OEM	Original Equipment Manufacturer
OS	Orchestration System
OZ	Operation Zone
PFE	automated valet Parking Facility Equipment (see 3.11)
PO	Parking Operator
RO	Remote vehicle Operation (sub-system)

SMS	Safety Management System
SO	System Operator
SOC	State Of Charge
SS	System Supplier
SV	Subject Vehicle (see 3.3)
UB	User Backend (sub-system)
UF	User Frontend (sub-system)
VAS	Value Added Service system
VB	Vehicle Backend (sub-system)
VMC	Vehicle Motion Control
VO	on-board Vehicle Operation (sub-system)
Vov	speed of the other vehicle
Vsv	speed of subject vehicle
VRU	Vulnerable Road User

5 System framework

5.1 System description

AVDS is considered as a use case and operational design domain (ODD) extension of ISO 23374 - 1 including indoor and outdoor applications to perform e.g. driverless maneuvering on company premises, outdoor valet parking with driving on public roads e.g. from an airport terminal to a parking garage. AVDS also enables additional services e.g. driving to a charging station for electric vehicles or to a car wash station.

The AVDS is comprised of physically separated sub-systems distributed among vehicles, facility equipment and user domains. The functionalities of AVDS are realized by cooperation of these sub-systems, which are, in many cases, provided by different organizations.

The AVDS manage its system participants (e.g. AVDS compliant vehicles, facilities and users) and provides necessary interfaces between them.

Furthermore, the AVDS is intended for use by a system operator upon receiving authorization of vehicles from individual service recipients.

5.1.1 Basic functionalities

The basic functionalities of AVDS can be separately described as the (automated vehicle) operation functions related to driving operations and the (system participants) management functions related to the planning, organization and coordination of the whole AVDS session. [Table 2](#) describes these basic functionalities of AVDS.

- Performance requirements associated with the (automated vehicle) operation functions are specified in chapter [6](#).
- General requirements associated with the (system participants) management functions are specified in [Clause 5.3](#).

Table 2 — Basic functionalities and their description

Basic functionalities	Description
Operation functions	— Determines a destination and route — Performs L4 automated driving — Monitors in which state the SV is and verifies that the SV is able to receive and process vehicle operation commands — Responds to commands of the system management functionalities
Management functions	— Manages surrounding conditions in the facility — Checks the compatibility between vehicles and facility — Identifies the correct SV as the communication participant — Remotely engages and disengages an SV — Performs remote assistance [1] when necessary — Issues command to stop the operation when necessary — Reacts upon incapacitation of the automated vehicle operation — Processes user requests including additional services like e.g. car wash and EV charging — Sets priorities when several vehicles are operated in parallel

5.1.2 Basic flow

5.1.2.1 General

- A session and a mission are defined analogous to ISO23374-1 (AVPS).
- [Figure 1](#) describes the basic flow of a complete AVDS sequence based on the user action and the system reaction.
 - Steps 3 to 8 describe the flow of a generic use case where the user initially hands over authorization to the AVDS. It includes the execution of optional VAS
 - Steps 9 to 12 describe the flow of a typical car retrieval process for valet parking as a separate mission
 - In many use cases AVDS consists of a sequence of missions. The retrieval action may be reduced to only handing over authorization to the user (or management system, see [5.5](#))
- In AVDS the user may request additional VAS (e.g. EV charging, car wash) to be carried out during the time the authorization of the SV is with the AVDS system operator. The requested services and the earliest pick-up time may be communicated to the AVDS with the reservation. Depending on the remaining timeframe additional services can as well be requested while the authorization is already with the AVDS system operator. Also, services that are not yet executed can be changed by the user. Conditions and requirements for each of the requested services can be added or revised by the user e.g. for EV charging a target SOC (state of charge) and a maximum price per kWh can be specified.

Such a session including additional VAS will consist of more missions and tasks than in AVPS (e.g. a sequence of parking, waiting, charging, parking, waiting, washing, parking). Organizing the sequence of the requested services and the corresponding missions within the given timeframe is the task of the orchestration system.

- The initial mission after hand-over of the authorization and the retrieval mission use to be initiated by the UB based on the user's request while missions related to VAS are initiated by OS. All missions are assigned by OB as specified in ISO 23374 AVPS (see Annex [A.2.7](#), mission assignment sequence).

- Re-parking may be requested by the OS when a service is completed (e.g. charging level is reached, washing is finished), and when the next service or parking spot for re-parking is available.
- For each VAS the compatibility of vehicle and service shall be checked. This includes geometrical (e.g. vehicle height, width, length, charge plug position), electrical (e.g. plug type, charging power, requested charging level), and other service specific characteristics.

