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Electronic fee collection — Investigation of EFC standards for common payment schemes for multi-modal transport services

Perception du télépéage — Recherche sur les normes de perception du télépéage pour des schémas de paiement communs pour les services multimodaux de transport

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Foreword

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The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

On-board account payment means are used, e.g., in public transport systems and in some electronic fee collection (EFC) systems. It is expected that the deployment of on-board account payment scheme will grow, as it has little dependence on the communication network and as it potentially can provide users with a common payment means for a range of multi-modal transport services.

This Technical Report (TR) provides an analysis of the specific requirements of common payment schemes within the framework of EFC systems as outlined in the existing EFC standards. The Technical Report does this by providing more specific information about the Payment means (such as IC cards) and the interfaces between Payment means and the other parts of an EFC system (see e.g. the previous edition of the ISO/TS 17573:2003). Payment means and Payment means Issuer are described in ISO 17573:2010, the latest version of the EFC architecture role model, hence allowing for the usage of the Payment means of the EFC On-board account for payment for other services. This Technical Report provides for an additional information (e.g. requirements, descriptions) relevant to the role of Payment means Issuer and information flows.

The motivation for this Technical Report is as follows:

— On-board account based EFC systems using payment means are widely adopted in many countries in Asia. In several of these countries, payment means are already used or planned to be used for both for the EFC and for the public transport services.

— Central account based EFC systems are widely adopted in many European countries and in the USA. Payment means used in such EFC systems can also be used in the common payment scheme (i.e. for the payment for other services).

Though there is a description of interaction between Toll charging environment and Financial system in the ISO 17573:2010, to provide for the On-board account EFC system used in the common payment schemes, additional information, relevant to the interactions between the Financial system and the Toll charging environment (i.e. interface between the Toll charging environment and objects outside of this environment), is required.

The following are the envisaged benefits of the common usage of payment means in ITS and EFC services:

— greater convenience of transport usage both for EFC and for public transport;

— enhanced multi-modal transport, more cost-effective, efficient and environmentally friendly.

Electronic fee collection — Investigation of EFC standards for common payment schemes for multi-modal transport services

1 Scope

Common payment scheme for multi-modal transport services, such as toll roads and public transport, are implemented all over the world. These systems are often based on a common payment medium, e.g. IC cards, for use in more than one transport service. The aim of this Technical Report is to analyse the existing set of EFC standards for their suitability for using common payment media for multi-modal transport services, where applicable identify standardisation gaps and to make proposals for such EFC standardisation projects. This includes definition of additional information to be exchanged among the related entities and to define the specific requirements for common payment scheme.

The scope of this Technical Report includes:

— investigation of a suitable model for EFC systems and other transport services;

— identification of the required interface definitions between the EFC and the public transport services including e-money services;

— identification of additional needs for additional EFC related information exchange among the related entities;

— provision of guiding information to be considered in revisions of EFC standards.

The scope includes all types of EFC systems, i.e. including both DSRC based EFC and autonomous EFC systems, and both pre-pay type and post-pay type.

Service related information of both public transport and e-money are outside the scope of this Technical Report.

2 Normative references

None.

3 Terms and definitions

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

3.1
central account
payment means, e.g. electronic values or number of passages in an EFC system, stored in a central system operated by the Toll Service Provider

3.2
clearing house
organisation re-allocating value generated in the payment system between the various actors, enabling these actors to execute settlement

3.3
EFC architecture
description of the key elements of an EFC system, their functions, and the interrelationships among the elements

[SOURCE: ISO 22902-1:2006, 3.1.8 modified]

3.4
EFC information exchange
exchange of EFC related information between EFC actors

3.5
electronic-money
value having its equivalence in real money, electronically stored e.g. on a bank account or an IC-card, which thus can be used by the user for payments

3.6
fare collection regime
set of rules, including enforcement rules, governing the fare system in the public transport domain

3.7
integrated circuit card
IC card
card containing electronic components performing processing or memory functions and with the capability to communicate with an interrogator

Note 1 to entry: Contact IC cards are specified in the ISO/IEC 7816 suite of standards, contactless proximity IC cards are specified in the ISO/IEC 14443 suite of standards, contactless near-field communication IC cards are specified in ISO/IEC 18092 and ISO/IEC 21481, whereas contactless vicinity IC cards are specified in ISO/IEC 15693 suite of standards.

