

PD CEN ISO/TS 17444-2:2013



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Electronic fee collection — Charging performance

Part 2: Examination Framework

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National foreword

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**Electronic fee collection - Charging performance - Part 2:
Examination Framework (ISO/TS 17444-2:2013)**

Perception du télépéage - Performance d'imputation -
Partie 2: Cadre d'examen (ISO/TS 17444-2:2013)

Elektronische Gebührenerhebung - Erhebungsqualität - Teil
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Foreword

This document (CEN ISO/TS 17444-2:2013) has been prepared by Technical Committee ISO/TC 204 "Intelligent transport systems" in collaboration with Technical Committee CEN/TC 278 "Intelligent transport systems" the secretariat of which is held by NEN.

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Endorsement notice

The text of ISO/TS 17444-2:2013 has been approved by CEN as CEN ISO/TS 17444-2:2013 without any modification.

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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.

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.

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".

[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. $\text{Relative Charging Error} = \text{Absolute Charging Error} / \text{Actual Value}$

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]

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]

3.29

Toll Service Provider

legal entity providing customer toll services on one or more toll domains for one or more classes of vehicle

Note 1 to entry: In other documents the terms issuer or contract issuer can be used.

Note 2 to entry: The Toll Service Provider can provide the OBE or can provide only a magnetic card or a smart card to be used with OBE provided by a third party (just as a mobile telephone and a SIM card can be obtained from different parties).

Note 3 to entry: The Toll Service Provider is responsible for the operation (functioning) of the OBE with respect to tolling.

[SOURCE: ISO 17573: 2010, definition 3.23]

3.30

toll declaration

statement to a Toll Charger that confirms the presence of a vehicle in a toll domain in a format agreed between the Toll Service Provider and the Toll Charger

Note 1 to entry: A valid Toll Declaration has to fulfil formal requirements, including security requirements, agreed between the Toll Service Provider and the Toll Charger.

[SOURCE: ISO 12855 2012, declaration 3.19]

3.31

trip

part of space-time trajectory of a particular vehicle within a Toll Scheme

Note 1 to entry: The exact definition of the start and end of trip is dependent on the Toll Regime and technology approach.

[SOURCE: ISO/TS 17444-1:2012, definition 3.28]

3.32

undercharging

situation where the calculated charge is below the Accepted Charging Error Interval

[SOURCE: ISO/TS 17444-1:2012, definition 3.29]

3.33

user

generic term used for the 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, definition 3.29]

3.34

user account

assets, liabilities, income, expenses, and equity of a Service User in his relationship to his Toll Service Provider

[SOURCE: ISO/TS 17444-1:2012, definition 3.31]

3.35

user complaint

complaints related to service provision received by the Toll Service Provider from its Users via contact channels

[SOURCE: ISO/TS 17444-1:2012, definition 3.32]

4 Symbols and Abbreviated terms

ARCE	Average Relative Charging Error
BD	Billing Details
CCR	Continuous Charge Report
CCTV	Closed Circuit Television (ISO/TS 17444-1)
CELB	Charging Error Interval Lower Bound
CEUB	Charging Error Interval Upper Bound
CI	Charging Input
CM	Charging Metric
CR	Charge Report
CTD	Continuous Toll Declaration
DCR	Discrete Charge Report
DSRC	Dedicated Short Range Communications (EN ISO 14906)
DTD	Discrete Toll Declaration
DO	Dedicated OBE Testing
E2E	End to End (ISO/TS 17444-1)
EFC	Electronic Fee Collection (ISO 17573)
EETS	European Electronic Toll Service (ISO 17573)
ESA	Enforcement System ANPR
ESD	Enforcement System DSRC
FE	Front End (ISO/TS 17575-1)
GNSS	Global Navigation Satellite System (ISO/TS 17444-1)
GPP	GNSS path post processing
ICT	Information and Communications Technology
IS	Independent Reference System
ITS	Intelligent Transport Systems (ISO/TS 17444-1)
KPI	Key Performance Indicator
MBDD	Maximum Billing Details Delay
MPCD	Maximum Payment Claim Delay
MTDD	Maximum Toll Declaration Delay
MUSD	Maximum User Statement Delay
OBE	On-Board Equipment (ISO 17573)

PC	Payment Claim
SLA	Service Level Agreement (ISO/IEC 20000-1)
SO	Simulated OBE / FE
TSP	Toll Service Provider (ISO 17573)
TSP-BO	Toll Service Provider back office
TC	Toll Charger (ISO 17573)
TC-BO	Toll Charger back office
TD	Toll Declaration
UA	User Account

5 Examination Framework

5.1 General

Clauses 6.1 to 6.4 contain a toolbox of Examination Tests for the following scheme types:

- a) DSRC Discrete (Clause 6.1 & optionally Clause 6.2);
- b) Autonomous Discrete (Clause 6.3);
- c) Autonomous Continuous (Clause 6.4).

NOTE These Scheme Types are defined in ISO/TS 17444-1.

Each of these clauses contains the specific examination tests for the applicable Charging Metrics identified in ISO/TS 17444-1.

Clause 5.2 defines the process that should be followed to define a specific Examination Framework for a particular purpose.

Clause 5.3 provides a definition of the sources of data that can be used by the Examination Tests to calculate the Charging Metrics.

Clause 5.4 provides the definitions of the methods of generating Charging Input referenced in the Examination Tests defined in Clause 5.5.

