
**Automatic vehicle and equipment
identification — Electronic registration
identification (ERI) for vehicles —**

**Part 4:
Secure communications using
asymmetrical techniques**

*Identification automatique des véhicules et des équipements —
Identification d'enregistrement électronique (ERI) pour les véhicules —
Partie 4: Communications sûres utilisant des techniques asymétriques*



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Contents

Page

Foreword	iv
Introduction.....	v
1 Scope	1
2 Normative references	2
3 Terms and definitions	2
4 Abbreviations.....	10
5 System communications concept	11
5.1 Introduction.....	11
5.2 Overview.....	11
5.3 Security services	18
5.4 Communication architecture description	23
5.5 Interfaces.....	25
6 Interface requirements.....	26
6.1 Overview.....	26
6.2 Abstract transaction definitions	27
6.3 The ERT interfaces	63
Annex A (normative) ASN.1 modules	66
Annex B (normative) PICS pro forma	77
Annex C (informative) Operational scenarios	81
Bibliography.....	93

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 24534-4 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Road transport and traffic telematics*, in collaboration with Technical Committee ISO/TC 204, *Intelligent transport systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 24534-4 cancels and replaces ISO/TS 24534-4:2008, which has been technically revised.

ISO 24534 consists of the following parts, under the general title *Automatic vehicle and equipment identification — Electronic registration identification (ERI) for vehicles*:

- *Part 1: Architecture*
- *Part 2: Operational requirements*
- *Part 3: Vehicle data*
- *Part 4: Secure communications using asymmetrical techniques*
- *Part 5: Secure communications using symmetrical techniques*

Introduction

A quickly emerging need has been identified with administrations to improve the unique identification of vehicles for a variety of services. Situations are already occurring where manufacturers intend to fit lifetime tags to vehicles. Various governments are considering the needs and benefits of electronic registration identification (ERI) as a legal proof of vehicle identity with potential mandatory uses. There is commercial and economic justification in respect of both tags and infrastructure that a standard enables an interoperable solution.

ERI is a means of uniquely identifying road vehicles. The application of ERI will offer significant benefits over existing techniques for vehicle identification. It will be a suitable tool for the future management and administration of traffic and transport, including applications in free-flow, multi-lane traffic conditions with the capability to support mobile transactions. ERI addresses the need of authorities and other road users for a trusted electronic identification, including roaming vehicles.

This part of ISO 24534 specifies the application layer interfaces for the exchange of data between an onboard component containing the ERI data and a reader or writer inside or outside the vehicle.

The exchanged identification data consists of a unique vehicle identifier and may also include data typically found in the vehicle's registration certificate. The authenticity of the exchanged vehicle data can be further enhanced by ensuring data has been obtained by request from a commissioned device, with the data electronically signed by the registration authority.

In order to facilitate (international) resales of vehicles, the ERI interface includes provisions for another accredited registration authority to take over the registration of a vehicle.

The ERI interface supports confidentiality measures to adhere to (inter)national privacy regulation and to prevent other misuse of electronic identification of vehicles. A registration authority may authorize other authorities to access the vehicle's data. A holder of a registration certificate may authorize an additional service provider to identify the vehicle when he/she wants commercial service.

However, it is perceived that different users may have different requirements for authentication and confidentiality. This International Standard therefore supports different levels of security with maximum compatibility. Much attention is given to the interoperability of the component containing the ERI data and readers of various levels of capability, e.g. the identification of a vehicle with a less capable ERI data component by a more sophisticated reader equipment and vice versa.

The supported complexity of the device containing the ERI data may range from a very simple read-only device that only contains the vehicle's identifier, to a sophisticated device that includes both authentication and confidentiality measures and maintains a historic list of the vehicle data written by the manufacturer and by vehicle registration authorities.

Following the events of 11 September 2001, and subsequent reviews of anti-terrorism measures, the need for ERI has been identified as a possible anti-terrorism measure. The need for international or pan-European harmonization of such ERI is therefore important. It is also important to ensure that any ERI measures contain protection against misuse by terrorists.

This part of ISO 24534 makes use of the basic automatic vehicle identification (AVI) provisions already defined in ISO 14814 and ISO 14816.

Automatic vehicle and equipment identification — Electronic registration identification (ERI) for vehicles —

Part 4: Secure communications using asymmetrical techniques

1 Scope

This part of ISO 24534 provides requirements for electronic registration identification (ERI) that are based on an identifier assigned to a vehicle (e.g. for recognition by national authorities) suitable to be used for:

- electronic identification of local and foreign vehicles by national authorities;
- vehicle manufacturing, in-life maintenance and end-of-life identification (vehicle life cycle management);
- adaptation of vehicle data (e.g. for international resales);
- safety-related purposes;
- crime reduction;
- commercial services.

It adheres to privacy and data protection regulations.

This part of ISO 24534 specifies the interfaces for a secure exchange of data between an ERT and an ERI reader or ERI writer in or outside the vehicle using asymmetric encryption techniques.

NOTE 1 The onboard device containing the ERI data is called the electronic registration tag (ERT).

This part of ISO 24534 includes:

- the application layer interface between an ERT and an onboard ERI reader or writer;
- the application layer interface between the onboard ERI equipment and external ERI readers and writers;
- security issues related to the communication with the ERT.

NOTE 2 The vehicle identifiers and possible additional vehicle data (as typically contained in vehicle registration certificates) are defined in ISO 24534-3.

NOTE 3 The secure application layer interfaces for the exchange of ERI data with an ERI reader or writer are specified in both this part of ISO 24534 and ISO 24534-5.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 8824 (all parts), *Information technology — Abstract Syntax Notation One (ASN.1)*

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

ISO/IEC 14443 (all parts), *Identification cards — Contactless integrated circuit cards — Proximity cards*

ISO 15628:2007, *Road transport and traffic telematics — Dedicated short range communication (DSRC) — DSRC application layer*

3 Terms and definitions

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

3.1
access control
prevention of unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner

[ISO 7498-2:1989, definition 3.3.1]

3.2
access control list
list of entities, together with their access rights, which are authorized to have access to a resource

[ISO 7498-2:1989, definition 3.3.2]

3.3
active threat
threat of a deliberate unauthorized change to the state of the system

[ISO 7498-2:1989, definition 3.3.4]

EXAMPLE Examples of security-relevant active threats may include modification of messages, replay of messages, and insertion of spurious messages, masquerading as an authorized entity and denial of service.

3.4
additional vehicle data
ERI data in addition to the vehicle identifier

[ISO 24534-3:2008, definition 3.1]

3.5
air interface
conductor-free medium between onboard equipment (OBE) and the reader/interrogator through which the linking of the OBE to the reader/interrogator is achieved by means of electromagnetic signals

[ISO 14814:2006, definition 3.2]

3.6
authority
organization that is allowed by public law to identify a vehicle using ERI

3.7**authorization**

granting of rights, which includes the granting of access based on access rights

[ISO 7498-2:1989, definition 3.3.10]

3.8**certification authority**

natural or legal person trusted to create public key certificates

NOTE See also top-level certification authority and intermediate certification authority.

3.9**challenge**

data item chosen at random and sent by the verifier to the claimant, which is used by the claimant, in conjunction with secret information held by the claimant, to generate a response which is sent to the verifier

[ISO/IEC 9798-1:1997, definition 3.3.5]

NOTE In this part of ISO 24534 the term challenge is also used in case an ERT does not have enabled encryption capabilities and the challenge is merely copied without any secret information applied.

