INTERNATIONAL STANDARD

ISO 17573-1

First edition
2019-07

Electronic fee collection — System architecture for vehicle-related tolling —

Part 1: Reference model

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

Partie 1: Modèle de référence

Reference number
ISO 17573-1:2019(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This first edition of ISO 17573-1, cancels and replaces ISO 17573:2010, which has been technically revised.

The main changes compared to ISO 17573:2010 are as follows:

— update of the normative references, terms and definitions and abbreviated terms clauses and the Bibliography;

— relocation of previous Clause 8 (Information schemata and basic information types) to informative Annex B;

— removal of Clauses 9 (interfaces and computational objects) and 10 (Points of observation and view point correspondences), Annex A (Short Open Distributed Processing (ODP) description), Annex B (Comparison with ISO/TS 17573:2003), Annex C (Relations with this International Standard and IFMSA), Annex D (Relation with the European Electronic Tolls Service) and Annex E (Example of the Japanese electronic toll system);

— addition of the new informative Annex A (Mapping of the EFC architecture onto the C-ITS architecture) and Annex C (Enterprise objects within roles).

A list of all parts in the ISO 17573 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The widespread use of tolling also 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 systems in the various toll domains. In Europe, for example, this need has been recognised and legislation on interoperability has been adopted (Directive 2004/52).

In addition to specialised standards there is also a 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 supports its users to improve the quality of specifications to be used in an international market,

  — to reduce the risk for conflicting 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, which enables both:

  — identification of potential activities subject to standardization, and

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

— defines the boundaries between the EFC and external domains;

— identifies all architectural objects that lay inside the EFC boundaries;

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

Toll systems conforming to this document may be used for various purposes including measured distance toll, road segment toll, closed network toll, cordon toll, area toll, time-based toll and collecting fees for the use of bridges, tunnels, ferries, or for parking.

ISO 17573:2010 was based on a conceptual model defined in ISO/TR 14904 (withdrawn standard). 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 17573:2010 and are closer to real life implementations. This document is based on these new conceptual models and uses the associated terms and definitions.

Although there are many differences, collecting a toll for vehicles can, to some extent, be compared with collecting a fare for public transport. Architectural harmonisation of the collection of fee and fare may be desirable from a policy and from a user point of view. In the past, ISO 24014-1 prepared by ISO TC 204 used ISO 17573:2010 as a starting point. This document has benefited from that and has also taken ISO 24014-1 into account.

In this document, 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 (the viewpoints), in order to cover, e.g. hardware components as well as network protocols or interfaces or roles and general policies of the system itself. This is accomplished using different sets of concepts and terminologies, each one of those expressed as a viewpoint language. A complete description of a real system can only be achieved when all viewpoint models are designed. This allows for a clear separation of concerns and an easier way to define a system.

In more recent years, the development of concepts and standards in the field of Cooperative ITS (C-ITS, ISO TC 204 and CEN TC 278) led to the definition of a general enterprise viewpoint architecture for C-ITS (ISO 17427-1) that, by following the same approach of using the ODP architecture to model a complex system, defined concepts and terms for the more general realm of C-ITS.

This document gives a description of the architecture of the toll systems environment from the enterprise viewpoint, by refining and extending what had been already done in ISO 17573:2010. Correspondences between concepts and terms in this document and those in ISO 17427-1 are shown in Annex A. In addition, this document gives in Annex B the foundations of the information viewpoint by identifying information interactions and general information objects. With respect to ISO 17573:2010, this document removes all security requirements on interfaces, which are better and more generally dealt with in ISO 19299.

This document is Part 1 of a multipart standard that is made up of the following parts:

— ISO 17573-1, *Electronic fee collection — System architecture for vehicle related tolling — Part 1: Reference model* (this document)

— ISO/TR 17573-2[1)], *Electronic fee collection — System architecture for vehicle related tolling — Part 2: Terminology*

1) Under development. Current stage: 30.99

Electronic fee collection — System architecture for vehicle-related tolling —

Part 1: Reference model

1 Scope

This document defines the architecture of electronic fee collection (EFC) system environments, in which a customer with one contract may use a vehicle in a variety of toll domains with a different toll charger for each domain.

EFC systems conforming to this document can be used for various purposes including road (network) tolling, area tolling, collecting fees for the usage of bridges, tunnels, ferries, for access or for parking. From a technical point of view the considered toll systems may identify vehicles subject to tolling by means of electronic equipment on-board in a vehicle or by other means (e.g. automatic number plate recognition, ANPR).

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 outside of the scope of this document.

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

This document as a whole 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;

— the terms and definitions for common use in an EFC environment;

— a decomposition of the EFC systems environment into its main enterprise objects;

— the roles and responsibilities of the main actors. This document does not impose that all roles perform all indicated responsibilities. It should also be clear that the responsibilities of a role may be shared between two or more actors. Mandating the performance of certain responsibilities is the task of standards derived from this architecture;

— identification of the provided services by means of action diagrams that underline the needed standardised exchanges;

— identification of the interoperability interfaces for EFC systems, in specialised standards (specified or to be specified).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 7498-1:1994, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model — Part 1*

ISO/IEC 10746-2, *Information technology — Open distributed processing — Reference model: Foundations — Part 2*

ISO/IEC 10746-3, *Information technology — Open distributed processing — Reference model: Architecture — Part 3*

ISO 14813-5, *Transport information and control systems — Reference model architecture(s) for the TICS sector — Part 5: Requirements for architecture description in TICS standard*

ISO/IEC 15414, *Information technology — Open distributed processing — Reference model — Enterprise language*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 7498-1:1994, ISO/IEC 10746-2, ISO/IEC 10746-3, ISO 14813-5 and ISO/IEC 15414, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
automatic number plate recognition
technology that uses optical character recognition on images to read vehicle registration plates

3.2
artefact
physical object of material or physical piece of information or a system or subsystem that is used in an ITS system

3.3
billing detail
information needed to determine or verify the amount due for the usage of a given service

3.4
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

3.5
electronic fee collection
fee collection by electronic means

Note 1 to entry: The actual payment (collection of the fee) may take place outside the toll system.

3.6
enforcement
measures or actions performed to achieve compliance with laws, regulations or rules

Note 1 to entry: In this context: the process of compelling observance of a toll regime.

3.7
interoperability
ability of systems to exchange information and to make mutual use of the information that has been exchanged

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

3.9
on-board equipment
all required equipment on-board a vehicle for performing required electronic fee collection (EFC) functions and communication services

3.10
roadside equipment
equipment located along the road, either fixed or mobile

3.11
role
set of responsibilities

3.12
short-range communication
tolling technique based on transfer of information via a radio connection between a roadside equipment and an on-board equipment

Note 1 to entry: This includes 5,8 GHz DSRC as well as ITS-G5 and RFID.

3.13
tariff scheme
set of rules to determine the fee due for a vehicle within a toll domain

3.14
toll
charge, tax or duty levied in connection to using a vehicle in a toll domain

3.15
Toll Charger
entity which levies a toll for the use of vehicles in a toll domain

3.16
toll declaration
statement to declare the usage of a given toll service to a toll charger

3.17
toll domain
area or part of a road network where a certain toll regime is applied

3.18
toll regime
set of rules, including enforcement rules, governing the collection of a toll in a toll domain

3.19
toll scheme
organizational view of a toll regime, including the actors and their relationships

3.20
toll service
service enabling users to pay a toll

3.21
Toll Service Provider
entity providing toll services in one or more toll domains

3.22
transport service
transport infrastructure related service which is offered to the user

3.23
trust object
information object that is exchanged between entities to ensure mutual trust

EXAMPLE Electronic signature or an electronic certificate.

4 Symbols and abbreviated terms

4.1 Symbols

In action diagrams, the following graphical conventions apply:

Rounded corner boxes indicate responsibilities and related activities within roles

Arrows crossing borders between roles indicate information exchanges between roles as activities performed within responsibilities

Vertical arrows within activities represent execution steps

Solid circles represent start of activities

Partially coloured circles represent end of activities

Solid horizontal bars represent decision gates

4.2 Abbreviated terms

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

ANPR Automatic Number Plate Recognition

CE Central Equipment

C-ITS Cooperative ITS

DSRC Dedicated Short-Range Communication

EETS European Electronic Toll Service

EFC Electronic Fee Collection

GNSS Global Navigation Satellite Systems

ID	Identity
IFMSA	Interoperable Fare Management System Architecture
ITS	Intelligent Transport Systems
OBE	On-board Equipment
ODP	Open Distributed Processing
RFID	Radio Frequency Identification
RSE	Roadside Equipment
SAM	Secure Application Module
SLA	Service Level Agreement
SRC	Short Range Communication
TC	toll charger
TSP	toll service provider

5 The EFC community: roles and objectives

5.1 General

Electronic fee collection (EFC) is an ITS service enabling the user of a vehicle-related transport service to pay for the related transport service, e.g. the use of a tolled road, without manual intervention. The ITS application providing the ITS service will usually be implemented in equipment installed in the vehicle, at the roadside and in central systems. In some scenarios, it also includes personal equipment, e.g. smartphones.

The EFC architecture can be described by a community of external and internal enterprise objects with the objective of providing an EFC service with its benefits regarding traffic safety, traffic efficiency, comfort and mobility to the EFC service user. External enterprise objects are involved in the provision of the EFC service but are not set up for the sole purpose of EFC. This document only includes the definition of the internal enterprise objects, but the external enterprise objects are shortly described in this clause to give the complete picture of the EFC community. Figure 1 shows the external objects in the EFC community.

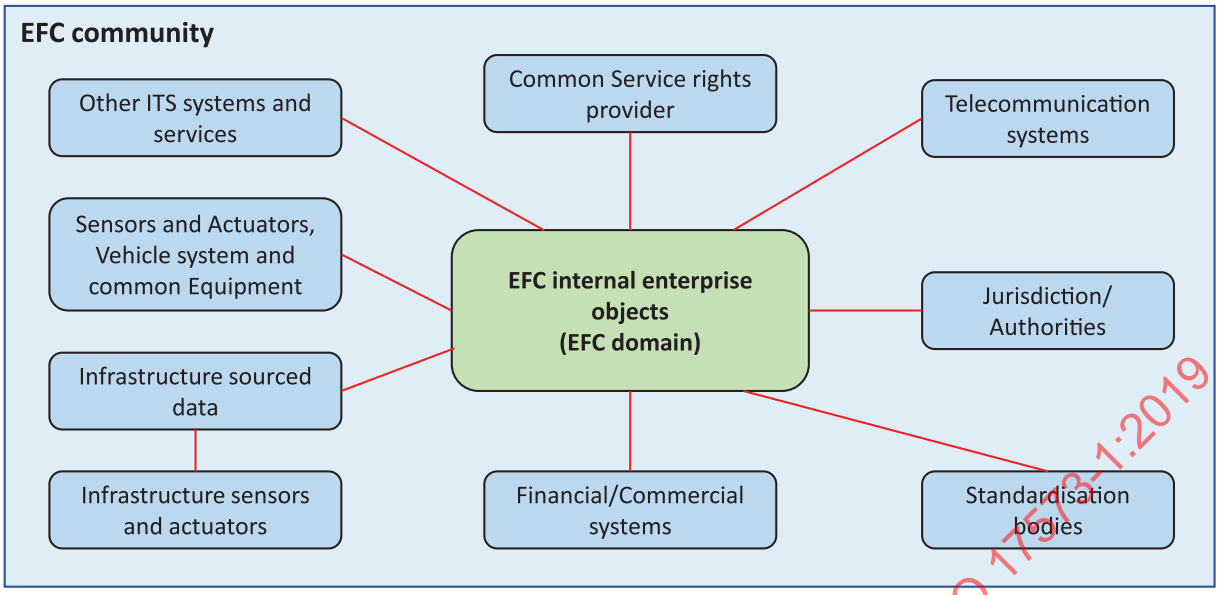

Figure 1 — Enterprise objects in the EFC community

The following subclauses give a concise description of each enterprise object depicted in Figure 1. Detailed responsibilities for roles defined within the EFC domain are dealt with in Clause 6.

5.2 Other ITS systems and services

An ITS service may generally build on data provided by other ITS systems or ITS services. Objects in the EFC domain may for instance receive data from other traffic management or information systems as input to pricing algorithms used in an EFC system.

5.3 Sensors, vehicle system and common equipment

An EFC domain 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 or fee calculation. Examples of such sensors and data stores are GNSS sensors (e.g. in devices used for navigation, fleet management), tachograph, trailer sensor, suspension sensors, axle 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 EFC domain.

NOTE Shipped goods may become relevant in future tolling schemes.

5.4 Infrastructure sourced data

An EFC domain may use data from environmental sensors, e.g. pollution measurements, for the toll or fee 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 for the dynamic toll or fee calculation. Sensors that are solely installed for the purpose of EFC are defined to be part of the internal enterprise objects.

5.5 Financial/Commercial systems

The functionality requested from financial/commercial systems is to provide the financial services requested by the EFC internal enterprise objects. The services will mainly be transfer of money between entities in the EFC community. It is important to note that the EFC internal enterprise objects handle charging data while the financial/commercial systems handle payment information ('money').

This document makes a strict distinction between the payment (financial) domain supporting the EFC domain and the charging domain within the EFC domain itself. Only the charging in the EFC domain is covered by this document.

5.6 Telecommunication systems

The functionality requested from the telecommunication systems is to provide telecom services requested by the EFC domain. Examples of such services could be cable network for transfer of data between the operators of the EFC internal enterprise objects and air-interface network for transfer of data between the EFC charging equipment and the OBE, when not covered by EFC specific artifacts.

5.7 Jurisdiction/Authorities

The responsibilities of the external enterprise object called Jurisdiction/Authorities is to define the framework in which an EFC domain 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 of and availability, reliability and quality of the transport service subject to a toll or fee. The authorities may also, in co-operation with the financial authorities, define policies for tariffing principles to be used in an EFC domain. 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 environmental 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 an EFC domain 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 EFC domain and the financial systems.

— Data protection authorities may define policies for the security and privacy in an EFC domain.

— Certification authorities may issue public key certificates.

The interactions between the EFC domain and the authorities also cover access to information kept by the authorities, e.g. national vehicle registers.

