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Electronic fee collection — Systems architecture for vehicle-related tolling

Perception du télépéage — Architecture de systèmes pour le péage lié aux véhicules

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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 17573 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*, in collaboration with Technical Committee CEN/TC 278, *Road transport and traffic telematics*.

This second edition cancels and replaces the first edition (ISO/TS 17573:2003), which has been technically revised.

Introduction

The widespread use of tolling requires provisions for users of vehicles that are roaming through many different toll domains. Users should be offered a single contract for driving a vehicle through various toll domains and those vehicles require on-board equipment (OBE) that is interoperable with the toll system in the various toll domains. In Europe, for example, this need has been officially recognized and legislation on interoperability has already been adopted. See EFC Directive 2004/52/EC. There is a commercial and economic justification both in respect to the OBE and the toll systems for standards enabling interoperability.

In addition to other standards, there is also a further need for a system architecture that

— provides an architectural “umbrella” for other EFC standards in terms of a common definition of terms and concepts, basic system functionalities, and structure;

— provides a common terminology which enables its users

  — to improve the quality of specifications to be used in an international market,

  — to reduce the risk for different interpretations of specifications (purchaser) and descriptions (supplier),

  — to simplify the communication between experts from different continents, and

  — to enhance the potential use of other EFC standards;

— defines a common framework, that enables both

  — identification of potential activities subject to standardization, and

  — maintenance of a common and consistent view of the whole area;

— defines the boundaries between the EFC and the external world;

— identifies all architectural objects that are within the EFC boundaries;

— provides a basic understanding of EFC, EFC interoperability, and the EFC services being offered.

The previous edition of this International Standard was based on a conceptual model defined in ISO/TS 14904. Since then, ideas on conceptual models have evolved in several regional projects and implementations, e.g. in Japan and Europe. Those new models have been detailed to a further extent compared to ISO/TS 17573:2003 and are closer to real-life implementations. This International Standard is based on these new conceptual models and uses the associated terms and definitions. A comparison between ISO/TS 17573:2003 and this edition is shown in Annex B.

Although there are many differences, collecting tolls for vehicles can be to some extent compared with collecting fares for public transport. Architectural harmonization of the collection of fees and fares can be desirable from a policy and from a user point of view. In the past ISO 24014-1 (prepared by CEN/TC 278 WG 3, Public Transport) used ISO/TS 17573:2003 as a starting point for their work. This International Standard has benefited from that and has also taken ISO 24014-1 into account.

In this International Standard the open distributed processing (ODP) standard is used for the description of the architecture.

The ODP standard gives a vocabulary and modelling tools to see the architecture of a system from different perspectives (viewpoints), in order to cover, for example, hardware components as well as network protocols

or interfaces or roles and general policies of the system itself. This is accomplished using different sets of concepts and terminologies, each one of those expressed as a viewpoint language. A complete description of a real system can only be achieved when all viewpoint models are designed. This allows for a clear separation of concerns and an easier way to define a system. A brief description of the ODP concepts can be found in Annex A.

This International Standard gives a description of the architecture of the toll systems environment from the enterprise viewpoint. In addition, this International Standard defines the foundations of the information viewpoint by defining information interactions and general information objects, and gives the basis for the computational view, by identifying needed computational objects and their interfaces.

Electronic fee collection — Systems architecture for vehicle-related tolling

1 Scope

This International Standard defines the architecture of a toll system environment in which a customer with one contract can use a vehicle in a variety of toll domains and with a different Toll Charger for each domain.

Toll systems covered by this International Standard can be used for various purposes including road (network) tolling, area tolling, collecting toll for bridges, tunnels, ferries, for access, and for parking. From a technical point of view the considered toll systems use electronic equipment on board a vehicle.

From a process point of view the architectural description focuses on toll determination, toll charging, and the associated enforcement measures. The actual collection of the toll, i.e. collecting payments, is not included.

The architecture in this International Standard is defined with no more details than those required for an overall overview, a common language, an identification of the need for other standards, and the drafting of these standards.

This International Standard provides

— the enterprise view on the architecture, which is concerned with the purpose, scope and policies governing the activities of the specified system within the organization of which it is a part,

— terms and definitions for common use in a toll environment,

— a decomposition of the toll systems environment into its main objects,

— the responsibilities of the main actors,

— an identification of the main interfaces between the main objects,

— an identification of the main flows of information between the main objects, and

— action diagrams reflecting the co-operation between the main actors.