3.10**ciphertext**

data produced, through the use of encipherment; the semantic content of the resulting data is not available

[ISO 7498-2:1989, definition 3.3.14]

3.11**claimant**

entity which is or represents a principal for the purposes of authentication

NOTE A claimant includes the functions necessary for engaging in authentication exchanges on behalf of a principal.

[ISO/IEC 10181-2:1996, definition 3.10]

3.12**cleartext**

intelligible data, the semantic content of which is available

[ISO 7498-2:1989, definition 3.3.15]

3.13**confidentiality**

property that information is not made available or disclosed to unauthorized individuals, entities, or processes

[ISO 7498-2:1989, definition 3.3.16]

3.14**credentials**

data that is transferred to establish the claimed identity of an entity

[ISO 7498-2:1989, definition 3.3.17]

3.15**cryptography**

discipline which embodies principles, means, and methods for the transformation of data in order to hide its information content, prevent its undetected modification and/or prevent its unauthorized use

[ISO 7498-2:1989, definition 3.3.20]

3.16

data integrity

integrity

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

[ISO 7498-2:1989, definition 3.3.21]

3.17

decipherment

decryption

reversal of a corresponding reversible encipherment

[ISO 7498-2:1989, definition 3.3.23]

3.18

digital signature

signature

data appended to, or a cryptographic transformation of, a data unit that allows a recipient of the data unit to prove the source and integrity of the data unit and protect against forgery, e.g. by the recipient

[ISO 7498-2:1989, definition 3.3.26]

NOTE See also cryptography.

3.19

distinguishing identifier

information which unambiguously distinguishes an entity

[ISO/IEC 9798-1:1997, definition 3.3.9]

3.20

electronic registration identification

ERI

action or act of identifying a vehicle with electronic means for purposes as mentioned in the scope of this part of ISO 24534

3.21

electronic registration reader

ERR

device used to read or read/write data from or to an ERT

3.22

electronic registration tag

ERT

onboard ERI device that contains the ERI data including relevant security provisions and one or more interfaces to access that data

NOTE 1 In the case of high security, the ERT is a type of SAM (secure application module).

NOTE 2 The ERT can be a separate device or can be integrated into an onboard device that also provides other capabilities (e.g. DSRC communications).

3.23

encipherment

encryption

cryptographic transformation of data to produce ciphertext

NOTE 1 Encipherment may be irreversible, in which case the corresponding decipherment process cannot feasibly be performed.

NOTE 2 Adapted from ISO 7498-2.

3.24**end-to-end encipherment**

encipherment of data within or at the source end system, with the corresponding decipherment occurring only within or at the destination end system

[ISO 7498-2:1989, definition 3.3.29]

3.25**entity authentication**

corroboration that an entity is the one claimed

[ISO/IEC 9798-1:1997, definition 3.3.11]

3.26**ERI data**

vehicle identifying data which can be obtained from an ERT

NOTE ERI data consists of the vehicle identifier and possible additional vehicle data.

3.27**ERI reader**

device used to read ERI data directly or indirectly from an ERT by invoking ERI transactions

NOTE 1 In the case that an ERI reader exchanges the ERI protocol data units directly via a data link with an ERT it is also called an ERR. In case it communicates via one or more nodes, only the last node in this sequence is called an ERR. As a consequence, an external ERI reader can, depending on the onboard configuration for example, act for some, but not all, vehicles as an ERR.

NOTE 2 See also onboard ERI reader and external ERI reader.

3.28**ERI transaction**

transaction as defined in Clause 6

3.29**ERI writer**

device used to write ERI data directly or indirectly into an ERT by invoking ERI transactions

NOTE 1 In case an ERI writer exchanges the ERI protocol data units directly via a data link with an ERT it is also called an ERR. In case it communicates via one or more nodes, only the last node in this sequence is called an ERR. As a consequence, an external ERI writer may, e.g. depending on the onboard configuration, act for some vehicles as an ERR and for others not.

NOTE 2 See also onboard ERI writer and external ERI writer.

3.30**ERT holder**

legal or natural person holding an ERT

NOTE The ERT holder could be, for example, the holder of the registration number or the owner, operator or keeper of the vehicle.

3.31**ERT number**

number assigned to and written into an ERT that acts as an ERT unique identifier

NOTE The ERT number is assumed to be written into the ERT during its manufacture and once written cannot be changed.

3.32

external ERI reader

ERI reader not being part of the onboard ERI equipment

NOTE 1 An external ERI reader is fitted neither within nor on the outside of the vehicle.

NOTE 2 A distinction is made between proximity, short-range (DSRC), and remote external readers. A proximity reader can be a PCD (proximity coupling device) as specified in ISO/IEC 14443. A short-range external ERI reader may be a part of roadside equipment, handheld equipment, or mobile equipment. A remote external ERI reader may be part of the back office equipment (BOE).

3.33

external ERI writer

ERI writer not being part of the onboard ERI equipment

NOTE 1 An external ERI writer is not fitted within or on the outside of the vehicle.

NOTE 2 A distinction is made between proximity, short-range (DSRC), and remote external writers. A proximity reader can be, for example, a PCD (proximity coupling device) as specified in ISO/IEC 14443. A short-range external ERI writer can be (a part of) roadside equipment, handheld equipment, or mobile equipment. A remote external ERI writer can be part of the back office equipment (BOE).

3.34

hash-code

string of bits which is the output of a hash-function

3.35

hash-function

function which maps strings of bits to fixed-length strings of bits, satisfying the following two properties:

- a) for a given output, it is computationally infeasible to find an input which maps to this output; and
- b) for a given output, it is computationally infeasible to find a second input which maps to the same output

[ISO/IEC 10118-1:2000, definition 3.5]

NOTE Computational feasibility depends on the specific security requirements and environment.

3.36

identification

action or act of establishing the identity

NOTE See also vehicle identification.

3.37

intermediate certification authority

certification authority for which public key certificates are issued by the top-level certification authority

NOTE This definition implies that there can be only one "level" of intermediate certification authorities.

3.38

key

sequence of symbols that controls the operations of a cryptographic transformation (e.g. encipherment, decipherment, cryptographic check function, signature generation, or signature verification)

[ISO/IEC 9798-1:1997, definition 3.3.13]

NOTE See ISO/IEC 9798-1 for the meaning of the terms used for the examples of cryptographic transformations.

3.39**lifetime**

period of time during which an item of equipment exists and functions

NOTE Adapted from ISO 14815.

3.40**manipulation detection**

mechanism which is used to detect whether a data unit has been modified (either accidentally or intentionally)

[ISO 7498-2:1989, definition 3.3.35]

3.41**masquerade**

pretence by an entity to be a different entity

[ISO 7498-2:1989, definition 3.3.36]

3.42**non-repudiation**

property that none of the entities involved in a communication can deny in all or in part its participation in the communication

NOTE Adapted from ISO 7498-2.

3.43**onboard ERI equipment**

equipment fitted within or on the outside of the vehicle and used for ERI purposes

NOTE The onboard ERI equipment comprises an ERT and can also comprise any additional communication devices.

3.44**onboard ERI reader**

ERI reader which is part of the onboard ERI equipment

NOTE An onboard ERI reader can be, for example, a proximity coupling device (PCD) as specified in ISO/IEC 14443.

3.45**onboard ERI writer**

ERI writer which is part of the onboard ERI equipment

NOTE An onboard ERI writer can be, for example, a proximity coupling device (PCD) as specified in ISO/IEC 14443.

