TECHNICAL SPECIFICATION

ISO/TS 17444-1

Second edition
2017-09

Electronic fee collection — Charging performance —

Part 1: Metrics

Perception du télépéage — Performance d'imputation —

Partie 1: Métrique

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

Reference number
ISO/TS 17444-1:2017(E)

© ISO 2017

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

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).

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 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.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

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

This second edition cancels and replaces the first edition (ISO/TS 17444-1:2012), which has been revised with the following changes:

ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

— 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.

© ISO 2017 – All rights reserved

Introduction

Electronic tolling systems are complex distributed systems involving mission-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, it is covered in ISO/TS 17444-2.

Toll schemes take on various forms as identified in ISO 17575 (all parts) 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 when a vehicle crosses or stands within a certain zone), and those based on a continuous measurement (duration or distance).

The following are examples of discrete (event-based) toll schemes.

— Single object charging: a road section, bypass, bridge, tunnel, mountain pass or even a ferry, charged per passage; most tolled bridges belong to this category.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

— Closed road charging: a fixed amount is charged for a certain combination of entry and exit on a motorway or other closed road network; many of the motorways in Southern Europe belong to this category.

— Discrete road links charging: determined by usage of specified road links, whether or not used in their entirety.

ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/59ba9352-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

EXAMPLE German heavy goods vehicle (HGV) charge.

— Charging for cordon crossing: triggered by passing in or out through a cordon that encircles a city core, for example.

EXAMPLE Stockholm congestion charging.

The following are examples of continuous toll schemes.

— Charging based on direct distance measurement: defined as an amount per kilometre driven.

EXAMPLE Switzerland’s HGV charge; US basic vehicle miles travelled approach.

— Charging based on direct distance measurement in different tariff zones or road types: defined as an amount per kilometre driven, with different tariffs applying in different zones or on different road types. This is a widely discussed approach, also known as Time-Distance-Place charging, and is under consideration in many European countries.

EXAMPLE OReGO, the pilot programme in Oregon, is an example from North America.

— Time in use charge: determined by the accumulated time a vehicle has been in operation, or, alternatively, by the time the vehicle has been present inside a predefined zone.

In all these examples of 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, so that, for example, tariffs are higher in rush hour and lower on the weekends.

© ISO 2017 – All rights reserved

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 on an individual basis each time a procurement or study is initiated, and with only limited ability to reuse prior comparisons made by other testing entities.

The identification of different types of schemes as proposed in ISO 17575 (all parts) and their grouping in the mentioned two classes is described in Table 1, which also identifies the examples mentioned above.

Table 1 — Tolling scheme designs grouped according to Scheme categories

Examples	Scheme type	ISO 17575 category
Single object charging	Discrete	Sectioned roads pricing
Closed road charging	Discrete	Sectioned roads pricing
Discrete road links charging	Discrete	Sectioned roads pricing
Charging for cordon crossing	Discrete	Cordon pricing
Time in use charge	Continuous	Area pricing — time
Cumulative distance charge	Continuous	Area pricing — distance
Charging for cumulative distance (or time) in different zones (or by road type)	Continuous	Area pricing — distance

No toll schemes are purely continuous. At the very least, a system must be able to stop accumulating charges when it leaves a jurisdiction in which a charge is due, and resume charging when it returns or enters another. Additionally, many Charging Schemes are set up so that the tariff is modified using discrete parameters, such as spatial zones, time spans, vehicle classes, etc. Under those circumstances, each unit of distance or time costs a different amount depending, for example, on whether it takes place inside or outside an area, such as a city, whether a trip takes place in rush hour or at night, or depending on what type of vehicle is used. In this document references to a "continuous system" have to be understood as those systems having some continuous behaviour even though they can also integrate some discrete nature. References to "discrete systems" are limited to those systems that are purely discrete.

iTeh Standards (https://standards.iteh.ai) Document Preview ISO/TS 17444-1:2017

In these schemes, all the discrete parts (zones, cordons, events, time, vehicle class, etc.) that a system has to identify are translated into a particular tariff (e.g. price per kilometre) that has to be applied to the measured continuous variable (e.g. distance travelled) resulting in another continuous parameter, money.

