FINAL
DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 12813

ISO/TC **204**

Secretariat: **ANSI**

Voting begins on:
2023-09-29

Voting terminates on:
2023-11-24

Electronic fee collection — Compliance check communication for autonomous systems

Perception de télépéage — Communication de contrôle de conformité pour systèmes autonomes

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/FDIS 12813:2023(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document 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).

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 278 *Intelligent transport systems,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 12813:2019), which has been technically revised.

The main changes are as follows:

— Clause 6 has been added, concerning conformance requirements;

— Clause 3 has been updated and ISO/TS 17573-2 has been made the primary source for terms and definitions;

— data definitions have been updated, including making reference to ISO 17573-3 as the primary source;

— Annex A has been restructured;

— temporary optional support of legacy encoding in some data types in OBE and RSE in CEN countries has been added;

— a second level of version identifier (i.e. minor version) of the abstract syntax notation one (ASN.1) module has been added in order to provide enhanced support to standards that import data types from this document (imported ASN.1 types are used to be subsequent editions, including all future minor versions).

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

Introduction

On-board equipment (OBE) that uses satellite-based positioning technology to collect data required for charging for the use of roads operates in an autonomous way (i.e. without relying on dedicated roadside infrastructure). The OBE will record the amount of road usage in all toll charging systems it passes through.

This document specifies requirements for dedicated short-range communication (DSRC) between OBE and an interrogator for the purpose of checking compliance of road use with a local toll regime. It assumes an electronic fee collection (EFC) services architecture according to ISO 17573-1 (see Figure 1).

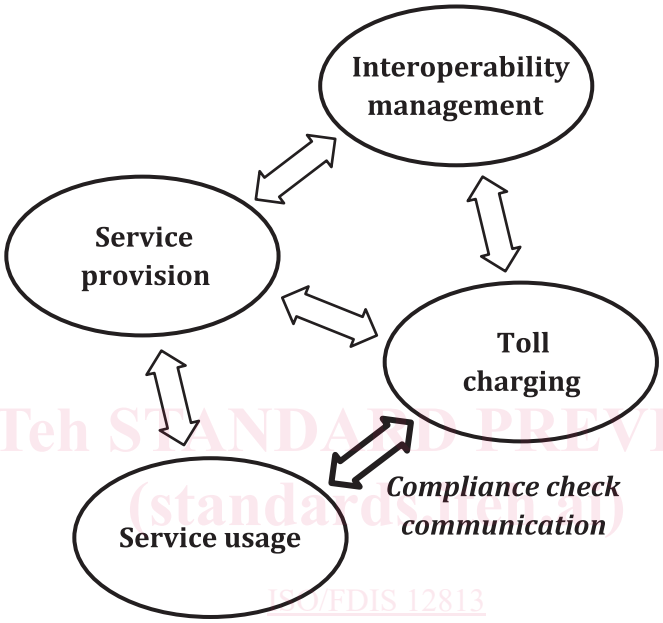


Figure 1 — Compliance check communication in EFC architecture according to ISO 17573-1

Toll chargers (TCs) need to check whether or not the road is used in compliance with the rules in the local toll regime. One way of checking compliance is to observe a passing vehicle and to interrogate the OBE. This interrogation happens under control of an entity responsible for toll charging (see Figure 1), accomplished via short-range communication between an interrogator at the roadside or in another vehicle (operated by a competent enforcement agency) and the OBE. In an interoperable environment, it is essential that this interrogation communication be standardized such that every operator of compliance checking equipment can check all passing OBE. For that purpose, this document defines attributes required on all OBE for reading by an interrogator.

This document has been prepared to fulfil the following statements:

a) Collected evidence can be used as court proof. Data is indisputable and secured such that the operator of the compliance checking interrogator can prove the integrity and authenticity of the data in case of dispute.

b) The data required for compliance checking is read only, since the operator of the interrogator does not interfere with the working of the OBE.

c) All attributes, standardized at the time of personalization of the OBE, are present in the OBE such that an operator of an interrogator can essentially read the same data from all OBE, independent of the type and make. In case an attribute does not make sense in a certain OBE implementation, a value assignment for “not applicable” or “not defined” is provided in each case. An OBE compliant to the first edition of this document will not answer with such a response for new attributes introduced in the current edition of this document.

d) The attributes, derived from the individual toll regime are of general importance for all toll system types (motorway tolling, area tolling, tolls for ferries, bridges, tunnels, cordon pricing, etc.).

e) The attributes apply to all OBE architectures, and especially to both thin (edge-light) and fat (edge heavy) client architectures. The interrogator is intended to receive essentially the same information, irrespective of the type of OBE.

