TECHNICAL SPECIFICATION

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Electronic fee collection — Localisation augmentation communication for autonomous systems

Perception de télépéage — Communications d'augmentation de localisations pour systèmes autonomes

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 13141 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Road transport and traffic telematics*, in collaboration with ISO Technical Committee ISO/TC 204, *Intelligent transport systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Introduction

On-board equipment (OBE) working with satellite-based positioning to collect data required for charging for the use of roads operate in a so-called autonomous way (i.e. generally without relying on dedicated road-side infrastructure). However, these autonomous systems can, in particular places, need some road-side infrastructure support for proper identification of charge objects. Such assistance might be required at places where satellite-based localisation accuracy or availability is insufficient or at places where the OBE is directly informed about the identity of the relevant charge object.

In an interoperable environment, it is essential that this localisation information be available in a standardized way. This Technical Specification defines requirements for localisation augmentation by dedicated short-range communication (DSRC) between road-side equipment and on-board equipment. This Technical Specification makes no assumptions about the operator of the road-side equipment, in terms of his role according to ISO 17573, i.e. whether the road-side equipment is operated by an entity in the Service Provision role or in the Toll Charging role.

This Technical Specification has been prepared considering the following requirements:

— the localisation augmentation communication (LAC) serves to transmit localisation information to passing OBE without identifying individual OBE;

— the localisation information contains both geographical location independent of charging context, and context-dependent identification of charge objects;

— a single road-side installation is able to provide localisation augmentation for several overlapping EFC contexts;

— this Technical Specification is according to the EFC architecture specified in ISO 17573;

— the communication applies to all OBE architectures;

— this Technical Specification is applicable to various DSRC media, including the CEN DSRC stack;

— the communication supports security services for data origin authentication, integrity and non-repudiation.

This Technical Specification defines an attribute, LACData, which is communicated from the roadside to the OBE by means of an acknowledged writing service, which is implemented through the SET service of DSRC Layer 7 (ISO 15628 and EN 12834). The LAC application is defined as a self-contained DSRC application with its own application identifier (AID). Regarding the DSRC communications stack, this Technical Specification gives definitions for the CEN DSRC stack, as used in EN 15509 and the Annexes C, D and E demonstrate the use of ISO CALM IR, UNI DSRC and ARIB DSRC.

All data relevant for the LAC application have been put into the attribute LACData, in order to create a single standard communications content transmitted by all road-side equipment, and always signed as a whole. LACData can transport both geographic coordinates (Lat, Long, Alt) and the identification of a specific charge object. All elements of LACData are mandatory, but Null values are defined to allow LAC installations to transmit only a selection of all defined data elements.

Access credentials are mandatory for writing LACData in order to protect OBE from non-authentic road-side equipment. LACData are critical for charge determination and need to have evidentiary quality. For these purposes, the authenticators which are defined can be used to provide for data origin authentication, data integrity and non-repudiation for LACData. There are two separate authenticator fields defined to allow for separate authentication and non-repudiation, if required by the institutional arrangements of a toll system.

This Technical Specification is minimal, in order to be able to cover what is required by operational EFC systems and systems planned in the foreseeable future.

Electronic fee collection — Localisation augmentation communication for autonomous systems

1 Scope

This Technical Specification establishes requirements for short-range communication for the purposes of augmenting the localisation in autonomous electronic fee collection (EFC) systems. Localisation augmentation serves to inform OBE about geographical location and the identification of a charge object. This Technical Specification specifies the provision of location and heading information and security means to protect from the manipulation of the OBE with false road-side equipment (RSE).

The localisation augmentation communication takes place between an OBE in a vehicle and fixed road-side equipment. This Technical Specification is applicable to OBE in an autonomous mode of operation.

This Technical Specification defines attributes and functions for the purpose of localisation augmentation, by making use of the DSRC communication services provided by DSRC Layer 7, and makes these LAC attributes and functions available to the LAC applications at the RSE and the OBE. Attributes and functions are defined on the level of ADUs (Application Data Units, see Figure 1).

As depicted in Figure 1, this Technical Specification is applicable to:

— the application interface definition between OBE and RSE;

— the interface to the DSRC application layer, as specified in ISO 15628 and EN 12834;

— the use of the DSRC stack.

The localisation augmentation communication is suitable for a range of short-range communication media. This Technical Specification gives specific definitions regarding the CEN DSRC stack as used in EN 15509, and Annexes C, D and E give the use of ISO CALM IR, UNI DSRC and ARIB DSRC.