Note 2 to entry: All references to an IC card are understood to be references to the IC of the card and not to any other storage on the card (e.g. magnetic stripe).

3.8
issuer
entity responsible for issuing the payment means to the user

3.9
on-board account
payment means, e.g. electronic values, tokens or evidence of passage in an EFC system, stored on-board the payment media held by the user, such as on-board equipment or an IC card

3.10
payment means
value (e.g. cash or stored electronic values), a reference to a central account or a credit card account number or a contract (e.g. a ticket) that gives the user access to available services

3.11
payment medium
the carrier of payment means, such as paper ticket, IC-card, smart phone or on-board unit (OBU)

3.12
prebilling operator
entity for clearing of billing data and for informing on payment claims to issuers

3.13
public transport services
shared passenger transport service which is available for use by the general public, such as buses, trams or trains

3.14
toll regime
set of rules, including enforcement rules, governing the collection of toll in a toll domain

[SOURCE: ISO 17573: 2010, 3.20]

4 Abbreviations

DSRC	Dedicated Short Range Communications
EFC	Electronic Fee Collection
ETC	Electronic Toll Collection
ERP	Electronic Road Pricing
ITS	Intelligent Transport Systems
OBU	On-Board Unit
ODP	Open Distributed Processing
RUC	Road User Charging
HGV	Heavy Good Vehicle
ICC	Integrated Circuit card, IC card
WAN	Wide Area Network

5 Background and context

5.1 Various EFC systems

EFC systems have been introduced all over the world and have become one of the fundamental services of Intelligent Transport Systems (ITS). Regardless of the same type of the service provided, the technical and operational aspects across the existing EFC systems vary (e.g. classification of the charging methods for the DSRC based systems and autonomous systems or account methods for the Central account and On-board account).

A comparison between European EFC and Asian EFC is provided in Table 1.

— In Europe, both DSRC based and Autonomous systems are in operation. In Asia, currently the EFC systems deployed are based on DSRC, the introduction of Autonomous systems is being studied.

— The majority of the EFC systems in Asia use an On-board account method, while most of the European EFC systems use the Central account method.

— An OBU is used as Payment means in EFC systems in Europe, while an IC card in systems in Asia. The issuer of the Payment means is the issuer of the card. In terms of the systems in Asia, this applies to banks, credit card companies and road operators.

— In Europe, service providers, banks or the toll road operators issue the OBU to the user, while in Asia the user usually purchases (and owns) the OBU.

— Interoperability with public transports will be realized by utilizing the common use Payment means in Asia.

Table 1 — Various EFC systems

Item	Region	
	Europe	Asia
1. EFC method	DSRC based EFC Autonomous system	DSRC based EFC (Autonomous system - in Future)
2. Account method	Central account (mainly) and On-board account (Austria and France)	On-Board account (mainly)
3. Payment method	Debit or credit from user's account in central system	Prepaid card and/or Credit card
4. Payment means issuer	Service provision, banks or toll road operators (Payment means=OBU)	Transport related institution (Toll road operator) and/or Financial related institution (Bank, Credit card)
5. OBU issuer	Service provider, banks or Toll road operators	OBU dealers or Toll road operator
6. OBU holder	Service provision (mainly)	User
7. Toll payer	Payment means holder, Vehicle owner	Payment means holder
8. Common payment with public transport	--	YES

5.2 Consideration of EFC architecture and models

5.2.1 General

In order to consider an On-board-account EFC system for common payment scheme for multi-modal transport services, an architecture level (i.e. EFC architecture in ISO 17573:2010) has to be considered.

ISO 17573:2010 contains a role model of the EFC architecture including On-board-account, where the Payment means issuer is an important entity in the On-board-account EFC system. Therefore, the role of this entity in the EFC architecture should be described in more specific and clear way (especially how to use the payment means in EFC system including potential interoperability with any of the relevant transport services).

NOTE The first version of EFC architecture standard was published in 2003. This first version (ISO/TS 17573) described the conceptual model for EFC. The architecture of the on-board account EFC system could be well described in this model, which includes the licensed Collection Agent who recharges prepaid cards and the Clearing operator who will be needed to exchange the transaction data and the claiming data with external Charging systems when common payment with public transport becomes necessary.