5.8 Standardisation bodies

The responsibilities of the standardisation bodies are to provide EFC standards and other standards or specifications relevant for EFC domain. There are interactions with an EFC domain concerning EFC standards to be used for EFC domain as well as input from EFC domain to the standardisation bodies, e.g. by toll charging operators taking part in the preparation of EFC standards.

5.9 Common service rights provider

The responsibilities of the common service rights provider are to provide the basic artefacts, mechanism, organizational structure, and information transfer tools by which an EFC system can interoperate with other transport systems. The common service rights provider allows, among other things, for a single means of payment to be used, e.g. in both EFC systems and public transport systems.

Its role, responsibilities, and requirements on EFC systems, as well as its interactions with the roles internal to the EFC domain are standardised in ISO/TS 21193[2)][5].

6 Roles internal to the EFC domain

6.1 General

This document describes the different roles in an EFC domain 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 responsibilities that are logically related to each other, either by their objectives or the actors that may take the role.

6.2 EFC domain roles

EFC domain roles can be grouped in two sets, one related to the functional operation of the systems, and another one related to system operation. This document is built on the terminology of the EFC domain that can be summarised by the diagram in Figure 2.

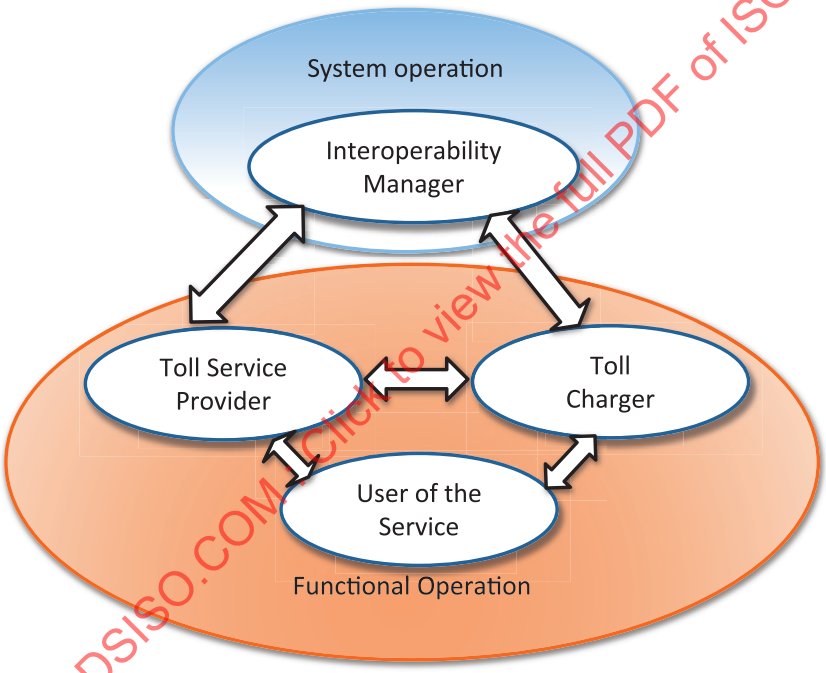

Figure 2 — Roles in a tolling environment

The functional operation roles are responsible for all activities related to the functional operation of the system, in this case the system providing the services in the ITS service group called Electronic Fee Collection (EFC).

The following clauses describe the above identified EFC roles, indicating the responsibilities for each role.

6.3 Interoperability manager

6.3.1 Short description

A specific role is identified to manage an EFC domain, i.e. defining and maintaining a set of rules that, taken together, defines the policy of a given regime or of the overall EFC domain. These responsibilities pertain to the system operation, and it is to be noted that, differently from other roles, the

2) Under development. Current stage: 30.99.

interoperability manager role can hardly be fulfilled by a single actor. Rather, its responsibilities are in real EFC systems often taken (if at all) by different actors and regulations. Given its general nature, this role will not be specified further in this document.

6.3.2 Responsibilities

The responsibilities of the interoperability manager role include:

- Setting rules, including:
  - Defining the supported security and privacy policies for the EFC system, acting as security authority that defines the security interaction policy among the different security domains.
  - Defining and maintaining ID-schemes and, if necessary, supporting the issuing of IDs ensuring unique registration codes for organisations 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,
  - Giving or withdrawing permissions to operate to involved actors,
  - Monitoring of operations via periodical report.
- Handling disputes, including:
  - Defining the operational procedures among the operators,
  - Managing disputes among operators.

6.4 Toll service provider

6.4.1 Short description

The toll service provider role is responsible for the contracts with the user role, and provides artefacts, mechanisms, organizational structures, and information transfer tools needed to run an EFC system. Responsibilities of this role pertain to the functional operation of the system. This role is fulfilled by direct interactions with the interoperability manager role, the toll charger role, and the user role.

6.4.2 Responsibilities

Responsibilities of the toll service provider role include:

- Providing basic provisions, including:
  - providing the OBE, when tolling is performed by means of on-board electronic equipment,
  - guaranteeing the payment of the toll to the entity performing the toll charger role,
  - organizing the payment modalities for the user,
  - 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,

  - monitoring the actual operational quality relative to agreed SLAs.
- Acting as a contract agent, including:
  - offering contractual relations according to defined conditions to interested users and concluding contractual agreements,
  - 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 information needed for the toll charging in a secure way,
  - providing context data originated elsewhere (e.g. by a toll charger role) in a way that they can be installed in the OBE.
- Customising the OBE, including customising the OBE in a secure way.
- Maintaining the OBE, including maintaining the functionality of the OBE.

6.5 User of the service

6.5.1 Short description

In this document, 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 a road (e.g. a bridge or a tunnel) or a specific area offering a service (e.g. a ferry, 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 commonly refer to this role as, e.g. driver, user or customer. Responsibilities of this role pertain to the functional operation of the system. This role directly interacts with the toll service provider role.

6.5.2 Responsibilities

Responsibilities of the user role include:

- Being liable for the toll including:
  - using the OBE, when tolling is performed by means of on-board equipment, as a tool to fulfil its obligations,
  - interacting with the OBE when it is present on-board, e.g. declaring the vehicle characteristics for the vehicle subject to toll or receiving messages and acting on the messages from the OBE,
  - behaving according to the rules of a specific toll system, e.g. recognising a signal or a road sign.
- 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 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 bill, 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 bill,
- storing and protecting the contractual data and eventually the payment means, e.g. an electronic purse, needed for the 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.

6.6 Toll charger role

6.6.1 Short description

The toll charger role defines the toll regime, operates the toll system and may provide transport services. It provides artefacts, mechanisms, organizational structures, and information transfer tools needed to run an EFC system. Responsibilities of this role pertain to the functional operation of the system. This role is fulfilled by direct interactions with the interoperability manager and the toll service provider roles.

6.6.2 Responsibilities

The responsibilities of the toll charger role include:

- Basic charging, including:
  - providing, if applicable, the transport service, e.g. access to a road network, a parking lot or a ferry connection,
  - defining the charging principles for the service offered, e.g. the tariffing principles for a tolled road or zone.
- Calculating the toll (directly or by delegation to the toll service provider), including:
  - possibly communicating to the user the result of the charging process,
  - 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:
  - providing, if applicable, to autonomous systems geographical details of the charge objects in the toll domain, as well as providing positioning information. This process is also known as localisation 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 data base or vehicle register (off-line toll calculation),
  - communicating in a secure way with the OBE, when present on-board, by exchanging information needed for the toll charging,

— accepting the service rights stored in the OBE, i.e. the medium carrying the contractual data, when the OBE is present on-board.

— 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 as driver,

— implementing and adhering to the security and privacy policies for the EFC domains.

6.7 EFC functional roles and responsibilities

Figure 3 summarises the EFC roles, adding their responsibilities and mutual interactions.

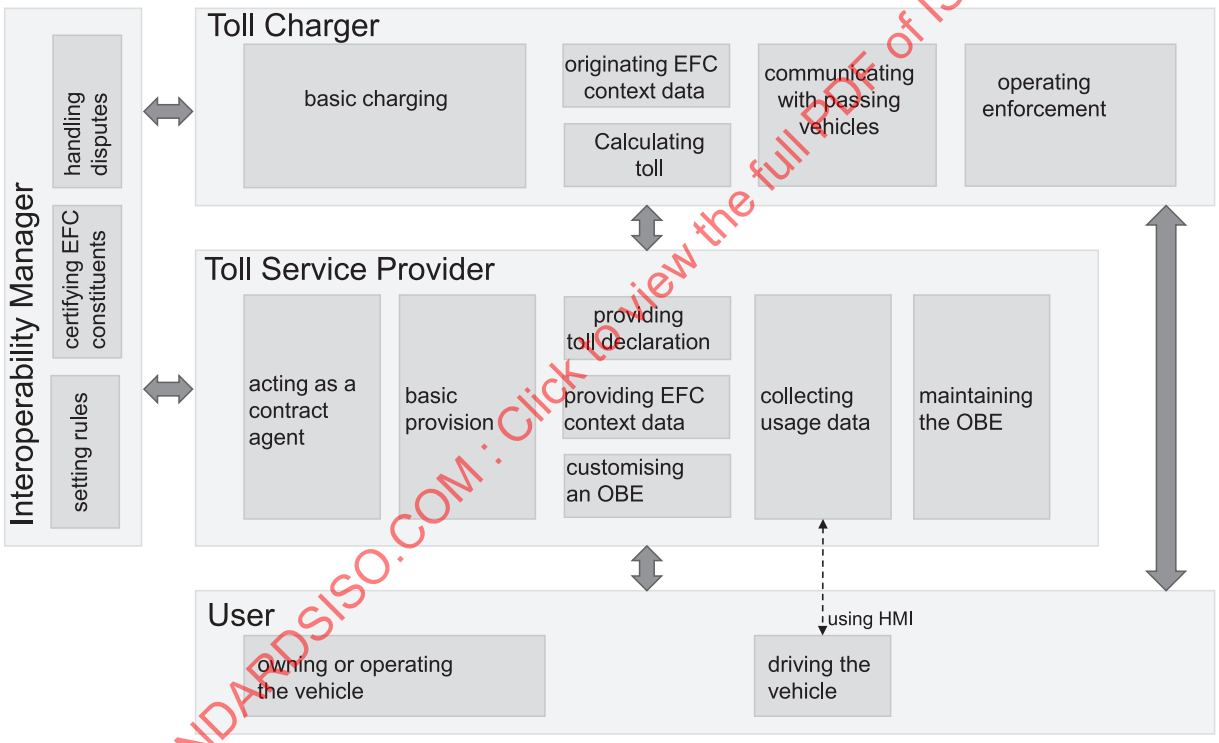

Figure 3 — EFC roles, their responsibilities and their interactions

The main aim of the architecture is to identify those services that lead to interactions that need to be standardized, i.e.:

— interactions between different actors;

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

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 3. A real tolling system may implement as many roles and responsibilities among those defined in this document as needed. The only obligation is that those interactions among roles and information exchanges that are implemented shall

be compliant to those herein specified, in order to achieve interoperability among systems belonging to different organizations, or implementations by different suppliers.

7 Services

7.1 Overview

The EFC service is performed by actors playing the four identified operational EFC roles (see Figure 4) by means of a set of sub-services.

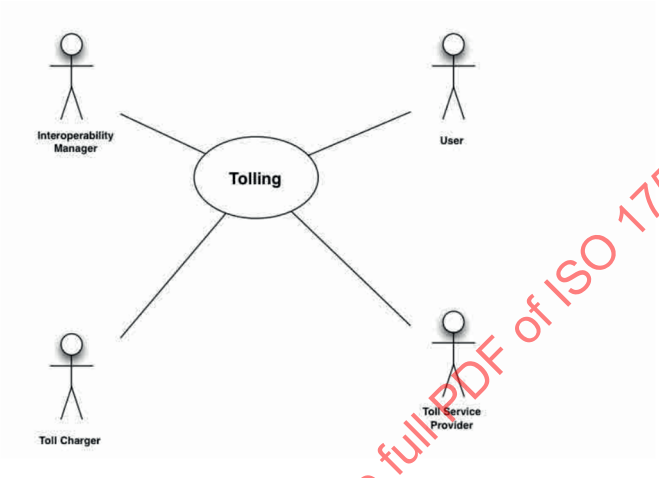

Figure 4 — Overall tolling service

In the course of a sub-service execution, each operational role may act as:

— **A service provider**, when the actor playing the role is providing the given service,

— **A service recipient,** when the actor playing the role is using the given service,

— **A content provider,** when the actor playing the role provides information,

— **An information sink,** when the actor playing the role receives information.

Detailed descriptions of all those sub-services that are performed internally within a role are outside the scope of this document. However, for those services which imply interactions among different actors, that is when separate organizations might be involved, a need for a standardized set of information exchanges is present. These particular services are thus detailed in this clause.

Sub-services are grouped according to which roles are interacting. Groups and detailed descriptions of the sub-services are specified in the following clauses.

Interaction diagrams that are shown in the following clauses focus on the information exchanges between actors. Details of the execution of one actor's internal activities 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 3, to better explain 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 by an actor are only shown to the level of detail needed for understanding how information that is exchanged is generated.

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

For each identified interaction existing technical standards, if any, are mentioned. Most of the mentioned standards are accompanied by conformity assessment standards (e.g. ISO 13143 is the associated conformity assessment suite of standards for ISO 12813), but which are not cited in this document.

7.2 Sub-services involving toll charger, toll service provider and interoperability manager roles

Figure 5 shows the sub-services that involve toll charger, toll service provider and interoperability manager.

