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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

Reference number
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Contents

Page

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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.

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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

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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.

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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)

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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.

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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

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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.

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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.

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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.

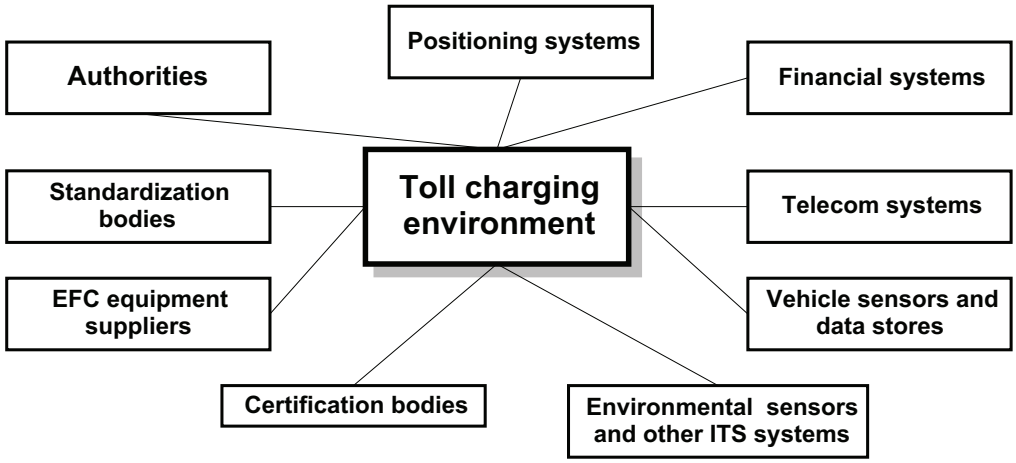

Figure 1 — Enterprise objects in the EFC community

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.

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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

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main role of the EFC equipment suppliers will be to provide EFC equipment with EFC functionality in accordance with the requirements.

5.3.7 Certification bodies

The role of the certification bodies is to certify the objects in a toll charging environment. The certification may cover both the certification of roles and equipment/functions in the toll charging environment.

Certification of roles, e.g. the actors (companies) that take crucial roles, is important in an interoperable environment with several different operators.

5.3.8 Standardization bodies

The role of the standardization bodies is to provide EFC standards and other standards or specifications relevant for toll charging environments. There are interactions with a toll charging environment concerning EFC standards to be used for toll charging environment requirements as well as input from toll charging environments to the standardization bodies, e.g. by toll charging operators taking part in the preparation of EFC standards.

5.3.9 Authorities

The role of the authorities is to define the framework in which a toll charging environment shall operate. The framework is defined by policies constituting laws and regulations, mandates, constraints and requirements. Different authorities define different policies:

— Road and transport authorities, e.g. a Department of Transport, may define policies related to the type, availability, reliability and quality of the transport service subject to a toll. The authorities may also, in co-operation with the financial authorities, define policies for tariffing principles to be used in a toll charging environment. The authorities may also, in co-operation with the financial authorities, define the policies that govern the configuration of the EFC enterprise objects and assignment of roles to enterprise objects as well as the environment contracts that govern the system. An example here would be that the authorities define the policy which is the basis for the contract between an operator taking the role of issuing EFC contracts and the operators taking the toll charging roles.

— Telecom authorities may define policies for the use of telecom systems, e.g. frequencies in air-interface communication systems.

— Financial authorities may define policies for a toll charging environment and the financial environment it shall operate, e.g. whether the toll is a tax or a fee. They may also define policies for the use of certain types of payment means, e.g. electronic purses, and the split of roles between the toll charging environment and the financial systems.

— Data protection authorities may define policies for the security and privacy in a toll charging environment.

— Certification authorities may issue public key certificates.

The interactions with the authorities also cover access to information kept by the authorities, e.g. national vehicle registers.

6 Roles in a toll charging environment

6.1 General

Since a role is a collection of responsibilities for certain tasks (or functions), this International Standard describes the different roles in a toll charging environment as the defined collections of responsibilities in the EFC scope. Roles are described in general terms, i.e. as sets of responsibilities where each set includes

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responsibilities that are logically related to each other, either by their objectives and/or the actors that may take the role. The following roles are identified:

— A role related to the provision of the toll service.

— A role related to the use of the toll services.

— A role related to the charging of the toll.

— A role related to the management of a toll charging environment. Responsibilities in this role include managing the interoperability among different EFC domains and acting like an advisory board, in the sense of not covering any commercial responsibility or risk.

An overall picture of the main roles and their interactions is summarized in Figure 2. The two-way arrows between roles are meant to indicate collections of interactions. Interactions to and from the management role are management information flows, while interactions between the three other roles are operational information flows of the toll charging environment, i.e. information flows that are present during daily operation.

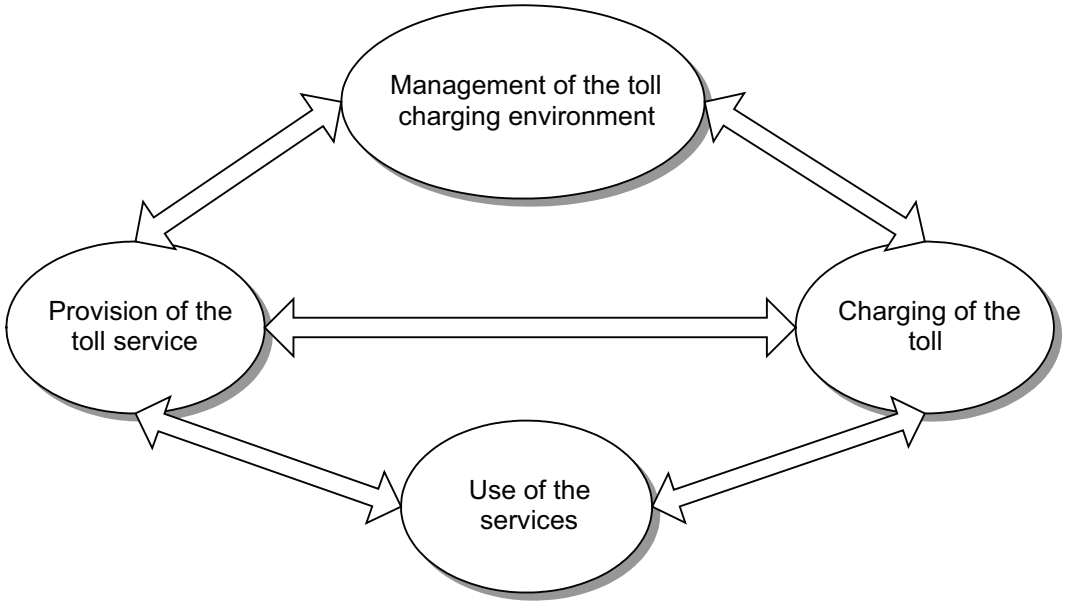

Figure 2 — Roles in a toll charging environment

The following clauses describe the above identified roles, indicating, for each role, its responsibilities. It has to be clear that this International Standard does not impose that all roles perform all indicated responsibilities. Mandating the performance of certain responsibilities is the task of base standards derived from this architecture.

6.2 Role related to the provision of the toll service

The role related to the provision of the toll service is responsible for providing the basic artefacts, mechanisms, organization structures, and information transfer tools needed to run an EFC system.

Responsibilities related to this role include

— providing basic provision, including

  — providing the OBE,

  — guaranteeing that the entity performing the charging of the toll role will be paid for it,

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- providing the payment means to the user or accepting an existing one,
- collecting the money from the signer of the EFC contract,
- managing the customer relationships related to the use of the toll service concerning information, claims, questions and answers, error handling and any contractual or financial matters,
- implementing and adhering to the security and privacy policies for the toll systems, and
- monitoring the actual operational quality relative to agreed SLA's;

— acting as a contract agent, including

- offering contractual relations according to defined conditions to interested users and concluding contractual agreements, and
- providing and managing the EFC contract including the service rights for the toll service user;

— providing toll declaration, including

- making sure that the OBE is reporting in a secure way information needed for the toll charging;

— providing EFC context data, including

- providing context data originated elsewhere (e.g. by a Toll Charger) in a way that they can be installed in the OBE;

— customizing the OBE, including

- customizing the OBE in a secure way;

— maintaining the OBE, including

- maintaining the functionality of the OBE.

6.3 Role related to the use of the toll service

In this International Standard, a transport service is related to the use of, or the presence of, a vehicle in a toll domain. The toll domain may encompass a road network, a specific section of road (e.g. a bridge, a tunnel or a ferry connection) or a specific area offering a service (e.g. a parking lot or access to a protected area in a city). It could also be any service related to the use of a vehicle in the transport system, e.g. a petrol station enabling the driver to buy petrol by means of EFC.

A role is thus identified that covers all aspects of using the toll system and, if applicable, of the transport service. Implementations of toll systems in various domains identify actors in this role that are commonly referred to as, e.g., driver, user or customer.

This role covers the following responsibilities:

— Driving the vehicle subject to toll including

- using the OBE as a tool to fulfil one's obligations,
- interacting with the OBE, e.g. declaring the vehicle characteristics for the vehicle subject to toll or receiving messages and acting on the messages from the OBE, and
- behaving according to the rules of a specific toll system, e.g. recognizing a signal or a road sign.

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— Owning or operating a vehicle, including

  — adhering to the toll regime for a toll domain,

  — signing a contract with a Toll Service Provider,

  — signing a contract with the issuer of the EFC contract and becoming responsible for compliance to the rules related to the use of the toll service,

  — acquiring an OBE,

  — installing and eventually de-installing the OBE in the vehicle,

  — terminating the contractual relation to the Toll Service Provider,

  — receiving the claim, e.g. by means of an invoice, for a service that has been used and a toll to be paid,

  — paying the toll included in the claim,

  — storing and protecting the contractual data and eventually the payment means, e.g. an electronic purse, needed for toll charging and communicating the data to other actors having roles related to issuing or toll charging (this role is always bound to the OBE), and

  — contacting the CRM of the service provider in order to clarify uncertainties about issues covered by contractual relations.

6.4 Role related to the charging of the toll

The role related to the charging of the toll covers all actors who define the toll regime, operate the toll system and may provide transport services. The role includes the related charging infrastructures and who defines the toll and operates the toll system. Enforcement operators also play this role.

The role related to the toll charging includes the following responsibilities:

— Basic charging, including

  — providing, if applicable, the transport service, e.g. access to a road network, a parking lot or a ferry connection, and

  — defining the charging principles for the service offered, e.g. the tariffing principles for a tolled road or zone.

— Calculating the toll, including

  — possibly communicating to the user the result of the charging process, and

  — communicating in a secure way with actors having roles related to the issuing of the EFC contract, payment means and OBE.

— Originating EFC context data, including

  — informing the driver of the vehicle about the EFC availability and the toll charging principles, e.g. through signs and messages either directly or via the OBE.

— Communicating with passing vehicles, including, whenever applicable and according to the technology chosen in the given toll domain

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- providing, if applicable, to autonomous systems, geographical details of the charge objects in the toll domain, as well as positioning information; this process is also known as localization augmentation,
- detecting a vehicle subject to a toll,
- collecting the characteristics of a vehicle enabling a correct classification of the vehicle used for a toll calculation; the information collected can either be read from the OBE, measured (both used for toll calculation or verification of data read from the OBE) or collected from a central database or vehicle register (off-line toll calculation),
- communicating in a secure way with the OBE, exchanging information needed for the toll charging,
- accepting the service rights stored in the OBE, i.e. the medium carrying the contractual data, and
- collecting the information enabling the operator of the toll domain to identify the receiver of a claim for a transport service provided, e.g. by licence plate recognition. The role enables toll collection without an OBE installed in the vehicle.

— Operating enforcement, including

- detecting, recording and handling exceptions (including fraud) whenever a vehicle passes through a toll domain; compliance check of autonomous systems is included in this responsibility,
- handling enforcement cases while protecting the privacy of the actors having taken the role of driver, and
- implementing and adhering to the security and privacy policies for the toll charging environments.

6.5 Role related to the management of a toll charging environment

There is also a need for overall management of a toll charging environment defining and organizing the policy that enables the daily operation of the toll charging equipment involving several different actors. A specific role is identified to manage a toll charging environment, i.e. defining and maintaining a set of rules that, taken together, defines the policy of a given regime or of the overall toll charging environment.

The responsibilities of this role include

— setting rules, including

- defining the supported security and privacy policies for the EFC system, acting as the security authority that defines the security interaction policy among the different security domains, and
- defining and maintaining ID schemes and, if necessary, supporting the issuing of IDs ensuring unique registration codes for organizations and components and unique identifiers or rules for generating unique identifiers for the EFC applications and messages;

— certifying EFC constituents, including

- defining the certification requirements for actors involved and equipment used in the EFC system;

— handling disputes, including

- defining the operational procedures among the operators, and
- managing disputes among operators.

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6.6 Decomposition of a toll charging environment

6.6.1 General

This International Standard describes how the roles described in 6.1 to 6.5 are allocated to four different types of domains within a toll charging environment:

a) The Toll Service Provider domain covers all roles described in 6.2.

b) The user domain covers all roles described in 6.3.

c) The Toll Charger domain covers all roles described in 6.4.

d) The toll charging environment management domain covers all roles described in 6.5.

Each domain can be described by objects on the following three levels:

e) the organizational level where different objects describe the actors that have been assigned the different roles within that domain;

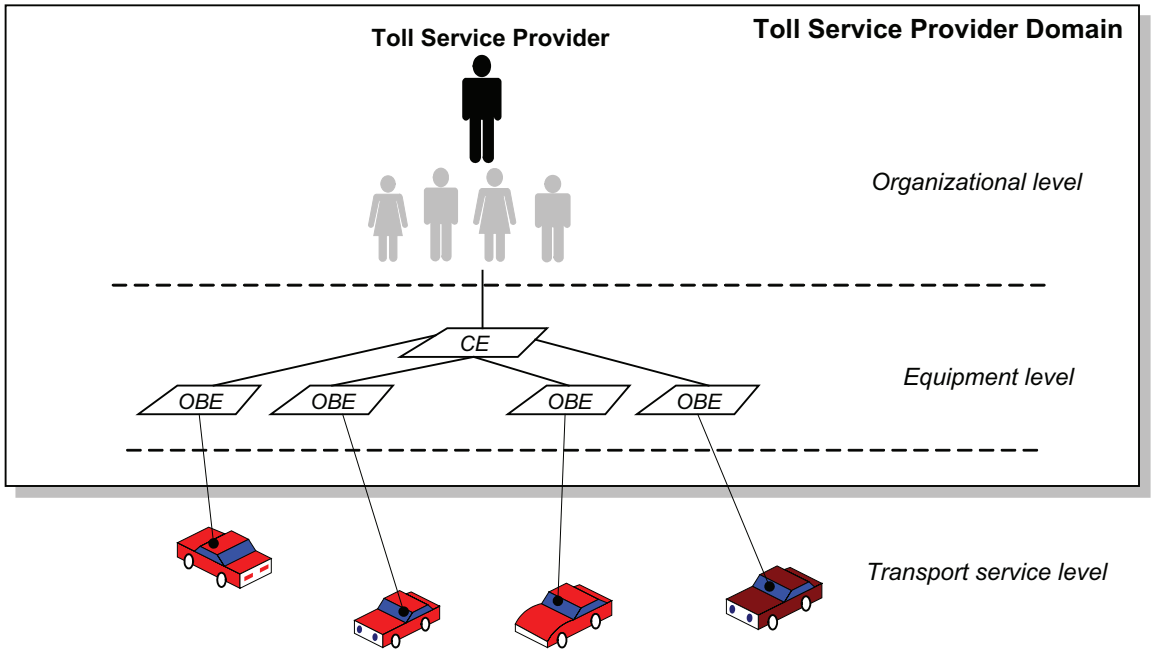
f) the equipment level where objects describe the artefacts, e.g. the OBE, used by actors to perform their roles;

g) the transport service level where objects describe the type of vehicle-related services that are offered within the domain.

6.6.2 The Toll Service Provider domain

6.6.2.1 General

This subclause defines the objects involved in performing the toll service provisioning role (see Note in Figure 3). Note also that a Toll Service Provider domain is controlled by a Toll Service Provider.



NOTE Vehicles do not belong to the toll service provider domain.

Figure 3 — Toll service provider domain

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6.6.2.2 Organizational level

The Toll Service Provider is the legal entity that provides the customers (users) with toll services in one or more toll domains, (see 6.6.4), for one or more classes of vehicle. A toll service is a service enabling users having only one contract and one OBE to use a vehicle in one or more toll domains.

The Toll Service Provider may purchase services from other legal persons and/or organizations operating on their behalf. These organizations are often given names that reflect the responsibilities they have taken, e.g. OBE provider and contract provider or issuer. However, any distinction between a Toll Service Provider and entities acting on their behalf is outside of the scope of this International Standard.

A Toll Service Provider may as well act as the Toll Charger for one or more toll domains.

The Toll Service Provider controls the OBE and is responsible for its operation (functioning).

NOTE 1 The OBE does not need to include payment means.

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).

6.6.2.3 Equipment level

The off-board equipment used by a Toll Service Provider for providing toll services is called the central equipment (CE in Figure 3). The CE may be split into different types of equipment depending on the allocation of roles within the Toll Service Provider organizational level.

The OBE is initialized and eventually maintained by the Toll Service Provider.

The OBE may be connected to one or more external sensors, e.g. a GNSS sensor (e.g. in devices used for navigation, fleet management), a tachograph, an odometer, a trailer sensor, suspension sensors, axle in use sensors and vehicle-related information stored in a secure application module.

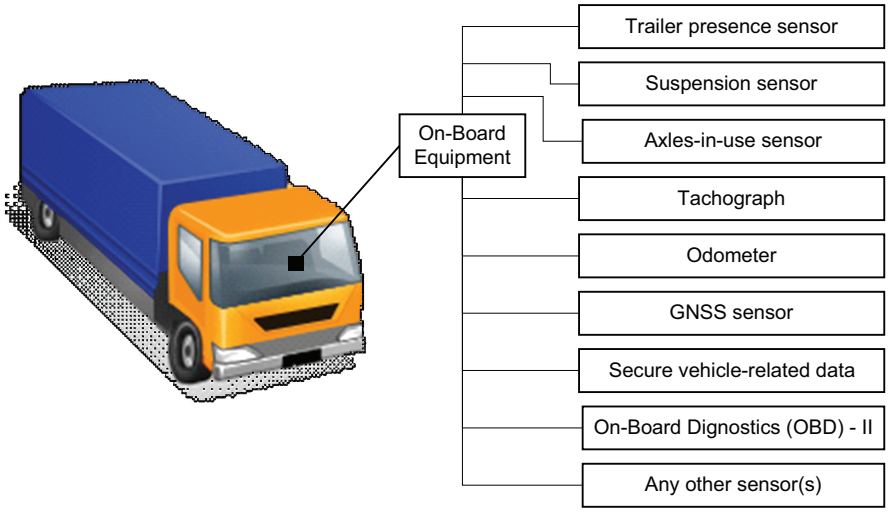

Figure 4 — OBE and external sensors

6.6.2.4 Transport service level

The OBE may be linked to a specific vehicle (with its specific vehicle attributes) that is used at the Transport service level. The vehicle may be used in one or several toll domains covered by the EFC contract.

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6.6.3 The user domain

6.6.3.1 General

This subclause defines the objects involved in performing the toll and transport service using role (see Figure 5).

