BS EN ISO 12855:2022

BSI Standards Publication

Electronic fee collection — Information exchange between service provision and toll charging

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National foreword

This British Standard is the UK implementation of EN ISO 12855:2022. It is identical to ISO 12855:2022. It supersedes BS EN ISO 12855:2015, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 12855

May 2022

ICS 03.220.20; 35.240.60

Supersedes EN ISO 12855:2015

English Version

Electronic fee collection - Information exchange between service provision and toll charging (ISO 12855:2022)

Perception du télépéage - Échange d'informations entre la prestation de service et la perception du péage (ISO 12855:2022)

Elektronische Gebührenerhebung - Informationsaustausch zwischen Dienstleistern und Gebühreneinzugsunternehmen (ISO 12855:2022)

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European foreword

This document (EN ISO 12855:2022) 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.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2022, and conflicting national standards shall be withdrawn at the latest by November 2022.

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

This document supersedes EN ISO 12855:2015.

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INTERNATIONAL STANDARD

ISO 12855

Third edition
2022-04

Electronic fee collection — Information exchange between service provision and toll charging

Perception du télépéage — Échange d'informations entre la prestation de service et la perception du péage

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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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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 12855:2015), which has been technically revised.

The main changes are as follows:

— addition of new application data units (ADUs);

— alignment of the ASN.1 data definitions with the current edition of ISO 14906;

— removal of all dependencies on the ISO 17575 series ASN.1 data types and creation of corresponding definitions;

— re-classification of the electronic fee collection (EFC) context types by tolling and geographical characteristics and removal of the previous distinction based on tolling technology;

— splitting of the ASN.1 module into two modules: one containing ISO 12855-specific definitions, and another containing data-type definitions that are common to other standards in the EFC domain. This common data types module has then been moved to ISO/TS 17573-3;

— clarification of the semantics of all parameters in ADUs;

— alignment of the structure of all major clauses in a consistent manner to improve readability.

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Introduction

The widespread use of road tolling requires provisions for users of vehicles that circulate through many different toll domains. Users should be offered a single contract for driving a vehicle through various toll domains. Where those vehicles require on-board equipment (OBE) this should be interoperable with the toll systems in the various toll domains. In Europe, for example, this need has been officially recognized and legislation on interoperability has already been adopted (see Directive 2019/520[8], related Commission delegated regulation 2020/2003[10] and Commission implementing regulation 2020/204[9]). There is both a commercial and economic justification regarding the OBE and the toll systems for International Standards supporting interoperability.

The system architecture defined in ISO 17573-1 is the basis for all International Standards that relate to tolling systems in the toll domain. With respect to ISO 17573-1, this document:

— adopts its definitions of terms and concepts and basic system functionalities and structure,

— uses its terminology, and

— specifies the interfaces identified therein.

ISO 17573-1 uses ISO/IEC 10746-3 for the description of the architecture.

Figure 1 shows the scope of the group of International Standards related to electronic fee collection (EFC) based upon the ISO 17573-1 system architecture.

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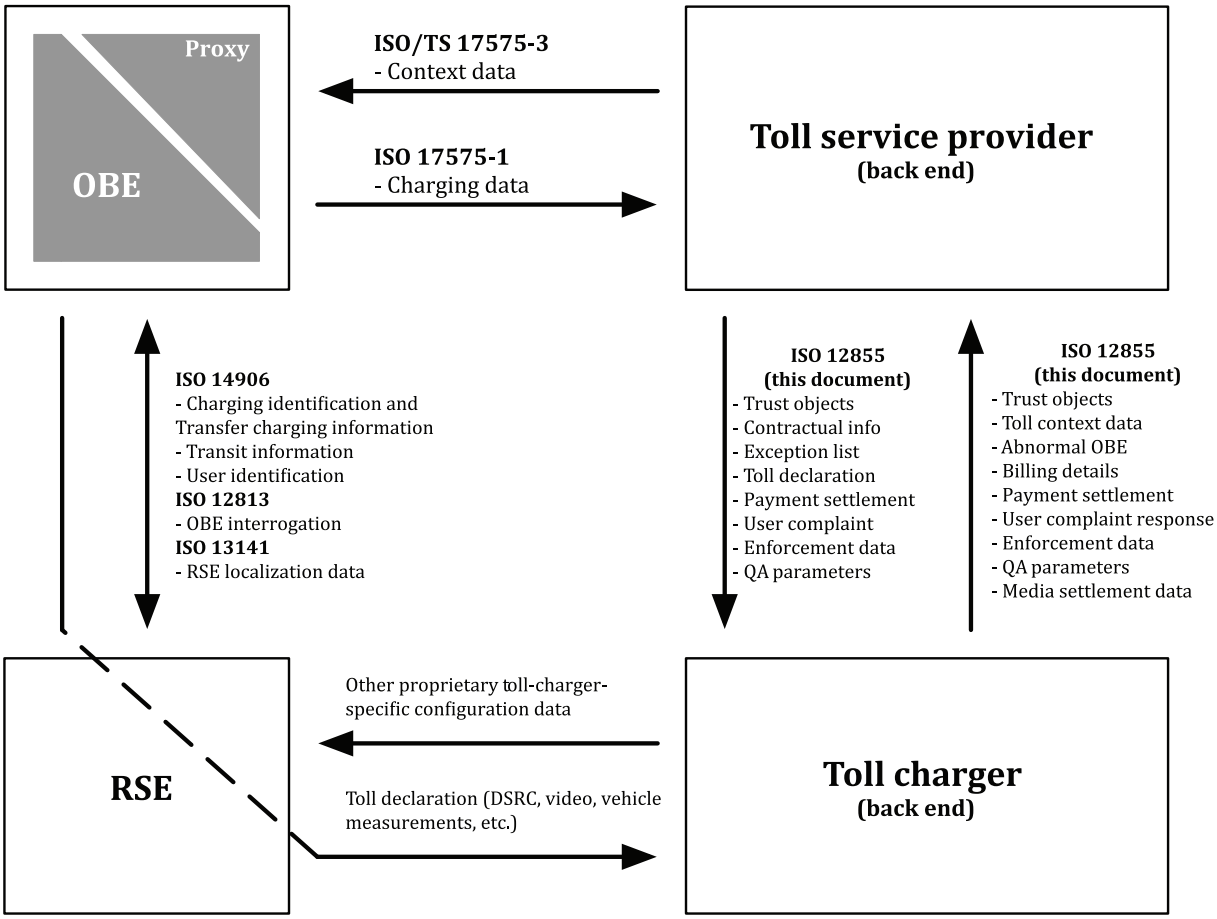

Key

DSRC dedicated short-range communication

QA quality assurance

RSE roadside equipment

Figure 1 — Scope of EFC-related International Standards

A given transport service for a given vehicle is fully identified by one or several toll declarations made available to the toll charger (TC). It is necessary to make toll declarations available according to the rules of the toll regime of the toll domain.

The amount due for a given transport service used by a vehicle liable to toll is finalized by the TC with the use of toll declarations (as described above) and calculations are made according to the rules of the toll regime (formula, tariff tables, specific situations rules, traffic conditions, etc.). This means that the TC has the authority to decide on the amount due, even if it decides to assign the toll service provider (TSP) the task of calculating the amount due.

The information above, associated with a given transport service, is referred to as "billing details"; for a given transport service, the billing details refer to one or several toll declarations.

Depending on the toll regime, billing details are computed by means of the information collected by the TC and/or the relevant TSP; they are finalized by the TC or by the TSP if the TC has assigned this task to the TSP.

The TC settles the payment claims (or toll payment claims) and makes them available to each TSP, or requires the TSP to send payment announcements, according to the bilateral agreements it has with each TSP, referring to billing details. These payment claims include an amount due, taking into account any specific commercial conditions applicable to a vehicle, a fleet of vehicles or a given TSP.

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This document defines a set of interactions in support of technical interoperability between back-office systems of TCs and TSPs. The EFC service and the EFC system model on which this document is based are defined in ISO 17573-1.

This document does not provide a full solution for interoperability and it does not define other parts of the EFC system, other services, other technologies and non-technical elements of interoperability. It is defined as a toolbox International Standard of application protocol data units (APDUs), which can be used for the assigned purpose. The detailed definitions of mandatory and optional elements in a real implementation are defined elsewhere. It does not define all communication sequences, communication stacks and timings.

The development of a common European Electronic Toll Service (EETS), as a part of the already cited European EFC Directive and related Regulation and Implementing acts, also calls for the definition of an interoperable EFC service. It should be noted that CEN/TS 16986 (to be revised and converted into a European Standard) specifies interoperable application profiles (IAP), applicable based on this document. These profiles define a specific coherent set of transactions, triggers, conditions, data elements, transfer mechanisms and supporting functions for an interoperable exchange of data between the back end system of TCs and TSPs. CEN/TS 16986 is consistent with and is intended to provide support for the technical specification of the EETS.

This document identifies and specifies the set of APDUs exchanged between two actors in the roles of TSP and TC as defined in ISO 17573-1. To specify these interfaces, this document uses the enterprise description of the toll environment, and the interactions defined between the named classes of roles, as defined in ISO 17573-1. This supports a complete specification of the data that is transferred between those identified entities. In addition, a number of computational interfaces are identified and interactions in terms of sequences of application protocol data units are defined.

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Electronic fee collection — Information exchange between service provision and toll charging

1 Scope

This document specifies:

— the interfaces between electronic fee collection (EFC) back-office systems for vehicle-related transport services, e.g. road user charging, parking and access control;

— an exchange of information between the back end system of the two roles of service provision and toll charging, e.g.:

  — charging-related data (toll declarations, billing details),

  — administrative data, and

  — confirmation data;

— transfer mechanisms and supporting functions;

— information objects, data syntax and semantics.

This document is applicable for any vehicle-related toll service and any technology used for charging.

The data types and associated coding related to the data elements described in Clause 6 are defined in Annex A, using the abstract syntax notation one (ASN.1) according to ISO/IEC 8824-1.

This document specifies basic protocol mechanisms over which implementations can specify and perform complex transfers (transactions).

This document does not specify, amongst others:

— any communication between toll charger (TC) or toll service provider (TSP) with any other involved party;

— any communication between elements of the TC and the TSP that is not part of the back-office communication;

— interfaces for EFC systems for public transport;

— any complex transfers (transactions), i.e. sequences of inter-related application data units (ADUs) that can possibly involve several application protocol data unit (APDU) exchanges;

— processes regarding payments and exchanges of fiscal, commercial or legal accounting documents; and

— definitions of service communication channels, protocols and service primitives to transfer the APDUs.

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 612, *Road vehicles — Dimensions of motor vehicles and towed vehicles — Terms and definitions*

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ISO 639-1, *Codes for the representation of names of languages — Part 1: Alpha-2 code*

ISO 1176, *Road vehicles — Masses — Vocabulary and codes*

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country code*

ISO 4217, *Codes for the representation of currencies*

ISO 8583-1, *Financial transaction card originated messages — Interchange message specifications — Part 1: Messages, data elements and code values*

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

ISO/IEC 8825-4, *Information technology — ASN.1 encoding rules — Part 4: XML Encoding Rules (XER)*

ISO/IEC 9594-8, *Information technology — Open systems interconnection — Part 8: The Directory: Public-key and attribute certificate frameworks*

ISO/IEC 9797-1:2011, *Information technology — Security techniques — Message Authentication Codes (MACs) — Part 1: Mechanisms using a block cipher*

ISO/IEC 10118-3, *IT Security techniques — Hash-functions — Part 3: Dedicated hash-functions*

ISO/IEC 11770-3, *Information security — Key management — Part 3: Mechanisms using asymmetric techniques*

ISO 13616-1, *Financial services — International bank account number (IBAN) — Part 1: Structure of the IBAN*

ISO/IEC 14888-2:2008, *Information technology — Security techniques — Digital signatures with appendix — Part 2: Integer factorization based mechanisms*

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

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

ISO/TS 17573-2, *Electronic fee collection — System architecture for vehicle related tolling — Part 2: Vocabulary*

ISO/IEC 18033-2, *Information technology — Security techniques — Encryption algorithms — Part 2: Asymmetric ciphers*

ISO 19299, *Electronic fee collection — Security framework*

ISO 20524-1:2020, *Intelligent transport systems — Geographic Data Files (GDF) GDF5.1 — Part 1: Application independent map data shared between multiple sources*

IETF RFC 4347, *Datagram Transport Layer Security, April 2006*

IETF RFC 5246, *The Transport Layer Security (TLS) Protocol, August 2008*

IETF RFC 5746, *Transport Layer Security (TLS) Renegotiation Indication Extension, February 2010*

IETF RFC 6040, *Tunnelling of Explicit Congestion Notification, February 2013*

W3C Recommendation *XML Signature Syntax and Processing Version 1.1*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 17573-2 apply.