3.46**passive threat**

threat of unauthorized disclosure of information without changing the state of the system

[ISO 7498-2:1989, definition 3.3.38]

3.47**password**

confidential authentication information, usually composed of a string of characters

[ISO 7498-2:1989, definition 3.3.39]

3.48**periodic motor vehicle test**

compulsory periodic (e.g. annual) test of the roadworthiness of a motor vehicle of above a specified age, or a certificate of passing such a test

EXAMPLE The MOT test in the United Kingdom is a periodic motor vehicle test.

3.49

principal

entity whose identity can be authenticated

[ISO/IEC 10181-2:1996, definition 3.15]

3.50

privacy

right of individuals to control or influence what information related to them may be collected and stored and by whom and to whom that information may be disclosed

[ISO 7498-2:1989, definition 3.3.43]

NOTE Because this term relates to the right of individuals, it cannot be very precise and its use should be avoided except as a motivation for requiring security.

3.51

private decipherment key

private key which defines the private decipherment transformation

[ISO/IEC 9798-1:1997, definition 3.3.16]

3.52

private key

key of an entity's asymmetric key pair which should only be used by that entity

[ISO/IEC 9798-1:1997, definition 3.3.17]

NOTE In the case of an asymmetric signature system the private key defines the signature transformation. In the case of an asymmetric encipherment system the private key defines the decipherment transformation.

3.53

private signature key

private key which defines the private signature transformation

[ISO/IEC 9798-1:1997, definition 3.3.18]

3.54

public encipherment key

public key which defines the public encipherment transformation

[ISO/IEC 9798-1:1997, definition 3.3.19]

3.55

public key

key of an entity's asymmetric key pair which can be made public

[ISO/IEC 9798-1:1997, definition 3.3.20]

NOTE In the case of an asymmetric signature system the public key defines the verification transformation. In the case of an asymmetric encipherment system the public key defines the encipherment transformation. A key that is "publicly" known is not necessarily globally available. The key is only made available to all members of a pre-specified group.

3.56

**public key certificate
certificate**

public key information of an entity signed by the certification authority and therefore rendered unforgeable

[ISO/IEC 9798-1:1997, definition 3.3.21]

NOTE In this International Standard, a public key certificate also specifies the role of the entity for which the public key information is provided, e.g. manufacturer or registration authority.

3.57**public verification key**

public key which defines the public verification transformation

[ISO/IEC 9798-1:1997, definition 3.3.23]

3.58**random number**

time variant parameter whose value is unpredictable

[ISO/IEC 9798-1:1997, definition 3.3.24]

3.59**registration authority**

⟨for vehicles⟩ authority responsible for the registration and maintenance of vehicle records

NOTE The authority may provide vehicle records to accredited organizations.

3.60**registration authority**

⟨for ERI data⟩ organization responsible for writing ERI data and security data according to local legislation

NOTE The registration authority for ERI data can be the same as the registration authority for vehicles. This part of ISO 24534, however, does not require this.

3.61**registration certificate**

vehicle registration document (paper or smart card) issued by the registration authority for vehicles in which the vehicle and its owner or lessee are registered

3.62**replay attack**

masquerade which involves use of previous transmitted messages

[ISO/IEC 9798-1:1997, definition 3.3.26]

3.63**security**

protection of information and data so that unauthorized persons or systems cannot read or modify them and authorized persons or systems are not denied access to them

[ISO/IEC 12207, definition 3.25]

3.64**sequence number**

time variant parameter whose value is taken from a specified sequence which is non-repeating within a certain time period

[ISO/IEC 9798-1:1997, definition 3.3.27]

3.65**threat**

potential violation of security

[ISO 7498-2:1989, definition 3.3.55]

3.66

top-level certification authority

certification authority whose certificates can be verified because its public verification key(s) are written as read-only data into the ERT before the ERT is customized or commissioned

3.67

unilateral authentication

entity authentication which provides one entity with the assurance of the other's identity but not vice versa

[ISO/IEC 9798-1:1997, definition 3.3.33]

3.68

vehicle identification

action or act of establishing the identity of a vehicle

3.69

verifier

entity which is or represents the entity requiring an authenticated identity

NOTE 1 A verifier includes the functions necessary for engaging in authentication exchanges.

NOTE 2 Adapted from ISO/IEC 10181-2.

4 Abbreviations

AEI	automatic equipment identification
AES	advanced encryption standard
ASN.1	Abstract Syntax Notation One [as defined in ISO/IEC 8824 (all parts)]
AVI	automatic vehicle identification
BOE	back office equipment
EN	Europäische Norm (German), English: European Standard
ENV	Europäische Norm Vorauskabe (German), English: European Pre-Standard
ERI	electronic registration identification
ERR	electronic registration reader
ERT	electronic registration tag
EU	European Union
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
OBE	onboard equipment (including non-ERI equipment)
OSI	Open Systems Interconnection (see ISO/IEC 7498-1)
PICS	protocol implementation conformance statement(s)
PIN	personal identification number
SAM	secure application module
VIN	vehicle identification number

5 System communications concept

5.1 Introduction

This clause is informative only. It provides an introduction to the context in which ERI data and security data may be read from, or written into, the ERT and in which vehicles can be identified. It also outlines options that may or may not be used in an actual implementation. The normative requirements for the application layer interfaces are provided in Clause 6 and Annex A. Annex B contains a form to specify the limitations of an actual communication protocol implementation.

5.2 Overview

5.2.1 Vehicle registration identification

ERI (electronic registration identification) is the action or act of identifying a vehicle by electronic means for the purposes mentioned in the scope of this part of ISO 24534.

The identifier used to identify a vehicle is called the vehicle identifier or vehicleId.

NOTE 1 The preferred vehicle identifier is the VIN that is assigned to the vehicle by its manufacturer in accordance with ISO 3779, but alternatives are supported as well (see ISO 24534-3 for details).

NOTE 2 See ISO 24534-3 for details about the vehicle identifier and ERI data.

In this part of ISO 24534, the combination of the almost unique vehicleId and a unique ERT number is used as the unambiguous distinguishing identifier.

5.2.2 System concept and supported interfaces

Figure 1 presents the interfaces for which the application layer is specified in this part of ISO 24534.

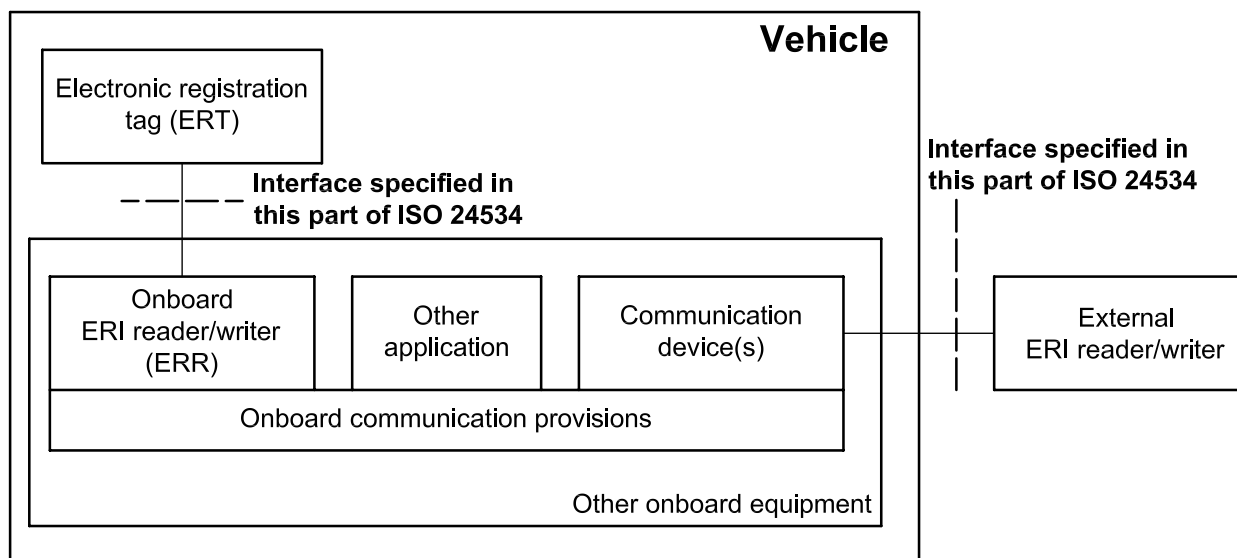


Figure 1 — System concept and supported interfaces

The onboard component that provides a secure environment for the ERI data and security data is called the ERT (electronic registration tag).

