TECHNICAL SPECIFICATION

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Electronic Fee Collection (EFC) — Application interface definition between DSRC-OBE and external in-vehicle devices

Perception du télépéage — Définition de l'interface entre l'équipement à bord à communications dédiées à courte portée (DSRC-OBE) et les dispostifs externes embarqués

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO 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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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Background and motivation

In recent years, the road tolling policy in the world has spread to other than conventional toll road tolling such as funding for road infrastructure management and maintenance, environmental measures, and traffic management. Specifically, in order to accommodate the widespread use of low-fuel-consumption and electric vehicles, introduction of road use tolling instead of fuel tax, congestion tolling on urban roads and inter-urban roads is planned and implemented.

In the countries where dedicated short-range communication (DSRC)-based electronic fee collection (EFC) systems are widely deployed, upgrading and extension of the schemes, to include presently non-toll roads become a significant issue to be considered and solved.

This document describes how DSRC-based EFC systems, especially on-board equipment (OBE), can be enhanced to meet these needs.

There are three cases of introducing EFC systems to cope with those situations:

— Case-1: Existing DSRC-based EFC system is extended and introduced on new roads.

— Case-2: Autonomous tolling system is introduced on both new roads and the existing toll roads.

— Case-3: DSRC-based EFC system continues to operate on existing toll roads, and the autonomous tolling system is introduced on new toll roads.

For Case-1 and Case-2, the necessary interface definitions and the test procedures are already defined by existing EFC standards. For Case-3 as shown in Figure 1, the OBE used for DSRC-based EFC can also be used for the autonomous tolling system covering new roads and existing toll roads.

DSRC-OBE is possible to be reused for new EFC environments consisting of DSRC-based EFC and the autonomous tolling system by expanding functionally by interfacing with the external in-vehicle device that includes global navigation satellite systems (GNSS) module, cellular module and other related modules.

Consequently, an application interface definition between DSRC-OBE and the external in-vehicle devices is essential and needs to be standardized.

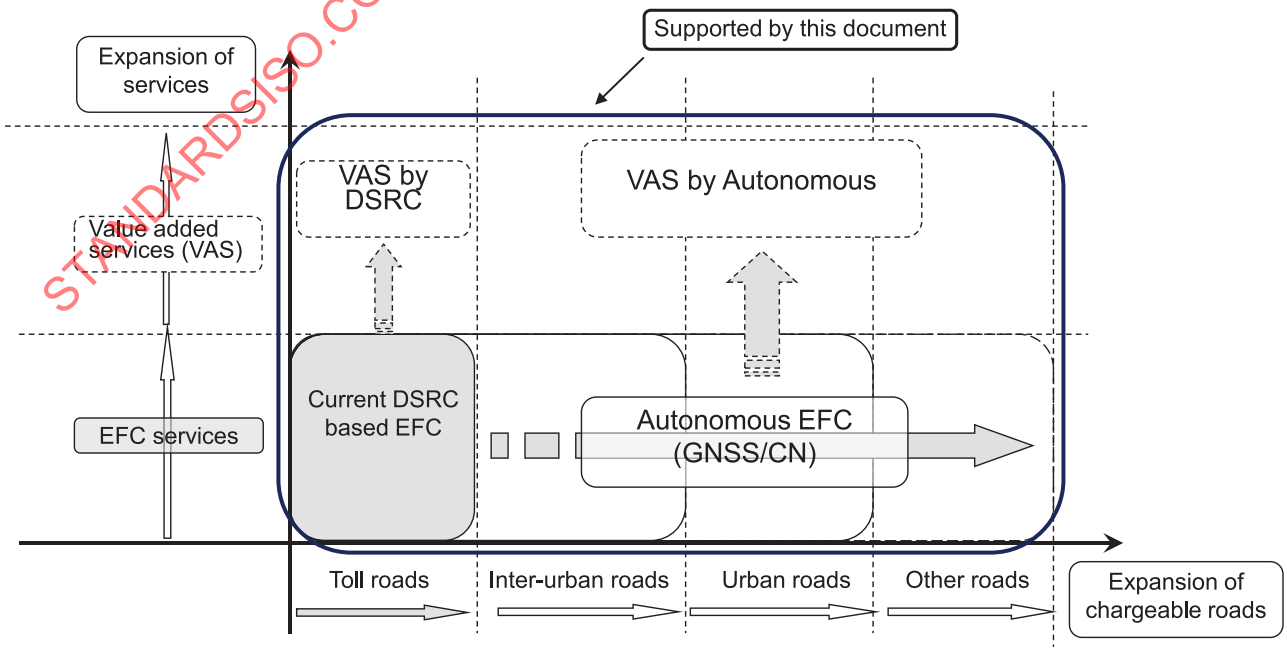

Figure 1 — Image of expanding toll roads and services (Case-3)

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Purpose of this document

The purpose of this document is to provide support for enhanced functionalities of DSRC-OBE by means of external in-vehicle devices.

This document aims at defining:

— A tolling model with the external in-vehicle devices (in the main part of the document);

— Definitions of data groups and data elements (in the main part of the document);

— Data type definition and implementation conformance statement (ICS) proforma (in Annexes A and B).