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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/

4 Symbols and abbreviated terms

ADU application data unit

ANPR automatic number plate recognition

APCI application protocol control information

APDU application protocol data unit

BIC bank identifier code

CCC compliance check communication

CRL certificate revocation list

cXER canonical XML encoding rules

DSRC dedicated short-range communication

DST daylight saving time

DTLS datagram transport layer security

EFC electronic fee collection

FTP file transfer protocol

GDF geographical data file

GNSS global navigation satellite system

HOT high occupancy tolling

HTTPS hyper-text transfer protocol secure

IANA internet assigned numbers authority

IBAN international bank account number

ICC integrated circuit card

IEC International Electrotechnical Commission

ITU International Telecommunication Union

LAC localization augmentation communication

LPN licence plate number

NMEA National Marine Electronics Association

OBE on-board equipment

OBU on-board unit

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OCSP	online certificate status protocol
OSI	open systems interconnection
PAN	personal account number
QA	quality assurance
RINEX	receiver independent exchange format
RSA	Rivest, Shamir and Adleman
RSE	roadside equipment
SLA	service level agreement
SMTP	simple mail transfer protocol
SU	service user
TC	toll charger
TLS	transport layer security
TSP	toll service provider
UTC	coordinated universal time
VAT	value added tax
VPN	virtual private network
VRM	vehicle registration mark
XER	XML encoding rules

NOTE RSA is an algorithm for public-key cryptography, also referred to as asymmetrical cryptographic technique.

5 Architectural concepts and information exchanges

5.1 Main roles in the toll charging environment

This document is built upon ISO 17573-1.

ISO 17573-1 specifies the four main roles shown in Figure 2.

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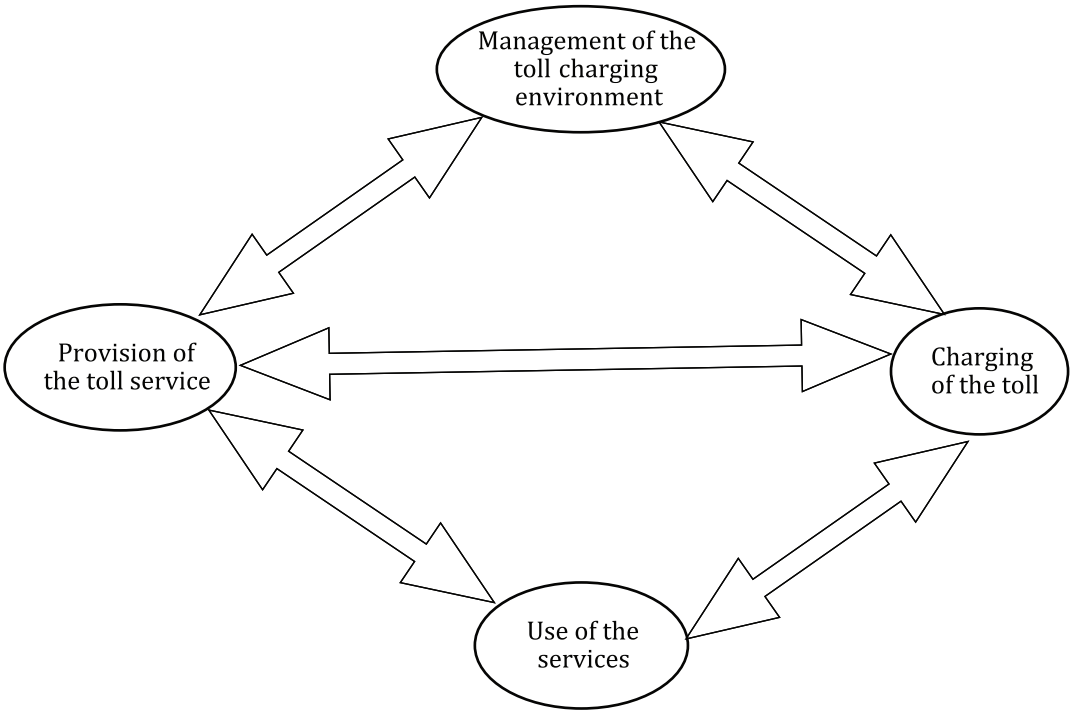

Figure 2 — Roles in the toll charging environment

Information exchanges are agreed upon between TC and TSP, taking into account privacy regulations. The information exchanges needed by the TC and the TSP to perform their roles are described in this clause.

5.2 Information exchange between toll charging and provision

5.2.1 General

The information exchange between the service provision and the toll charging roles supports the provision of functionalities that are based on the EFC system service specifications in ISO 17573-1. Figure 3 gives a general picture of the functionalities provided in this document.

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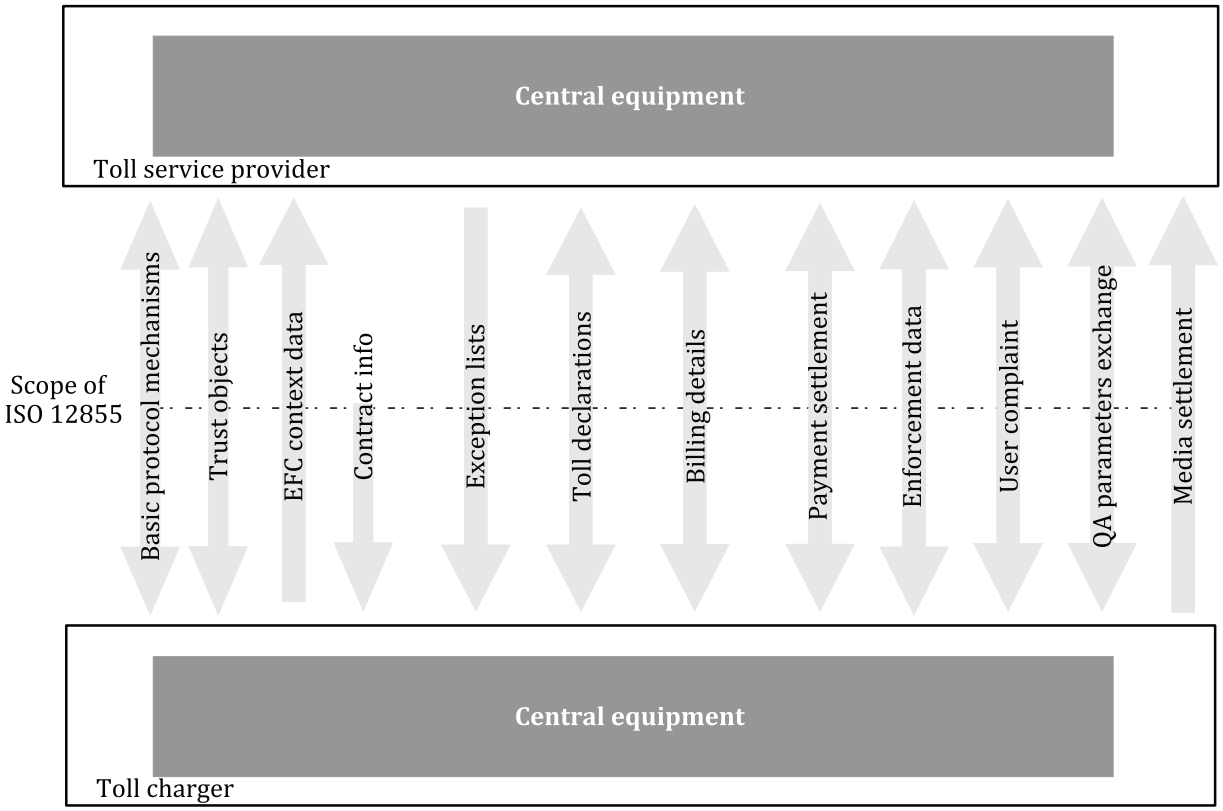

Figure 3 — Functionalities of this document (ISO 12855)

These functionalities are listed below, in the order in which they are given in Clause 5:

— basic protocol mechanisms;

— exchange trust objects;

— provide EFC context data;

— provide contract issuer list;

— manage exception list;

— report toll declarations;

— report billing details;

— payment settlement:

  — claim payment for service usage,

  — announce payments.

— exchange enforcement data:

  — exchange of user details,

— exchange of compliance check communication (CCC) events,

  — exchange of UserId lists,

— process user complaints:

  — provide a user complaint;

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  — response to a user complaint.

— exchange quality assurance parameters.

— provide media settlement data.

This document leaves implementers the freedom of specifying suitable protocol procedures, i.e. for complex transactions. Therefore, it only specifies:

— a basic interaction protocol (request – response) for information exchange;

— basic protocol mechanisms, to be used to build more complex protocol procedures; and

— the semantics and the format of the APDUs that are exchanged.

These functionalities are described in 5.2.2 to 5.2.13.

5.2.2 Basic protocol mechanisms

5.2.2.1 General approach

Information exchanges are performed by means of APDU transfers.

Some APDU transfers need to be acknowledged. When this happens, related protocol procedures are specified. This document specifies no provisions for complex transfers (transactions), i.e. sequences of inter-related ADUs which may involve several APDU exchanges. Instead, this document specifies basic protocol mechanisms to be used by implementations that need to specify and perform transactions.

This document provides the following basic protocol mechanisms to exchange information between the TSP's and the TC's back end system. These basic protocol mechanisms consist of:

— an identification schema for the APDUs that are exchanged,

— a generic interaction (i.e. not related to any specific functionality) that supports requesting a specific information exchange from the counterpart. This interaction is provided by the "request" ADU,

— a generic acknowledge mechanism (i.e. not related to any specific functionality) that supports acknowledging a specific interaction. The "ack" ADU provides this mechanism, and

— an optional generic status mechanism (i.e. not related to any specific functionality) that supports providing status information for a specific interchange. This mechanism is provided by the "status" ADU.

By means of the above mechanisms, an implementation can build more complex protocol procedures, including rollback, recovery, checkpoint or restart.

This document does not specify timings and retry procedures for acknowledgements. Timeouts can be specified as agreements between TC and TSP to cover the case of missing acknowledgements.

5.2.2.2 Identification schema

Each APDU contains a unique identifier in the namespace of the originator of the APDU. The combination of originator identifier and APDU identifier ensures that all APDUs are uniquely identified.

5.2.2.3 Request functionality

The request functionality is used to:

— alert the counterpart that one is ready to accept any kind of information exchange,

— inform the counterpart that one is ready to accept a specific type of ADU, by indicating the type of ADU one is ready to accept,

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— request the counterpart re-issue a specific APDU, by indicating the type and the identifier of the APDU, and

— request information identified by type and ADU content.

5.2.2.4 Acknowledgement functionality

The acknowledgement functionality is used to inform the counterpart that a specific ADU has been received correctly, or that errors have been detected.

5.2.2.5 Status functionality

The status functionality may be used to provide the counterpart with general status information about the interface or to inform it about a status on previously transferred information. It is used to:

— provide general information on the status of the interface,

— alert the counterpart that some previously provided information becomes invalid without any new information being currently available, and

— alert the counterpart that the previous information contained an error and should be recalled.

