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Electronic fee collection — Compliance check communication for autonomous systems

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

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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 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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

This first edition replaces the Technical Specification ISO/TS 12813:2009, which has been technically revised. This first edition incorporates the following main modifications compared to the Technical Specification:

- conversion from a Technical Specification to an International Standard;
- new attributes added (TrailerCharacteristics, AttributeUpdateInterval, VehicleCurrentMaxTrainWeight, VehicleWeightHistory, ExtendedOBEStatusHistory, ExtendedVehicleAxlesHistory and LocalVehicleClassId);
- amendment of terms, in order to reflect harmonization of terms across electronic fee collection (EFC) standards;
- amendments to reflect changes to the underlying base standards, in particular ISO 14906 and EN 15509;
- addition of a new informative annex (i.e. Annex H) on how to use this International Standard for the European electronic toll service;
- editorial and formal corrections as well as changes to improve readability.

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 road side infrastructure). The OBE will record the amount of road usage in all toll charging systems it passes through.

This International Standard defines 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. See Figure 1.

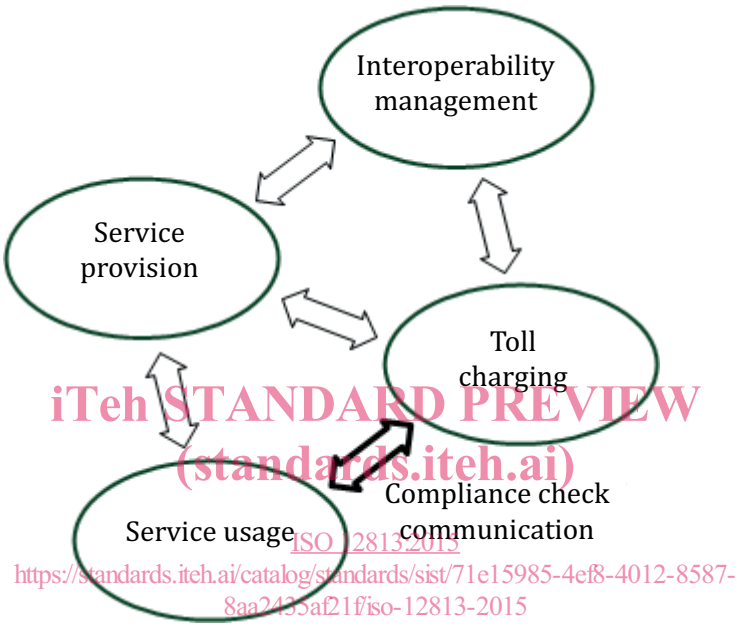

Figure 1 — Compliance check communication in EFC architecture as per ISO 17573

Toll chargers have the need to check whether 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 road-side 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 International Standard defines attributes required on all OBE for reading by an interrogator.

This International Standard has been prepared considering the prerequisites listed below in a) to e).

a) Collected evidence must be court proof. Data must be 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 must be read only, since the operator of the interrogator must not interfere with the working of the OBE.

c) All attributes, standardised at the time of personalisation of the OBE, should be present in the OBE such that an operator of an interrogator essentially can read the same data from all OBE independent of 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 will not answer with such a response for new attributes introduced in the current edition of this International Standard.

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

e) The attributes must apply to all OBE architectures, and especially to both thin (edge-light) and fat (edge heavy) client architectures. The interrogator must be able to receive essentially the same information irrespective of OBE implementation decisions.

It is assumed that the prime objective of the operator of the compliance checking interrogator is to check whether the user has fulfilled his obligations, especially:

— 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 working 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 to the user correct operational status ("green"), the service provider takes full responsibility for the correct working of the OBE and for the payment by the user. Hence, as long as the OBE signals "green" and the user fulfils his other obligations (such as 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 ("red") — either set by the central system of the service provider (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 has to use alternative means of toll declaration or payment until the problem is remedied and the OBE is "green" again[1)].

Ultimately, the policy of when to signal "green" or "red" is defined by the service provider in accordance with the requirements defined by the toll charger(s).

