TECHNICAL SPECIFICATION

ISO/TS 5255-1

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

Part 1:
Role and functional model

Systèmes intelligents de transport — Service de système de conduite automatisée à vitesse réduite (CAVR) —

Partie 1: Rôle général et modèle fonctionnel

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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.

Introduction

In order to introduce low-speed automated driving systems (LSADS) to support mobility used as a means of moving people, goods and services in urban and rural areas, it is necessary to standardize the related service role and functional model.

ISO 22737 describes vehicle driving supports, but does not cover the requirements of the service role or the functional model covering infrastructure facilities. Therefore, a document covering these topics is necessary.

Business use cases regarding LSADS services are currently emerging and further variations are coming to be deployed. Various roles and functional model presentation methodologies are available for use, and there is a need for a set of more commonly understandable role and functional model presentation guidelines. This document defines a common LSADS service role and functional model presentation.

Future emerging business cases can refer to this document as a baseline document. Indeed, this it is intended to assist in the development of future business, and does not hinder them. This document can also contribute to the development of future automated driving system service business cases other than LSADS services.

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

Part 1:
Role and functional model

1 Scope

This document defines the requirements of the basic role and functional model of service applications for the introduction of low-speed automated driving system (LSADS) services including infrastructure facilities for supporting mobility in urban and rural areas.

This document covers services using LSADS-equipped vehicles only; in-vehicle control systems are outside the scope.

Examples of infrastructure facilities and road furniture include driving monitoring platforms, emergency response platforms, operation management platforms, user service platforms (e.g. for online reservations and online payments) and platforms for supporting automated driving systems.

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/TR 4445, *Intelligent transport systems — Mobility integration — Role model of ITS service application in smart cities*

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 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/

4 Abbreviated terms

AD   automated driving

CAD   connected and automated driving

CONOPS   concept of operations

E-call   emergency call

ISAD   infrastructure support levels for automated driving

LSAD   low-speed automated driving

LSADS   low-speed automated driving system

METR   management for electronic traffic regulations

ODD   operational design domain

PT   public transport

SCMS   security credential management system

5   Automated driving system classification and service evolution

5.1   Introduction

The automated driving (AD) system classification and service evolution vision are described in this clause in order to present the current development and deployment situation of LSADS services.

5.2   Service classification of AD systems

A suggested AD system service classification is shown in Table 1.

Within the context of the scope of this document, L2 operational design domain (ODD) is not classified as AD.

AD system services cover a range of use cases as described in Table 1, including carrying people and goods, urban and rural use, normal mobility uses and emergency mobility use such as in pandemic/lockdown situations, where human driving vehicles can be unusable for transporting people and goods.

The majority of current LSADSs deployed are as per the SAE-defined ODD levels L3 and L4. However, LSADSs of L5 and above are anticipated as being the ideal mobility for flexible use cases in the future.

Table 1 — AD system service classification

ODD levels (OEM definition)	Mobility for people	Mobility for goods (including road service vehicles)	Urban use (Last/first mile use)	Rural area use (replacing PT)	Used under emergency or pandemic status
L5	A	A	A	A	A
L4	A	A	A	A	A
L3	O/S	O/S	O/S	O/S	O/S
L2	O/S	O/S	O/S	O/S	O/S
Key					
A: applicable to this document;					
O/S: out of scope of this document.					

5.3   AD system service evolution

Table 2 shows the expected AD system service evolution. The deployment of the current low-speed automated driving (LSAD) service is for limited use only, as the safety function and emergency case manoeuvring ability are not qualified as being a sufficiently safely reliable services. However, the LSADS is intended to evolve into a fully functional connected and automated driving (CAD) system in the future. For this reason, it is necessary to develop a LSADS service role and a functional model defining and covering fully automated and connected driving such as is described by the term CAD.

Tables 2 and 3 show where a current LSADS service sits within the fully automated CAD paradigm.

Table 2 — AD system service evolution (current)

Service type	Public transport use (PT)	Shared and personal use (Robot taxi)	Demand management	Integration with kerbside operation	All levels of ODDs
Mobility for people	C/L	C/L	C/L		
Mobility for goods	C/L	C/L	C/L		
Dedicated lane (road) Mixed lane	C/L	C/L	C/L		
Road service vehicles (snowplough)					
Key					
C/L: current LSAD emerging status.					