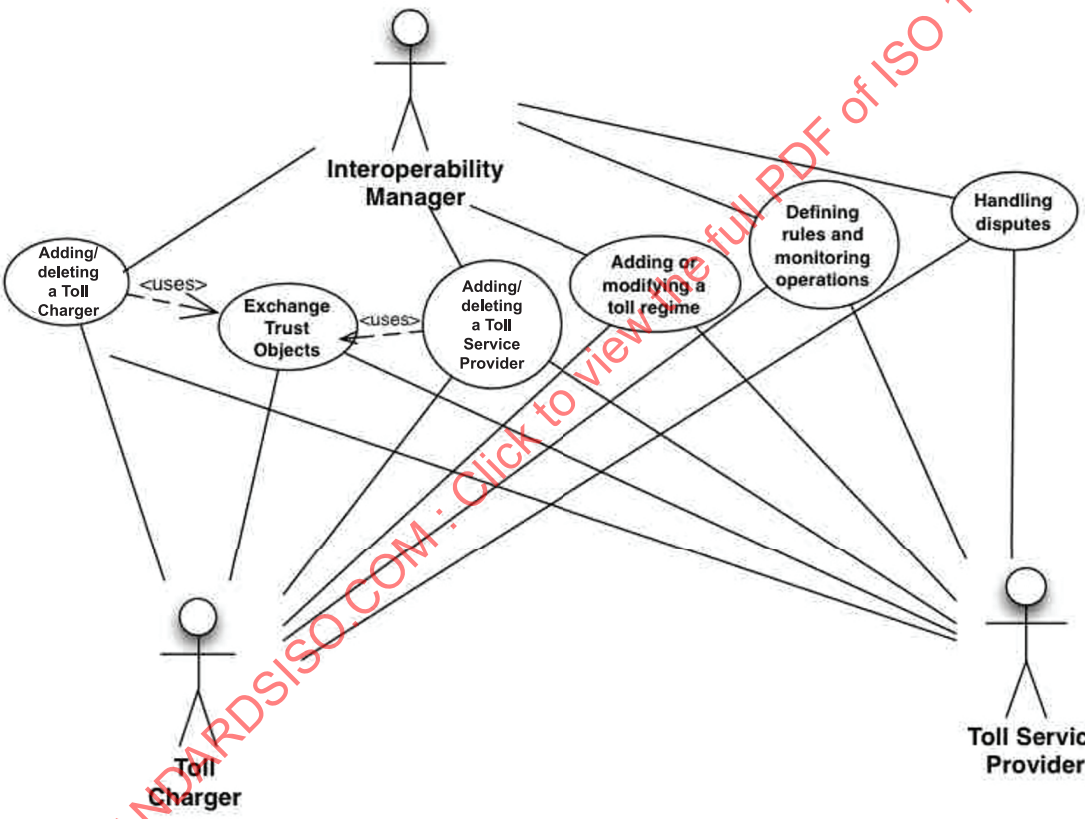

Figure 5 — Sub-services involving toll charger, toll service provider and interoperability manager

7.2.1 Adding or deleting a new toll charger

Adding at least one toll charger to a community acting as interoperable EFC scheme is a precondition to starting the overall operation. This sub-service is initiated by a candidate toll charger applying for accreditation. If the certification is granted, it is forwarded to all known actors playing the toll service provider role to start to negotiate bilateral agreements on common operations. This sub-service uses the exchange Trust objects sub-service, which can be also used alone in other circumstances.

Figure 6 shows the related action diagram. The actor playing the toll service provider role fulfils the basic provision responsibilities.

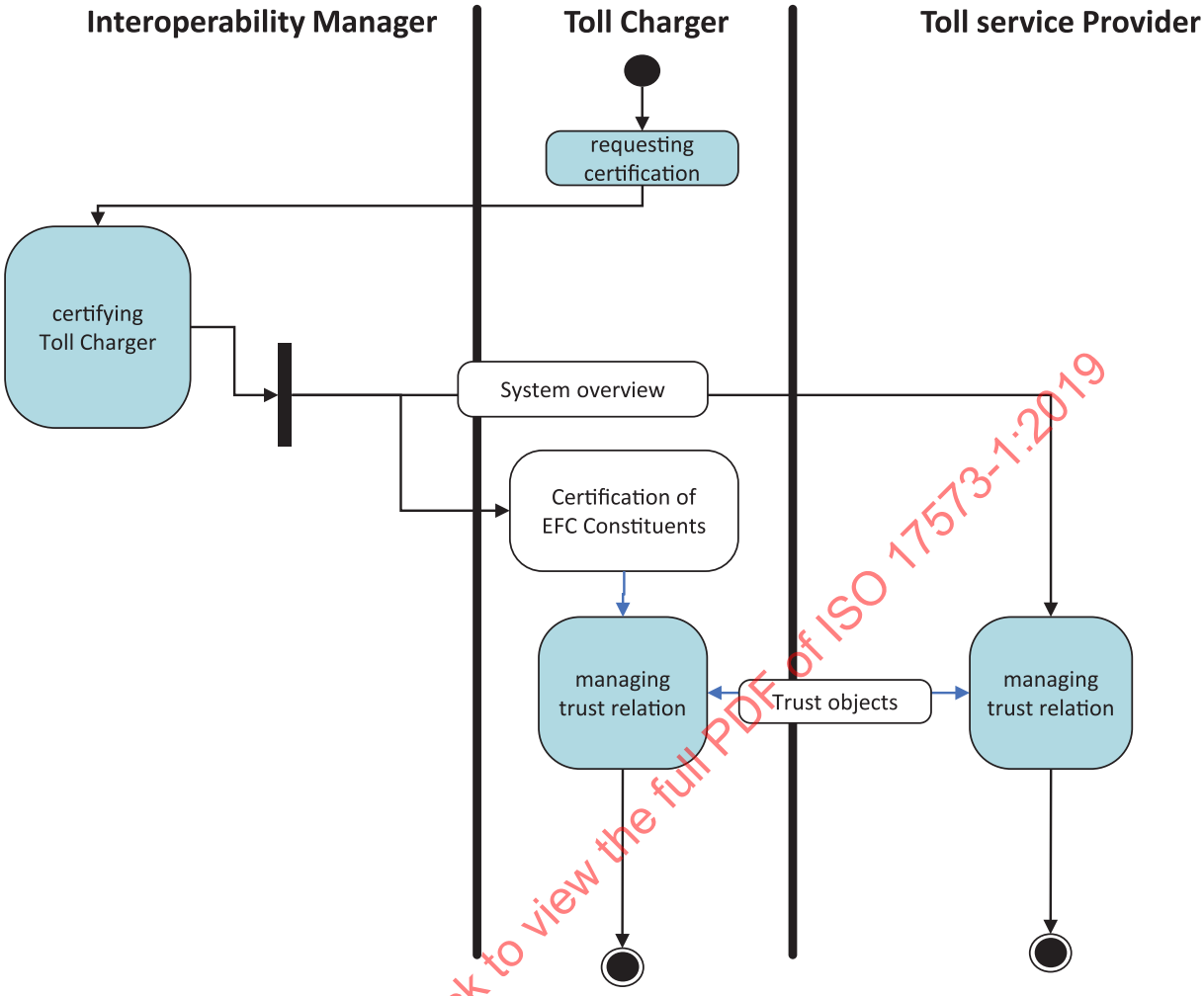

Figure 6 — Adding/deleting a new toll charger to/from an interoperability region

Adding a new toll charger implies a new version of the tolling system overview to be generated and exchanged. Also, the new toll charger will exchange Trust objects with the service providers that will operate within its domain.

Deleting a previously certified toll charger will follow a similar logical sequence, the only difference being that the service can be initiated by a request of either the toll charger or the interoperability manager.

The following interactions are identified:

1. A **certification of EFC constituent** interaction, that allows toll chargers to be certified to operate.
2. A **system overview** interaction, which allows standardised tolling system characteristics to be exchanged.
3. A **Trust objects** interaction, to exchange objects such as keys and certificates among actors in a tolling system. Trust object exchanges are standardised in ISO 12855.

In terms of service interactions:

— The **interoperability manager** shall act as service provider when certifying a toll charger, and as content provider when distributing the updated system overview to all other actors.

— The **toll charger** shall act as service recipient when certified by the interoperability manager, and as content provider when exchanging Trust objects with the toll service provider.

— The **toll service provider** shall act as content provider when exchanging Trust objects with the toll charger.

7.2.2 Adding or deleting a new toll service provider

Adding at least one provider to a community acting as interoperable EFC scheme is a precondition to start overall operation. It is initiated by the candidate toll service provider applying for accreditation. When the accreditation is granted it will be forwarded by the interoperability manager to all known toll chargers to start to negotiate bilateral agreements on common operations.

Figure 7 shows the related action diagram. The actor playing the toll service provider role fulfils the Basic Provision responsibilities.

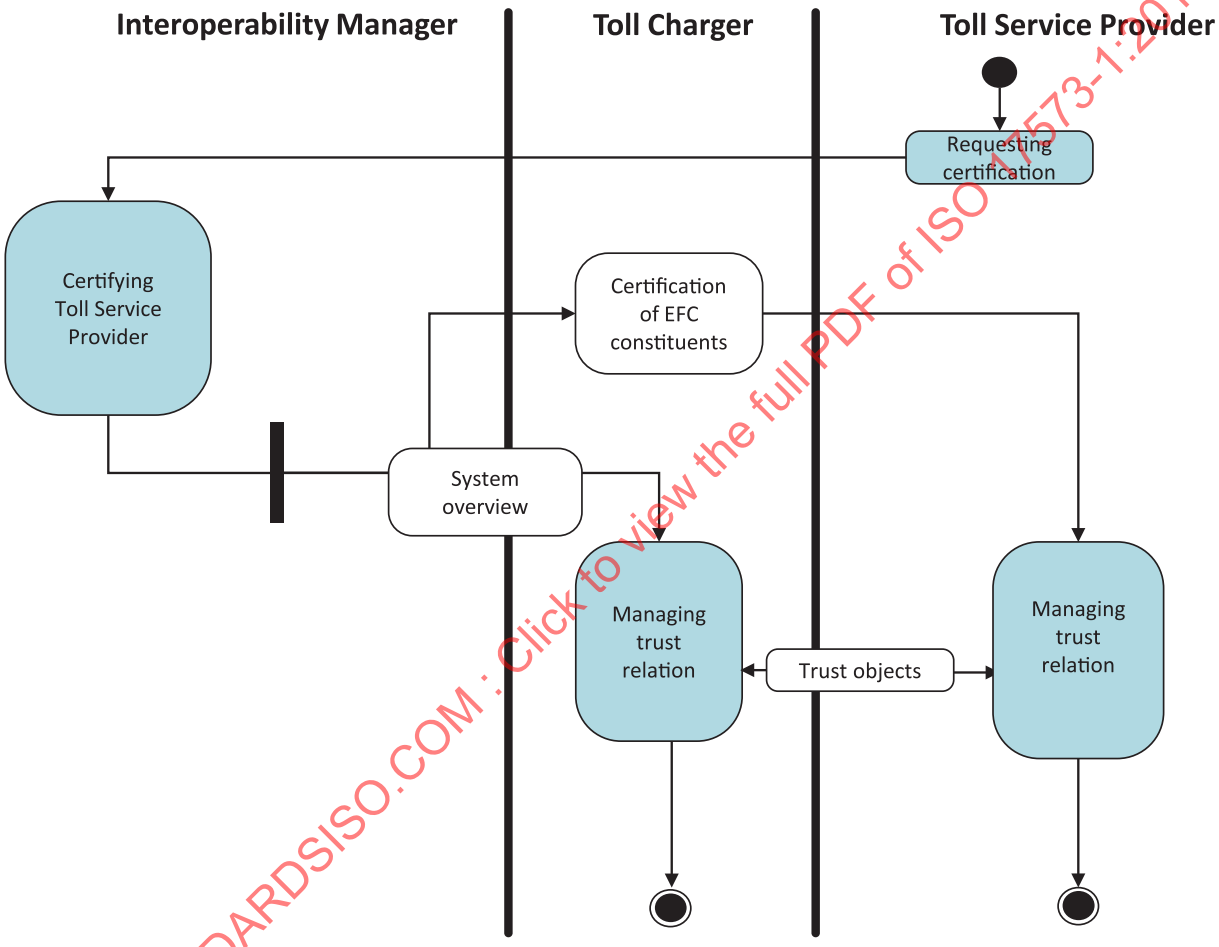

Figure 7 — Adding/deleting a new service provider to/from an interoperability region

Accrediting a new toll service provider implies a new version of the tolling system overview to be generated and exchanged. Also, the new toll service provider will exchange Trust objects with the toll chargers for toll domains in which it intends to operate.

Deleting a previously accredited toll service provider will follow a similar logical sequence, the only difference being that the service can be initiated by a request of either the toll service provider or the interoperability manager.

The following interactions are identified:

1. A **certification of EFC constituent** interaction, that allows toll service providers to be certified to operate.

2. A **system overview** interaction, which allows standardised tolling system characteristics to be exchanged.

3. A **Trust objects** interaction, to exchange objects such as, e.g. keys and certificates among actors in a tolling system. Trust object exchanges are standardised in ISO 12855.

In terms of service interactions:

— The **interoperability manager** shall act as service provider when certifying a toll service provider, and as content provider when distributing the updated system overview to all other actors.

— The **toll charger** shall act as content provider when exchanging Trust objects with the toll service provider.

— The **toll service provider** shall act as service recipient when certified by the interoperability manager, and as content provider when exchanging Trust objects with the toll charger.

7.2.3 Adding or modifying a toll regime

Adding at least one toll regime to a community acting as interoperable EFC scheme is a precondition to start overall operation. It is initiated by the toll charger informing the interoperability manager about the start of operation for a new EFC system under its responsibility. The same action is started when a toll regime is modified. The interoperability manager 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 customising the OBE (when present) 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 8 shows the related action diagram.

