Introduction to standards on electronic fee collection (EFC)

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Outline

1. **Introduction to standards**
2. **Introduction to EFC-related standards**
    1. Scope, principles and use
    2. System architecture
    3. DSRC-based EFC
    4. GNSS-based EFC
    5. Info exchanges between Toll Charger and Service Provider
    6. Integrated circuits cards (ICC)-related standards
    7. Security
    8. Test suites for conformance assessment and examination frameworks
    9. Summary
3. **The European electronic toll service and CEN EFC standards**

Annex – Published EFC CEN/ISO documents

1. Introduction to standards

1) Introduction to standards

What is a standard?

- A document approved by a recognized standardization body (CEN, ISO,..)
- Intended to be used repeatedly, creating synergies and reducing costs
- Transparency and broad consensus
- Rely mainly on voluntary contributions
- Maintained to keep abreast with market developments and technology advancements
- **Voluntary in application, supports agreements**
- Sometimes referred in legislation – **8 CEN EFC standards are referred to in the EU legislation on the European electronic toll service (EETS)**

1) Introduction to standards

Role and benefits of standards

1) Standards, laws and specifications

Standards are not laws

- Facilitate agreements
- Sometimes referred to as part of legislation, e.g. the European electronic toll service (EETS)

Standards are more stable than (project) specifications

- Structured decision-making and voting procedures
- Clear ownership of documents
- Handling of comments, revision and corrections
- Often referred to in public procurements
- Test standards often complement “requirements standards” for conformity evaluation

2. Introduction to EFC-related standards

2.1) Overall scope of EFC-related standards

- **Fee collection (as opposed to fare collection)**
- **EFC system architecture** (User, Toll Charger and Service Provider)
- **Information exchanges for charging and compliance checking**
  - DSRC-based systems
  - GNSS-based systems (aka autonomous-based systems)
  - Systems using automatic number plate recognition (ANPR) technologies
  - Systems using integrated circuit cards (ICCs)
- **Security of EFC systems and interfaces**
- **Tests for conformance assessment and examination frameworks**

2.1) Principles for EFC standardization

- **Goal: support agreement, open market and interoperability**
- **Mainly technical standardization (not services)**
- **Focusing on interfaces between roles and sub-systems (not on the internal interfaces)**
- **Differences between DSRC-based and GNSS-based EFC**
  - Maturity (10+ years ?)
  - No fixed charging infrastructure (but fixed and movable enforcement systems)
  - Greater variety between GNSS-based schemes in the allocation of functionality between OBE and back-office systems
  - Potentially different media for communication with CS/proxy

2.1) What support do EFC standards bring?

- **Framework standards**
  - Common understanding, scoping, architecture, data dictionary, terms etc
- **Technical toolbox standards**
  - Necessary but not sufficient basis for compatibility
  - Why? Changing needs, technological developments, lack of common view, different needs of stakeholder
  - E.g. “Application interface definition (AID) for DSRC 14906”
- **Profile standards**
  - Coherent selection of choices in underlying toolbox standards for compatibility and interoperability
  - Based on common policies and services agreed by key stakeholders
  - E.g. “Interoperable application profile (IAP) for DSRC 15509”
- **Test standards**
  - Conformity evaluation of implementation to standard specification
  - E.g. EN 15876 test standard - “Conformity evaluation of OBE and RSE to EN 15509”
- **Maintenance of standards**

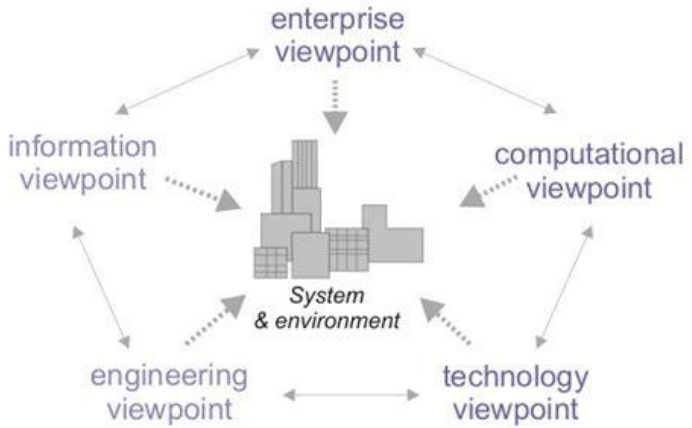
2.2) EFC system reference architecture – the 17573 series

Objectives

- Reference architecture to ensure a common understanding and consistent usage across EFC standards

Parts

- Part 1: Reference architecture model; Enterprise viewpoint, service action diagrams, identification of interfaces and information exchanges subject to EFC standardization
- Part 2: Vocabulary of 230+ terms
- Part 3: Data dictionary with 100+ data types and semantics in accordance with ASN.1



3.35
charge report
information containing road usage and related information originated at the *front end* (3.85)

Table 4 —Axles

Subtype	Parent type	Semantics
-	INTEGER	Axles provides the number of axles of either the tractor or trailer including drop axles.