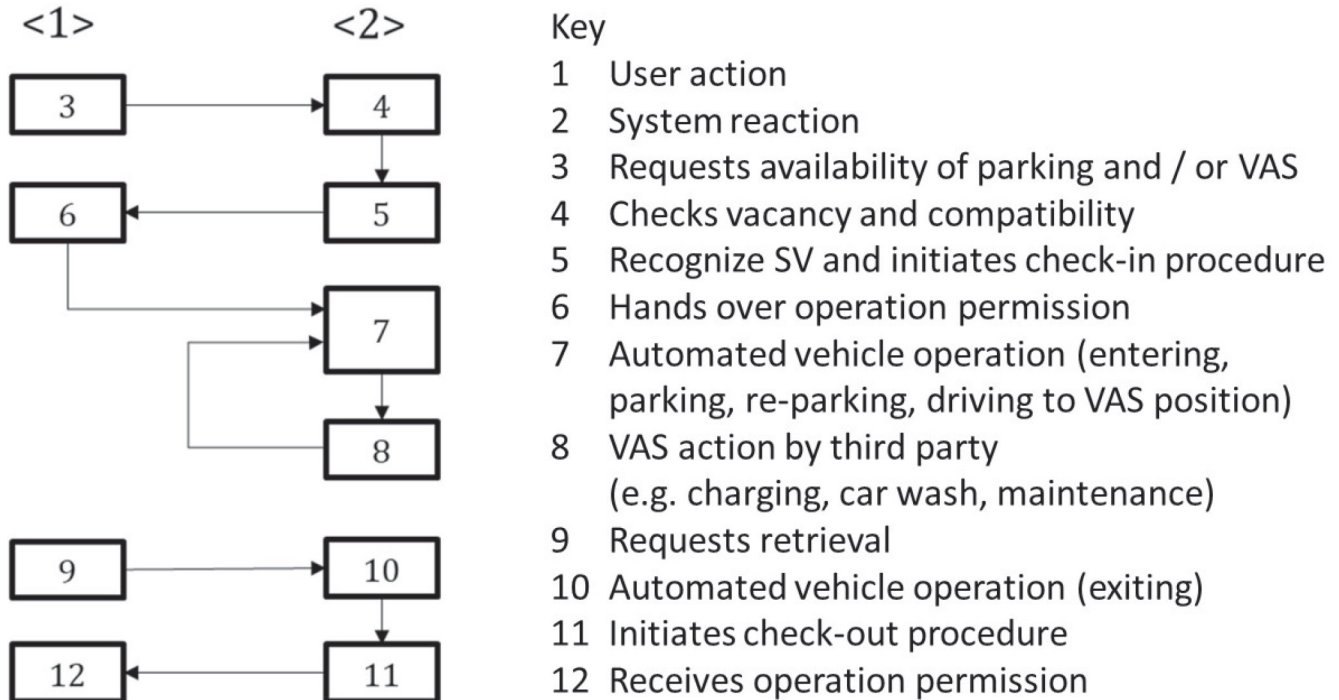


Figure 1 — Basic flow of AVDS

5.2 System configuration

5.2.1 Use cases

This document specifies different use cases for AVDS. All use cases are based on the AVPS functionality of ISO23374-1 but with use case specific additional requirements. A short overview of these use cases is given in [table 3](#). Any combination of use cases is allowed. Detailed requirements for these use cases are specified in [clause 6](#).

Table 3 — Use case overview (informative)

Use case	Short description
Indoor AVPS	AVPS in parking facilities as specified in ISO23374-1
Outdoor AVPS	AVPS at outdoor parking facilities or using public roads e.g. at airport terminals
EV charging	Driving to and from charging stations
Plant maneuvering	Driving in vehicle manufacturing plants e.g. between line segments, to calibration stations or on test tracks
Logistic yards	Driving to and from loading platforms
Car wash	Driving to and from car wash stations
Rental car premises	maneuvering vehicles to different service stations
Other services	Services with vehicle access like parcel delivery or vehicle maintenance

5.2.2 Additional AVDS sub-systems

An AVDS basically consists of the same sub-systems as defined in ISO23374-1. Due to the additional services which are facilitated by AVDS two additional sub-systems are required.

- Orchestration system (OS)
- Value added service system (VAS) which represents a physically different sub-system for e.g. car wash, EV charging or maintenance.