NOTE 1 An implementer may integrate other provisions (e.g. additional communication provisions) into an ERT as long as this does not compromise the security of the ERT.

Depending on its capabilities, an ERT is tailored to a specific vehicle in three consecutive steps (see Figure C.2).

- a) First, it is customized with the vehicle identifier and, optionally, additional vehicle data. This step can only be performed once in the lifetime of an ERT. Customizing does not yet enable any ERT encipherment or signing services.
- b) Second, a registration authority may commission itself as the registration authority for the vehicle by adding its security data. This step may be performed at any time by a registration authority when it wants to commission itself as the current registration authority. A registration authority may change its security data by recommissioning itself. If supported by the ERT, commissioning enables ERT confidentiality and authentication services by providing the required security keys. If a key is not provided, the corresponding services will not be enabled.

NOTE 2 Most smart cards are “owned” and “controlled” by one issuer during their whole lifetime. For an ERT this is more complicated. When a vehicle is sold to another country a new registration authority will take over the “control” or “ownership” of the ERT when it issues a new number plate and a new registration certificate for the vehicle. The ERT is then recommissioned.

- c) Third, a registration authority that has commissioned itself may change the additional vehicle data to register a change of the vehicle data (with the exception of the vehicleId).

NOTE 3 In order to accommodate the needs of different countries, different selections of additional vehicle data can be included. (See ISO 24534-3 for details.)

The onboard communication provisions shall be capable of transferring data from or to the ERT without modifying that data.

NOTE 4 The onboard communication provisions may e.g. be part of an onboard platform for transport applications.

A communication device may communicate with an external proximity reader or writer, with a short-range ERI reader and/or writer, or with remote back office equipment (BOE).

A communication device that communicates with an external ERI reader/writer acts as a relay between this external ERI reader/writer and the onboard ERI reader/writer. A communication device may also be used for other applications.

5.2.3 Roles involved

Within the context of this part of ISO 24534 the following “roles” for natural or legal persons are distinguished.

- Manufacturers, who assign a VIN or chassis number to each vehicle they build. A manufacturer may also once customize an ERT for a particular vehicle.
- Registration authorities (with respect to the ERI data), which may:
 - assign a new vehicleId to the vehicle (in the case of defects) and may customize an ERT (e.g. in the case of defects or retrofitting),

NOTE 1 A registration authority can assign a new vehicle ID to the vehicle (e.g. when the number on the chassis has become corrupted). Then it will put that new ID on the chassis and write it in a new ERT (a vehicle ID can never be overwritten).

- commission themselves as the registration authority for a vehicle,
- authorize other authorities to read the ERI data,
- authorize an ERT holder to grant additional service providers access to ERI data, and which

- which are responsible for the registration of additional vehicle data into an ERT according to local legislation (see below for details).

NOTE 2 It is expected that the registration authority with respect to the ERI data is the same authority that keeps the official register in which the vehicle is listed. This is however not required by this part of ISO 24534.

NOTE 3 It is assumed that each vehicle is listed in a register that contains the vehicle identifier and additional data related to the vehicle. It is implicitly assumed that this register also identifies the one(s) responsible for the vehicle (e.g. its owner, operator, keeper, lessee, and/or regular driver).

- Certification authorities, which are trusted to create public key certificates (referred to as “certificates” in this part of ISO 24534). Public key certificates are used to prevent a fraudulent organization from disguising itself as a manufacturer or registration authority. There are two types of certification authorities:
 - one top-level certification authority, and
 - zero or more intermediate certification authorities.

NOTE 4 A certification authority will not directly communicate with the ERT. Their certificates are used by manufacturers and registration authorities.

NOTE 5 With two levels of certification authority, the top-level authority can delegate the distribution of certificates to an intermediate authority, which is then responsible for creating the certificates for registration authorities and manufacturers within some region (e.g. the states of the United States or the member states of the EU).

- Authorities, which are authorized by the registration authority to read the ERI data from a vehicle (e.g. because they are entitled to do so by virtue of public legislation).
- Additional service providers (public or private), which provide a service that requires an electronic identification of a vehicle and/or certificated vehicle data. The ERT holder may or may not authorize an additional service provider to read the vehicle's identifier and the additional vehicle data.
- ERT holders, which are holding the ERT. An ERT holder may e.g. be the holder of the vehicle's registration number or the owner, operator, or keeper of the vehicle.

Even in cases where confidentiality of the ERI data is supported, the ERT holder is entitled both to read the ERI in its vehicle and to allow other service providers to read the vehicle identifier. A PIN issued by the registration authority to the ERT holder provides the required access control for the ERT holder.

NOTE 6 Roles and requirements related to the specification, design and manufacturing (including testing) of an ERT are outside the scope of this part of ISO 24534.

5.2.4 The communications context for reading

Figure 2 shows the communications context for reading data from an ERT.

An onboard or an external ERI reader is used to read data from the ERT. An onboard ERI reader communicates directly with the ERT. An external ERI reader may communicate either directly or indirectly with the ERT, e.g. directly in the case of a handheld reader or an integrated ERI device, or indirectly via an onboard communication module and the onboard ERI reader. The onboard communication module may also be used for other applications.

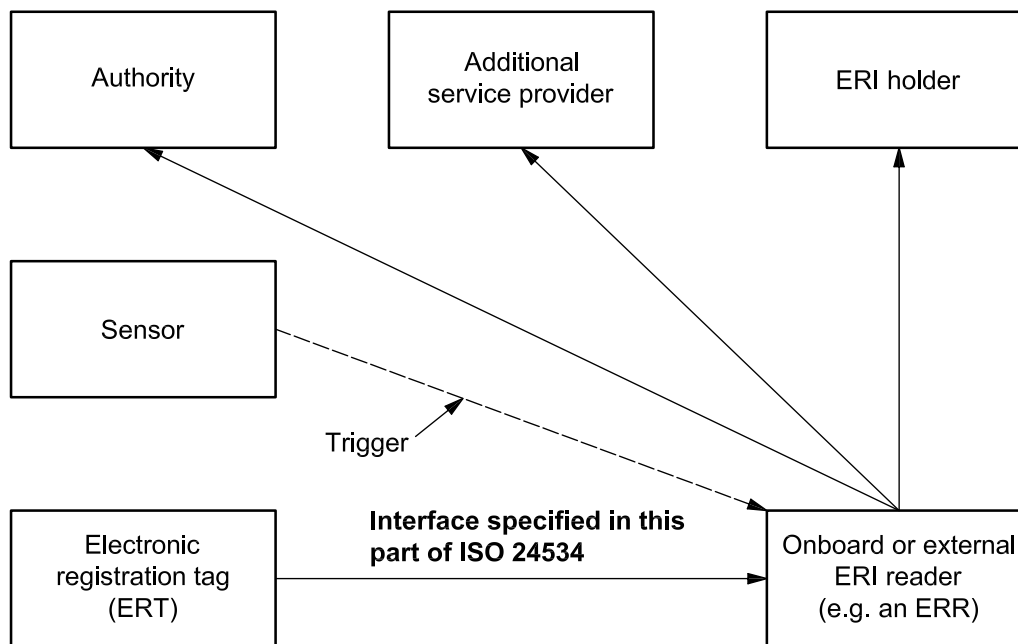


Figure 2 — Communication context for reading from an ERT

A sensor system (outside the scope of this International Standard) may be used to trigger an external ERI reader when it senses the presence of a vehicle that needs to be identified.