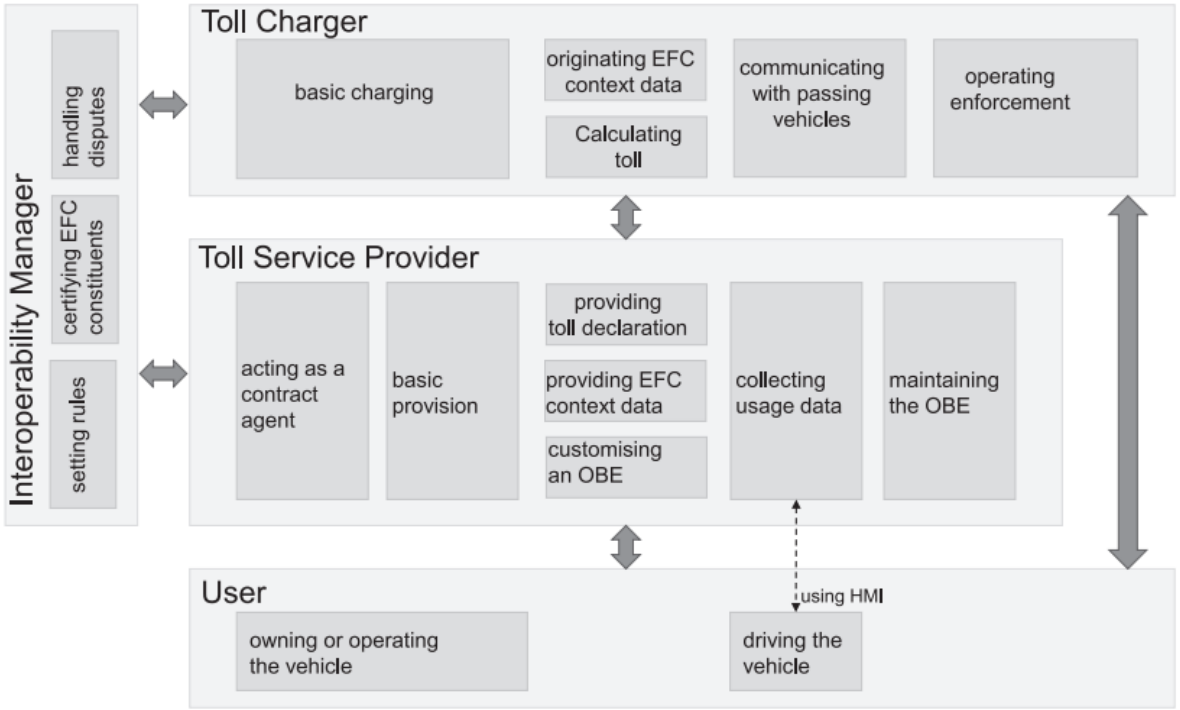
2.2) EFC system architecture (17573-1)