Clause 5.5 defines the applicability of the defined Charging Metrics for the Roles of Toll Charger and Toll Service Provider for the 3 identified scheme types.

Clause 5.6 provides tables for the selection of Charging Metrics and associated Examination Tests for the Roles of Toll Charger and Toll Service Provider for each identified Scheme Type.

5.2 Method for defining a Specific Examination Framework

Figure 1 provides an overview of the process that should be followed to define a specific instance of an Examination Framework for the evaluation of Charging Metrics for the roles of Toll Service Provider and/or Toll Charger in a particular Toll Scheme. Further details are provided in the Clauses 5.2.1 to 5.2.6.

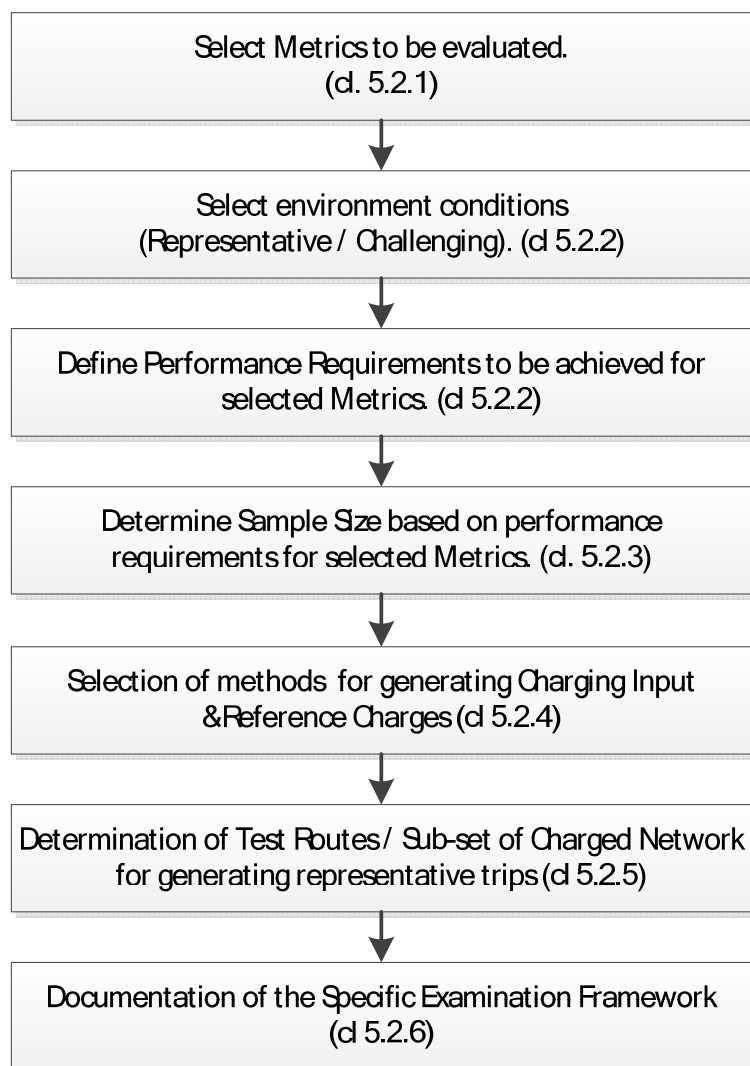


Figure 1 — Method for Defining a Specific Examination Framework

5.2.1 Selection of Metrics to be evaluated

The entity responsible for the definition of the specific Examination Framework shall determine the metrics to be measured in the phases of Evaluation and Monitoring for the roles of Toll Service Provider and / or Toll Charger using the appropriate tables in Clause 5.6

a) DSRC Discrete

- Table 5 — DSRC Discrete - Metric Selection Table
- Table 6 — DSRC Discrete – Optional DSRC Toll Declaration Metric Selection Table

b) Autonomous Discrete

— Table 7 — Autonomous Discrete - Metric Selection Table

c) Autonomous Continuous

— Table 8 — Autonomous Continuous - Metric Selection Table

5.2.2 Definition of environmental conditions and associated performance requirements

The entity responsible for the definition of the specific Examination Framework shall determine the environmental conditions (Representative / Challenging) and associated performance requirements to be met for each metric selected in 5.2.1.

NOTE 1 Assessment of Charging Metrics in a Representative Environment allows performance in the operational environment to be assessed. However care is to be taken to ensure that the Charging Data Input / selection of representative trips is comparable to that expected for the operational environment.

The choice of representative environmental conditions will in practice result in a multidimensional parameter space (e.g. air moisture, topography, electromagnetic environment, etc.). It is important to choose these parameters and their values with care to ensure that tests are performed in all realistic sets of conditions (or at least the most probable ones) while keeping the number of necessary tests to a minimum.

NOTE 2 Assessments of Charging Metrics in a Challenging Environment are typically used to determine behaviour for worst case scenarios in the operational environment. Due to the non-linear dependence of system performance on the environmental conditions it is difficult to transpose measured performance levels to those in operational systems.

The environmental conditions and associated performance requirements to be met for each metric selected should be documented in each Examination Test within the specific Examination Framework.

NOTE 3 In cases where comparative testing is chosen (e.g. a new population of OBE is introduced into an existing tolling system), the influence of the environmental conditions on the comparison results could be reduced if the tests were performed in parallel. In this case both populations are exposed to the same conditions. Nonetheless it is still necessary to perform the step described in Clause 5.2.2. This is important to ensure that the comparative test is performed under all relevant conditions; it also helps to pinpoint dependencies of performance differences to issues with robustness to certain environmental conditions, i.e. one population of equipment being more sensitive to certain environmental conditions than the other.