Applicable DSRC-OBE

There are five major DSRC standards currently deployed for EFC around the world. In standardizing an application interface between DSRC-OBE and an external on-vehicle device, the interface should be applied for every type of DSRC as shown in Figure 2.

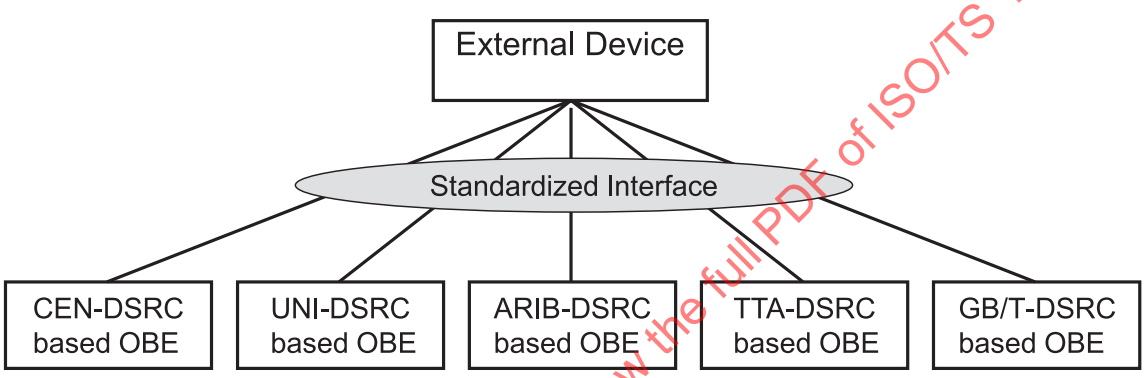

Figure 2 — Applicable DSRC-OBE

Thanks to its operational reliability and robustness, DSRC-OBE is suitable for long-term use for EFC. On the other hand, each component of external in-vehicle devices typically has a shorter product life than DSRC-OBE in order to meet changing user demands for multi-functional and high performance equipment.

Once an application interface has been standardized, DSRC-OBE can be used continuously in a variety of EFC environments with an enhanced new external in-vehicle device as shown in Figure 3.

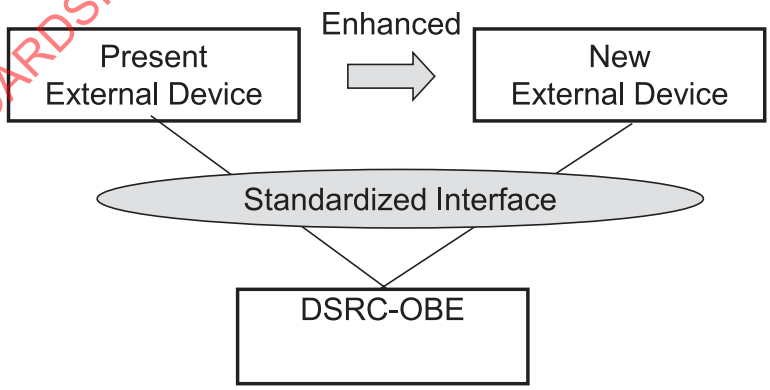

Figure 3 — Applicability for future upgrading

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Electronic Fee Collection (EFC) — Application interface definition between DSRC-OBE and external in-vehicle devices

1 Scope

This document defines an application interface between DSRC-based OBE (hereinafter referred to as "DSRC-OBE") and an external in-vehicle device (hereinafter referred to as "the external device") to make DSRC-OBE applicable for diversified external devices.

NOTE For use in autonomous tolling and DSRC-based (CEN, UNI, ARIB, TTA and GB/T) electronic fee collection (EFC) systems. For use in urban and inter-urban toll schemes.

The scope of this document covers the following items (as shown in Figure 4):

— definitions of the application interface between DSRC-OBE and external devices, including global navigation satellite system (GNSS), cellular network (CN) and controller area network (CAN) device;

— definitions of data groups and data elements.

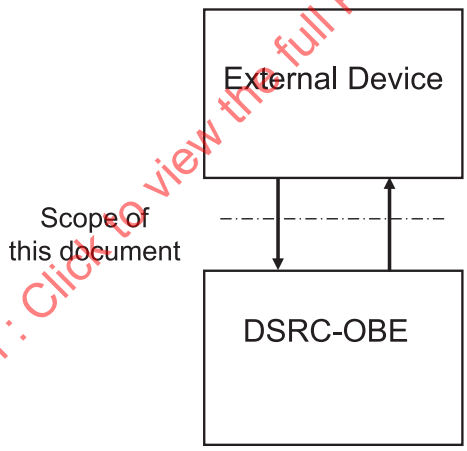

Figure 4 — Scope of this document

The following items are out of the scope of this document:

— definitions of hardware components in the external device such as GNSS module, CN module and mobile devices;

— definitions of the physical interface between DSRC-OBE and the external device such as USB and Bluetooth;

— definition of ITS services other than EFC;

— definition of algorithms for authentication, encryption and key management.

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.