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/IEC 7498-1, *Information Technology — Open systems interconnection reference model — Basic Reference Model: The Basic Model* (ITU-T Recommendation X.200, 1994)

ISO/IEC 10746-2, *Information technology — Open distributed processing — Reference model: Foundations* (ITU-T Recommendation X.902)

ISO/IEC 10746-3, *Information technology — Open distributed processing — Reference model: Architecture* (ITU-T Recommendation X.903)

ISO/IEC 15414, *Information technology — Open distributed processing — Reference model: Enterprise language* (ITU-T Recommendation X.911)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 7498-1, ISO/IEC 10746-2, ISO/IEC 10746-3, ISO/IEC 15414, and the following apply.

3.1
context data
information defined by the responsible Toll Charger necessary to establish the toll due for circulating a vehicle on a particular Toll Domain and to conclude the toll transaction

3.2
customer (of a Toll Service Provider)
person or legal entity that uses the service of a Toll Service Provider

NOTE Depending on the local situation, the customer can be the owner, lesser, lessee, keeper, (fleet) operator, holder of the vehicle's registration certificate, driver of the vehicle, or any other third person.

3.3
driver
person who drives a vehicle

NOTE The driver is assumed to operate (use/serve) the OBE (e.g. the setting of the number of axles).

3.4
electronic fee collection
EFC
toll charging supported by electronic equipment on board a vehicle

NOTE The actual payment (collection of the fee) can take place outside the toll system.

3.5
enforcement
process of compelling observance of a law, regulation, etc.

NOTE In this context, “enforcement” is the process of compelling observance of a toll regime.

3.6
equipment interoperability
ability of two or more pieces of equipment to operate in conjunction

3.7
interoperability
ability of systems to provide services to, and accept services from, other systems and to use the services so exchanged to enable them to operate effectively together

EXAMPLE Tolling interoperability aims at enabling a vehicle to drive through various toll domains while having only one OBE operating under one contract with a Toll Service Provider.

3.8
localization augmentation
information sent by the roadside equipment to the on-board equipment to augment the positioning for autonomous systems

3.9
on-board equipment
OBE
equipment fitted within or on the outside of a vehicle and used for toll purposes

NOTE The OBE does not need to include payment means.

3.10
one(s) liable for toll
person(s) or legal entity(ies) liable to pay toll under the operation of a toll regime

NOTE A toll regime can designate more than one person to be (jointly and severally) liable for paying the toll.

3.11
point of observation
interface, or in general identifiable access to a system, where conformance can be stated and verified

3.12
roadside equipment
equipment located along a road transport network, for the purpose of communication and data exchanges with on-board equipments

3.13
role
set of responsibilities

3.14
tariff scheme
set of rules to determine the toll due for a vehicle in a toll domain for a tolled object at a certain day and time

EXAMPLE A table that shows the toll for various classes of vehicle.

3.15
toll
charge, tax, fee, or duty in connection with using a vehicle within a toll domain

NOTE The definition is a generalization of the classic definition of a toll as “a charge, a tax, or a duty for permission to pass a barrier or to proceed along a road, over a bridge, etc.” The definition above also includes fees regarded as an (administrative) obligation, e.g. a tax or a duty.

3.16
Toll Charger
legal entity charging toll for vehicles in a toll domain

NOTE In other documents the terms operator or toll operator can be used.

3.17
toll declaration
statement to a Toll Charger that confirms the presence of a vehicle in a toll domain in a format agreed between the Toll Service Provider and the Toll Charger

NOTE A valid toll declaration has to fulfil formal requirements, including security requirements, agreed between the Toll Service Provider and the Toll Charger.

3.18
toll domain
area or part of a road network where a toll regime is applied

3.19
toll point
location within a toll domain where the OBE has to issue a toll declaration

EXAMPLE A part of a toll plaza for electronic fee collection.

3.20
toll regime
set of rules, including enforcement rules, governing the collection of toll in a toll domain

3.21
toll schema
generic term used for toll regime and/or toll domain and/or toll system depending on the context

3.22
toll service
service enabling users having only one contract and one set of OBE to use a vehicle in one or more toll domains

3.23
Toll Service Provider
legal entity providing customer toll services on one or more toll domains for one or more classes of vehicle

NOTE 1 In other documents the terms “issuer” or “contract issuer” can be used.