These two sub-systems are designed as plug-in systems and are separately attached to the initial AVPS architecture. They shall keep the AVPS architecture unchanged to preserve compatibility between AVPS and AVDS when only parking systems are implemented in AVDS.

The role of the OS is described in clause 5.3.1.2 and the different AVDS specific VAS requirements are specified in the respective subclauses of [clause 6.3](#).

5.2.3 System architecture

[Figure 2](#) shows the logical architecture of the AVDS sub-systems. Implementation of the logical sub-systems to physical components is up to system design and not subject to this document. The sub-systems may be implemented in individual physical components, or several sub-systems may be integrated in one physical component. In addition, a sub-system may be comprised of multiple physical components. For example, the remote vehicle operation sub-system may be comprised of sensors, control units, and communication devices. The interfaces between these physical components are also not subject to this document.

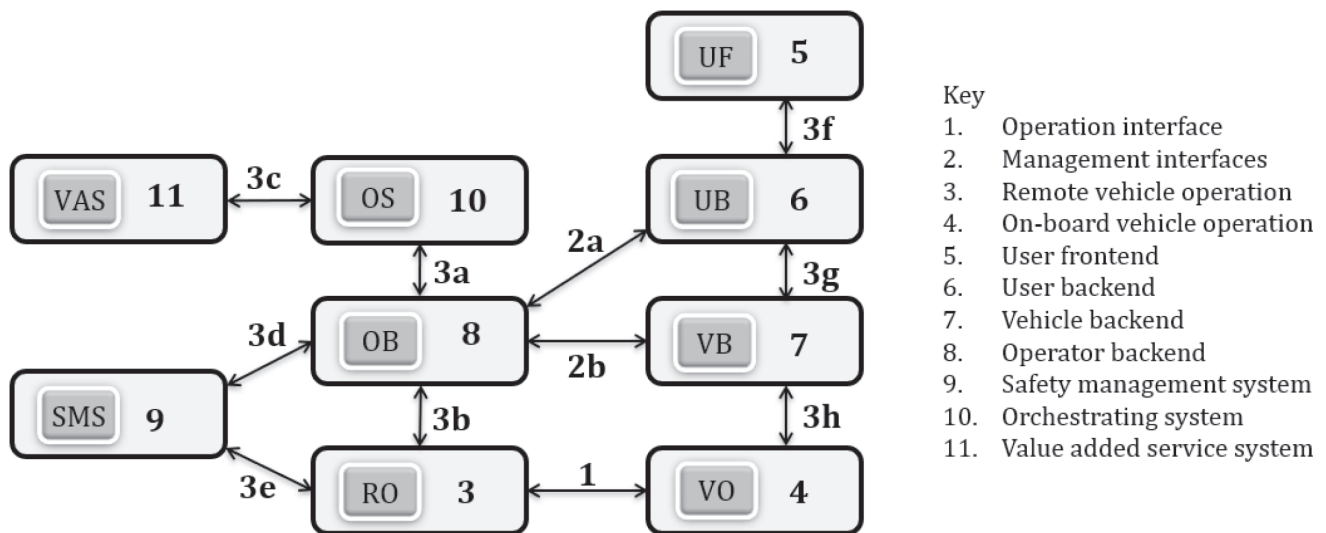


Figure 2 — Basic system architecture

The OB is considered as a local or a global system. It has all relevant information about at least one or a cluster of facilities of the respective AVDS operator and coordinates the AVDS operation within these facilities. In addition, it provides the capabilities to manage the sessions and missions in the respective facility.

The OS (see 5.3.2.4) is a local system in a dedicated facility coordinating the activities of all local VAS sub-systems. Therefore, each OB may coordinate more than one local OS.

In the use case plant maneuvering (also named plant marshalling) the plant specific services are managed by the OS and VAS according to the architecture in [fig. 2](#). Both OS and VAS use to be integrated in an overarching manufacturing system.

5.2.4 Interfaces

Arrows in [figure 2](#) represent the interfaces and communication links between the sub-systems.