It is assumed that the prime objective of the operator of the compliance checking interrogation is to check whether the user has fulfilled its obligations, in particular:

— whether the OBE is mounted in the correct vehicle;

— whether the classification data transmitted by the OBE are correct; and

— whether the OBE is in operational condition, both in a technical and a contractual sense.

Regarding the last point of the above list, on the operational status of OBE, the following model is assumed.

As long as the OBE signals the correct operational status to the user ("go" / "green"), the toll service provider (TSP) takes full responsibility for the correct operation of the OBE and for the payment by the user. Hence, as long as the OBE signals "green" and the user fulfils its other obligations (e.g. entering correct classification data and not tampering with the OBE), the user can expect the OBE to serve as a valid payment means. As soon as the OBE signals an invalid operational status ("no go" / "red") — either set by the central system of the TSP (e.g. because the user account is negative), by internal mechanisms of the OBE itself (e.g. because of a detected defect or an outdated data set) or a user manipulation with such result — the user knows that the OBE is no longer a valid payment means. The user then uses alternative means of toll declaration or payment until the problem is remedied and the OBE indicates "green" again.

NOTE In this case, "red" and "green" are used in the abstract, symbolic sense, and do not imply any physical implementation. The design of the user interface of the OBE is implementation-dependent, and several methods for signalling "red" or "green" are conceivable.

Ultimately, the policy of when to signal "green" or "red" is specified by the TSP in accordance with the requirements specified by the TC(s).

In the case where the OBE status turns "red", the user takes action, declares road usage subject to fees or pays by some alternative means as soon as practicable. Until the user does this, they are in a potentially non-compliant situation. To allow a judgment to be made as to whether or not a user has taken the appropriate action within an acceptable period of time, information is provided by this document not only on the "green/red" operational status but also on the length of time that the OBE has been in its current status.

Different toll contexts can overlap geographically. A user could be liable in several toll contexts at once, e.g. for a nationwide distance-dependent road tax and a local city access pricing scheme — a fact of which the user might not in all cases be aware. This document builds on the concept that regarding compliance, as far as possible, there is no notion of toll context (see 5.4). It is within the responsibility of the TSP to resolve issues with overlapping toll contexts and to distil all information into a binary "red/green" message to the user.

A secondary objective of the operator of the compliance checking interrogator can be to collect data on the performance of the OBE, e.g. in order to check for the correct technical functioning. Since different OBE can work according to quite different principles, the possibilities for doing this in a standardized way are quite limited. This document contains some provisions for this task (e.g. the attributes `CommunicationStatus`, `GnssStatus`, `DistanceRecordingStatus`), but otherwise assumes that TCs monitor correct recording by comparing observed traffic (e.g. with cameras) with usage data received from TSPs.

This document has been prepared with the intention to be "minimalist" in the sense that it covers what is required by operational and planned systems.

This document is complemented by ISO 13143-1, which specifies how to evaluate on-board and roadside equipment for conformity to ISO 12813 (this document).

Electronic fee collection — Compliance check communication for autonomous systems

1 Scope

This document specifies requirements for short-range communication for the purposes of compliance checking in autonomous electronic fee collecting systems. Compliance checking communication (CCC) takes place between a road vehicle's on-board equipment (OBE) and an interrogator [fixed and mobile roadside equipment (RSE) or hand-held unit] and serves to establish whether the data that are delivered by the OBE correctly reflect the road usage of the corresponding vehicle according to the rules of the pertinent toll regime.

The operator of the compliance checking interrogator is assumed to be part of the toll charging role as defined in ISO 17573-1. The CCC permits identification of the OBE, vehicle and contract, and verification of whether the driver has fulfilled their obligations and the checking status and performance of the OBE. The CCC reads, but does not write, OBE data.

This document is applicable to OBE in an autonomous mode of operation. It is not applicable to compliance checking in dedicated short-range communication (DSRC)-based charging systems.

It specifies data syntax and semantics, but not a communication sequence. All the attributes specified herein are required in any OBE claimed to be compliant with this document, even if some values are set to “not specified” in cases where a certain functionality is not present in an OBE. The interrogator is free to choose which attributes are read in the data retrieval phase, as well as the sequence in which they are read. In order to achieve compatibility with existing systems, the communication makes use of the attributes specified in ISO 17573-3 wherever useful.