Table 3 — AD system service anticipated evolution (future)

Service type	Public transport use (PT)	Shared and personal use (Robot taxi)	Demand management	Integration with kerbside operation	All levels of ODDs
Mobility for people	F/L	F/L	F/L	F/L	F/L
Mobility for goods	F/L	F/L	F/L	F/L	F/L
Dedicated lane (road) Mixed lane	F/L	F/L	F/L	F/L	F/L
Road service vehicles (snowplough)	F/L	F/L	F/L	F/L	F/L
Key					
F/L: future LSAD emerging status --> reaching to CAD mobility status					

6 Infrastructure support for LSADS service role and functional model

The LSADS service shall be fully functional with support from infrastructures, such as safety information provisioning, kerb operation interactions, road signs and road digital and physical facilities for CAD.

— Kerb operation, LSADS shall use the kerb for loading and unloading goods and people. The operation environment should be carefully considered to achieve safe operations.

— Management for electronic traffic regulations (METR), for the efficient and safer operation of CAD-type LSADS, electronic regulation information shall be given to the vehicle with the safety information provisioning given from infrastructure facilities.

— V2X communication path between vehicle and infrastructure (LTE, 5G and beyond) should be carefully designed and the various communication paths between LSADS and infrastructure should be according to relevant International Standards.

— Infrastructure support levels for automated driving (ISAD) system service categorization per infrastructure support platform utilization levels shall be according to the Level A (highest level: cooperative driving) to level E (basic level: conventional infrastructure/no AV support), as developed by the EU INFRAMIX project.

NOTE   A technical report issued by the EU INFRAMIX project proposes the careful study of LSAD operation according to the ISAD concept, and it is recommended that adoption of this concept be thoroughly discussed in order to classify the levels for automated driving for supports from infrastructure facilities (see Annex A).

7   Role and functional model

7.1   Objective

This clause describes a generic role and functional model for the provision of ITS service applications for LSADS services. It explains the general concept of role and functional model operations. It also provides a definition for the role and functional model and the elaboration of the model at a conceptual level.

7.2   National variations

The definition of what comprises an ITS service application is an issue for national decision and can vary from country to country. The instantiation of interoperable on-board platforms (or nomadic devices such as smart phones) for ITS service application with common features is ideal but varies between countries, as does the provision of services. It is possible that certain countries will mandate the use of such a platform, while others will offer it as an option to meet the requirements of the ITS service application with minimum administration and paperwork (providing a good business case for operators to fit and use the equipment). Certain countries might implement a single, government-operated, -controlled, or -contracted service provider, which will be the single communication manager between the user and the service. Other countries might provide a market-based solution with multiple service providers competing for the business of vehicle operators.

7.3   Basic role model

The role model concept defined in ISO/TR 4445 shall be considered as baseline document. Figure 1 shows the basic role model for ITS service application for smart cities.
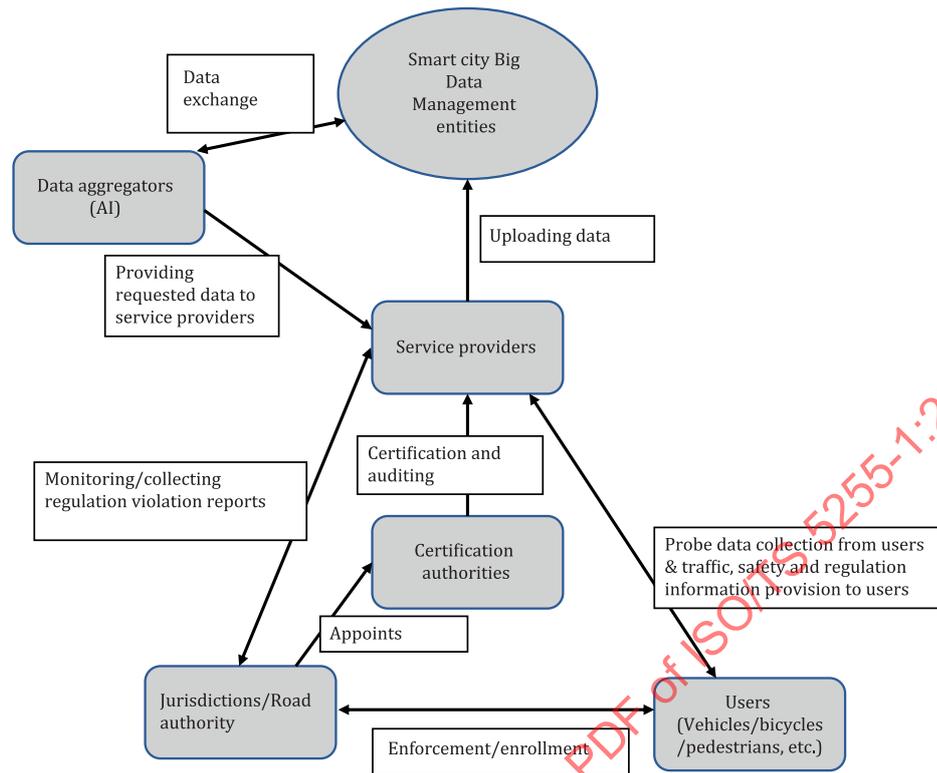
Figure 1 — Role model defined in ISO/TR 4445