5.2.3 Determination of Required Sample Sizes

Based on the performance requirements set for each metric selected in Clause 5.2.2 the entity responsible for the definition of the specific Examination Framework shall determine the sample sizes required to provide statistically significant measurements based on the respective formulas for discrete and continuous systems in Annex C. The required sample sizes shall be documented for each Examination Test in the specific Examination Framework.

5.2.4 Selection of methods for generating Charging Input and Reference Data

For each Examination Test in the Specific Examination Framework that requires specific Charging Input to be generated, the responsible entity shall document which identified option for the generation of the Charging Input shall be used (Clause 5.4). Where reference data are required for the calculation of the metric within a specific Examination Test, the method of generating the reference data shall be documented in the Examination Test.

As a reference for the definition of the methods for generating input data, an analysis of different data sources that can be used for that generation are identified in Clause 5.3.

5.2.5 Determination of Test Routes / Sub-set of Charged Network for generating representative trips

For each selected Examination Test in the Specific Examination Framework that requires the generation of specific Charging Input / Representative Trips, the responsible entity shall determine and document the Test Route of the Charged Network which shall be used to generate the representative trips.

NOTE 1 As indicated in Clause 5.2.2, particular care has to be taken to ensure that the selected test routes of charged network are selected to meet the required test environment conditions.

NOTE 2 In cases where the test vehicles are not under control of the test, this step is still useful and necessary: It helps in the selection of suitable test vehicles, which should be expected to drive as much as possible on the sub-set of the charged network. Additionally it might be necessary to prepare the OBE for the test, e.g. generating geo-data defining the sub-set of the charged network and loading those data into the Front End.

5.2.6 Documentation of the Specific Examination Framework

By following the process defined in Clause 5.2.1 to Clause 5.2.5 the entity responsible for the definition of the Specific Evaluation Framework will have fully defined and documented the selected Examination Tests within its Specific Examination Framework. A template for the documentation of Examination Tests is provided in Annex A and examples can be found in Annex E.

5.3 Sources of Data

The selection of the methods for generating input data is very much constrained by the availability of the different data sources that can be of very different nature depending on:

- the different phases (evaluation/monitoring);
- the type of system (discrete/continuous);
- the available technologies (e.g. DSRC, GNSS, ANPR).

Because the definition of metrics involves in general the comparison of measured system values to expected values, their computation requires both the outputs of the charging system under test and reference data that represent those expected values. The establishment of expected values is, obviously, the most complex task as it requires some independent system that has to provide expected values (which are an estimation of the truth with much higher accuracy and reliability than the operational charging system to be analysed.) or a concise statistical analysis applied to a sufficiently large data set, or in most cases both.

Data from the system under test need to be acquired at the different interfaces for which metrics are established including:

- outputs from Front-End (Charge Reports);
- outputs from Toll Service Provider back office (Toll Declarations and User Account);
- outputs from Toll Charger back office (Billing Details and Payment Claims).

The following sources of data are identified:

- a) **The Operational Charging System** for the provision of the charges computed by the system that needs to be compared with the reference. These references can be obtained by any of the means described in the following items.
- b) **The Operational Enforcement System.**
- c) **Independent detection systems** (e.g. road side cameras, a second toll charging system or other records) that allow the determination that a vehicle has or has not passed through a particular road segment.
- d) **Simulated OBEs and Front-Ends** (to feed the back office) that allow analyzing the capabilities of that back office having as reference the known (simulated) data generated by those OBEs.
- e) **Reference systems installed in vehicles** (e.g. highly accurate positioning system based on GPS + inertial measurement unit, Odometer, etc.).

- f) **Dedicated probe vehicles.** Depending on the type of metric to be computed (in particular if it refers to discrete or continuous systems) two types of approaches can be used to know the detailed trajectory (and hence the charge due) of these probe vehicles:
- 1) Known routes: the basis for the reference data is known by the a priori definition of those routes. This is only applicable to discrete systems since continuous systems require a detailed knowledge of the actually followed trajectory;
 - 2) Use of reference systems as described in item E.
- g) **Data from OBE testing** based for instance in the use of GNSS signal simulators or DSRC simulators.

The potential use of these data for the different cases considered is summarized in the following table:

Table 1 — Identification of where different sources of data can be used (valid for both DSRC and autonomous systems)

Identifier	Source of Data	Valid for:			
		Phase		Scheme Type	
		Evaluation	Monitoring	Discrete	Continuous
A	Operational charging system	As far as available	Yes	Yes	Yes
B	Operational Enforcement	As far as available	Yes	Yes	Yes
C	Independent detection systems	Yes	Yes	Yes	Yes
D	Simulated OBEs and FE	Yes	Yes	Yes	Yes
E	Reference systems installed in vehicles	Yes	Yes	Yes	Yes
F	Dedicated probe vehicles	Yes	Yes	Yes	Yes
G	Data from OBE Testing	Yes	Yes	Yes	Yes

Figure 2 and Figure 3 analyse for each of the levels for which metrics are defined:

- What are the performance drivers, i.e. the key elements of the system that affects the performances.
- What is the key data (identifier from Table 1) required for the metrics computation.