The various parties that can read ERI data from an ERT are described in 5.2.3. The access rights of the various entities are described in 5.3.5.1.

An ERT holder may wish to have access to the ERI data for various reasons:

- to verify the correctness of the ERI data;
- to obtain an authenticated (i.e. signed) vehicle identifier or ERI data to be used for another application;
- to verify the access control list (see 5.3.5), if present in the ERT;
- to verify the historic ERI data and/or historic commissioning data, if present in the ERT.

The equipment used by an authority, additional service provider or ERT holder in its office (i.e. not at the roadside) is called back office equipment (BOE).

The distribution of functions between BOE and an external ERI reader is outside the scope of this International Standard.

5.2.5 The communications context for writing

Figure 3 presents the communications context for writing data into an ERT.

The onboard or external ERI writer is used to write data into the ERT. An onboard ERI writer communicates directly with the ERT. An external ERI writer may communicate either directly or indirectly with the ERT, e.g. directly in the case of a handheld writer or an integrated ERI device, or indirectly via an onboard communication module and the onboard ERI writer. The onboard communication module may also be used for other applications.

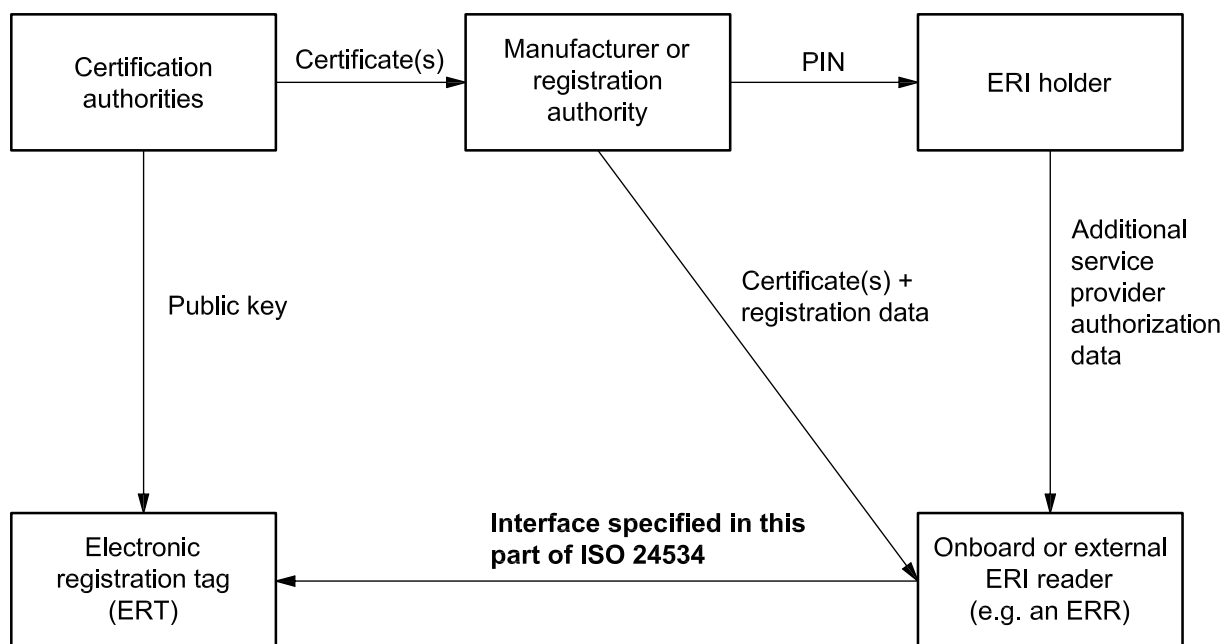


Figure 3 — Communication context for writing into an ERT

The various parties that can write ERI (security) data into an ERT are described in 5.2.3. The access rights of the various entities are described in 5.3.5.2.

The certification authorities provide public key certificates for genuine manufacturers and genuine registration authorities. The certificates are used while writing data into the ERT in order to prove that (signed) data originates from a genuine manufacturer or genuine registration authority. The certificates are also used while the ERI data is read in order to check that the data received stems from a genuine ERT, manufacturer or registration authority.

The registration authority authorizes the ERT holder by providing a password (PIN). The ERT holder may then authorize an additional service provider to read ERI data.

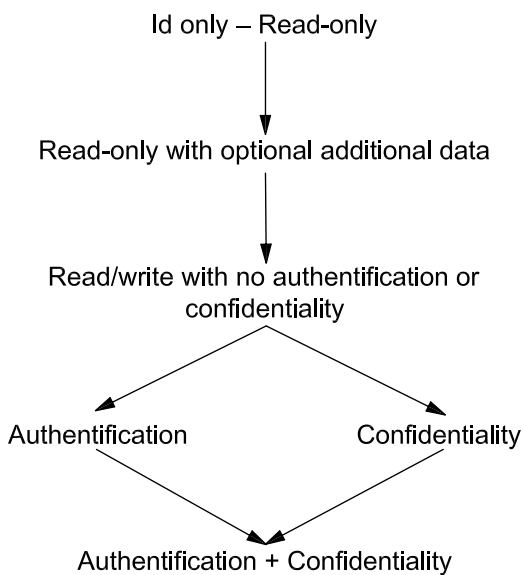
The distribution of functions between BOE and an external ERI writer is outside the scope of this International Standard. A registration authority may e.g. commission a writer to operate on its behalf or it may use e.g. the writer only as a relay device for remote writing from its back office.

5.2.6 ERT capability levels supported

It is envisioned that different users may have different requirements for ERI. Therefore, this part of ISO 24534 supports different service levels of ERT capabilities.

Figure 4 presents an overview of the various capability levels supported by this part of ISO 24534. See also the protocol implementation conformance statements (PICS) pro forma in Annex B.

Main variants:



Sub variants:

For a read/write ERT:

- with or without historic data

For an ERT that supports confidentiality:

With or without access for:

- other authorities
- additional service providers

Legend:

A → B B possesses A's capabilities as well

Figure 4 — ERT capability levels supported

The following main variants are distinguished (a variant at the arrowhead also includes the capabilities of the one at the arrow tail):

- Id only – Read only: this is the simplest ERT. The vehicle identifier is written only once and no other information can be added. In this case an ERI reader can only read the vehicle identifier from the vehicle (ERT).
- Read only with optional additional vehicle data: in this case the ERT may also contain additional vehicle data as specified in ISO 24534-3. However, all data can only be written once in the lifetime of an ERT. For security reasons the data may also contain a signature from the origination entity.
- Read/write with no authentication or confidentiality: in this case the ERT contains the vehicle identifier plus optional additional vehicle data. This additional vehicle data can be updated if required.
- Read/write with authentication: in this case the ERT also provides authentication services. The ERT can check a signature attached to data written into it. If enabled, the ERT can also attach a signature to data it sends to an ERI reader. An ERI reader can then check that the data it receives stems from a genuine ERT and not from a fake one.

NOTE 1 A registration authority can disable the ERT signing capabilities but not the signature verification capabilities.

