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**Electronic fee collection — Charging  
performance —**

**Part 2:  
Examination framework**

*Perception du télépéage — Performance d'imputation —*

*Partie 2: Cadre d'examen*

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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.

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](http://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](http://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 on 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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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

This second edition cancels and replaces the first edition (ISO/TS 17444-2:2013), which has been revised with the following changes:

- editorial and formal corrections, as well as changes, to improve readability;
- updated terminology.

A list of all parts in the ISO/TS 17444 series can be found on the ISO website.

## Introduction

Electronic tolling systems are complex distributed systems involving critical technology such as dedicated short-range communication (DSRC) and global navigation satellite systems (GNSS), both subject to a certain random behaviour that may affect the computation of the charges. Thus, in order to protect the interests of the different involved stakeholders, in particular Service Users and Toll Chargers, it is essential to define metrics that measure the performance of the system as far as computation of charges is concerned and ensure that the potential resulting errors in terms of size and probability are acceptable. These metrics will be an essential tool when establishing requirements for the systems and also for examination of the system capabilities both during acceptance and during the operational life of the system.

In addition, in order to ensure the interoperability of different systems, it will be necessary to agree on common metrics to be used and on the actual values that define the required acceptable performances although this is not covered in this document.

This document is defined as a toolbox standard of examination tests plus a method for defining and documenting Specific Examination Frameworks to meet specific needs. The detailed choice of the set of examination tests within an Examination Framework depends on the application and the respective context. Compliance with this specification is understood as using the definitions and prescriptions laid out in this document whenever the respective system aspects are subjected to performance measurements, rather than using other definitions and examination methods than the ones specified in this document.

ISO/TS 17444-1 defines a set of charging performance metrics with appropriate definitions, principles and formulations, which together make up a reference framework for the establishment of requirements for EFC systems and their later examination of the charging performance.

These charging performance metrics are intended for use with any toll scheme, regardless of its technical underpinnings, system architecture, tariff structure, geographical coverage, or organizational model. They are defined to treat technical details that may be different among technologies as a “black box”. They focus solely on the outcome of the charging process, i.e. the amount charged in relation to a pre-measured or theoretically correct amount, rather than intermediate variables from various components as sensors, such as positioning accuracy, signal range, or optical resolution. This approach ensures comparable results for each metric in all relevant situations.

The metrics are designed to cover the information exchanged on the front-end interface and the interoperability interfaces between Toll Service Providers and Toll Chargers, as well as information on the end-to-end level.

Metrics for the following information exchanges are defined:

- Charge Reports;
- Toll Declarations;
- Billing Details and associated event data;
- Payment Claims on the level of user accounts;
- End-to-End Metrics which assess the overall performance of the charging process.

The proposed metrics are specifically addressed to protect the interests of the actors in a toll system, such as Toll Service Providers, Toll Chargers and Service Users. The metrics can be used to define requirements (e.g. for requests for proposals) and for performance assessment.

Toll schemes take on various forms as identified in the ISO 17575 series and ISO 14906. In order to create a uniform performance metric specification, toll schemes are grouped into two classes based on the character of their primary charging variable:

- charging based on discrete events (charges associated to the fact that a vehicle is crossing or standing within a certain zone);
- those based on a continuous measurement (duration or distance).

In all these toll schemes, tolls may additionally vary as a function of vehicle class characteristics such as trailer presence, number of axles, taxation class, operating function, and depending on time of day or day of week, such that, for example, tariffs are higher in rush hour and lower on the weekends.

With this degree of complexity, it is not surprising to find that the attempts to evaluate and compare technical solutions for Service User charging have been made uniquely each time a procurement or study is initiated, and with only limited ability to reuse prior comparisons made by other testing entities.

### Examination Framework

The Examination Framework that is defined in this document is designed for measuring the metrics defined in ISO/TS 17444-1. The general aim is to achieve a maximum comparability and reproducibility of the results without restricting the technological choices in system design. Specific Examination Frameworks may be defined for the Evaluation and Monitoring Phases of a project due to the differences in the availability of equipped vehicles.

### Evaluation Phase

This phase encompasses system evaluation and selection, as well as commissioning and ramp up during implementation. Important aspects of this phase are

- relatively small sample sizes, and
- well controlled behaviour of test vehicles.

