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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 dispositifs externes embarqués

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Foreword

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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*.

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

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.

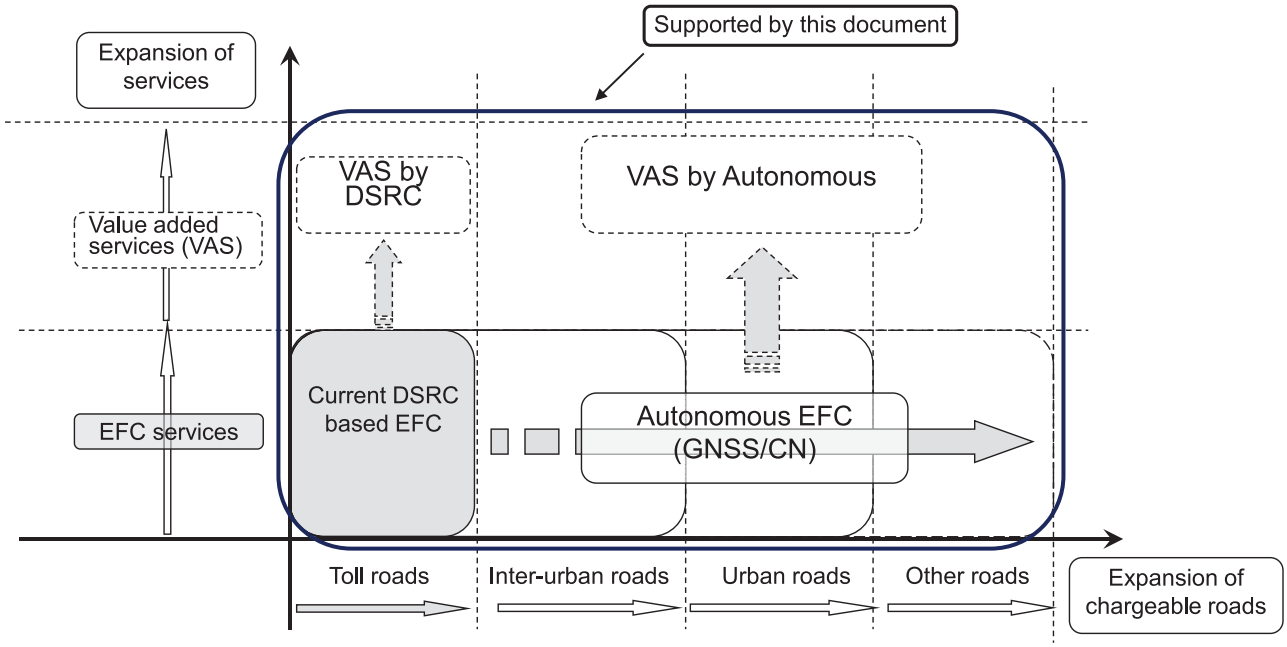

Figure 1 — Image of expanding toll roads and services (Case-3)

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.

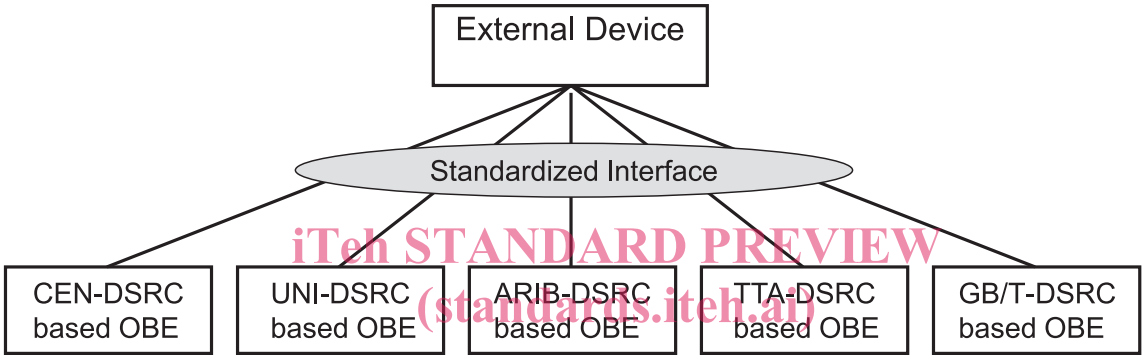

Figure 2 — Applicable DSRC-OBE

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.

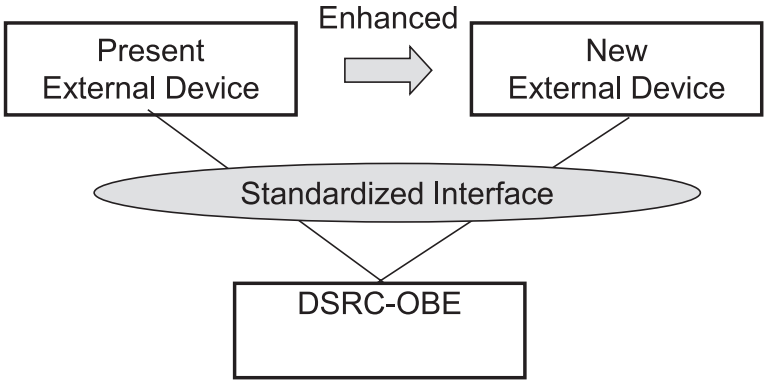

Figure 3 — Applicability for future upgrading

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.