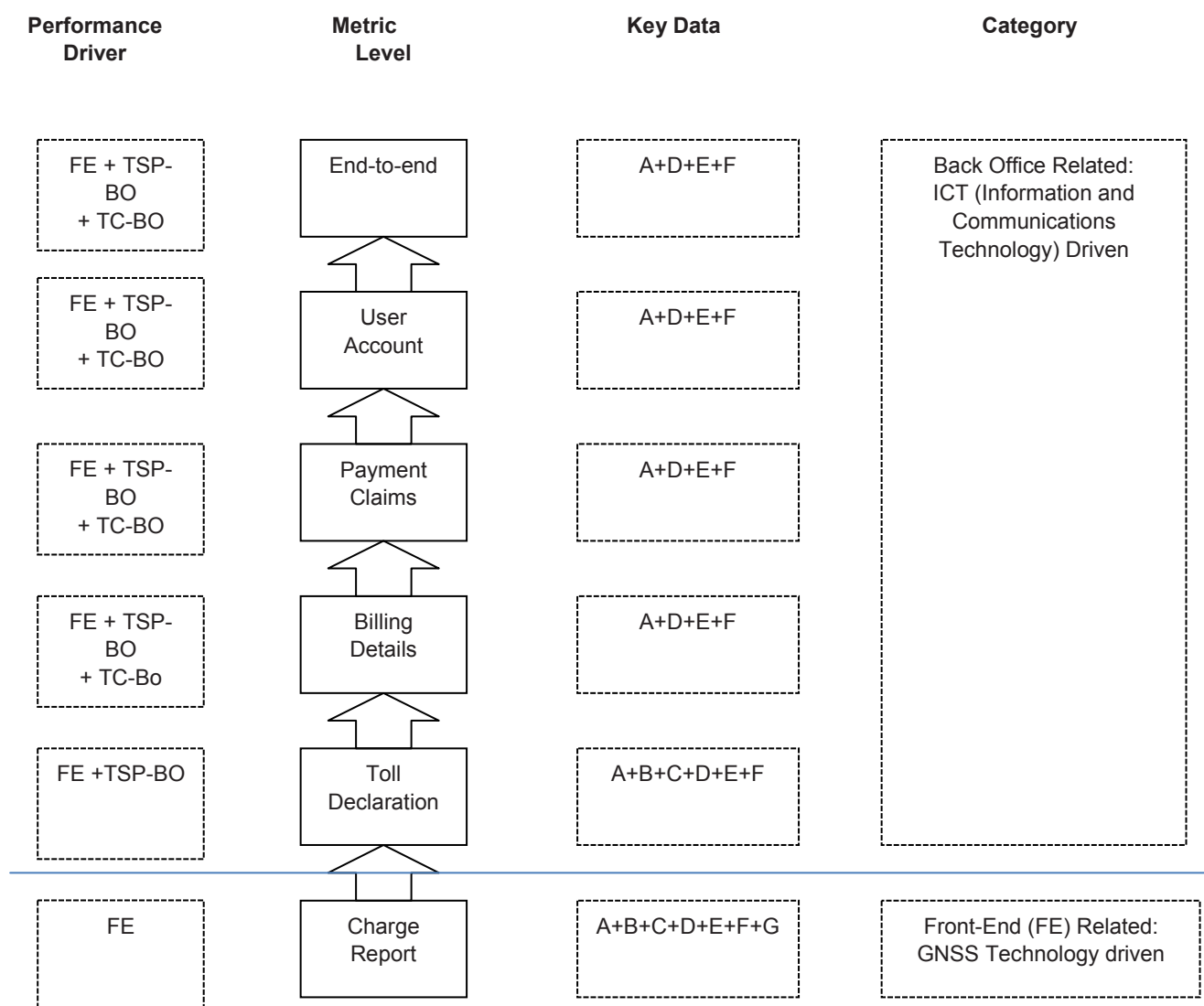


Figure 2 — Applicability of Different Sources of Data to Different Charging Metrics for Autonomous Systems, both discrete and continuous; Key Data refers to identifier from Table 1