Some features of discrete and continuous toll schemes that are of relevance for the definition of metrics proposed in this document are analysed below.

Discrete toll schemes

In a discrete toll scheme, distinct events are associated with the identification of Charge Objects. It can happen that a vehicle crossed a cordon, passed a bridge or was present in an area on a given day. An event that takes place can either be correctly recorded by the system or can be missed. However, there is also the possibility that an event is recorded even though it did not actually take place. This is summarized in the following matrix in Table 2.

Table 2 — Theoretical event decision matrix for discrete schemes

Event Matrix		*System detects charge object detection*	
		Yes	*No*
Charge object detection takes place	*Yes*	**Correct Charging**	**Missed Recognition** (Undercharging)
	No	**False Positive** (Overcharging)	**Correct Non-charging**

 © ISO 2017 – All rights reserved

In Table 2 are two successful scenarios (Correct Charging and Correct Non-charging) and two unsuccessful (Missed Recognition and False Positive). The unsuccessful scenarios have very different consequences. A Missed Recognition, i.e. a charge object detection that takes place but is not recorded by the system, implies an undercharging, as the Service User is not charged.

In the case of False Positive, a *vehicle that is not using the toll domain* is being charged for an event which did not take place. This implies an overcharging which is in violation of the legal rights of the *Service User*, and ultimately risks eroding trust in the system.

This document therefore makes a distinction between the two types of errors and defines associated metrics to protect the interests of the Toll Charger and Service Users in terms of the allowed probabilities of those events.

Continuous toll schemes

A continuous toll scheme is one where the charge is calculated using accumulated time or distance the base tariff is applied to.