- The main communication content of each arrow is described in [table 4](#)
- This document specifies the minimum set of data elements to be communicated through the operation interface (key 1) and management interfaces (key 2a, 2b, 3a)
- This document describes the flow of information represented by the arrows with key2 in [figure 2](#). The operation interface (key 1) is specified in ISO23374-1

Table 4 — Description of communication links

# Link	Sub-systems	Main purpose
2a	UB – OB	clarification of available facilities including VAS and reservation
2b	VB – OB	SV status, engagement/disengagement, vehicle compatibility
3a	OB – OS	Forward reservation to local VAS, VAS status information.
3b	OB – RO	Start and control missions
3c	OS – VAS	Coordinate missions and services for VAS
3d	OB – SMS	Inform about issues in the OZ. conduct remote or manual control in case of incapacitation
3e	SMS – RO	Disable the AVDS operation
3f	UF – UB	User request to user backend
3g	UB – VB	Match SV to the user
3h	VB – VO	Vehicle wake up, enable remote operation

5.3 Functional allocation

5.3.1 Description of sub-systems

[Table 5](#) gives an overview of the AVDS sub-systems and the allocation of the main functions of AVDS to each sub-system of the architecture.

The sub-system specification is given in ISO23374-1 except for the AVDS specific OS and VAS sub-systems (see [clause 5.3.1.1](#) and [5.3.1.2](#)) and the SMS sub-system which is modified compared with AVPS (see [5.3.2](#)).

Different abbreviations are used for the remote vehicle operation (RO), the on-board vehicle operation (VO), and the user front end (UF) in this document compared to ISO23374-1, where these sub-systems are abbreviated with the single letters R, V, and U.

Table 5 — Functional allocation to sub-systems

ID	Sub-system	Main functions	Role	Remarks
RO	Remote vehicle operation	— Longitudinal and lateral vehicle control	Performs automated vehicle operation	The functional allocation between the vehicle operation sub-systems RO and VO differs depending on the vehicle operation type
VO	On-board vehicle operation	— SV identification and localization		
		— Destination assignment		
		— Route planning, path determination and trajectory calculation		
		— OEDR		
		— Emergency stopping		
UF	User frontend	— Sends user requests — Receives and updates vehicle status to user	Interface to the user	OEM and/or any other provider specific realizations possible
UB	User backend	— User request processing — Clarification of available facilities with OB	Manages the system participants in the facility	The four backend sub-systems UB, VB, OB, and OS cooperate to respond to user requests (e.g. retrieval of vehicles, requests of value added services). OS is optional and only required if VAS are provided in the facility
VB	Vehicle backend	— Remote engagement/ disengagement — Additional commands to SV (e.g. open charging cover)		
OB	Operator backend	— Manages facility availability — Checks compatibility between SV and facility — Dispatches SV into driverless operation — Terminates system operation when necessary — Performs remote assistance either automatically or manually — Disposes manual transfer of incapacitated vehicles by the incident manager		

Table 5 (continued)

ID	Sub-system	Main functions	Role	Remarks
OS	Orchestration system	— Coordination of VAS within the facility — Receives user data and checks and answers requests — Checks compatibility of SV and VAS — elaborates and continuously maintains activity plan for the VAS		
SMS	Safety managing system	— Monitors and controls safety measures — Manages environmental conditions — Responds to incapacitation of the operation functions	Manages operating conditions	SMS provides conditions for a safe AVDS operation
VAS	Value added service system	— Additional services like e.g. car wash, EV charging, maintenance — Operation of AVDS related plant service systems (e.g. marshalling) — VAS are optional	Provides services	VAS ensures VAS performance and safe conditions during VAS execution

5.3.1.1 Value-added service system (VAS)

A VAS provides a dedicated optional service within an AVDS facility.

Basically, AVDS only drives SV to the service location, informs the VAS of the availability of SV and, after the service is finished, drives SV back to a parking spot. The service itself is performed by the VAS, the specific requirements and SV conditions to perform that service are defined by VAS.

In general a service can be performed either in „standby state“ where the respective requirements and SV conditions as defined in ISO 23374-1 (AVPS) have to be met.

For services where the specific requirements and SV conditions for that service would violate the requirements of „standby state“, the service needs to be performed in „service state“. In „service state“ the authorization is transferred to VAS.

The OS, which knows the specific VAS characteristics has to determine whether a service can be performed in “standby state” (obeying the respective requirements) or needs to be performed in “service state”.

Differences of the two states related to VAS:

In “standby state”

- AVDS has the authorization of the SV
- RO monitors and controls the SV
- A direct communication between RO and VO is established
- The AVDS controls the SV and is responsible for safety related to SV movements
- All requirements for the system state “standby” and conditions for the corresponding transitions apply

In “service state”

- AVDS does not have the authorization of the SV
- RO sub-system does not control the SV and may not monitor the SV during the service operation

- RO may not have direct communication established with VO
- VAS controls the SV and provides safe operation conditions

The VAS provides a communication interface to AVDS according to the interface requirements described in this document.