In the case where the OBE status turns "red", the user has to take action, declare road usage subject to fees or pay by some alternative means as quickly as possible. Until he does, the user is in a potentially non-compliant situation. In order 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 International Standard 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 nation-wide 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 International Standard builds on the concept that regarding compliance, there is no notion of toll context (see especially 5.4). It is within the responsibility of the service provider 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 might 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 standardised way are quite limited. This International Standard contains some provisions for this task (e.g. the attributes CommunicationStatus, GnssStatus, DistanceRecordingStatus), but otherwise assumes that toll chargers monitor correct recording by comparing observed traffic (e.g. with cameras) with usage data received from service providers.

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

1) Here, "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.

A test suite for checking an OBE or RSE implementation for compliance with the first edition of this International Standard is defined in the corresponding edition of ISO/TS 13143-1 and ISO/TS 13143-2. This test suite is currently being updated to reflect the changes incorporated into this first edition of ISO 12813.

Electronic fee collection — Compliance check communication for autonomous systems

1 Scope

This International Standard defines 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 outside interrogator (road-side mounted equipment, mobile device 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. The CCC permits identification of the OBE, vehicle and contract, and verification of whether the driver has fulfilled his obligations and the checking status and performance of the OBE. The CCC reads, but does not write, OBE data.

This International Standard 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 defines data syntax and semantics, but does not define a communication sequence. All the attributes defined herein are required in any OBE claimed to be compliant with this International Standard, even if some values are set to "not defined" in cases where certain functionality is not present in an OBE. The interrogator is free to choose which attributes are read, 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 defined in ISO 14906 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 and ARIB DSRC as alternatives to the CEN-DSRC. The attributes and functions defined are for compliance checking by means of the DSRC communication services provided by DSRC layer 7, with the CCC attributes and functions made available to the CCC applications at the road-side equipment (RSE) and OBE. The attributes and functions are defined on the level of application data units (ADU).

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,

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

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

CCC data type specifications are given in Annex A, protocol implementation conformance statement (PICS) proforma in Annex B. An example CCC transaction is presented in Annex F. The informative Annex H highlights how to use this International Standard for the European electronic toll service (as defined in Commission Decision 2009/750/EC).

Test specifications are not within the scope of this International Standard.

