TECHNICAL SPECIFICATION

ISO/TS 16785

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2014-11-01

Electronic Fee Collection (EFC) — 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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The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

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Introduction

Background and motivation

With regards to reassessing the present fuel tax schemes to cope with prevailing plug-in hybrid vehicle and electric vehicle or introducing congestion charging system to urban roads or inter-urban roads etc., the needs for expanding toll roads are becoming worthy of notice in the world.

In countries where Dedicated Short-Range Communication (DSRC)-based Electronic Fee Collection (EFC) systems were introduced for toll roads and have been operated widely, making their EFC equipment applicable to present non-toll roads, such as urban roads or inter-urban roads, becomes a significant issue to be considered and solved.

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

— Case-1: DSRC-based EFC should be introduced to new toll roads, as well as present toll roads.

— Case-2: Autonomous EFC should be introduced to new toll roads and present toll roads as replacing.

— Case-3: DSRC-based EFC should be operated for present toll roads as they are, and autonomous EFC should be introduced to new toll roads.

In case of both Case-1 and Case-2, necessary interface definitions and test procedures are already covered by existing EFC standards. However, in Case-3, as shown in Figure 1, current On-Board Equipment (OBE) used for DSRC-based EFC should be considered to be used for autonomous EFC covering new toll roads in keeping consistency with present toll roads.

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DSRC-OBE should be expanded functionally by cooperating with external in-vehicle devices composed of a Global Navigation Satellite Systems (GNSS) module and/or a cellular module and/or other related modules; therefore, DSRC-OBE is possible to be reused for new EFC environment consisting of DSRC-based EFC and autonomous systems.

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

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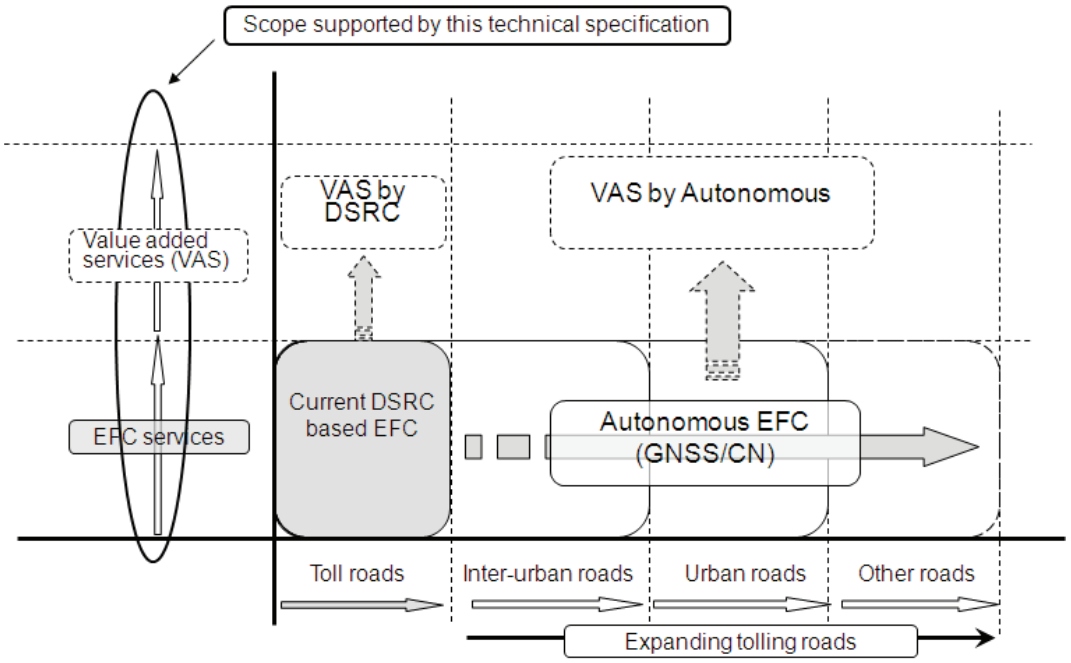

Figure 1 — Image of expanding toll roads and services (Case-3)

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Purpose of this Technical Specification

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This Technical Specification aims to make it possible for toll road operators to introduce autonomous systems to present non-toll roads by enhancing the functionalities of DSRC-On-Board Equipment (OBE) cooperating with external in-vehicle devices.