5.2.3 Exchange trust objects functionality

The exchange trust objects functionality is derived from the EFC system service "trust object exchange". The functionality is used whenever an entity, both TC and TSP, needs to send unsolicitedly new or updated trust objects to its counterpart or when asked by its counterpart to update or resend an already existing trust object.

NOTE Examples of trust objects are: asymmetric public keys, certificates, symmetric keys and certificate revocation lists.

Requiring the counterpart to send trust objects is performed by means of a "request" ADU. The "request" ADU supports requesting already issued trust objects to be resent, as well as requesting newly issued trust objects.

The exchange trust objects functionality provides the "trust objects" ADU to transfer the requested or newly generated trust objects to the counterpart, which has the possibility of confirming or rejecting the received trust objects by using the acknowledgement functionality.

The exchanged trust objects are valid from either the time of their acknowledgment or from the validity starting, if specified in the "trust object" ADU. Trust objects may also become valid based on bilateral agreements between TSP and TC (as defined in the implementation conformance statement).

5.2.4 Originating and providing EFC context data functionality

The originating and providing EFC context data functionality is derived from ISO 17573-1 as specified in the EFC system service "adding or modifying a toll regime".

The originating and providing EFC context data functionality gives a TC the possibility to communicate any change of a toll domain or toll regime, including the start of a new toll domain, by issuing an "EFC context data" ADU.

A TSP has the possibility of requiring a TC to provide information about the toll context data for a toll domain under its responsibility by using a "request" ADU. The TC provides the information requested by this "request" ADU by using an "EFC context data" ADU.

The TSP has the possibility to confirm reception of an "EFC context data" ADU by using the acknowledgement functionality.

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5.2.5 Provide contract issuer information functionality

The contractual information functionality supports a TSP in delivering to the TC any type of user contract related information that is stored in the OBE, among which the personal account number (PAN), the supported security level and the key set to be used in the calculation of dedicated short-range communication (DSRC) authenticators. This functionality supports, among others, the TC in comparing data retrieved from the OBEs with information received by the TSP.

5.2.6 Manage exception list functionality

5.2.6.1 General

The manage exception list functionality originates from ISO 17573-1 and is specified in the EFC system service "exceptions handling".

NOTE 1 This document uses the term "exception list" to summarize all possibilities of limiting the availability of transport services to a user or giving information on the special handling of an OBE in a toll regime. Other standards use different terms, but they are all included in the term "exception list".

NOTE 2 The conditions and the periods of time that a user can be accepted within a toll regime are limited by putting it on the exception list or removing it. This is solely the responsibility of the related TSP. Any information sufficient for the identification of a specific vehicle or OBE by the TC, e.g. OBE ID, PAN, LPN (licence plate number), are included in the exception list as agreed between TC and TSP.

5.2.6.2 Exception list entry requested by a toll charger

The manage exception list functionality supports a TC in notifying a TSP about detected violations by a specific service user or wrong technical behaviour by a specific OBE by using a "report abnormal OBE" ADU. The "acknowledgement" functionality is used to confirm reception of a "report abnormal OBE" ADU. Subsequently, this OBE may be included in the exception list of the TSP.

5.2.6.3 Exception list entry decided by the toll service provider

The manage exception list functionality supports a TSP in notifying a TC about additions, modifications or deletions of items in its exception lists by using the "exception list" ADU.

NOTE 1 The ADU can include, among others, one of the following reasons:

— the TSP has terminated its support/responsibility for a vehicle/OBE;

— an OBE was lost or stolen;

— the TSP has started/accepted its support/responsibility for a vehicle/OBE;

— the TC is informed about the commercial conditions to apply to an OBE (e.g. discount for a group of vehicles).

NOTE 2 The exception list can be used to provide additional information on a vehicle/OBE for a toll regime (e.g. specific commercial conditions) and/or limit or restrict the acceptance of an OBE within a toll regime operated via the road infrastructure of a TC, where an exchange of data between TSP and TC is needed.

NOTE 3 The exception list can be used to provide information on the country of registration of a vehicle and a value added tax identifier (VAT ID) to support a TC in the correct application of VAT for ferry operations, where this information is needed for handling of reverse charge VAT in the EU.

The TC may dispute the received exception list by using the acknowledgment functionality and transmitting an error code. In this case, the last correct list remains active in the systems of the TC until a newly transmitted list has been positively acknowledged by using the acknowledgement functionality.

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5.2.7 Report toll declarations functionality

The report toll declarations functionality originates from ISO 17573-1 and is specified in the EFC system service "collecting charging information (autonomous systems)".

NOTE 1 The charging data generated by an OBE is used to report a service user (SU) entering, moving around in or leaving a toll domain. A service usage statement with an amount due can be made either by a single tolled object or by a combination of several tolled objects. Any service usage is reported as charging data through an exchange of data between an OBE/proxy (front-end system) and the back end system managed by a TSP. This interface between front-end and TSP is specified in ISO 17575-1 and ISO 17575-3, and is not covered by this document.

The TSP has the possibility to enrich the gathered charging data that are stored in its back end system, before sending that data as a "toll declarations" ADU to the TC. This possibility supports the concept of shared user data, where only limited information may be included in the OBE, while the rest of it is held centrally at the issuing TSP.

The "toll declarations" ADU provides the TC with all information needed to calculate the amount due for the use of a toll domain or to verify the calculation done by the TSP, or it may contain only summary data, according to the optional data elements that are implemented.

NOTE 2 The toll declarations can be delivered periodically in an agreed frequency (e.g. weekly, daily, hourly, in real time, etc.) or upon triggering the delivery and with the quantity of information agreed for a toll regime.

The TC has the possibility to confirm a received "toll declaration" ADU by using the acknowledgement functionality.

NOTE 3 If the TC detects a contradiction between the toll declarations provided by the TSP and its own data (e.g. CCC data, LPN reading, etc.), it has the possibility to ask the TSP for additional information about the provided toll declarations for a specific vehicle or service user by sending a "request" ADU to the TSP to provide any detailed toll declarations for a specific service user and/or a specific period of time. This enables the TC to receive only summation records of the use of its toll domain from the TSP and to produce its billing details in normal operation without any detailed knowledge about each segment passed by an OBE. When the TC detects a contradiction in the provided high level toll declarations during comparison with the CCC data it recorded, it can ask the TSP for detailed toll declarations for this specific vehicle or Service User.

The procedure for handling a possible negative "ack" ADU as a response to a "toll declaration" ADU is outside the scope of this document.

5.2.8 Report billing details functionality

Depending on the characteristics of a toll system, a TC either acquires the toll declarations directly from the roadside equipment (RSE) it operates (e.g. DSRC-based systems) or receives it from the TSP's back end system (e.g. autonomous systems). That information is then used for the generation of billing details.

A single billing detail may refer to one or more toll declarations. The generation of billing details is based on the requirements specified for the toll regime. Thus, a billing detail may consist of:

— an elementary usage of a transport service (e.g. regarding the toll for a road section);

— several usages of a transport service within a given period of time (a day, a week, a month, etc.); or

— several elementary usages of a transport service within a given journey.

If some relevant information is missing to build a billing detail out of the available toll declarations, the TC has the possibility to request it from the back end system of the TSP (see 5.2.7).

The TC and TSP can agree to aggregate the generated billing details in order to reduce the number of lines to be processed in their bookkeeping systems. The TC and the TSP need to agree on common aggregation methods for billing details in order to avoid any rounding differences between VAT

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declarations for the local tax authorities (when applicable). Consequently, rounding rules are not defined in this document.

NOTE 1 Aggregation methods can be, for example:

— after generating the billing details, the TC aggregates any billing details prior to claiming the payment, if this is bilaterally agreed. A unique identifier (reference number) for each aggregate is generated during aggregation and associated with all billing details in order to link them to the derived payment claim. By this method, the TSP is always able to check the consistency of the payment claim with the billing details from which they stem;

— the TC and TSP agree to use the same aggregation process and aggregate the billing details independently from each other for the representation on the invoice in their own back end system to avoid any rounding differences.

See informative Annex E for an example of one possible solution to deal with the aggregation of billing details.

The TC or the TSP, depending on the respective operational model, have the possibility of transferring billing details by means of a “billing detail” ADU.

NOTE 2 The operational model of the TC in a global navigation satellite system (GNSS)-based environment can require the generating of any billing details and the maintaining of complete control over the usage of its toll domain. This is typically the case for privately operated TCs or road concessionaires. If a government body conducts the role of TC, on the other hand, it can only want to carry out spot checks to avoid the operational workload of being a TC in a GNSS environment. In this case, the TC can require the TSP to generate the "billing details" ADU to be sent to it.

It can be necessary for the recipient of a “billing details” ADU to check the completeness and the conformity of the provided billing details for a given service usage. Therefore, the billing details can optionally reference previously exchanged toll declarations so as to provide further information.

The recipient of a “billing details” ADU can accept or deny it by using the acknowledgement functionality.

5.2.9 Payment settlement functionality

5.2.9.1 Claim payment for service usage

The claim payment for service usage functionality is derived from ISO 17573-1 and is specified in the EFC system service “payment settlement”.

The claim payment phase may, for example, start once the billing details have been agreed between the TC and the TSP (see 5.2.8). In this case, the payment claim is based upon these agreed and possibly aggregated billing details.

The TC uses the claim payment functionality by sending a “payment claim” ADU to the TSP.

The “payment claim” ADU also gives the possibility of including additional claims for other services that do not directly derive from the bilaterally agreed billing details (e.g. overdue payment, reimbursement, penalties, etc.). Discounts may be specified as a particular type of payment claim, which may, for example, carry the reference to the services for which a discount has been applied, or they may be included at a later time in a separate payment claim as a credit note (e.g. when billing details for a whole month specified the discount level of a scaled discount scheme).

The “payment claim” is intended to contain or to address all information required according to each toll regime to be used for invoicing between the TC, the TSP and the service user.

NOTE 1 The payment claim can be used by the TSP to generate invoices for its customers (service users) on behalf of the relevant TC or for its own account (if the TSP is buying the toll from the TC and reselling it to the service user).

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The TSP can accept or refuse a received "payment claim" ADU by using the acknowledgement functionality.

NOTE 2 Possible reasons for dispute, among others, are inconsistency of the payment claim with received billing details or non-conformance of specific commercial conditions.

5.2.9.2 Payment announcement

The payment announcement functionality is derived from ISO 17573-1 and is specified in the EFC system service "payment settlement". This functionality supports a TSP in informing a TC of a payment that has been made consequently to the use of transport services. Unlike the payment claim functionality, the payment announcement functionality is initiated by the TSP either unsolicitedly or on request from the TC.

The TSP can use this functionality by sending a "payment announcement" ADU to the TC informing it about an upcoming payment. The information carried in the "payment announcement" ADU may include references to billing details, toll declarations or even single elements of a charge report.

The TC has the possibility of accepting or refusing a received "payment announcement" ADU by using the acknowledgement functionality.

5.2.10 Exchange enforcement data functionality

5.2.10.1 General

The exchange enforcement data functionality originates from ISO 17573-1 and is specified in the EFC system service "exceptions detection".

The exchange enforcement data functionality may be used each time a TC needs additional information for a compliance checking process. The compliance checking process consists of:

— verifying if the service user fulfils its obligation to co-operate; and

— gathering facts required for later performance monitoring and/or service level agreement (SLA) evaluation.

A subsequent offline process performed by the TC may:

— issue toll violation tickets for service users if the service user was responsible for the wrong toll declaration; and

— compare roadside observations with toll declarations received from the TSP and update the performance monitoring parameters with these results.

Even if the details on how to perform compliance checking/enforcement back end processes are left to the TCs, it can be necessary for some basic information exchange to be supported on both sides.

5.2.10.2 Retrieve user details functionality

The "request" ADU may be used by a TC to ask the TSP(s) whether they have a contractual relationship with a given service user identified in the ADU and/or to provide additional details on a service user by specifying the requested details.

This ADU can either be sent to a specific TSP or broadcasted to a group or all TSPs.