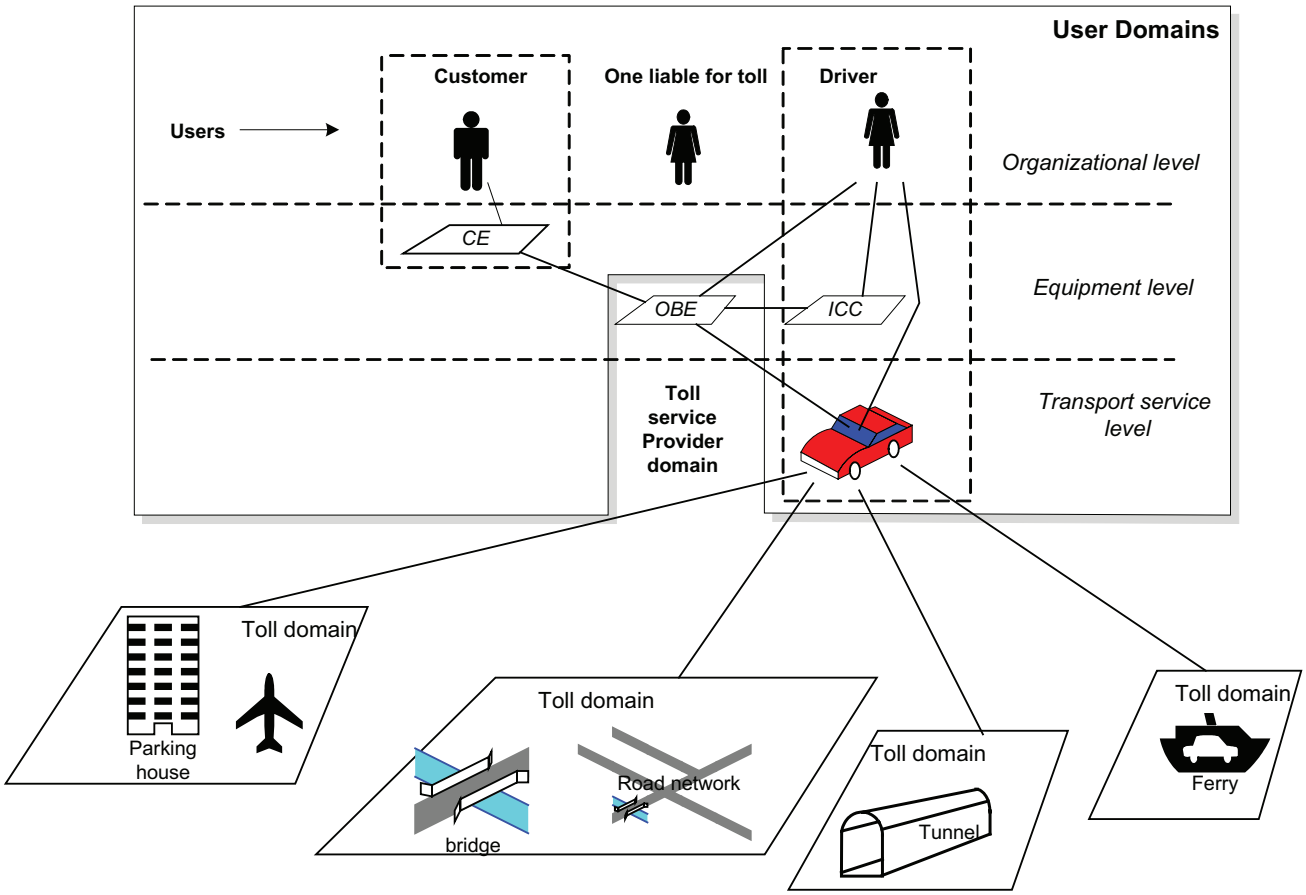

Figure 5 — User domain

6.6.3.2 Organizational level

The “customer” in Figure 5 is the customer of the Toll Service Provider.

The one(s) liable for toll are the one(s) that are liable for paying the toll according to the local toll regime.

EXAMPLE The driver, the owner of the vehicle or the hauler can be separately or jointly liable for the toll.

NOTE 1 Selection of the one liable for paying the toll for a vehicle is a local matter. It should facilitate enforcement but is outside the scope of this International Standard.

NOTE 2 The customer can but does not have to be liable for paying the toll according to a toll regime.

The driver is the one who drives the vehicle for which the toll is levied.

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

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6.6.3.3 Equipment level

The off-board equipment used by a customer in relation to his of her toll duties is called his or her CE, e.g. the CE of a fleet manager having several EFC contracts. The OBE is part of the Service Provision responsibilities.

6.6.3.4 Transport service level

A vehicle is controlled by its driver and is therefore part of the driver's domain.

6.6.4 The Toll Charger domain

6.6.4.1 General

This subclause defines the objects involved in performing the toll charging role (see Figure 6).

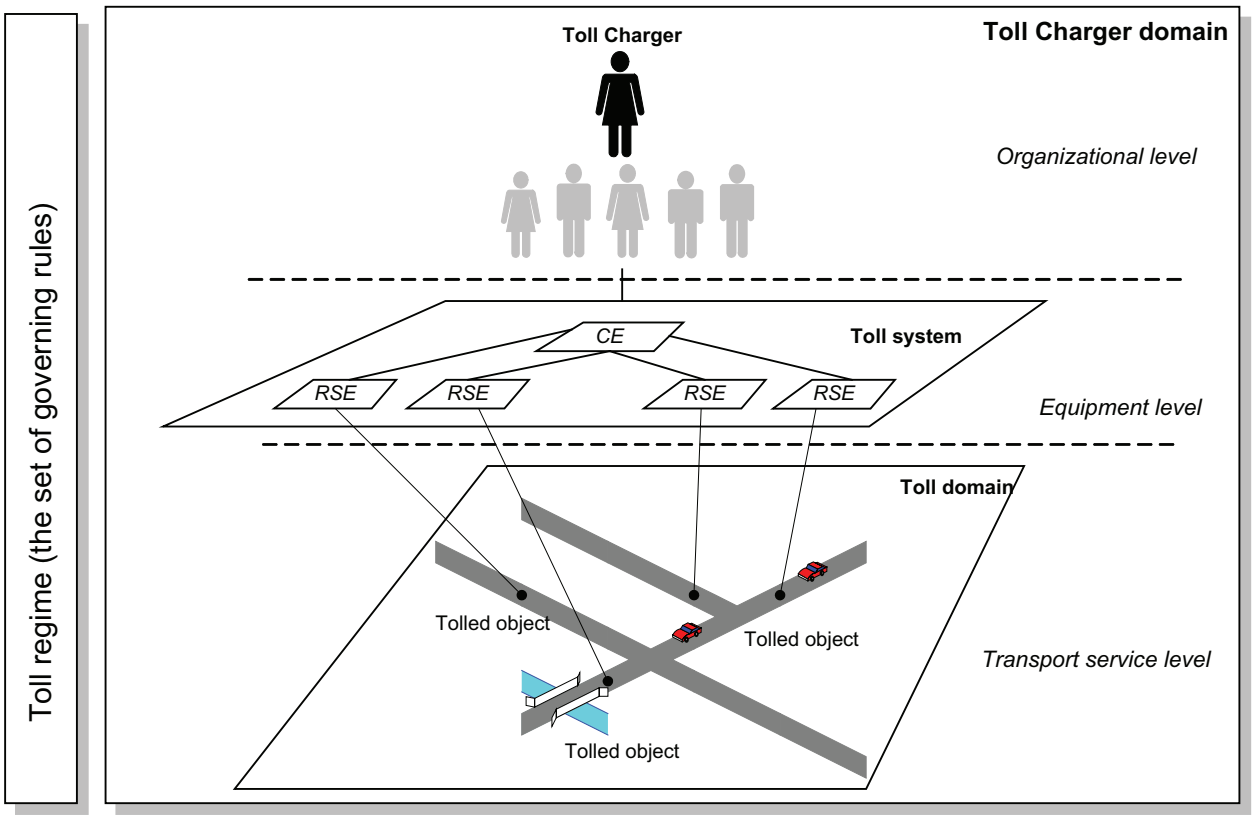

Figure 6 — Toll charger domain

6.6.4.2 Organizational level

The Toll Charger is the legal entity responsible for the collection of tolls in one or more toll domains, e.g. areas or (parts of) a road network where a toll is collected according to some toll regime.

The Toll Charger may purchase services from other legal persons and/or organizations operating on their behalf. These organizations are often given names that reflect the responsibilities they have taken, e.g. EFC operator and enforcement operator.

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A Toll Charger is said to control the toll domain and, for each toll domain, there is only one Toll Charger that controls it.

NOTE 1 Which legal entity will act as the Toll Charger in an actual situation is outside the scope of this International Standard. It can be e.g. a government, or it can be delegated to a concessionaire (e.g. a toll operator). This International Standard only assumes that, for each toll domain, one legal entity exists that acts as its Toll Charger.

NOTE 2 Any distinction between a Toll Charger and entities acting on their behalf is outside the scope of this International Standard. For example, enforcement operators who act on behalf of a Toll Charger are therefore not distinguished (but can be distinguished in standards addressing more detailed issues).

6.6.4.3 Equipment level

The off-board equipment and possible other provisions used by a Toll Charger for the collection of toll for vehicles is called the toll system of this Toll Charger.

NOTE 1 The OBE is excluded from the definition.

NOTE 2 Off-board is read relative to the vehicle that is subjected to toll. However, it can include mobile equipment, e.g. mobile enforcement equipment.

NOTE 3 The actual payment (collection of the toll) can take place outside the toll system.

Depending on the location of the equipment, a toll system can be decomposed into

— RSE, including mobile equipment and equipment above the road or in its surface,

— CE as used in their offices.

The toll system may use data from other external sensors or systems for the calculation of the toll, e.g. pollution level sensors and traffic speed and volume sensors.

6.6.4.4 Transport service level

A toll domain is an area or a part of a road network where a toll regime is applied and one or more transport services may be offered. The toll regime consists of a set of rules, including enforcement rules, governing the collection of toll in the toll domain.

NOTE Depending on the toll regime, a toll domain can include private roads and off-road premises or terrain.

A toll domain may consist of one or more tolled objects (providing the transport service), being distinguished parts of a toll domain for which one or more tariff schemes apply.

EXAMPLE 1 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).

EXAMPLE 2 For one tolled object both a national and a local tariff scheme can apply.

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6.6.5 The toll charging environment management domain

6.6.5.1 General

This subclause defines the objects involved in performing the management of the roles, responsibilities, equipment operation, toll domains and interoperability (see Figure 7).

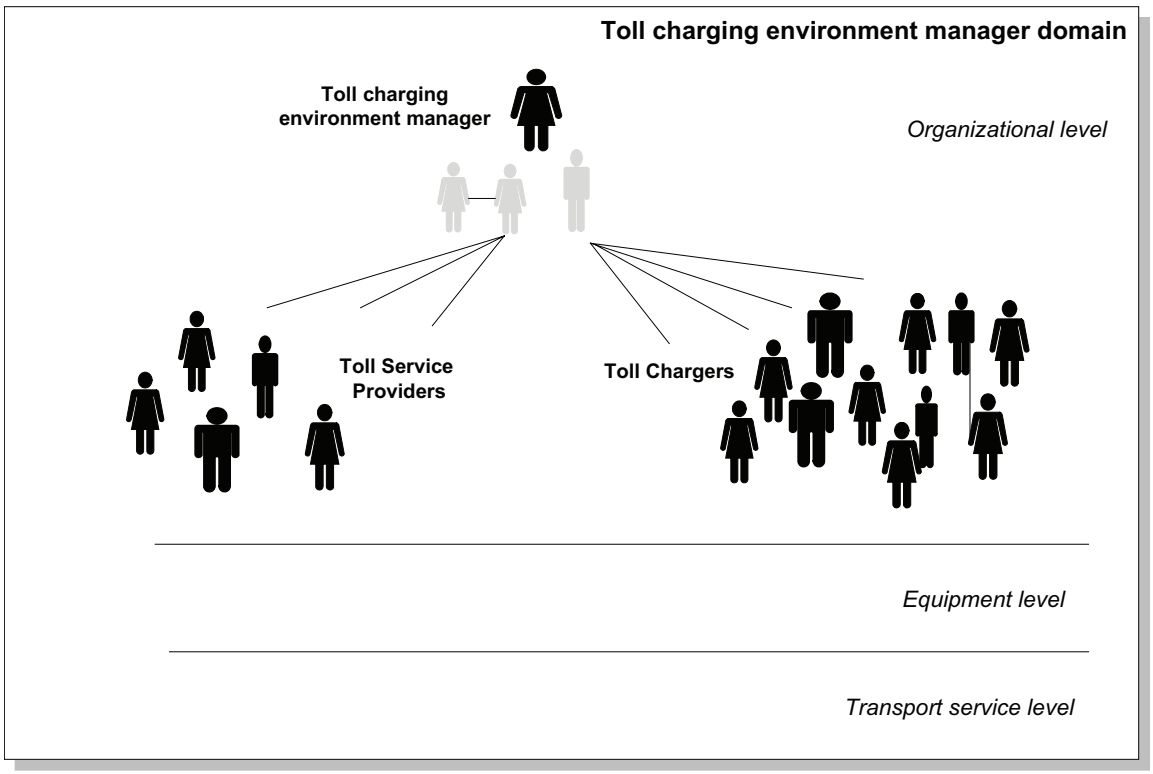

Figure 7 — Toll charging environment manager domain

6.6.5.2 Organizational level

A toll charging environment manager is a legal entity responsible for the management of a toll charging environment concerning the co-operation and interoperability between the Toll Service Providers and the Toll Chargers. Just as there is a set of governing rules for a toll domain, there is a set of governing rules for all objects within the toll charging environment. A toll charging environment manager is responsible for the life cycle of these rules, taking into account the constraints and requirements from the external objects in the EFC community as well as the constraints and requirements from the Toll Service Providers, Toll Chargers and users. The governing rules define both the commercial, functional and technical issues needed for co-operation and interoperability.

A toll charging environment manager may purchase services from other legal persons and/or organizations operating on his of her behalf. These organizations are often given names that reflect the responsibilities they have taken, e.g. TTP, certification body and registrar.

6.6.5.3 Equipment level

There is no EFC-specific OBE or RSE related to the roles of the toll charging environment manager.

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6.6.5.4 Transport service level

Not applicable.

7 EFC system behaviour

7.1 General

Responsibilities related to roles imply that certain behaviours be exhibited, as listed in Clause 6. Detailed descriptions of all behaviours that are performed internally within a role are outside the scope of this International Standard. Some behaviours may, however, imply interactions among different actors that play (part of) a role by taking responsibilities. In these cases, separate organizations might be involved, which can imply a need for a standardized set of information exchanges. These behaviours are thus detailed in this clause, at least as far as information exchanges are concerned.

7.2 Roles, responsibilities and actors

In Clause 6, the responsibilities of the roles in the EFC architecture are defined. These responsibilities may be undertaken by a number of actors that may fulfil part of one role, an entire role, or more than one role.

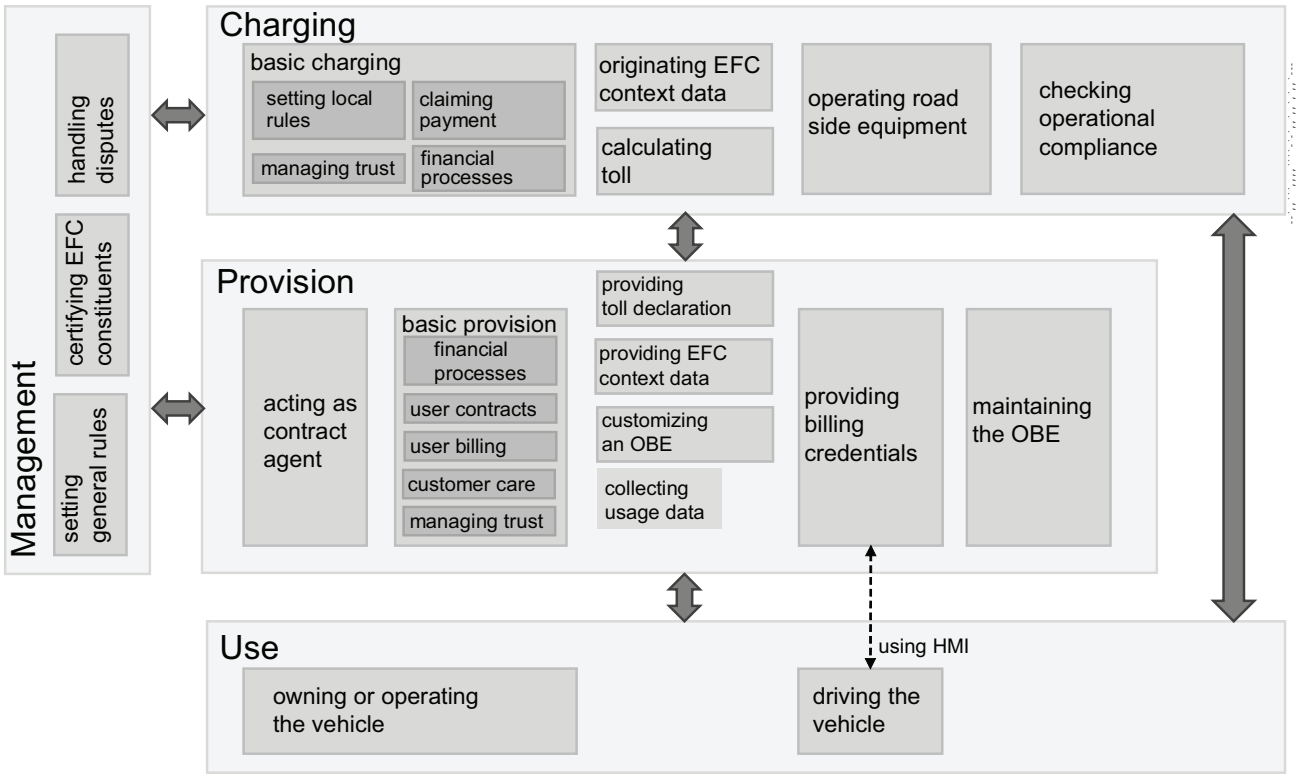

Figure 8 — Responsibilities and their relations

As indicated in Figure 8, the management, charging, and use roles of the service have very distinct responsibilities that can be played by clearly identifiable actors. On the other hand, for the provision role, one actor can typically fulfil the following responsibilities, which can be grouped together as belonging to the basic provision role.

— Managing the financial buying process. This is the main intention of the service provider. It covers the process of transferring the usage right from the toll charger to the user by an exchange of money from the

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user to the toll charger. This can be either through a buying-and-reselling process, when the toll is a private fee, or by acting as an agent on behalf of the user if the toll is a tax or custom;

— Operating the user billing, including issuing and forwarding an invoice to the customer;

— Providing customer care in the view of the user. This is clearly a responsibility of the contract holder and with that part of the Basic Provision role;

— Holding the user contract. It defines the legally contractual counterpart of the user and the obligations on both sides;

— Managing the trust relations. This is a background task generating and exchanging keys and trust certificates to enable a technically secured operation of the system.

The remaining responsibilities of the provision role can clearly be allocated to the same actor playing the basic provision role or to different actors (e.g., other organizations). These responsibilities and their interactions are explicitly mentioned in the interaction diagrams in the following clauses, in order to ease an open market for actors performing these roles for more than one provider. These more independent responsibilities include the following.

— **Providing toll declaration**. This responsibility, particularly in autonomous EFC systems, includes receipting the charging reports of the vehicles.

— **Providing** (not originating) **EFC context data**, which may be in some cases a responsibility of an actor also playing the role of service provider. This may be the case if proprietary data formats and downloading procedures are used, e.g. for optimization needs. There may also be cases of service providers acting as provider of the EFC context data, when, e.g., it is deemed necessary to outsource this responsibility and group it with other service providers. In this case, service providers have to agree on common formats and interfaces that all involved parties must accept. In other cases, when well-standardized formats and download procedures are used, this responsibility can be undertaken by an actor also playing the role of the toll charger, to reduce the workload of the group of service providers. Even further, digital map providers for in-car navigation systems may take on this responsibility as an independent third party. In road infrastructure-based systems, this responsibility, where applicable, is reduced to providing the regime border to allow the OBE to indicate to the driver the status of his or her OBE relative to a given Toll regime before passing a charging road infrastructure.

— **Acting as contract agent** can be seen as a separate responsibility which is required when the operational actions contacting a new customer and agreeing with him or her on contractual details is outsourced to actors specialized in this task. These kinds of specialized actors may be automobile clubs or just rest areas on highways just outside of a toll regime. Also the toll charger may act as a contract agent if non-interoperable EFC schemes provide their OBE to be re-used in other toll regimes under a separated contract.

— **Customizing an OBE** is a responsibility which may be outsourced either to the OBE installer or to the entity physically providing the OBE. Also the toll charger may re-customize their OBE if non-interoperable toll schemes provide their OBE to be re-used in other toll regimes under a separated contract.

— **Maintaining an OBE** covering the software and security administration as well as the monitoring of the achieved operational SLA is not within the scope of this International Standard. However, to understand the complete allocation of actions with its resulting overall function, it is required at least to allocate the responsibility of software updating. This will be a mandatory action when the customization of an OBE requires changes in the software. This responsibility will be most likely allocated to the actor playing the service Provisioning role. However, in future implementations this responsibility may also be provided by the car industry when OBE will be part of standard car or truck electronics. Also the toll charger may act as maintenance provider if non-interoperable EFC schemes provide their OBE to be re-used in other toll regimes under a separated contract.

— **Providing billing credentials** covers the information exchange(s) between the service provider and the user about billing, which is performed by driver interaction with the OBE through its HMI (human machine

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interface). As this interaction is a typically not standardized feature, it is not dealt with in this International Standard and is only quoted here for completeness.

NOTE 1 If toll chargers organize themselves in a cluster and all relations to service providers are managed by the cluster rather than each individual toll charger then in the view of each service provider the cluster performs the same action as it would be expected from an individual toll charger.

NOTE 2 If service providers organize themselves in a cluster and all relations to toll chargers are managed by the cluster rather than each individual service provider then in the view of each toll charger the cluster performs the same action as it would be expected from an individual service provider.

The main aim of the architecture is to identify those behaviours that lead to interactions that need to be standardized, which means

— interactions between roles as a whole, and

— interactions between distinct responsibilities within roles, when actors undertaking those responsibilities may be different (i.e., belonging to separate organizations).

Given that, a real tolling system that implements this architecture **does not need** to implement all roles and responsibilities that are herein detailed and summarized in Figure 8. A real tolling system may implement as many roles and responsibilities among those defined in this International Standard as needed, the only obligation being that those interactions among roles and information exchanges that are implemented shall be compliant with those herein specified, in order to achieve interoperability among systems belonging to different organizations, or implementations realized by different suppliers.