### Monitoring Phase

After the system has gone into operation, its behaviour needs to be monitored for several reasons, such as fine-tuning of the system performance, monitoring of SLAs between contractual partners (supplier, Toll Charger, Toll Service Provider, etc.). In this phase, the following system aspects can be expected:

- very large sample sizes possible, but with unknown behaviour of the vehicles;
- in principle all measurements from implementation phase possible, too.

### Readers Guide

To understand the content of this document, the reader should be aware of the methodology and assumptions used to develop the Examination Framework and associated examination tests; therefore, a suggested reading order is given below.

- [Annex B](#) provides details of the underlying considerations for developing the Examination Framework.
- [Annex C](#) provides background statistical information which will enable the reader to determine sample sizes and confidence limits based on the defined performance requirements.
- [Clause 5](#) provides the definition of the Examination Framework for the evaluation of Charging Performance.
- [Clause 6](#) contains the toolbox of Examination Tests for the evaluation of charging performance for the identified scheme types.



- e) [Annex D](#) contains methods which can be used to reduce the required sample sizes for metrics with high/low probabilities during the evaluation phase.
- f) [Annex E](#) provides examples of Specific Examination Frameworks which have been developed in accordance with the methodology in [5.2](#).

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# Electronic fee collection — Charging performance —

## Part 2: Examination framework

### 1 Scope

This document defines the Examination Framework for the measurement of charging performance metrics defined in ISO/TS 17444-1 to be used during Evaluation and/or on-going Monitoring.

It specifies a method for the specification and documentation of a Specific Examination Framework which can be used by the responsible entity to evaluate charging performance for a particular information exchange interface or for overall charging performance within a Toll Scheme.

It provides a toolbox of Examination Tests for the roles of Toll Charger and Toll Service Provider for the following Scheme types:

- a) DSRC Discrete;
- b) Autonomous Discrete;
- c) Autonomous Continuous.

The detailed choice of the set of examination tests to be used depends on the application and the respective context. Compliance with this specification is understood as using the definitions and prescriptions laid out in this document whenever the respective system aspects are subjected to performance measurements, rather than using other definitions and examination methods than the ones specified in this document.

The following aspects are outside the scope of this document.

- This document does not propose specific numeric performance bounds, or average or worst-case error bounds in percentage or monetary units. Those decisions are left to the Toll Charger (or to agreements between Toll Charger and Service Provider). This document does not consider the evaluation of the expected performance of a system based on modelling and measured data from trial at another place.
- This document does not consider the specification of a common reference system which would be required for comparison of performance between systems.
- This document defines measurements only on standardized interfaces. Proprietary interfaces are excluded, because it is not possible to define standardized metrics on such system properties. These excluded interfaces are among others the link between Toll Charger RSE and central systems in DSRC systems, and the additional sensor input of GNSS modules (inertial sensors, CAN-bus for wheel ticks, etc.).

### 2 Normative references

There are no normative references in this document.

### 3 Terms and definitions

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

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

#### 3.1

##### **absolute charging error**

difference between the measured charge (toll) value and the actual value as measured by a reference system where a positive error means that the measurement exceeds the actual value

[SOURCE: ISO/TS 17444-1:2017, 3.1]

#### 3.2

##### **accepted charging error interval**

interval of the relative charging error that the toll charger considers as acceptable, i.e. as correct charging

[SOURCE: ISO/TS 17444-1:2017, 3.2]

#### 3.3

##### **average relative charging error**

ratio between the sum of computed charges (measurement) associated to a set of vehicles during a certain period of time and the actual charge due (reference) minus 1

[SOURCE: ISO/TS 17444-1:2017, 3.3]

#### 3.4

##### **billing detail**

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

Note 1 to entry: If the data is accepted by both the Toll Charger and the Toll Service Provider, then it is called a concluded Billing Detail which can be used to issue a Payment Claim.

Note 2 to entry: For a given Transport Service, the Billing Detail is referring to one or several valid Toll Declaration(s). A valid Billing Detail should fulfil formal requirements, including security requirements, agreed between the Toll Service Provider and the Toll Charger.