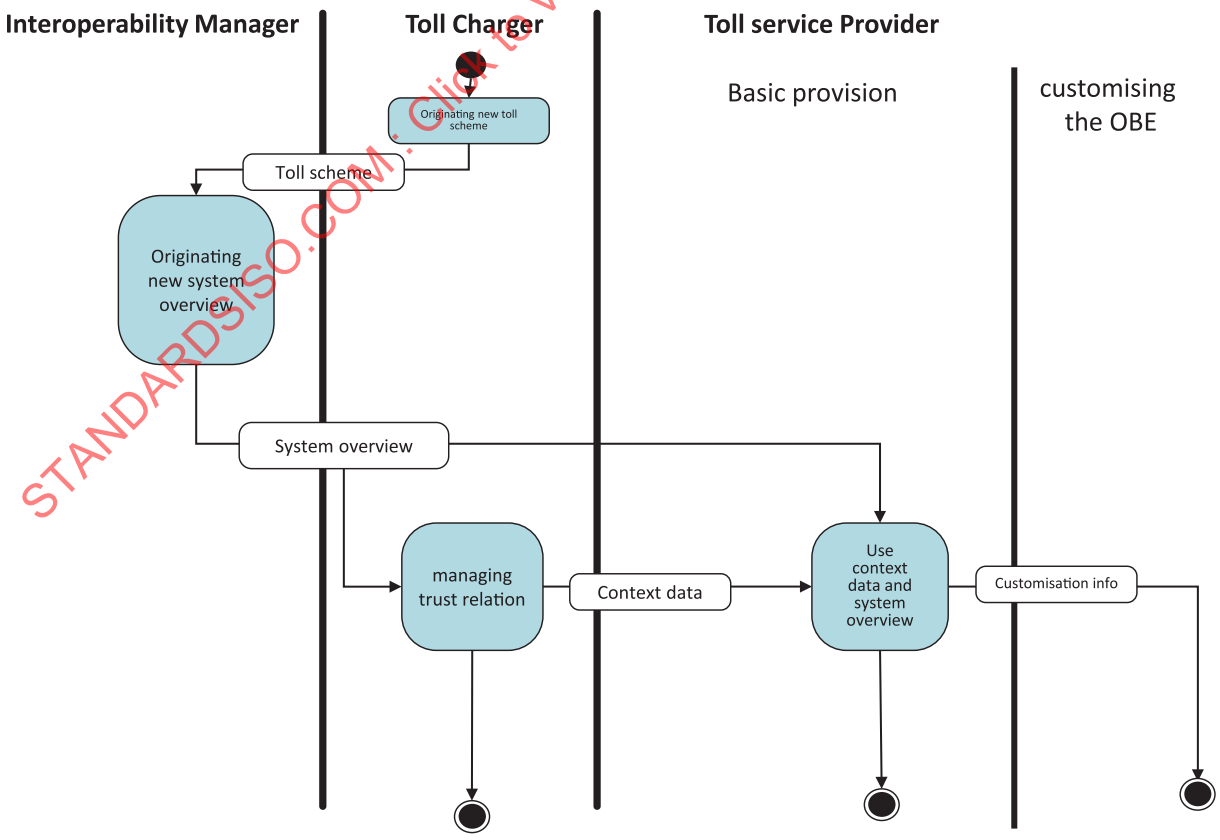

Figure 8 — Adding or modifying a toll regime

Note that using context data and system overview by the toll service provider role implies further information exchanges inside the toll service provider that may need to be standardised if the involved responsibilities/activities are played by different actors. In particular, customisation of OBEs in autonomous tolling system will be needed when a tolling regime changes.

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

The following interactions are identified:

1. A **toll scheme** interaction that allows the actor playing the toll charger role to inform the change of toll scheme.
2. A **system overview** interaction, which allows standardised tolling system characteristics to be exchanged.
3. A **context data** interaction, which allows context data to be communicated to an actor playing the role of the toll service provider. Context data exchanges are standardised in ISO 12855.
4. A **customisation info** interaction, which allows context data information to be updated in the OBE, when this is present. Customisation info interaction is standardised in ISO 17575-3.

In terms of service interactions:

— The **interoperability manager** shall act as content provider when distributing system overview information.

— The **toll charger** shall act as content provider when communicating updated toll schema to the interoperability manager, and when communicating updated context data to the toll service provider.

— The **toll service provider** shall act as information sink for the defined information exchanges.

7.2.4 Defining rules

One responsibility of the manager is to define rules for the EFC community and to diffuse them to the providers and chargers. Figure 9 shows the related action diagram.

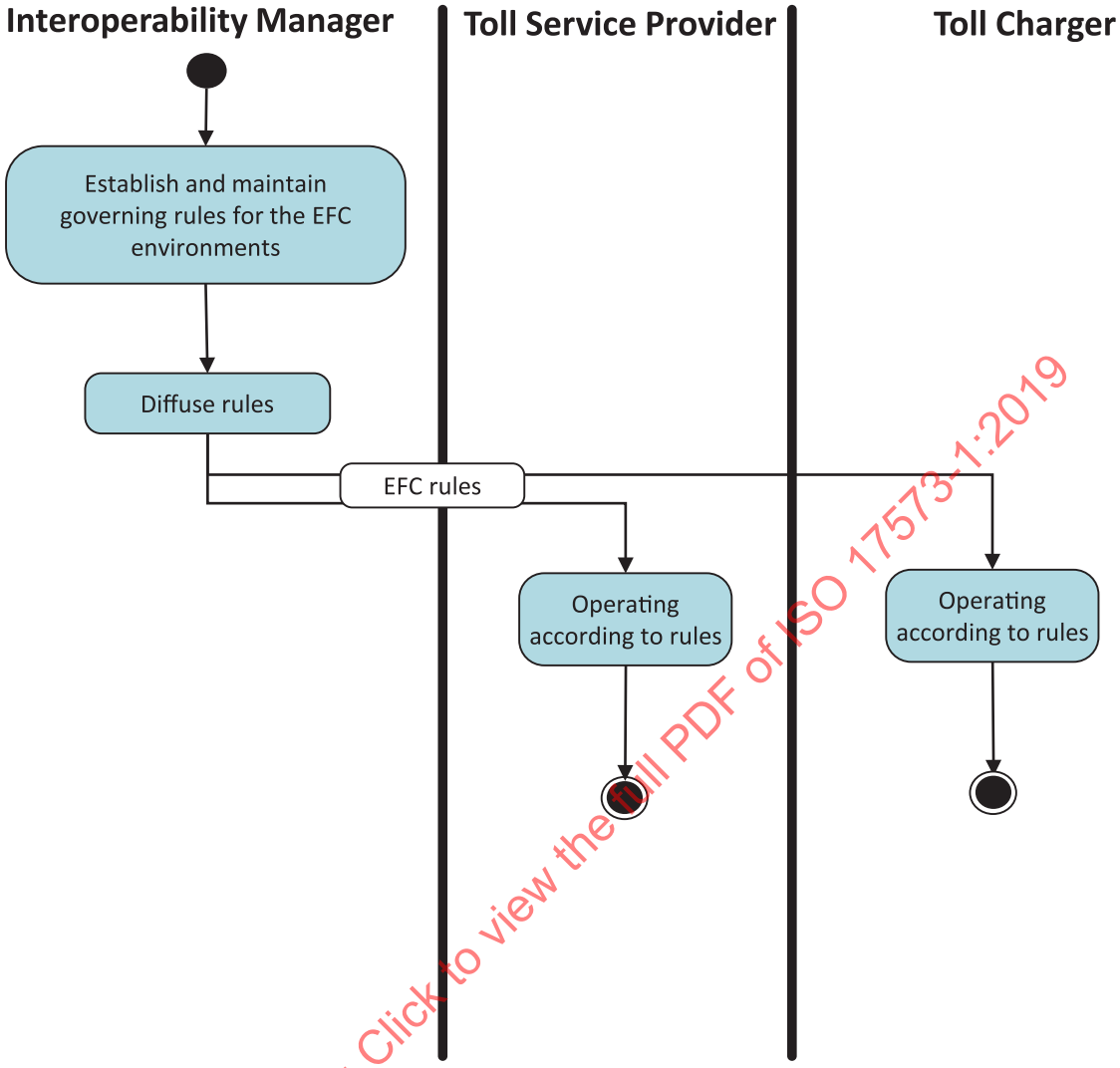

Figure 9 — Defining rules

The following interactions are identified:

1. An **EFC rules** interaction that allows the actor playing the interoperability manager role to inform all other actors about the rules governing the EFC system.

In terms of service interactions:

— The **interoperability manager** shall act as content provider when distributing EFC rules.

— The **toll charger** shall act as information sink for the defined information exchange.

— The **toll service provider** shall act as information sink for the defined information exchange.

7.2.5 Monitoring operations

One responsibility of the manager is to monitor the EFC activities. Figure 10 shows the related action diagram.

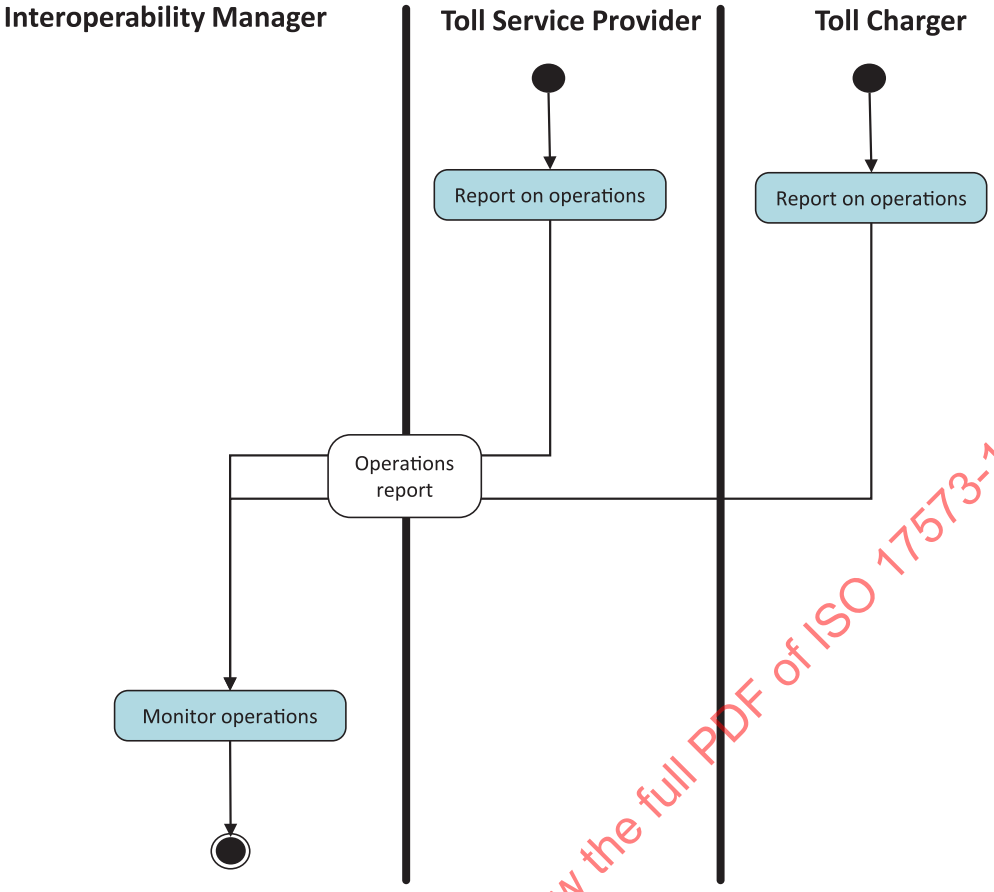

Figure 10 — Monitor operations

The following interactions are identified:

1. An **operations report** interaction, that allows the actors playing the toll service provider and toll charger roles to inform the interoperability manager about the current operation status.

In terms of service interactions:

— The **interoperability manager** shall act as information sink for the defined information exchange.

— The **toll charger** shall act as content provider for the defined information exchange.

— The **toll service provider** shall act as content provider for the defined information exchange.

7.2.6 Handling disputes

One responsibility of the manager is to handle disputes between involved actors playing the roles of toll charger and toll service provider. Disputes can be initiated by either the toll charger role or by the toll service provider role when disagreements in the toll service operation cannot be solved. The result of handling disputes can cause the permission to operate as toll charger or toll service provider be revoked (see 7.2.1 and 7.2.2). Figure 11 shows the related action diagram.

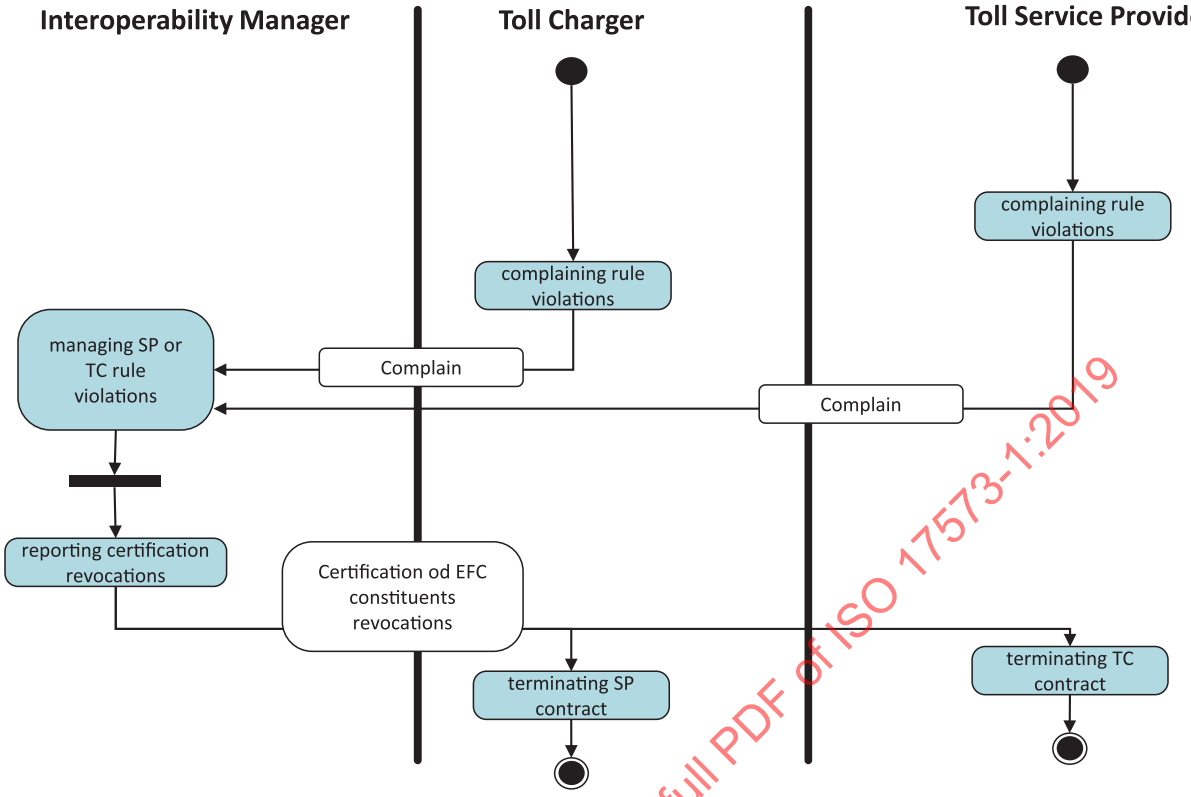

Figure 11 — Handling disputes

According to the result of the dispute, either the actor playing the toll charger role or the actor playing the toll service provider role, or both, may have their accreditations revoked. Termination of a contract shall be notified to the users that are contracted with the interested TSP(s). This can be done in various ways, such as, e.g., using additional information in the user billing interaction (see 7.3.3).