The CCC is suitable for a range of short-range communication media. Specific definitions are given for the CEN-DSRC as specified in EN 15509, as well as for the use of ISO CALM IR, the Italian DSRC as specified in ETSI ES 200 674-1, ARIB DSRC, and WAVE DSRC as alternatives to the CEN-DSRC. The attributes and functions specified are for compliance checking by means of the DSRC communication services provided by DSRC application layer, with the CCC attributes and functions made available to the CCC applications at the RSE and OBE. The attributes and functions are specified on the level of application data units (ADUs).

The definition of the CCC includes:

— the application interface between OBE and RSE (as depicted in Figure 2);

— use of the generic DSRC application layer as specified in ISO 15628 and EN 12834;

— CCC data type specifications given in Annex A;

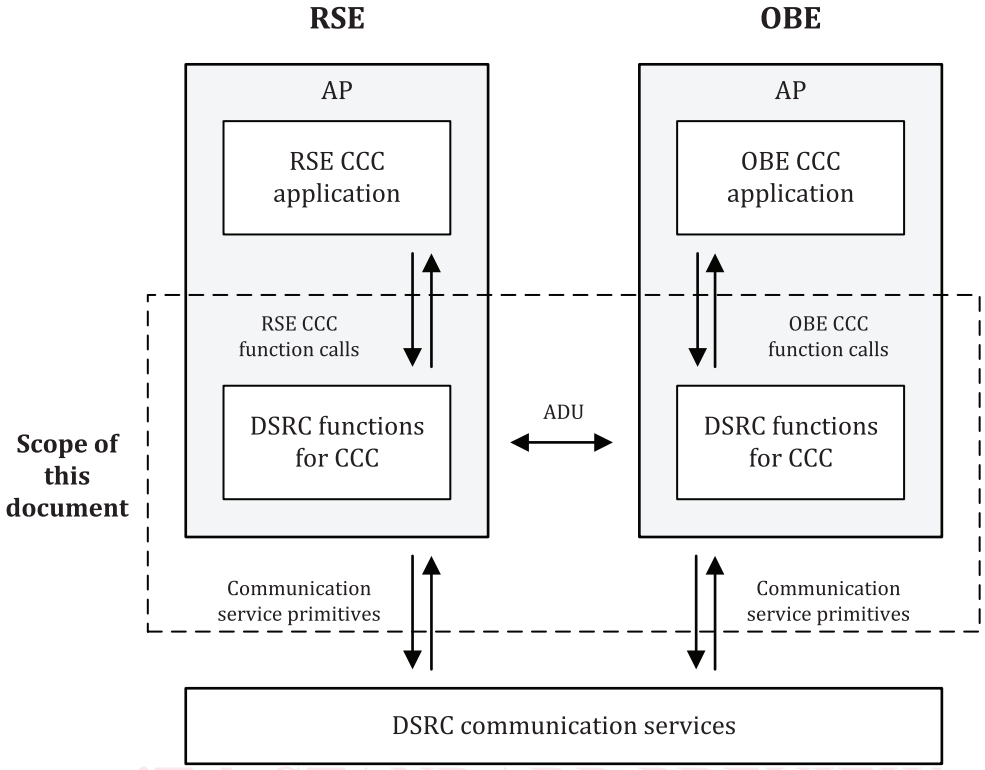
— a protocol implementation conformance statement (PICS) proforma is given in Annex B;

— use of the CEN-DSRC stack as specified in EN 15509, or other equivalent DSRC stacks as described in Annex C, Annex D, Annex E and Annex F;

— security services for mutual authentication of the communication partners and for signing of data (see Annex H);

In addition, an example CCC transaction is presented in Annex G and Annex I highlights how to use this document for the European Electronic Toll Service (EETS).