Objectives

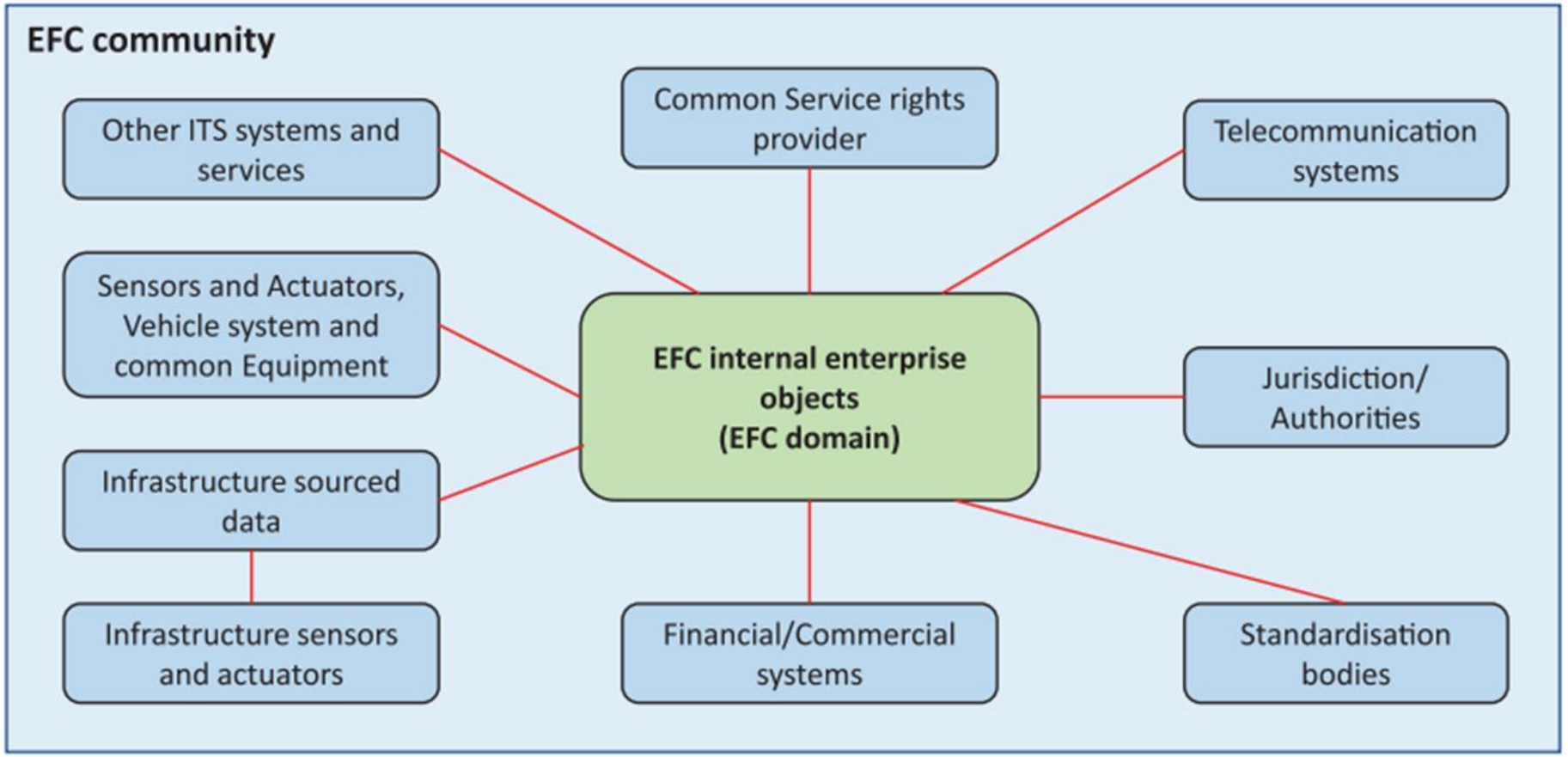
- Overall system reference architecture for EFC systems
- Common technical understanding

Scope

- System architecture and interfaces, roles and responsibilities
- Use diagrams for typical scenarios (mngt of charges, claim and payment settlement …)