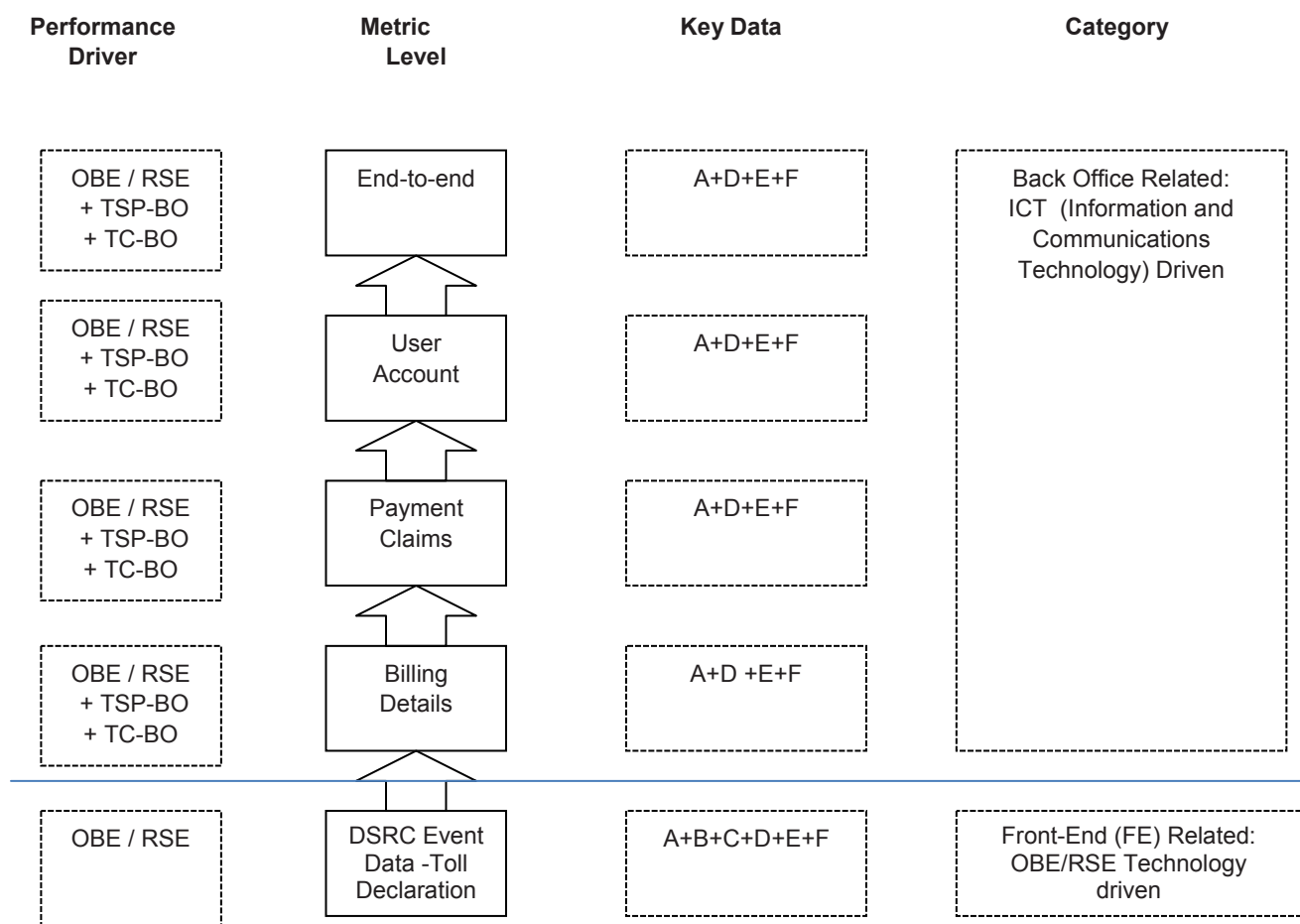


Figure 3 — Applicability of Different Sources of Data to Different Charging Metrics for DSRC based Systems, Key Data refers to identifier from Table 1

As a result of this analysis it can be easily derived that two groups of metrics require data and methodology that are of a very different nature:

- Charge Reports and / or Toll Declaration metrics require specific data to determine a reference, which makes the process complex.
- Billing Details, Payment Claims, User Account and E2E metrics can be derived from the Charge Report / Toll Declaration metrics and including additional data that can be easily simulated.

This implies that a major complexity is required for the definition of the Examination Framework at Charge Report / Toll Declaration level.

5.4 Methods of generating charging input

The decisions for one or a combination of methods for generating charging input shall take into account the advantages and disadvantages of the respective examination methods. Particular attention has to be paid to:

- number of OBE tested (and what kind of variation of OBEs is necessary);
- number of toll objects verses number of different toll objects examined;
- cost vs. benefit;
- statistics.

Table 2 gives an overview over the methods of generating charging input within the Toll Scheme. In Table 3, a subset of those methods are ordered according to whether the vehicle generating the input is a Service User vehicle ("UVR"), the driver of which might not even be aware that they are participating in performance measurements, or a possibly dedicated probe vehicle ("PV"). The meaning of "predefined routes" and "reference system" are described in the following clauses.

Table 2 — Overview of Methods of Generating Charging Input

Name	Description	Source of Data (cl 5.3)	Identifier for later reference	Link to Section 5.4.x
Probe Vehicles (PV)	Controlled / dedicated vehicles on either predefined routes (PVP) or in relation to a reference system (PVR)	A, B, C, E, F	PVP (for predefined routes) PVR (for reference system)	5.4.1 and 5.4.2
Service User vehicles (UVR)	Service Users vehicles in relation to a reference system	A, B, C, E	UVR	5.4.2
Compliance Checking (CC)	Controlled / dedicated vehicles or Service User vehicles at known spots where compliance checking takes places	A, B	CCD (for DSRC system information) CCA (for ANPR system information)	5.4.2.1
Simulated OBE/FE	Simulators used to generate Chargeable Events	A, D	SO	5.4.3
Dedicated OBE Testing	White box OBE testing	G	DO	5.4.4

Table 3 — Overview of Methods of Generating Charging Input by vehicles using the Toll Scheme

	Type of vehicle used to generate data	
	Probe vehicle	Service User vehicle
<i>Predefined routes</i>	PVP	not applicable
<i>Reference system (one or more of CCD, CCA, PR, IS, GPP) see Clause 5.4.2</i>	PVR	UVR

5.4.1 Predefined routes (identifier: "PVP")

Testing charging performance via predefined routes is widely used in many toll schemes. Test routes are set up to sample realistic and challenging road conditions in order to evaluate the charging performances of the whole system, which includes the operation of OBEs, roadside equipment, back offices, etc. Owing to the nature of this set-up, predefined routes are only applied for vehicles under the control of the organisation responsible for the performance measurements ("probe vehicles"),

The routes shall be designed to be representative of the real Toll Domain. It will sample a driver's overall driving behaviour in combination with occasional complex geographical features and conditions expected to challenge the technologies. The probe vehicles, which could consist of dedicated vehicles and volunteer vehicles, will undertake a variety of specific manoeuvres/test routes designed to test different aspects of the system. The distance of the routes shall be long enough and the vehicle may drive repeatedly a number of times to ensure that the test results are statistically significant. This may require a significant time (over a period of weeks or months).