7.3 Interaction matrix and action diagrams

Table 1 summarizes those behaviours that result in interactions between roles or responsibilities. The clauses that follow provide an activity diagram for each of the identified behaviours. Each performed behaviour, indicated in a row of the table, may initiate an interaction among roles, indicated in the columns. For each valid intersection, meaning a behaviour that caused an interaction to happen, a reference to the clause containing the related activity diagram is given.

Table 1 — Interactions and involved roles

				Provision							
		Management	Use	Acting as contract agent	Basic Provision	Providing toll declaration	Providing EFC Context Data	Customizing an OBE	Collecting Usage Data	Maintaining the OBE	Charging
adding a new toll charger	7.3.1	X			X						X
adding a new service provider	7.3.2	X			X						X
adding or modifying an toll regime	7.3.3	X	X		X		X	X			X
defining rules and monitoring operations	7.3.4	X			X						X

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				Provision							
		Management	Use	Acting as contract agent	Basic Provision	Providing toll declaration	Providing EFC Context Data	Customizing an OBE	Collecting Usage Data	Maintaining the OBE	Charging
providing EFC contract	7.3.5		X	X	X			X		X	
collecting toll information – user billing	7.3.6		X	X	X						X
collecting transit information (DSRC systems)	7.3.7		X								X
collecting charging information (autonomous systems)	7.3.8		X		X	X	X				X
claiming tolls	7.3.9	X			X						X
providing customer care	7.3.10		X		X						
detecting exceptions	7.3.11		X								X

As a general rule, each diagram is focused on the information exchanges between roles. This means that details of the execution of the activities that only involve actions inside a role are not shown, except for clarification purposes, nor are they subject to standardization.

In each diagram, rounded corner boxes indicate the responsibilities or activities. Names in these boxes can be slightly different from the names in Figure 8, to better indicate the type of action that is performed. Arrows in the diagrams show the direction of the information flows from information exchange initiator to information recipient. Arrows are labelled with names that indicate the information objects that are exchanged.

Decision gates are introduced in the diagrams to indicate when a particular behaviour may be subject to a decision. In general, a decision gate only indicates that there is a number of different possible ways to continue processing (for example, with different output data), or that the process might stop due to a decision. Not all possibilities are shown, and this simplification is done in order to avoid over-specification, as the activities performed inside a role are only shown to the level of detail needed for understanding how information that is exchanged among roles is generated.

While behaviours are, in general, independent of the tolling technology, there is a limited set of cases where this is not true. Activities whose behaviour is dependent on the tolling technology are clearly identified and described in separate clauses.

7.3.1 Adding (or excluding) a new toll charger

Adding at least one toll charger to a community acting as an interoperable EFC scheme is a precondition to start overall operation. It is initiated by the candidate toll charger applying for certification from the Management. If the certification is granted, it is forwarded by the Management to all existing instances of the Provision role to start to negotiate bilateral agreements on common operations.

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Figure 9 shows the related action diagram. The actor playing the Provision role fulfils the Basic Provision responsibilities.

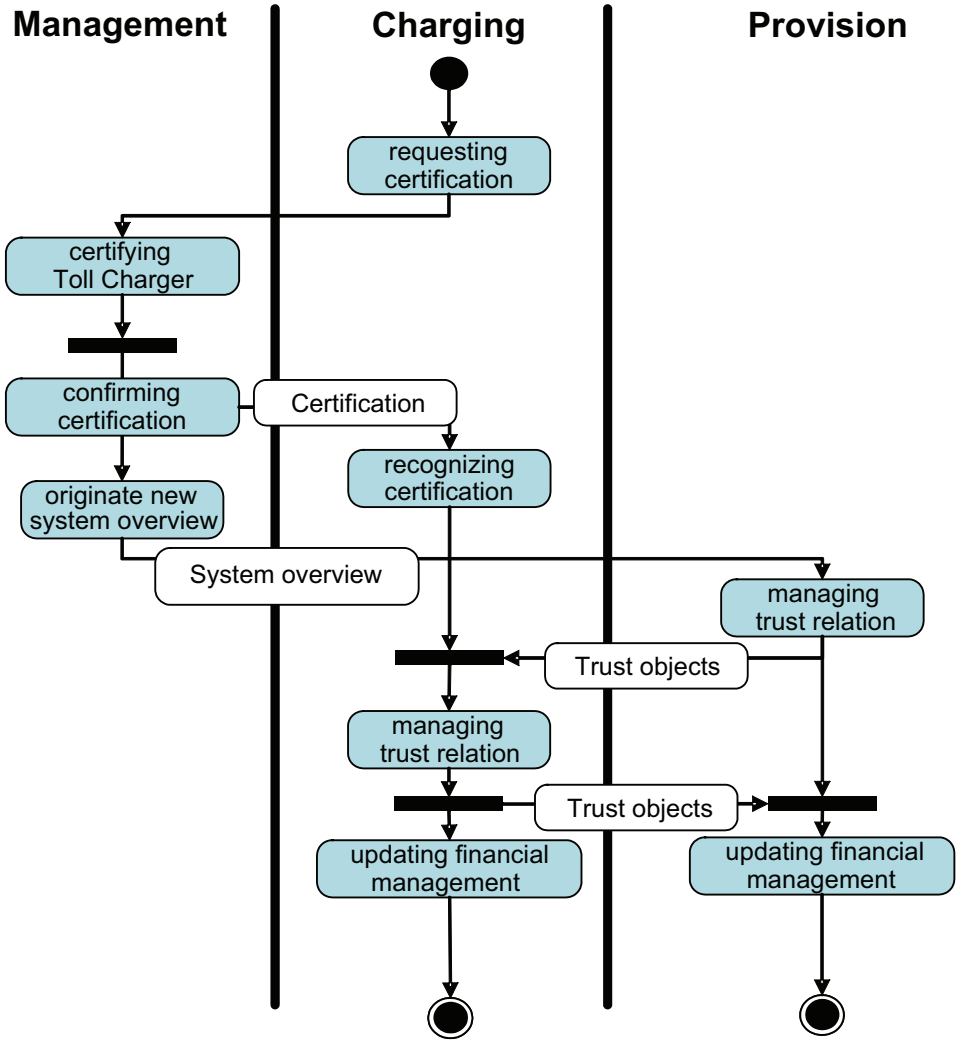

Figure 9 — Adding a new toll charger

Excluding a previously certified toll charger will follow the same logical sequence starting with the request of the charging actor or the Management.

7.3.2 Adding (or excluding) a new service provider

Adding at least one provider to a community acting as an interoperable EFC scheme is a precondition to start overall operation. It is initiated by the candidate provider applying for certification at the Management. When the certification is granted, this will be forwarded by the Management to all existing instances of the toll charging role to start to negotiate bilateral agreements on common operations.

Figure 10 shows the related action diagram. The actor playing the Provision role fulfils the Basic Provision responsibilities.

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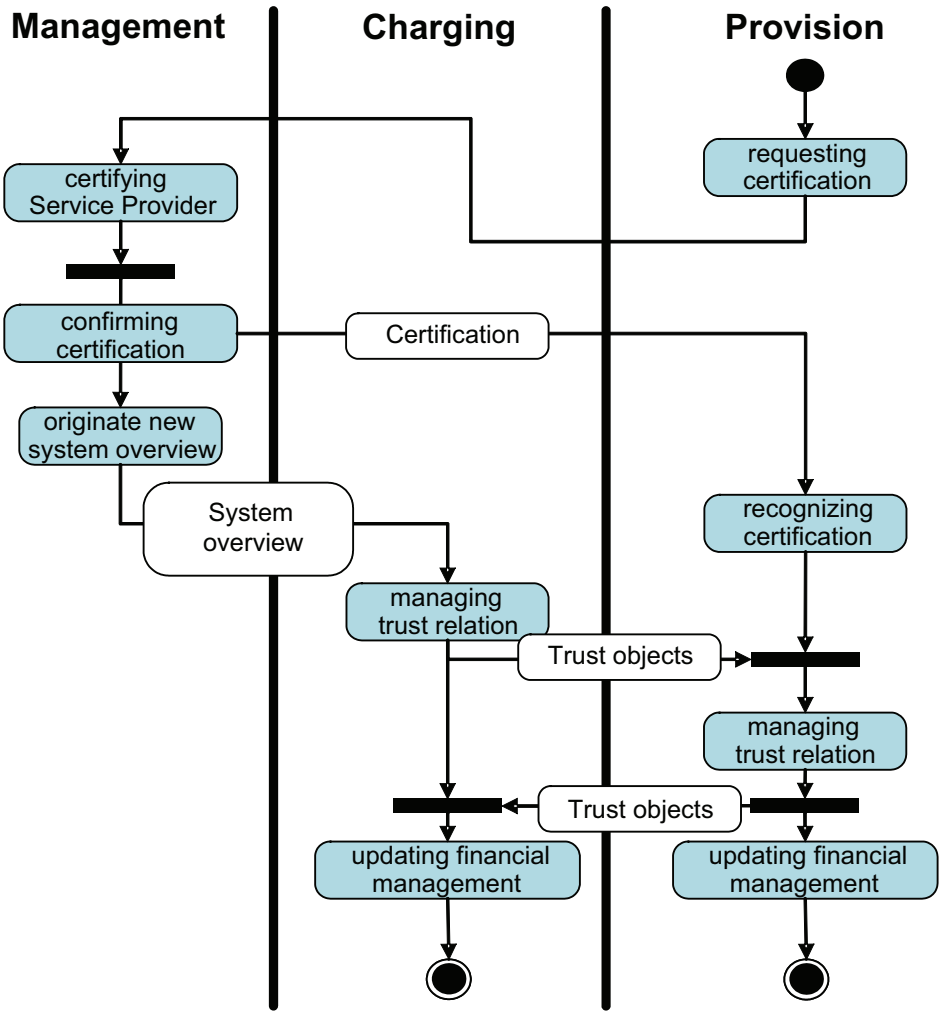

Figure 10 — Adding a new service provider

Excluding a previously certified service provider will follow the same logical sequence, starting with the request of the provision actor or the management.

7.3.3 Adding, modifying or closing a toll regime

Adding at least one toll regime to a community acting as an interoperable EFC scheme is a precondition to start overall operation. It is initiated by the toll charger informing the Management about the start of operation for a new EFC system under their responsibility. The same action is started when a toll regime is modified. The Management includes the new regime into the list of participating EFC schemes and informs all the actors providing toll service. If the new regime is added according to the basic contractual agreements between the user and the contract holder, the actor customizing the OBE will include the new toll regime into the list of operational regimes in the OBE of the user. The OBE is ready to operate according to the new EFC scheme if the context data is provided.

Figure 11 shows the related action diagram.

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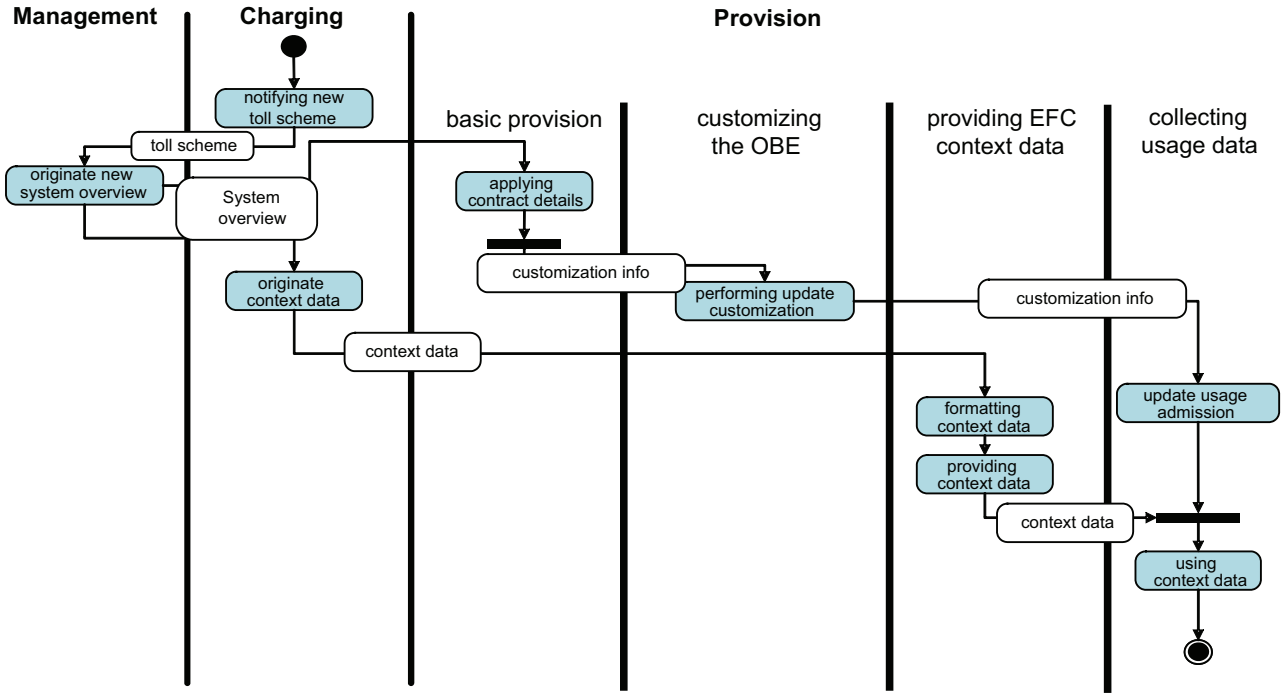

Figure 11 — Adding or modifying a toll regime

Note that the figure shows some actions that are played internally to a role, and the related information exchanges. This is because such actions may be played by different actors, so that the related information exchanges may need to be standardized.

Closing a previously included toll regime will follow the same logical sequence starting with the request of the charging actor.

7.3.4 Defining rules and monitoring operations

The main role of the manager is to define rules for the EFC community, to diffuse them to the providers and chargers, and to monitor the EFC activities. Figure 12 and Figure 13 show the related action diagrams. The actor playing the Provision role fulfils the Basic Provision responsibilities.

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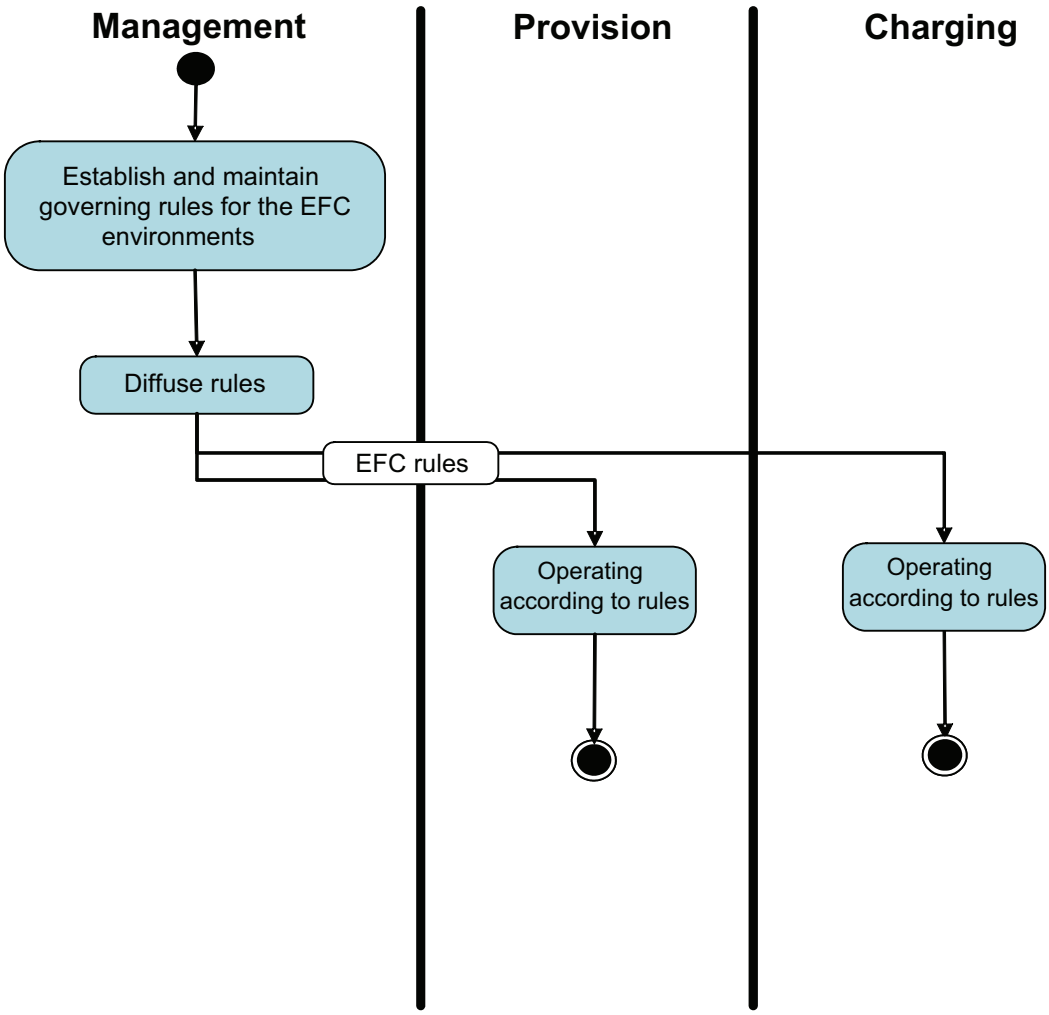

Figure 12 — Defining rules

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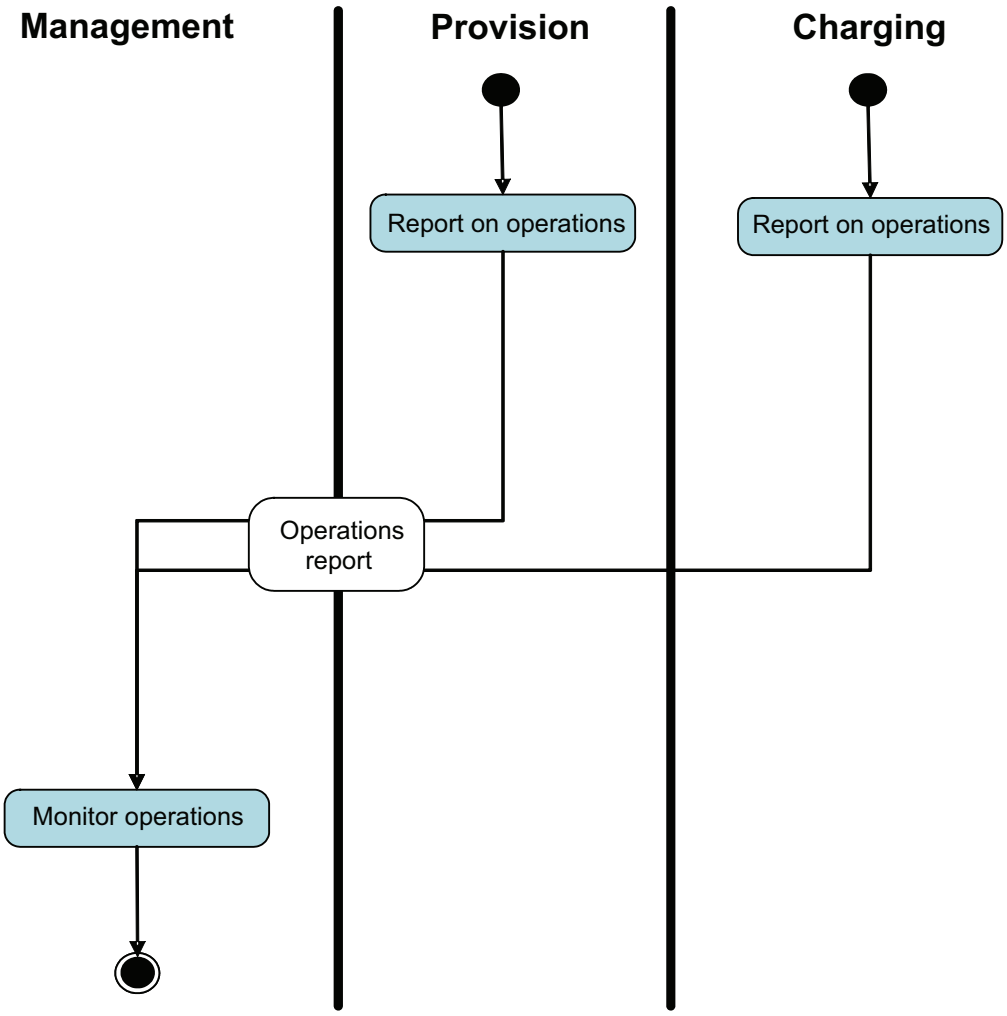

Figure 13 — Monitor operations

7.3.5 Providing EFC contract — Subscribing (or unsubscribing) a new user

Providing an EFC contract requires that the provider defines his or her conditions, offers the service and reaches future users with this information. The user will contact the contract agent who will verify if the user fulfils the conditions, in which case a contract will be established and signed. The contract agent will initialize the issuing and customization of a new OBE. In general, the OBE will be subsequently loaded with appropriate software and data before it is ready for operation. Figure 14 shows the related action diagram.