5.2.2 Role model (ISO 17573:2010)

At the time when standardization works for Autonomous EFC systems had progressed, the EFC architecture was reviewed and a new version established (in ISO 17573:2010). Figure 1 describes a new model (role model) in the Toll Charging environment of the EFC community. This new role model also explains the interoperability among multiple service providers and toll chargers which is an important aspect for cross-border toll services.

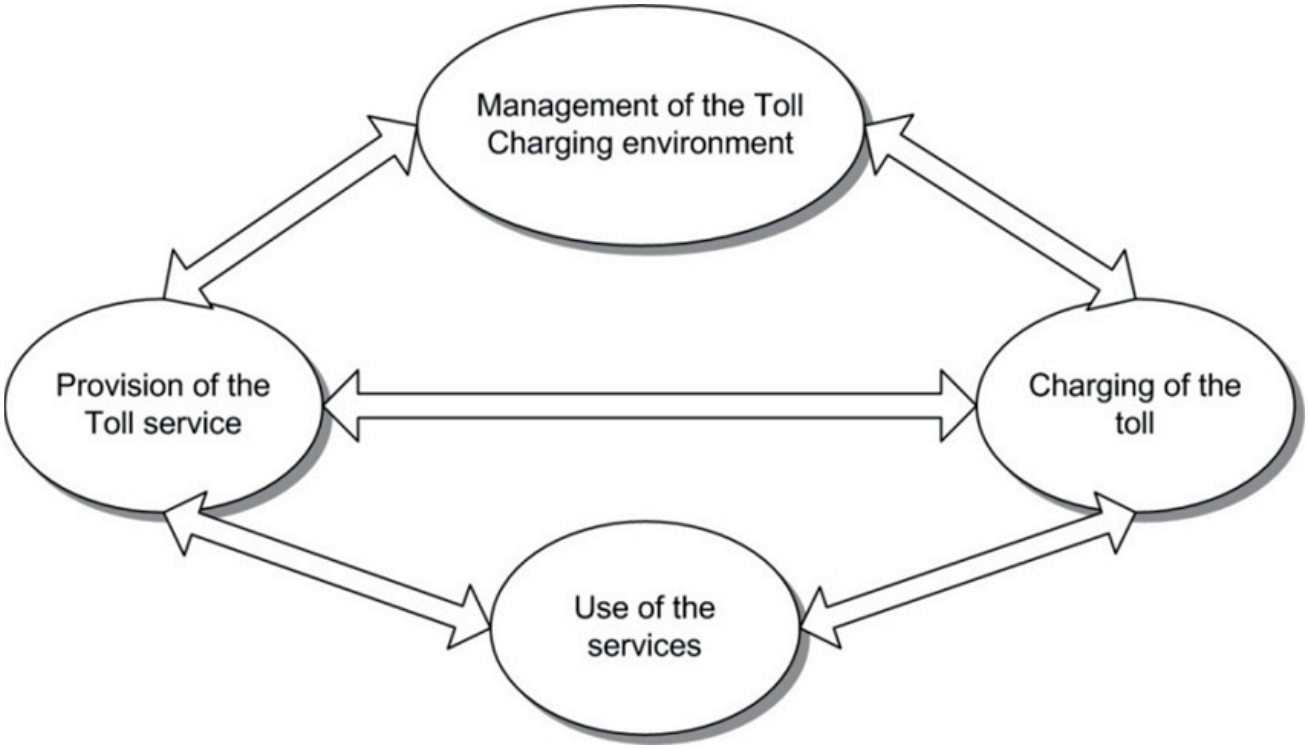

Figure 1 — Roles in the Toll Charging environment

5.2.3 Comparison

The relationships between the new role model and the old conceptual model of the EFC are described in Annex B of ISO 17573:2010. The Issuer role is included in the Provision of the toll service and the Clearing operator role is considered as being outside of the EFC environment and outside of the EFC architecture standard.