7.4 Application layer role and functional model for LSADS

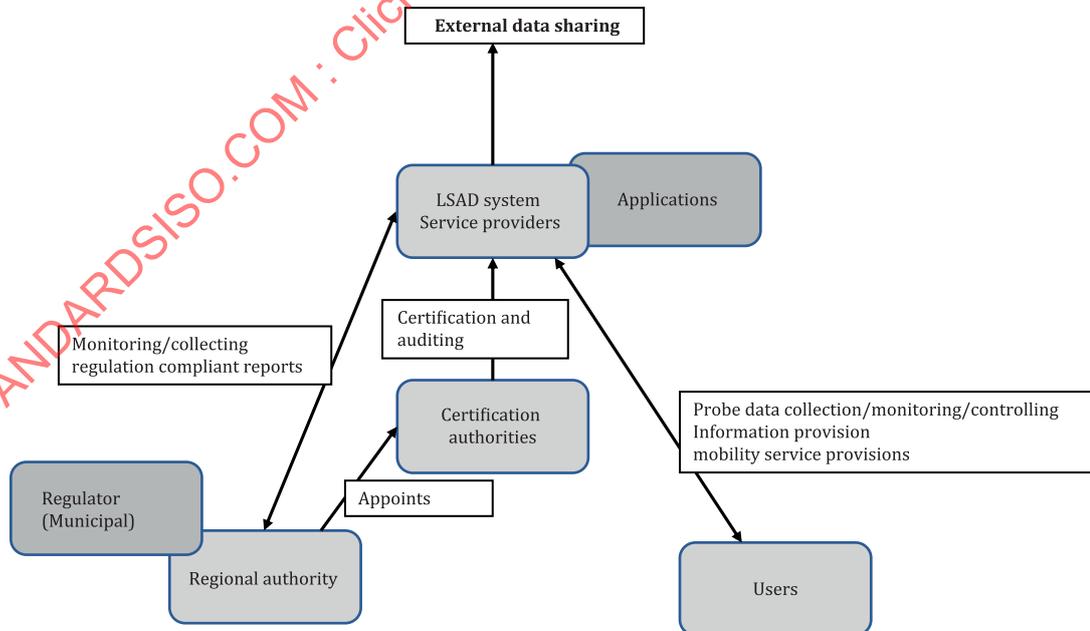The role model concept defined in ISO/TR 4445 is modified for LSADS service as shown in Figure 2.

Figure 2 — Application layer role and functional model

7.4.1 Role and functional model options

For the requirements of the role and functional model, it needs to be possible for an LSADS service application user to use the services of different service providers in different geographical areas, or for different services to be provided within the same geographical area. In these circumstances, where there is a market of competing service providers, it is likely that the solution will be for the user to choose a single service provider who will provide and maintain the LSADS service application on a nomadic device (such as a smart phone) and who will deliver to the user all services to which that user chooses to subscribe. Other options are possible, but should be able to support the peer conceptual role and functional model.