NOTE If performances of OBE of autonomous systems (the proposed method is not valid for continuous measurements) are to be compared, all those OBEs can be installed in only one test vehicle, thus reducing variations caused by external conditions and driving patterns (the OBEs also could be fitted in several vehicles to test). When comparing the performance of DSRC OBEs in a 'real' environment, only one OBE should be installed per test vehicle.

Although the paths of the test vehicles are known by definition, it shall be supported by a GNSS reference to account for the fact that even for predefined routes, deviations can occur, that need to be verified later on.

5.4.2 Reference System (used in combination with identifiers: "PVR" and "UVR")

A reference system is defined as a set-up where a reliable reference is generated in respect the toll due of the vehicles in question. The vehicles can be either ones under the control of the organisation responsible for the performance measurements (PVR) or vehicles of Service Users (UVR).

NOTE 1 "UVR" also refers to cases where the tolling service is not operational yet, but data can already be obtained from customers of a Toll Service Provider.

NOTE 2 This reference may be obtained in a two-step process, where first a reference position or track is generated and then – based on this position or track – the toll reference data necessary for the respective test.

In the following, methods for establishing a reliable reference are described.

5.4.2.1 Reference System: Comparison with a compliance checking system (identifiers: "CCD" and "CCA")

In order to evaluate the charging accuracy of a toll scheme, DSRC transactions (CCD) or ANPR detections (CCA) from compliance checking infrastructure can be used as reference for comparison of the performance of the OBE. It assumes that such a comparison between an OBE passing a compliance checking gantry and the same OBE passing a "nearby" Charge Object can be made in a meaningful way. This procedure compares the detected Charge Object with the actual Charge Object. It enables a significant number of spot checks for all passing vehicles at all times.

The measurement basis of this method is the comparison of events (from DSRC compliance checks or ANPR compliance checks, or both) detected from gantries with (one or more) closely positioned Charge Objects and fulfilling certain other criteria. A corresponding *Charging Report* is searched in a certain time window around every enforcement event contained in the sampled Service User vehicle.

CCD and CCA will not have a detection accuracy of 100%, so the reference of passing Service Users will not be complete. However this does not limit the use of this method. The sub-set of detected vehicles can be used as the population for which charging performance is determined.

NOTE Real time comparison of DSRC transactions in the above mentioned way makes it possible to continuously and real-time monitor the toll scheme performance at all times. It is also low cost in terms of personnel required.

5.4.2.2 Reference System: Positioning reference system (identifier: "PR")

Vehicles (either probe vehicles or Service User vehicles) shall be equipped with a positioning reference system. This can be either a commercial positioning system or a high accuracy positioning system. For UVR, Service User vehicles need to be acquired and consented, depending on data protection laws special contracts have to be signed, an incentive scheme might be necessary.

NOTE As an example, the vehicles could be equipped with high performance GNSS, such as differential or kinematic GPS, for positioning, supplemented by an inertial measurement unit (IMU). This would be to meet the highest possible accurate measurement of distance. Front-ends under evaluation will be installed by a Toll Service Provider (TSP).

The vehicles can either run repeatedly on pre-defined routes or at random on not predefined routes in a way that is typical for the tolled vehicles. The data generated by these vehicles will be reported to central back office (possibly through the whole computations and interfaces to the billing information – to mirror the End-to-End process), analysed and compared with data generated by the reference position and/or distance as measured by the equipment in the vehicle.

Charge events are designed for the toll schemes. Reliable detection of the occurrence of certain events can be assessed as one of the Key Performance Indicators for the system. The accuracy of continuous charging (time, distance) can be assessed between discrete charging events.

5.4.2.3 Reference System: Independent reference system (identifier: "IS")

It is possible to compare events from an independent system against output from the system under test. Examples of such independent systems are manual analysis of passing traffic, a second toll charging system (which might be already in place) or other records.

The case of a second toll charging system is especially relevant for tests of new (discrete) interoperable toll systems or introduction of new technology, which is then compared with an established system. The key issue with this method is the identification of the charge liable vehicles from the passing traffic or the recording of charges liable with a second system. The reliability of the independent reference system has to be established as well as a procedure for reconciliation of charging/non-charging events when there is a difference between the IS and the system under test.

The method is similar to the comparison with a compliance checking system, but may use alternative traffic monitoring infrastructure not installed specifically for the Toll Scheme.

5.4.2.4 Reference System: GNSS path post processing (identifier: "GPP")

GNSS path post processing is defined as a set-up where a reference is generated by route analysis of the vehicle in question. The vehicles can be either ones under the control of the organisation responsible for the performance measurements (PVR) or vehicles of Service Users (UVR).

The method is based on the analysis of GNSS-based vehicle tracks, which allows positioning and tracking of a single or multiple vehicles, mapping their location onto charging objects along with the routes travelled and its detailed historical analysis. This mapping of GNSS tracks onto Charge Objects will be performed by a system independent from the EFC OBE.