- Read/write with confidentiality: in this case the ERT is capable of providing confidentiality services. The ERT can decrypt security data encrypted by an ERD writer. If enabled, the ERT can also encrypt the data it sends to an ERI reader. This data can only be interpreted by those parties which possess the corresponding private decipherment key.

NOTE 2 A registration authority can disable the ERT encipherment capabilities but not the decipherment capabilities.

- Read/write with both authentication and confidentiality: in this case the ERT provides both authentication and confidentiality services.

In addition to these main variants, various subvariants may be distinguished, e.g.:

- A read/write ERT which also maintains a log of historic data, i.e. of previous write operations;
- An ERT with confidentiality services for which the registration authority can also authorize other authorities to read the ERI data;
- An ERT with confidentiality services for which the registration authority may also grant the ERT holder permission to read the (historic) ERI data in their ERT;
- An ERT with confidentiality services for which the registration authority may also grant the ERT holder permission to authorize additional service providers to read the ERI data in their ERT.

5.2.7 Security service levels and interoperability

This part of ISO 24534 supports authorities in identifying vehicles roaming from the jurisdiction of other registration authorities. Therefore, much attention is given to the interoperability of ERTs and readers of various capability levels, i.e. the identification of a vehicle with a simple ERT by a sophisticated reader and vice versa.

The basic principle for the interoperability of ERTs and ERI readers is that the reader will function with the full range of capabilities of the ERT. If the reader does not provide full functionality, e.g. the required decipherment capabilities, then the authority using the reader may ask for (decipherment) assistance from the registration authority. A similar situation applies when the ERT signs data.

Table 1 presents the various combinations when an ERT and an ERI reader have different cryptographic capabilities.

Table 1 — Interoperability between ERTs and ERI readers

ERT	ERI reader	Interoperability
<u>Encipherment</u>	<u>Decipherment</u>	
Yes	No	The reader will not understand the ERI data, which needs the assistance of the vehicle's registration authority for decrypting the data read.
No	Yes	The reader does not need to use its decryption capabilities.
<u>Signing</u>	<u>Signature verification</u>	
Yes	No	The reader will not be able to check any signature provided for the ERI data.
No	Yes	The reader does not need to use its signature verification capabilities.

In order to support readers with no decipherment capabilities, a registration authority may, if required, disable the encipherment capabilities of ERT for vehicles in its jurisdiction.

EXAMPLE When a vehicle is imported from a country with strict privacy protection into a country with less strict privacy protection and which consequently employs readers with no decipherment capabilities, then the registration authorities may disable the decipherment capabilities of the ERT when it is commissioned.

NOTE 1 Harmonization of the security requirements of the registration authority is outside the scope of this International Standard.

With respect to the interoperability between ERTs and ERI writers, precedence has been given to security above the support of international (re)sales. As a registration authority may replace an ERT, this is not considered to be a severe restriction. The basic principle for writing is that a writer and, hence, a registration authority can determine the capabilities of an ERT and, based upon this, the registration authority can decide to accept that ERT or replace it with one that matches its requirements.

NOTE 2 If a registration authority does not accept a particular ERT, then that authority should replace it with one that is acceptable and customize it as necessary.

The interoperability of ERTs and ERI writers of various capability levels is depicted in Table 2.

Table 2 — Interoperability between ERTs and ERI writers

ERI writer	ERT	Interoperability
<u>Encipherment</u>	<u>Decipherment</u>	
Yes	No	The ERI writer can only write data into such an ERT if it disables its encipherment capabilities.
No	Yes	The ERT will not accept any data that has to be encrypted from such a writer. More precise, the ERT will then not accept any private signature key or PIN in a commissioning transaction. As a consequence the invocation of a commissioning transaction will disable the ERT signing capabilities and will prevent the use of a PIN by an ERT holder.
<u>Signing</u>	<u>Signature verification</u>	
Yes	No	The ERT will not verify any signature provided by the writer. As a consequence every writer can be used to change the ERI data and its security data. NOTE This is not advisable, but allowed in this International Standard. It is the responsibility of the registration authority to allow or not to allow (i.e. to commission or not to commission) this kind of ERT.
No	Yes	The ERT will not accept any data from this writer.

It is the responsibility of a registration authority to accept or not to accept a particular ERT within its jurisdiction, i.e. a registration authority may or may not want to commission itself on a particular ERT.

5.3 Security services

5.3.1 Assumptions

The security concept for the exchange of data between an ERT and an ERI reader or writer is based on the following assumptions.

- The use of an ERT may be mandatory and, therefore, should be fraud resistant. Using ISO 7498-2 terminology, the ERT should be resistant against active threats (e.g. modification of messages, replay of messages, insertion of spurious messages, and masquerading).
- A reading of an ERT should be suitable as legal evidence (non-repudiation).

NOTE This may require the specification of a protection profile (including an adequate evaluation assurance level, EAL) for the ERT according to ISO 15408. However, such a specification is outside the scope of this International Standard.

- ERI shall have the capability to provide a high level of privacy protection (i.e. it should not be easily possible to monitor mobility patterns of a vehicle and, hence, of its regular driver). As a consequence, an ERT should also be resistant against passive threats.
- ERI shall have the capability to provide protection measures to prevent ERI from being used to trigger an attack on a vehicle.
- The performance of security mechanisms shall be achievable within the time available for communications whilst the vehicle is moving.

EXAMPLE Reading a vehicle at 180 km/h within a 10 metre read range should be achieved within 200 ms.

5.3.2 Entity authentication while reading ERI data

Trust in the authenticity of an ERI reading depends on the following authentication aspects, which must all be fulfilled to fully trust a reading:

- a) The ERT is customized with the correct vehicle identifier and is attached to the correct vehicle.
- b) The ERT cannot be removed from the vehicle without rendering it inoperable.
- c) The ERI data is read from a genuine ERT, i.e. from a legitimate device (it is not a replicated message from a fake one). This is achieved by signing the ERI data together with a challenge code provided by the ERI reader.
- d) The ERI data is correctly read from the ERT (data integrity, manipulation detection). This is achieved by standard mechanisms used in data communications, by signing data, and, as a sideeffect, by encrypting the ERI data (decipherment of corrupted ciphertext will not produce anything useful).
- e) When ERI data has been correctly read from a genuine ERT upon a particular request it shall be difficult to be disputed later on that this data was not read from this component upon that request (non-repudiation). This is achieved by signing the ERI data together with a challenge code provided by the ERI reader.

NOTE 1 This part of ISO 24534-4 only deals with c), d), and e). Item b) is specified in ISO 24534-2. Item a) is not dealt with in this part of ISO 24534-4.

NOTE 2 Using ISO/IEC 9798-3 terminology, c) and e) are supported using a two-pass unilateral authentication mechanism. Uniqueness/timeliness is then controlled by generating and checking a random number sent by the ERI reader (the verifier) to the ERT (the claimant).

5.3.3 Confidentiality while reading ERI data

This International Standard supports confidentiality by delivering ERI data in an encrypted format. The encrypted ERI data can then be made freely available but can only be decrypted and interpreted by authorized persons/equipment (end-to-end encipherment).

To prevent encrypted ERI data from being able to be used as a pseudonym, a sequence number is added to the ERI data before encryption.

NOTE Confidentiality is, in more technical terms, provided by means of asymmetric keys. In the case of read operations the ERT uses a public encipherment key of an authority written into the ERT by the registration authority or by the ERT holder (for an additional service provider). In the case of write operations, confidentiality is achieved with a public encipherment key which can be obtained from the ERT. The data to be written can then only be decrypted with the private decipherment key of the ERT.