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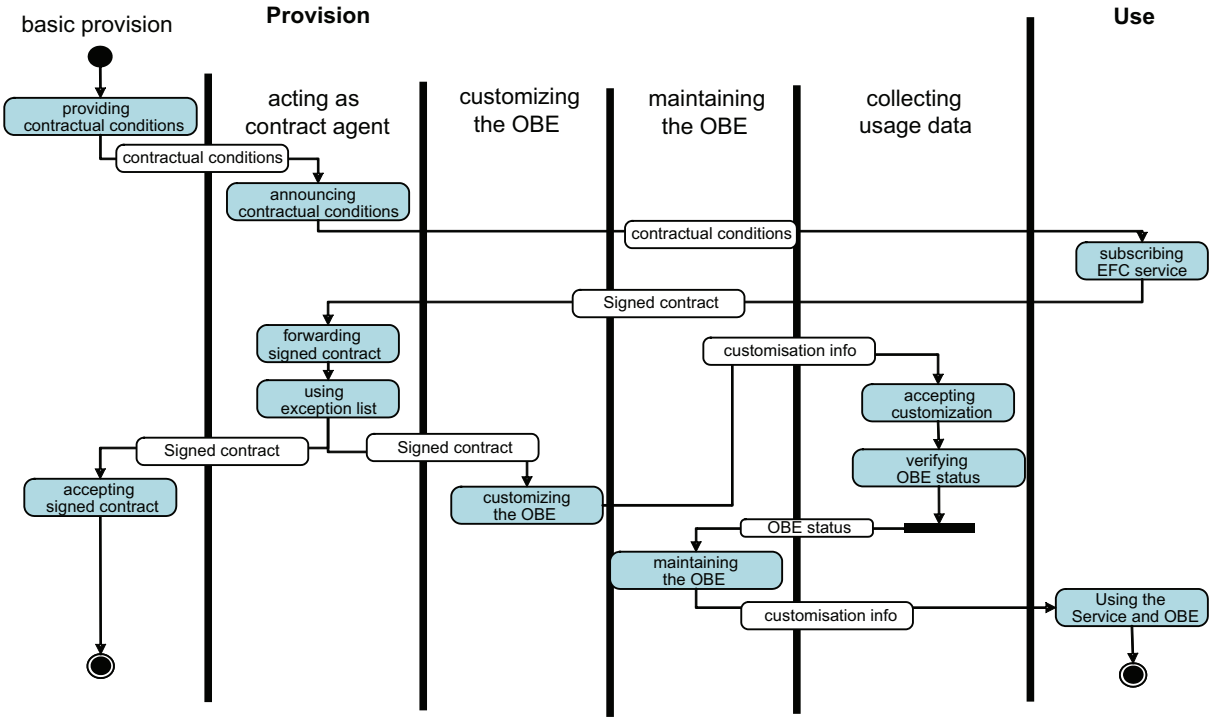

Figure 14 — Providing EFC contract

Note that the figure shows some actions that are played internally to a role, and the related information exchanges. This is because such actions may be played by different actors, so that the related information exchanges may need to be standardized.

Unsubscribing a previously signed service contract will follow the same logical sequence starting with the definition of conditions.

7.3.6 Collecting toll information — User billing

Collecting toll information is a series of interactions between the provider and the user. This also includes interactions between the provider and the charger in case the payment of the user failed and his or her OBE was blacklisted or in any case put on some exception list. The exception list information will also be used by all contract agents to detect users known as unsolvent customers from trying to sign new contracts. Figure 15 shows the related action diagram.

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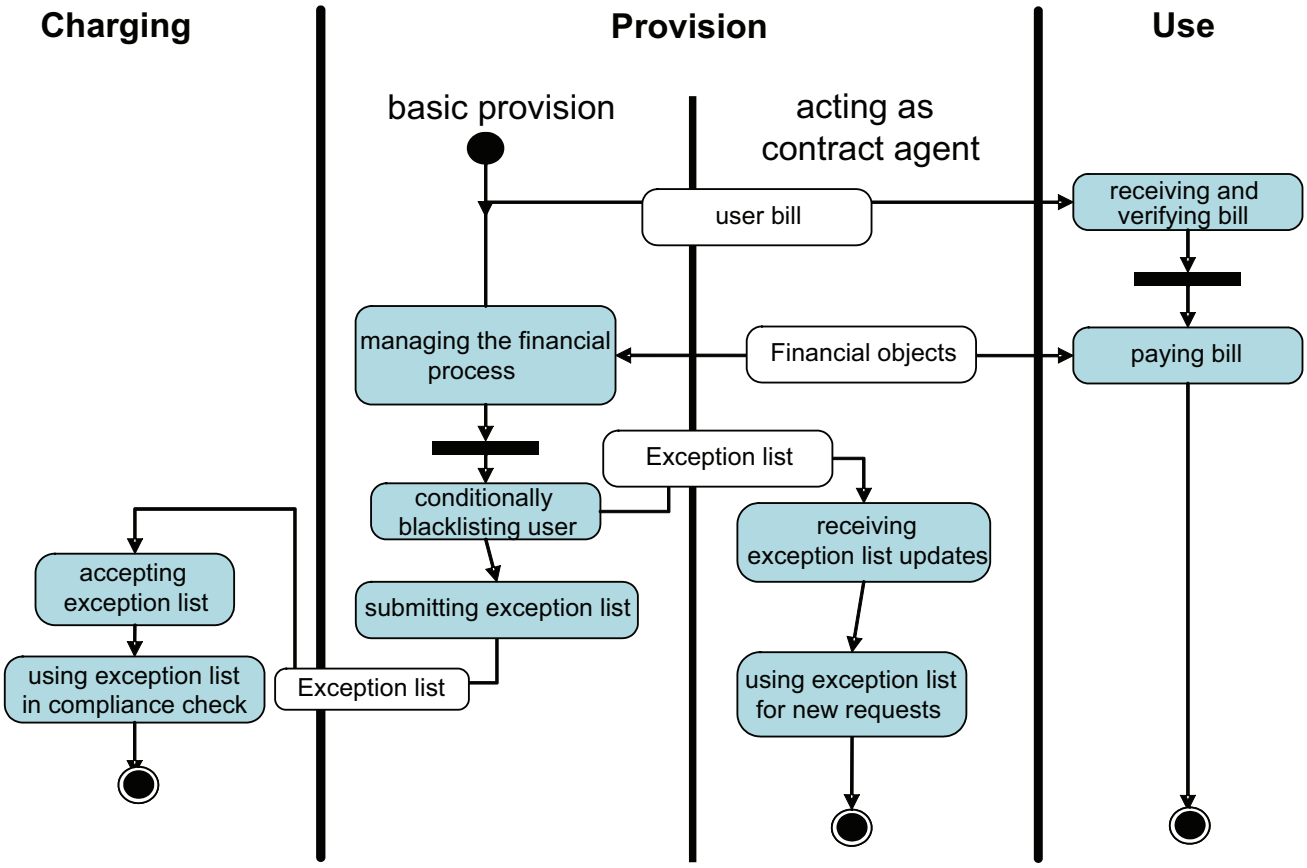

Figure 15 — Collecting toll information — User billing

7.3.7 Collecting transit information (DSRC systems)

Collection of transit information is performed by the charging roles in various ways, which may or may not involve interactions with the usage roles.

Figure 16 shows an activity diagram where interactions do happen between Charging and Provision in a DSRC-based system. In order to cover the most general case, the diagram shows the exchange of mutual identification information.

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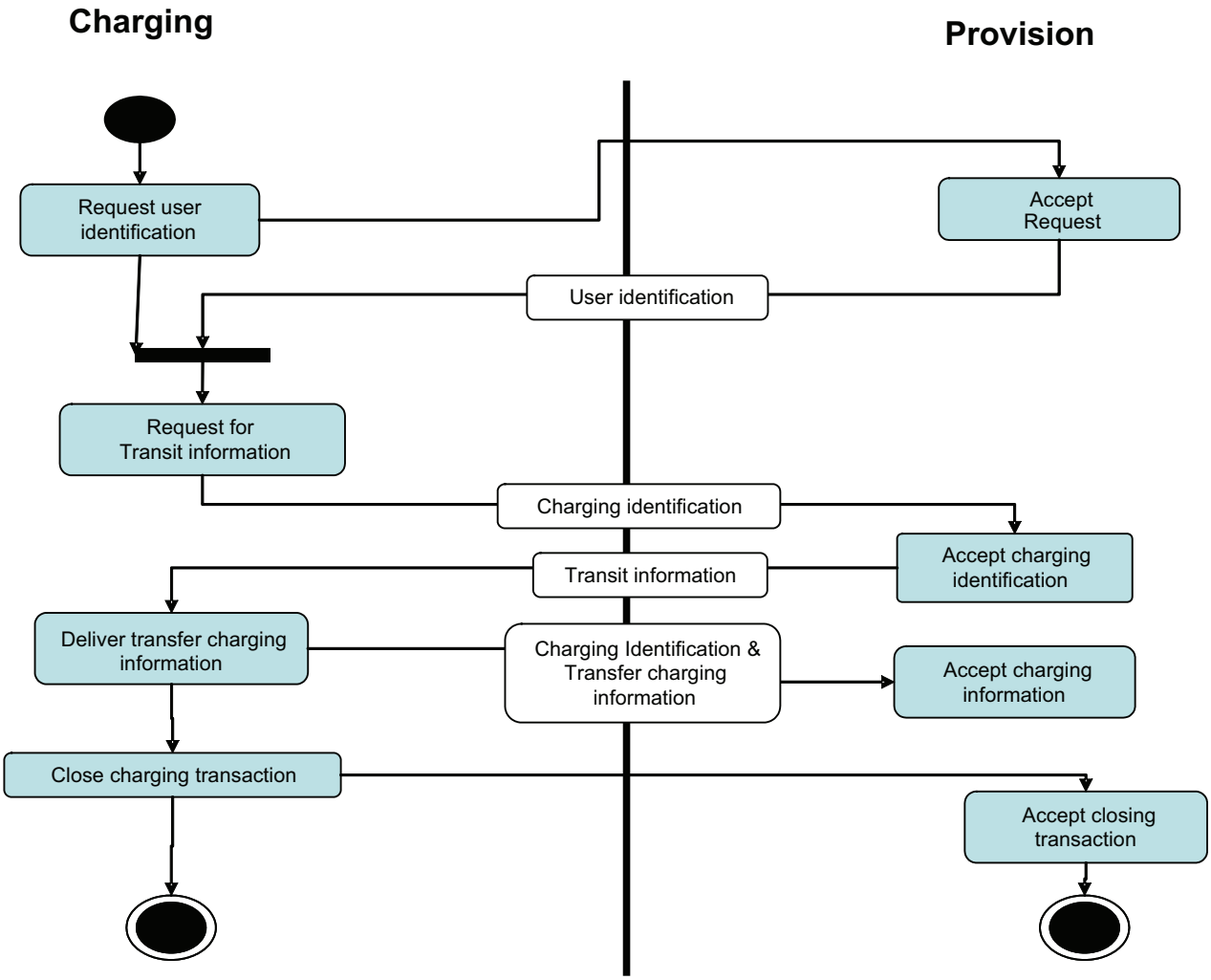

Figure 16 — Collecting transit information (DSRC systems)

7.3.8 Collecting charging information (autonomous systems)

The basic role of the OBE is to collect charging information. Therefore, it retrieves EFC context data from the context data provider (if required) and operates according to the local rules. When recognizing charge objects, relevant charge data is reported to the actor that provides toll declaration by using EFC context data.

The responsibility of the actor that provides toll declaration covers the conversion of these reports to billing messages and forwards them to the basic Charging as well as to the Basic Provision role. The granularity of billing details depends on specific agreements between entities playing the roles of Charging and Provision. The Provision role occasionally will validate the credit worthiness of its user and confirms that via the toll declaration provider to the OBE. In case of insolvency, the user may be blacklisted and the related information will be forwarded by means of an exception list to the Charging role to be used during compliance checks. Figure 17 shows the related action diagram.

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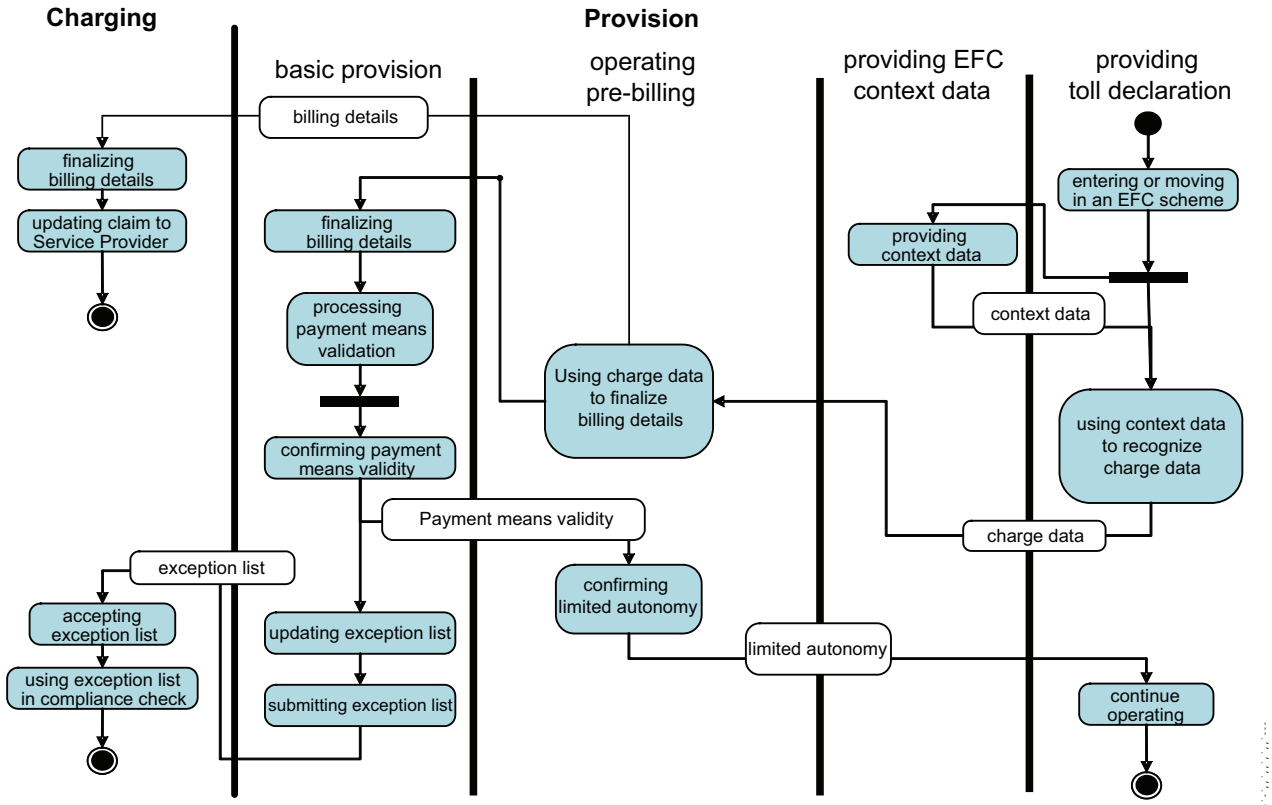

Figure 17 — Action diagram: Collecting charging information (autonomous systems)

7.3.9 Claiming tolls

The following Figure 18 depicts the claiming tolls action. The involved roles are Charging and Provision. The actor playing the Provision role fulfils the Basic Provision responsibilities. If one of the partners complains that the other partner does not fulfil the obligations defined in the certification, the Management will be called upon to settle the dispute.

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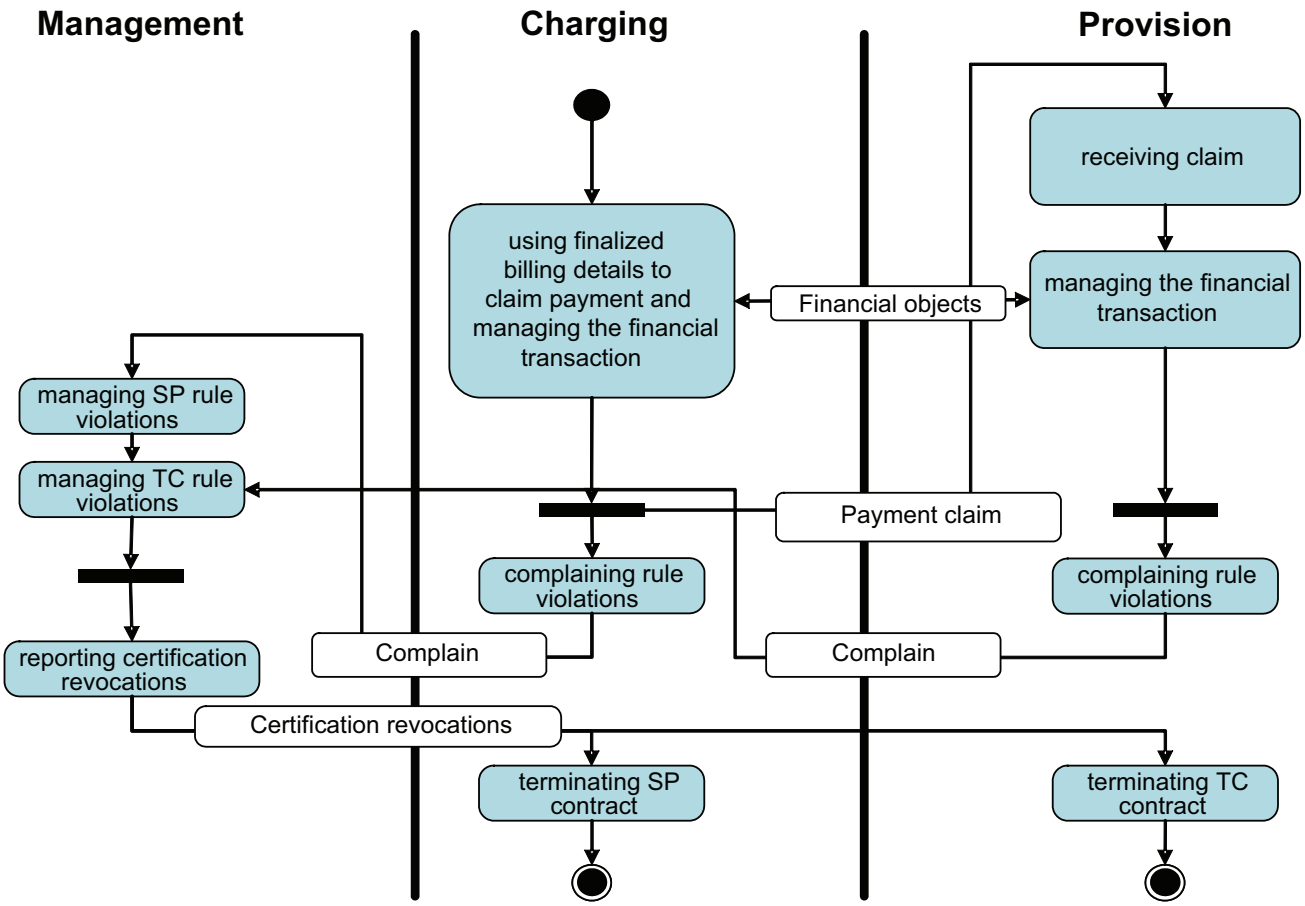

Figure 18 — Claiming tolls

7.3.10 Providing customer care

Customer care interactions include all requests for help and information, as well as complaints, from the user to the provider. The actor playing the Provision role fulfils the Basic Provision responsibilities. Figure 19 shows the related action diagram.