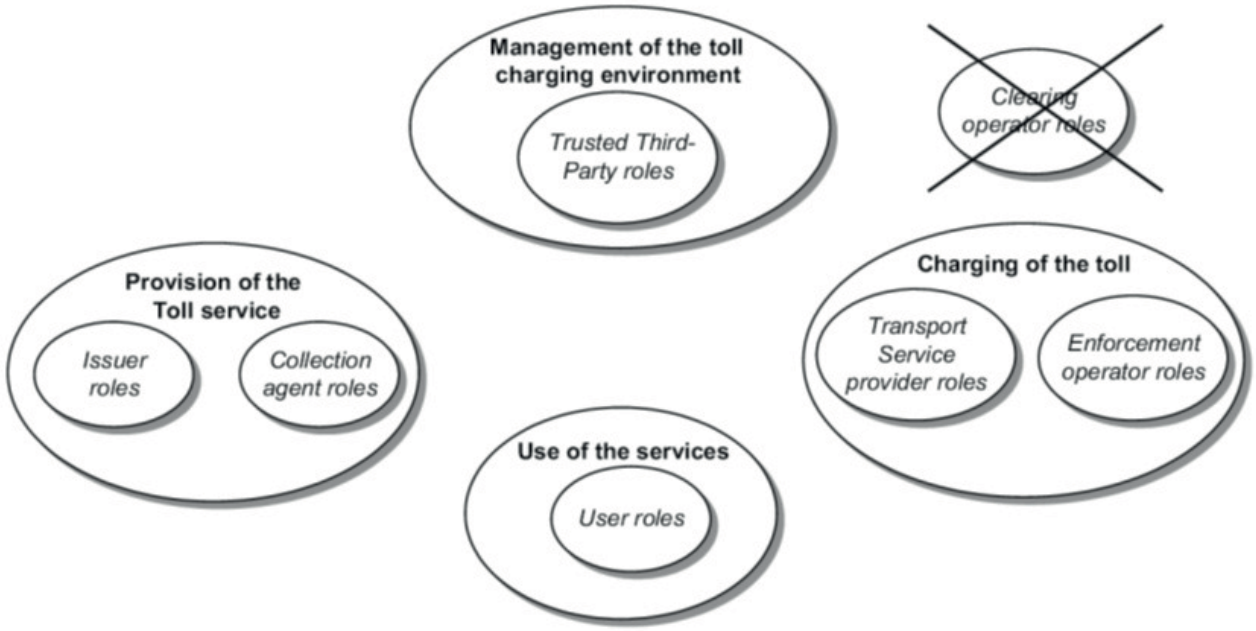

Figure 2 — Comparison of roles between new and old model

On-board account EFC systems using IC cards as payment means are operational in many Asian countries (in some of these countries, IC cards are used also for the public transport services).

A generic role model of On-board account EFC is shown in Figure 2 (as the Issuer role) in which the issuer of payment means has a big role and is an entity with direct interaction with users. Examples of actual EFC systems using payment means in several countries are shown in Annex A.

5.3 Consideration of different account type systems

There are two types of systems, based on the account type implemented: Central account systems and On-board account systems. Existing EFC standards do not fully specify how to realize a common payment scheme in the On-board account system. This is explained in clause 6.

In the case of the central account system, it is feasible to integrate user accounts existing in the central part of the system through the common central account. E.g. existing payment means for transport services are designed for individual service, therefore it seems difficult to migrate these devices into common payment means. The common central account system will have no impact on existing standards because the modification of the existing systems is not necessary. This concept is described in Annex D as well as in ISO/TR 14806:2013.

6 Consideration of On-board account EFC

6.1 Role model

As specified in ISO 17573:2010, the overall EFC architecture is defined by 4 main roles (see Figure 1). Some of these main roles are composed of roles, but adding no more interactions with other roles outside the main role. These definitions constitute the enterprise viewpoint to EFC systems according to the Open Distributed Processing (ODP) definition, see ISO/IEC 10746-1, clause 6.2.2.

As defined in clause 7.3 of ISO 17573:2010 the description of the roles covers also the interaction sequences between roles and therefore the overall functionality. These interaction diagrams represent the ODP information viewpoint of ISO/IEC 10746-1.

However, in case of EFC specific payment means issued by the actor in the EFC environment, in the 2010 version of ISO 17573 there is only the text “providing the payment means”, and no specific interactions defined including the loading/reloading of the on-board account using payment means and how to handle the payment claim by the reload operator getting the physical money or value from the user (however these interactions are included in the phrase “providing the payment meads” in ISO 17573:2010 essentially).

Therefore, descriptions of these interactions are added in this Technical Report (see Figure 4) which completes the information viewpoint for the use of on-board account using payment means.