5.3.4 Keys for authentication and confidentiality

A vehicle may be registered for many years and during those years many other vehicles are registered or deregistered. As a consequence a registration authority has either to always use the same keys, or to use different keys for different vehicles. In order to support this latter option a key can be identified with a key identifier.

In the case of encryption, the identifier of the public encipherment key is attached to the ciphertext and can then be used by a recipient to determine the corresponding private decipherment key.

For signature verification one or two public key certificates shall be appended to the signed data. For data signed by the ERT the certificate is provided by the registration authority when the private signature key is written into the ERT (see the commission ERT transaction). For data to be signed by the back office equipment the private signature key for the top level certificate is determined by means of a key identifier that can be obtained from the ERT. This key identifier and the public verification key are written into the ERT when it is manufactured.

This part of ISO 24534 allows a registration authority to change its public encipherment key, the private signature key and the PIN for the ERT holder. This may e.g. be part of a periodic motor vehicle test.

NOTE There is no implication that the garage performing the periodic test will change this key itself. Although, it is outside the scope of this part of ISO 24534 to prescribe the security measures to be applied by the registration authorities to protect their private keys, it is more likely that the garage will only establish a connection between the ERT and the registration authority; the registration authority may then securely update the ERT.

5.3.5 Access control to ERI data

5.3.5.1 Read access control

5.3.5.1.1 Entities with read access

The following three types of entities may require access to ERI data:

- authorities,
- authorized service providers, and
- the ERT holder.

In case the ERT has enabled encipherment capabilities, it controls read access of authorities and authorized additional service providers by means of an “access control list” that contains for each entity the following data:

- its identifier,
- its public encipherment key and key identifier, and
- an indication of whether or not this entity is an authority.

The public encipherment key is used for the encryption of a random secret key used to encrypt the ERI data sent to the ERI reader.

In case a registration authority does not support confidentiality, its public encipherment key will have a null value and any contents of the access control list will be ignored. In that case the ERI data will be sent in cleartext to the ERI reader.

5.3.5.1.2 Read access for authorized authorities

In case an ERT has enabled encipherment capabilities, a registration authority may authorize an authority for reading ERI data by writing its identifier, public encipherment key and key identifier into the access control list of the ERT (see 5.3.5.2).

The ERI reader of an authorized authority can have confidential access to the ERI data by providing the identifier of this authority. The ERT will then encrypt the ERI data with its public encipherment key.

5.3.5.1.3 Read access for unauthorized authorities

An authority that is not authorized to read the ERI data shall not provide any entity identifier in its read request. The ERT will then encrypt the ERI data with the public encipherment key of the vehicle's registration authority.

Decrypting this ERI data then requires the private decipherment key of the vehicle's registration authority. This can be accomplished in several ways (which are all outside the scope of this International Standard):

- The ERI reader can be commissioned providing the private decipherment key of registration authority in e.g. a SAM, in which case the reader can decrypt the ERI data itself.

- The local (registration) authority may have (a SAM with) this private key and may then decrypt the ERI data obtained by the reader.
- The vehicle's registration authority may be requested to decrypt the ERI data.

NOTE Procedures for the cooperation between registration authorities are outside the scope of this International Standard.

5.3.5.1.4 Read access for authorized service providers

Access of a service provider is controlled by adding its identifier, public encipherment key and key identifier to an access control list in the ERT. A reader of this service provider can then be commissioned with the corresponding private decipherment key (in a SAM).

When requesting the ERI data from a vehicle, the reader provides the ERT with the identifier of the service provider. If the access control list contains this identifier, the associated public encipherment key is used for the encryption of the ERI data returned to the reader. If not, the public encipherment key of the vehicle's registration authority is used.

5.3.5.1.5 Read access for the ERT holder

This International Standard provides access to cleartext ERI data if the request contains both the vehicleId and the password (PIN) supplied to the ERT holder.

Using only the VehicleId violates the requirement that the ERI shall not be easily usable for triggering an attack on the vehicle. The success of an attempt to read data using only the VehicleId as authentication information may then be used as such a trigger. The use of a PIN reduces this risk.

5.3.5.2 Write access control

5.3.5.2.1 Entities with write access

Write access may be required by the following types of entities:

- manufacturers and registration authorities in order to customize the ERT for a particular vehicle,
- registration authorities in order to commission and to update ERI data or security data, and
- the ERT holder.

5.3.5.2.2 Write access for customizing by manufacturers and registration authorities

This International Standard supports customizing an ERT for a particular vehicle by a manufacturer or a registration authority.

Customizing the ERT for a particular vehicle is accomplished by writing the vehicle identifier and, eventually, additional vehicle data (e.g. the registration date, registration number, engine type, etc.) into this component.

An ERT can only be customized once in its lifetime and the vehicle identifier in the ERT can then never be changed.

NOTE 1 This may be accomplished, for example, by a manufacturer during the vehicle build or by a registration authority if the ERT has to be replaced (e.g. because of a defect) or is to be retrofitted.

To obtain this write access the writing equipment shall prove that it is acting on behalf of a manufacturer or a registration authority. To this end the writing equipment shall supply one of two public key certificates:

- a public key certificate issued by either the top-level or an intermediate certification authority, or
- in case the public key certificate is issued by an intermediate certification authority, a public key certificate for this intermediate certification authority issued by the top-level authority.

NOTE 2 As the public verification key(s) of the top-level certification authority are put into the ERT at manufacturing, this component can verify the signature on a certificate issued by the top-level certification authority.

NOTE 3 As it is only required that the data to be written into the ERT be issued by an official registration authority (and contain the correct vehicle identifier) there is no need to authorize the writing equipment. The communication channel used to exchange the ERI data from the BOE of the registration authority to the ERT may be insecure.

5.3.5.2.3 Additional write access for registration authorities

In addition to customization, this International Standard also supports, as far as applicable, write access of a registration authority to the ERT, in order to:

- commission itself as the vehicle's registration authority;
- add or change the private signature key to be used by the ERT to sign messages and the certificate for the corresponding public verification key signed by itself;

NOTE 1 This certificate also includes the vehicle identifier.

- add or change its public encipherment key required for the encipherment of ERI data (if confidentiality is to be supported);
- authorize other authorities by adding their identifier, public encipherment key and key identifier into the ERT's access control list (if confidentiality is to be supported);
- add or change the PIN issued to the ERT holder (if confidentiality is to be supported);

NOTE 2 How and when a registration authority sends an ERT holder a (new) PIN is outside the scope of this International Standard.

- change the additional vehicle data (e.g. its registration number, its colour, its engine type, etc.) as required or allowed by local legislation.

Write access is obtained by handing over one or two public key certificates as described in the previous section.

5.3.5.2.4 Write access for ERT holders

This part of ISO 24534 supports write access of an ERT holder to authorize read access for

- an additional service provider by writing the identifier, public encipherment key and key identifier of this service provider into the ERT, and
- onboard applications/equipment that needs to verify or authenticate ERI data by writing the identifier, public encipherment key and key identifier into the ERT.

To obtain write access the ERT holder shall identify themselves as the holder of the ERT containing the ERI data. They do so by using the vehicle identifier and a password (PIN), obtained from the registration authority.

NOTE How and when an ERT holder obtains this password (PIN) is outside the scope of this International Standard.

Using only the vehicle identifier violates the requirement that the ERI shall not be easily usable for triggering an attack on the vehicle. The acceptance of an attempt to write data using only the vehicle identifier as authentication information may then be used as such a trigger. The use of a PIN reduces this risk.