As listed below, this Technical Specification defines several tolling models, message sets, and data elements to cope with diversified EFC environment in the main body, as well as data type definition and Protocol Implementation Conformance Statement (PICS) proforma defined in Annex A and Annex B respectively. Finally, applicable ITS-services with cooperation of DSRC-OBE and external in-vehicle devices are listed in Annex E with an example for each of them. This Technical Specification aims at defining the following:

— tolling models with external in-vehicle devices (in main body);

— definitions of message sets and data elements;

— data type definition and PICS proforma (in Annexes A and B);

— related example and applicable Intelligent Transport System (ITS) services (in Annex E).

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

1 Scope

This Technical Specification defines an application interface between DSRC-based OBE and external in-vehicle devices to make DSRC-OBE applicable for diversified tolling environment.

The scope of this Technical Specification covers the following items (also shown in Figure 2);

— Definitions of the application interface between DSRC-OBE and external in-vehicle devices (including GNSS, cellular units, CAN interface, etc.).

— Definitions of message sets and data elements on the interface (based on a sets of base standards, such as ISO 14906:2011, ISO/TS 17575, ISO/TS 13141, ISO/TS 12813, and ISO/TS 25110).

— For use in autonomous EFC systems, as well as DSRC-based EFC.

— For use in diversified tolling environment (in toll roads, inner-urban, inter-urban, etc.).

— For use in every kind of DSRC-OBE (based on CEN, UNI, ARIB, TTA, and GB/T).

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The following items are out of the scope for this TS:

— Definitions of hardware in the external in-vehicle devices such as GNSS modules, cellular modules, mobile devices, smartphones, etc.

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— Definitions of physical interface between DSRC-OBE and external in-vehicle devices such as USB, Bluetooth, etc.

— Definition of any ITS service other than EFC.

— Definition of algorithms for authentication, as well as encryption, and key management.

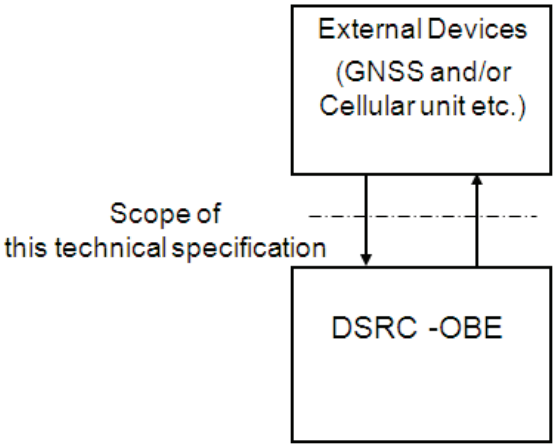

Figure 2 — Scope of this Technical Specification

Applicable DSRC-OBE

When standardizing an application interface between DSRC-OBE and external in-vehicle devices, external in-vehicle devices should be commonly applied for every kind of DSRC-based OBE as shown in Figure 3.

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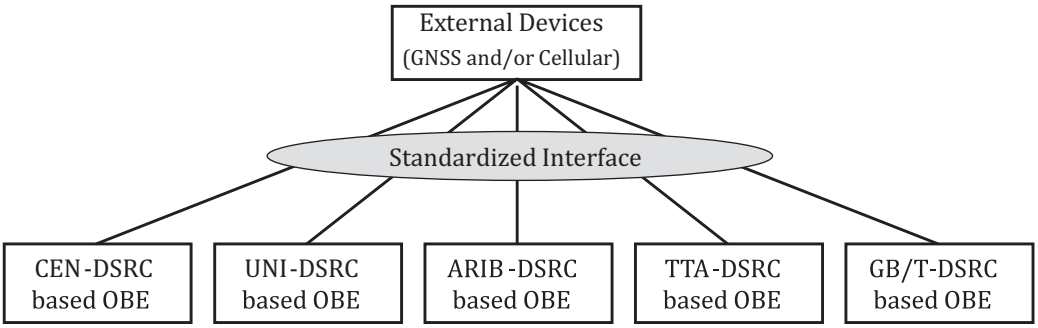

Figure 3 — Applicable DSRC-OBE

The solid and proven DSRC technology makes it possible for DSRC-OBE to have long product-life that enables DSRC-based EFC to be operated still in the future.