7.4.2 Certification of service providers

As determined by the regulator, the LSADS service provider will need to be certified by the regulator, and so some form of certification authority (regulatory) role forms an essential part of the role and functional model. However, the role can and will be instantiated differently by different jurisdictions. LSAD vehicle inspection and certification is performed by certain parties, taking into consideration regional authority-defined regulations.

8 Concept of operations

8.1 General

This clause describes the characteristics of a proposed LSADS from the viewpoint of an individual who will use that system. The objective is to communicate the quantitative and qualitative system characteristics to all stakeholders.

This clause describes the roles and responsibilities of the classes and actors involved in the provision of LSADS service applications. It is recognized that variations exist between regional authorities. This clause does not attempt, nor recommend, homogeneity between regional authorities; it is simply designed to provide a set of common standard features to enable the use of equipment of common specification. It is also intended to provide the common features of service provision so that they can be referenced by a regional authority in its regulatory and/or legislative regime simply by referring to an ISO document (thereby requiring it to specify in detail only the particular additional requirements).

A concept of operations (CONOPS) evolves from a concept and is a description of how a set of capabilities can be employed to achieve desired objectives.

8.2 Statement of the goals and objectives of the system

The overall objective of this role is the assessment and monitoring of LSADS service applications to meet the requirements of the regional authorities within which it is operating, using LSAD.

This concept of operations is achieved by the provision of application services for specific aspects of the control and management of LSADS service applications. These services should be provided by agreement with the user and by using an approved service provider, meeting the requirements of the regional authorities using ITS systems (or nomadic devices such as smart phones), with communications capability between the user (pedestrians) and LSADS service provider.

8.3 Strategies, tactics, policies and constraints affecting the system

Strategies, tactics, policies and constraints affecting the LSADS services can vary from regional authority to regional authority.

8.4 Operational processes for the system

The following description of operational processes is at a high abstracted level (above that of any application service). Specific services can have additional requirements not described herein, but guidance and specification for certain aspects should be obtained from ISO 22737.

A regional authority passes legislation/regulations to require or support the provision of a particular LSADS application service. The legislation/regulation needs to provide a clear and unambiguous definition of what is required.

8.5 Appointment of a certification authority

The regional authority creates or appoints an authority to certify and audit the LSADS service process. The structure of that authority is a matter for the regional authority, and it can be a separate appointed organization, or a department of the regional authority. Within the context of this document, it is the actor adopting the role of certification authority that is important, not its structure, ownership, or business model.

A certification authority can preside over the instantiation and operation of only one application service or can preside over the instantiation and operation of all application services for ITS services (at the discretion of the regional authority).

The certification authority will certify service providers, LSAD vehicles, and will provide an audit.

8.6 Role of the service provider

The service provider offers to provide to users the LSADS service needed to meet the requirements of the regional authority. The service provider may also provide additional ITS services so long as they do not impair, impede or interfere with the provision of the enrolled application service(s).

LSADS service data stored should be shared by other smart city entities. Interfaces for external data sharing function should be considered.

LSADS service provider service quality is inspected and monitored by the regional authority and the regional authority can collect regulation complying reports from service provider.

8.7 User

The user is usually the ITS service user, for example a shared/personal mobility user for a people-carrying LSADS and a logistics body for a goods-carrying LSADS. The user will appoint an approved service provider to provide the LSADS service.

It is the responsibility of the service provider of the LSAD vehicle to have their vehicle equipped to enable it to provide the service. So long as the user uses certified service providers, they can then assume that the application service ought to be provided in accordance with the regional legislation/regulations.

The user is responsible for paying any fees for the provision of the service agreed with the service provider, to the service provider. The means by which this is provided is a subject for the commercial marketplace and is outside the scope of this document.

User location data can be collected and monitored by the service provider of the LSADS service. The LSAD vehicle which the user uses can be monitored and controlled by the LSADS service provider. While the user remains in the LSAD service area, valuable information provisioning can be provided when the user provides their location data to the service provider.