5.3.6 Public certification key identification

The top-level certification authority may use different private signature keys. A key identifier is used to determine the private signature key that corresponds to the public verification key stored in the ERT. This key identifier is stored in and can be read from the ERT.

5.4 Communication architecture description

5.4.1 Identifying a vehicle with an authorized short-range reader

Figure 5 presents the communication concept for the identification of a vehicle with an authorized ERI reader using short-range communications.

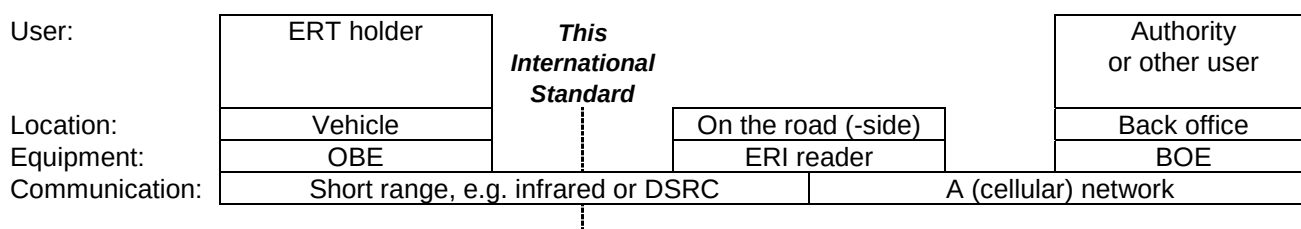


Figure 5 — Short-range communication with an authorized reader

This International Standard deals with the application layer of the air interface between the onboard ERI equipment and external short-range ERI readers.

NOTE The vehicle-external ERI-reader interface corresponds to the DELTA reference point, the air interface, in Annex A of ISO 14814:2006 (see 5.5.1 for details). The external ERI-reader-back-office interface corresponds to the ALPHA reference point in that annex.

The interface between an external ERI reader and the BOE of a back office is outside the scope of this International Standard. It may e.g. be used for commissioning the ERI reader, the exchange of white or black lists and/or uploading the reading results. It may e.g. be a local interface in the back office or a wide area network interface.

A back office may be an office from a (registration) authority or from an additional service provider.

A similar situation applies to, and a similar figure can be drawn for, the identification of a vehicle with an authorized external proximity reader.

5.4.2 Identifying a vehicle with a non-authorized short-range reader

Figure 6 presents the communication concept for the identification of a vehicle with a non-authorized short-range ERI reader, i.e. with an external ERI reader that does not have a private decipherment key for the decipherment of the ERI data.

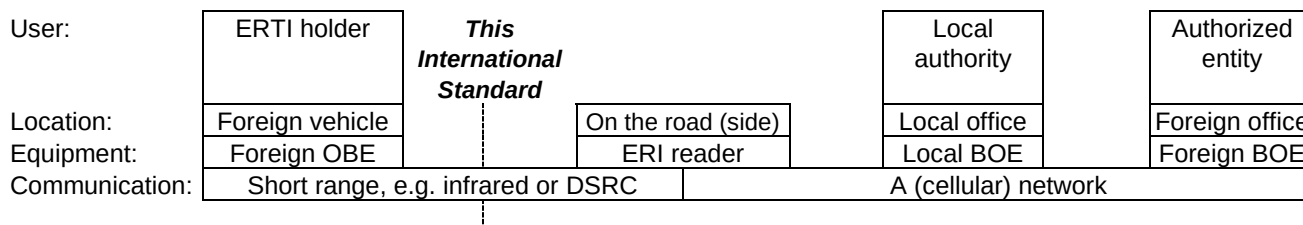


Figure 6 — Short-range communications with a non-authorized reader

Identification of a foreign vehicle, i.e. a vehicle for which the external ERI reader is not authorized, requires the cooperation of an authorized entity, e.g. the registration authority at which the vehicle is registered. This cooperation, however, is outside the scope of this International Standard. It may be used for decrypting the data read from the vehicle and/or obtaining additional information.

The reader may e.g. directly communicate with the foreign BOE or may archive it via its own local BOE.

A similar situation applies to, and a similar figure can be drawn for, the identification of a vehicle with a non-authorized external proximity reader.

5.4.3 Overall communication concept for remote access

This International Standard also supports remote access to an ERT. A registration authority may e.g. use remote access, if implemented, to check or update the additional vehicle data or the security data. An ERT holder may use remote access to check the ERI data or to authorize an additional service provider.

Figure 7 presents the communication concept for remote access to a vehicle's ERT.

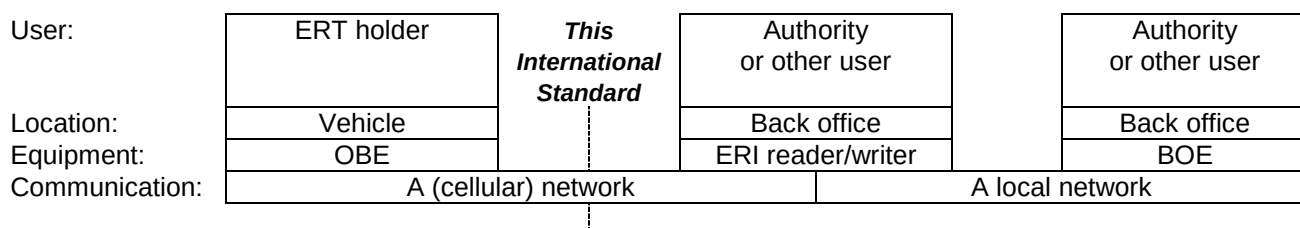


Figure 7 — Overall remote communication concept

This International Standard deals with the application layer of the network interface between the onboard ERI equipment and a remote external ERI reader/writer.

NOTE Whether or not remote access capabilities are implemented is outside the scope of this International Standard.

5.4.4 The onboard communication

Figure 8 presents an abstract overview of a possible onboard communication architecture.

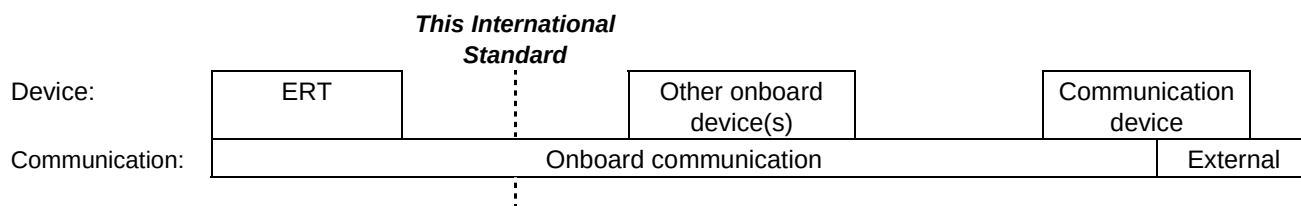


Figure 8 — The onboard architecture

NOTE The figure above does not imply that the ERT and the communication device shall be separate components. This may or may not be the case for a specific implementation.

5.5 Interfaces

5.5.1 The short-range air interface

The communication between the onboard ERI equipment and a short-range external ERI reader/writer uses the following protocol stack:

AVI layer (conforming to ISO 14816 plus additional services)
ERI layer (adding ERI security and management services)
An application layer, e.g. the DSRC application layer (conforming to ISO 15628) or a similar layer
Lower layers

Figure 9 — Protocol stack for the short-range air interface

NOTE The relation between these layers and the reference points BETA to ZETA in informative Annex A of ISO 14814 is depicted in the adapted Figure 10. (Reference point ALPHA is located between the ERI reader and the BOE of a back office.)