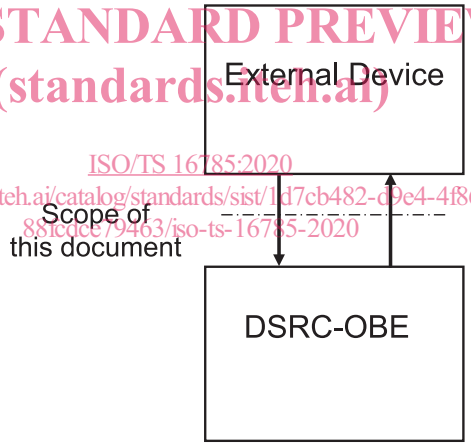

Figure 4 — Scope of this document

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.

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

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

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.

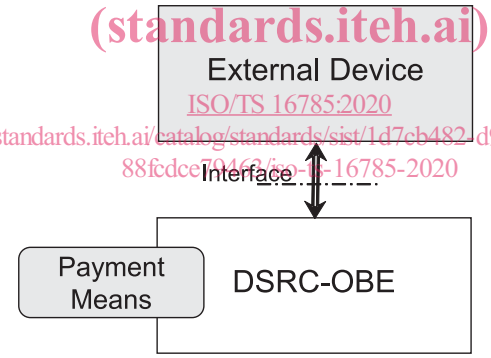

Figure 5 — Arrangement of payment means

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.

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.

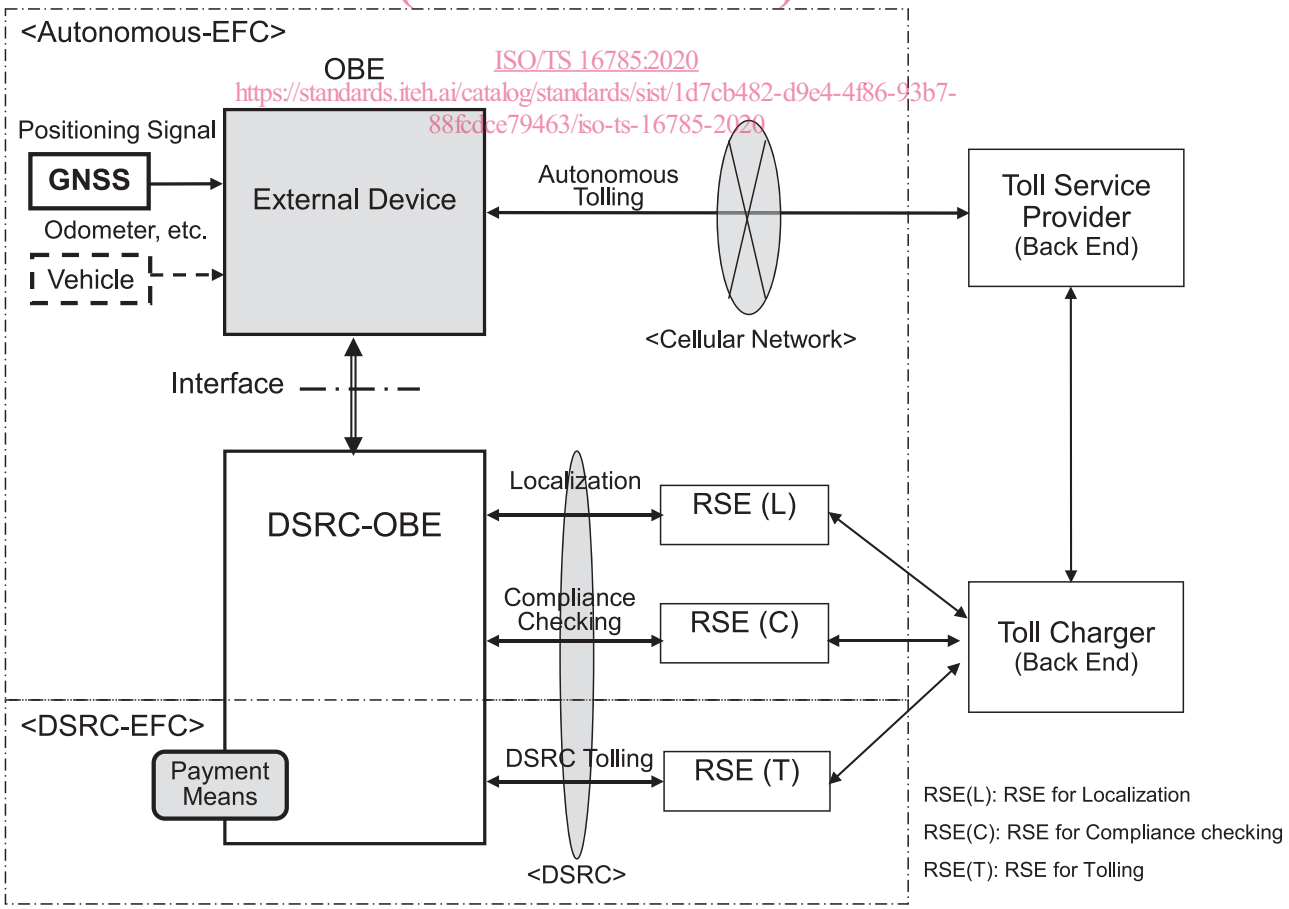

Figure 6 — Tolling model for the diversified tolling