The following interactions are identified:

1. A **Complain** interaction that allows the actors playing the toll service provider and toll charger roles to request the interoperability manager to solve a dispute.
2. A **Certification of EFC constituents revocation** interaction, that allows the interoperability manager to inform involved parties of a revocation of the permission to operate.

In terms of service interactions:

— The **interoperability manager** shall act as content provider for the Certification revocation operation, and as a Service Provider for the Complain interaction.

— The **toll charger** shall act as a service user for the Complain interaction and as an information sink for the Certification revocation interaction.

— The **toll service provider** shall act as a service user for the Complain interaction and as an information sink for the Certification revocation interaction.

7.3 Sub-services involving the toll service provider and user

Figure 12 shows the sub-services involving the toll service provider and the user.

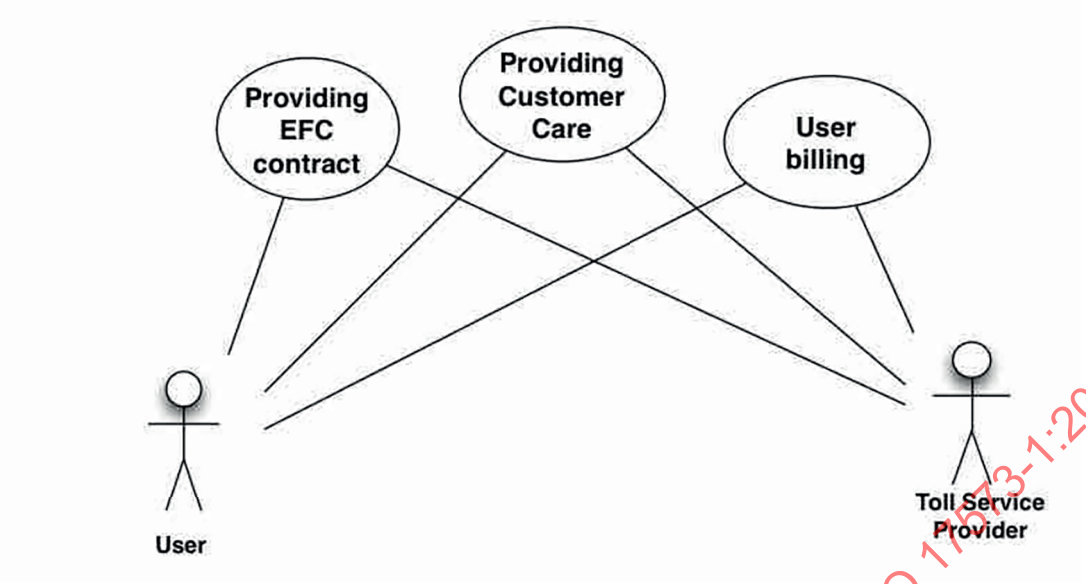

Figure 12 — Sub-services involving the toll service provider and user

7.3.1 Providing EFC contract

Providing an EFC contract requires that the toll service provider defines his conditions, offers its service and reaches a potential user with this information. The user will contact the contracting agent who will verify if the user fulfils the conditions. If the user does fulfil the conditions, a contract will be established and signed. The contracting agent will initialise the issuing and customisation of a new OBE, when an OBE is used for tolling. In the general case, the OBE will be subsequently loaded with appropriate information before it is ready for operation. Figure 13 shows the related action diagram.

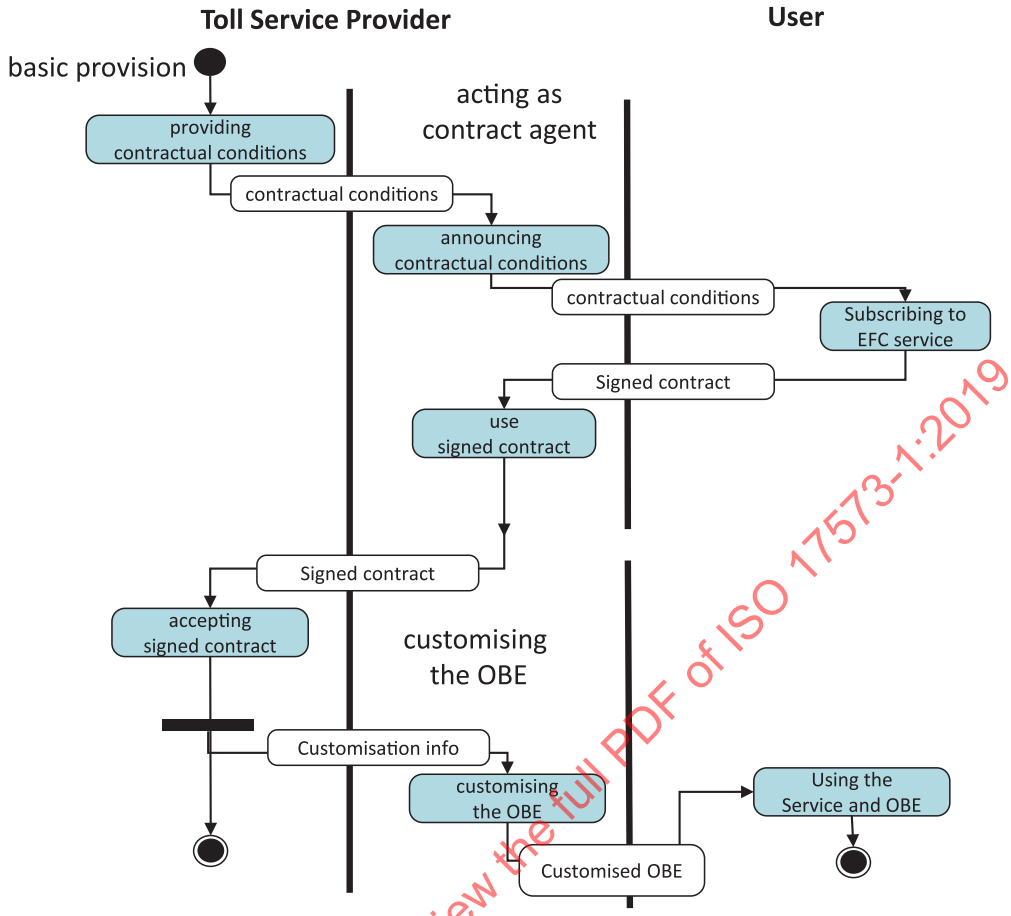

Figure 13 — Providing EFC contract

Note that Figure 13 shows some actions that only occur when an OBE is used for the specific toll domain. If no OBE is used (e.g. in ANPR tolling systems) those actions do not occur.

Note also that Figure 13 shows some actions that involve interactions and related information exchanges inside the same role (toll service provider). These information exchanges may need to be standardised if the involved responsibilities/activities are played by different actors.

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

The following interactions are identified:

1. A **Contractual conditions** interaction that allows transfer of the contractual information.
2. A **Signed Contract** interaction, that allows transfer of a signed contract.
3. A **Customisation info** interaction, that allows customisation of the OBE with contractual information when an OBE is used in the specific toll domain. Customisation info exchanges are standardised in ISO/TS 21719-1.

In terms of service interactions:

— The **toll service provider** shall act as content provider for the Contractual conditions, and as information sink for the Signed contract and the OBE status. If the responsibilities of maintaining the OBE and collecting usage data are performed by different actors, these will play the roles of respectively service provider and service user for the Customisation info interaction.

— The **user** shall act as a content provider for the Signed contract and as information sink for the Contractual information.

7.3.2 Providing customer care

Customer care interactions include all requests for help and information, as well as complaints, from the user to the provider. Figure 14 shows the related action diagram.

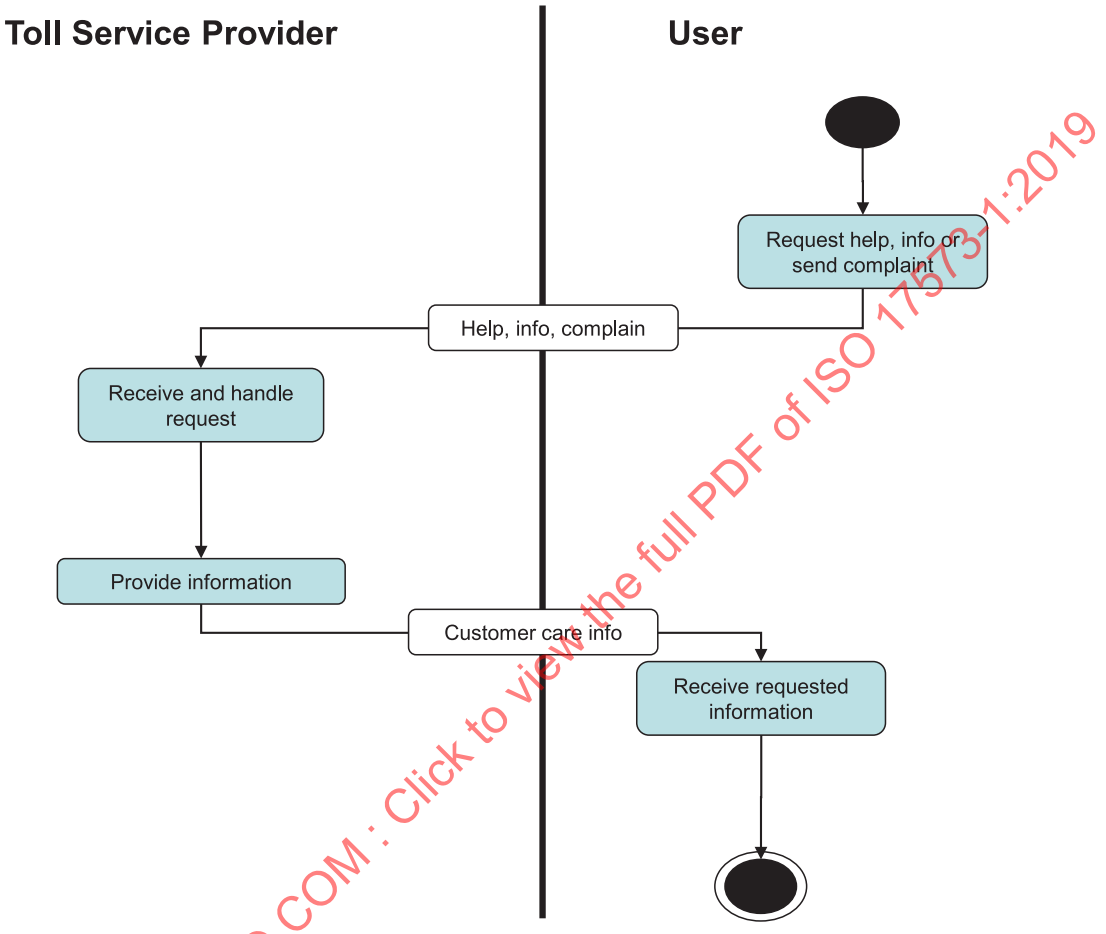

Figure 14 — Provide customer care

Information transmitted by the Use to the Provision includes all types of requests and complaints, including those that may cause the Provision to subsequently interact with other actors. Examples of these latter events are, e.g. reports on stolen or lost OBEs, which may cause the Provision to inform Chargers by means of exception lists that those OBEs are no longer valid.

The following interactions are identified:

1. A **Help, info or complain** interaction, that allows the user to request customer care.
2. A **Customer care** interaction, that allows the toll service provider to communicate the results of the service.

In terms of service interactions:

— The **toll service provider** shall act as service provider for the Help, info and complain interaction, as content provider for the Customer care info.

— The **user** shall act as a service user for the Help, info and complain interactions and as information sink for the Customer care info.

7.3.3 User billing

User billing is performed by means of a series of interactions between the toll service provider and the user. Exceptions happening in performing user billing may cause contracts to be revoked, and related information to be transmitted to toll chargers by using Handling Exceptions sub-services (see 7.4.7). The exception list information will be used also by all the contract agents to detect users being known as insolvent customers that try to sign new contracts. Figure 15 shows the related action diagram.

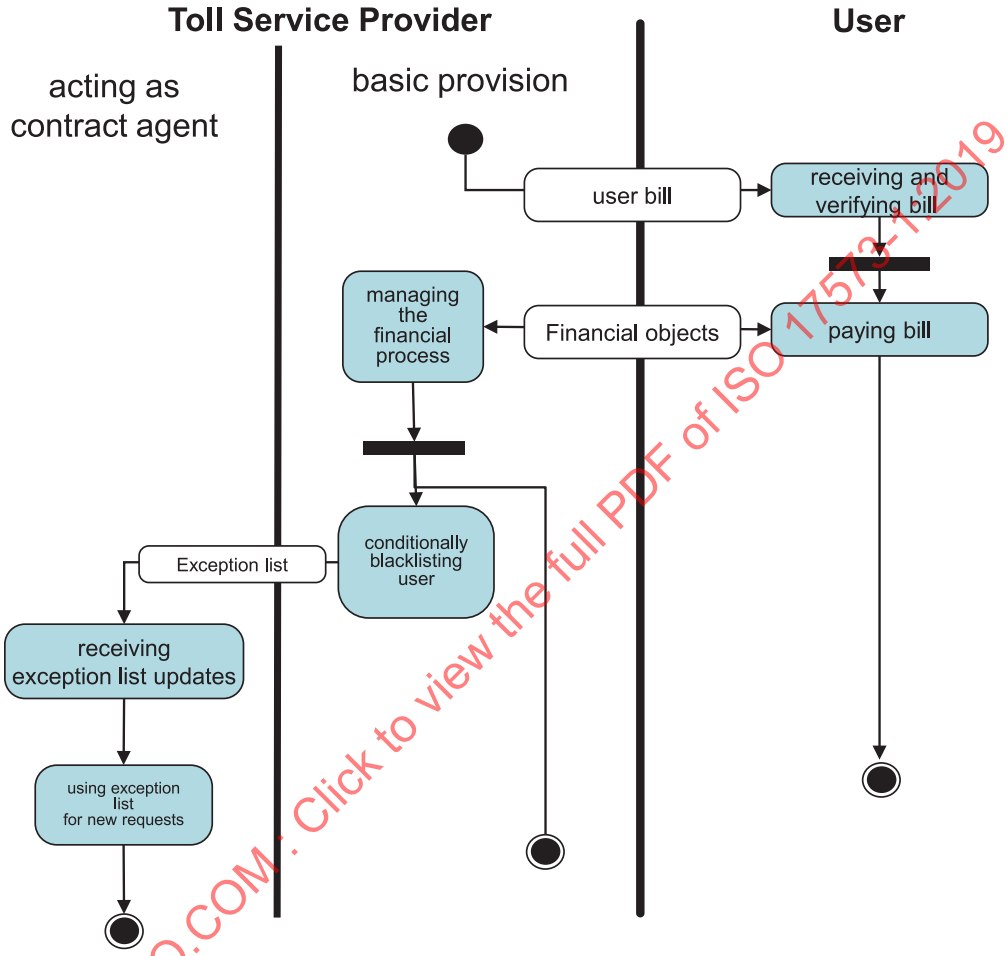

Figure 15 — User billing

The following interactions are identified:

1. A **user bill** interaction, to inform the user of a bill to be paid. This information may include also notifications, e.g., termination of a contract (last bill).
2. A **Financial object** interaction, to inform the toll service provider about a payment.
3. An **Exception list** interaction, to possibly indicate users that are to be blacklisted due to e.g. missing payments. Exception lists exchanges are standardised in ISO 12855.