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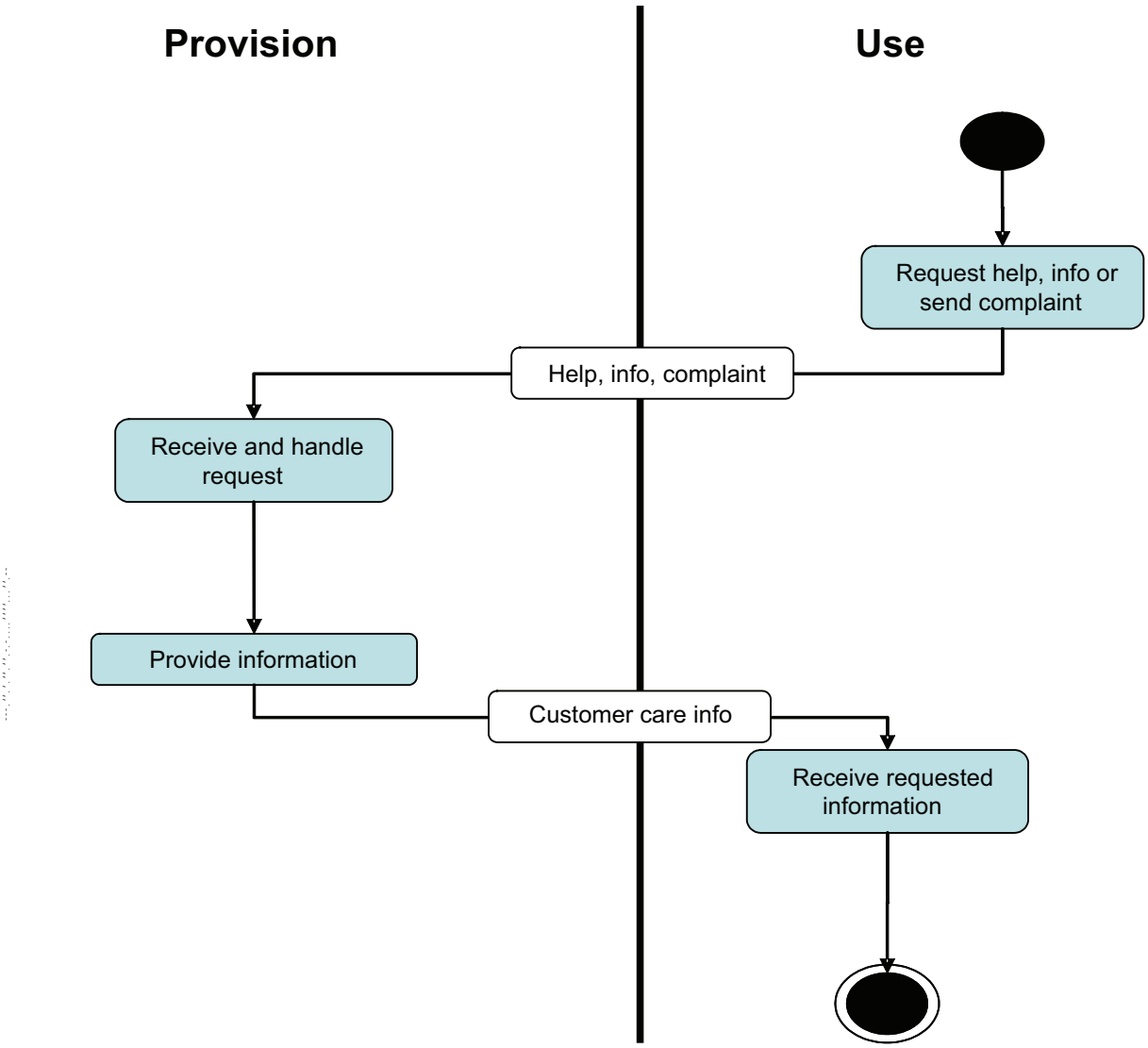

Figure 19 — Provide customer care

Information transmitted by the Use role to the Provision role includes all types of requests and complaints, including those that cause the Provision to subsequently interact with other roles. Examples of these latter events are, e.g., reports on stolen or lost OBEs, which may cause the Provision role to transmit to other roles' exception lists to indicate that those OBEs are not longer valid.

7.3.11 Exceptions detection — User and OBE compliance checking

Exceptions detection is an interaction between the user and the charger, which is initiated when the user's vehicle recognizes a tolled object. Different actions can be performed by the charger in order to detect exceptions, which include collecting own data (e.g. from sensors) or interacting with the user OBE to get data, or both. In order to cope with the general case, Figure 20 shows an action diagram where both actions are performed.

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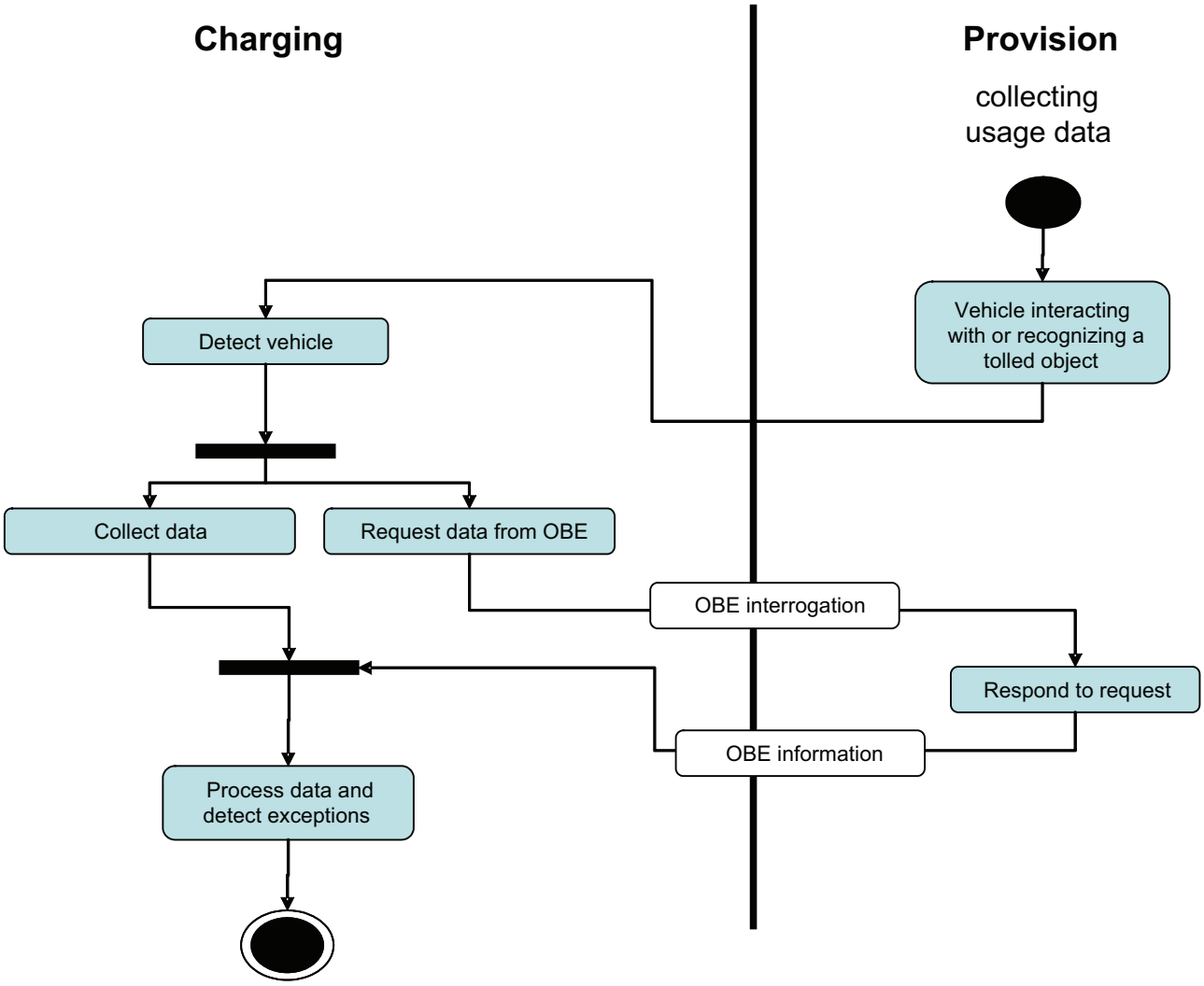

Figure 20 — Exceptions detection

7.4 Resulting interaction between actors

The action diagrams in the previous clauses allow deriving the interactions shown in Table 2. In Table 2, all relevant exchanges of information objects are marked. Note that interactions in Table 2 are separately identified for both directions. Note also that, in some cases, an information exchange may include more than one transaction. Standards derived from this architecture may define details of the data elements included in these transactions, as well as communication protocols used to convey the information.

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Table 2 — Interactions between responsibilities

		ref.	Management	Use	Provision							Charging
					Acting as contract agent	Basic provision	Providing Toll declaration	Providing EFC context data	Customizing the OBE	Collecting usage data	Maintaining the OBE	
Management		7.3.1				X						X
		7.3.2				X						X
		7.3.3				X						X
		7.3.4				X						X
		7.3.9				X						X
Use		7.3.5			X							
		7.3.6				X						
		7.3.10				X						
Provision	Acting as contract agent	7.3.5		X		X			X			
		7.3.6		X		X						
	Basic provision	7.3.1	X									X
		7.3.2	X									X
		7.3.3							X			
		7.3.4	X									
		7.3.5			X							
		7.3.6		X	X							X
		7.3.8					X					X
		7.3.9	X									X
		7.3.10		X								
	Providing toll declaration	7.3.8				X				X		X
	Providing EFC context data	7.3.3								X		X
		7.3.8								X		
	Customizing the OBE	7.3.3								X		
		7.3.5			X					X		
	Collecting usage data	7.3.3						X	X			
		7.3.5							X		X	
		7.3.7										X
		7.3.8					X	X				
		7.3.11										X
	Maintaining the OBE	7.3.5								X		
Charging		7.3.1	X			X						
		7.3.2	X			X						
		7.3.3	X			X		X				
		7.3.4	X									
		7.3.6				X						
		7.3.7								X		
		7.3.8				X	X					
		7.3.9	X			X						
		7.3.11								X		

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8 Information schemata and basic information types

8.1 Static schema

The following table synthesizes the information that is exchanged for the sole purpose of tolling between general roles as described in the action diagrams of 7.3. The information exchanged is generally indicated as classes of objects, which should be detailed in specific standards. Other information exchanges, e.g. for compliance check or for enforcement, are not dealt with in this clause.

For each valid intersection, the classes of information that are exchanged between the two roles are named. It has to be noted that the same class exchanged between different roles does not necessarily represent an identical physical information exchange, e.g., the “transit info” exchanged between the user and the Toll Charger belongs to the same class of the “transit info” exchanged between the Toll Charger and the contract provider, although the actual data contents may be different (one more detailed than the other one, for example). Information classes and their specializations are described later in this International Standard.

Table 3 — Classes of information exchanges

	Provision	**Use**	**Charging**	**Management**
Provision		Invoices contract setup	Administrative info	Operational info
Use	Administrative info Contract agreement			
Charging	Transit info			Operational info
Management	Regulations	Regulations	Regulations	

The static schema synthesized in Table 3 can be represented by the diagram in Figure 21.

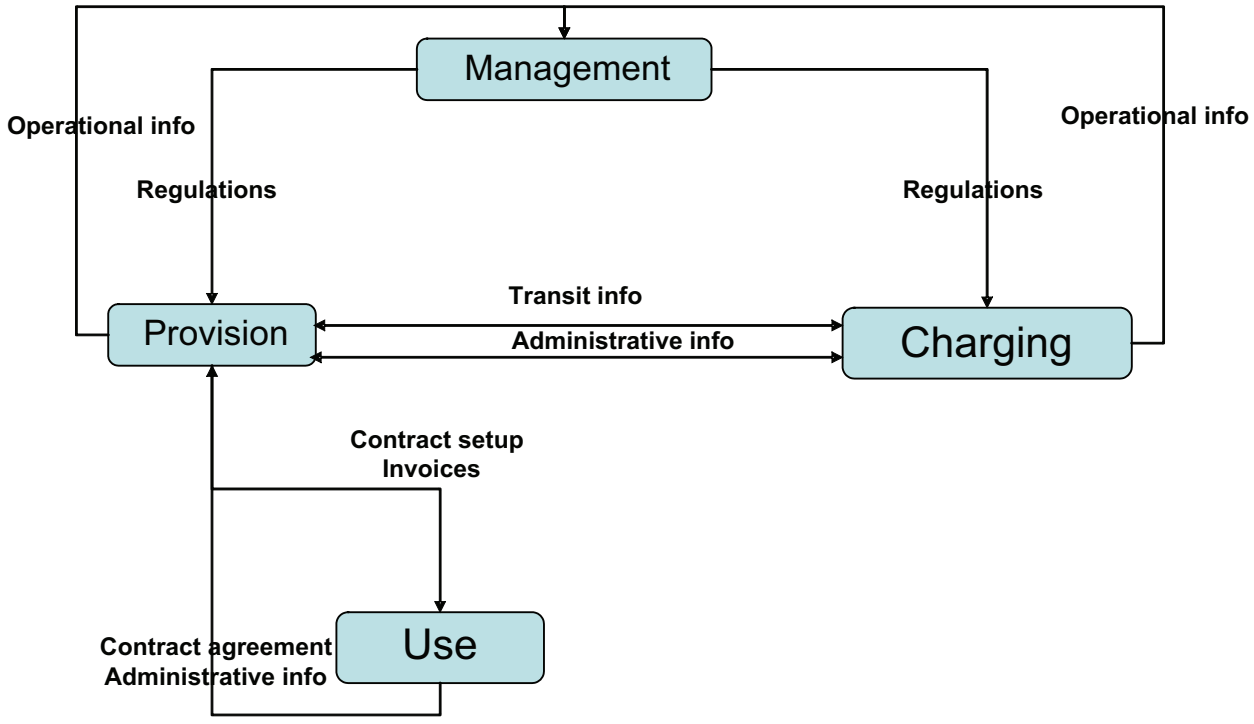

Figure 21 — Static schema of information exchanges

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The related information objects to be exchanged if actors are physically or organizationally separated are identified in the following clauses.

8.2 Basic information objects

Among roles, information is exchanged in terms of classes of objects, which represent generalizations and abstractions of the real information exchanges.

In terms of exchanged information objects, which are the only information objects within the scope of this International Standard, four basic classes are identified:

a) The EFC rules, as that class that contains permissions and obligations for the roles in the EFC system, as well as terms of payment and user identification. This information class includes, but is not limited to, the contractual data between the user and the provider.

b) Transit information, as that class that represents all information objects relevant for toll calculation.

c) Operational information, as that class that represents all information objects relevant for the management of the EFC system.

d) Payment information, as that class that represents all information objects relevant for the transfer of financial data.

8.2.1 The EFC rules

The association among the different roles of the EFC system is expressed as the **EFC rules**, which satisfy requirements and objectives as defined in the Enterprise specification. In the EFC rules, among others, the rules for information transformations, including information exchanges, are expressed. An EFC rules object, thus, does not only specify which is the relevant information in an EFC system, but also the rules for manipulating it, in terms of who can do what to which information object. As different types of rules may be envisaged, the association attribute is in fact a class, representing all possible sets. The following Figure 22 depicts this association concept, which is actually one type of correspondence between Enterprise and Information specifications.

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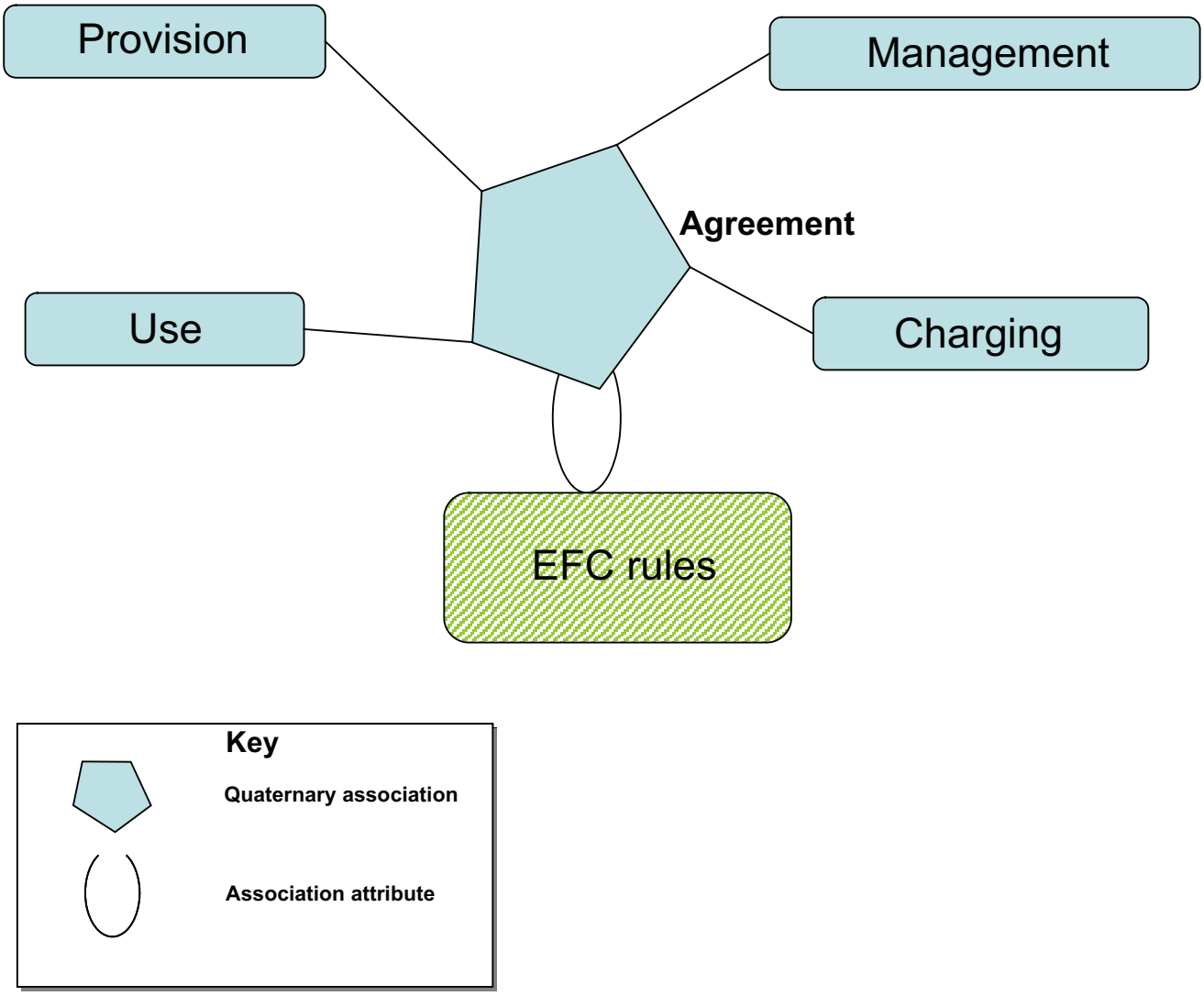

Figure 22 — The EFC rules as the association attribute among enterprise roles

The EFC rules also specify the Invariant schema in the EFC system, i.e. that information which does not change during system operation. By system operation it is meant the period of time during which a given user, with a given contract, is allowed to use a given EFC system. A number of different invariant schemata may be considered for the same real system, if different sets of rules are available between users and providers.

Objects in the EFC rules class are listed in Table 4.

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Table 4 — Information objects in the EFC rules class

Object	Description	Originating role(s)/actor(s)	Recipient role(s)/actor(s)
Certification	Permission to operate	Management	Charging, Basic Provision
Contract	Contract with the user including all parameters relevant for tolling, and the way they are handled	Contract agent	Basic Provision, Customizing the OBE
Contractual conditions	Rules for the contract agent and user operation	Basic Provision, Contract agent	Contract agent, Use
Operational rules	Rules governing the EFC system, e.g. identifiers, SLAs, security rules	Management	Charging, Basic Provision
Customization	Usage admission, vehicle- and contract-fixed parameters for a specific OBE	Basic Provision, Customizing the OBE	Customizing the OBE, Use
Trust objects	Certificates, signatures	Basic Provision, Charging	Charging, Basic Provision

8.2.2 Transit information

Objects in the Transit information class are listed in Table 5 below.

Table 5 — Information objects in the transit information class

Object	Description	Originating role(s)/actor(s)	Recipient role(s)/actor(s)
Charging identification	DSRC-based transaction detail	Charging	Provision
Charging identification and transfer charging information	DSRC-based transaction detail	Charging	Provision
OBE interrogation	OBE attribute list for compliance check	Provision	Charging
Transit information	DSRC-based transaction detail	Charging	Provision
User identification	DSRC-based transaction detail	Charging	Provision

8.2.3 Operational information

Objects in the Operational information class are listed in Table 6 below.

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Table 6 — Information objects in the operational information class

Object	Description	Originating role(s)/actor(s)	Recipient role(s)/actor(s)
Exception lists	To indicate that some contracts are no longer supported	Basic Provision	Contract agent, Charging
Complaint	Complaint	Charging, Basic Provision	Management
Context data	Raw EFC context	Charging	Providing EFC context data
Context data	Refined EFC context	Providing EFC context data	Use
EFC Scheme	New or amended EFC scheme	Charging	Management
Help, info, complaint	General request by the user asking for clarification or action by the provision actor	Use	Providing customer care
OBE status	Software status of the OBE to check if updates are requested	Use	Maintaining the OBE
Operational report	Report on operations	Charging, Basic Provision	Management
Customization	Customization info, including updated software	Personalizing the OBE, Maintaining the OBE	Use
System overview	Certified service providers, EFC schemata, Toll Chargers	Management	Charging, Basic Provision

8.2.4 Payment information

Objects in the Payment information class are listed in Table 7 below.

Table 7 — Information objects in the payment information class

Object	Description	Originating role(s)/actor(s)	Recipient role(s)/actor(s)
Billing details	Refined charge report of the OBE up to the level of detail requested in the user bill, including the payment claim	Providing toll declaration	Charging
Charge data	OBE charge report	Basic provision	Providing toll declaration
Limited autonomy	Amount of money the OBE is allowed to use autonomously	Providing toll declaration	Basic Provision
Financial objects	Objects exchanged to manage a selling-buying process or in case the fee is a tax, managing the tax payment of the user	Charging, Basic Provision, Use	Charging, Basic Provision
Payment means validity	Confirmation or rejection of the validity of the payment means of the customer	Basic Provision	Providing toll declaration
User bill	Invoice for a period of service usage as agreed in the service contract	Basic Provision	Use

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8.3 Dynamic schema

The information objects identified previously as not invariant (i.e. not listed in Table 4) may vary in time according to the operations that are performed. A dynamic schema for the identified information objects has two aspects. Firstly, the effect that invoking operations have on the object and, secondly, the conditions under which these operations can be invoked. Table 8 synthesizes informally the dynamic schema for EFC. More refined and formal descriptions are left to specific standards on information exchanges.