9 Operational physical layer role and functional model

9.1 General

The model of the overall operational physical layer role and functional model of the LSADS service is provided in Figure 3 for reference.
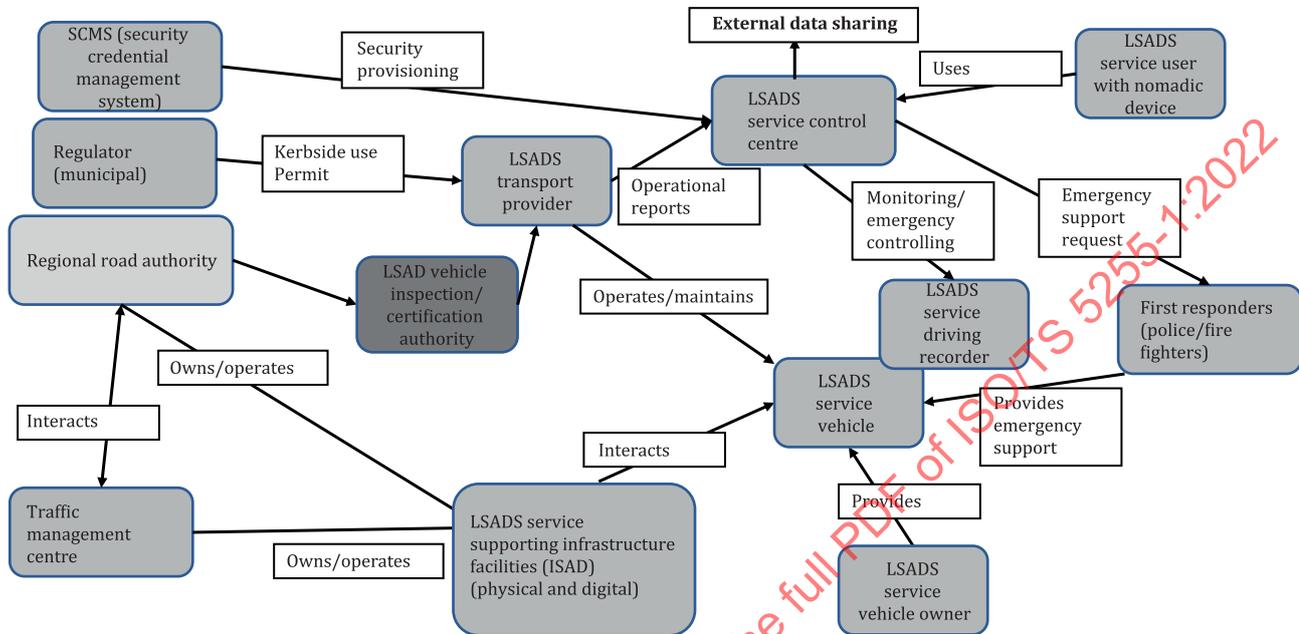

Figure 3 — Operational physical layer role and functional model

Clause 8 provided the generic concept of operations which these actors enact to provide the LSADS service. To specify a generic operational physical layer role and functional model of the LSADS service application, this clause identifies core actors and interactions between them as described in the following subclauses. The role and functional model shown in this document is an aggregated model; a modified LSADS service with only some of the actors can be possible for actual deployment. However, in that case, only limited functions with limited safety mobility can be available.

9.2 Actors

This subclause describes a role model where the roles and responsibilities of key actors are explained to provide an LSADS service concept of operation:

a) the LSADS service control centre;

b) the LSADS service user with nomadic device;

c) the LSADS transport provider;

d) the LSADS service vehicle;

e) the LSADS service driving recorder;

f) the LSADS service vehicle owner;

g) the LSAD vehicle inspection/certification authority;

h) the First responders (police/fire fighters);

i) the LSADS service supporting infrastructure facilities (ISAD) (physical and digital);

j)   the regulator (municipal);

k)   the regional road authority;

l)   the SCMS (security credential management system);

m) the traffic management centre.

9.3   LSADS service role and functional model

9.3.1   General

This subclause considers the roles of the actors defined in 9.2 and their interrelationship in greater detail. It also considers their relationship to the provision of the LSADS service.

9.3.2   LSADS service control centre

The LSADS service control centre is the body that monitors and emergency controls the LSAD service vehicle through the LSAD service driving recorder. The LSADS service user uses the LSADS service through the LSADS service control centre for booking. External (outside of LSADS service) data sharing can be done through this service control centre. The emergency support request should be issued from this centre to first responders. The SCMS should function through this centre to the entire LSADS service for security provisioning. The LSADS transport provider shall report LSADS service operation to this control centre.

