
**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.

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 17444-2 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*, and by Technical Committee CEN/TC 278, *Road transport and traffic telematics* in collaboration.

ISO/TS 17444 consists of the following parts, under the general title *Electronic fee collection — Charging performance*:

- *Part 1: Metrics*
- *Part 2: Examination Framework*

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 Technical Specification.

This Technical Specification 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 Technical Specification whenever the respective system aspects are subjected to performance measurements, rather than using other definitions and examination methods than the ones specified in this Technical Specification.

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 ISO/TS 17575 suite 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), and 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 e.g. 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 part of ISO/TS 17444 is designed for measuring the metrics defined in ISO/TS 17444-1. The general aim is to achieve a maximum of comparability and reproducibility of the results without restricting the technological choices in system design. Specific Examination Frameworks maybe 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;
- well controlled behaviour of test vehicles.

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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 part of ISO/TS 17444, 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:

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

- 5) Annex D contains methods which can be used to reduce the required sample sizes for metrics with high / low probabilities during the evaluation phase.
- 6) Annex E provides an example(s) of Specific Examination Frameworks which have been developed in accordance with the methodology in Clause 5.2.

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Electronic fee collection — Charging performance — Part 2: Examination Framework

1 Scope

This part of ISO/TS 17444 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 Technical Specification whenever the respective system aspects are subjected to performance measurements, rather than using other definitions and examination methods than the ones specified in this Technical Specification.

Out of scope of this specification are the following aspects:

- This Technical Specification 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 Technical Specification does not consider the evaluation of the expected performance of a system based on modelling and measured data from trial at another place.
- This Technical Specification does not consider the specification of a common reference system which would be required for comparison of performance between systems.
- This Technical Specification defines measurements only on standardised interfaces. Proprietary interfaces are excluded, because it is not possible to define standardised 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

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 17444-1, *Electronic fee collection — Charging performance — Part 1: Metrics*

ISO 12855:2012, *Electronic fee collection — Information exchange between service provision and toll charging*

ISO/TS 17575-1:2010, *Electronic fee collection — Application interface definition for autonomous systems — Part 1: Charging*

ISO 17573:2010, *Electronic fee collection — Systems architecture for vehicle-related tolling*

3 Terms and definitions

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

3.1 absolute charging error
difference between the measured charge (toll) value and the actual value (as measured by a reference system)

Note 1 to entry: A positive error means that the measurement exceeds the actual one.

[SOURCE: ISO/TS 17444-1:2012, definition 3.1]

3.2 accepted charging error interval
interval of the Relative Charging Error varying from a negative (undercharge) to a positive (overcharge) value that the Toll Charger considers as acceptable, i.e. correct charging

[SOURCE: ISO/TS 17444-1:2012, definition 3.2]

3.3 average relative charging error
ratio between the sum of computed charges associated to a set of vehicles during a certain period of time and the actual due charge (for the same set of vehicles and the same period) minus 1

[SOURCE: ISO/TS 17444-1:2012, definition 3.3]

3.4 billing detail
for a given Transport Service, all necessary data required to determine and/or verify the amount due for the Service User

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 has to fulfil formal requirements, including security requirements, agreed between the Toll Service Provider and the Toll Charger.

[SOURCE: ISO 12855:2012, definition 3.1]

3.5 chargeable event
event in which a vehicle passes through a Charge Object that implies that vehicle has to be charged or a different rate (e.g. price per kilometre) applied

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 17444-1:2012, definition 3.5]

3.6**charge object**

any object that is part of the toll context description that may be charged for its use under certain conditions

[SOURCE: ISO/TS 17575-1:2010, definition 3.6]

3.7**charging period**

period of time which is used to define the frequency of the Toll Declarations, when Charge Reports are aggregated to form Toll Declarations

Note 1 to entry: If the Charging Period is set to 24 h then in the Toll Context Data a single Toll Declaration is submitted for each 24 h period for each Service User.