Table 8 — Dynamic schema

Information Object	Modification	Modifier	Condition(s)
Billing details	Create	Providing toll declaration	
Exception lists	Create	Basic Provision	
Charge data	Create	Charging, Collecting usage data	
Complaint	Create	Charging, Basic Provision, Use	
Context data	Create	Charging	
Context data	Re-format	Providing EFC context data	
Limited autonomy	Write	Providing toll declaration	Charge data received and payment means validated
EFC Scheme	Create	Charging	
Financial objects	Create	Charging, Basic Provision, Use	
Help, info	Create	Use	
OBE status	Create	Use	New customization received
Operational report	Create	Charging, Basic Provision	
Payment means validity	Create	Basic Provision	Billing details processed
Customization	Write	Personalizing the OBE, Maintaining the OBE	Variations in contractual or OBE parameters
System overview	Write	Management	New toll regime created
User bill	Create	Basic Provision	

9 Interfaces and computational objects

9.1 General

From a computational viewpoint, the EFC system is described as a set of interfaces giving access to the services of the computational objects that constitute the system itself. This clause models those actors identified in Clause 7 as computational objects, and identifies their interfaces, independently of how many computational objects (applications) an actor is made of in a real implementation. Some interfaces that are identified in this clause may not necessarily be implemented by real information systems: they are, however, described for the sake of completeness. Also, interfaces are here modelled in general terms only to describe their functionalities. In no way should it be assumed that real implementations must strictly adhere in terms of number of parameters, names, and syntax to the interfaces as described in this clause.

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This clause also identifies possible requirements on infrastructure security functions for each interface and each data type that is exchanged at that interface. These security requirements are, however, dependent on the security policy as defined by the Management role or by bilateral agreements of contracting entities, so that this clause only indicates which object should be subject to which security function, should a security policy be defined for that type of exchange.

A complete architectural description of security in tolling systems is to be provided in a companion International Standard.

The security functions are as listed in Table 9:

Table 9 — Security functions

Security Function	Description
Confidentiality (**C**)	The data is transferred in such a way that only the sender and the recipient can read the data.
Authenticity (**A**)	The originator and/or the recipient of the transferred data need to authenticate themselves.
Integrity (**I**)	The transferred data cannot be altered and any alteration of data can be easily detected.
Non-repudiation (**N**)	The sender of any data cannot deny that he or she was the originator.
Availability (**V**)	The transmission of the information object requires special measures to provide a high level of availability of the interface.

9.2 Management object interfaces

9.2.1 General

The Management object features two interfaces with

a) the Basic Provision object, and

b) the Charging object.

Both interfaces are able to

— distribute EFC system overviews,

— distribute EFC rules,

— accept requests for certifications and deliver certificates to operate,

— accept operation reports, and

— accept complaints.

In addition to that, the interface with Charging object shall be able to

— accept new EFC schemata.

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9.2.2 Security requirements

The security functions listed in Table 10 may be requested on data exchanged at the Management object interfaces, according to the established security policy.

Table 10 — Security requirements for data exchanged at the Management object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
EFC system overview		X	X	X	
EFC rules		X	X	X	
Certificates		X	X	X	
Operation reports	X	X	X	X	
Complaints	X	X	X	X	
EFC schema		X	X	X	

9.3 Charging object interfaces

9.3.1 General

The Charging object features interfaces with

— the Management object,

— the Basic Provision object,

— the Providing EFC Context Data object,

— the Providing toll declaration object, and

— the Collecting Usage Data object.

9.3.2 Charging-Management interface

The Charging-Management interface shall be able to

— accept system overviews and EFC rules,

— request certification and accept related responses,

— deliver operation reports,

— deliver EFC schemata, and

— deliver complaints.

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9.3.3 Charging-Basic Provision interface

The Charging-Basic Provision interface shall be able to

— exchange trust objects, and

— accept exception lists.

9.3.4 Charging-Providing EFC Context Data interface

The Charging-Providing EFC Context Data interface shall be able to

— deliver context data.

9.3.5 Charging-Providing toll declaration interface

The Charging-Providing toll declaration interface shall be able to

— accept billing details.

9.3.6 Charging-Collecting Usage Data interface

The Charging-Collecting-Usage-Data interface shall be able to

— request user identification and accept related responses,

— deliver charger identification,

— deliver charging information, and

— request OBE characteristics for compliance and accept related responses.

9.3.7 Security requirements

The security functions listed in Table 11 may be requested on data exchanged at the Charging object interfaces, according to the established security policy.

Table 11 — Security requirements at the Charging object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
EFC system overview		X	X	X	
EFC rules		X	X	X	
Certificates		X	X	X	
Operation reports	X	X	X	X	
Complaints	X	X	X	X	
EFC schema		X	X	X	

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Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Trust objects	X	X	X	X	X
Exception lists	X	X	X	X	X
Context data	X	X	X	X	
Billing details	X	X	X	X	X
User identification	X	X	X	X	X
Charger identification	X	X	X		X
Charging information	X	X	X	X	X
OBE characteristics	X	X	X	X	X

9.4 Basic Provision object interfaces

9.4.1 General

The Basic Provision object features interfaces with

— the Management object,

— the Charging object,

— the Customizing the OBE object,

— the Acting as a Contract Agent object,

— the Providing toll declaration object, and

— the Use object.

9.4.2 Basic Provision-Management interface

The Basic Provision-Management interface shall be able to

— accept system overviews and EFC rules,

— request certification and accept related responses,

— deliver operation reports, and

— deliver complaints.

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9.4.3 Basic Provision-Charging interface

The Basic Provision-Charging interface shall be able to

— exchange trust objects,

— deliver exception lists, and

— accept payment claims.

9.4.4 Basic Provision-Customizing the OBE interface

The Basic Provision-Customizing the OBE interface shall be able to

— deliver customization information.

9.4.5 Basic Provision-Acting as a Contract Agent interface

The Basic Provision-Acting as a Contract Agent interface shall be able to

— deliver contractual conditions,

— accept signed contracts,

— deliver user bills, and

— deliver exception lists.

9.4.6 Basic Provision-Providing toll declaration interface

The Basic Provision-Providing toll declaration interface shall be able to

— accept billing details and answer with validation of the payment means.

9.4.7 Basic Provision-Use interface

The Basic Provision-Use interface shall be able to

— exchange financial objects, and

— accept requests for help, general information and complaints, and deliver related responses.

9.4.8 Security requirements

The following security functions may be requested on data exchanged at the Basic Provision object interfaces, according to the established security policy.

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Table 12 — Security requirements for data exchange at the Basis Provision object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
EFC system overview		X	X	X	
EFC rules		X	X	X	
Certificates		X	X	X	
Operation reports	X	X	X	X	
Complaints		X	X	X	
Trust objects	X	X	X	X	X
Exception lists	X	X	X	X	X
Payment claims	X	X	X	X	X
Customization information	X	X	X	X	X
Contractual conditions	X	X	X	X	
Signed contracts	X	X	X	X	X
User bills	X	X	X	X	X
Exception lists	X	X	X	X	X
Payment means validation	X	X	X		X
Financial objects	X	X	X	X	X
Help, info and complaints	X	X	X		

9.5 Maintaining the OBE object interfaces

9.5.1 General

The Maintaining the OBE object features interfaces with

— the customizing the OBE object, and

— the collecting Usage Data object.

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9.5.2 Maintaining the OBE-Customizing the OBE interface

The Maintaining the OBE-Customizing the OBE interface shall be able to

— accept customization information.

9.5.3 Maintaining the OBE-Collecting Usage Data interface

The Maintaining the OBE-Collecting Usage Data interface shall be able to

— accept OBE status, and

— deliver customization information.

9.5.4 Security requirements

The following security functions may be requested on data exchanged at the Maintaining the OBE object interfaces, according to the established security policy.

Table 13 — Security requirements for data exchanged at the Maintaining the OBE object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Customization info	X	X	X	X	X
OBE status	X	X	X		X

9.6 Customizing the OBE object interfaces

9.6.1 General

The Customizing the OBE object features interfaces with

— the basic Provision object,

— the maintaining the OBE object,

— the acting as a Contract Agent object, and

— the collecting Usage Data object.

9.6.2 Customizing the OBE-Basic Provision interface

The Customizing the OBE-Basic Provision interface shall be able to

— accept customization information.

9.6.3 Customizing the OBE-Maintaining the OBE interface

The Customizing the OBE-Maintaining the OBE interface shall be able to

— deliver customization information.

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9.6.4 Customizing the OBE-Acting as a Contract Agent interface

The Customizing the OBE-Acting as a Contract Agent interface shall be able to

— accept a signed contract.

9.6.5 Customizing the OBE-Collecting Usage Data interface

The Customizing the OBE-Collecting Usage Data interface shall be able to

— deliver customization information.

9.6.6 Security requirements

The security functions listed in Table 14 may be requested on data exchanged at the Customizing the OBE object interfaces, according to the established security policy.

Table 14 — Security requirements for data exchange at the Customizing the OBE object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Customization info	X	X	X	X	X
Contract	X	X	X	X	X

9.7 Acting as a Contract Agent object interfaces

9.7.1 General

The Acting as a Contract Agent object features interfaces with

— the basic Provision object,

— the maintaining the OBE object,

— the customizing the OBE object, and

— the use object.

9.7.2 Acting as a Contract Agent-Basic Provision interface

The Acting as a Contract Agent-Basic Provision interface shall be able to

— accept contractual conditions,

— deliver signed contracts,

— accept user bills, and

— accept exception lists.

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9.7.3 Acting as a Contract Agent-Maintaining the OBE interface

The Acting as a Contract Agent-Maintaining the OBE interface shall be able to

— deliver customization information.

9.7.4 Acting as a Contract Agent-Customizing the OBE interface

The Acting as a Contract Agent-Customizing the OBE interface shall be able to

— deliver signed contracts.

9.7.5 Acting as a Contract Agent-Charging interface

The Acting as a Contract Agent-Charging interface shall be able to

— accept contractual conditions.

9.7.6 Acting as a Contract Agent-Use interface

The Acting as a Contract Agent-Use interface shall be able to

— deliver contractual conditions, and

— accept signed contracts.

9.7.7 Security requirements

The security functions listed in Table 15 may be requested on data exchanged at the Acting as a Contract Agent object interfaces, according to the established security policy.

Table 15 — Security requirements for data exchange at the Acting as a Contract Agent object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Contractual conditions	X	X	X	X	
Signed contract	X	X	X	X	X
User bill	X	X	X	X	X
Exception list	X	X	X	X	X
Customization info	X	X	X	X	X

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9.8 Providing EFC Context Data object interfaces

9.8.1 General

The Providing EFC Context Data object features interfaces with

— the charging object, and

— the collecting Usage Data object.

9.8.2 Providing EFC Context Data-Charging interface

The Providing EFC Context Data-Charging interface shall be able to

— accept context data.

9.8.3 Providing EFC Context Data-Collecting Usage Data interface

The Providing EFC Context Data-Collecting Usage Data interface shall be able to

— accept location information, and

— deliver context data.

9.8.4 Security requirements

The security functions listed in Table 16 may be requested on data exchanged at the Providing Context Data object interfaces, according to the established security policy.

Table 16 — Security requirements for data exchange at the Providing Context Data object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Context data	X	X	X	X	
Location info					X

9.9 Providing toll declaration object interfaces

9.9.1 General

The Providing toll declaration object features interfaces with

— the basic Provision object,

— the charging object, and

— the collecting Usage Data object.

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9.9.2 Providing toll declaration-Basic Provision interface

The Providing toll declaration-Basic Provision interface shall be able to

— deliver billing details and accept the related validation of the payment means.

9.9.3 Providing toll declaration-Charging interface

The Providing toll declaration-Charging interface shall be able to

— deliver billing details.

9.9.4 Providing toll declaration-Collecting Usage Data interface

The Providing toll declaration-Collecting Usage Data interface shall be able to

— accept charge data,

— deliver related limited autonomy.

9.9.5 Security requirements

The security functions listed in Table 17 may be requested on data exchanged at the Providing toll declaration object interfaces, according to the established security policy.

Table 17 — Security requirements for data exchange at the Providing toll declaration object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Billing details	X	X	X	X	X
Payment means validation	X	X	X		X
Charge data	X	X	X	X	X
Limited autonomy	X	X	X		X

9.10 Collecting Usage Data object interfaces

9.10.1 General

The Collecting Usage Data object features interfaces with

— the Providing toll declaration object,

— the Providing EFC Context Data object,

— the Customizing the OBE object,

— the Maintaining the OBE object, and

— the Charging object.

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9.10.2 Collecting Usage Data-Providing toll declaration interface

The Collecting Usage Data-Providing toll declaration interface shall be able to

— accept limited autonomy information, and

— deliver charge data.

9.10.3 Collecting Usage Data-Providing EFC Context Data interface

The Collecting Usage Data-Providing EFC Context Data interface shall be able to

— deliver location information, and

— accept context data.

9.10.4 Collecting Usage Data-Customizing the OBE interface

The Collecting Usage Data-Customizing the OBE interface shall be able to

— accept customization information.

9.10.5 Collecting Usage Data-Maintaining the OBE interface

The Collecting Usage Data-Maintaining the OBE interface shall be able to

— accept customization information, and

— deliver OBE status.

9.10.6 Collecting Usage Data-Charging interface

The Collecting Usage Data-Charging interface shall be able to

— accept charger identification and charging information,

— accept requests for OBE characteristics and user identification, and deliver related responses.

9.10.7 Security requirements

The security functions listed in Table 18 may be requested on data exchanged at the Collecting Usage Data object interfaces, according to the established security policy.

Table 18 — Security requirements for data exchange at the Collecting Usage Data object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Charge data	X	X	X	X	X
Charger identification	X	X	X		X
Charging information	X	X	X	X	X

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Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Context data	X	X	X	X	
Customization info	X	X	X	X	X
Limited autonomy	X	X	X		X
Location info					X
OBE characteristics	X	X	X	X	X
OBE status	X	X	X		X
User identification	X	X	X	X	X

9.11 Use object interfaces

9.11.1 General

The Use object features interfaces with

— the basic Provision object, and

— the acting as a Contract Agent object.

9.11.2 Use-Basic Provision interface

The Use-Basic Provision interface shall be able to

— exchange financial objects, and

— deliver requests for help, general information and complaints, and accept related responses.

9.11.3 Use-Acting as a Contract Agent interface

The Use-Acting as a Contract Agent interface shall be able to

— accept contractual conditions, and

— deliver signed contracts.

9.11.4 Security requirements

The security functions listed in Table 19 may be requested on data exchanged at the Use object interfaces, according to the established security policy.

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Table 19 — Security requirements for data exchange at the Use object interfaces

Data type	Confidentiality	Authenticity	Integrity	Non-repudiation	Availability
Financial object	X	X	X	X	X
Help, info and complaint	X	X	X		X
Contractual conditions	X	X	X	X	
Signed contracts	X	X	X	X	X

10 Points of observation and viewpoint correspondences

10.1 Points of observation

For the enterprise viewpoint, conformance shall be defined and measured at the interaction points defined by the interactions in Clause 8, in terms of Information objects that are exchanged at the correspondent computational interfaces identified in Clause 9.

10.2 Correspondence between enterprise and information viewpoints

The Enterprise architecture described in this International Standard identifies in Clause 6 roles and interactions among roles. Interactions identify the Information objects that are exchanged and defined in other Standards. The correspondence between the enterprise and the Information description of the EFC system is thus established in terms of, on one side, interactions between roles, and, on the other side, Information objects that are exchanged. This allows for maintaining coherence between the two descriptions. The interactions in 7.3 and the basic information objects in 8.2 identify such correspondences.

10.3 Correspondence between enterprise and computational viewpoints

Each interaction in 7.3 is performed at a computational Interface, so that correspondences between the enterprise and the computational descriptions are defined by identifying which interaction is performed at which interface. The exact list of correspondences depends on a detailed computational description which is outside the scope of this International Standard.

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Annex A
(informative)

Short Open Distributed Processing (ODP) description

The complete specification of any non-trivial distributed system involves a very large amount of information. Attempting to capture all aspects of the design in a single description is generally unworkable. Most design methodologies aim to establish a co-ordinated, interlocking set of models, each aimed at capturing one facet of the design, satisfying the requirements which are the concern of some particular group involved in the design process.

The objective of the ODP is to allow the definition of architecture standards to facilitate design and analysis of distributed heterogeneous systems and to define standards of components and infrastructure functions for the development of applications in distributed heterogeneous environments.

The ODP model (ISO/IEC 10746-4) defines an architecture made of concepts, definitions and rules to combine them, which can be used as a framework to define any system.

Under this aspect, ODP may be seen as a tool set, which does not impose any structuring on the system or on its specification, but rather gives a complete and coherent set of definitions and concepts.

One of the basic and most useful concepts of the ODP Reference Model is the concept of viewpoint, which is based on the assumption that a complete system's specification is made of a complex set of information types, which is generally not describable by a unique model or by using a unique language.

To give an example, one thing is describing a system in terms of its hardware and software components, a completely different thing is describing the same system in terms of its objectives, purposes, and utility, and yet another thing is to describe the information that is handled, and the way it is handled, by the various logical components of the same system. The above are three different models of the same thing, which need three different languages to be expressed.

At the same time, there is the obvious need to find a way to correlate these different descriptions in order to ensure that they do in fact describe the same thing.

In ODP, this separation of concerns is established by identifying five viewpoints, each with an associated viewpoint language which expresses concepts and rules relevant to a particular area of concern in terms of which parts of a system can be described from that viewpoint. ODP defines a co-ordinated and coherent set of models by means of its five perspectives (viewpoints).

Viewpoints are not independent from each other. Each viewpoint expresses a partial view of the complete system's specification, as depicted in Figure A.1.

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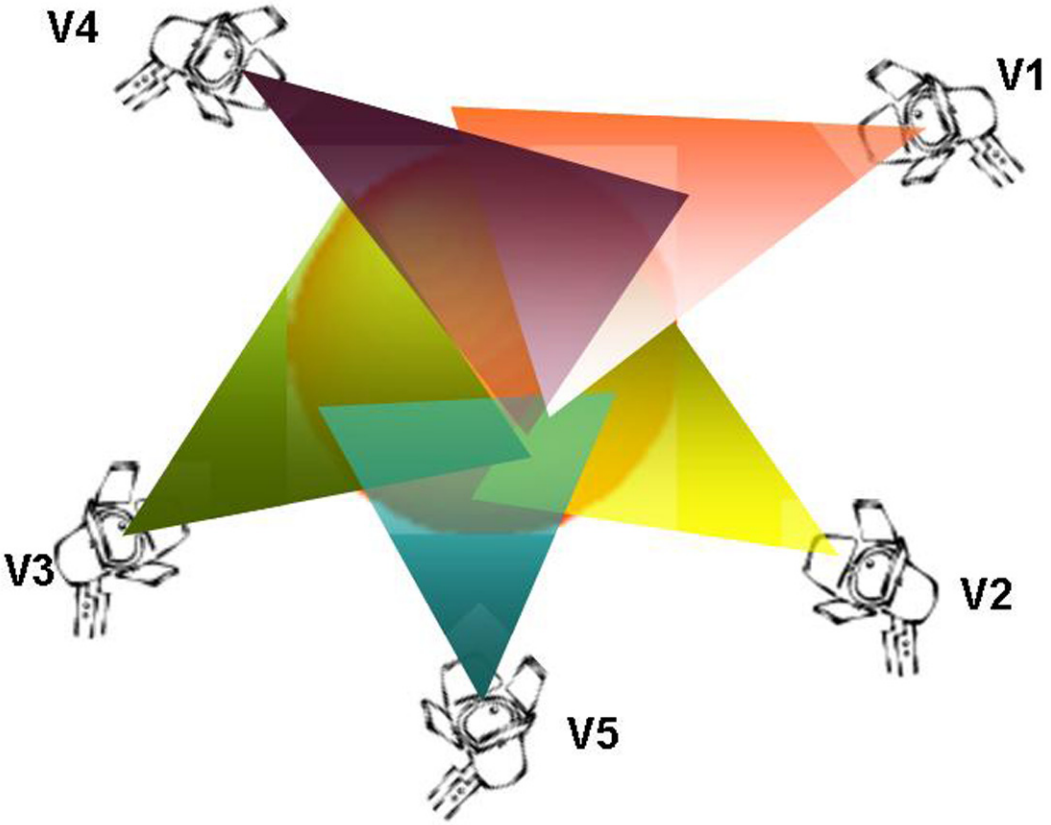

Figure A.1 — Viewpoints as partial views of a system

The ODP standard defines five viewpoints that, as a whole, allow for a complete system specification. Each viewpoint uses a specific language.