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

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

ISO 12813:2019, *Electronic fee collection — Compliance check communication for autonomous systems*

ISO 13141, *Electronic fee collection — Localisation augmentation communication for autonomous systems*

ISO 14906:2018, *Electronic fee collection — Application interface definition for dedicated short-range communication*

ISO 17575-1:2016, *Electronic fee collection — Application interface definition for autonomous systems — Part 1: Charging*

ISO 17575-3:2016, *Electronic fee collection — Application interface definition for autonomous systems — Part 3: Context data*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 http://www.electropedia.org/

3.1
attribute
addressable package of data consisting of a single data element or structured sequences of data elements

3.2
autonomous tolling system
tolling system which is able to obtain usage data using on-board equipment independent from roadside equipment

3.3
data element
coded information, which might itself consist of lower level information structures

3.4
data group
class of closely related *attributes* (3.1)

3.5
external in-vehicle device
component that can be connected to a piece of on-board equipment (OBE) in a vehicle

EXAMPLE Mobile phone or digital tachograph.

3.6
issuer
entity responsible for issuing the payment means to the user

3.7
on-board equipment
OBE
all required equipment on-board a vehicle for performing required electronic fee collection (EFC) functions and communication services

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3.8
on-board unit
OBU
single electronic unit on-board a vehicle for performing specific electronic fee collection (EFC) functions and for communication with the external systems

3.9
roadside equipment
RSE
equipment located along the road, either fixed or mobile

3.10
toll service provider
TSP
entity providing toll services in one or more toll domains

3.11
transaction
whole of the exchange of information between two physically separated communication facilities

4 Symbols and abbreviated terms

For the purpose of this document, the following abbreviated terms apply throughout the document unless otherwise specified.

ARIB	Association of Radio Industries and Businesses (Communication standardizing body in Japan)
ASN.1	Abstract Syntax Notation One (ISO/IEC 8824-1)
CAN	Controller Area Network
CCC	Compliance check Communication (ISO 12813)
CE	Central Equipment
CN	Cellular Network
DSRC	Dedicated Short-Range Communication
EFC	Electronic Fee Collection
GB/T	Guojia Biaozhun/Tuijian (Chinese "Recommended National Standard")
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
ICC	Integrated Circuit Card
ICS	Implementation Conformance Statement
ITS	Intelligent Transport Systems
LAC	Localisation Augmentation Communication
OBE	On-board Equipment
OBD	On-board diagnostics

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OBU	On-board Unit
RSE	Roadside Equipment
TSP	Toll Service Provider
TTA	Telecommunications Technology Association (Communication standardizing body in Korea)
UNI	Ente Nazionale Italiano di Unificazione
USB	Universal Serial Bus

5 Tolling models with the in-vehicle device

5.1 General

The DSRC-OBE with an external device can support various EFC environments and further ITS services.

There are two kinds of settlement method in EFC, one is the on-board account system, and the other method is the central account system. In the on-board account system, payment means may be connected to DSRC-OBE as shown in Figure 5, and the toll amount determined by the tolling transaction processes is directly deducted from payment means.

This document only address EFC schemes where the on-board account system is operated using an ICC.

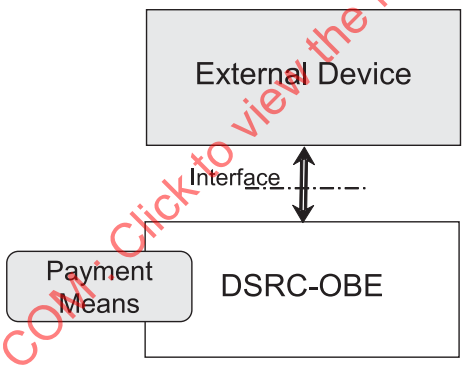

Figure 5 — Arrangement of payment means

5.2 Tolling model

5.2.1 Operating environment

The system in which DSRC-OBE is connected to an external device should support the diversified tolling system that supports both the autonomous tolling system and DSRC-based tolling system as shown in Figure 6. In the diversified tolling system, the external device consists of the various components listed in Table 1.

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Table 1 — Configurations for tolling system

Tolling system	DSRC-OBE	Major components of the external device					
		GNSS	CN device	HMI	Motion sensors	Interface	
						Digital tachograph	CAN (OBD-II)
DSRC tolling	M	—	—	—	—	—	—
Diversified tolling	M	M	M	O	O	O	O
M: Mandate, O: Option, —: not applicable							

The external device included at minimum of GNSS receiver, cellular communication module and data processing module. The following components are considered as optional parts for implementation that depends on the requirements of the autonomous tolling system:

1) Motion sensors;

2) Digital tachograph interface;

3) Controller area network's on-board diagnostics (CAN, OBD-II) interface.

The external device is connected with the toll service provider to exchange the reload-related data and the autonomous tolling-related data defined by ISO 17575-1 through cellular networks. DSRC-OBE is connected with individual RSE that exchange the related data for DSRC tolling, or compliance check or localization using DSRC.

Whereas Figure 6 shows the configuration in which the external device and DSRC-OBE are physically separated, it is also possible to integrate them into one unit in manufacturing a new OBE.