NOTE 2 The toll service provider can provide the OBE or can provide only a magnetic card or a smart card to be used with the OBE provided by a third party (just as a mobile telephone and a SIM card can be obtained from different parties).

NOTE 3 The toll service provider is responsible for the operation (functioning) of the OBE with respect to tolling.

3.24
toll system
off-board equipment and possible other provisions used by a toll charger for the collection of toll for vehicles

NOTE 1 The OBE is excluded from the definition.

NOTE 2 The actual payment (collection of the fee) can take place outside the toll system.

3.25
toll systems environment management
controlling enterprise object for the toll systems environment

NOTE The toll systems environment management can encompass several distinct entities, e.g. a political/legislative one, a regulatory one, private associations, standardization authorities, and so on.

3.26
tolled object
distinguished part of a toll domain for which one or more tariff schemes apply

EXAMPLE A tolled object can be e.g. an area, all public roads within an area, a bridge, a zone, or a stretch of road (network).

3.27
transport service
service used by a toll-liable vehicle in a given toll regime under the responsibility of a toll charger

3.28
trust object
information object that is exchanged between entities to ensure mutual trust

EXAMPLE A trust object can be e.g. an electronic signature or an electronic certificate.

3.29
user
customer of a toll service provider, one liable for toll, the owner of the vehicle, a fleet operator, a driver, etc.

NOTE This is a generic term which is context dependent.

4 Symbols and abbreviated terms

4.1 Abbreviated terms

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

CE	Central Equipment
CRM	Customer Relationship Management
DSRC	Dedicated Short-Range Communication
EETS	European Electronic Toll System
EFC	Electronic Fee Collection
GNSS	Global Navigation Satellite Systems
ID	Identity
IFMSA	Interoperable Fare Management System Architecture
OBU	On-board Unit
ODP	Open Distributed Processing
RSE	Roadside Equipment
SLA	Service Level Agreements
TC	Toll Charger
TMS	Traffic Management System
TTP	Trusted Third Party
UML	Unified Modelling Language

4.2 Symbols

In action diagrams, the following graphical conventions apply.

Rounded corner boxes indicate responsibilities and related activities within roles

Horizontal arrows indicate information exchanges between roles as activities performed within responsibilities

Vertical arrows represent execution steps within activities

Solid circles represent the start of activities

Partially coloured circles represent the end of activities

Solid horizontal bars represent decision gates

5 The EFC community: roles and objectives

5.1 General

This clause specifies the EFC community in terms of its relationships and interactions with the external objects with which the EFC community interacts.

The EFC community is

a) the collection of all entities that have been set up for carrying through the different roles,

b) the EFC-specific equipment needed to fulfill the roles, and

c) the vehicle-related transport services subject to tolling.

External entities are objects that are involved in the toll charging but that are not set up for the only purpose of toll charging, e.g. satellite positioning systems and standardization bodies.

The EFC community is represented as a toll charging environment and the objects that the toll charging environment interacts with, which together act as a configuration of objects formed to meet an objective which, in this case, is the electronic collection of tolls for vehicle-related transport services. The toll charging environment itself is represented as an enterprise object in the community and the objectives and scope of the toll charging environment are defined in terms of the roles it fulfils within the community of which it is part and the policy statements about these roles. Also, the roles of the enterprise objects external to a toll charging environment are defined here in terms of their implication in the tolling.

Figure 1 shows the external enterprise objects that define the environment of this International Standard. Objects shown are the major objects, although there may be others, explicitly or implicitly involved in the toll collection. There might also be interfaces between a toll charging environment and other types of ITS systems, e.g. traffic information systems.

The lines between the objects indicate the major interactions between the enterprise objects, where interfaces are located. Interfaces between the toll charging environment and the other objects in the EFC community will be external interfaces to the toll charging environment while interfaces within the toll charging environment will be internal interfaces.