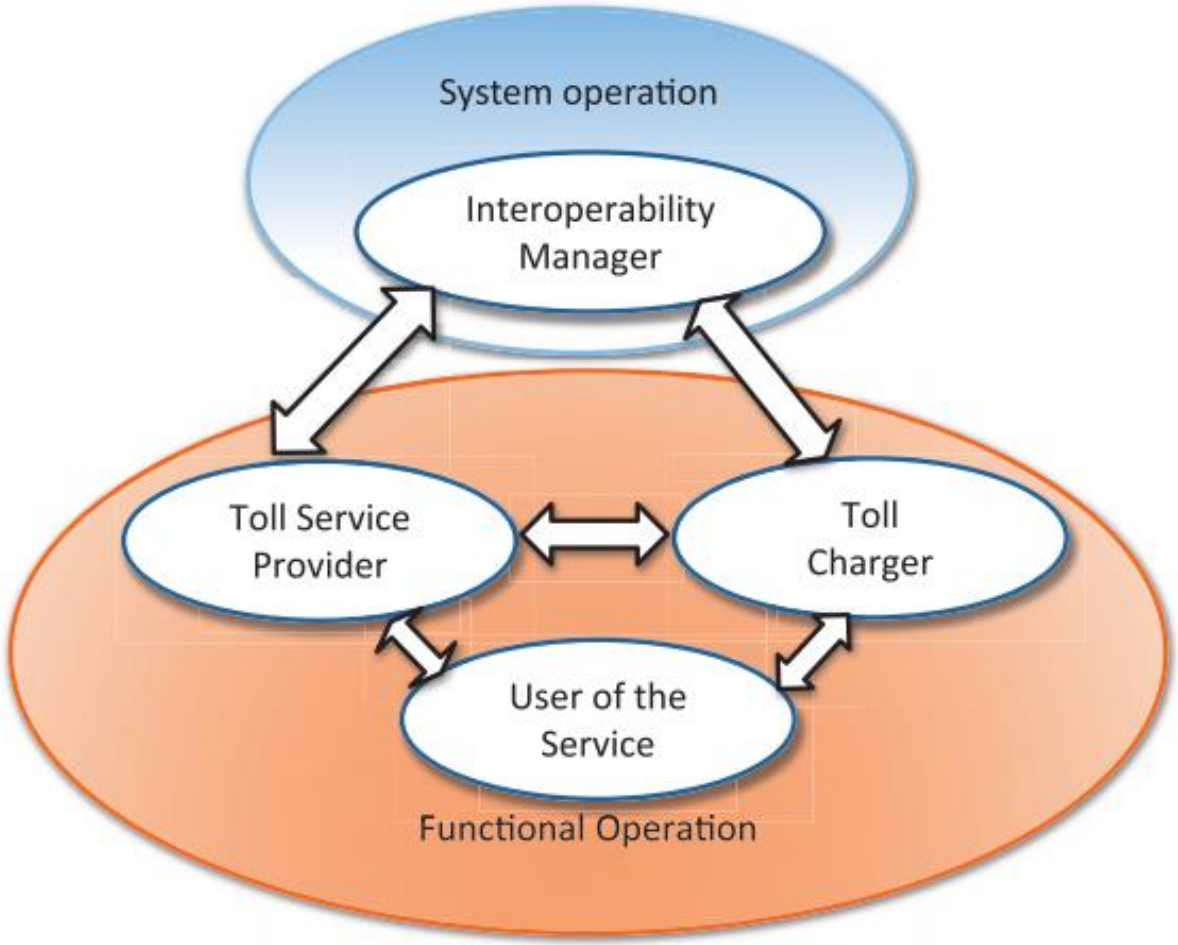


2.2) EFC system architecture – Enterprise objects

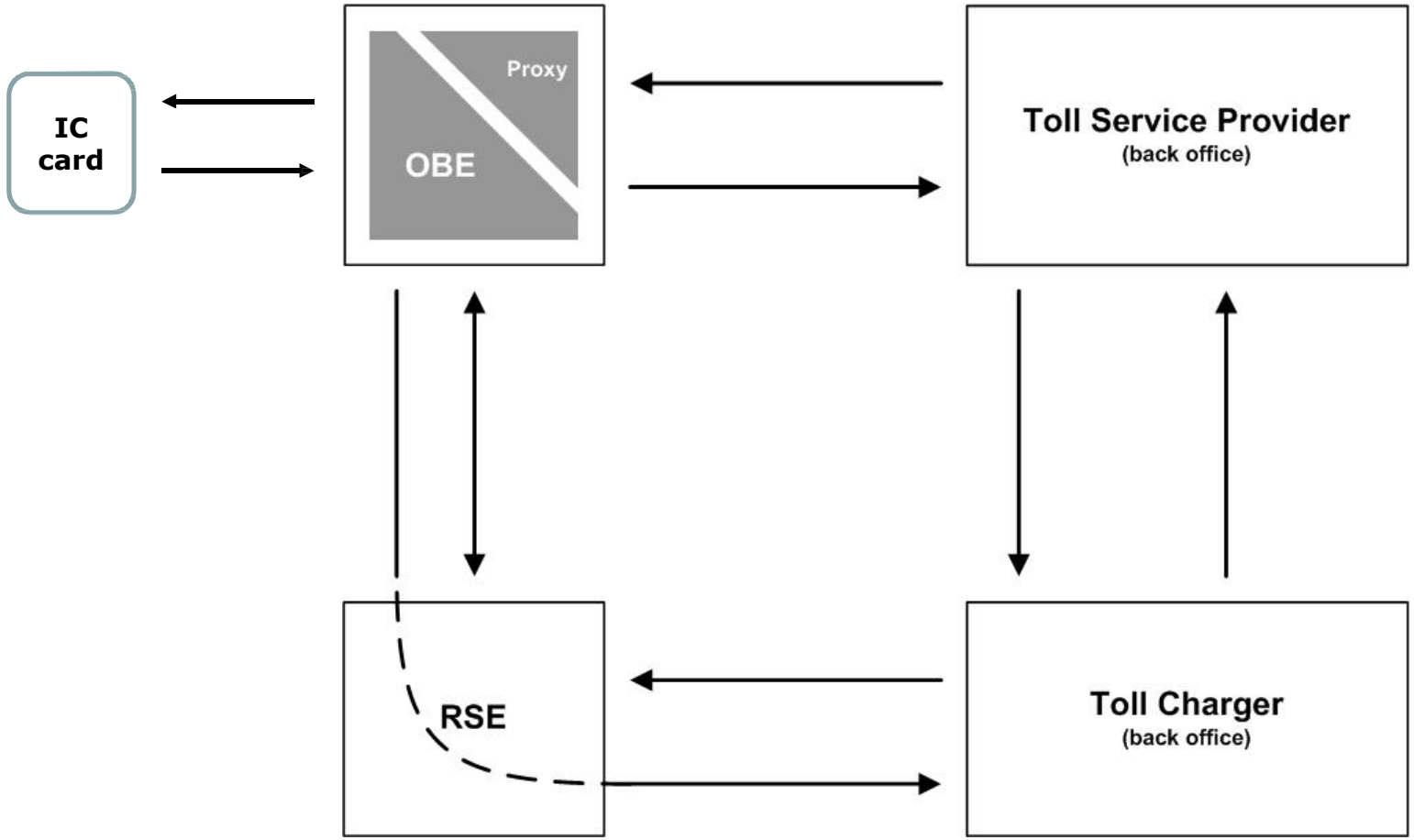


2.2) EFC system architecture – Enterprise viewpoint

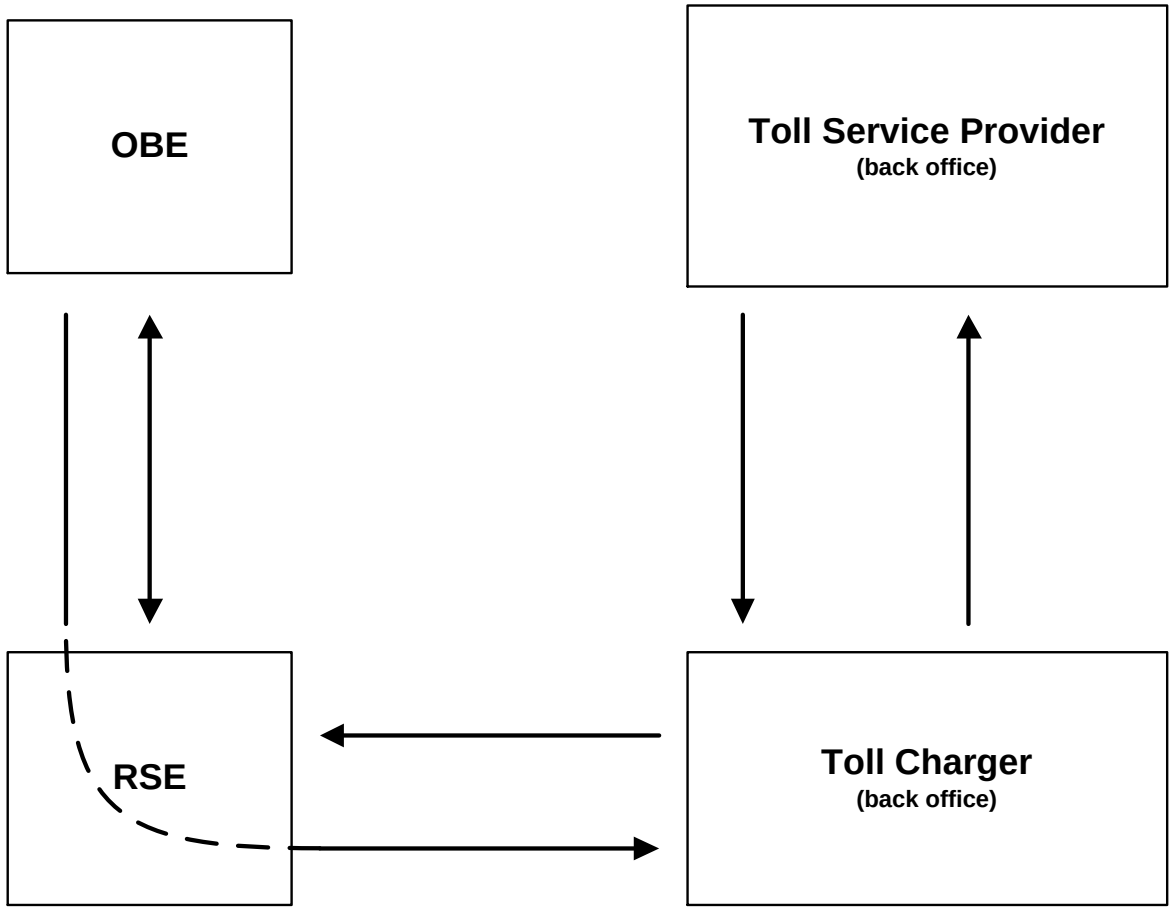
Basic roles



2.2) EFC system architecture – Engineering viewpoint



2.3) DSRC-based EFC



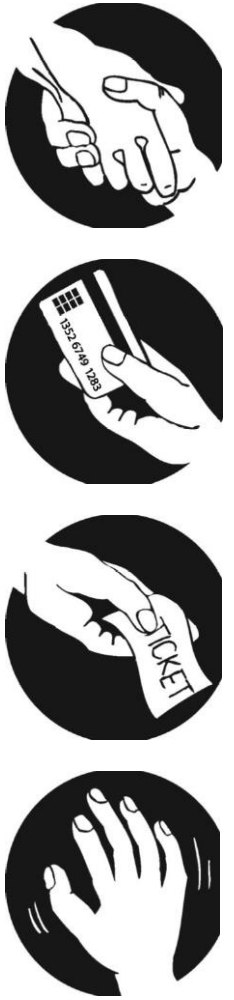
2.3) EFC AID for DSRC (14906)

Scope

- Transaction model
- 16 functions (e.g. “read”, “write”)
- 46 data sets (contract, vehicle, payment, receipt etc)