5.2.10.3 Provide user details

Provision of details of a given user is a functionality that supports a TSP in responding to a "request" ADU requiring user details. The functionality is performed by either sending a "provide user details"

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ADU that contains details about a contractual relationship with the given user, or by using the acknowledgement functionality with a specific negative reason code.

When details on a user are provided, the minimum set of data contained in a "provide user details" ADU includes the userId.

Any additional details about the service user depend on what is specified in the "request" ADU and on the actual availability of the requested data. The actual delivery of user details can be subject to local data protection regulations.

The TC may acknowledge any received "provide user details" ADU by using the acknowledgement functionality.

5.2.10.4 Retrieve and report CCC event

The retrieve and report CCC event functionality supports a TC either unsolicitedly or after receiving a "request ADU" from the TSP in delivering the details of any CCC events for a specific service user and/or a specific period of time.

This service is realized by issuing a "report CCC event" ADU.

The TSP can acknowledge any received "report CCC event" ADU by using the acknowledgement functionality.

5.2.10.5 List of users

The list of users functionality provides support to the TC in its enforcement activities and is useful in particular for detecting potential fraud. The functionality supports a TC in requesting, by means of a specific "request" ADU, information about all user identifiers that belong to a given service user (e.g. haulier).

5.2.11 Process user complaints functionality

The process user complaints functionality is derived from the ISO 17573-1 service "Providing customer care". In ISO 17573-1, the providing customer care service belongs in the group of services that involve the user and the TSP. This functionality specifies an aspect of customer care that involves interaction between the TC and the TSP to handle user complaints, covering the case where a previously accepted billing detail, possibly included in an accepted payment claim, is requested to be revoked because of a complaint by the user.

The TSP, after having examined a user complaint and verified it is well-founded, can deliver the complaint to the TC, by means of a "user complaint" ADU.

The TC can acknowledge any received "user complaint" ADU by using the acknowledgement functionality, thereby indicating that the complaint will be processed.

When processing of the user complaint is complete, the TC may signal the completion of the evaluation process by issuing a "user complaint response" ADU, thereby indicating the acceptance or the refusal of the user complaint.

5.2.12 Exchange quality assurance parameters functionality

The report quality assurance parameters functionality is derived from ISO 17573-1 and is specified in the EFC system service "monitoring operations".

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In ISO 17573-1, the report quality assurance parameters functionality is used to report and monitor the EFC activities of TCs and TSPs. In this document, it is used additionally to exchange any information necessary to monitor the quality of operations between the TC and the TSP.

EXAMPLE One of these quality assurance parameters is the detection rate (i.e. the percentage of detected OBE of a given TSP in a given toll regime of a TC). As it is important for both the TC and the TSP that the detection rate of the TSP's OBEs in a toll regime of a TC be as high as possible, this can need to be constantly monitored by an SLA level.

Types and ranges of quality assurance (QA) parameters are agreed upon between TCs and TSPs with bilateral agreements.

The functionality is used whenever an entity, both TC and TSP, needs to send unsolicitedly new or updated QA parameters to its counterpart or when asked by its counterpart to update or resend already sent QA parameters. It is performed by issuing a “report QA” ADU.

Requiring the counterpart to send QA parameters is performed by means of a “request” ADU. The “request” ADU supports requests for already issued QA parameters to be resent, and also requests additional QA parameters.

The receiver of a “report QA” ADU can acknowledge the received QA parameters by using the “acknowledgement” functionality.

5.2.13 Provide media settlement data functionality

The provide media settlement data functionality supports a TC in responding to a “request” ADU from a TSP asking payment settlement data to be transmitted to the media provider. This functionality is performed by means of the “media settlement data” ADU. The information in the “media settlement data” ADU is generated from a medium connected with an OBE independently of the used tolling technology.

The settlement is initiated by an OBE and transparently performed via the OBE from the RSE and/or central server. Media settlement data is provided to an OBE when a vehicle is passing close to a physical charging station in a DSRC-based system or whenever settlement data need to be generated in a GNSS-based system.

NOTE 1 Media settlement data contain evidence of payment settlement using a medium for both road charging and invoicing to the service user and are transmitted to the media provider via the TC and the TSP without any modification since they contain a tamper-proof code.

The toll service can confirm the received media settlement data by using the acknowledgment functionality.

NOTE 2 If the media provider has doubts and/or suspicions about received media settlement data, another recovery processing is performed by the TSP and the TC under a bilateral agreement with the media provider.

6 Computational specification

6.1 Overview

This clause specifies the computational objects for the information exchanges between TCs and TSPs. Each computational object is identified by:

— a name;

— the function(s) it performs; and

— the ADUs it is able to generate or accept.

For the sake of simplicity, the functionalities identified in the previous clauses correspond to computational objects in this clause. This means that the functions performed by each object have

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already been described in the previous clauses. A given computational object can be instantiated for the TSP or for the TC role, with the limitations and permissions stated as rules in the previous clauses. The fact that computational objects are modelled here as each having one logical interface for interactions does not put any limits on the number of real interfaces offered in an implementation of this document.

Table 1 lists the specified computational objects. For each object, the relevant interface interactions are listed, together with the limitations, permissions and obligations for each role derived by the rules specified in previous clauses.

An implementation conforming to this document shall declare which of the computational objects and related interactions listed in Table 1 are supported. For each implemented computational object and interaction, the implementer declares their support, and depending on the implementation's role (TC or TSP), the rules stated in Table 1 shall be obeyed, with the following meanings:

— may initiate: an entity is able and allowed to initiate an interaction;

— shall initiate: an entity is able and has to initiate an interaction;

— shall be able to receive: an entity shall be able to accept this kind of interaction. If a related ADU is not supported, the receiver shall respond with an ADU reason code "Not supported ADU".

Table 1 — Computational objects and interactions

Computational object	Interaction	TSP rules	TC rules
Exchange trust objects	Request	May initiate, shall be able to receive	May initiate, shall be able to receive
	Trust objects	May initiate, shall be able to receive	May initiate, shall be able to receive
	Acknowledge	Shall initiate, shall be able to receive	Shall initiate, shall be able to receive
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Originating and providing EFC context data and contractual information	Request (EFC context data)	May initiate	Shall be able to receive
	Request (contractual information)	Shall be able to receive	May initiate
	EFC context data	Shall be able to receive	May initiate
	Contractual information	May initiate	Shall be able to receive
	Acknowledge (EFC context data)	Shall initiate	Shall be able to receive
	Acknowledge (contractual information)	Shall be able to receive	Shall initiate
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Manage exception list	Request (exception list)	Shall be able to receive	May initiate
	Request (abnormal OBE)	May initiate	Shall be able to receive
	Exception list	May initiate	Shall be able to receive
	Report abnormal OBE	Shall be able to receive	May initiate
	Acknowledge (exception list)	Shall be able to receive	Shall initiate
	Acknowledge (report abnormal OBE)	Shall initiate	Shall be able to receive
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive

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Table 1 *(continued)*

Computational object	Interaction	TSP rules	TC rules
Toll declaration	Request	Shall be able to receive	May initiate
	Toll declaration	May initiate	Shall be able to receive
	Acknowledge	Shall be able to receive	Shall initiate
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Report billing details	Request	May initiate, shall be able to receive	May initiate, shall be able to receive
	Billing details	May initiate, shall be able to receive	May initiate, shall be able to receive
	Acknowledge	Shall initiate, shall be able to receive	Shall initiate, shall be able to receive
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Payment settlement	Request (payment claim)	May initiate	Shall be able to receive
	Request (payment announcement)	Shall be able to receive	May initiate
	Payment claim	Shall be able to receive	May initiate
	Payment announcement	May initiate	Shall be able to receive
	Acknowledge (payment claim)	Shall initiate	Shall be able to receive
	Acknowledge (payment announcement)	Shall be able to receive	Shall initiate
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Exchange enforcement data	Request (user details)	Shall be able to receive	May initiate
	Request (CCC event)	May initiate	Shall be able to receive
	Request (list of users)	Shall be able to receive	May initiate
	Provide user details	May initiate	Shall be able to receive
	Report CCC event	Shall be able to receive	May initiate
	List of Users	May initiate	Shall be able to receive
	Acknowledge (user details)	Shall be able to receive	May initiate
	Acknowledge (report CCC event)	Shall initiate	Shall be able to receive
	Acknowledge (list of users)	Shall be able to receive	May initiate
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Process user complaint	User complaint	May initiate	Shall be able to receive
	Acknowledge (user complaint)	Shall be able to receive	Shall initiate
	User complaint response	Shall be able to receive	May initiate
	Acknowledge (reception of user complaint response)	Shall initiate	Shall be able to receive

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Table 1 *(continued)*

Computational object	Interaction	TSP rules	TC rules
Exchange quality assurance parameters	Request	May initiate, shall be able to receive	May initiate, shall be able to receive
	Report QA	May initiate, shall be able to receive	May initiate, shall be able to receive
	Acknowledge (report QA)	Shall initiate, shall be able to receive	Shall initiate, shall be able to receive
	Status	May initiate, shall be able to receive	May initiate, shall be able to receive
Provide Media Settlement Data	Request	May initiate	Shall be able to receive
	Media settelement data	Shall be able to receive	May initiate
	Acknowledge (media settlement data)	Shall initiate	Shall be able to receive

The offering of an interface by an actor may require different behaviours depending on the activities to be performed with the exchange of information.

The interface interactions summarized in Table 1 are performed by exchanging open systems interconnection (OSI) application layer APDUs. They are described in detail in the following subclauses and are formally defined in Annex A. In case of any conflict between this description and the definition in Annex A, the definition in Annex A takes precedence.

To facilitate reading, the following conventions are adopted in subclause 6.2:

a) the names and values of the fields in APDUs are in **boldface**;

b) the corresponding ASN.1 types are written using `Courier` font.

6.2 Application protocol data units

6.2.1 General

The APDU content is formally defined in Annex A by the ASN.1 type InfoExchange, which is made of the following elements:

a) a mandatory **infoExchangeContent** field;

b) an optional **infoExchangeAuthenticator** field.

Table 2 describes the fields in the infoExchange APDU.

Table 2 — InfoExchange APDU fields

Field name	Data type/data description	m/o
infoExchangeContent	`InfoExchangeContent`. Actual content of the APDU. See Table 3.	m
infoExchangeAuthenticator	`AuthenticatorEfc`. Record (ASN.1 SEQUENCE) made of two fields of types `authenticatorEfc`, and `ackAuthenticatorEfc`	o

Each **infoExchangeContent** field shall contain one **apci** field and one **adus** field as specified in the `InfoExchangeContent` data type (see Table 3).

Any APDU may optionally be signed by calculating an authenticator over the **infoExchangeContent** field. The calculated authenticator shall be included as **infoExchangeAuthenticator** in the resulting APDU. Semantics of the two fields of the **infoExchangeAuthenticator**, as well as the algorithms used to calculate them, are specified in 7.3.2.

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The **infoExchangeAuthenticator** is a dynamic object and shall be generated each time a new APDU is issued. The **infoExchangeAuthenticator** can be calculated by either the APDU originator or the information sender (see 6.2.2).

Table 3 indicates the fields in the `InfoExchangeContent` data type, which is defined in Annex A.

Table 3 — InfoExchangeContent data type fields

Field name	Data type/data description	m/o
apci	`ApciFields`. Record (ASN.1 SEQUENCE) containing protocol control information	m
adus	`Adus`. Contains one or more (ASN.1 SEQUENCE OF) ADUs of the same type, as a selection (ASN.1 CHOICE) among the types of specified ADUs.	m

A top-level view of the structure of `InfoExchangeContent` data type and its fields is given in Figure 4.