9.3.3   LSADS service user with nomadic device

The user is the body that uses the LSADS service. Booking and payment can be done through the LSADS service control centre by using a nomadic device which is carried by the user.

9.3.4   LSADS transport provider

The LSADS transport provider is the body that provides the LSADS service and operates and maintains LSADS service vehicles. Operational reports shall be reported to the LSADS control centre. The LSADS transport provider shall be selected and audited by an LSAD inspection/certification authority and LSADS service vehicles shall be frequently inspected by this authority for safety operation. Detailed procedures and regulations of kerbside operations shall be examined by the corresponding authority. LSADS service vehicles shall use kerbside with permit issued by regulator (municipal) for picking up/ loading people/goods and getting off/unloading people/goods.

9.3.5   LSADS service vehicle

The LSADS service vehicle is a component that provides LSADS service rides. The LSADS service vehicles shall be the property of the LSADS service vehicle owner who provides the LSADS service vehicle to the ride service. The LSADS service vehicle shall equip the LSADS service driving recorder. In emergency cases, the LSADS service vehicle shall be treated by first responders. The LSADS service vehicle shall be operated with infrastructure support through the LSADS service infrastructure facilities that is appropriate for designated levels defined in ISAD rules created and regulated by the corresponding road authority. Interaction between infrastructure and the LSADS service vehicle is essential for safe LSADS service. Support can include road signs, road markings, V2X communications-based information providing facilities, road embedded magnets and road embedded electronic guided wires.

9.3.6   LSADS service driving recorder

The LSADS service driving recorder is a component that is equipped/installed or attached to the LSADS service vehicle. It provides operational supports from the LSADS service control centre. The control centre monitors LSAD vehicle operation and controls as needed for emergency cases.

9.3.7 LSADS service vehicle owner

The LSADS service vehicle owner is a body that owns LSADS vehicles and provides them for LSADS services by lending vehicles to the transport provider.

9.3.8 LSAD vehicle inspection/certification authority

The LSAD vehicle inspection/certification authority is a body that appoints and audits the LSADS transport provider. The safety facility/measure inspection of the LSADS service vehicle shall be performed by this authority. This authority shall be selected/appointed by the regional road authority.

9.3.9 First responders (police/fire fighters)

The first responders (police/fire fighters) are a body that supports the LSADS service in case of emergency upon request from the LSADS service control centre.

9.3.10 LSADS service supporting infrastructure facilities (ISAD) (physical and digital)

The LSADS service supporting infrastructure facilities (ISAD) (physical and digital) are a component that supports the LSADS service vehicles through infrastructure. "Physical" items refer to road signs, road markings and road embedded magnets. "Digital" items refer to information provisioning services such as METR, a digital infrastructure data base created, owned and maintained by the regional road authority and traffic management centre. The regional road authority and traffic management centre interact to accomplish safe operation of road vehicles by providing safety information through roadside V2I ITS communication facilities.

9.3.11 Regulator (municipal)

The regulator (municipal) is an entity that maintains road operations including kerbside where the space is used by LSADS service vehicles for loading and unloading people and goods. The kerb use shall be operated/maintained and use of kerb shall be permitted only for designated vehicles regulated by the regulator. Permits shall be issued to the LSADS transport provider.

9.3.12 Regional road authority

The regional road authority is an entity that maintains safe road operations and appoints/audits the LSAD vehicle inspection and certification authority. It also owns, operates and maintains LSADS service supporting infrastructure facilities. Interaction with traffic management is anticipated and it is required to provide efficient infrastructure support for LSADS service.

9.3.13 SCMS (security credential management system)

The SCMS is a component that provides security provisioning for LSADS service. SCMS for LSADS service shall be created by the authority and SCMS services shall be provided to the LSADS control centre. The security certificate issued by the SCMS shall be installed in the LSAD vehicles at the manufacturing factory and refreshed frequently while used for operation through the control centre by using over the air updating functions.

9.3.14 Traffic management centre

The traffic management centre is a body that owns, operates and maintains the LSADS service supporting infrastructure facilities. It interacts with the regional road authority.