- Basis for defining transactions, with one example from the CARDME project

Impact

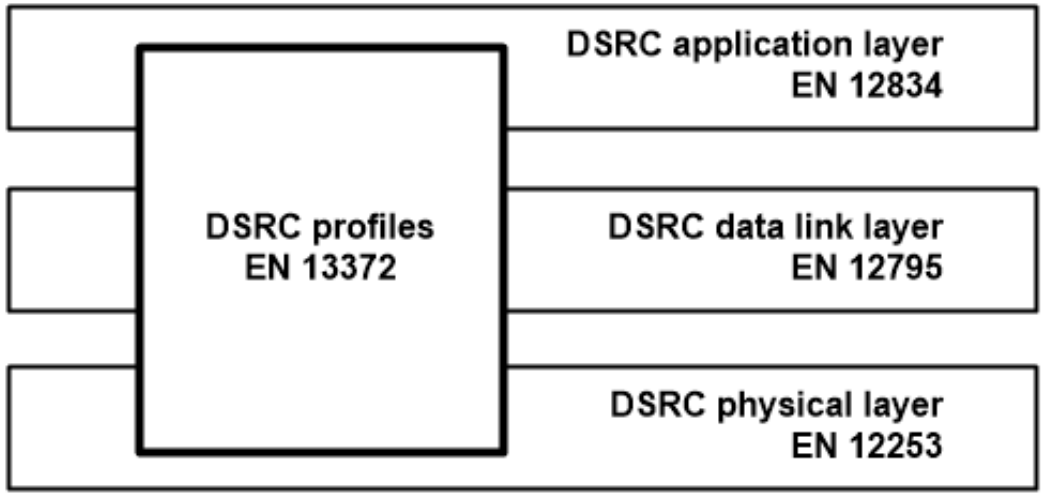
- Harmonized OBUs, basis for national / international tolling service
- 150 million compliant OBE and 70 thousand RSE



2.3) CEN DSRC 5,8 GHz suite

Complete set of DSRC 5,8 GHz standards

- Single and high-speed multi-lane tolling
- High reliability, fast connection and low latency
- Small service areas to facilitate compliance checking
- Inexpensive end-user technology



- **Impact: single open market**

Adopted in EU regulations

- European electronic toll service (EETS, Directive 2019/520)
- Tachographs in road transport (Regulation No 165/2014)
- Max authorized dimensions and weights for road motor vehicles (Directive 2015/719)

2.3) ETSI DSRC test standards

Electromagnetic compatibility and radio spectrum matters - DSRC transmission equipment operating in the 5.8 GHz band (EN 300 674)

- Part 1: General characteristics and test methods for RSU and OBU
- Part 2: Harmonised EN for RSU (sub-part 1) and OBU (sub-part 2) under the “Spectrum article” of the Radio Equipment Directive (RED)