In terms of service interactions:

— The **user** shall act as information sink for the user bill, and as a content provider for the Financial objects.

— The **toll service provider** shall act as content provider for the Exception list and for the user bill, and as information sink for the Financial objects.

7.4 Sub-services involving the toll charger and toll service provider

Figure 16 shows the sub-services involving the toll charger and the toll service provider.

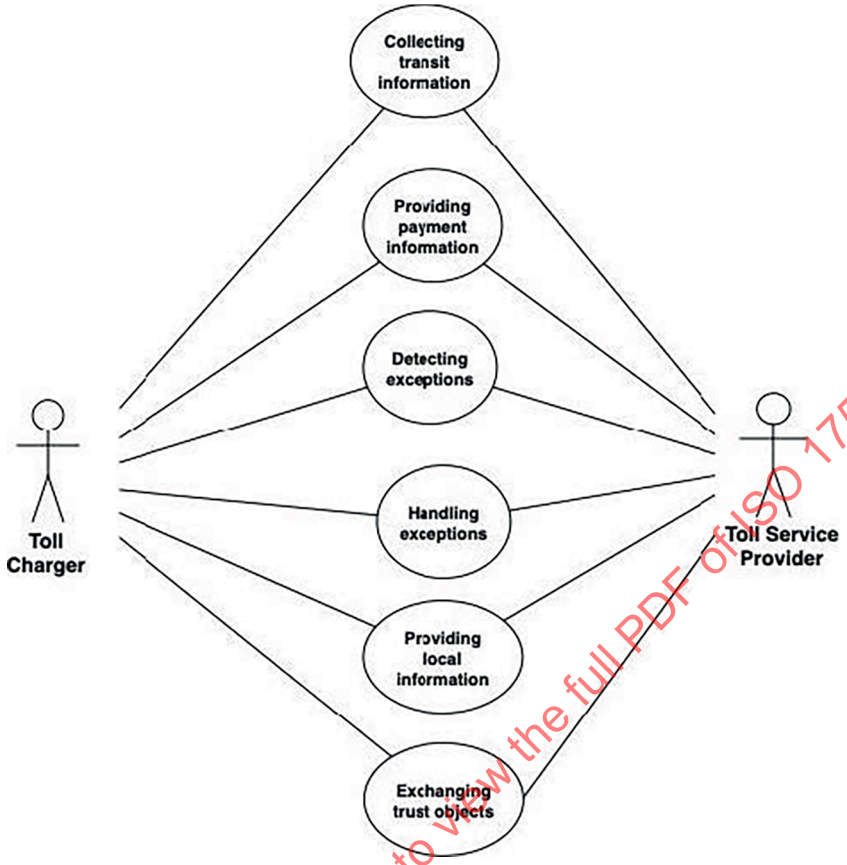

Figure 16 — Sub-services involving the toll charger and the toll service provider

7.4.1 Collecting transit information in short-range communication systems

Collection of transit information in short-range communication (SRC)-based EFC systems is performed by an actor performing the role of toll charger in various ways, which generally do not involve interactions with the user. Figure 17 shows an activity diagram where interactions happen between toll charger and toll service provider in an SRC-based system. Collection of transit information happens in an SRC domain when an actor playing the role of toll charger recognises the presence of an OBE. In order to cover the most general case, exchange of mutual identification information is shown in the diagram, at the end of which the toll charger identifies the user, and the toll service provider recognises the charging domain.

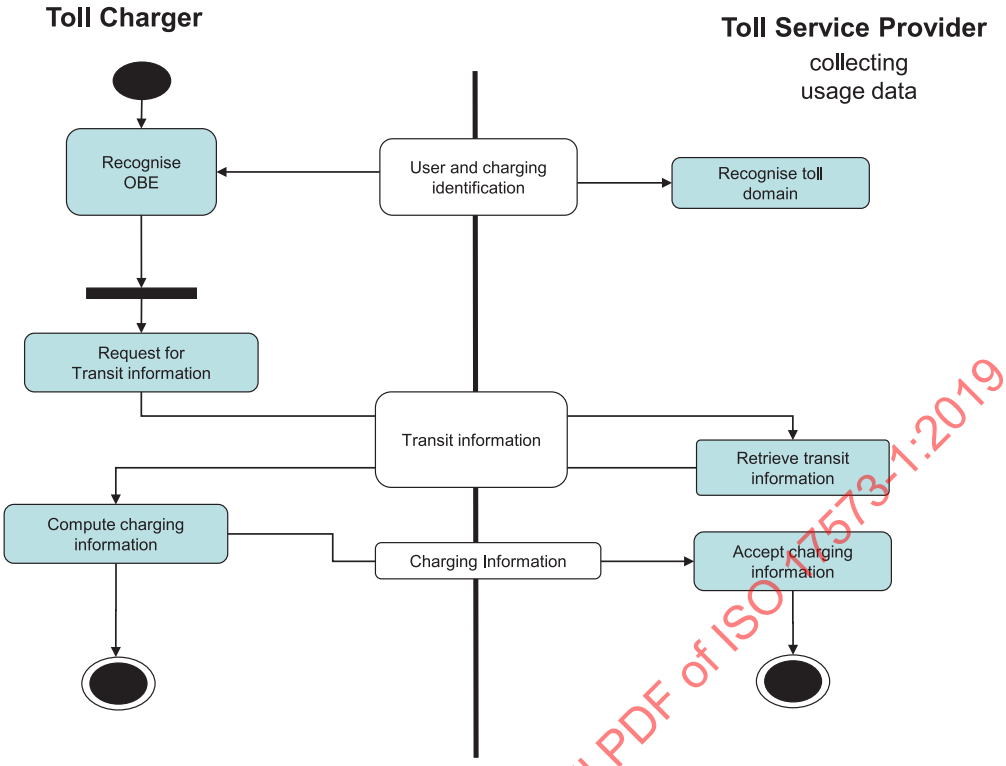

Figure 17 — Collecting transit information (SRC systems)

The following interactions are identified:

1. A **user identification** interaction, to verify customer's credentials by means of toll service provider's available information.
2. A **Charging identification** interaction, to verify toll charger's credentials.
3. A **Transit information** interaction, to transfer transit related information.
4. A **Charging information** interaction, to notify the result of the charging transaction.

All above interactions are standardised in ISO 14906:2018.

In terms of service interactions:

— The **toll charger** shall act as service user for the user identification, Charging identification and Transit information exchanges, and as content provider for the Charging information exchange.

— The **toll service provider** shall act as service provider for the user identification, Charging identification and Transit information exchanges, and information sink for the Charging information exchange.

7.4.2 Collecting charging information (autonomous systems)

In autonomous systems based tolling systems, collection of transit information is performed by the toll service provider, which by means of the OBE recognises charge objects (locations, areas, road segments), on the basis of available EFC context data, determines the transit information (in some cases also the charging information), and communicates it to the toll charger in the form of toll declarations. The set of activities to collect charging information in autonomous systems is performed almost entirely within the toll service provider, and is detailed in Figure 18 solely for the sake of clarity.

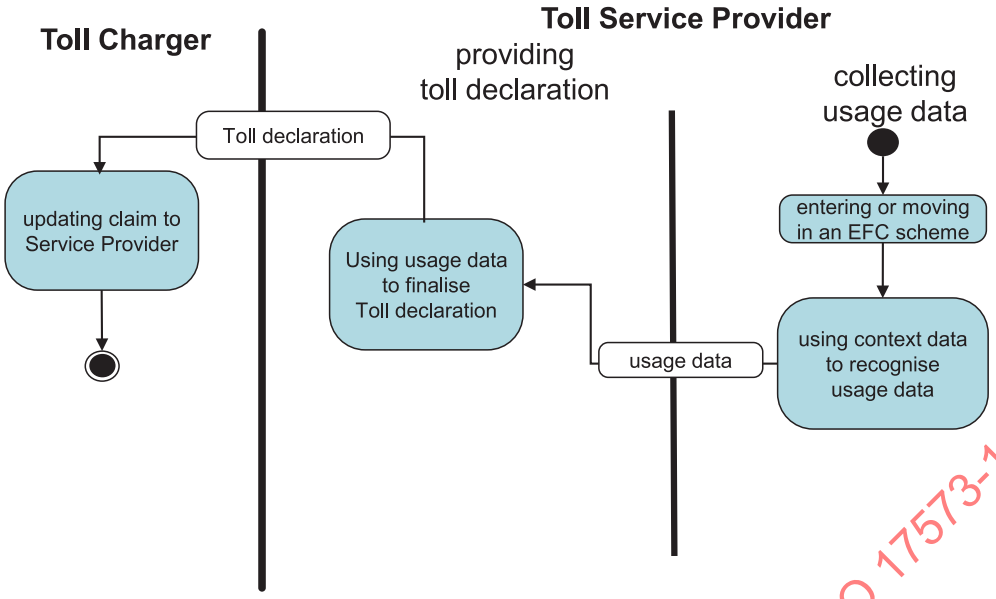

Figure 18 — Collecting charging information (autonomous systems)

The granularity of toll declarations depends on specific agreements between the actors playing the toll charger and toll service provider roles. The toll service provider may invalidate a user (for example, in case of credit threshold overridden) subsequently to the processing of usage data, and consequently put it in an exception list. Exchange and usage of exception lists is detailed in 7.4.5.

The following interactions are identified:

1. A **toll declaration** interaction, to notify charging information related to one or more transits. toll declaration exchanges are standardised in ISO 12855.

2. A **Usage data** interaction, to notify the actor performing the function of providing toll operation of the collected usage data. Usage data exchanges are standardised in ISO 17575-1.

In terms of service interactions:

— The **toll service provider** shall act as content provider for the toll declaration information. If collecting usage data and providing toll declarations are performed by different actors, these actors shall act as content provider and information sink, respectively, for the usage data interaction.

— The **toll charger** shall act as information sink.

7.4.3 Collecting transit information (not OBE-based systems)

Collection of transit information happens in such a tolling domain when an actor playing the role of toll charger recognises the presence of a vehicle and is able to identify the user without any direct interactions with either the user or the toll service provider.

Vehicle identification, together with transit information, is subsequently provided by the toll charger to the toll service provider by means of the Providing payment information sub-service, detailed in 7.4.4.

7.4.4 Providing payment information

The Providing payment information sub-service is based on previous exchanges of billing details and can be actualized in two ways:

1. on demand by the toll charger, which requires the toll service provider the payment of a number of transits related to previously exchanged billing details;

2. spontaneously by the toll service provider, which only notifies the toll charger of an effected payment, together with the indication of the billing details the payment is related to.

Figure 19 summarises the providing payment information action.

In case one of the partners complains that the other partner does not fulfil his obligations defined in the certification, the Management can be involved to settle the dispute, as detailed in 7.2.6.

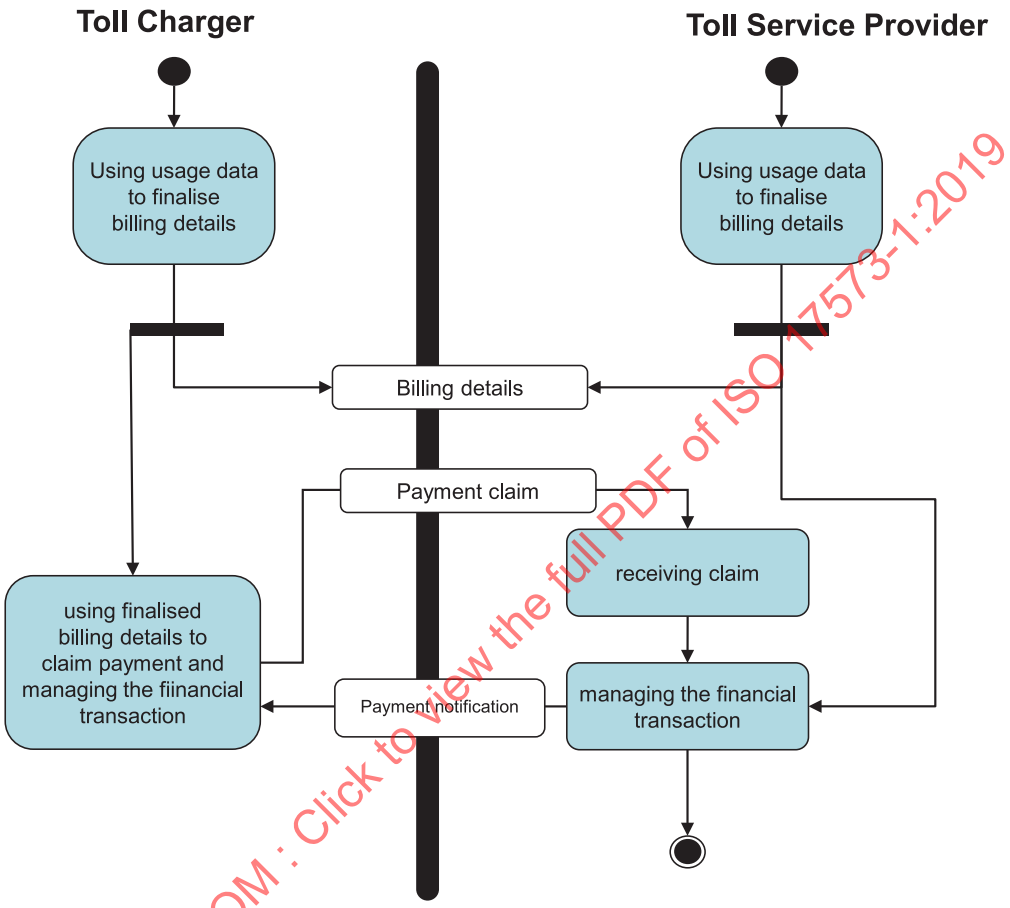

Figure 19 — Providing payment information

The following interactions are identified:

1. A **Billing details** interaction, which allows either the toll charger or the toll service provider to notify transit information, possibly with associated charging information.
2. A **Payment claim** interaction, which allows toll chargers to request payments.
3. A **Payment notification** interaction, which allows the toll service provider to notify payments.