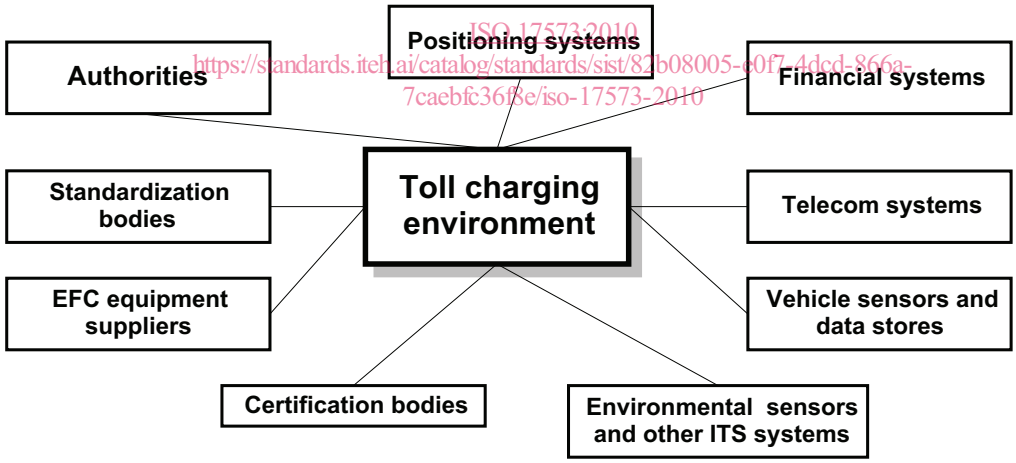

Figure 1 — Enterprise objects in the EFC community

5.2 Toll charging environment

The role of a toll charging environment is to electronically collect a toll in a secure and safe way enabling issuing of a toll declaration without stopping at a charging point, e.g. a toll station.

The interactions between a toll charging environment and the other objects in the EFC community are described below.

5.3 External objects

5.3.1 Financial systems, e.g. banks, credit card companies and clearing houses

The role of a financial system is to provide the financial services requested by a toll charging environment. The services will mainly be the transfer of money between entities in the toll charging environment, including users. It is important to note that the toll charging environment roles handle charging data while the financial system handles payment information ("money"). The interactions between the toll charging environment and the financial system are based on explicit and implicit contracts between the objects in the toll charging environment and the objects in the financial system.

This International Standard makes a strict distinction between the payment (financial) domain supporting a toll charging environment and the charging domain within the toll charging environment itself. Only the charging domain is covered by this International Standard.

5.3.2 Telecom systems

The role of the telecom systems is to provide the telecom services requested by a toll charging environment. Examples of such services could be cable network for transfer of data between the operators of the toll charging environment and air-interface network for transfer of data between the toll charging equipment and the OBE. The interactions between the toll charging environment and the telecom system are based on explicit and implicit contracts between the objects in the toll charging environment and the objects in the telecom system.

5.3.3 Positioning systems

The role of the positioning systems is to provide positioning services as part of the toll calculation, i.e. to provide signals for registering the position of the vehicle subject to a toll. Examples of such registrations are the registration of when a vehicle recognizes a tolling object or the distance that a vehicle has travelled in a road network. Examples of real-life positioning systems are GPS and GALILEO. DSRC road infrastructure could also be used for positioning but, in this case, it would be part of the toll charging environment as it has no other roles outside the EFC community. The interactions between a toll charging environment and the positioning system are based on explicit and implicit contracts between the objects in the toll charging environment (objects related to the toll charging roles) and the objects in the positioning system.

5.3.4 Vehicle sensors and data stores

A toll charging environment may use information from vehicle sensors and data stores integrated in the vehicle where the main purposes of the sensor or data store are not related to EFC. The information is retrieved from the sensors and data stores and used for the toll calculation. Examples of such sensors and data stores are GNSS sensors (e.g. in devices used for navigation, fleet management), tachographs, trailer sensors, suspension sensors, axles in use sensors and vehicle-related information stored in a secure application module (SAM). The data stores could be either in the vehicle or elsewhere, e.g. a computer installed within the toll domain.

5.3.5 Environmental sensors and other ITS systems

A toll charging environment may use data from environmental sensors, e.g. pollution measurements, for the toll calculation. Data from other ITS systems, e.g. traffic management systems (TMSs), may also be used for toll calculation. A dynamic road pricing scheme may for instance use both the pollution measurements from environmental sensors and the data on traffic flows and speeds from a TMS for the dynamic toll calculation.

5.3.6 EFC equipment suppliers

The role of the EFC equipment suppliers is to provide EFC equipment to a toll charging environment, e.g. OBE and RSE. The interactions between the EFC equipment suppliers and the toll charging environment are based on contracts between the different objects in the toll charging environment and the EFC equipment suppliers. The main role of the toll charging environment will be to provide system requirements while the