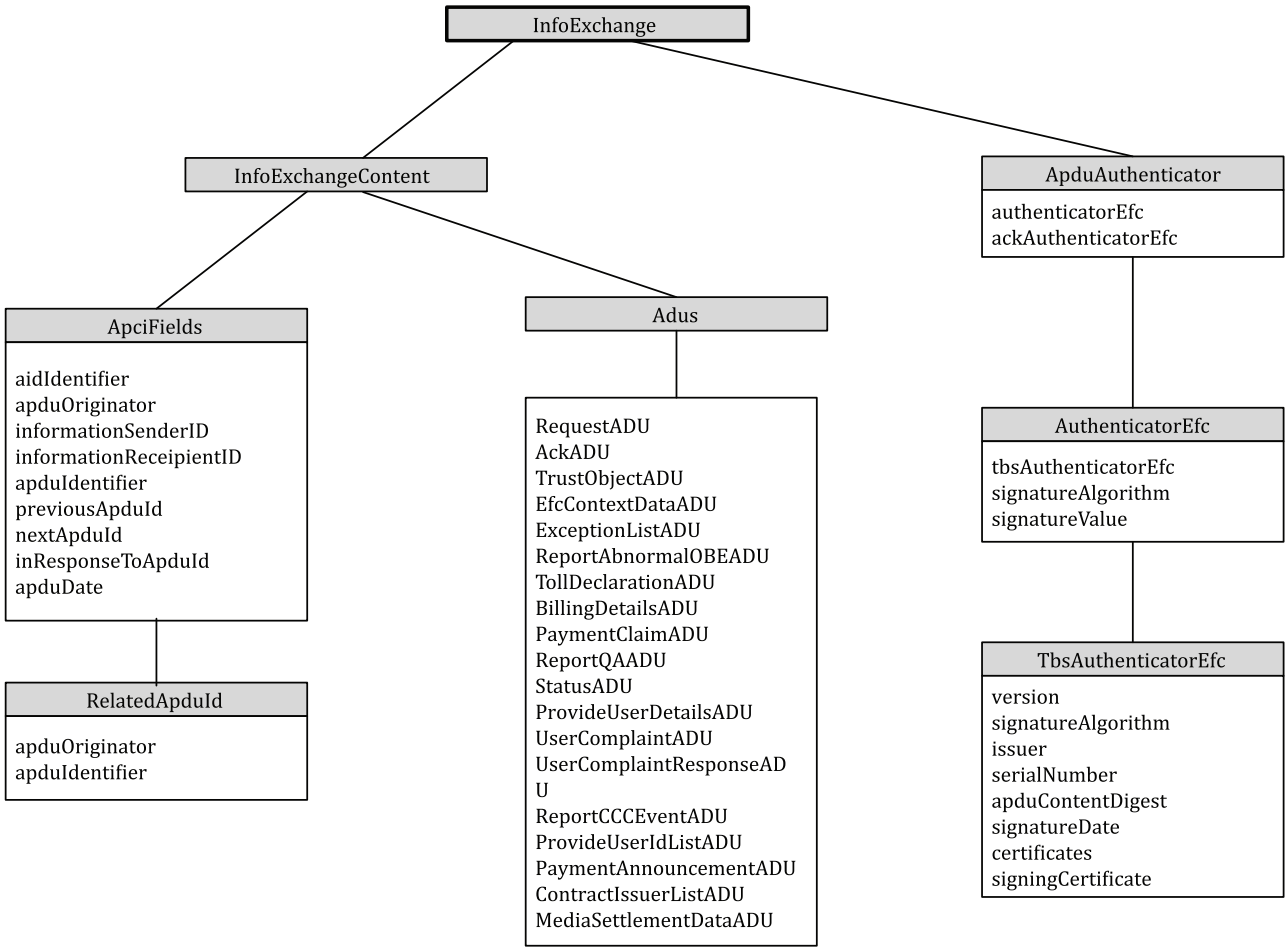

Figure 4 — InfoExchange data type structure

The following subclauses describe the APCI and the ADUs for the specified APDUs.

APDUs are described in the following terms:

a) tables that list the parameters that make up the APDUs. For each table, the parameter names are listed, together with an indication of their fields and formats and whether the parameter is mandatory (m) or optional (o). The parameter description is indicative and is formally specified in Annex A. In cases where there are discrepancies, the formal definition in Annex A takes precedence;

b) additional tables are inserted to better describe parameters with a complex structure;

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c) additional semantics definition and usage of each parameter are given as text after each table.

6.2.2 Application protocol control information (APCI)

The APCI for all APDUs shall consist of the fields described in Table 4.

Table 4 — APCI fields

Field name	Data type/data description	m/o
aidIdentifier	`AidIdentifier`. Integer ranging from 0 to 255	m
apduOriginator	`Provider`	m
informationSenderId	`Provider`	m
informationRecipientId	`Provider`	m
apduIdentifier	`ApduIdentifier`. Integer ranging from 0 to 2^{63}-1	m
previousApduId	`RelatedApduId`	o
nextApduId	`RelatedApduId`	o
inResponseToApduId	`RelatedApduId`	o
apduDate	`GeneralizedTime`	m

aidIdentifier shall identify the protocol version number. The following values are specified:

— **iso12855x2015,** which identifies the 2015 version of the IS document;

— **isoDIS12855x2020,** which identifies the 2020 version of the DIS document;

— **isoFDIS12855x2021,** which identifies the 2021 version of the FDIS document;

— **iso12855x2022,** which identifies the 2022 version of the IS document;

— **cen16986x2016,** which identifies the 2016 version of the CEN 16986 profile of the 2015 version of the IS 12855.

— **cen16986x2022,** which identifies the 2022 version of the CEN 16986 profile of the 2022 version of the IS document.

In addition to the values specified above and the ranges of ISO/CEN reserved values, a range of values is reserved for private usage. Private versions shall be identified by one of these values in association with the informationSenderId value.

apduOriginator shall be the identifier of the entity originating the contents of the APDU, which can be either a TC or a service provider. This may be, but is not necessarily, the actual sender of the information.

informationSenderId shall identify the entity actually sending the APDU. It may be used to identify a technical entity supporting the apdu originator in the task of transferring information. It may contain the same identifier as the **apduOriginator** field, when the originator and the sender are the same entity.

informationRecipientId shall identify the entity responsible for processing the content of the APDU and is an entity of type TC or service provider. In some APDUs a null value is admitted for this field, with the special meaning to indicate that the ADU is intended for more than one recipient. If the values of both the CountryCode and the IssuerIdentifier fields of informationRecipientId are zero, the PDU is meant to be sent to all connected entities. If only the value of the IssuerIdentifier is zero, the PDU is meant to be sent to all entities of the stated country.

apduIdentifier shall be a unique identifier for each given apdu originator that is assigned by the APDU originator themselves. It is used to either acknowledge or request retransmission of a previously issued APDU.

previousApduId may optionally be used to indicate that the APDU is related to a previously sent APDU from the apdu originator. If used, it shall identify the APDU in terms of the identifier of the originator

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(of type `Provider`) and of the unique APDU identifier (of type `INTEGER` defined as `Int8Unsigned`) within the originator. It shall not be used if no APDU has been sent by the originator yet. This field, together with the **nextApduId** field, may be used to identify chains of APDUs. The `RelatedApduId` data type is a record (ASN.1 SEQUENCE) of:

— **apduOriginator**, of type `Provider` which shall identify the APDU originator;

— **apduIdentifier**, of type `ApduIdentifier` which shall identify the APDU within **apduOriginator**.

nextApduId may optionally be used to indicate that the APDU is related to a next to be sent APDU from the APDU originator. This field, together with the **previousApduId** field, may be used to identify chains of APDUs.

inResponseToApduId may optionally be used to indicate that the APDU is either a response to a request or an ACK. It may be needed to identify a chain of APDUs to be processed in a workflow.

apduDate shall specify a time stamp for the APDU.

6.2.3 Application data units

The ADUs field shall contain (ASN.1 SEQUENCE OF) one or more data structures of the same type.

The ADUs listed in Table 5 are specified in this document.

Table 5 — ADUs overview

Functionality	ADU type name	Description
Basic	`RequestAdu`	Generic request
	`AckAdu`	Generic acknowledge
	`StatusAdu`	Generic status
Exchange trust objects	`TrustObjectAdu`	Send trust objects
Provide EFC context data	`EfcContextDataAdu`	Send EFC context data
Provide contract issuer information	`ContractIssuerListAdu`	Provide information on contract issuer
Manage exception lists	`ExceptionListAdu`	Send exception list
	`ReportAbnormalObeAdu`	Report abnormal OBE
Report toll declarations	`TollDeclarationAdu`	Toll declaration
Report billing details	`BillingDetailsAdu`	Billing details
Payment settlement	`PaymentClaimAdu`	Payment claim
	`PaymentAnnouncementAdu`	Payment announcement
Exchange enforcement data	`ProvideUserDetailsAdu`	Provide user details
	`ReportCccEventAdu`	Report CCC event
	`ProvideUserIdListAdu`	Provide a user list
Exchange QA parameters	`ReportQaAdu`	Report QA
Process user complaint	`UserComplaintAdu`	Send a user complaint
	`UserComplaintResponseAdu`	Reply to a user complaint
Provide media settlement data	`MediaSettlementDataAdu`	Send media settlement data

These data structures are specified in 6.3 to 6.21.

6.2.4 ADU identification

Each ADU is identified by a mandatory field named **aduIdentifier** of type `AduIdentifier`, which is defined as an integer ranging from 0 to 2^{63}-1. The field **aduIdentifier** is specified by the ADU originator with the rule that the **aduIdentifier** shall be unique within the ADU type. With that rule, considering

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that each ADU originator is univoquely identified by its **providerId**, each ADU may be univoquely identified by a triple of identifiers of types `ProviderId`, `AduType`, and `AduIdentifier`.

To ensure backwards compatibility, there is also another way to identify a toll declaration in the `TollDeclarationAdu` by the means of the value of its **tollDeclarationId** field (see Table 80).

To ensure backwards compatibility, there is also another way to identify a billing detail in the `BillingDetailsAdu` by the means of the value of its **billingDetailsInfo** field (see Table 84).

6.2.5 ADU action code

When sending or requesting an ADU, an action code may optionally be specified, to indicate to the receiver of the ADU which action is supposed to be done with that ADU. While the exact behaviour to be followed is implementation-specific and varies from ADU to ADU, the following generally available values are specified in this document:

— **send**, which specifies a normal (probably initial) sending of the ADU

— **revoke**, which specifies a revocation of a previously sent ADU

— **adjust**, which specifies an adjustment of a previously sent ADU

— **resend**, which specifies a resending of an ADU

6.2.6 User identification

A data type used in most ADUs to identify a user is the `UserId` data type. As a user can be identified in various ways, and by different methods, the `UserId` data type is represented as a series (ASN.1 SEQUENCE) of different types, all optional. However, when the data type `UserId` is used, at least one of the fields shall be specified. The structure of the `UserId` data type is shown in Table 6 and is formally specified as per Annex A.

Table 6 — UserId fields

Field name	Data type	m/o
pan	`PersonalAccountNumber`	o
contractSerialNumber	`ContractSerialNumber`	o
licencePlateNumber	`LPN`	o
obeId	Record (ASN.1 SEQUENCE) made of the following fields: **manufacturerId**, **equipmentObuId**	o
equipmentIccId	`EquipmentIccId`	o
customerId	`OCTET STRING`	o

pan may optionally be used to identify the user by their personal account number. It shall be used as specified in ISO/TS 17573-3.

contractSerialNumber may optionally be used to identify the user by their contract serial number. It shall be used as specified in ISO/TS 17573-3.

licencePlateNumber may optionally be used to identify the user by the licence plate number of the user's vehicle. It shall be used as specified in ISO/TS 17573-3.

obeId may optionally be used to identify the user by the OBE identifier of the user. The **obeId** field is made of the following data elements:

— **manufacturerId** which shall be used to uniquely identify the OBE manufacturer. It shall be used as specified in ISO 14906;

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— **equipmentObuId** which shall be used to uniquely identify the OBE within the manufacturer. It shall be used as specified in ISO/TS 17573-3.

equipmentIccId may optionally be used to identify the integrated circuit card (ICC) which may be associated to a user of EFC equipment for the purposes of identification of payments. It shall be used as specified in ISO/TS 17573-3.

customerId may optionally be used to identify the user by means of their identifier as a TSP customer.