This Technical Specification contains a protocol implementation conformance statement (PICS) proforma and informative transaction examples. This Technical Specification is not applicable to test specifications.

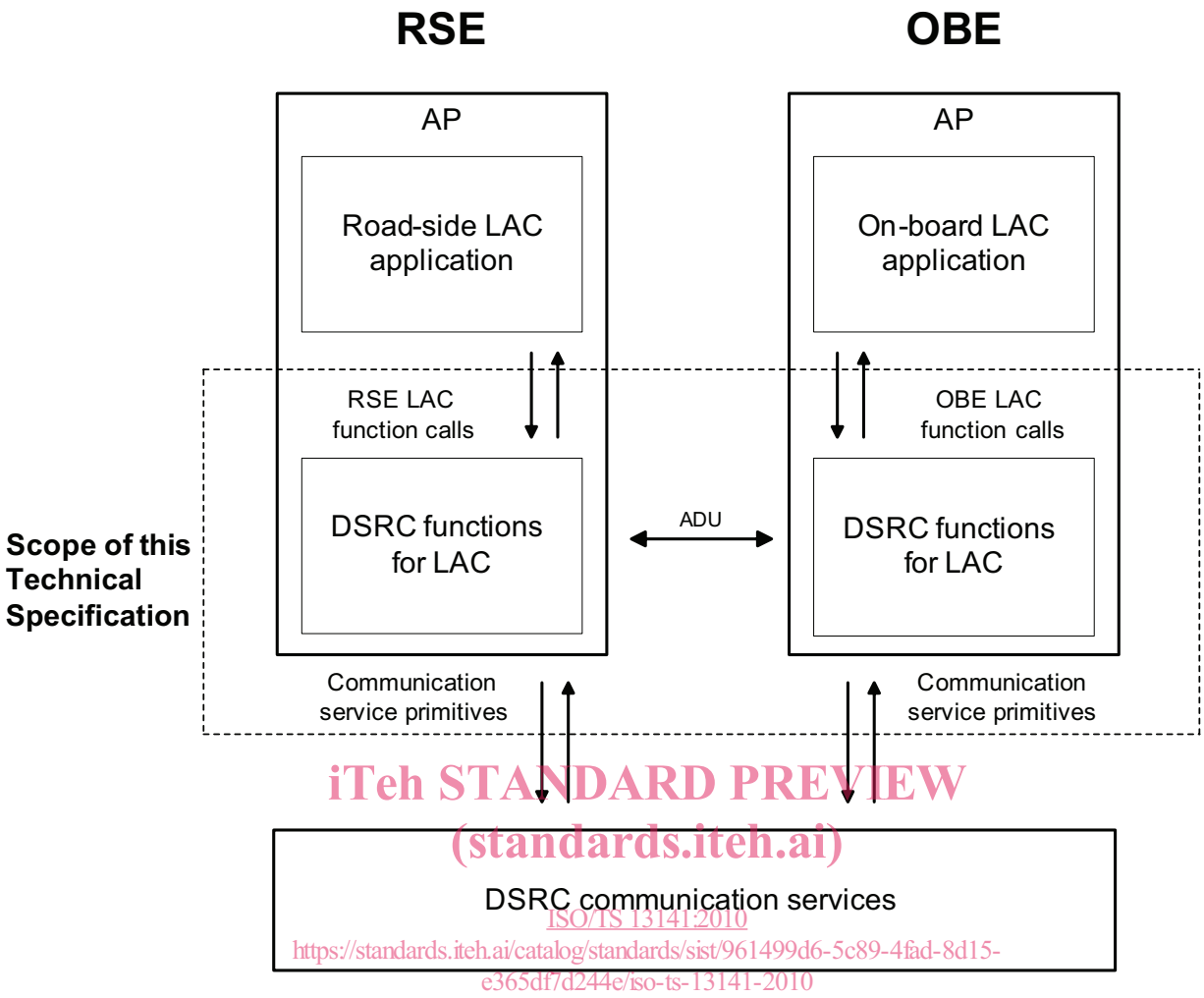

Figure 1 — The LAC application interface

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 12813, *Electronic fee collection — Compliance check communication for autonomous systems*

ISO 14906:—[1)], *Road transport and traffic telematics — Electronic fee collection — Application interface definition for dedicated short-range communication*

ISO 15628:2007, *Road transport and traffic telematics — Dedicated short range communication (DSRC) — DSRC application layer*

ISO/IEC 8824-1:2002, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation — Part 1*

1) To be published. (Revision of ISO 14906:2004).