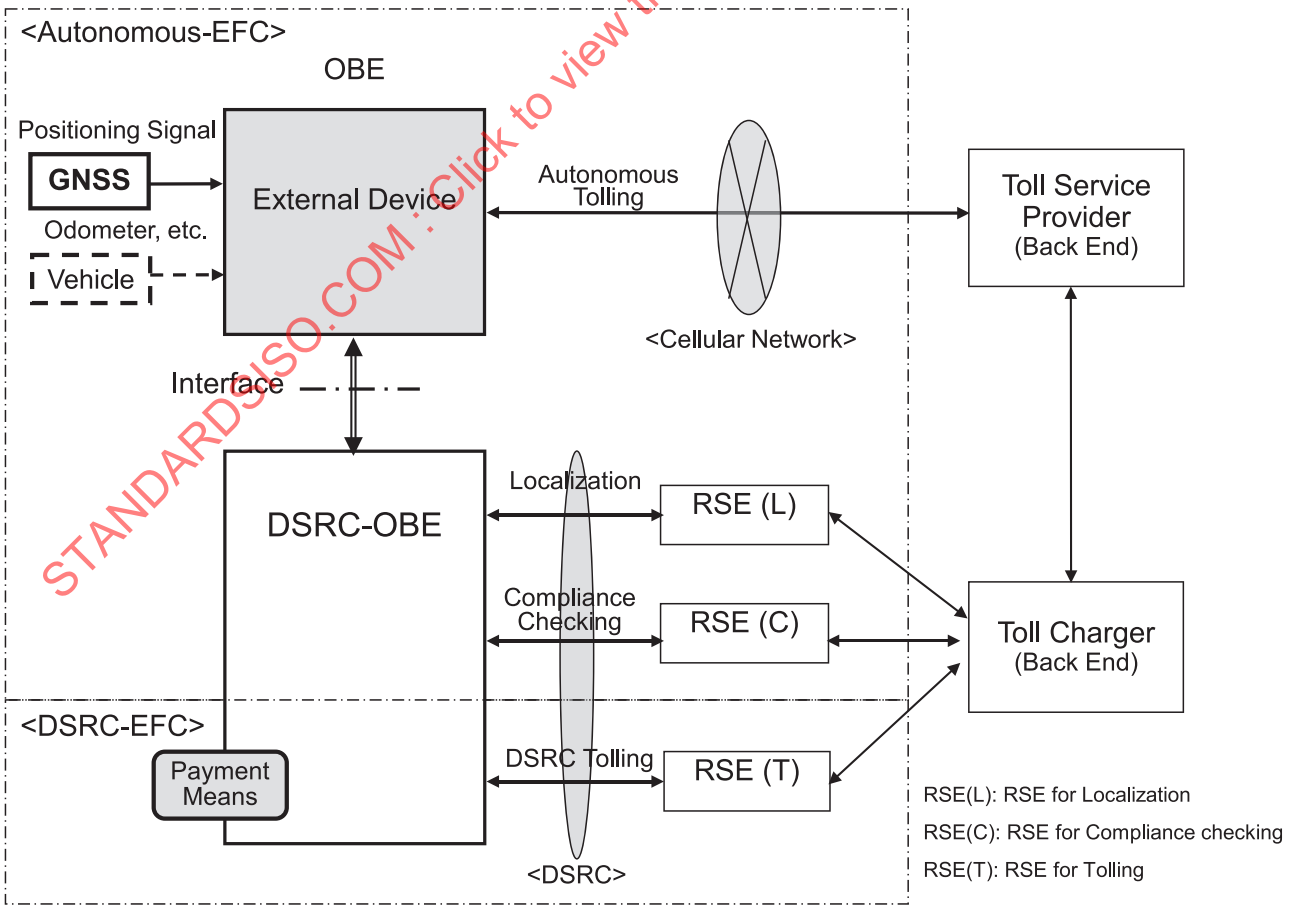

Figure 6 — Tolling model for the diversified tolling

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5.2.2 Data exchanges

Figure 7 shows the general data exchanges between the external device and DSRC-OBE. Among these are the data elements related to a vehicle that constitutes CCC attributes, which are periodically transferred from DSRC-OBE and shared with the external device (see Table C.3). Other data exchanges between the external device and toll service provider (TSP) and between DSRC-OBE and RSEs are defined in ISO 17575-1, ISO 17575-3, ISO 14906, ISO 12813 and ISO 13141 (see Figure 7).