— **Enterprise viewpoint**. The enterprise model of a system views the roles of various agents (objects) defined in the system, and the environment “around” the system. It describes the rules (policies) that apply to the various roles, and the activities that are performed by the system. For the EFC architecture, the enterprise model is fully exploited in this International Standard.

— **Information viewpoint**. The information viewpoint deals with the information objects and their schemata. In actuality, an information specification will see a system from the perspective of information definition (which part is invariant, which part is exchanged among system components, in which way and by which flows information is exchanged).

— **Computational viewpoint**. The computational viewpoint is the view of an application software architect. Here, you will see a system as made of a set of interacting objects, which perform functions by exchanging data at interfaces. Interaction details (the mechanisms, the coding techniques, the system functions that are used to perform interactions) are not considered under this viewpoint, in the same way as, e.g., disk access drivers are not seen by an application programmer.

— **Engineering viewpoint**. The engineering viewpoint is the system engineer perspective of a system. Here, operating system details and supporting functions and protocols are considered, like for example security, data transfer, physical distribution of applications or the like. This viewpoint is the typical perspective of the deployment of a real system, and, as such, is the less probable model to be viewed in a standard.

— **Technology viewpoint**. The technology viewpoint describes the physical objects in the system in terms of their characteristics. This includes, e.g., the standards that are used for the implementation of the system.

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A common basis to all viewpoint descriptions is the use of concepts derived from object-oriented methodologies. In addition to that, a developer of an ODP specification is expressly requested to identify the correspondences among the various viewpoint specifications; this means specifying which concepts of one specification are mapped into which concepts of another specification and ensures, although in a non-standardized way, that a consistency check is at least performed.

In terms of languages used in each viewpoint, the ODP architecture does not impose any restraint.

— An **enterprise specification** of an ODP system is a model of the system and the environment with which the system interacts. It covers the role of the system in the business, and the human user roles and business policies related to the system.

— An **information specification** of an ODP system is a model of the information that it holds and of the information processing that it carries out. The information model is extracted from the individual components and provides a consistent common view which can be referenced by the specifications of information sources and sinks, and the information flows between them.

— A **computational specification** of an ODP system is a model of the system in terms of the individual, logical components which are sources and sinks of information. Using the computational language, computational specifications can express the requirements of the full range of distributed systems, providing the maximum potential for portability and interworking, and enabling the definition of constraints on distribution, while not specifying the detailed mechanisms involved.

— An **engineering specification** of an ODP system defines a networked computing infrastructure that supports the system structure defined in the computational specification and provides the distribution transparencies that it identifies. It describes mechanisms corresponding to the elements of the programming model, effectively defining an abstract machine which can carry out the computational actions and the provision of the various transparencies needed to support distribution.

— A **technology specification** defines how a system is structured in terms of hardware and software components.

It should be noted that enterprise and information specifications are directly concerned with distribution only where distribution issues arise from the requirements of the enterprise (e.g. from the geographical spread of points of access to system services). Nevertheless, these specifications may need to take into account constraints arising from the choices about distribution made in the computational, engineering and technology specifications.

The viewpoints are not independent. Specifications of a system from each viewpoint are partial views of the complete system and there are consistency constraints between the different viewpoint specifications that arise from the relationships between the real world entities represented in the different specifications and from the fact that the same entities may be represented in more than one specification.

This International Standard uses the ODP definitions and concepts to define the EFC architecture in terms of actors, roles and policies, by exploiting the enterprise viewpoint concepts of the ODP Reference Model.

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Annex B
(informative)

Comparison with ISO/TS 17573:2003

B.1 Previous model for EFC used for vehicle-related transport services

Figure B.1 shows the model for EFC for vehicle-related transport services defined in ISO/TS 17573:2003. The model was formed by the complete set of entities needed to operate an EFC system. The definitions of the entities are given below.

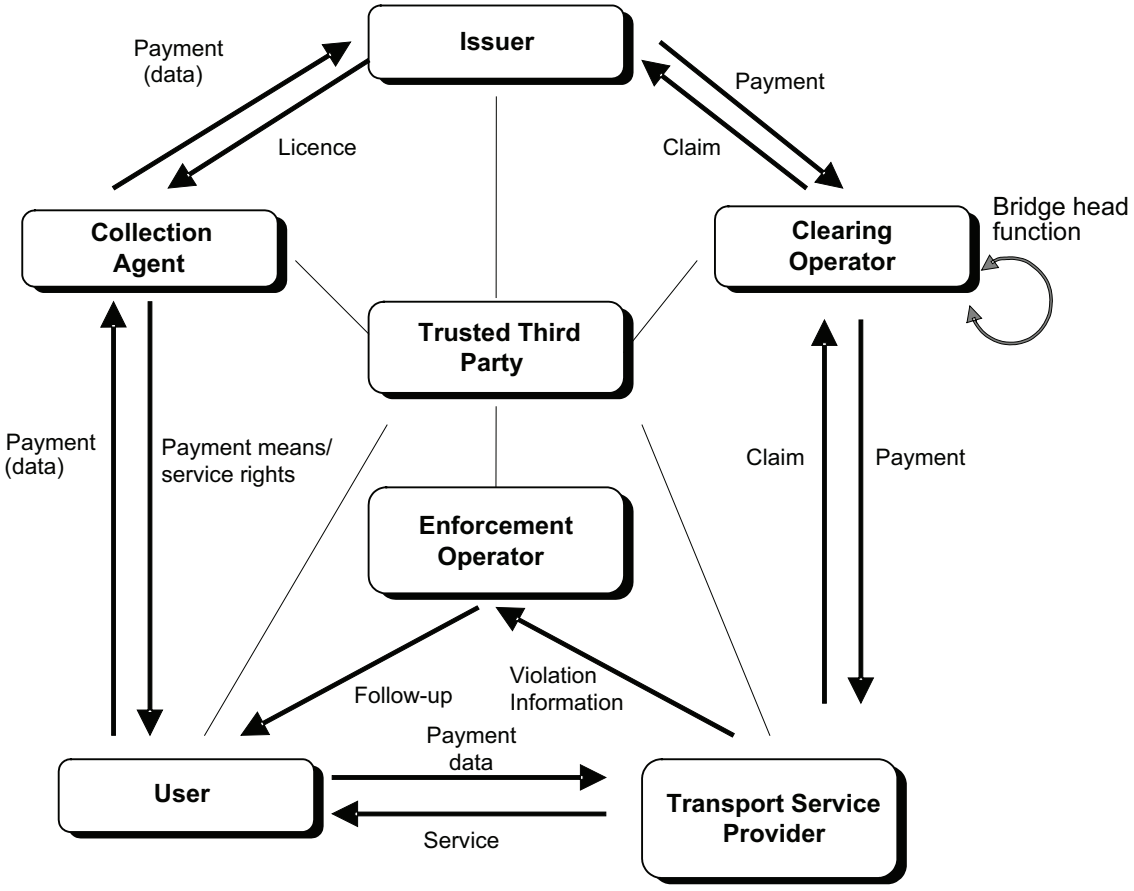

Figure B.1 — The conceptual model

Clearing operator The entity that collects and possibly aggregates transactions from one or more Transport service providers for delivery to the Issuer(s). The clearing operator can also handle the apportionment between the transport service providers. In the financial world this operator is equivalent to an acquirer.

Collection agent The entity responsible for selling, reloading or delivering the payment means to the user and collecting the payment from the user on behalf of the issuer. The collection agent can also collect user-related application-specific data from the user. The collection agent is also referred to as retailer.

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Enforcement operator	An entity handling the enforcement of users.
Issuer	The entity responsible for the payment system and responsible for issuing the payment means to the user.
Transport service provider	The person, company, authority or abstract entity offering a transport service to the user for which the user has to pay a toll (the toll will in some cases be zero, e.g. emergency vehicles).
Trusted Third Party	The entity that might be responsible for operation monitoring, system and security assessment (including security key management) as well as granting licences.
User (client, customer, consumer)	The entity that uses a transport service provided by the transport service provider according to the terms of an agreement. The user may also be described as the subscriber of an EFC contract, the vehicle owner and the driver in those cases where these are not the same person or company.

The entities in the model constitute abstract entities and not real organizations.

The conceptual model neither implies nor mandates/requires that there should always be a separate organization for each abstract entity in any real system. Depending on the particular business arrangements and resulting organizational models, the abstract entity may or may not have direct counterparts in the real world.

This model is one model able to fully support the transport world while being highly compatible with the models used in the financial world (by the banking industry and the inter-sector electronic purse). In reading this International Standard, no assumptions should be made concerning the presence or absence of competing organizations that seek to, or undertake, one or more of the organizational roles. Consequently an issuer could act as an Issuer for one or more EFC systems, e.g. several or all EFC systems on a national level. Similarly, one or many organizations could act as transport service providers or collection agents. However, there are likely to be fewer clearing operators than EFC systems.

The inner chain of flows in Figure B.1 (counter-clockwise) corresponds to the data flow, the outer circle (clockwise) to the money and service flow.

B.2 The relationships between the new and the previous conceptual model

The previous EFC model was an entity relationship model while the new EFC model described in this International Standard is a functional model. However, the previous entity model also had some roles described and the comparison between the two EFC models is based on the role descriptions of the two models.

Provision of the toll service covers the roles allocated to the entities “issuer” and “collection agent” in the previous EFC model.

Use of the toll and transport service covers the roles allocated to the entity “user”.

Charging of the toll covers the roles allocated to the entities “transport service provider” and “enforcement operator”.

Management of a toll charging environment covers the roles allocated to the entity “trusted third party”. It also covers several other roles that were not defined in the previous model. Hence, the new functional model gives a more correct and updated picture of a toll charging environment.

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The “clearing operator” in the previous model has a role that is not defined in the new functional model. The reason for this is that the role is found to be superfluous. In some cases several operators may implement equipment that collects, sorts, merges and distributes transaction files and exception lists between the Toll Service Provider and the Toll Chargers but this is more or less an operational and technical solution for the data transfer between the operators.

The comparison of the roles is shown in Figure B.2.

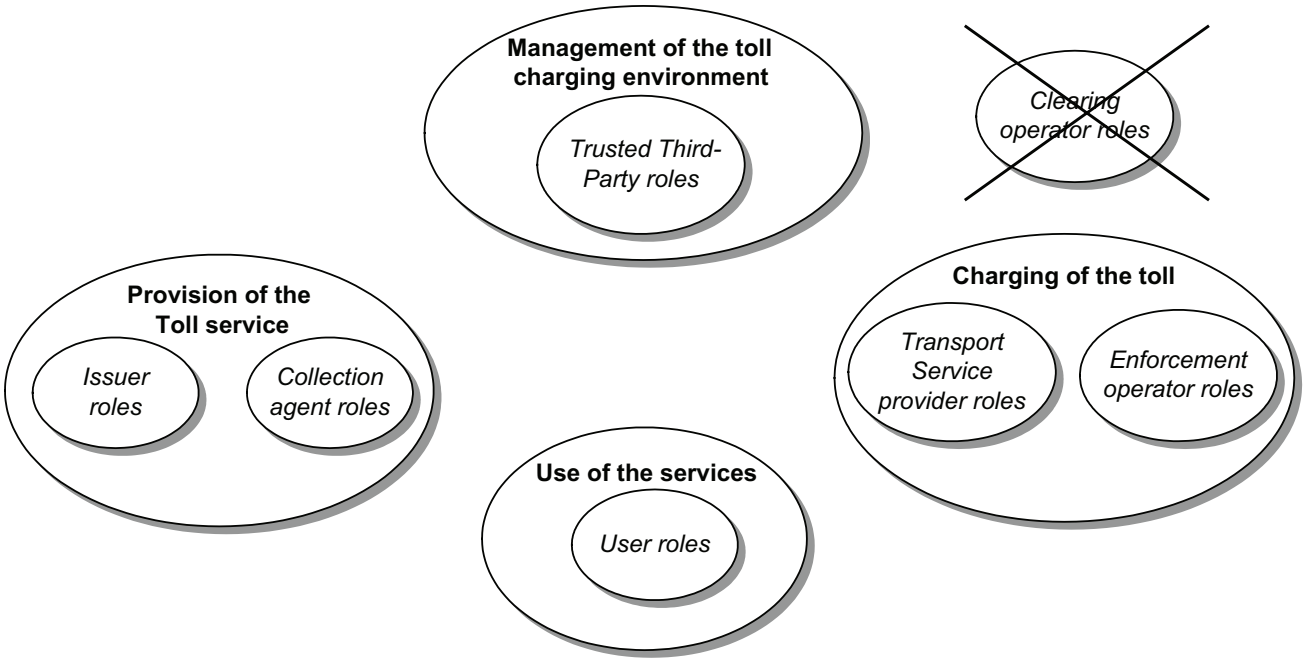

Figure B.2 — Comparison of roles

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Annex C
(informative)

Relations between this International Standard and IFMSA

C.1 Introduction: the IFM environment

ISO 24014-1 defines the roles of the electronic ticketing systems in an interoperable fare management (IFM) collection environment. The IFM system may be run by a single transport undertaking, a transport authority, and an association of public and private companies or other groups.

Figure C.1 shows the conceptual IFM environment where the groups of roles have been given names according to the main functions. The definitions of the groups of roles are given below.

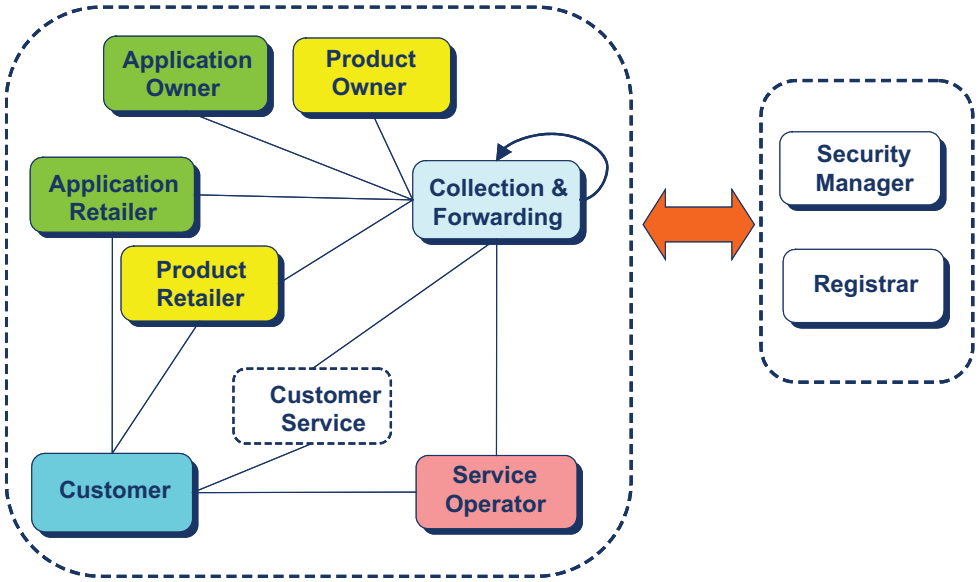

Figure C.1 — The conceptual IFM model

Application owner Holds the application contract for the use of the application with the customer.

Application retailer Sells and terminates applications, collects and refunds value to a customer as authorized by an application owner. The application retailer is the only financial interface between the customer and the IFMS related to applications.

Collection and forwarding The role of collection and forwarding is the facilitation of data interchanges of the IFMS. The general functions are data collection and forwarding.

Customer Holds an application. Acquires products in order to use the public transport services.

Customer service Subject to commercial agreements, may provide “helpline” and any similar facilities including stolen and damaged customer medium replacement and consequential product reinstalling.

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IFM manager An IFM manager establishes and manages the IFM Policies on behalf of the IFMS. These policies are embedded in the set of rules. To manage the elements of the IFMS dealt with in the standard the IFM manager shall appoint a security manager and a registrar. The functions and the responsibilities of the security manager and the registrar may be distributed to several organizations within an IFM.

Product owner Is responsible for his or her products and specifies the usage, pricing and commercial rules of his or her products. The product owner also clears the use of the products and the payments for the products and reports the use of the products to the relevant operators and authorities.

Product retailer Sells and terminates products, collects and refunds value to a customer as authorized by a product owner. The product retailer is the only financial interface between the customer and the IFMS related to the products.

Registrar After the certification, he or she issues unique registration codes for organizations, components, application templates, and product templates. The registrar function also issues unique identifiers or rules for generating unique identifiers for the applications, products and messages.

Security manager The security manager is responsible for establishing and co-ordinating of the security policy and for the

— certification of organizations, application templates, components and product templates,

— auditing of organizations, application templates/applications, components and product templates/products,

— monitoring the system, and

— operation of the security of the IFMS, e.g. key management.

Service operator The service operator provides a service to the customer against the use of a product.

C.2 The relationships between the EFC model in this International Standard and the IFMSA model

C.2.1 General

The term “product” is very essential in public transport and electronic ticketing. A product is described by a set of rules defining how the product could be used (usage rules), how the customer should pay for it (pricing rules) and how the fare paid by the customer should be divided by the involved parties (commercial rules), e.g. between the product owner, product retailer and service operator. One of the basic differences between the toll collection world and the public transport world is related to the terms “product” and “vehicle-related transport service”:

— A product usually describes the travel rights of a person to go from A to B with one or more modes of transport using the relevant transport infrastructure, e.g. a bus in a road network or a train in a rail network.

— A vehicle-related transport service usually describes the access of a vehicle to a toll domain, e.g. a road network, bridge, tunnel or ferry crossing.

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Hence, the fare paid by a customer for a product is related to the transport of the customer from one place to another, e.g. from one zone to another or within a zone, with different types of transport modes in different transport infrastructures. This implies that a product may be independent of the transport modes the customer chooses to use in cases where several transport modes and transport infrastructures provide the core service which is the transport of the customer from A to B.

The differences between a product and a vehicle-related transport service are the main reasons why the roles in the EFC model and IFMSA are difficult to map 100 % to each other. For instance, in EFC, it is the Toll Charger that defines and provides the transport service while, in IFM, it is the product owner that defines the product while the service itself (the transport of a person) is provided by one or more service operators.

The comparison between the two models is based on the role descriptions of the two models.

C.2.2 Roles

— **Application owner** and **application retailer** roles are comparable with some of the responsibilities of the EFC role “provision of the toll service”.

— **Customer service** roles are comparable with some of the responsibilities of the EFC role “provision of the toll service”.

— **Product owner** roles are partly comparable with some of the responsibilities of the EFC role “provision of the toll service” and partly comparable with some of the responsibilities of the EFC role “Toll Charger”. The product owner defines the product with its usage, pricing and commercial rules while this could be compared to what the Toll Charger is doing by providing a transport service and defining the charging principles including prices. On the other hand, the product owner has also some responsibilities that are taken care of by the role “provision of the toll service”, e.g. some clearing and reporting tasks.

— **Product retailer** roles are comparable with some of the responsibilities of the EFC role “provision of the toll service”. The provision of the customer media (which could be compared with the OBE) is outside the scope of the IFMSA functional architecture. It is assumed that the customer already has a customer media, e.g. an IC-card.

— **Service operator** roles are comparable with most of the responsibilities of the EFC “role charging of the toll”. One of the major exceptions is that it is the product owner that is defining the charging principles, e.g. the tariff structure, and not the Toll Charger.

— **Customer roles** are comparable with most of the responsibilities of the EFC role “use of the services”.

— **Collection and forwarding** roles are not comparable with any of the EFC roles. In some cases, operators may implement equipment that collects, sorts, merges and distributes transaction files and exception lists between the Toll Service Provider and the Toll Chargers but this is more or less an operational and technical solution for the data transfer between the operators.

— **IFM manager** including the **Security manager** and **Registrar** roles are comparable with the EFC roles “management of a toll charging environment”.

The comparison of roles is shown in Figure C.2.