All above interactions are standardised in ISO 12855.

In terms of service interactions:

— The **toll service provider** shall act as content provider for Payment notifications, and information sink or Content Provider for Billing details, according to the type of tolling system. The toll service provider shall act as service provider for the Payment claim interaction.

— The **toll charger** shall act as information sink for Payment notifications, and information sink or content provider for Billing details, according to the type of tolling system. The toll charger shall act as service user for the Payment claim interaction.

7.4.5 Detecting Exceptions

Detecting Exceptions is an interaction which may be initiated when the user's vehicle enters a charging zone. Different actions can be performed by the charger in order to detect exceptions, which include collecting own data (from, i.e. 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.

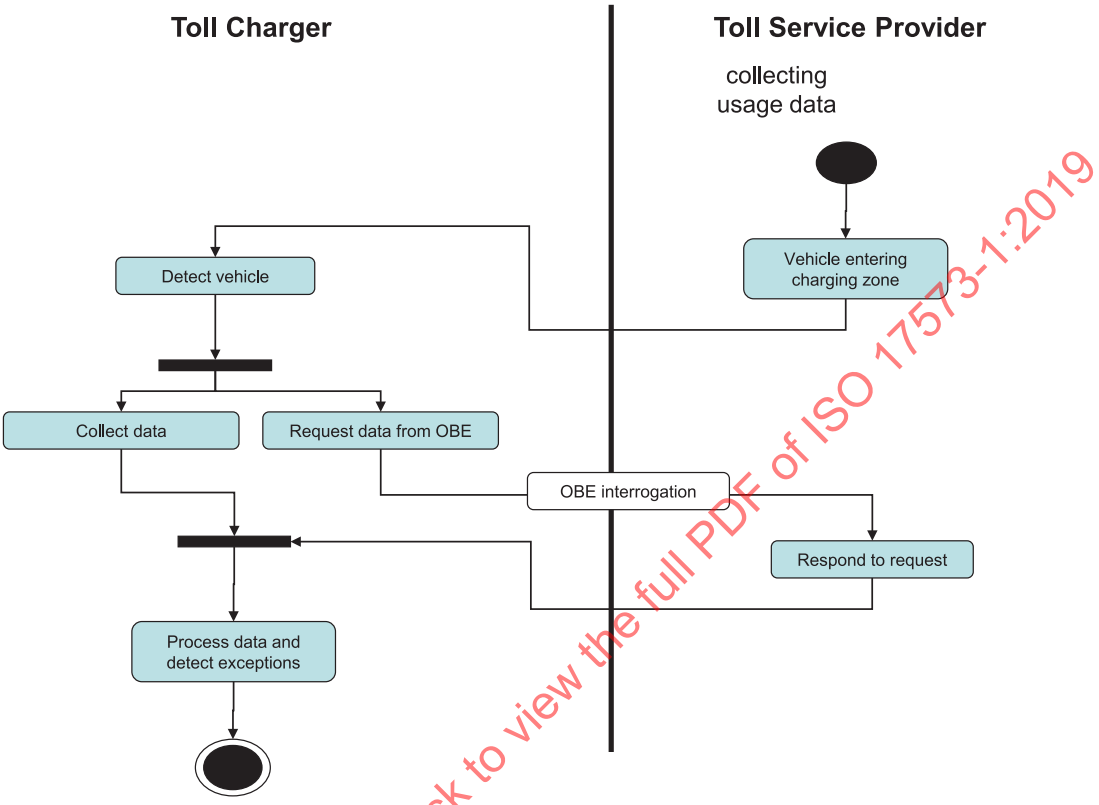

Figure 20 — Detecting Exceptions

The following interaction is identified:

1. An **OBE interrogation** interaction, that allows an actor playing the toll charger role to request OBE's operational parameters and status. OBE interrogation interactions are standardised in ISO 12813.

In terms of service interactions:

— The **toll charger** shall act as service user.

— The **toll service provider** shall act as service provider.

7.4.6 Trust objects exchange

The Trust object exchange sub-service is symmetrical and not necessarily solicited, i.e.:

1. Both the toll charger and the toll service provider can provide or request Trust objects.
2. Trust objects may be provided by either the toll charger or the toll service provider without a previous request.

Figure 21 summarises the Trust object exchange action.

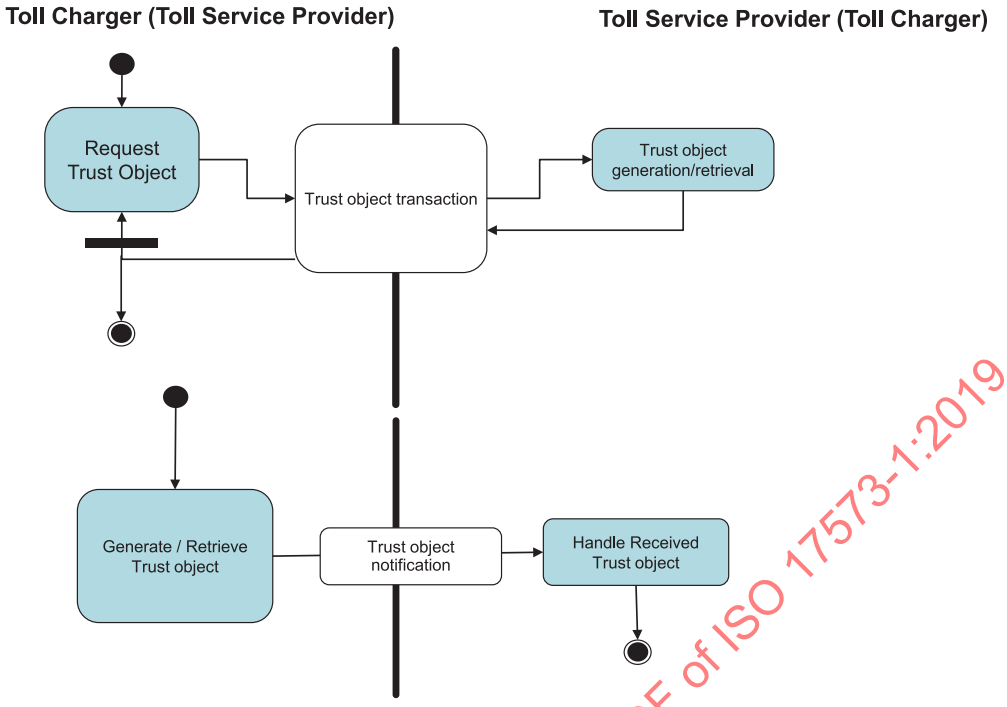

Figure 21 — Trust object exchange

The following interactions are identified:

1. A **Trust object transaction** interaction, which allows either the toll charger or the toll service provider to request a Trust object to its counterpart.
2. A **Trust object notification** interaction, which allows the either the toll charger or the toll service provider to deliver a Trust object to its counterpart.

All above interactions are standardised in ISO 12855.

In terms of service interactions:

— Either the **toll service provider** or the **toll service provider** shall act as service user for the Trust object transaction interaction, depending on who is issuing the request for a Trust object. Symmetrically, the counterpart shall act as a service provider.

— Either the **toll charger** or the **toll service provider** shall act as information sink for the Trust object notification interaction, depending on who is delivering the Trust object. Symmetrically, the counterpart shall act as content provider.

7.4.7 Handling exceptions

Exceptions can be detected (see 7.4.5) by either the toll charger when, e.g. an OBE transiting in the toll charger's domain is inspected or for ANPR systems when a vehicle's license plate is not recognised as valid, or by the toll service provider when, e.g. a user status is to be updated (user cancelled due to missing payments, user put in a special list). The result of detecting an exception causes the interactions depicted in Figure 22 to happen.

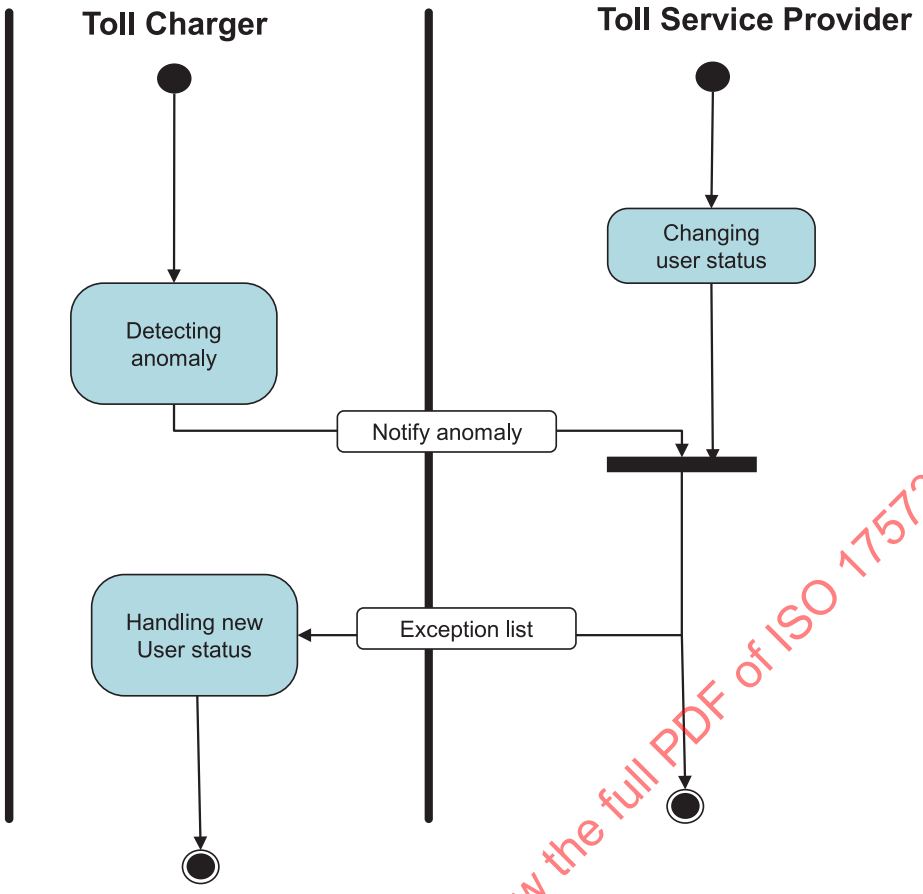

Figure 22 — Handling Exceptions

The following interactions are identified:

1. A **Notify anomaly** interaction that allows an actor playing the toll charger role to inform the toll service provider of some detected anomalies, e.g. in an OBE's operational parameters or status.
2. An **Exception list** interaction that allows the toll service provider to inform an actor playing the role of toll charger about change of status for one user.

All above interactions are standardised in ISO 12855.

In terms of service interactions:

— The **toll charger** shall act as content provider for the Notify anomaly.

— The **toll service provider** shall act as content provider for the Exception list.

7.4.8 Providing local information

When detecting a user's vehicle entering a charging zone, the toll charger may provide local information if the vehicle has an OBE. A practical example of such information is localisation data, to be used to improve location accuracy. Figure 23 shows an action diagram where such an action is performed.

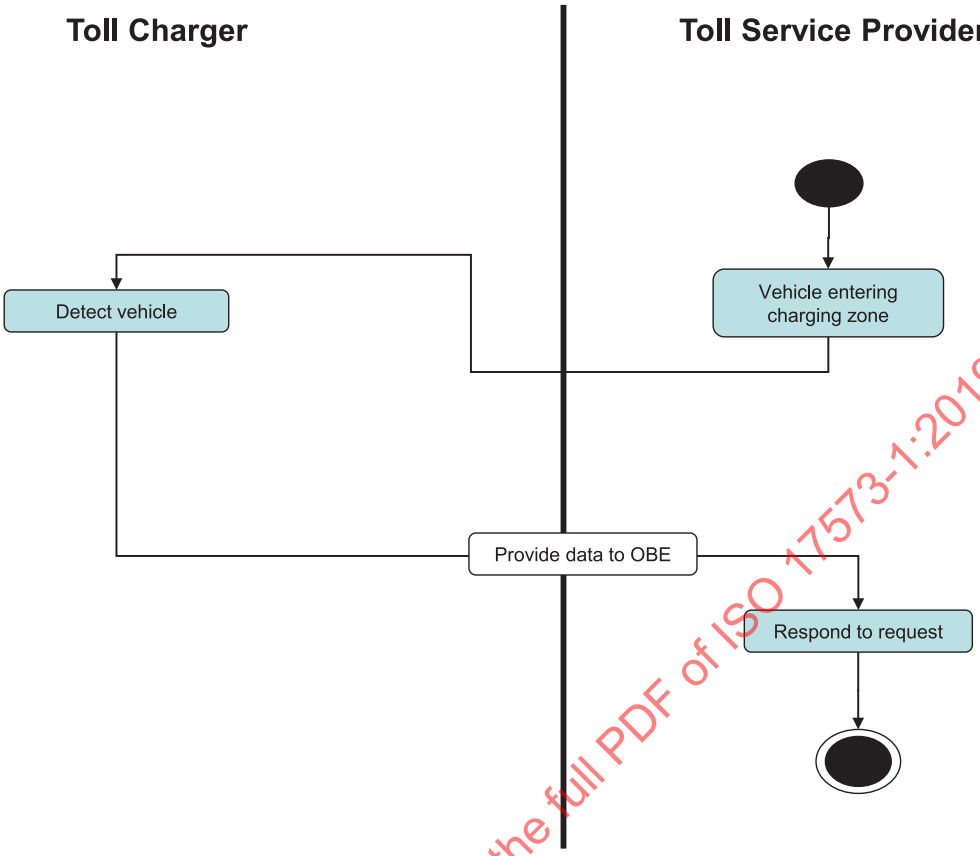

Figure 23 — Providing local information

The following interaction is identified:

1. A **Provide data to OBE** interaction that allows an actor playing the toll charger role to inform the OBE about local information. Localisation information interaction is standardised in ISO 13141.