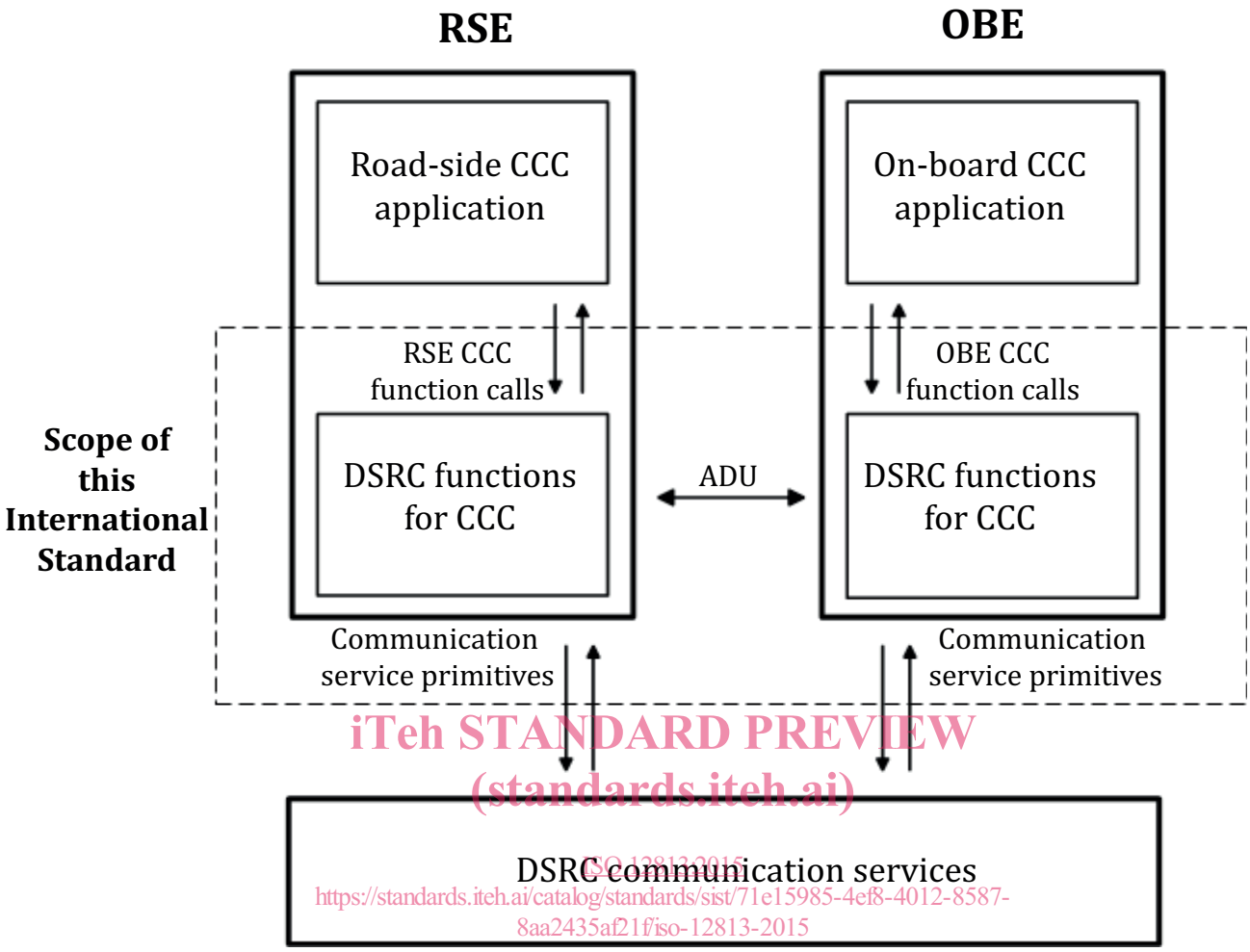

Figure 2 — CCC application interface

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/IEC 8824-1:2008, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation — Part 1*

ISO/IEC 8825-2:2008, *Information technology — ASN.1 encoding rules: Specification of Packed Encoding Rules (PER) — Part 2*

ISO 14906:2011/Amd1:2005, *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*

EN 12834:2003, *Road transport and traffic telematics — Dedicated Short Range Communication (DSRC) — DSRC application layer*

EN 15509:2014, *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.

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

[SOURCE: EN 15509:2014, 3.1]

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

3.3
authentication
security mechanism allowing verification of the provided identity

[SOURCE: EN 301 175]

3.4
authenticator
data, possibly encrypted, that is used for authentication

[SOURCE: ISO/TS 19299:2015, 3.5]

3.5
data integrity
property that data has not been altered or destroyed in an unauthorized manner

[SOURCE: ISO/TS 19299:2015, 3.28]

3.6
fixed roadside equipment
roadside equipment located at a fixed position

3.7
mobile roadside equipment
equipment mounted on a mobile unit or handheld equipment to be used along the road

3.8
on-board equipment
OBE
all required equipment on-board a vehicle for performing required EFC functions and communication services

3.9
roadside equipment
RSE
equipment located along the road, either fixed or mobile

3.10
toll service provider
TSP
entity providing toll services in one or more toll domains

[SOURCE: ISO 17573:2010]

3.11
service primitive
elementary communication service provided by the application layer protocol to the application processes

[SOURCE: ISO 14906:2011, 3.18 modified]

3.12
toll context
logical view as defined by attributes 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

3.13
toll regime
set of rules, including enforcement rules, governing the collection of a toll in a toll domain

[SOURCE: ISO 17573:2010, 3.20]

3.14
transaction
whole of the exchange of information between two physically separated communication facilities

4 Abbreviated terms

For the purpose of this document, the following abbreviations apply.

AC_CR	access credentials
ADU	application data unit (ISO 14906)
ASN.1	abstract syntax notation one (ISO/IEC 8824-2)
BST	beacon service table (ISO 14906)
CCC	compliance check communication
DSRC	dedicated short-range communication (ISO 14906)
EID	element identifier (ISO 15628 and EN 12834)
EFC	electronic fee collection
GNSS/CN	global navigation satellite systems/cellular network
MAC	media access control (EN 12795) or message authentication code (ISO 14906)
OBE	on-board equipment (ISO 14906)
PICS	protocol implementation conformance statement
RSE	roadside equipment (ISO 14906)
TSP	toll service provider
VST	vehicle service table (ISO 14906)
WGS84	World Geodetic System 1984

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 primitives. A detailed description of the functions is given in Clause 6, whilst the detailed list of the attributes is given in Clause 7.