Impact

- DSRC equipment must meet the “essential requirements” to be placed on the European market (indicated by CE marking)
- Compliance to part 2 gives presumption to conformity to the “essential requirements”

	CEN DSRC Standards / ETSI test specifications
Toolboxes	**CEN EN 12834** Application layer **CEN EN 12795** Data link layer **CEN EN 12253** Physical layer
Profiles	**CEN EN 13372** Profiles
Tests	**ETSI TS 102 486-2** Tests against 12834 Application layer [Protocol Implementation Conformance Statement] [Test Suite Structure and Test Purposes] [Abstract Test Suite] **ETSI TS 102 486-1** Tests against 12795 Data link layer [Protocol Implementation Conformance Statement] [Test Suite Structure and Test Purposes] [Abstract Test Suite] **ETSI EN 300 674-1** Physical layer tests against 12253 **ETSI 300 674-2-1/2** Physical layer tests covering the essential requirements of the European Radio Directive [RSU] [OBU]

2.3) Interoperability application profile (15509)

Objectives

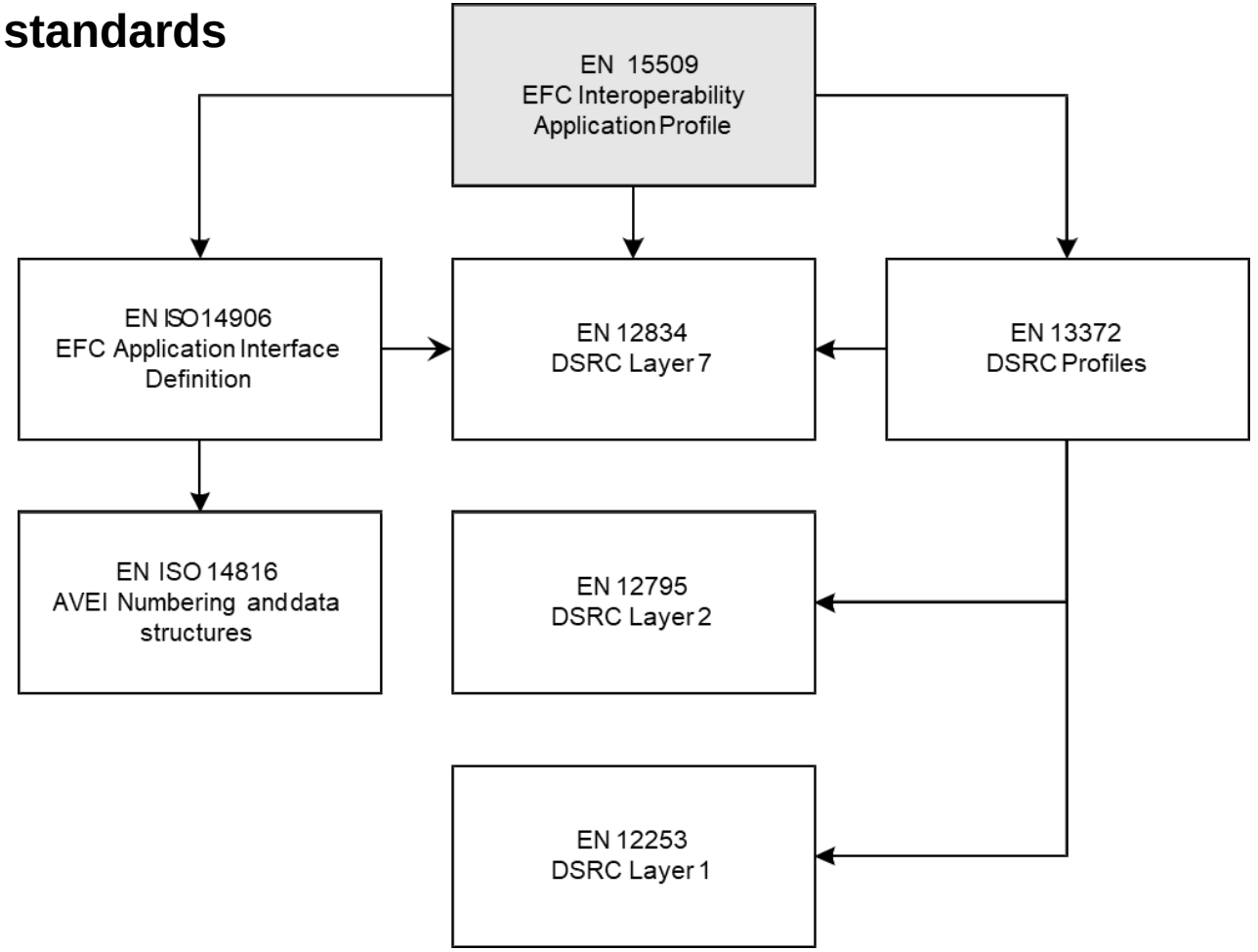
- Interoperability, equipment compatibility, best industry practice
- Support the European Electronic Toll Service (EETS) legislation