9.4 Operational physical layer data flow

9.4.1 General

The operational physical layer data flow is described as shown in Figure 4.
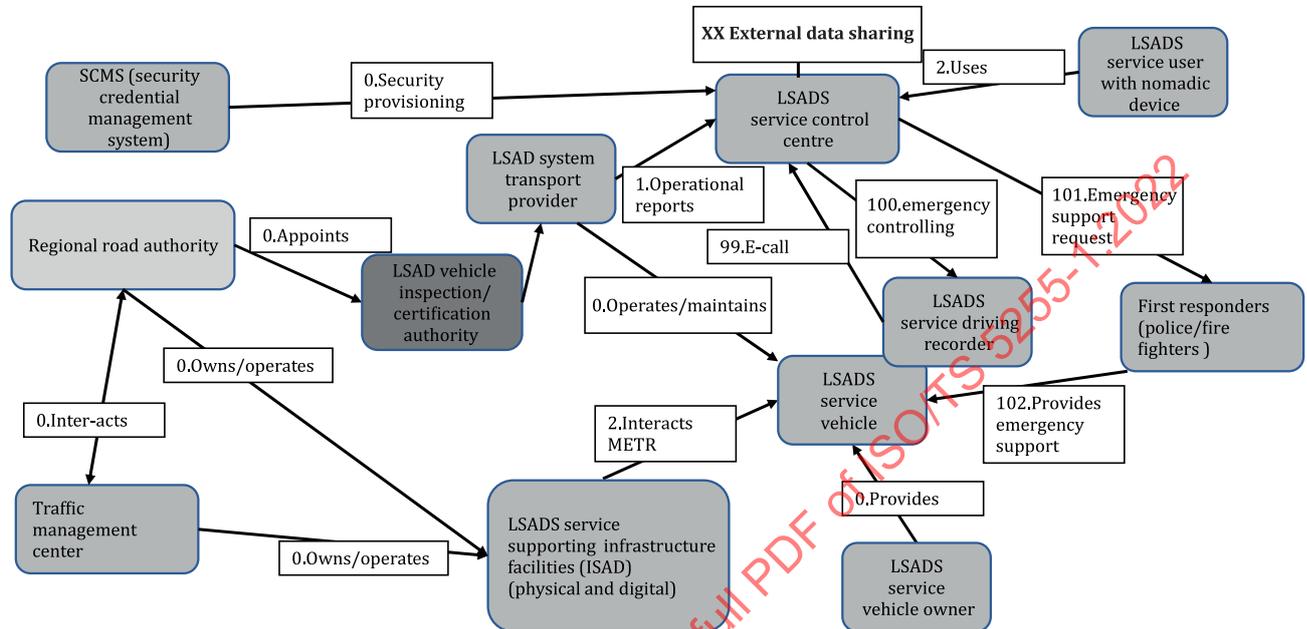

Figure 4 — Operational physical layer data flow

9.4.2 External data sharing

The external data sharing function shall be provided so that the smart city data management entity can access the LSADS service for data sharing purposes.

9.4.3 LSADS service supporting infrastructure facilities

The LSADS service supporting infrastructure facilities shall provide physical and digital support for CADs. Physical facilities shall provide safety static information to conventional and automated driving vehicles. Digital information generated from roadside sensors and vehicle probe data shall be provided to the digital infrastructure platform and used for various ITS services such as the traffic management centre. Static and dynamic road regulation data shall also be provided from the regional road authority as METR metadata to this digital infrastructure platform. LSADS service supporting infrastructure facilities shall get METR data from that digital infrastructure METR metadata. The LSADS provides LSAD vehicle probe data to this digital infrastructure platform.

9.4.4 Interaction between LSADS components

The LSADS service control centre shall receive an operational report from the LSADS transport provider which operates and maintains the LSADS service vehicle. Each vehicle operational status shall be remotely monitored by the LSADS service control centre through the LSADS service driving recorder equipped/installed in the LSAD vehicle. In an emergency, the LSADS service control centre shall perform emergency controlling of the vehicle for safety purposes triggered by an emergency call (E-call) from the vehicle. Upon receipt of such a call from the vehicle, the control centre shall request emergency support to first responders who provide emergency support on site.