NOTE The GNSS tracks may be obtained from the EFC OBE itself.

5.4.3 Simulated OBE / FE (identifier: "SO")

Simulators / Emulators that can be used to generate simulated Chargeable Events from the Front-End of the Toll Service Provider (Charge Reports) or Toll Charger (DSRC Transaction Reports). This method can be used on one of two ways:

- a) Evaluation of Charge Report Generation for given GNSS path
- b) Generation of reference Charging Input for the evaluation of metrics for Toll Declaration, Payment Claims, User Account and End-2-End

Depending on the sophistication of the simulators it may be possible to simulate operational charging performance under certain defined conditions.

NOTE An example of the possible application of such method could be the suitability for use tests in EETS.

5.4.4 Dedicated OBE Testing (identifier: "DO")

While "black box testing" (i.e. testing based only in the information available in the "public" interfaces) is intended as the main mechanism for the definition of the examination tests described in Clause 6, it is anticipated that some metrics, especially those involving very high or very low probabilities would require a huge sample size that can make "black box testing" unfeasible due to the high cost and long schedule required.

In those cases alternative testing methods are required and dedicated OBE testing ("white box testing") is one of those alternative methods. In this method either simulated inputs are injected to the OBE and/or internal data analysed. This sort of analysis is potentially technology dependent and, therefore, may require knowledge of the OBE design. As such they cannot be defined a priori and therefore they require special procedure to be agreed between the Toll Service Provider and the OBE supplier.

Dedicated OBE testing may involve the use of GNSS signal simulators (if no other position technology is hybridised within the OBE) to simulate demanding environment conditions as well as the access to intermediate data of the OBE from which metrics can be derived.

A more detailed description of alternative methods to the one described in Clause 6 including dedicated OBE testing are proposed in Annex D.

While the departure from the black box testing approach makes it all but impossible to provide input for reliable comparison, methods like that are widely used and expected to gain even more importance in the future. If used with care, dedicated OBE testing could provide valuable insight hard to obtain otherwise. In evaluating the result, the nonlinear system behaviour shall be taken into account (e.g. barely or just not quite receiving the signal of the fourth GNSS satellite, resulting in good or no position data).

5.5 Applicability of metrics scheme types

Table 4 defines the applicability of the defined Charging Metrics for the following types of Toll Schemes:

- a) DSRC Toll Scheme (DD) – Toll Charger with one or more Toll Service Providers;
- b) Autonomous Discrete Toll Scheme (AD) – Toll Charger with one or more Toll Service Providers;
- c) Autonomous Continuous Toll Scheme (AC) – Toll Charger with one or more Toll Service Providers.

The entries in Table 4 Scheme Type have the following meaning when considering their inclusion in the definition of a specific Examination Framework: "Y" indicates that the metric is applicable, "O" indicates that this is an optional metric, " " indicates that the metric is not applicable.

In addition for each metric the following information is provided

- a) Key Data Requirements- Data required to calculate the metric:
 - 1) RD – Reference Data;
 - 2) UA – User Account;
 - 3) PC - Payment Claims;
 - 4) BD – Billing Details;
 - 5) TD – Toll Declarations;
 - 6) CR – Charge Reports;
 - 7) CCR – Compliance Check Records.
- b) Evaluation – Charging Input Method Options– the applicable methods that could be used (Clause 5.4), entries of PVR and UVR imply the use of one or more of the Reference Identifiers: CCD, CCA, PR, IS, GPP.
- c) Monitoring – Charging Input Method Options – the applicable methods that could be used (Clause 5.4), entries of PVR and UVR imply the use of one or more of the Reference Identifiers: CCD, CCA, PR, IS, GPP.

Table 4 — Applicability of Charging Metrics for Scheme Types and Roles

Metric ID	Metric Name	Scheme Type			Key Data Requirements	Evaluation Charging Options	Input	Method	Monitoring Charging Options	Input	Method
		DD	AD	AC							
CM-E2E-1	E2E Correct Charging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-E2E-2	E2E Overcharging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-E2E-3	E2E Undercharging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-E2E-4	E2E Late Charging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-UA-1	UA - Correct Charging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-UA-2	UA - Overcharging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-UA-3	UA - Undercharging Rate	Y	Y	Y	RD, UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-UA-4	UA - Accurate application of Payments and Refunds	Y	Y	Y	UA	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-UA-5	UA - Accurate Personalisation of OBUs	Y	Y	Y	CCR	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-PC-1	PC - Correct Charging Rate	Y	Y	Y	RD, PC	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-PC-2	PC - Overcharging Rate	Y	Y	Y	RD, PC	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-PC-3	PC - Undercharging Rate	Y	Y	Y	RD, PC	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-PC-4	PC - Latency – TC	Y	Y	Y	PC	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-PC-5	PC - Late Payment Claims	Y	Y	Y	PC	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-PC-6	PC – Rejected Payment Claim Rate	Y	Y	Y	RD, PC	PVP, PVR, UVR, SO			PVP, PVR, UVR, SO		
CM-BD-1	BD - Correct Charging Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-2	BD – Overcharging Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-3	BD - Undercharging Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-4	BD - Incorrect Charging Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-5	BD - Latency – TC	Y	Y	Y	BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-6	BD – Late Billing Details	Y	Y	Y	BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-7	BD – Rejected Billing Details Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-8	BD – Incorrect rejected Billing Details Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		
CM-BD-9	BD – Inferred Billing Details Rate	Y	Y	Y	RD, BD	PVP, PVR, UVR, IS, SO			PVP, PVR, UVR, IS, SO		