6.3 RequestAdu data structure

The `RequestAdu` data type is used to indicate a general readiness to receive, or to specifically request a data structure to be sent.

The `RequestAdu` type is a selection (ASN.1 CHOICE) among different substructures, each one specifying a different type of request. Table 7 describes the fields specified as CHOICE in the data structure, which is formally defined in Annex A.

Table 7 — RequestAdu fields

Field name	Data type/data description	m/o
genericRequest	Record (ASN.1 SEQUENCE) made of the following fields: **apduIdentifier**, **requestedAduType**, **aduIdentifier**, **actionCode**	N/A
exceptionListRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(exceptionListRequest), **aduIdentifier**, **period**, **exceptionListType**, **exceptionListVersion**, **actionCode**	N/A
trustObjectRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(trustObject), **aduIdentifier**, **trustObjectSpec**, **actionCode**	N/A
tollDeclarationRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(TollDeclaration), **aduIdentifier**, **userId**, **startTime**, **endTime**, **actionCode**	N/A
userDetailsRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(userDetails), **aduIdentifier**, **userId**, **listOfParametersRequested**, **userDetailsRequestReason**, **period**, **actionCode**	N/A
cccEventRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(reportCCCEventAdu), **aduIdentifier**, **userId**, **startTime**, **endTime**, **actionCode**	N/A
userListRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(provideUserIdListAdu), **aduIdentifier**, **userIdRequestType**, **userId**, **userIdRequestTime**, **actionCode**	N/A
mediaSettlementDataRequest	Record (ASN.1 SEQUENCE) made of the following fields: **requestedAduType**(mediaSettlementDataAdu), **aduIdentifier**, **period**, **equipmentIccId**, **mediaSettlementListVersion**, **actionCode**	N/A

If the **genericRequest** is selected, the following rules apply:

— If none of the fields is specified, the RequestAdu indicates a general readiness to receive;

— **apduIdentifier** may optionally be used to request that the APDU carrying the same identifier be (re) sent. If the **apduIdentifier** is specified, neither the **requestedAduType** nor the **aduIdentifier** may be specified. If the **apduIdentifier** is not specified, the **requestedAduType** or the **aduIdentifier** may be specified;

— if the **requestedAduType** field is specified, an ADU of the indicated data type is expected. It is used to indicate generic readiness to receive ADUs of the indicated type;

— **aduIdentifier** is a list (ASN.1 SEQUENCE OF) of identifiers of type `AduIdentifier` which may optionally be used to ask for retransmission of the specified ADU's. If **aduIdentifier** is specified, then **requestedAduType** shall be also specified, to indicate the type of the ADU's to be re-transmitted;

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— **actionCode** may optionally be used to indicate specific actions to be pursued by the receiver of the requestAdu (see 6.2.5).

If the **exceptionListRequest** is selected, the following rules apply:

— **requestedAduType** field shall bear the value **exceptionListAdu**;

— if no optional fields are specified, this indicates generic readiness to receive ADUs of the ExceptionList type. In this case it is recommended to use a **genericRequest**, with the **requestedAduType** field bearing the value **exceptionListAdu**;

— **aduIdentifier** may optionally be used to identify the exceptionListAdu to be re-transmitted.

— **period** field may optionally be used to request to retransmit all ExceptionList ADUs that are related to the given period of time. If **period** is not specified, the request is not limited to a specific period of time;

— **exceptionListType** field may optionally be used to request to re-transmit all ExceptionList ADUs that are of the specified type;

— **exceptionListVersion** field may optionally be used to request to retransmit all ExceptionList ADUs that are of the specified version. If the field is not specified, the last available version is meant;

— **actionCode** may optionally be used to indicate specific actions to be pursued by the receiver of the requestAdu (see 6.2.5).

If the **trustObjectRequest** is selected, the following rules apply:

— **requestedAduType** field shall bear the value **trustObjectAdu**;

— if no optional fields are specified, this indicates generic readiness to receive ADUs of the `TrustObject` type. In this case it is recommended to use a **genericRequest**, with the **requestedAduType** field bearing the value **trustObjectAdu**;

— **aduIdentifier** may optionally be used to identify the requested TrustObjectAdu to be re-transmitted. If the **aduIdentifier** is specified, the **trustObjectSpec** field shall not be set;

— **trustObjectSpec** may optionally be used to specify the type and purpose of the requested trust object. The type of the trust object requested shall be specified in the field typeOfTrustObject, of type `RequestedTrustObjectType`, which is a selection (ASN.1 CHOICE) of:

  — certificates;

  — public keys;

  — DSRC master keys;

  — MAC master keys;

  — DSRC key references;

  — other trust objects.

  Detailed descriptions of trust objects types and purposes are in subclause 6.6.

  NOTE This document does not limit the use of individual combinations of trust object types and trust object purposes. In real systems, however, some of the theoretically possible combinations of these two parameters do not make sense and are not normally used in implementations. The correct use of these parameters remains under the responsibility of the implementor(s) and/or the entities operating the TC and TSP systems.

— **actionCode** may optionally be used to indicate specific actions to be pursued by the receiver of the requestAdu (see 6.2.5).

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If the **tollDeclarationRequest** is selected, the following rules apply:

— **requestedAduType** field shall bear the value **tollDeclarationAdu**;

— if no optional fields are specified, this indicates generic readiness to receive ADUs of the TollDeclaration type. In this case it is recommended to use a **genericRequest**, with the **requestedAduType** field bearing the value **tollDeclarationAdu**;

— **aduIdentifier** may optionally be used to identify the requested TollDeclarationAdu to be re-transmitted. If the **aduIdentifier** is specified, the **userId**, **startTime,** and **endTime** fields shall not be specified;

— **userId** field may optionally be used to identify the user for which toll declarations are requested;

— **startTime** field may optionally be used to indicate a start of a period for which toll declarations are requested;

— **endTime** field may optionally be used to specify the end of a period for which toll declarations are requested. If **endTime** is specified, then the **startTime** shall be specified as well;

— **actionCode** may optionally be used to indicate specific actions to be pursued by the receiver of the requestAdu (see 6.2.5).

If the **userDetailsRequest** is selected, the following rules apply:

— **requestedAduType** field shall bear the value **provideUserDetailsAdu**;

— **aduIdentifier** may optionally be used to identify the requested UserDetailsAdu to be re-transmitted;

— **userId** field shall specify the identifier of the user for which additional details are requested;

— **listOfParametersRequested** may optionally be used to specify which additional parameters, if any, are required. If this field is not specified, then the response shall contain all available details;

— **userDetailsRequestReason** may optionally be used to specify the reason for the request;

— **period** may optionally be used to request user information related to the specified period in time, including cases where user information is varied during the period. If not specified, it is the currently available user information that is to be requested;

— **actionCode** may optionally be used to indicate specific actions to be pursued by the receiver of the requestAdu (see 6.2.5).

If the **cccEventRequest** is selected, the following rules apply:

— **requestedAduType** field shall bear the value “reportCCCEventAdu”;

— if no optional fields are specified, this indicates generic readiness to receive ADUs of the reportCccEvent type. In this case it is recommended to use a **genericRequest**, with the **requestedAduType** field bearing the value **reportCCCEventAdu**;

— **aduIdentifier** may optionally be used to identify the requested **reportCCCEventAdu** to be re-transmitted;

— **userId** field may optionally be used to specify the identifier of the user for which the CCC events are requested;

— **startTime** field may optionally be used to specify a start of a period for which CCC events are requested;

— **endTime** field may optionally be used to specify the end of a period for which CCC events are requested. If **endTime** is specified, the **startTime** shall be specified as well;

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— **actionCode** may optionally be used to indicate specific actions to be pursued be the receiver of the requestAdu (see 6.2.5).

If the **userListRequest** is selected, the TC is meant to request a TSP to provide information on vehicles that belong to the same Service User. The following rules apply:

— **requestedAduType** field shall bear the value "**provideUserIdListAdu**";

— **aduIdentifier** may optionally be used to identify the requested `provideUserIdListAdu` to be re-transmitted;

— **userIdRequestType** field shall indicate the type of request. Currently, only one value is defined: **allUserIdsToGivenCustomer**;

— **userId** field may optionally be used to identify a vehicle or OBE that is known to the TC and where further vehicles or OBEs are requested that belong to the same service user. If the **userId** field is not specified, the request is intended to retrieve the identifiers of all service users of that TSP as filtered by the value of **userIdRequestType**;

— **userIdRequestTime** field may optionally be used to specify a point of time. If this attribute is specified, the TSP shall answer to the request based on data valid at the provided point of time and not at the time of the request. If this attribute is not specified, the latest information shall be provided;

— **actionCode** may optionally be used to indicate specific actions to be pursued be the receiver of the requestAdu (see 6.2.5).

If the **mediaSettlementDataRequest** is selected, the following rules apply:

— **requestedAduType** field shall bear the value "**mediaSettlementDataAdu**";

— if no optional fields are specified, this indicates generic readiness to receive ADUs of the `mediaSettlementData` type. In this case it is recommended to use a **genericRequest**, with the **requestedAduType** field bearing the value "**mediaSettlementDataAdu**";

— **aduIdentifier** may optionally be used to identify the requested mediaSettlementDataAdu to be re-transmitted;

— **period** may optionally be used to request to re-transmit all MediaSettlementDataAdus that are related to the given period of time;

— **equipmentIccId** may optionally be used to request to re-transmit all MediaSettlementDataAdus that contain the specified identifier;

— **mediaSettlementListVersion** may optionally be used to request to re-transmit MediaSettlementDataAdus that are of the specified version. If the field is not specified, the last available version is meant;

— **actionCode** may optionally be used to indicate specific actions to be pursued be the receiver of the requestAdu (see 6.2.5).

6.4 AckAdu data structure

The `AckAdu` data type is used to indicate that a specific data structure has been received. It can optionally indicate acceptance or rejection of the previously received data structure, or of the whole APDU that transported the data structure. When transferring this ADU, the value in the **informationRecipientID** field of the APCI shall identify a valid entity (a null value is not permitted).

Table 8 describes the fields in an `AckAdu` data type, which is formally defined in Annex A.

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Table 8 — AckAdu fields

Field name	Data type/data description	m/o
apduIdentifier	`ApduIdentifier`. Integer ranging from 0 to 2^{63}-1	m
apduAckCode	`ApduReasonCode`. Integer ranging fro 0 to 255 (see Table 9)	m
apduAckText	`UTF8String`	o
issues	List of records (ASN.1 SEQUENCE OF SEQUENCE), each record defined as per Table 10	o
actionCode	`ActionCode`	o

apduIdentifier shall identify the APDU containing the data structure(s) being acknowledged.

apduAckCode shall contain the status of the APDU or a reason for accepting or rejecting the APDU. The **apduAckCode** accepts or rejects an APDU as a whole. If an APDU is accepted, there can be additional responses on individual elements of the APDU (ADUs). A single ADU could be rejected while the APDU itself is accepted. This is dealt with by using the optional **issues** field (see below). If the **apduAckCode** indicates rejection, the whole APDU is rejected, irrespective of the possible acceptance codes indicated in the **issues** field. The values defined in this document for **apduAckCode** are listed (in decimal notation) in Table 9.