Test specifications are not within the scope of this document



Key

ADU application data unit
AP application process
CCC compliance check communication
DSRC dedicated short-range communication
OBE on-board equipment
RSE roadside equipment

Figure 2 — CCC application interface

2 Normative references

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

ISO/IEC 8825-2, *Information technology — ASN.1 encoding rules — Part 2: Specification of Packed Encoding Rules (PER)*

ISO/IEC 9646-7, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 7: Implementation Conformance Statements*

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

ISO 14906:2022, *Electronic fee collection — Application interface definition for dedicated short-range communication*

ISO 15628:2013, *Intelligent transport systems — Dedicated short range communication (DSRC) — DSRC application layer*

ISO 17573-3:2023, *Electronic fee collection — System architecture for vehicle-related tolling — Part 3: Data dictionary*

EN 12834, *Road transport and traffic telematics — Dedicated Short Range Communication (DSRC) — DSRC application layer*

EN 15509:2023, *Electronic fee collection — Interoperability application profile for DSRC*

NIMA Technical Report TR8350.2 version 3 — *Department of Defense World Geodetic System* 1984, *Its Definition and Relationships With Local Geodetic Systems*

3 Terms and definitions

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

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

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

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

3.1
access credentials
trusted attestation or secure module that establishes the claimed identity of an object or application

[SOURCE: ISO/TS 17573-2:2020, 3.4]

3.2
attribute
addressable package of data consisting of a single data element or structured sequences of data elements

[SOURCE: ISO/TS 17573-2:2020, 3.13]

3.3
authentication
security mechanism allowing verification of the provided identity

[SOURCE: EN 301 175 V1.1.1:1998, 3]

3.4
authenticator
data, possibly encrypted, that is used for *authentication* (3.3)

[SOURCE: ISO/TS 17573-2:2020, 3.16]

3.5
back end
part of a back-office system interfacing to one or more *front ends* (3.8)

[SOURCE: ISO/TS 17573-2:2020, 3.22]

3.6
data integrity
property that data has not been altered or destroyed in an unauthorized manner

[SOURCE: ISO 7498-2:1989, 3.3.21]

3.7
fixed roadside equipment
roadside equipment (3.11) located at a fixed position

[SOURCE: ISO/TS 17573-2:2020, 3.81]

3.8
front end
part of an electronic fee collection (EFC) system which consists of *on-board equipment (OBE)* (3.10) and possibly of a proxy where road tolling information and usage data are collected and processed for delivery to the *back end* (3.5)

[SOURCE: ISO/TS 17573-2:2020, 3.85]

3.9
mobile roadside equipment
equipment mounted on a mobile unit or handheld equipment to be used along the road

[SOURCE: ISO/TS 17573-2:2020, 3.119]

3.10
on-board equipment
all required equipment on-board a vehicle for performing required electronic fee collection (EFC) functions and communication services

[SOURCE: ISO/TS 17573-2:2020, 3.126]

3.11
roadside equipment
fixed or movable electronic fee collection (EFC) equipment located along or on the road

[SOURCE: ISO/TS 17573-2:2020, 3.161]

3.12
service primitive
elementary communication service provided by the application layer protocol to the application processes

[SOURCE: ISO/TS 17573-2:2020, 3.173]

3.13
toll
charge, tax or duty levied in connection to using a vehicle in a *toll domain* (3.16)

[SOURCE: ISO/TS 17573-2:2020, 3.193]

3.14
toll charger
entity which levies *toll* (3.13) for the use of vehicles in a *toll domain* (3.16)

[SOURCE: ISO/TS 17573-2:2020, 3.194]

3.15
toll context
logical view as defined by *attributes* (3.2) and functions of the basic elements of a toll scheme consisting of a single basic tolling principle, a spatial distribution of the charge objects and a single behaviour of the related *front end* (3.8)

[SOURCE: ISO/TS 17573-2:2020, 3.196]

3.16
toll domain
area or a part of a road network where a certain *toll regime* (3.17) is applied

[SOURCE: ISO/TS 17573-2:2020, 3.201]

3.17
toll regime
set of rules, including enforcement rules, governing the collection of *tolls* (3.13) in a *toll domain* (3.16)

[SOURCE: ISO/TS 17573-2:2020, 3.203]

3.18
toll service provider
entity providing toll services in one or more *toll domains* (3.16)

[SOURCE: ISO/TS 17573-2:2020, 3.206]

3.19
transaction
whole of the exchange of information between two physically separated communication facilities

[SOURCE: ISO/TS 17573-2:2020, 3.211]

4 Abbreviated terms

For the purpose of this document, the following abbreviated terms apply.