ISO/IEC 8825-2, *Information technology — ASN.1 encoding rules: Specification of Packed Encoding Rules (PER) — Part 2*

EN 12834, *Road transport and traffic telematics — Dedicated Short Range Communication (DSRC) — DSRC application layer*

EN 15509:2007, *Road transport and traffic telematics — Electronic fee collection — Interoperability application profile for DSRC*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
access credentials
data that are transferred to on-board equipment in order to establish the claimed identity of a road-side equipment application process entity

[ISO 14906]

3.2
attribute
application information formed by one or by a sequence of data elements, used for implementation of a transaction

NOTE Adapted from ISO 14906:—, definition 3.3.

3.3
authenticator
data appended to, or a cryptographic transformation of, a data unit that allows a recipient of the data unit to prove the source and/or the integrity of the data unit and protect against forgery

NOTE Adapted from ISO 14906:—, definition 3.4.

3.4
charge object
geographic object where a charge for the use of infrastructure is due according to the definition in the toll regime

3.5
contract
expression of an agreement between two or more parties concerning the use of the road infrastructure

[ISO 14906]

3.6
data integrity
property that data has not been altered or destroyed in an unauthorized manner

[ISO 14906]

3.7
road-side equipment
equipment installed at a fixed position along the road transport network, for the purposes of communication and data exchange with the on-board equipment of passing vehicles

[ISO 14906]

3.8
on-board equipment
equipment located within the interrogated vehicle and supporting the information exchange with the road-side equipment

3.9
service
toll service
service enabling users having a contract and an OBE to use a vehicle in one or more toll domains

3.10
service primitive
service primitive communication
elementary communication service provided by the application layer protocol to the application processes

[ISO 14906]

NOTE The invocation of a service primitive by an application process implicitly calls upon and uses services offered by the lower protocol layers.

3.11
toll regime
set of rules defining a toll scheme, i.e. the rules defining the charge and the charging processes for a specific road-user charging measure

3.12
toll context
logical view of a toll regime as defined by attributes and functions

3.13
transaction
whole of the exchange of information between the road-side equipment and the on-board equipment necessary for the completion of a toll or compliance checking operation

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

ADU	Application data unit (see ISO 14906)
AID	Application identifier (see ISO 15628 and EN 12834)
ASN.1	Abstract syntax notation one (see ISO/IEC 8824-1:2002)
BST	Beacon service table (see ISO 14906)
CCC	Compliance check communication
DSRC	Dedicated short-range communication (see ISO 14906)
EID	Element identifier (see ISO 15628 and EN 12834)
EFC	Electronic fee collection (see ISO 14906)
IR	Infrared
LAC	Localisation augmentation communication
MAC	Media Access control (see ISO 14906) or Message authentication code
OBE	On-board equipment (see ISO 14906)

PICS Protocol implementation conformance statement

RSE Road-side equipment (see ISO 14906)

VST Vehicle service table (see ISO 14906)

5 Application interface architecture

5.1 General

This clause gives an insight into the LAC architecture by identifying the functions, the use of DSRC communication primitives, and the attributes addressed. A detailed description of the functions is given in Clause 6, while details of the attributes are in Clause 7.

The LAC application interface has been designed to make use of the CEN DSRC communication stack, via the application layer as specified in ISO 15628 and EN 12834. For other identified DSRC communication media, detailed mappings to corresponding services are given in the annexes.

5.2 Services provided

The LAC application interface offers the following services to LAC applications:

— writing of data in order for the RSE to communicate location data to the OBE;

— authentication of the RSE by the OBE by means of access credentials.

There is no read service provided within the LAC communication. The RSE transmits data to the OBE using the underlying acknowledged communication services, in order to verify that the data indeed are properly transmitted over the DSRC interface.

The above services are realized by means of protocol exchanges performed by means of communication services and transactions as described in Clause 8.

The services are provided by the following functions:

— the “Initialise communication” function, which is used to establish the LAC communication link between the RSE and OBE;

— the “Write data” function, which is used to send LAC attributes to the OBE;

— the “Terminate communication” function, which is used to terminate the LAC communication.

5.3 Attributes

There is a single attribute defined for localisation augmentation. This attribute contains a set of data in order for the OBE to be able to determine its localisation with better accuracy and availability or to directly receive a charge object identification related to the local toll context. This set of data contains:

— geographic coordinates (latitude, longitude and altitude);

— charge object reference.