In terms of service interactions:

— The **toll charger** shall act as service provider.

— The **toll service provider** shall act as service user.

Annex A
(informative)

Mapping EFC architecture to the C-ITS architecture

A.1 General

ISO 17427-1 defines the organisational architecture depicted in Figure A.1 which identifies abstract roles which apply to all C-ITS systems.

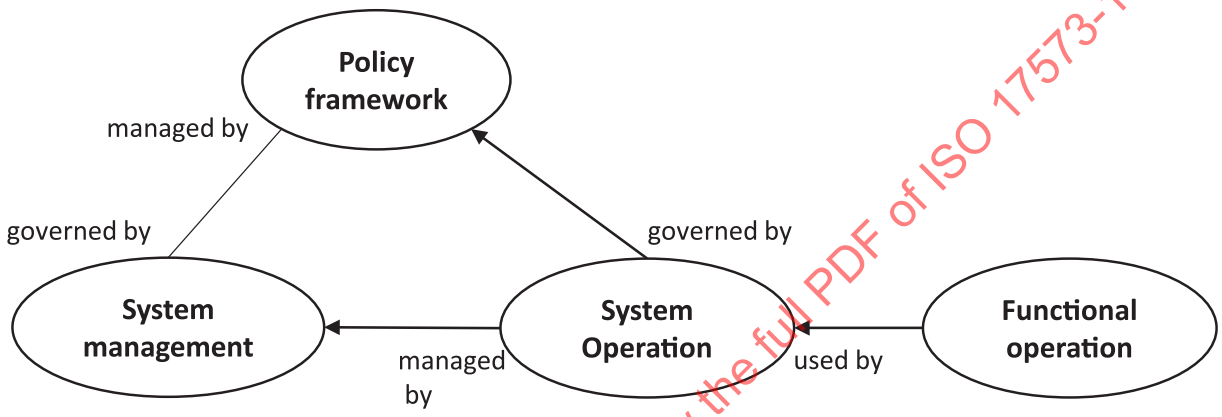

Figure A.1 — High-level roles in the C-ITS organisational architecture (ISO 17427-1)

The scope of this document is related to the *System operation* role and the *Functional operation* role. The two other major roles in a C-ITS organisational architecture defined in ISO 17427-1 are out of the scope of this document.

A.2 System operation and Functional operation roles

A.2.1 System operation role

The System operation role is responsible for the proper execution of the application that provides the end-to-end ITS service. In the case of EFC, it is the role that is responsible for the proper execution of the applications providing the EFC service to the EFC service users. The responsibilities include the reliability for the coordination, organisation and execution of the entire process. This may include the provision of rules and guidelines for the EFC system, certification of EFC constituents, monitoring and handling disputes.

A.2.2 Functional operation

The Functional operation role is split into two sub-roles in ISO 17427-1. The first sub-role is *Generic functional operation* and the other sub-role is *Specific functional operation*. The sub-role *Generic functional role* is further split into three sub-roles that covers the functionality defined in this document. The sub-role *Specific functional operation* is split into 10 sub-roles that are outside the scope of this document.

Figure A.2 shows the C-ITS roles, being part of the generic C-ITS organisational architecture, that are covered by this document.

The role *Content provider* shall provide several types of content. This includes every type of data between raw data and highly processed information. The main responsibilities of the *Content provider* are to receive content requests, obtain content (data/information) and provide content (data/information).

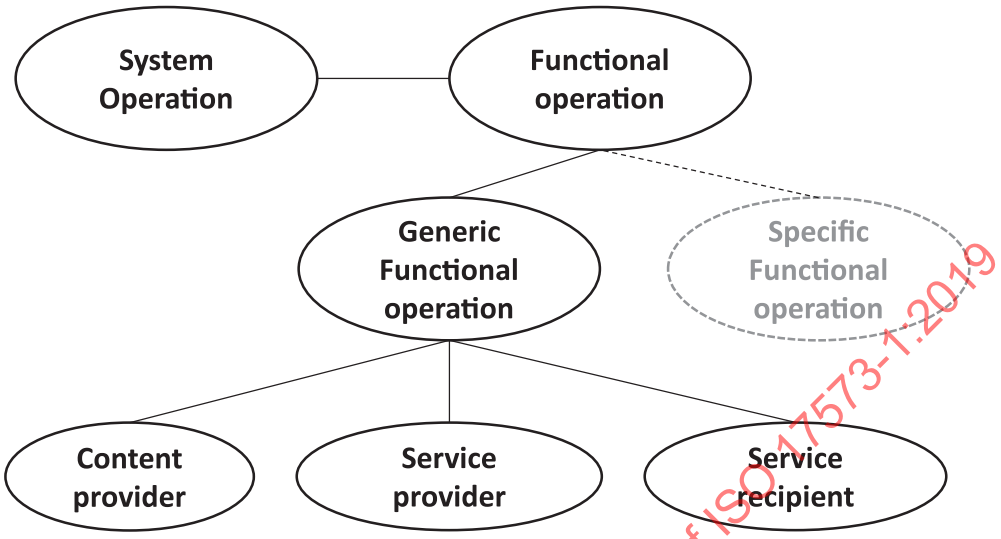

Figure A.2 — C-ITS roles covered by this document

The role *Service provider* shall provide the C-ITS service to the *Service recipient*. The main responsibilities of the *Service provider* are to receive service requests, select and operate the appropriate C-ITS service, request and receive content for service execution and provide the service to the *Service recipient*.

The role *Service recipient* shall request and receive the C-ITS service. The main responsibilities of the *Service recipient* are to subscribe to the service, request the service, receive the service and possibly pay for the service.

From a role point of view the following mappings of the C-ITS and EFC roles apply:

— The C-ITS role *System operation* is in principal equal to the EFC role *interoperability manager*.

— The C-ITS role *Generic Functional operation* covers the EFC roles *toll service provider, toll charger,* and *user of the service*.

— The responsibilities of the C-ITS role *Content provider* are shared between the EFC roles *toll service provider, toll charger,* and *user of the service*. The three EFC roles are all responsible for the provision of data/information that is needed for the provision of the EFC service.

— The responsibilities of the C-ITS role *Service provider* are shared between the EFC roles *toll service provider, toll charger,* and *user of the service.* The three EFC roles are in a C-ITS environment all responsible for providing C-ITS services.

— The responsibilities of the C-ITS role *Service recipient* are shared between the EFC roles *toll service provider, toll charger,* and *user of the service.* The three EFC roles are in a C-ITS environment all responsible for receiving C-ITS services.

It is important to note the difference between an ITS service and a C-ITS service. The EFC service is an example on a service provided by an ITS application in intelligent transport systems. The C-ITS service is a defined functionality to the system which requires a defined set of data as input, processes this data and delivers a defined output (ISO 17427-1:2018).

Figure A.3 shows the mapping between the C-ITS roles defined in ISO 17427-1 and the roles identified in this document.

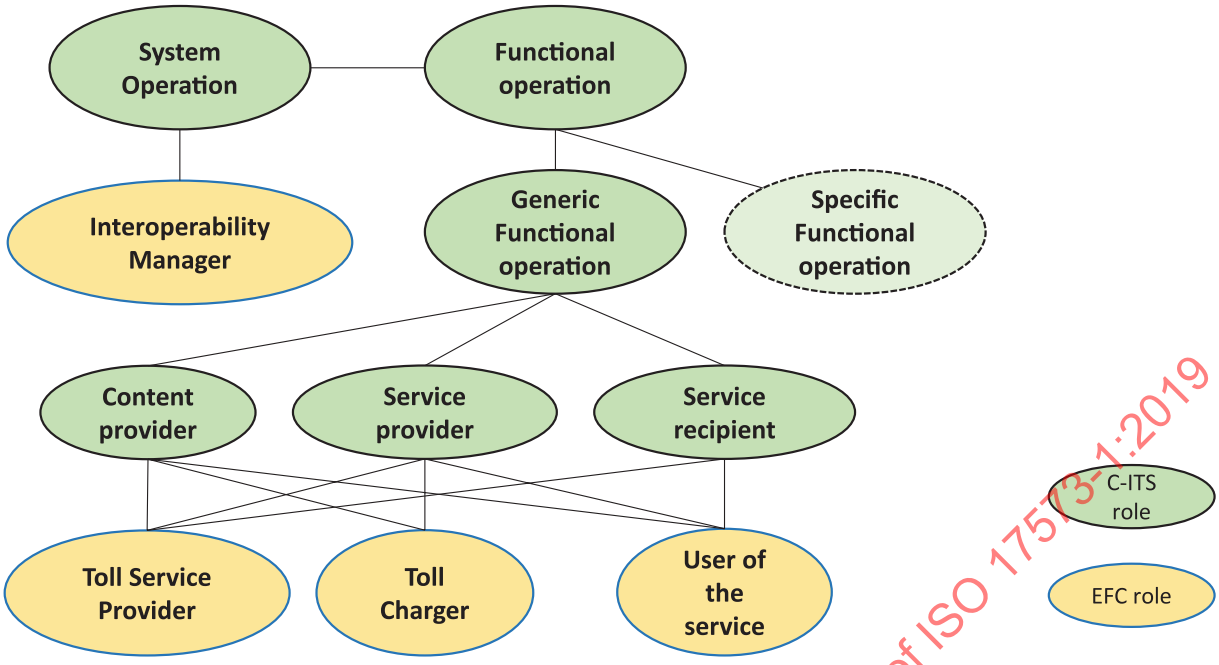

Figure A.3 — Mapping of C-ITS and EFC roles

In Clause 7 EFC services are described by interactions between the EFC specific roles and by the roles' generic functional operation sub-roles defined in ISO 17427-1 (service provider, service recipient, and content provider). The additional functional operation sub-role of information sink, which is not present in ISO 17427-1, has been defined in this document (see 7.1).

Annex B
(informative)

Information schemata and basic information types

B.1 General

The ODP model (ISO/IEC 10746-2 to -4) defines an architecture made of concepts, definitions and rules to combine them, which can be used as a framework to define any 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 document.

— **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.

While most of the body of this document deals with the Enterprise and the Computational viewpoint description of the EFC architecture, and partly with a Technology viewpoint description, this Annex gives a succinct Information viewpoint description.

B.2 Static schema

The following table synthesizes the information that is exchanged for the sole scope of tolling between general roles as described in the action diagrams of Clause 7. 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 "administrative info" exchanged between the user and the toll charger belongs to the same class of the "administrative info" exchanged between the user and the toll service 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 document.

Table B.1 — Classes of information exchanges

	Toll Service Provider	User	Toll charger	Interoperability manager
Toll service provider		invoices contract setup	administrative info	operational info
User	administrative info contract agreement			
Toll charger	transit info			operational info
Interoperability Manager	regulations	regulations	regulations	

The static schema synthesized by the previous table can be represented by the diagram in Figure B.1.

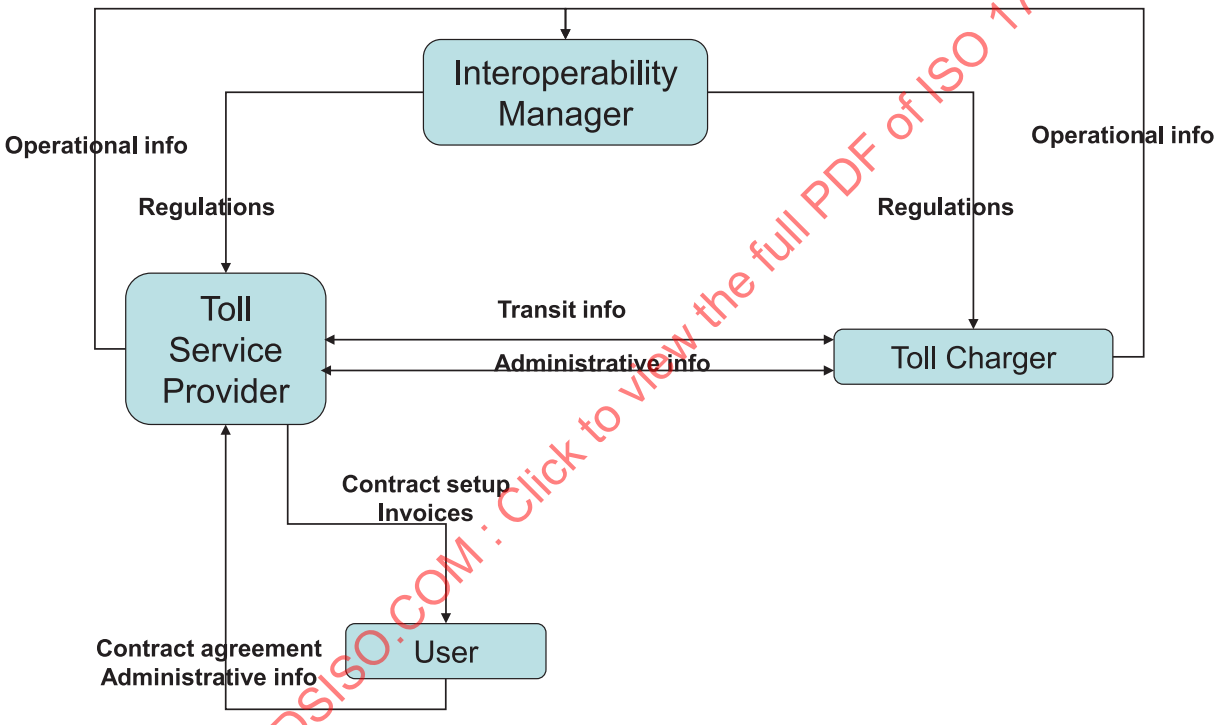

Figure B.1 — Static schema of information exchanges

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

B.3 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 document, 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 toll service provider.