AC_CR	access credentials
ADU	application data unit
AID	application identifier
ASN.1	abstract syntax notation one
BST	beacon service table
CCC	compliance check communication
CN	cellular network
DSRC	dedicated short-range communication
EFC	electronic fee collection
EID	element identifier
GNSS	global navigation satellite systems
HMI	human-machine interface
IID	invoker identifier
MAC	message authentication code
OBE	on-board equipment
PICS	protocol implementation conformance statement
PSC	provider service context
RSE	roadside equipment
SAM	secure application module
TC	toll charger

TSP	toll service provider
VST	vehicle service table
WGS84	World Geodetic System 1984
WSA	WAVE service advertisement

5 Application interface architecture

5.1 General

This clause gives an insight into the CCC architecture. It identifies the services provided to CCC applications and the functions that implement these services. It also defines principles regarding attributes and the use of DSRC communication service primitives. A detailed description of the functions is given in Clause 7, whilst the detailed list of the attributes is given in Clause 8.

The CCC application interface has been designed to make use of the CEN-DSRC communication stack, via the application layer specified in ISO 15628 and EN 12834. For other identified DSRC communication media, detailed mappings to corresponding services are given in annexes.

From a general addressing viewpoint, it should be noted that only one CCC context is used, as compliance checking attributes are independent of context.

5.2 Services provided

The CCC application interface offers the following services to CCC applications:

— retrieval of compliance significant attributes, in order for RSE to assess OBE compliance,

— mutual authentication of RSE and OBE by means of exchange of credentials and authenticators, and

— a command to the OBE to signal to the user the result of the compliance check.

NOTE 1 The policy on whether the result of the compliance check or the fact that a transaction has taken place is signalled to the user is decided by the entity operating the CCC interrogator and is outside the scope of this document.

The above services are realized by means of protocol exchanges performed by means of communication services and transactions as described in Clause 9.

The services are provided by the following functions:

— the “initialise communication” function, which shall be used to establish the CCC communication link between RSE and OBE;

— the “data retrieval” function, which shall be used to retrieve CCC attributes;

— the “authenticated data retrieval” function, which shall be used to retrieve data with an authenticator from the OBE;

— the “driver notification” function, which shall be used to invoke a human-machine interface (HMI) function (e.g. signal “OK” via a buzzer sound);

— the “terminate communication” function, which shall be used to terminate the CCC communication;

— the “test communication” function, which shall be used for testing and localizing the OBE.

NOTE 2 A “write” service is not provided, since the writing of data into the OBE is not foreseen.

5.3 Attributes

The attributes available on the OBE side for a CCC application at roadside for checking the compliance of a vehicle are given in detail in Clause 8.

All attributes specified in this document shall be available on the OBE side.

The RSE is free to decide to read any combination of attributes from the OBE. The attributes shall be identified and retrieved using the mechanisms specified in ISO 14906. More specifically, the addressing of the CCC application data implemented by the OBE and RSE shall conform to the rules specified in ISO 14906:2022, 5.3.

Multiple instances of attributes are not supported.

5.4 Toll context

An OBE may be located in several tolling contexts at once.

NOTE This can occur, e.g. in situations where a motorway toll geographically overlaps with an area-based charging system.

In these different tolling contexts, the OBE can potentially run different charging applications or several instances of one charging application in parallel.

This document builds on the concept that for compliance checking, there is basically no need to distinguish between tolling contexts. In certain circumstances and in the cases specified in the semantic definition, the toll service provider (TSP) shall ensure that the attribute content complies with the specifications of the toll charger (TC) (e.g. for local vehicle classes).

The OBE should hold only one CCC context, represented by a single element as specified in ISO 14906. However, for backwards compatibility reasons, one additional CCC context, represented by a second element may be used to support ISO 12813:2015, the previous edition of this document (see also 9.2.3).

5.5 Use of lower layers

5.5.1 Supported DSRC communication stacks

The CCC application interface makes use of the CEN-DSRC communication stack as defined in Table 1. Other communication media can be used as listed in Table 1 if an equivalent mapping to corresponding services is provided. Detailed examples are provided in informative annexes.

Table 1 — Supported short-range communication stacks

Medium	Application layer	Lower layers	Detailed specifications
CEN-DSRC	ISO 15628 EN 12834	EN 12795 EN 12253	Specification in 5.5.2
Italian DSRC	ETSI ES 200 674–1 (Clause 11 and Annex D)	ETSI ES 200 674–1 (Clauses 7 to 10 and Annex D)	Implementation example in Annex C
ISO CALM IR	ISO 15628 EN 12834	ISO 21214	Implementation example in Annex D
ARIB DSRC	ARIB STD-T75 ISO 15628	ARIB STD-T75 ITU-R.M1453–2	Implementation example in Annex E
NOTE EN 12795 and EN 12253 have been adopted in ITU-R.M 1453–2.			