[SOURCE: ISO/TS 17444-1:2012, definition 3.7]

3.8**Charge Relevant Event**

event occurring within a tolling system, which is relevant for charge calculation, but not for the detection of a Charge Object itself

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

[SOURCE: ISO/TS 17444-1:2012, definition 3.8]

3.9**charge report**

data structure transmitted from the Front End to the Back End to report road usage data and supplementary related information

Note 1 to entry: In 2009/750/EC, Charge Report is referred to as "Toll Declaration".
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[SOURCE: ISO 12855:2012, definition 3.2]

3.10**discrete toll scheme**

toll scheme where the charge is calculated based on distinct events associated with the identification of Charge Objects 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 17444-1:2012, definition 3.10]

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 17444-1:2012, definition 3.11]

3.12**event detection**

element of the system responsible for detecting Chargeable Events associated with a Charge Object

Note 1 to entry: The output of this element provides the key information to compute a charge in a discrete scheme, or act as input for a function in a continuous scheme (e.g. for zones where distance tariffs apply).

[SOURCE: ISO/TS 17444-1:2012, definition 3.12]

**3.13
evaluation**

process applied for measuring a specific metric or set of metrics during an evaluation phase

[SOURCE: ISO/TS 17444-1:2012, definition 3.13]

**3.14
Front End**

part(s) of the toll system where road usage data for an individual Service User are collected, processed and delivered to the Back End

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

[SOURCE: ISO/TS 17575-1, definition 3.13]

**3.15
false positive event**

Chargeable Event that did not take place but is recorded by the system

[SOURCE: ISO/TS 17444-1:2012, definition 3.15]

**3.16
missed recognition event**

Chargeable Event that takes place but is not recorded by the system

[SOURCE: ISO/TS 17444-1:2012, definition 3.16]

**3.17
monitoring**

process within a distributed system for collecting and storing state data

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

[SOURCE: ISO/TS 17444-1:2012, definition 3.17]

**3.18
overcharging**

situation when the calculated charge is above the Accepted Charging Error Interval

[SOURCE: ISO/TS 17444-1:2012, definition 3.18]

**3.19
payment claim**

recurring statement referring to concluded Billing Details made available to the Toll Service Provider by the Toll Charger who indicated and justified 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 is referring to concluded 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" has to fulfil formal requirements, including security requirements, agreed between the Toll Service Provider and the Toll Charger.

[SOURCE: ISO 12855:2012, definition 3.14]

**3.20
performance metrics**

specific calculations used to describe the charging performance of a system. These calculations are technology- and schema-independent

[SOURCE: ISO/TS 17444-1:2012, definition 3.20]

3.21**population**

totality of items under consideration

[SOURCE: ISO 3534-1:2006]

3.22**relative charging error**

ratio between the Absolute Charging Error and the actual value, i.e. Relative Charging Error = Absolute Charging Error / Actual Value

Note 1 to entry: The topic of Actual Values and how to handle them will be dealt with in the Examination Framework.

[SOURCE: ISO/TS 17444-1:2012, definition 3.21]

3.23**representative trips**

trips that are of a distance larger than a defined threshold and so have to 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 have to be considered.

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

[SOURCE: ISO/TS 17444-1:2012, definition 3.22]

3.24**sample**

subset of a population made up of one or more of the individual parts in which the population is divided

[SOURCE: ISO 3534-1:2006, modified]

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3.25**service user**

customer of a Toll Service Provider, one liable for toll, the owner of the vehicle, a fleet operator, a driver, etc., depending on the context

[SOURCE: ISO 12855:2012, definition 3.29]

3.26**specific examination framework**

particular instance of a set of Examination Tests defined by an entity to determine the performance of specific selected Charging Metrics during either Evaluation and or Monitoring

3.27**successful charging**

situation where the user has been correctly charged according to the rules of the system

Note 1 to entry: For discrete Toll Schemes this means that for a given chargeable journey the Chargeable Events have been correctly identified and for continuous schemes that the Charge determined is within the Accepted Charging Error Interval.

[SOURCE: ISO/TS 17444-1:2012, definition 3.24]

3.28**Toll Charger**

legal entity charging toll for vehicles in a toll domain

Note 1 to entry: In other documents the terms operator or toll operator can be used.

[SOURCE: ISO 17573:2010, definition 3.16]