On the other hand, each component of external in-vehicle devices has been developed year by year to cope with user's demands on high performance, as well as multi-functional devices; therefore, they have shorter product-life rather than DSRC-OBE. Once an application interface is standardized, DSRC-OBE can be used continuously for diversified EFC environment with enhanced new external in-vehicle devices. See Figure 4.

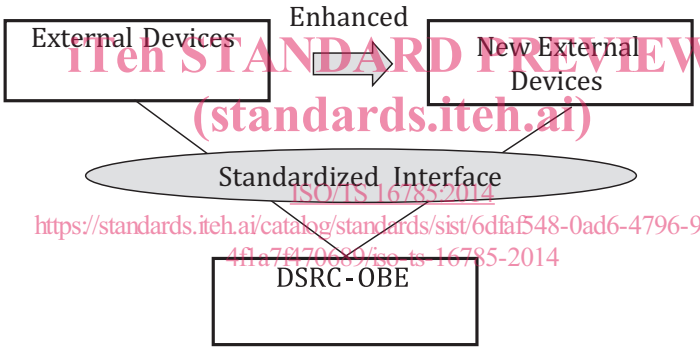

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Figure 4 — Applicability for future upgrading

2 Normative references

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

ISO/IEC 9798-4:1999, *Information technology — Security techniques — Entity authentication — Part 4: Mechanisms using a cryptographic check function*

ISO 14906:2011, *Electronic Fee Collection — Application interface definition for dedicated short-range communication*

ISO/TS 17575-1:2010, *Electronic Fee Collection — Application interface definition for autonomous systems — Part 1: Charging*

ISO/TS 17575-3:2011, *Electronic Fee Collection — Application interface definition for autonomous systems — Part 3: Context data*

ISO/TS 13141:2010, *Electronic Fee Collection — Localisation augmentation communication for autonomous systems*

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ISO/TS 12813:2009, *Electronic Fee Collection — Compliance check communication for autonomous systems*

3 Terms and definitions

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

3.1
access credentials
trusted attestation or secure module that establishes the claimed identity of an object or application

3.2
attribute
addressable package of data consisting of a single data element or structured sequences of data elements

3.3
autonomous systems
one method of EFC that operate without relying on dedicated road-side infrastructure by employing wide-area technologies such as Global Navigation Satellite Systems (GNSS) and Cellular Communications Networks (CN)

3.4
authenticator
data, possibly encrypted, that is used for authentication

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

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[SOURCE: ISO 14906:2011, 3.7]

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3.6
cryptography
principles, means, and methods for the transformation of data in order to hide its information content, prevent its undetected modification, or prevent its unauthorised use

[SOURCE: ISO 7498-2:1989, 3.3.20, modified]

3.7
data group
class of closely related attributes

3.8
external in-vehicle devices
devices such as mobile phones or dedicated units consisting of GNSS and/or cellular modules that are connected to DSRC-OBE for upgrading the functionalities of it

3.9
issuer
entity responsible for issuing the payment means to the user

3.10
on-board equipment
OBE
equipment located on-board a vehicle including nomadic devices with the function of exchanging information with external systems

Note 1 to entry: The OBE does not need to include payment means.

[SOURCE: ISO 14906:2011, 3.13]

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3.11
on-board unit
OBU
minimum component of an *on-board equipment* [3.10], whose functionality always includes at least the support of the DSRC interface

[SOURCE: ISO 14906:2011, 3.14]

3.12
roadside equipment
equipment located along the road, either fixed or mobile

3.13
Toll Service Provider
entity providing toll services in one or more toll domains

Note 1 to entry: In other documents, the terms issuer or contract issuer may be used.

Note 2 to entry: The Toll Service Provider may provide the OBE or may provide only a magnetic card or a smart card to be used with OBE provided by a third party (like a mobile telephone and a SIM card that can be obtained from different parties).

Note 3 to entry: The Toll Service Provider is responsible for the operation (functioning) of the OBE with respect to tolling.