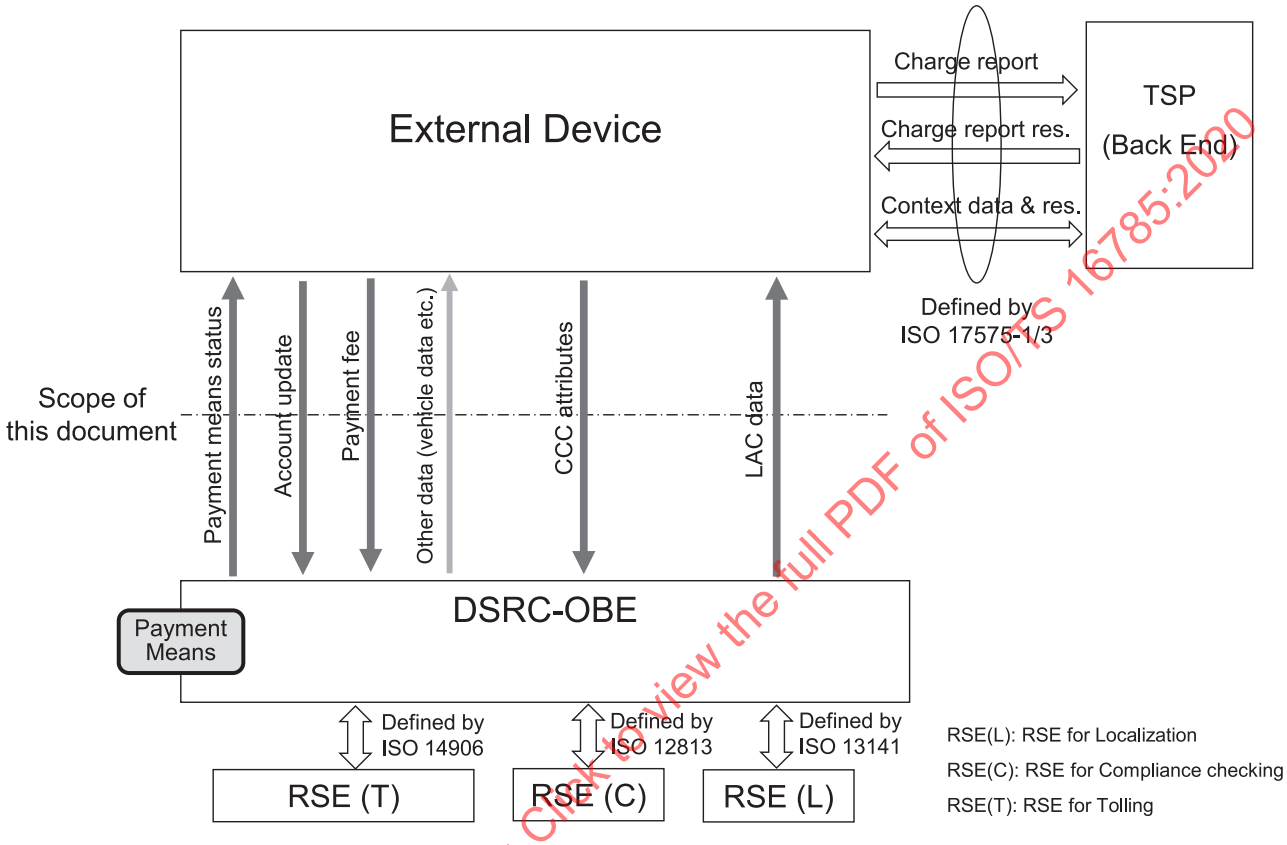

Figure 7 — Data exchanges for the diversified tolling

Table 2 shows application processes and processing of data in data exchanges between the external device and DSRC-OBE.

Table 2 — Application execution by data group

Application process	Data group to execute	Execution timing	Remarks
Reloading to Payment means	Payment means status	— Payment medium is inserted. — Payment medium is updated.	
	Account update	— Charge report response is received.	
Payment	Payment fee	— Charge amount is determined.	
Compliance check	CCC attributes	— A period specified by `AttributeUpdateInterval` in CCC attributes.	
Localization	LAC data	— LAC data is received.	

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6 Data group

6.1 General

Each data group exchanged on the interface between DSRC-OBE and the external device consists of several data elements. Data groups related on payment means and account are defined in ISO 14906 and ISO 17575-1 and support direct deduction or post-payment processing from payment means associated with an DSRC-OBE. In case of a prepaid medium, it can be reloaded from the back end of an TSP, via cellular network.

In the other data groups, CCC attributes are defined in ISO 12813, and LAC data are defined in ISO 13141.

6.2 Payment means status

This data group consists of the data elements shown in Table 3 and its validity is checked prior to the payment process. In case of pre-payment mode, if the prepaid means is short of balance, its account is updated by TSP (backend) through cellular communication.

Table 3 — Payment means status

Data group	Data element	Definition	Informative remarks (source)
Payment means status	`PaymentMode`	Define payment mode such as pre-payment or post-payment.	EN 1545-2:2015
	`AccountStatus`	Indicate the payment means status such as positive value for tolling or not, and other information.	ISO 17575-1
	`PaymentMeans`	Define the characteristics of the payment means.	ISO 14906
	`PaymentMeansBalance`	Indicate the balance of the payment means.	ISO 14906
	`PaymentMeansUnit`	Define the unit of the payment means value.	ISO 14906
	`PaymentSecurityData`	Indicate security-related data for the authentication of the data integrity.	ISO 14906

6.2.1 PaymentMode

Payment means have one of the following respective payment modes as defined and operated by the payment means issuer:

— Pre-payment (prepaid card);

— Post-payment (credit card or other post-pay cards);

— Other payment modes.

6.2.2 AccountStatus

In case of pre-payment, the external device can get information of the account that indicates the following status (not valued) through the data element `AccountStatus` from the DSRC-OBE.

— Ok, i.e. contains a positive value above a defined threshold;

— Low, i.e. contains a positive value below a defined threshold;

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— Empty, i.e. contains the value zero;

— Negative, i.e. contains a value below zero;

— Other optional status for future uses.