10 Booking and payment layer role and functional model

10.1 General

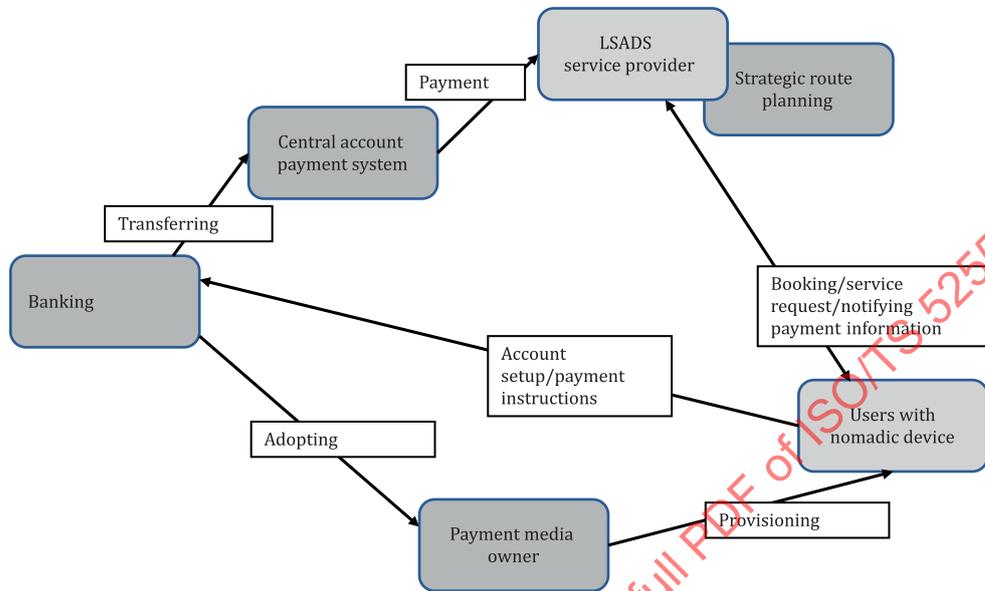The overall booking and payment layer role and functional model of the LSADS service is shown in Figure 5.

Figure 5 — Booking and payment layer role and functional model

Clause 9 provided the operational physical layer role and functional model concept of operations to provide the LSADS service. This clause provides the booking and payment layer role and functional model.

10.2 Actors

This subclause describes a role model where the roles and responsibilities of key actors are explained to provide an LSADS service concept of booking and payment:

a) the user with nomadic device

b) the LSADS service provider

c) the strategic route planning

d) the banking

e) the central account payment system

f) the payment media owner

10.3 LSADS service role and functional model in booking and payment layer

10.3.1 General

This subclause considers the roles of the actors defined in 10.2 and their interrelationship in greater detail, alongside their relationship to the provision of the LSADS service.

10.3.2 User with nomadic device

The user with nomadic device is a body that makes bookings and settles ridership payment of a LSADS service. The user settles payment accounts in banking and gives payment instructions upon using/ booking the LSADS service. When the user wants to use the LSADS service, they first make a booking to LSADS service provider through the nomadic device they are carrying by providing a service request. The user then normally receives a confirmation notification from the service provider with fare payment information. Payment may be made through the nomadic device service application or fare media issued/provided by the payment media owner.

10.3.3 LSADS service provider

The LSADS service provider is a body that provides the LSADS service to the user. Upon receiving a service request from the user, the strategic route planning shall be done so that the optimal and most efficient service plan can be created. Payment from the user may be made from a central account payment system for comfortable user service as the user can use the same booking system for various other mobility services.

10.3.4 Strategic route planning

Strategic route planning is a component that is used for efficient ride sharing route planning purposes by the LSADS service provider.

10.3.5 Banking

Banking is a body that gives payment services to the user. The user sets up an account at banking and instructs banking when they use the LSADS service. Banking adopts certain payment media and instructs the payment media owner to provide payment media to the user. Upon receiving payment instructions from the user, banking transfers the payment to the central account payment system which pays out to the LSADS service provider.

10.3.6 Central account payment system

The central account payment system is a component that provides aggregated payment service functions for mobility service providers including LSADS service.

10.3.7 Payment media owner

The payment media owner is a body that issues/provides fare payment media to the user for the use of the LSADS service.

10.4 Booking and payment layer data flow

10.4.1 General

The booking and payment layer data flow is described in Figure 6.