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

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

NOTE 1 The policy of whether or not 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 International Standard.

The above services are realized by means of protocol exchanges performed by means of communication services and transactions as described in Clause 8.

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 road-side for checking the compliance of a vehicle are given in detail in Clause 7.

All attributes defined in this International Standard 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 defined in ISO 14906. More specifically, the addressing

of the CCC application data implemented by the OBE and RSE shall conform to the rules defined in ISO 14906:2011, 5.3.

Multiple instances of attributes are not supported.

5.4 Toll context

An OBE may be in several tolling contexts at once. This can occur, e.g. in situations where a motorway toll geographically overlaps with an area charging system. In these different tolling contexts, the OBE might run different charging applications or several instances of one charging application in parallel.

This International Standard builds on the concept that for compliance checking, there is no need to distinguish between tolling contexts. The data relevant for checking compliance, e.g. the identity of the vehicle, classification parameters and operational status of the OBE ("red" or "green"), are independent of the tolling context. Also, for legal reasons, a user must know whether or not he is acting in a compliant way without understanding technical detail, such as how many overlapping tolling contexts there are at a given moment.

Hence, there is only one CCC context, and context-related concepts known from DSRC charging — such as identification of the toll context via the EFC context mark or addressing a specific context via a corresponding EID — are not required. Therefore, the OBE shall hold only one CCC context, identified by a single EID value.

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 described 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 1:EN 12795 and EN 12253 have been adopted in ITU-R.M 1453–2.			

If more than one communication medium is implemented in an OBE, then the OBE shall respond to RSE interrogations on the same medium that the RSE has initiated the CCC interrogation.

5.5.2 Use of the CEN-DSRC stack

The following requirements apply to the CCC application when used with the CEN-DSRC communication stack.

The OBE shall comply with EN 15509:2014, 6.1.2.

Fixed RSE shall comply with EN 15509:2014, 6.2.2.

Mobile RSE shall comply with EN 15509:2014, 6.2.2, except for *Downlink Parameter D4a* (not applicable to mobile RSE).

NOTE EN 15509 defines the CEN-DSRC communication stack for fixed RSE only.

6 Functions

6.1 Functions in detail

6.1.1 General

All functions defined in 6.1 shall be available on the OBE side.

For CEN-DSRC, the OBE shall provide the following functions:

— INITIALISATION, GET, and RELEASE application layer services according to ISO 15628 and EN 12834;

— GET_STAMPED, SET_MMI, and ECHO EFC functions according to ISO 14906.

Subclauses 6.1.2 to 6.1.7 define the functions for CEN-DSRC only. For other supported media, according to 5.5.1, equivalent functionality should be provided. See Annex C for ETSI/ES 200 674-1 5.8 GHz microwave DSRC, Annex D for CALM Infrared DSRC, and Annex E for ARIB microwave DSRC.

6.1.2 Initialise communication

Initialisation of the communication between the RSE and the OBE shall be initiated by the RSE, by means of the invocation of an initialisation request by the RSE. After successful initialisation, the function “Initialise communication” shall notify the applications on the RSE and OBE sides.

The initialisation notification on the OBE side shall carry at least the identity of the beacon (e.g. beacon serial number) and absolute time.

The initialisation notification on the RSE side shall carry the CCC application identity and shall also carry data required for the security services (e.g. nonce value, key identifier).

The function “Initialise communication” shall be provided by the application layer INITIALISATION services as specified in ISO 15628 and EN 12834. It is defined in Annex A: refer to CCC-InitialiseComm-Request and CCC-InitialiseComm-Response.

6.1.3 Data retrieval

The function “Data retrieval” shall be provided by the application layer GET service as specified in ISO 15628 and EN 12834. It is defined in Annex A: refer to CCC-DataRetrieval-Request and CCC-DataRetrieval-Response.

In the GET service primitives, iid shall not be used.

NOTE The invocation of a service primitive by an application process implicitly calls upon and uses services offered by the lower protocol layers.

GET shall always carry access credentials.

6.1.4 Authenticated data retrieval

The function “Authenticated data retrieval” shall be implemented by the EFC function GET_STAMPED as specified in ISO 14906. It is defined in Annex A: refer to CCC-AuthDataRetrieval-Request and CCC-AuthDataRetrieval-Response.