End-to-End

User Account

Payment Claims

Billing Details



Documents

Document Sharing Hub

Table 4 (continued)

Metric ID	Metric Name	Scheme Type			Key Data Requirements	Evaluation Charging Input Method Options	Monitoring Charging Input Method Options
		DD	AD	AC			
CM-TD-1	TD - Correct Toll Declaration Generation	O	Y	Y	RD, TD	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-TD-2	TD - Incorrect Toll Declaration Generation	O	Y	Y	RD, TD	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-TD-3	TD - Late Toll Declarations	O	Y	Y	RD, TD	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-TD-4	TD - TSP Event Detection	O	Y	Y	RD, TD	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-TD-5	TD - TSP False Positive	O	Y	Y	RD, TD	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-DTD-1	DTD - Correct Charging Rate (Chargeable Events)		Y		RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-DTD-2	DTD - Incorrect Charge Event recognition		Y		RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-DTD-3	DTD - Missed Charge Event Recognition		Y		RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-DTD-4	DTD Overcharging Rate		Y		RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CTD-1	CTD Correct Charging Rate			Y	RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CTD-2	CTD Overcharging Rate			Y	RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CTD-3	CTD Accuracy of Distance / Time Measurement			Y	RD, TD	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CR-1	CR - Correct Charge Report Generation		Y	Y	RD, CR	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-CR-2	CR - Incorrect Charge Report Generation		Y	Y	RD, CR	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-CR-3	CR - Charge Report Latency		Y	Y	RD, CR	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-CR-4	CR - TSP Front End Event Detection		Y	Y	RD, CR	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-CR-5	CR - TSP Front End False Positive		Y	Y	RD, CR	PVP, PVR, UVR, IS, SO	PVP, PVR, UVR, IS, SO
CM-DCR-1	DCR - Correct Charging Rate (Chargeable Events)		Y		RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-DCR-2	DCR - Incorrect Charge Event recognition		Y		RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-DCR-3	DCR - Missed Charge Event Recognition		Y		RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-DCR-4	DCR - Overcharging rate (Incorrect false positive Charge Event Recognition)		Y		RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CCR-1	CCR - Correct Charging Rate			Y	RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CCR-2	CCR - Overcharging Rate			Y	RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO
CM-CCR-3	CCR - Accuracy of Distance / Time Measurement			Y	RD, CR	PVP, PVR, UVR, IS, SO, DO	PVP, PVR, UVR, IS, SO, DO

5.6 Charging Metric Selection Tables

5.6.1 General

The entity responsible for the definition of the specific Examination Framework shall use the appropriate table(s) from the following Clause 5.6.2 to Clause 5.6.4 to define, for each selected Metric to be measured during an Evaluation and/or Monitoring, the:

- Charging Input (CI) Method to be used;
- Target Value to be achieved.

The completed table(s) shall form part of the documentation of the specific Examination Framework.

5.6.2 DSRC Discrete

Table 5 should be used to define the examination tests to be performed for a specific Examination Framework in a DSRC Discrete Scheme.

Table 6 contains additional tests which might be helpful for DSRC systems, but which cannot be prescribed in a normative way, because the respective interfaces are proprietary.

Table 5 — DSRC Discrete - Metric Selection Table

Metric ID	Examination Test	Evaluation		Monitoring	
		CI Method	Target Value	CI Method	Target Value
CM-E2E-1 E2E Correct Charging Rate	cl. 6.1.2				
CM-E2E-2 E2E Overcharging Rate	cl.6.1.3				
CM-E2E-3 E2E Undercharging Rate	cl.6.1.4				
CM-E2E-4 E2E Late Charging Rate	cl.0				
CM-UA-1 UA - Correct Charging Rate	cl.6.1.6				
CM-UA-2 UA - Overcharging Rate	cl.6.1.7				
CM-UA-3 UA - Undercharging Rate	cl.6.1.8				
CM-UA-4 UA - Accurate application of Payments and Refunds	cl.6.1.9				
CM-UA-5 UA – Accurate Personalisation of OBUs	cl.6.1.10				
CM-PC-1 PC - Correct Charging Rate	cl.6.1.11				
CM-PC-2 PC – Overcharging Rate	cl.6.1.12				
CM-PC-3 PC - Undercharging Rate	cl.6.1.13				
CM-PC-4 PC - Latency – TC	cl.6.1.14				
CM-PC-5 PC - Late Payment Claims	cl.6.1.15				
CM-PC-6 PC – Rejected Payment Claim Rate	cl.6.1.16				
CM-BD-1 BD - Correct Charging Rate	cl.6.1.17				
CM-BD-2 BD – Overcharging Rate	cl.6.1.18				
CM-BD-3 BD - Undercharging Rate	cl.6.1.19				
CM-BD-4 BD - Incorrect Charging Rate	cl.6.1.20				
CM-BD-5 BD - Latency – TC	cl.6.1.21				
CM-BD-6 BD – Late Billing Details	cl.6.1.22				
CM-BD-7 BD – Rejected Billing Details Rate	cl.6.1.23				
CM-BD-8 BD – Incorrect rejected Billing Details Rate	cl.6.1.24				
CM-BD-9 BD – Inferred Billing Details Rate	cl.6.1.25				