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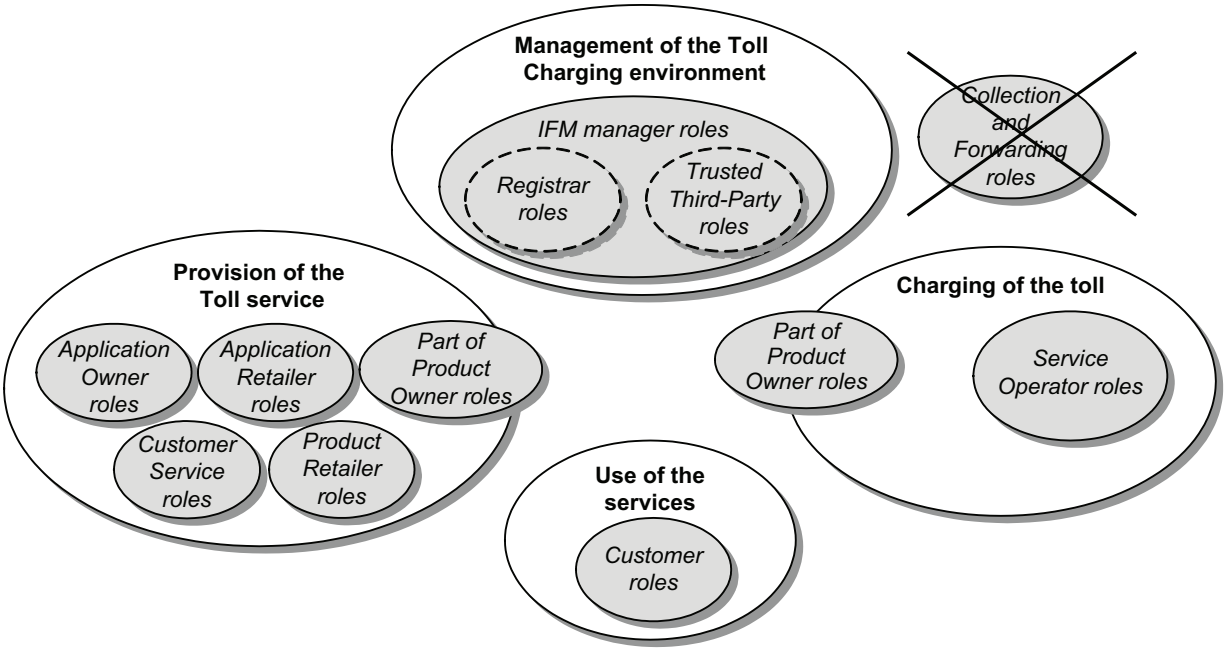

Figure C.2 — Comparison of roles

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Annex D
(informative)

Relation with the European Electronic Toll Service

D.1 Terms

The terms used in this International Standard correspond to the following terms in ISO/TS 17573:2003 and other terms being used by the Commission of the EU as follows:

Terms in ISO/TS 17573:2010	Term(s) in ISO/TS 17573:2003	European EETS term	Remark
Toll domain	Charging domain	Toll domain	
Toll service		EETS	EETS stands for European Electronic Toll Service
Toll service provider	Contract issuer, OBE provider	EETS provider	
Toll system	EFC domain	Toll system	
Toll charging environment management	Overall EFC management	N/A	

D.2 EETS roles model

The roles and responsibilities defined in this International Standard are comparable with the roles and responsibilities defined in the conceptual description of EETS as delivered by the European R&D project CESARE IV. Figure D.1 shows the terms used in the EETS definition of the roles. It should be noted that the term Interoperability Management (IM) is not used in the EFC Directive 2004/52/EC or its Decision. Hence, the role Interoperability Management, as used in this annex, covers terms like Member states, Conciliation Bodies, etc., fulfilling the whole or parts of the IM responsibilities defined in this International Standard.

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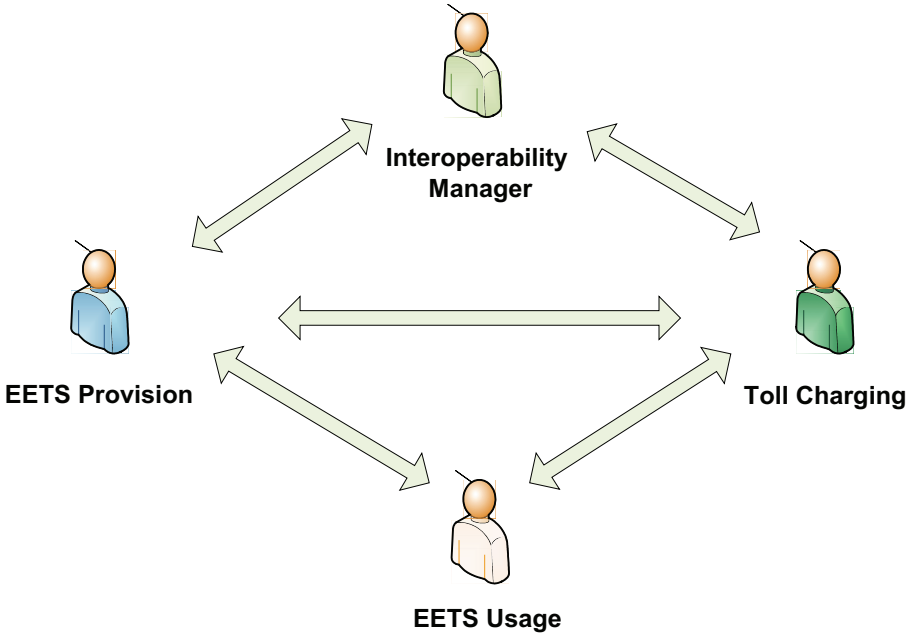

Figure D.1 — EETS roles model

Based on the responsibilities described in Clause 7, Figure 8, and the architecture developed in the European R&D project Road Charging Interoperability (RCI), which is shown in the diagram of Figure D.2, the relationship between the EETS roles based on this International Standard and the RCI interfaces are shown in Figure D.3.

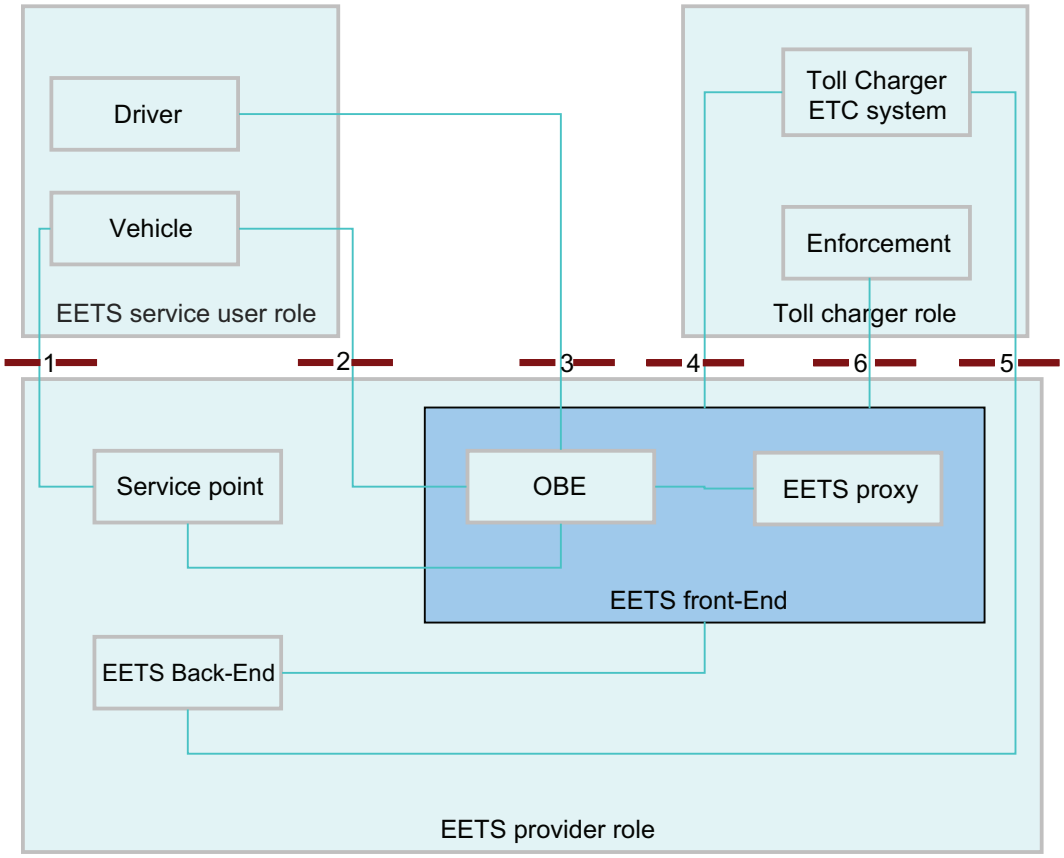

Figure D.2 — RCI architecture

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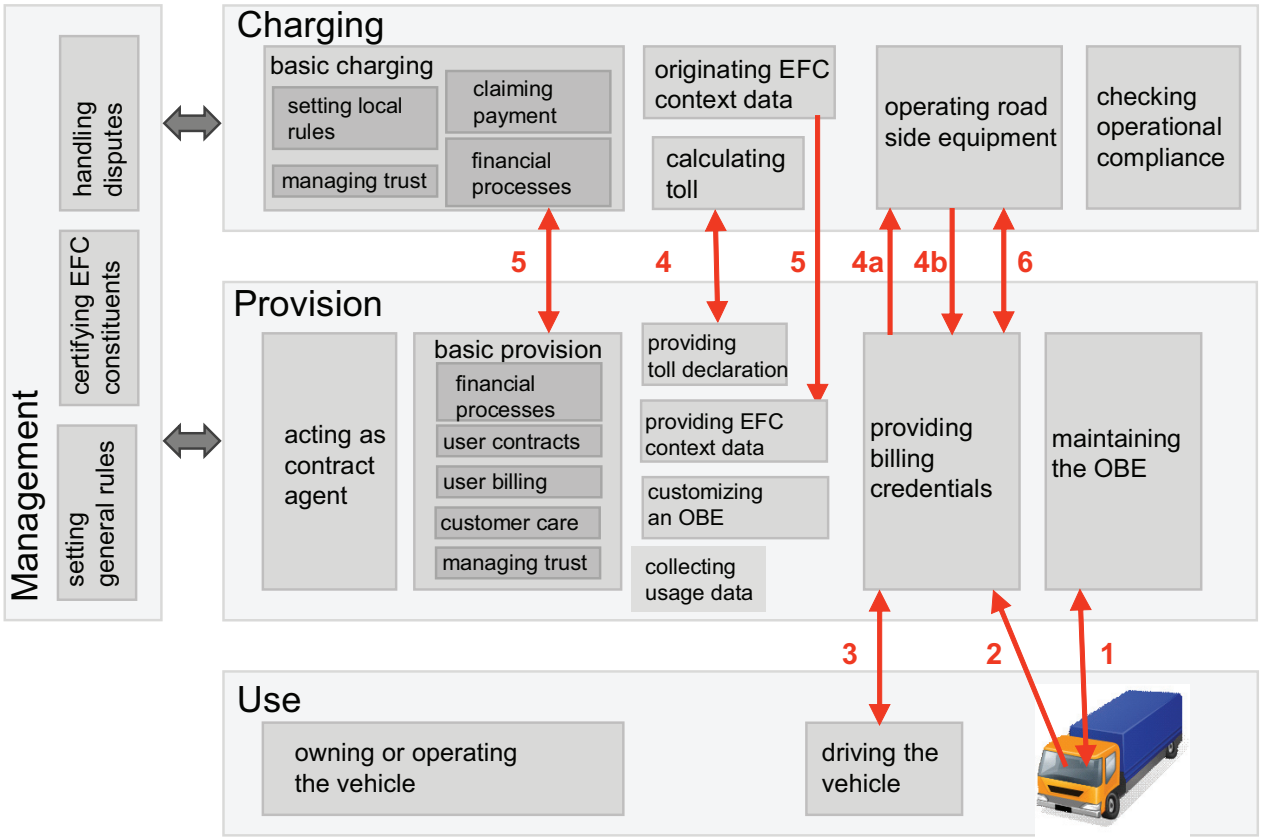

Figure D.3 — EETS detailed roles model

RCI has described the following interfaces:

— Interface 1: Service Interface. This interface provides an in-vehicle access point for the servicing and maintenance of road charging OBE. The interface is not seen as critical for interoperability.

— Interface 2: Vehicle integration interface. This interface describes the interface between the OBE and the vehicle. Some data may be collected from the vehicle and used for calculation of the toll. The interface is not seen as critical for interoperability.

— Interface 3: Human-machine interface. This interface provides access to the OBE for human interaction. The interface is not considered critical for interoperability but should preferably be harmonized.

— Interface 4: Charge data exchange/toll declaration. This interface has been divided in the following interfaces:

  — 4: Charging data (autonomous systems) defined in ISO 12855 mostly based on Data Definition of ISO 17575-1

  — 4a: Charging data (DSRC-based systems) based on EN 15509

  — 4b: Localization support

— Interface 5: Toll Context Data publishing. This interface enables the exchange of the specifications that define the specification of the Toll Chargers tolled infrastructure and the expected behaviour of the EETS Providers systems when transmitting data. The interface also hosts the back-office transactions/clearing between the Toll Charger and the EETS Service Provider (the interface is split in two arrows in the figure).

— Interface 6: Enforcement. This interface enables the Toll Charger to carry out enforcement and compliance checking transactions with the OBE.

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Annex E
(informative)

Example of the Japanese electronic toll system

E.1 Updated previous class diagram for EFC system.

Figure E.1 shows an example of the UML notification class diagram for an EFC system, updated from Annex B of ISO/TS 17573:2003. The diagram consists of 19 classes. The updated class diagram reflects actual ETC operation in Japan since 2000.

Some of the classes are adopted paying attention to the information of EFC systems. The concept <<Agent>> is introduced to express the information class of the corresponding Actor:

<<Agent>>Clearing Operator

<<Agent>>Collection Agent

<<Agent>>Enforcement Operator

<<Agent>>Issuer of OBE

<<Agent>>Trusted third party

<<Agent>>Issuer of payment method

<<Agent>>OBE

<<Agent>>service provider

<<Agent>>user

<<Agent>>Vehicle

Other classes are adopted paying attention to information that is essential to expressing systems. They are information classes:

EFC subscriber contract information

Payment method contract information

OBE issuing information

user toll information

Passing information

Tariff

Negative List

Negative information

charging Point

Classes are represented by boxes subdivided into rectangles. Each class has a class name in the upper rectangle. The middle rectangle has its attributes or information that the class entails. The lower rectangle has the operations that the class carries out.

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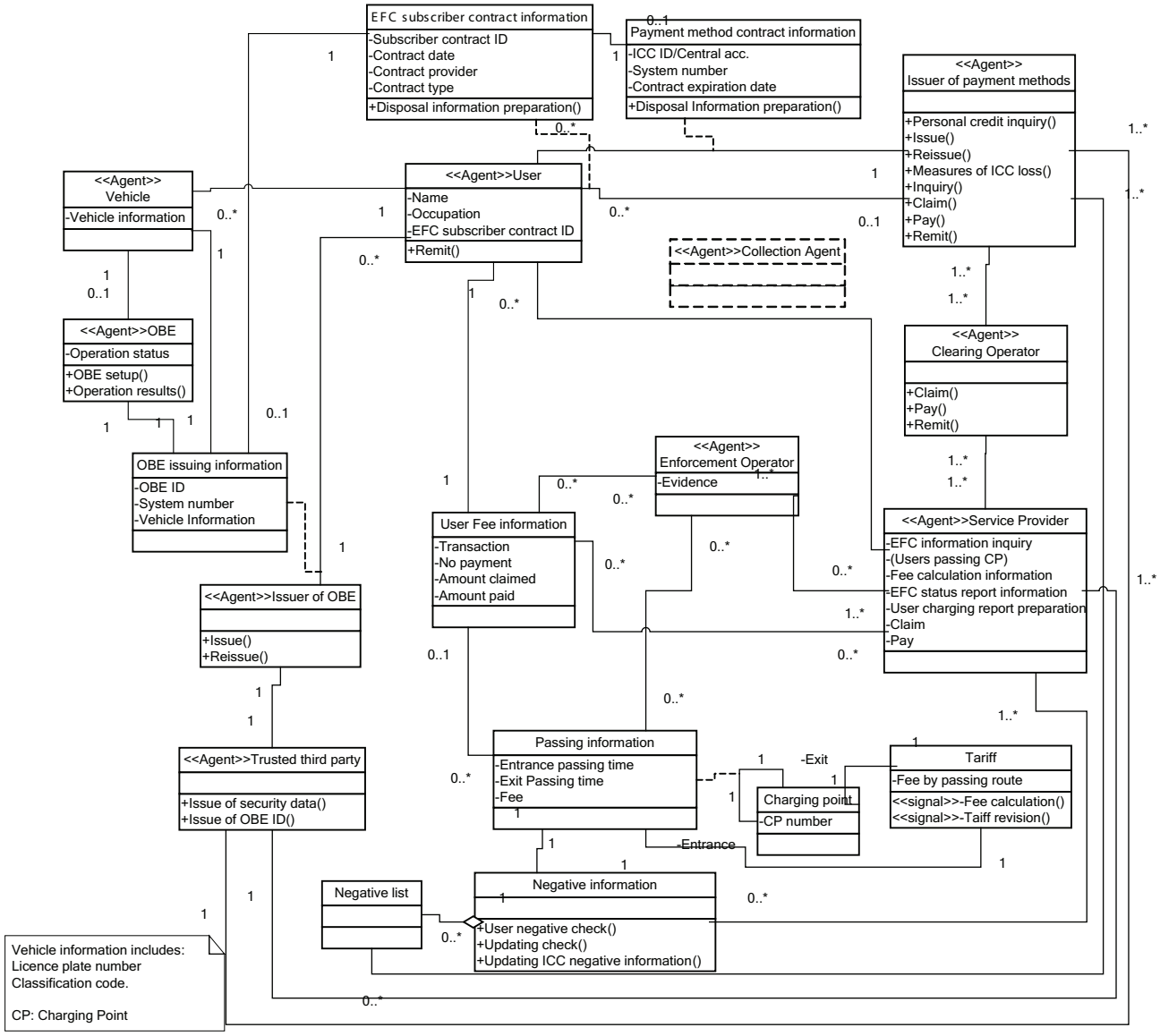

Figure E.1 — Example of a class diagram of UML notification for toll collection

E.2 The relation with the new model

The class diagram describes the relation of actors and Information classes for toll collection model, while the new EFC model described in this International Standard is a functional model. The class diagram has some functional actors and each actor can be projected into the new model shown in Figure E.2.

Though there are differences in notation, the consistency is found to be kept between the class diagram and the new functional model.

Provision of the toll service covers the roles allocated to the class “Issuer of OBE roles” and “Issuer of payment methods roles” in the UML class diagram.

Use of the toll service covers the roles allocated to the classes “user roles” and “vehicle roles” and “OBE roles” in the UML class diagram.

Charging of the toll service covers the roles allocated to the classes “service provider roles” and “enforcement operator roles” in the UML class diagram.

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Management of the toll service environment covers the roles allocated to the class “trusted third party roles” in the UML class diagram.

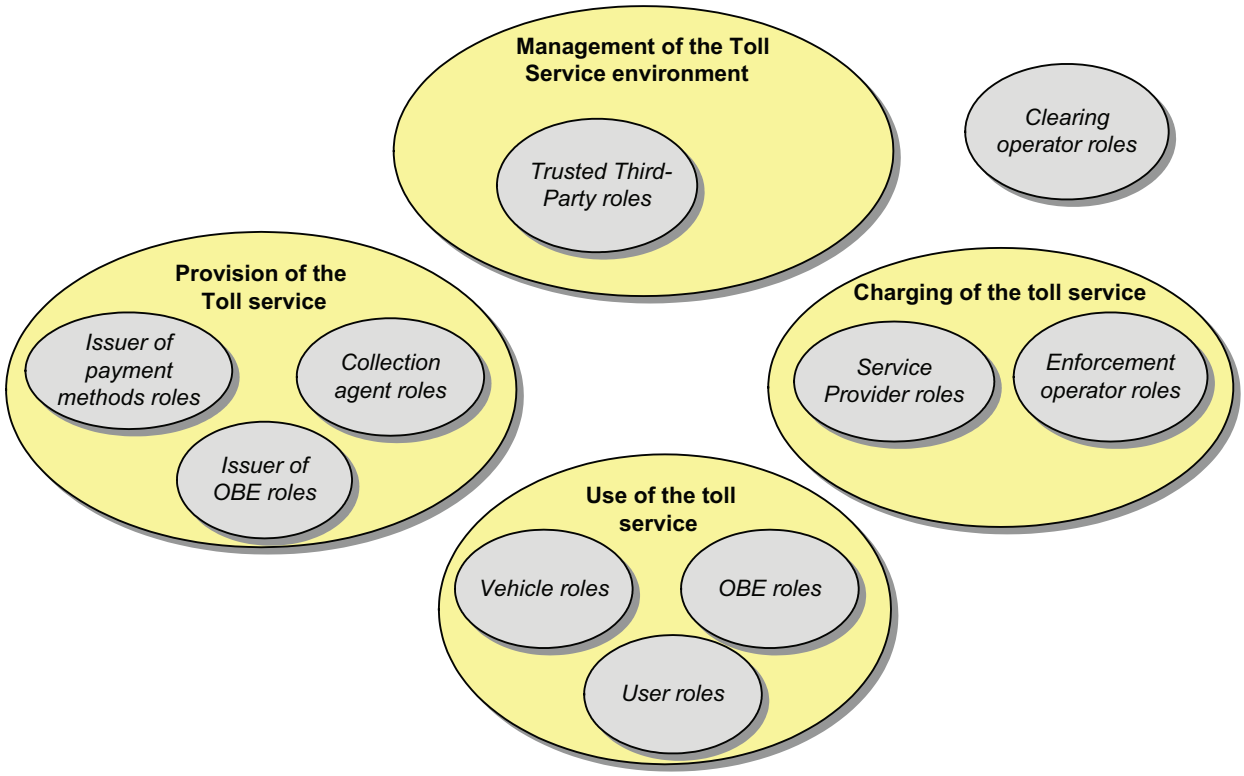

Figure E.2 — UML actor's roles in the new model

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