When the RSE writes this attribute to the OBE, it shall transmit geographic coordinates or charge object reference or both.

5.4 Contract and toll context

Regarding LAC, the OBE shall identify itself in the initialisation phase with a single LAC Context Mark in the VST. This Context Mark identifies the user contract in terms of the service provider, type of contract and version information. This information enables the RSE to decide whether the OBE carries a contract which it can support, and if so, to choose the corresponding security elements.

A RSE can provide the OBE with localisation augmentation for several overlapping contexts simultaneously, by writing the LAC attribute (which includes the applicable toll context) several times in one transaction.

NOTE The LAC works in a broadcast fashion, where the roadside has only minimal information about the OBE and is not able to assess the liability of a vehicle for tolls. For this reason, the OBE can receive LAC information which is not applicable.

5.5 Use of lower layers

5.5.1 Supported DSRC communication stacks

The LAC application interface makes use of the CEN DSRC communication stack as described in Table 1. Other communication media can be used as listed in Table 1 if an equivalent mapping to corresponding services is provided. Detailed examples are provided in Annexes C, D and E.

Table 1 — Supported short-range communication stacks

Medium	Application layer	Lower layers	Detailed specifications
CEN-DSRC	ISO 15628 and EN 12834	EN 12795 EN 12253	Specification in 5.5.2
Italian UNI DSRC	UNI 10607-4:2007 UNI 10607-3:2007	UNI 10607-2:2007 UNI 10607-1:2007	Example implementation in Annex C
ISO CALM IR	ISO 15628 and EN 12834	ISO 21214	Example implementation in Annex D
ARIB DSRC	ARIB STD-T75 and ISO 15628	ARIB STD-T75 ITU-R.M1453-2	Example implementation in Annex E

If more than one communication medium is implemented in an OBE, the OBE shall respond to RSE interrogations on the same medium as the RSE has used.

5.5.2 The use of the CEN DSRC stack

The LAC application shall be used with the CEN DSRC communication stack in the following ways:

— the OBE shall comply with EN 15509:2007, 5.1.2;

— the RSE shall comply with EN 15509:2007, 5.2.2.

Compliance with EN 15509 implies compliance of the DSRC stack with ISO 15628 and EN 12834 regarding the application layer, and EN 12795 and EN 12253 for the lower layers.

6 Functions

6.1 Functions in detail

6.1.1 General

All functions defined in this clause shall be available on the OBE side.

For CEN-DSRC, the functions shall be provided by the DSRC application layer as specified in ISO 15628 and EN 12834 (services INITIALISATION, SET and RELEASE).

Only the functions for CEN DSRC are defined in 6.1.2 to 6.1.4. For other supported media according to 5.5.1, equivalent functionality shall be provided; see Annex C for UNI 5.8 GHZ microwave DSRC, Annex D for CALM infrared DSRC and Annex E for ARIB microwave DSRC.

6.1.2 Initialising communication

Initialisation of the communication shall be carried out by the RSE. The invocation of an initialisation request by the RSE attempts to initialise communication between RSE and OBE. After successful initialisation, the function “Initialise communication” shall notify the applications on the RSE and OBE sides.

The initialisation notification on the OBE side shall carry at least the identity of the beacon (e.g. the beacon serial number) and absolute time. The initialisation notification on the RSE side shall carry the LAC application identity and also the data required for the security services (e.g. random number and key identifier).

The function “Initialise communication” shall be provided by the application layer INITIALISATION services, as specified in ISO 15628 and EN 12834. It is defined in Annex A (see LAC-InitialiseComm-Request and LAC-InitialiseComm-Response).

6.1.3 Writing of data

The function “Write data” shall be provided by the application layer SET service as specified in ISO 15628 and EN 12834, and is defined in Annex A (see LAC-DataTx-Request and LAC-DataTx-Response).

NOTE The “mode” parameter in the LAC-DataTx-Request indicates whether or not the corresponding response is expected. If mode=false, the response primitive is not used and the reception is only acknowledged by the OBE on lower layers.

In the SET service primitives, iid shall not be used.

The SET shall always carry access credentials.

6.1.4 Termination of communication

The RSE may terminate the communication with the function “Terminate communication”. The invocation of a release request by the RSE attempts to close the communication on the application level.

NOTE A termination of the communication on link level is outside of the scope of this Technical Specification.

The function “Terminate communication” shall be provided by the application layer service EVENT-REPORT, as specified in ISO 15628 and EN 12834, and is defined in Annex A (see LAC-TerminateComm).