Table 9 — ApduReasonCode values

Name	Semantics	Value
reserved	Code reserved for future ISO/CEN extensions.	0
obsoleteApdu	The APDU is no longer valid or to be used.	1
apduOk	The APDU was accepted.	2
apduNotOk	The APDU was rejected.	3
sequenceError	The APDU was rejected because the APDU was sent out of the logical sequence of a transaction.	4
otherReason	The APDU was rejected. No predefined APDU reason code could be used, or a bilateral agreement on the APDU reason code exists.	5
protocolVersionError	The APDU was rejected because the Protocol Version used is not supported by the recipient.	6
originatorRejected	The APDU was rejected because the Apdu Originator is not known, or no valid contract exists.	7
recipientUnknown	The APDU was rejected because the Information Recipient is not known, or no valid contract exists.	8
relatedApduUnknown	The APDU was rejected because the related APDU is unknown or the transaction was finished.	9
requestSentTooOften	The APDU was rejected because the request was sent too often or to early (processing of similar request still active).	10

The following rules apply for handling the reception of an AckAdu:

— if the **apduAckCode** field indicates rejection (value of apduNotOk), the whole referred APDU is rejected;

— if the **apduAckCode** field indicates acceptance, the referred APDU is accepted (syntactically and semantically correct;

apduAckText of type `UTF8String` may optionally be used to add a text to further explain the reason for accepting or rejecting the APDU.

EXAMPLE A number of ADUs of the type `BillingDetails` have been transferred in a previous APDU. The receiver accepts one specific BillingDetail and rejects all others. To do so, the receiver sends an AckAdu with the apduAckCode set to **apduOk** and indicates for each of the rejected ADUs the reason for rejection.

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issues may optionally be used to list detailed error and/or warning information that respond to multiple instances of ADUs in the APDU being acknowledged. This supports the system in accepting an APDU as a whole, but to possibly individually reject single ADUs. The data structure of issues is specified in Table 10.

actionCode may optionally be used to indicate the action associated with the specific ADU (see 6.2.5).

Table 10 — issues fields

Field name	Data type/data description	m/o
issueAduIdentifier	`AduIdentifier`	o
issueLocation	`UTF8String`	o
issueContent	`UTF8String`	o
issueCode	`INTEGER`	m
issueText	`UTF8String`	o

issueAduIdentifier may optionally be used to specify the unique identifier of the ADU that contains an issue. It shall not be specified if the issue applies to all ADUs within the APDU.

issueLocation may optionally be used to address the location of the issue within the ADU by using XPath expression.

issueContent may optionally be used to provide further information on the content of the issue. The usage of this attribute is based on bilateral agreements between TC and TSP.

issueCode shall contain the reason code (see Table 11) of an issue.

issueText may optionally be used to provide a description of the issue. The usage of this attribute is based on bilateral agreements between TC and TSP.

Some values of the **AduReasonCode** field are reserved for CEN and ISO use. The values that are specified in this document are listed (in decimal notation) in Table 11 and are formally defined in Annex A. The value of the **AduReasonCode** provides feedback information to the sender or originator of an ADU about the acceptance or rejection of an ADU that was received and processed by the information recipient.

Table 11 — AduReasonCode values

Name	Semantics	Value
invalidAdu	The specified ADU is invalid.	0
notSupportedAdu	The specified ADU is not supported.	1
aduPartiallyRejected	Part of the specified ADU is rejected.	2
reserved	Codes reserved for general ADU-related errors.	3 .. 99
trustObjectExpired	The exchanged trust object is no longer valid.	100
trustObjectUnreadable	The received trust object is not readable.	101
reserved	Codes reserved for trust object data exchange errors.	102 .. 199
contextDataChargeObjectIdRejected	The charge object Id in context data has been rejected.	200
contextDataChargeObjectDescriptionRejected	The charge object description has been rejected.	201
contextDataSystemTypeRejected	The system type in context data has been rejected.	202
contextDataChargeObjectTypeRejected	The type of charge object in context data has been rejected.	203

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Table 11 *(continued)*

Name	Semantics	Value
contextDataTollChargerRejected	The TC in context data has been rejected.	204
contextDataChargeObjectValidityStartRejected	The start of validity of the charge object in context data has been rejected.	205
contextDataChargeObjectValidityEndRejected	The end of validity of the charge object in context data has been rejected.	206
reserved	Codes reserved for context data exchange errors.	207 .. 299
reserved	Codes reserved for contract issuer exchange errors.	300 .. 399
exceptionListsVersionRejected	The exception list version has been rejected.	400
exceptionListsTypeRejected	The type of exception list has been rejected.	401
exceptionListsUserIdRejected	The user ID in exception list has been rejected.	402
exceptionListsStatusTypeRejected	The type of status in exception list has been rejected.	403
exceptionListsReasonTypeRejected	The reason code in exception list has been rejected.	404
exceptionListsDateAndTimeRejected	The date and time in exception list has been rejected.	405
reserved	Codes reserved for exception lists exchange errors.	406 .. 499
abnormalObeUserIdRejected	The user id in abnormal OBE has been rejected.	500
abnormalObeDateAndTimeRejected	The date and time in abnormal OBE has been rejected.	501
abnormalObeReasonCodeRejected	The reason code in abnormal OBE has been rejected.	502
reserved	Codes reserved for abnormal OBE exchange errors.	503 .. 599
tollDeclartionDuplicateTollDeclarationIdRejected	A duplicate of the tollDeclarationId has been identified.	600
tollDeclarationActionCodeRejected	The actionCode in a toll declaration ADU is unknown or not supported by the recipient of the toll declaration.	601
tollDeclarationChargeReportStructureRejected	One or more elements inside the charge report structure of the toll declaration ADU are not supported by the recipient of the toll declaration. NOTE For some data elements inside the charge report there are individual ADU reason codes defined below.	602
tollDeclarationActionCodeSendSentTooOftenRejected	The actionCode = send has been sent too often in toll declaration ADUs.	603
tollDeclarationInvalidChargeObjectRejected	One or more validations failed inside the elements chargeObjectId, or timeWhenUsed, or vehicleDescription.	604
tollDeclarationActionCodeAdjustSentTooOftenRejected	The actionCode = adjust has been sent too often in toll declaration ADUs.	605
tollDeclarationTariffClassIdRejected	The TariffClassId declared in the toll declaration ADU was not found by the recipient of the toll declaration.	606

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Table 11 *(continued)*

Name	Semantics	Value
tollDeclarationTariffRejected	The tariff declared in the toll declaration ADU was not found by the recipient of the toll declaration.	607
tollDeclarationDuplicateVehiclePassageRejected	A duplicate vehicle passage has been identified by the recipient of the toll declaration. A duplicate vehicle passage is specified by the identical combination of: [chargeReport.obeId + chargeReport.vehicleLPNr + chargeReport.paymentMeans.personalAccountNumber + DetectedChargeObject.chargeObjectId + DetectedChargeObject.timeWhenUsed]	608
tollDeclarationInvalidDetectedChargeObjectManyRejected	One or more validation steps for a toll declaration failed in many DetectedChargeObjects.	609
tollDeclarationTollChargerIssueRejected	Toll declaration declined by TC due to error in TC system, further organizational handling required between TC and TSP. NOTE This can be used, for example, in case errors on the TC side prevent correct acceptance of a toll declaration.	610
tollDeclarationTollContextRejected	The tollContext declared in the toll declaration ADU is not known by the recipient of the toll declaration.	611
tollDeclarationTollFeeRejected	The toll fee decalared in the toll declaration ADU has been rejected by the recipient of the toll declaration. NOTE Depending on the use of optional data elements inside the toll declaration, toll fee information can be provided in different data elements.	612
reserved	Codes reserved for toll declarations exchange errors.	613 .. 699
billingDetailsIssuerIdRejected	The issuer ID in billing details has been rejected.	700
billingDetailsClaimIdRejected	The claim ID in billing details has been rejected.	701
billingDetailsTollChargerIdRejected	The TC ID in billing details has been rejected.	702
billingDetailsContextIdRejected	The context ID in billing details has been rejected.	703
billingDetailsUserIdRejected	The user ID in billing details has been rejected.	704
billingDetailsPeriodRejected	The period in billing details has been rejected.	705
billingDetailsAmountRejected	The amount in billing details has been rejected.	706
billingDetailsContextNameRejected	The context name in billing details has been rejected.	707
billingDetailsAppliedUserClassRejected	The applied user class in billing details has been rejected.	708
billingDetailsDeclaredVehicleClassRejected	The declared vehicle class in billing details has been rejected.	709

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Table 11 *(continued)*

Name	Semantics	Value
billingDetailsAppliedTimeClassRejected	The applied time class in billing details has been rejected.	710
billingDetailsEntranceTimeRejected	The entrance time in billing details has been rejected.	711
billingDetailsEntranceChargeObjectRejected	The entrance charge object in billing details has been rejected.	712
billingDetailsIntermediateSectionRejected	The intermediate section in billing details has been rejected.	713
billingDetailsExitChargeObjectRejected	The exit charge object in billing details has been rejected.	714
billingDetailsExitTimeRejected	The exit time in billing details has been rejected.	715
billingDetailsReferenceRejected	The reference in billing details has been rejected.	716
reserved	Codes reserved for billing details exchange errors.	717 .. 799
claimRejectedByTSP	The related payment claim has been rejected by the TSP.	800
claimApprovedByTSP	The related payment claim has been approved and accepted by the TSP.	801
paymentClaimIdRejected	The ID in payment claim has been rejected.	802
paymentStartDateTimeRejected	The start date and time in payment claim has been rejected.	803
paymentEndDateTimeRejected	The end date and time in payment claim has been rejected.	804
paymentUserIdRejected	The user ID in payment claim has been rejected.	805
paymentAmountRejected	The amount in payment claim has been rejected.	806
paymentStatusRejected	The status in payment claim has been rejected.	807
paymentTypeOfFeeRejected	The type of fee in payment claim has been rejected.	808
paymentRelatedApduIdRejected	The related APDU ID in payment claim has been rejected.	809
reserved	Codes reserved for payment claim exchange errors.	810 .. 899
reserved	Codes reserved for payment announcement exchange errors.	900 .. 999
reserved	Codes reserved for provide user details exchange errors.	1 000 .. 1 099
reserved	Codes reserved for provide user lists exchange errors.	1 100 .. 1 199
reportQaAccepted	The quality assurance parameters have been accepted.	1 200
reportQaNotAccepted	The quality assurance parameters have been rejected.	1 201
paymentGuaranteeAccepted	The payment guarantee has been accepted.	1 202
smCCBackEndDataCheckingThresholdExceeded	Secure monitoring reason code.	1 203

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Table 11 *(continued)*

Name	Semantics	Value
reserved	Codes reserved for quality assurance exchange errors.	1 204 .. 1 299
complaintIdMissing	Identifier missing in a UserComplaintAdu.	1 301
relatedBillingDetailsUnknown	The billing details ID referred to in the user complaint ADU is not known by the TC.	1 302
paymentClaimUnknown	The payment claim ID referred to in the user complaint ADU is not known by the TC.	1 303
dateOfComplaintIncorrect	The date of the complaint is incorrect.	1 304
dateOfComplaintMissing	The date of the complaint is missing.	1 305
complaintReasonMissing	The reason of the complaint is missing.	1 306
complaintReasonUnknown	The reason of the complaint is not known.	1 307
addComplaintReasonMissing	Additional complaint information is missing and the reason of the complaint is “other”.	1 308
additionalInfoIdMissing	The ID in the additional complaint information is not specified.	1 309
infoDateTimeMissing	The field date in additional information is missing.	1 310
infoDateIncorrect	The field date in additional information is incorrect.	1 311
incorrectAuthenticator	The authenticator is wrong.	1 312
relatedBillingDetailsAlreadyComplained	The referred billing details is mentioned in another user complaint currently being processed.	1 313
reserved	Codes reserved for complaint-related errors.	1 314 .. 1 399
reserved	Codes reserved for future ISO/CEN extensions.	1 400 .. 2 999
semanticError	The semantics of the message received was not understood by the recipient. NOTE Every message (except AckAdu) can be responded to with a “semantic error” code when its semantics are not understood.	3 000
reserved	Codes reserved for future ISO/CEN extensions.	3 001 3 009
actionCodeNotSupported	The sent action code is not supported. NOTE 4 This AduReasonCode is used only in response to ADUs which contain action codes.	3 010
reserved	Codes reserved for future ISO/CEN extensions.	3 011 3 999
acceptedWithWarning	The ADU was accepted and will be processed by the recipient. Further information will be provided by means of warnings. NOTE Bilateral agreement on any other issue which semantics needs to be specified for the attributes issueLocation, issueContent and issueText.	4 000
reserved	Codes reserved for future ISO/CEN extensions.	4 001 ... 9 999

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Table 11 *(continued)*

Name	Semantics	Value
reserved	Codes reserved for private extensions defined in bilateral agreements between TCs and TSPs.	1 000 0 … 6 553 5

6.5 StatusAdu data structure

The `StatusAdu` data type can be used to indicate to the recipient that previously sent (and possibly acknowledged) APDUs are obsolete (e.g. to support rollback scenarios) or to indicate the inability to receive APDUs. When transferring this ADU, the value in the **informationRecipientID** field of the APCI shall identify a valid entity (a null value is not permitted).