[SOURCE: ISO 12855:2015, 3.1]

#### 3.5

##### **charge object detection**

functionality of the system responsible for detecting chargeable events associated with a *charge object* (3.6)

Note 1 to entry: This event refers to the use of a certain object and not to the mechanisms by which detection is produced.

[SOURCE: ISO/TS 17444-1:2017, 3.5]

#### 3.6

##### **charge object**

geographic or road related object for the use of which a charge is applied

[SOURCE: ISO 17575-1:2016, 3.6]

**3.8****charge parameter change**

event occurring within a tolling system, that is relevant for charge calculation, such as change of vehicle category, but not for the detection of a *charge object* (3.6) itself

Note 1 to entry: Examples of this type of event are changes in vehicle category or time zone.

[SOURCE: ISO/TS 17444-1:2017, 3.7]

**3.9****charge report**

information containing road usage and related information originated at the Front End

[SOURCE: ISO 17575-1:2016, 3.6]

Note 1 to entry: In the 2009/750/EC, Charge Report is referred to as "Toll Declaration".

**3.10****discrete toll scheme**

toll scheme where the charge is calculated based on distinct events associated with the identification of *charge objects* (3.6) such as crossing a cordon, passing a bridge, being present in an area, etc.

Note 1 to entry: Each event is associated with a certain charge.

[SOURCE: ISO/TS 17444-1:2017, 3.11]

**3.11****continuous toll scheme**

toll scheme where the charge is calculated based on the accumulation of continuously measured parameter(s), such as, distance, time, etc.

[SOURCE: ISO/TS 17444-1:2017, 3.10]

**3.13****evaluation**

systematic process of determining how individuals, procedures, systems or programs have met formally agreed objectives and requirements

[SOURCE: ISO 10795:2011, 1.90]

**3.14****Front End**

part of a tolling system consisting of an OBE and possibly a proxy where road tolling information and usage data are collected and processed for delivery to the Back End

Note 1 to entry: The Front End comprises the on-board equipment and an optional proxy.

[SOURCE: ISO/TS 19299:2015, 3.17]

**3.15****false positive event**

event that was erroneously detected but did not take place

[SOURCE: ISO/TS 17444-1:2017, 3.13]

**3.16****missed recognition event**

usage of a *charge object* (3.6) that is not recorded by the system

[SOURCE: ISO/TS 17444-1:2017, 3.16]

**3.17**  
**monitoring**

collection and assessment of status data for a process or a system

Note 1 to entry: This can be used to observe metrics during operation.

[SOURCE: ISO/TS 17444-1:2017, 3.16]

**3.18**  
**overcharging**

situation when the calculated charge is above the *accepted charging error interval* (3.2)

[SOURCE: ISO/TS 17444-1:2017, 3.17]

**3.19**  
**payment claim**

recurring statement referring to concluded *billing details* (3.4) made available to the payer by the payee indicating and justifying the amount due

Note 1 to entry: The payment claim is used by the Toll Service Provider to issue financial objects to its customers (e.g. invoices on behalf of the Toll Charger). A given toll payment claim refers to billing details and takes into account any specific commercial conditions applicable to a vehicle, a fleet of vehicles, a customer of a Toll Service Provider and/or a Toll Service Provider. A valid payment claim should fulfil formal requirements, including security requirements, agreed between the Toll Service Provider and the Toll Charger.

[SOURCE: ISO 12855:2015, 3.10]

**3.20**  
**charging performance metrics**

specific calculations used to describe the charging performance of a system

Note 1 to entry: These calculations are technology and schema-independent.

[SOURCE: ISO/TS 17444-1:2017, 3.8]

**3.21**  
**population**

totality of items under consideration

[SOURCE: ISO 3534-1:2006]

**3.22**  
**relative charging error**

ratio between the *absolute charging error* (3.1) and the reference value

[SOURCE: ISO/TS 17444-1:2017, 3.19]

**3.23**  
**representative trips**

trips that are of a distance larger than a defined threshold and so should be considered by the related metrics

Note 1 to entry: Only trips which exceed the threshold and cover the specific types of roads of the Toll Regime should be considered.

Note 2 to entry: The threshold may be defined as zero.

[SOURCE: ISO/TS 17444-1:2017, 3.20]