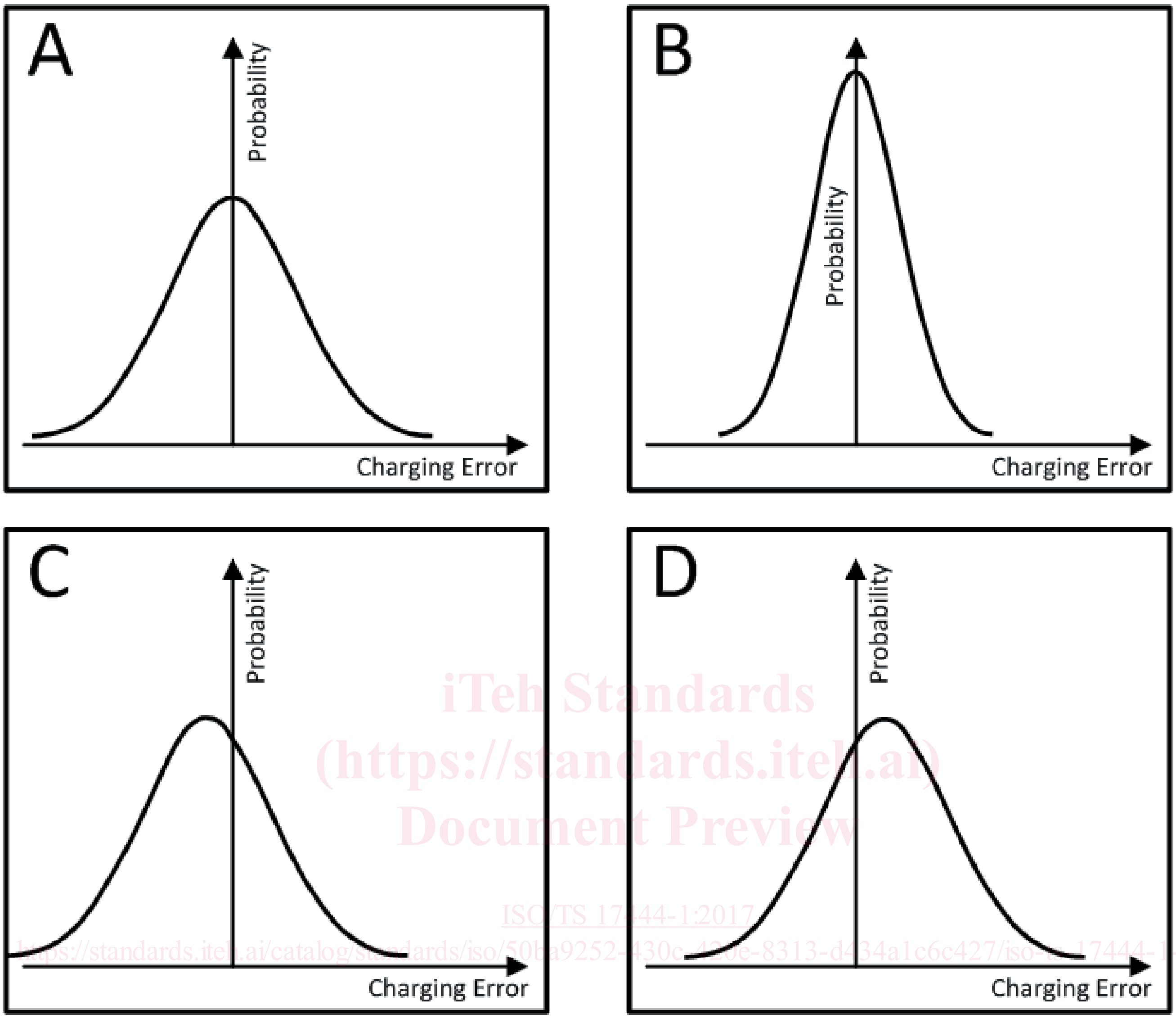
Note that a discrete scheme with a large number of Charge Objects would lead to charging incremental variations, and is hence approaching a continuous scheme (the higher the number of events the closer such schemes are to a continuous scheme). In any case, this would still formally be a discrete scheme.

In discrete toll schemes errors are binary: either a charge object detection is correctly recorded or it is not. However, in continuous schemes the errors are relatively small and they vary continuously, i.e. those errors are real (in the mathematical sense) variables instead of logical variables. Figure 1 shows different levels of dispersion and different directions of bias. The horizontal axis shows the size of the errors and the vertical axis the probability density. The vertical line in each plot represents zero charging error. Note that it is possible to have small dispersion (i.e. a small standard deviation) that still biases charging high or low (i.e. not accurate).

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

© ISO 2017 – All rights reserved



iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-426e-8313-d434a1c6c427/iso-ts-17444-1-2017

Figure 1 — Idealized plots of error distribution of four different result sets

In Figure 1, Chart A symbolizes the results from a Front End with more dispersion than that used for Chart B. For all parties involved, B is preferable to A. Charts C and D show two Front Ends with the same standard deviation, but where Chart C shows one that is consistently undercharging, and Chart D shows one that is consistently overcharging road usage.

By defining an *Accepted Charging Error Interval* to the chart, with a lower and an upper bound, as shown in Figure 2, it is possible to state that for a system to be accepted it must perform so that some minimum share of the measurements fall inside the interval specified as accepted by the *Toll Charger*.