The following clauses of this document are using the roles of Service Provisioning to recommend how the on-board account using payment means should be used within the overall EFC system configuration.

— payment means issuing

— reload operating

— hot-listing operation

— accepting the payment means

Both on-board account and centralized account payment means are allowed within the EFC regime, and the payment interactions between the Toll Charger and the Toll Service Provider are specified in ISO 12855:—[1)]. So far, the payment means interactions between user and Toll Service Provider, which also covers the role of the Payment Means Issuer, are not specified.

1) To be published. (Revision of ISO 12855:2012)

6.2 Computational architecture

6.2.1 Central account EFC

As discussed in the previous clause, the architecture standard ISO 17573:2010 specifies interoperable EFC clusters in the ODP enterprise and information viewpoint. Deriving from that, the required interfaces between information processing devices the ODP computational viewpoint defined in ISO/IEC 10746-1:1998, clause 6.2.2 is used. However, as shown in Figure 3, which is used in many EFC-related standards, the actual payment information flow is not only between the Toll Service Provider and the Toll Charger, but also between the Payment Service Provider and The Toll Service Provider. However, it is not clear whether the information exchange between the Payment Service Provider and the Toll Service Provider is in or out of the scope of the EFC architecture standard.

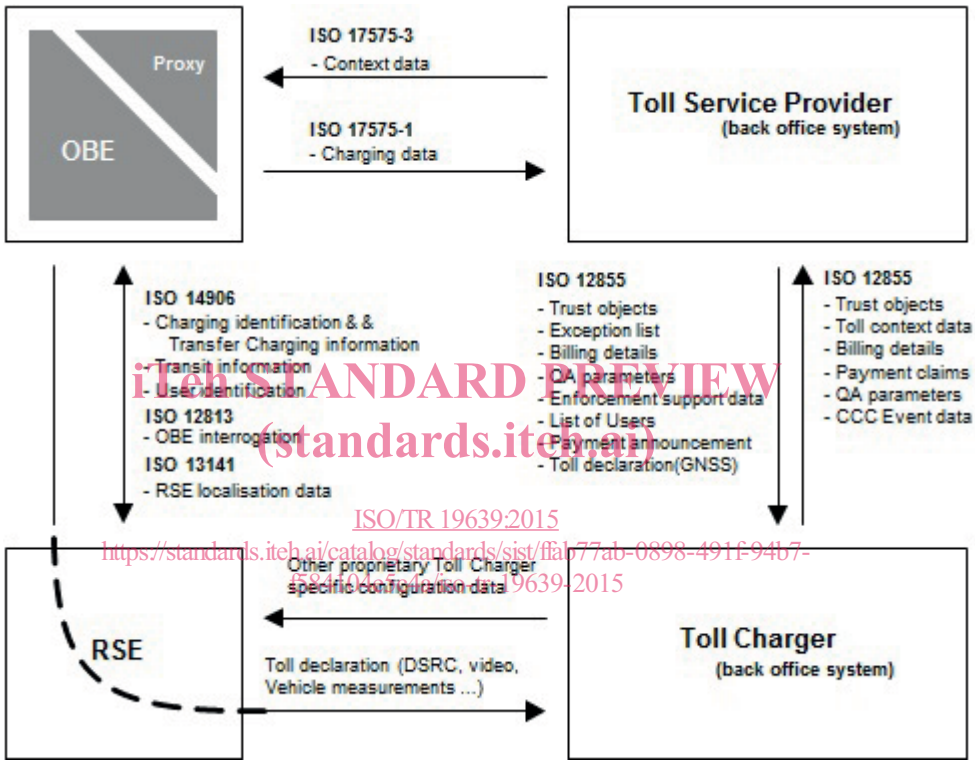

Figure 3 — Computational architecture

Providing on-board account payment means would require including the payment media into the OBE.

6.2.2 On-board account EFC

In Figure 4 the information processing tasks assigned to the actors including the information exchange for on-board accounts is illustrated. A further decomposition of its information processing devices at this level of the computational system architecture would have several options depending on the behaviour and information requirements towards the payment means.

Adding the payment information flows of the on-board account using payment means to the computational viewpoint diagram requires separating explicitly some actors or roles from the Service Provisioning main role. This is specified in clause 7.