6.2.3 PaymentMeansBalance

In case of pre-payment, the external device can also have an option to get a value information of the account though the data element `PaymentMeansBalance` from the DSRC-OBE.

6.2.4 PaymentMeans

In case of post-payment, the data element `PaymentMeans` is a unique identification of an individual road user account, and the respective data type is defined in ISO 14906. It consists of following data elements which indicate a payment means issuer's specified restrictions such as on the geographic usage and the services allowed for the applications.

— `PersonalAccountNumber`

— `PaymentMeansExpiryDate`

— `PaymentMeansUsageControl`

6.2.5 PaymentMeansUnit

The data element `PaymentMeansUnit` is the unit in which the payment means value is expressed as defined in ISO 4217.

6.2.6 PaymentSecurityData

The data element `PaymentSecurityData` is the security-related data for the authentication of the data integrity.

6.3 AccountUpdate

6.3.1 General

In case of pre-payment, the payment means account can be updated by an TSP, through cellular network. This data set is composed of data elements providing three options for updating the account as shown in Table 4.

Table 4 — Account update

Data group	Data element	Definition	Informative remarks (source)
Account update	ReloadAccount	Add a predefined value to the current balance of the payment means.	ISO 17575-1
	SetAccount	Set a specific value to the payment means.	ISO 17575-1
	AddToAccount	Add a specific value to the payment means.	ISO 17575-1

6.3.2 ReloadAccount

The first option is ReloadAccount that adds a predefined value to the current balance of the payment means. The value should be defined in advance during the initial set up process of the external device.

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6.3.3 SetAccount

The second option is SetAccount that sets a new balance to the payment means.

6.3.4 AddToAccount

The third option is AddToAccount that adds a specific value to the payment means.

6.4 PaymentFee

This data set is composed of data elements shown in Table 5 that qualifies the charge amount to be paid.

Table 5 — Payment fee

Data group	Data element	Definition	Informative remarks (source)
Payment fee	`PaymentFeeAmount`	Define the value of the fee being charged for the service.	ISO 14906
	`PaymentFeeUnit`	Define the unit in which the fee is expressed.	ISO 14906

6.4.1 PaymentFeeAmount

The data element `PaymentFeeAmount` is the value of the fee being charged for the service.

6.4.2 Payment FeeUnit

The data element `PaymentFeeUnit` is the unit in which the fee is expressed as defined in ISO 4217.

6.5 CCC attributes

The data elements in the structure CCCAttributes are defined in and imported from ISO 12813.

6.6 LAC data

The data elements in the structure LacData are defined in and imported from ISO 13141.

6.7 Other data

Data elements other than the above description that relate to Vehicle and Identification belong to the other data group. See C.2.1 and C.2.3 for more information on these data elements.

7 Security aspects

7.1 General

The interface between DSRC-OBE and the external device is exposed to security attacks. Hence, the following recommendations, based on ISO/TS 19299:2015, should be considered:

— Data exchange should only be done between authenticated entities for the respective data;

— Data exchange should guarantee data confidentially;

— Data exchange should guarantee data integrity.

Mutual authentication between DSRC-OBE and the external device, encryption of exchanged data and data authentication for manipulation checking should be implemented as the associated countermeasures.

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A conformance evaluation of DSRC-OBE and relevant external devices and interfaces related to the security measures should be conducted, both for DSRC tolling and the autonomous tolling systems.

7.2 OBE interface profile

Mutual authentication between DSRC-OBE and the external device should be 3-way authentication based on ISO/IEC 9798-4, and an encryption should be applied for exchanged data on the interface shown in Figure 8. However, definition of algorithm for authentication and encryption, and key management are be out of scope of this document.

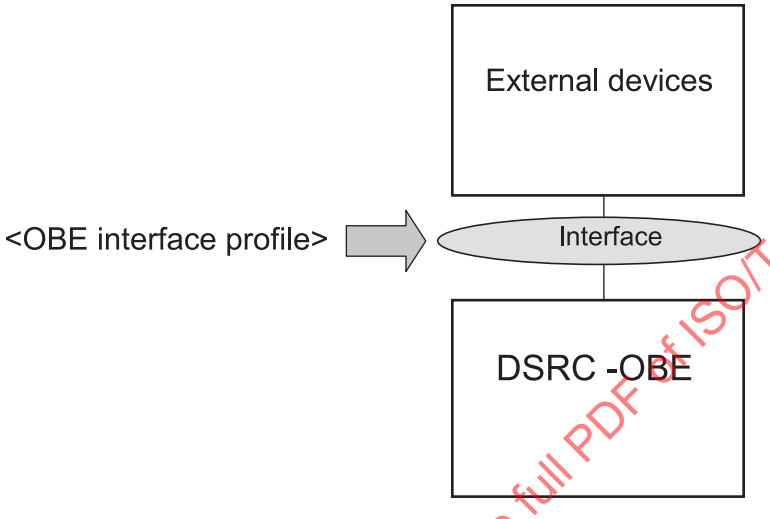

Figure 8 — OBE interface profile

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Annex A
(normative)

Data type specification

This Annex presents the abstract syntax notation one (ASN.1) definition of the data types related to the data group as specified in Clause 6 using the ASN.1 technique in accordance with ISO/IEC 8824-1. The packed encoding rules given in ISO/IEC 8825-2 with the restrictions defined in ISO 15628:2013, 6.2.7 apply.