[SOURCE: ISO 17573:2010, 3.23, modified]

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3.14
transaction
whole of the exchange of information between two physically separated communication facilities

[SOURCE: ISO 14906:2011, 3.24, modified]

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3.15
transaction model
functional model describing the structure of electronic payment transactions

[SOURCE: ISO 14906:2011, 3.25]

4 Symbols and abbreviated terms

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

ADU	Application Data Unit
APDU	Application Protocol Data Unit
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/TS 12813)
CE	Central Equipment
DSRC	Dedicated Short-Range communication
EFC	Electronic Fee Collection

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GB/T	Guojia Biaozhun/Tuijian (Chinese “Recommended National Standard”)
GNSS	Global Navigation Satellite Systems
HMI	Human Machine Interface
ICC	Integrated Circuit Card
ITS	Intelligent Transport Systems
LAC	Localization Augmentation Communication (ISO/TS 13141)
OBE	On-board Equipment
OBU	On-board Unit
PMI	Payment Means Issuer
PICS	Protocol Implementation Conformance Statement
RSE	Roadside Equipment
SAM	Secure Application Module
TSP	Toll Service Provider
TTA	Telecommunications Technology Association (Communication standardizing body in Korea)
UNI	Ente Nazionale Italiano di Unificazione
USB	Universal Serial Bus

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5 Tolling models with external in-vehicle devices

5.1 General

Multi-functional DSRC-OBE supported with external in-vehicle devices makes current societies smarter with introduction to diversified EFC environment and further ITS services.

There are two kinds of settlement method in EFC, one is on-board account (settlement) system using payment media such as IC card and the other is central account (settlement) system not using payment media. In this Technical Specification, on-board account system in which operational procedure is more complex than central account system is selected as a basic model for diversified EFC.

In the on-board account system, payment media is normally connected to DSRC-OBE and toll amount determined by charging transaction processes between DSRC-OBE and RSE is directly deducted from payment media. On the other hand, payment means can be included in or connected to external in-vehicle devices such as mobile phones. The latter case is shown in Annex D in which various possible tolling systems other than those mentioned in this clause are introduced.

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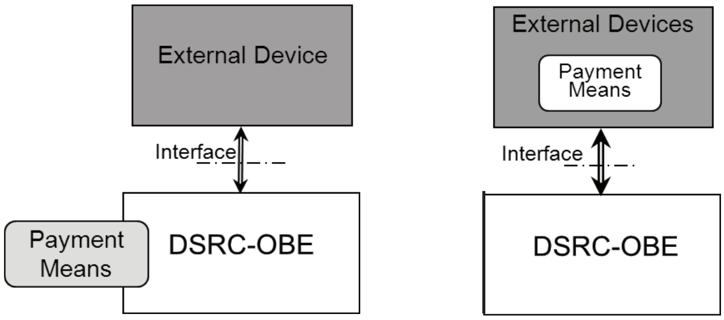

Figure 5 — Connection of payment means (left: in the main body, right: in Annex D)

5.2 Applicable tolling services

Applicable tolling services provided by a combination of DSRC-OBE and external in-vehicle devices are shown in Table 1. The basic DSRC tolling is the present DSRC tolling service as described in 5.3 and DSRC-OBE is used as the basic unit for extended tolling services and other ITS services as described in Annex E. As one of extended tolling services, mobile-assisted DSRC tolling performs auto-loading function for payment means via cellular networks as described in 5.4.

Universal tolling services both for DSRC tolling and autonomous system described in 5.5 that performed with DSRC-OBE and connected external in-vehicle devices are composed of a GNSS receiver, a CN device, and other optional components.

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Table 1 — Applicable tolling services with external in-vehicle devices

Tolling services	DSRC-OBE	Components of external in-vehicle devices						References
		GNSS	CN device	HMI	Motion sensors	Digital tachograph	CAN bus unit	
1. Basic DSRC tolling	M							5.3
2. Mobile-assisted DSRC tolling	M		M					5.4
3. Universal tolling	M	M	M	M	M	O	O	5.5
M: Mandatory, O: Option								

5.3 Basic DSRC tolling

Present DSRC-OBE used for tolling with payment means and its operating environment is shown in Figure 5. Figure 5 shows prepayment settlement; however, post-payment settlement has the same environment except for reloading operation.

In case of prepayment settlement, the most inconvenient issue for users is reloading to payment means by the terminal installed at the toll plaza or service area along toll roads or contracted shops and so on before payment means getting low balance. See Figure 6.

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