© ISO 2017 – All rights reserved

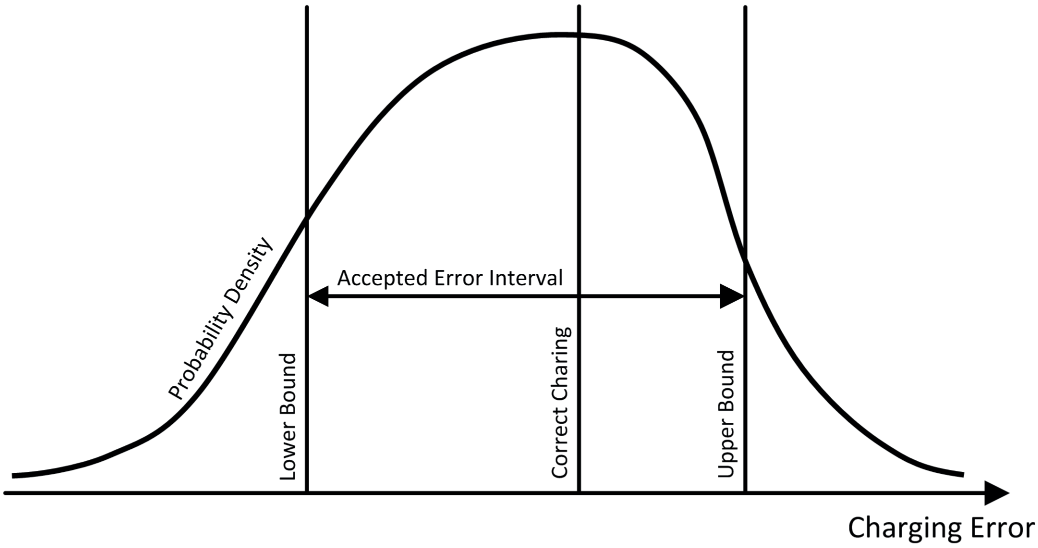


Figure 2 — Definition of Accepted Error Interval

Setting the upper and lower bounds far apart relaxes requirements on the equipment evaluated, while setting them closer together would make the requirement to fulfil harder to pass. By setting the upper bound closer to the correct charging value and the lower bound farther away, the Toll Charger can formalize exactly how much more important it is to avoid overcharging than it is to avoid undercharging. By defining those bounds (*Accepted Charging Error Interval*) together with the probabilities to be inside and above those bounds the Toll Charger can define precisely its requirements distinguishing between overcharging and undercharging. In reality no scheme is purely continuous and all foreseeable continuous schemes have some discrete components. The discrete nature of real systems can be either associated to the physical border of a country (continuous measurements take place only if vehicle is within the country) or to the identification of different urban zones or roads where different tariffs (per unit of time or distance) are applied.

Thus, continuous schemes have associated metrics that are specific to those continuous systems but the ones identified for discrete schemes are also applicable.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d434a1c6c427/iso-ts-17444-1-2017

Electronic fee collection — Charging performance —

Part 1: Metrics

1 Scope

This document defines metrics for the charging performance of electronic fee collection (EFC) systems in terms of the level of errors associated with charging computation.

This document is a toolbox standard of metrics. The detailed choice of metrics depends on the application and the respective context.

This document describes a set of 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*.

The charging performance metrics defined in this document are intended for use with any Charging Scheme, regardless of its technical underpinnings, system architecture, tariff structure, geographical coverage, or organizational model. They are defined to treat technical details that can be different among technologies and vendors or vary over time as a "black box".

iTeh Standards
(https://standards.iteh.ai)
Document Preview

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.

ISO/TS 17444-1:2017
https://standards.iteh.ai/catalog/standards/iso/50ba9252-430c-420e-8313-d454a1c6c427/iso-ts-17444-1-2017

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

Metrics on the following information exchanges are defined:

— Charge Reports;

— Toll Declarations;

— Billing Details and associated event data;

— Payment Claims on the level of toll service user accounts;

— User Accounts;

— End-to-End Metrics which assess the overall performance of the charging process.

The details on the rationale of this choice are described in 5.1.

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 Road Users. The metrics can be used to define requirements (e.g. for requests for proposals) and for performance assessment.

This document recognises two types of situations where a performance assessment is necessary:

a) when an assessment is carried out during a limited time span, such as when formulating requirements and assessing systems for acquisition purposes, conducting acceptance testing as

© ISO 2017 – All rights reserved