5.3.1.2 Orchestration system (OS)

The OS manages the local VAS operations to optimize the overall efficiency of the additional services according to the user demands which are communicated through UB and OB.

Examples for OS tasks are as follows:

- Continuously gather and administrate all properties as well as the static and dynamic operating conditions of the involved VAS
- Compare the user requests with the offered service conditions
- Check and approve compatibility between SV and VAS

From an OS point of view a VAS mainly is characterized by (see [clause 6.3.4](#)):

- a target position where AVDS aims to get SV to and the applicable target position tolerances
- the VAS specific requirements and SV conditions

The OS, which knows the specific VAS characteristics has to determine whether a service can be performed in standby state (state 12 in [fig. 8](#)) complying with the respective requirements or a service needs to be performed in service state (state 22 in [fig. 8](#)). For that purpose, AVDS will hand over the authorization to the VAS when SV has reached the service location.

For certain VAS, SV has to be placed at an exact position with tighter positioning tolerances than for standard parking. OS has to calculate the target position of SV in x, y and phi coordinates taking into account the positioning requirements of the VAS and the properties of SV.

OS together with plant specific VAS acts as operation system for plant specific use cases and services.

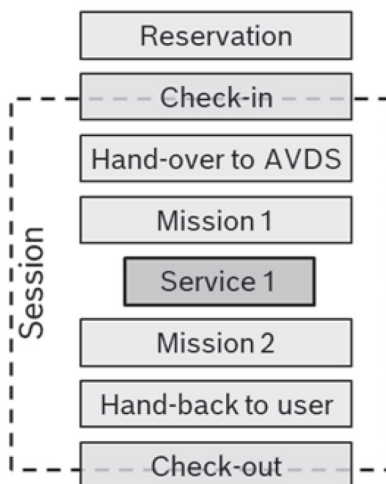


Figure 3 — Relation between mission and services

5.3.2 Modified SMS role

The following role description is modified compared with the role in ISO23374-1. As an AVDS subsystem it is directly involved in the AVDS operation.

The SMS approves drivable and safe OZ in the facility according to the AVDS requirements in this document. The SMS may be located onsite or remotely depending on the environment and the installed system. The role of the SMS includes at least the following tasks:

- Ensure that all specified safety measures are implemented and properly maintained which are necessary for the specific traffic environment of the provided use cases in the facility (see [5.4.2](#)).
- Ensure that the following measures are established and properly working on access-controlled facilities (e.g. plant, logistic yards, rental car) with informed, restricted or exclusive traffic environment
 - access control to the OZ according to the specific use case and traffic environment (see [5.4.2](#)).
 - instruction of road users who might encounter AVDS vehicles in access-controlled AVDS facilities with informed traffic environment.
 - training of personnel working under restricted traffic environment.
- Ensure that the environment in the facility is maintained (e.g. illuminance, floor or road conditions, DFE operating conditions, barriers or markings for construction areas)
- Regularly monitor weather and road conditions (see [6.2.3](#)) and react in a customized way on weather influences to avoid unsafe road conditions. A customized clearance from snow and ice by e.g. salt spray or gravel distribution shall be organized and approved by the SM
- Disable the AVDS operation and inform the involved sub-systems if a safe AVDS operation can no longer be kept due to adverse weather conditions or incidents like fire or traffic accident

Respond to incapacitation of AVDS vehicles and/or the operation functions RO and VO either through the AVDS or through the incident manager to avoid blockage of the pathways for other vehicles

Responsibility can be taken through a system or a qualified human.

5.3.3 Additional roles

The following roles are added in this document compared with ISO23374-1 and need a dedicated description. These roles are not involved in the direct AVDS operation. They are not considered as an AVDS sub-system and therefore not included in [fig. 2](#).

5.3.3.1 Facility operator (FO)

The FO is responsible for all activities in the facility including AVDS operation. The FO allows the system supplier to install AVDS equipment in the facility. The FO ensures that all necessary measures are implemented for a safe AVDS operation e.g. adapt physical structures on roads or buildings to enable safe AVDS operation,

The tasks of the FO may include the role or the supervision of the safety manager, the incident manager, and the management of VAS through the OS. In case of parking garages, it may also include reservation, access control, and billing.

The FO ensures the specification and implementation of appropriate access control means to the OZ with specific traffic environment (see [5.4.2](#)) including information or training of the persons allowed in the respective zones. The FO is understood as higher-level role which may be specifically defined for different facilities.