Table 12 indicates the fields of the `StatusAdu` data type, which is formally defined in Annex A.

Table 12 — StatusAdu fields

Field name	Data type/data description	m/o
generalStatusCode	`GeneralStatusCode`	m
apduStatusCode	Record (ASN.1 SEQUENCE) made of the following fields: apdu, reasonOfAduStruct	o
actionCode	`ActionCode`	o

generalStatusCode shall indicate readiness to receive APDUs. The following values are allowed:

— **notReadyToReceive**: the issuing entity is not ready to receive;

— **readyToReceive**: the issuing entity is ready to receive.

apduStatusCode may optionally be used to provide APDU-specific reason codes as a sequence of one or more reason codes for each by ADU in a related APDU. The **apdu** field identifies the APDU that contains the ADUs. The **reasonOfAduStruct** is a list (ASN.1 SEQUENCE OF SEQUENCE) made of two fields: **aduIdentifier**, which identifies an ADU within the addressed APDU, and **reason,** which carries an `AduReasonCode` value, defined in Table 11.

actionCode may optionally be used to indicate specific actions to be pursued by the receiver of the statusAdu (see 6.2.5).

6.6 TrustObjectAdu data structure

The `TrustObjectAdu` data type can be used by either the TC or the TSP to provide trust objects. The ADU can be either sent as a response to a Request ADU or initiated as a push ADU if new versions of trust objects are available. When transferring this ADU, the value in the **informationRecipientID** field of the APCI may have a null value, to indicate that the ADU is intended for all possible recipients.

Each `TrustObjectsAdu` data structure shall contain one trust object and additional information and parameters for that trust object.

Table 13 indicates the fields in a `TrustObjectsAdu` data type, which is formally defined in Annex A.

Table 13 — TrustObjectAdu fields

Field name	Data type/data description	m/o
aduIdentifier	`AduIdentifier`	m
replacedTrustObject	`AduIdentifier`	o
purposesOfTrustObject	Record made of fields of the same type (ASN.1 SEQUENCE OF), each of type `TrustObjectPurpose`	m

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Table 13 *(continued)*

Field name	Data type/data description	m/o
startValidity	`GeneralizedTime`	m
endValidity	`GeneralizedTime`	o
trustObjectStatus	`TrustObjectStatus`	m
trustObject	`TrustObjectCode`	o
actionCode	`ActionCode`	o

aduIdentifier shall indicate the unique identifier for the `TrustObjectAdu`. The uniqueness of the value of **aduIdentifier** shall be guaranteed by the initiator of the trust object (i.e. TC or TSP) inside the realm of the same provider ID.

replacedTrustObject may optionally be used to contain the trust object identifier of the trust object which shall be replaced by the new trust object that is transferred using the present `TrustObjectAdu` structure. This optional data element shall only be present and used in case an already existing and valid trust object shall be replaced by a new trust object. If **replacedTrustObject** is present, the new trust object shall have the **TrustObjectID** set to a new value.

purposesOfTrustObjects shall be used to indicate the possible usage(s) for which the trust object is intended. It contains a list of values which it supports in specifying the possible usage of the same trust object for one or more than one purposes. Allowed values shall be:

— **trustObjects**, unspecified purpose;

— **dSRCCharging**, to validate authenticators from DSRC charging applications;

— **dSRCAC**, to calculate access credentials for DSRC charging applications;

— **oBEInterrogation**, to validate authenticators received during a CCC transaction;

— **oBEInterrogationAC**, to calculate access credentials for CCC;

— **sIGExceptionList**, to authenticate received exception lists;

— **sIGContextData**, to authenticate received context data;

— **sIGBillingDetails**, to authenticate received billing details;

— **sIGFiscalObjects**, to authenticate received fiscal objects;

— **sIGCommunication**, to authenticate received ADUs by infoExchangeAuthenticator;

— **eNCCommunication**, to decrypt received ADUs;

— **dSRCKeyEncryption**, to encrypt DSRC keys;

— **secChannelEstablishment**, certificate to establish IPSec (virtual private network [VPN]);

— **certIssuing**, certificate to issue certificates;

— **sIGUserCommunication**, user certificate to verify communication via, e.g. email;

— **certRevocationListing**, certificate revocation list;

— **siGChargeReport**, certificate or certificate chain to validate charge report;

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— **oBEInterrogationNonRep**, key reference for the non-repudiation authenticatication for CCC or localization augmentation communication (LAC).

NOTE This document does not limit the use of individual combinations of trust object types and trust object purposes. In real systems, however, some of the theoretically possible combinations of these two parameters do not make sense and can therefore not be used in implementations. The correct use of these parameters remains under the responsibility of the implementor(s) and/or the entities operating the TC and the TSP systems.

startValidity shall be used to indicate the time from which the trust object is valid. The actual initial time of usage of the trust object may be agreed by the TC and the TSP by separate arrangements that are outside the scope of this document.

endValidity may optionally be used to indicate the expiry date for a trust object. In case this optional element is not present, the specified trust object has no expiry date.

trustObjectStatus shall be used to indicate the status of the specified trust object. The following values shall be used:

— **valid**, for a valid trust object;

— **expired**, for an expired trust object;

— **revoked**, for a revoked trust object;

— **update**, for a trust object which replaces an already existing and valid trust object.

trustObject is of data type `TrustObjectCode` and may optionally be used to specify the value of the trust object. If **trustObject** is omitted, a new value of **trustObjectStatus** is sent for an already transferred trust object.

TrustObjectCode is supported in this document for the following trust object types:

— certificates;

— public keys;

— DSRC keys;

— MAC keys;

— DSRC key references;

— generic trust objects.

For each specified type of trust object, a different definition applies, as per the following.

The `CertificateObject` data type supports exchanging certificates between TC and TSP. The certificate structure and coding shall be according to ISO/IEC 9594-8. Table 14 explains the fields in the `CertificateObject` data type, which is formally defined in Annex A.

Table 14 — CertificateObject fields

Field name	Data type/data description	m/o
certificateType	`CertificateType`	m
certificate	`OCTET STRING` containing the certificate	m

The **certificateType** field specifies the type of certificate. The following values are specified:

— **certTcHTTPS**, indicating a TC certificate for HTTPS usage;

— **certTcMAIL**, indicating a TC certificate for email exchange;

— **certTcNSIG**, indicating a TC certificate for signatures;

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— **certTcTA**, indicating the TCs' sub-certification authority certificate;

— **certTcpRoot**, indicating the TCs' root-certification authority certificate;

— **certTspHTTPS**, indicating a TSP certificate for HTTPS usage;

— **certTspMAIL**, indicating a TSP certificate for email exchange;

— **certTspNSIG**, indicating a TSP certificate for signatures;

— **certTspTA**, indicating the TSP sub-certification authority certificate;

— **certTspRoot**, indicating the TSP root-certification authority certificate;

— **certTspCR**, indicating the TSP charge report verification.

The **certificate** field shall contain the actual public-key certificate according to ISO/IEC 9594-8.

The `PublicKeyObject` data type is used to transfer public keys whose authenticity is proven by a fingerprint exchanged over a separate communication channel. Public keys without a certificate may be used to establish the initial trust relation between TC and TSP. Table 15 explains the fields in the `PublicKeyObject` data type, which is formally defined in Annex A.

Table 15 — PublicKeyObject fields

Field name	Data type/data description	m/o
publicKeyType	`PublicKeyType`	m
serialNumber	`INTEGER` ranging from 0 to 2^{63}-1	m
Issuer	`Provider`	m
algorithmIdentifier	Selection (ASN.1 CHOICE) between **rsa** and **ecc** fields	m
publicKey	`OCTET STRING`	m

publicKeyType shall specify the type of key. A key can be:

— **kpupTcSignature**, which is a signature key of the TC;

— **kpupTcEncrypt**, which is an encryption key for the TC;

— **kpupTspSignature**, which is a signature key of the TSP;

— **kpupTspEncrypt**, which is an encryption key for the TSP.

serialNumber shall indicate the key's serial number.

issuer shall identify the issuer of the key.

algorithmIdentifier shall identify the used public key algorithm, which can be either Rivest, Shamir and Adleman (RSA) algorithm, as imported from ISO/IEC 9594-8, or elliptic-curve cryptography algorithm.

publicKey field shall contain the key.

The `DSRCKeyObject` data type supports the exchange of CCC and LAC DSRC master keys. In addition, the structure supports sending a DSRC master key, which is encrypted by means of a public key without a certificate. Table 16 explains the fields in the `DSRCKeyObject` data type, which is formally defined in Annex A.

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Table 16 — DsrcKeyObject fields

Field name	Data type/data description	m/o
encryptionKeyId	Selection (ASN.1 CHOICE) between **certificate** and **publicKey** defined as `EncryptionKeyId` type	m
timestamp	`UTCTime`	m
dsrcKeys	Series of records (ASN.1 SEQUENCE OF SEQUENCE), each record containing the following fields: **efcCm**, **key**	m

encryptionKeyId of type `EncryptionKeyId` is a selection (ASN.1 CHOICE) between two types of trust objects identified by the fields **certificate** and **publicKey** which shall be used to identify the encryption type used. Both fields **certificate** and **publicKey** are defined as a record (ASN.1 SEQUENCE) of two elements (**serialNumber**, **issuer**) identifying either a certificate or a public key by means of its originator and the originator's assigned serial number.

timestamp of type `UTCTime` shall contain the time of the encryption.

dsrcKeys is a list (ASN.1 SEQUENCE OF) of couples (ASN.1 SEQUENCE), each made of elements of types **EfcCm** (described in Table 17 and formally described in Annex A) and `EncrKey` (described in Table 18 and formally described in Annex A).

Table 17 — EfcCm fields

Field name	Data type/data description	m/o
efcContextMark	`EfcContextMark`	m
bitmask	`OCTET STRING`	m
efcContextMarkVersion	`EfcContextMarkVersion`	o

efcContextMark shall be used to specify the context mark to be used either in a DSRC tolling environment or for CCC.

bitmask shall be used to indicate which type of contract and context version the key applies to by setting the applicable bits corresponding to the position in the concatenation of the elements **typeOfContract** and **contextVersion** of **efcContextMark**. A 0 value means ignore the respective element, while a 1 value means consider the respective element.

NOTE If a service provider uses several values for type of contract, using a corresponding bitmask allows the transmission of only one key that applies to all EFC context marks with the various values of type of contract.

EXAMPLE The bitmask "0000 0000 0000 0000 1111 1111" allows the transfer of a key that is applicable to all EFC Contextmarks with the specified contextVersion. The values of the attribute typeOfContract are not considered. The key is valid for all values of typeOfContract.

efcContextMarkVersion may optionally be used to indicate the version of the EfcContextMark used. Its values reflect the contents of EN 15509:2020, Table A.1, and are defined as:

— **en15509Version0**, meaning the current version of EN 15509;

— **en15509Version2007**, meaning the 2007 version of EN 15509;

— **en15509Version2014**, meaning the 2014 version of EN 15509;

— **en15509Version2021**, meaning the 2021 version of EN 15509;

— **iso12813Version0**, meaning the current version of ISO 12813;

— **iso12813Version2009**, meaning the 2009 version of ISO 12813;

— **iso12813Version2015**, meaning the 2015 version of ISO 12813;

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