The actual ASN.1 module is contained in the file "ISO16785(2020)EfcDsrcObeExtDevicesV2.asn", which is freely available for download via a hyperlink at www.itsstandards.eu/index.php/efc and http://standards.iso.org/iso/ts/16785/ed-2/en.

Table A.1 provides the SHA-256 cryptographic hash digests for the referenced files, offering a mean to verify the integrity of the referenced file. The SHA-256 algorithm is specified in NIST 180-4.

Table A.1 — SHA-256 cryptographic hash digest

File name	SHA-256 cryptographic hash digest
ISO16785(2020)EfcDsrcObeExtDevicesV2.asn	365B6C817DE053B86447F64482F06BFEA6F5FCE8B34134C6126FD0005B88765D

NOTE Be aware that pasting the text of the file into one of the hash digest computation pages available on the web can result in a non-matching hash digest due to changes in the underlying coding.

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Annex B
(normative)

Implementation conformance statement proforma

B.1 General

In order to evaluate the conformance of a particular implementation, it is necessary to have a statement of those capabilities and options that have been implemented. This is called an implementation conformance statement (ICS).

This Annex presents the proforma to be used for the attributes defined in Annex A, with ICS templates that are to be completed by equipment suppliers.

B.2 Purpose and structure

The purpose of this ICS is to provide a mechanism whereby a supplier of an implementation of the attribute in means defined in this document can provide information about the implementation in a standardised manner.

The ICS is subdivided as follows corresponding to categories of information:

— identification of the implementation;

— identification of the protocol;

— global statement of conformance;

— ICS tables.

B.3 Instruction for completing ICS

B.3.1 Definition of support

A capability is said to be supported if the implementation under test (IUT) can

— generate the corresponding operation parameters (either automatically or because the end user requires that capability explicitly), and

— interpret, handle and, when required, make available to the end user the corresponding error or result.

A protocol element is said to be supported for a sending implementation if it is able to generate it under certain circumstances (either automatically or because the end user requires relevant services explicitly).

A protocol element is said to be supported for a receiving implementation if it is correctly interpreted and handled and also, when appropriate, made available to the end user.

B.3.2 Status column

This column indicates the level of support required for conformance. Values in this column may be:

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m mandatory support is required;

o optional support is permitted for conformance to this document. If implemented it must conform to the specifications and restrictions contained in this document. These restrictions may affect the optionality of other items;

c the item is conditional (support of the capability is subject to a predicate);

— the item is not applicable;

i the item is outside the scope of this ICS.

In the ICS tables, every leading item marked "m" shall be supported by the IUT. Sub-items marked "m" shall be supported if the corresponding leading item is supported by the IUT.

B.3.3 Support column

This column shall be completed by the supplier or implementer to indicate the level of implementation of each item. The proforma has been designed such that values required are the following:

Y Yes, the item has been implemented;

N No, the item has not been implemented;

— the item is not applicable.

All entries within the ICS proforma shall be made in ink. Alterations to such entries shall be made by crossing out, neither erasing nor making the original entry illegible, and by writing the new entry alongside. All such alterations to records shall be initialised by the person who made them.

B.3.4 Item reference numbers

Each line within the ICS which requires that implementation details be entered is numbered at the left-hand edge of the line. This numbering is included as a means of uniquely identifying all possible implementation details within the ICS. This referencing is used both inside the ICS, and for references from other test specification documents.

The means of referencing individual responses is done in the following sequence:

a) a reference to the smallest individual response enclosing the relevant item;

b) a solidus character ("/");

c) the reference number of the row in which the response appears;

d) if, and only if, more than one response occurs in the row identified by the reference number, implicit labelling of each possible entry as "a", "b", "c", etc., from left to right, with this letter appended to the sequence.

B.4 ICS proforma tables

B.4.1 Identification of the implementation

The following proforma are used to identify the implementation on the external device side. See Tables B.1, B.2, B.3 and B.4.

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Table B.1 — Identification of ICS

Item no.	Question	Response
1	Date of statement (DD/MM/YY)	
2	ICS serial number	
3	System conformance statement cross-reference	

Table B.2 — Identification of the implementation and/or system

Item no.	Question	Response
1	Service provider name or EFC context name	
2	Version number	
3	Other information	

Table B.3 — Identification of the external device

Item no.	Question	Response
1	Brand name	
2	Type, version	
3	Manufacturer ID	
4	Serial numbers of supplied units	
5	Other information	

Table B.4 — Identification of the document

Item no.	Question	Response
1	Title, reference no., publication date of the document	
2	Document edition number	
3	Other information	

B.4.2 ICS proforma table

This part of the ICS identifies the supported application context, communication services and attributes in data exchange between the external device and the DSRC-OBE. See Tables B.5, B.6, B.7 and B.8.