5.3.3.2 System supplier (SS)

The AVDS system supplier supplies, installs, and maintains the AVDS equipment to safely conduct AVDS operations according to the specification in this document. The SS is fully or partly responsible for the approval of the AVDS in the facility. This includes at least the approval of the remote vehicle operation system (RO) and the operator backend (OB). The on-board vehicle operation system (VO) is physically provided by

the vehicle manufacturer. VO and RO jointly contribute to the overall AVDS performance, task assignment to VO and RO is depending on the AVDS type.

5.3.3.3 System operator (SO)

SO is an AVDS operator in an AVDS compliant facility who manages, monitors, and controls all driving related AVDS operations considering all user requests like reservation, VAS, etc. The SO role is considered as umbrella role which may comprise the OB, RO, and VO roles. This may also include e.g. access control to the OZ and operation of wireless communication.

SO receives authorization from the user to perform the AVDS vehicle operation and hands it back to users after termination of the AVDS session.

5.3.3.4 Parking operator (PO)

Manages reservation, access control (e.g. by license plate recognition) and optionally payment for AVDS and non-AVDS vehicles. This role is optional and only relevant for parking garages with AVDS service.

The PO role is optional and depends on the specific set-up and organization of the facility.

5.3.3.5 Incident manager (IM)

Handles situations with incapacitated AVDS vehicles either manually or through the AVDS to maintain proper AVDS operation as AVDS vehicles may block roads e.g. by a vehicle break-down, disruption of system communication, emergency stops or accidents.

To maintain normal traffic in the facility and/or in the OZ incapacitated AVDS vehicles need to be moved to a place where they don't hinder other traffic participants. For that purpose, the incident manager needs access to the vehicle through AVDS or s/he shall at least be able to clear the situation by towing the incapacitated vehicle to an appropriate place.

The incident manager gets information about incidents either through the AVDS system or through the SMS.

As an option the IM may move the vehicle utilizing remote assistance and remote driving according to ISO7856 (under development).

5.4 Classification

5.4.1 Vehicle operation types

ISO23374-1 specifies three different AVPS types with different functional allocation to the remote vehicle operation sub-system (RO) and to the on-board vehicle operation sub-system (VO), see ISO23374-1, chapter 5.4.1. In this document only type 2 systems are considered and specified.

5.4.2 Traffic environment categories

5.4.2.1 General

Facilities capable of handling AVDS are categorized into mixed, informed, restricted, and exclusive traffic areas depending on the traffic environment. They have different requirements for the ODD and OEDR. An informative overview about the different traffic environments is given in [table 7](#). Moving from one area to another area with different driving environment (e.g. from restricted to informed traffic environment) within one session or mission is allowed as long as the requirements related to the traffic environment are met and safe driving is guaranteed.

Table 7 — Traffic environment overview

	Mixed	Informed	Restricted	Exclusive
Speed limit for all road users	30 km/h	30 km/h	Depending on distance between SV and VRU	No general limit
VRU	allowed	informed about sharing road with AVDS vehicles	trained how to deal with AVDS vehicles	not allowed
other vehicles	allowed	Allowed	with permission of Safety Management System	only AVDS vehicles allowed
Operation zone	Publicly accessible	with access information	with access control	with access control

5.4.2.2 Mixed traffic environment

Mixed traffic is an environment where the vehicles operated by AVDS share the same public area with all kinds of other road users like manually driven vehicles and vulnerable road users (e.g. bicyclists and pedestrians including small children). These road users in the AVDS OZ may not be informed sharing the surrounding with driverless vehicles.

Typical use cases are e.g. outdoor AVPS at an airport terminal or any other outdoor parking lot and EV charging stations at a motorway service area.

Basically, AVDS have a limited performance due to the available perception sensors. Current systems are not able to handle situations where other road users drive faster than 30 km/h. To avoid safety critical situation where AVDS is unable to cope with fast driving road users the speed of all other road users shall be limited to 30 km/h in the AVDS OZ by e.g. traffic signs. For example, matched speeds of all vehicles facilitate merging maneuvers of AVDS vehicles with other road users which may not be aware of AVDS vehicles.

Public road traffic regulations apply for all road users including AVDS vehicles.

5.4.2.3 Informed traffic environment

In an informed traffic environment vehicles operated by AVDS share the same non-public area with all kinds of other road users. In comparison with mixed traffic (5.4.2.2) these road users are informed about sharing the OZ with AVDS vehicles. An access control to the non-public area which may contain one or more AVDS OZs is required to ensure that all road users are informed when entering this area. Typical use cases are e.g. car manufacturing plants where AVDS vehicles are driving from end of a production line to a distant parking space. On that route AVDS vehicles may share roads with manually driven vehicles and with VRUs like bicyclists and pedestrians using or crossing these roads. In addition, other automated transportation systems (e.g. driverless trucks for materials handling) may also be present. All the traffic participants, including AVDS vehicles and automated transportation systems should conform to site specific traffic regulations.

The AVDS OZ shall be indicated by e.g. information boards, floor markings, or other recognizable means which give the road users sufficient notice that they are approaching an AVDS OZ. It is sufficient that the road users are informed about the basic behavior of AVDS vehicles and how to behave in the proximity of AVDS vehicles. An additional and specific training how to deal with AVDS vehicles is therefore not required.

The Safety Management System shall ensure that only informed persons have access to those facilities, children are either excluded or need special supervision. Public road traffic regulations shall be effective on the entire non-public area as traffic participants may expect usual behavior of all road users.

5.4.2.4 Restricted traffic environment

Restricted traffic is an environment where the vehicles operated by AVDS share the non-public OZ only with specifically trained people and specific technical vehicles necessary for transport of goods or loading/unloading the AVDS vehicles (e.g. fork lifts, industrial trucks).

In case of manually operated transport vehicles the operator of these vehicles shall take care of AVDS vehicles to avoid any collision. However, if they intrude the safety zone of AVDS vehicles the AVDS vehicles shall trigger an emergency stop maneuver.

In case of automatically operated transport vehicles (see ISO3691), it is recommended that the management/marshalling system of the facility operates both AVDS and automated transport vehicles in a way that collisions are avoided.

The restricted zone is separated from the surroundings by appropriate means to avoid unauthorized access by untrained individuals.

Typical use cases are manufacturing plants where AVDS vehicles are driving short distances within the production line e.g. between line segments or to inspection stations.

Individuals in the OZ like manufacturing staff shall be specifically trained how AVDS vehicles operate and especially how to safely deal with them. Other vehicles e.g. for transportation of goods may be allowed with a dedicated permission of the FM.

Restricted OZs are only allowed on access-controlled facilities where public road traffic rules may not apply. The OZs are separated by appropriate means defined by the FM. These means like barriers, fences, and walls with e.g. gates or access locks shall ensure safety for all individuals in this area. Safety measures do not have to compulsorily derived from legal conditions or public safety standards but may be modified by the FM considering basic safety requirements and local aspects like specific factory agreements or conditions of employer's insurance associations.

The speed limit of AVDS vehicles is defined by the FM to avoid the risk of severe accidents. Higher SV speeds are allowed depending on the distance between the SV and VRU balancing safety aspects and needs e.g. at manufacturing lines.

Safety measures do not have to comply with legal regulations or public safety standards but may be modified by the FM considering particular safety requirements and local aspects like specific factory agreements or directives of employer's insurance associations. During AVDS operation safety mechanisms may be deliberately reduced according to the specific application. This may include weakening of safety stop requirements to allow access to the vehicle and to work with close distances to the AVDS vehicle.

5.4.2.5 Exclusive traffic environment

Exclusive traffic is an environment where the vehicles operated by AVDS are travelling in a non-public OZ exclusively reserved for AVDS operated vehicles. VRU and non-AVDS vehicles are not permitted in the OZ.

The OZ shall be delimited by fences, walls or other appropriate means which clearly mark the OZ and prevent other road users from entering the OZ. The OZ may be only temporarily used for AVDS traffic but never together with other road users. It is up to the FM to install solid safety barriers to prevent AVDS vehicles from unintendedly leaving the OZ at least in critical areas e.g. where pedestrian paths are close.

The speed of AVDS vehicles is not limited. The speed limit shall be defined by the FM according to the specific conditions on the OZ.

Typical use cases with exclusive traffic are e.g.

- Manufacturing plants where AVDS vehicles are driving long distances on dedicated roads from the production line to a distant parking space
- Sensor calibration drives for finished vehicles at manufacturing plants
- Endurance tests on dedicated test tracks

If individuals are present in the OZ (e.g. for road work or technical maintenance) the AVDS operation shall be stopped to avoid endangering of people.

5.5 System operation

5.5.1 General

The AVDS user is not restricted to a human user but may also be a management system which uses AVDS capable vehicles in specific use case.

5.5.2 AVDS utilization by a human user

Typical examples where a human is directly acting authorization as AVDS user are AVPS-outdoor and EV charging.