Table B.5 — Data requirements regarding data group

Item no.	Element	Reference	Status	Support
1	Payment means status	6.2	o	
2	Account update	6.3	o	
3	Payment fee	6.4	o	
4	Compliance checking data (CCCA-tributes)	6.5	m	
5	Localization data (LacData)	6.6	m	

Table B.6 — Data requirements regarding payment means status

Item no.	Element	Reference	Status	Support
1	`paymentMode`	6.2.1	o	
2	`accountStatus`	6.2.2	o	
3	`paymentMeansBalance`	6.2.3	o	

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Table B.6 *(continued)*

Item no.	Element	Reference	Status	Support
4	paymentMeans	6.2.4	o	
5	paymentMeansUnit	6.2.5	o	
6	paymentSecurityData	6.2.6	o	

Table B.7 — Data requirements regarding account update

Item no.	Element	Reference	Status	Support
1	reloadAccount	6.3.2	o	
2	setAccount	6.3.3	o	
3	addToAccount	6.3.4	o	

Table B.8 — Data requirements regarding payment fee

Item no.	Element	Reference	Status	Support
1	paymentFeeAmount	6.4.1	o	
2	paymentFeeUnit	6.4.2	o	

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Annex C
(informative)

Clarification of data elements

C.1 General

The data exchange between the external device and the DSRC-OBE and the flow of related data including the TSP (Back end) and the RSE are shown in Figure C.1. The external device in this figure has a built-in proxy function.

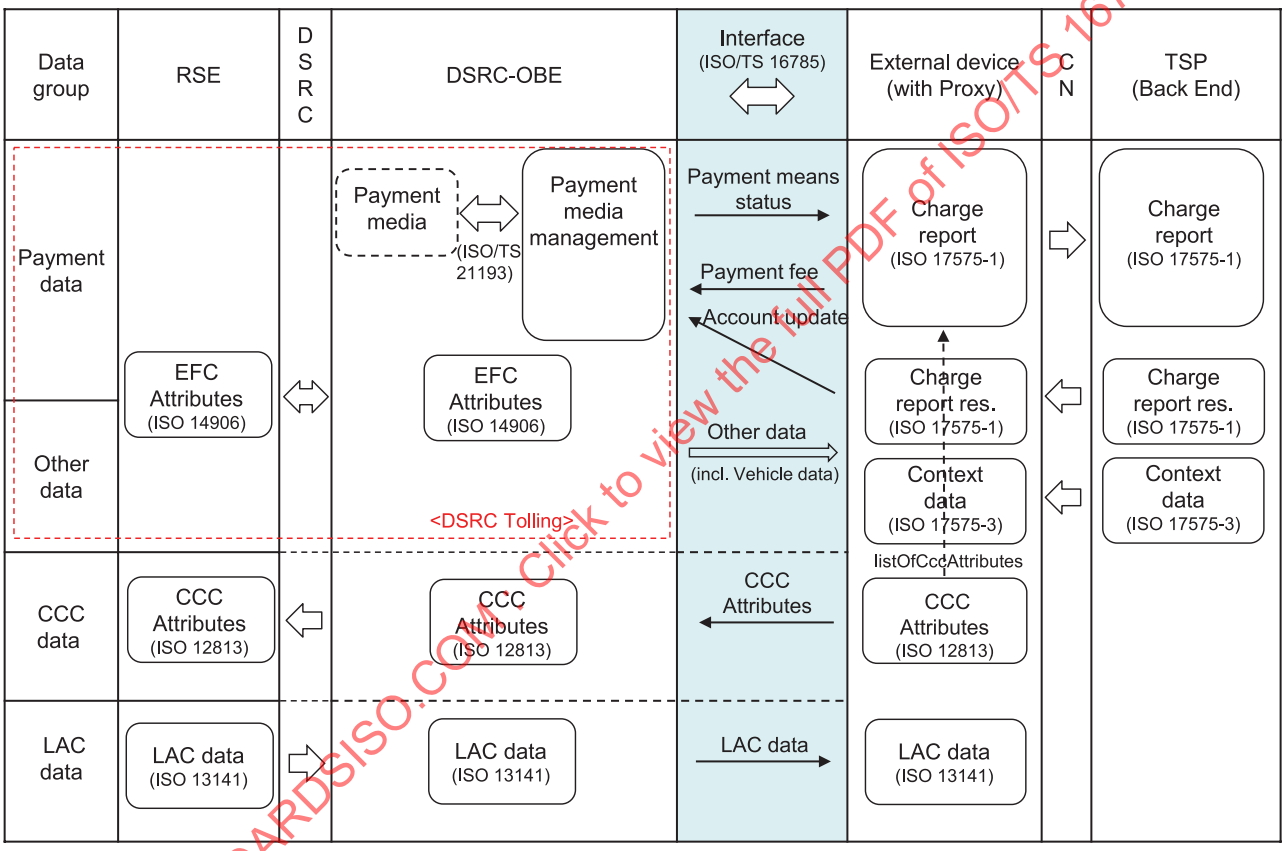

Figure C.1 — General data flow between the external device and DSRC-OBE

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C.2 Data elements

C.2.1 ChargeReport

All data elements of ChargeReport shown in Table C.1 are prepared by the external device and sent to the TSP (back end) at the specified event period. Of these, the following data elements are sent from the DSRC-OBE and subject to this document.

— obeID (as the other data);

— `vehicleLicencePlateNumber` (as the other data);

— `paymentMeans`;

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