When the user initially hands over the authorization of the SV to the AVDS system operator as illustrated in [Figure 1](#), this document presupposes that an agreement exists between the user and SO to perform the following tasks through AVDS, at a minimum:

- Dispatch the SV into driverless operation
- Perform L4 automated driving on that dispatched vehicle to the requested places
- Turn off the SV at the parking spot and, if required, at the service spot
- Allow the incident manager to enter the vehicle and manually operate the vehicle in the case that automated vehicle operation is not possible
- AVDS may be used for additional services which require access to the SV. By requesting these services, the user grants physical access to the SV for the purpose and duration of the requested service. Examples for these optional services are access to the trunk for parcel delivery or technical car maintenance (e.g. oil change, antifreeze filling)

It is assumed that the user and system operator agree on the terms and conditions when using AVDS, which would include the aspects above. However, the form and the contents of the agreement are not within the scope of this document.

It should be noted that the incident manager is required to manually relocate the SV in the case of incapacitation of automated vehicle operation (see [6.9.9](#)). If entering the vehicle cannot be agreed upon, alternative means shall be prepared in order to comply with the requirements of this document.

5.5.3 AVDS utilization by a management system

Typical examples are maneuvering in car manufacturing plants, logistic yards or rental car companies. AVDS on company premises considers use cases where the user is a management system (logistics, manufacturing) that provides the following information and operation conditions for each SV to the AVDS:

- Starting point (e.g. drop-off location) and starting time of SV operation
- Final destination (e.g. pick-up location) and requested end time of the AVDS sequence
- List of requested services incl. conditions and requirements for these services e.g. SV shall be washed with a requested program and charged to e.g. 80 % SOC
- Any specific conditions for vehicle operation like activation of sensors or actuators, open/lock doors or windows etc.

6 Requirements for automated vehicle functions

6.1 General

AVDS is basically assumed as an extension of AVPS with additional use cases listed in [table 3](#). Therefore, the performance requirements and operating conditions of the AVPS standard ISO23374-1 are valid if not

explicitly changed in this AVDS document. The following clauses contain additional requirements for these additional use cases.

The AVDS OZ shall be delimited either by structural measures, by geo fencing or based on the field of view of the stationary perception sensors in type 2 systems. Other road users should be informed with appropriate means before entering the AVDS OZ that they are sharing the road with automated driverless vehicles (see [5.4.2](#)).

In general, other traffic with speed over 30 km/h is not allowed in the AVDS OZ. Further restrictions for speed of non-AVDS vehicles may be applied depending on the specific use case and OZ. AVDS shall be able to detect and deal with non-AVDS vehicles according to the valid traffic rules in the OZ.

6.1.1 Safety considerations

The overall principles of performing automated vehicle operation shall be identical to AVPS:

- safe operation of the unoccupied AVDS vehicle shall be given the highest priority among the overall objectives of AVDS
- the performance of the AVDS operation functions should be at least equal to or better than the driving capabilities of an experienced and attentive human driver (i.e. recognizing the environment, planning the reaction, and operating the vehicle)
- even when fulfilling these basic safety guidelines AVDS has the same performance limitations as AVPS and cannot avoid all collisions with other road users (see ISO23374-1, clause 6.2.3.3)

Additional use cases beyond those defined in this document are covered by this standard if no additional performance requirements are necessary.

6.1.2 Basic performance requirements

6.1.2.1 General

OEDR is a primary function of the operation functions as the normal/routine operation of the SV is performed automatically without direct supervision or continuous monitoring by a human. It is crucial to verify that the performance requirements are satisfied independently of different combinations of the RO and VO sub-systems.

The following subclauses specify minimum requirements that are fundamental among various scenarios. System designers shall consider improving the performance beyond the minimum requirements during specific driving scenarios (e.g. to increase distances to other facility users under clear traffic conditions).

It is strongly recommended that OEDR be designed in a conservative and safety-oriented manner to avoid unnecessary risks and loss of social acceptance by commanding unnecessarily aggressive VMC which may be perceived as threatening by other facility users.

The performance requirements of AVDS are different for the specific traffic environment categories and use cases depending on the presence of VRU, road users with manually driven vehicles, and specifically trained staff. It also depends on whether the OZ is on access-controlled or public ground.

6.1.2.2 Basic performance requirements for all traffic environments

The following requirements apply during normal operation in mixed, informed, restricted, and exclusive traffic environment.

- AVDS shall be capable of using braking or evasive manoeuvres in order to avoid reasonably foreseeable and preventable collisions which may injure VRUs or cause damages to objects or SV
- AVDS shall be capable of providing smooth braking and acceleration. It shall avoid sudden braking or acceleration of the SV under non-emergency/non-hazardous situations