Scope

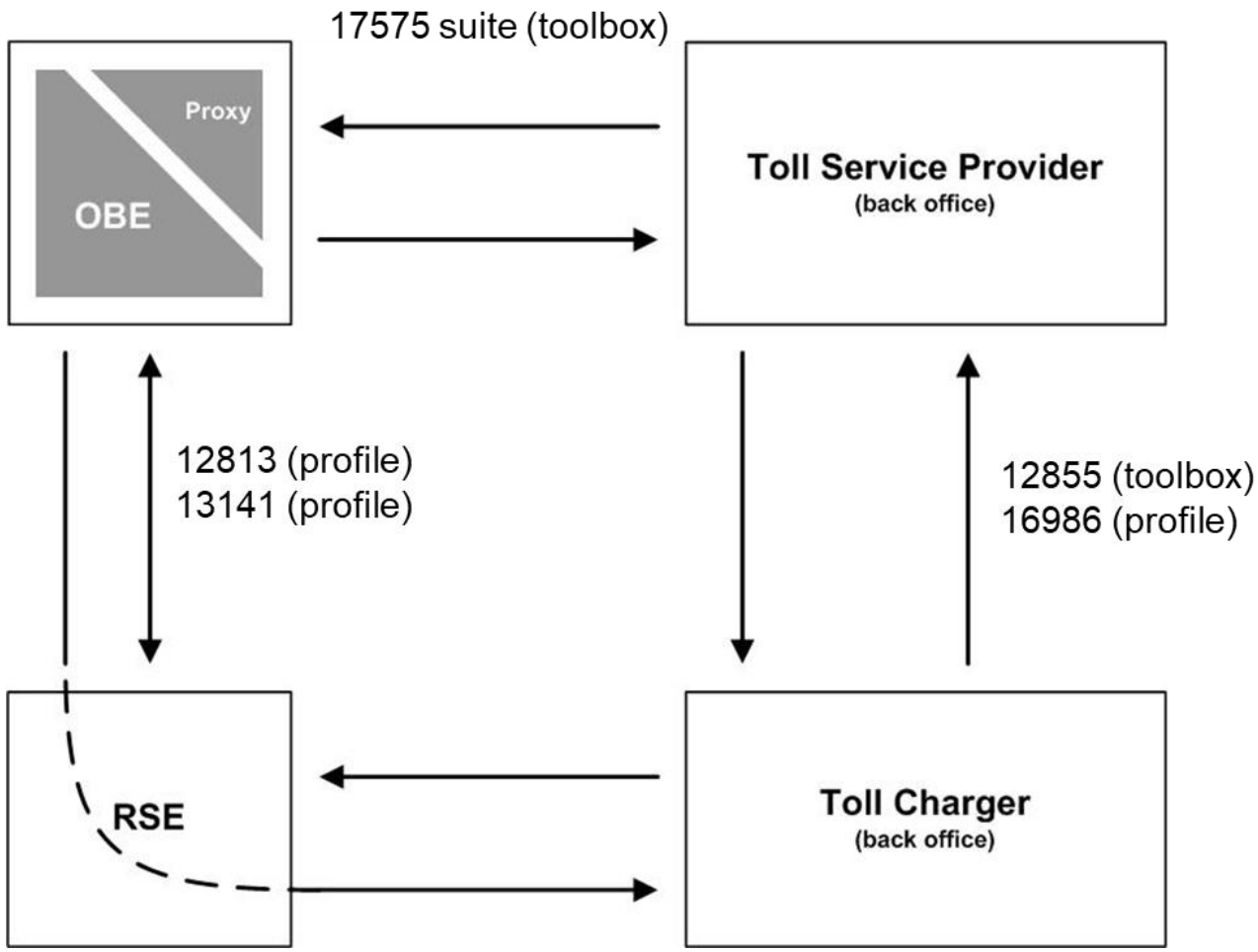
- DSRC requirements
- EFC functions, data and security
- Implementation conformance statement (ICS) proforma
- Use of this standard for the EETS, incl relationship to the requirements of EETS legislation

2.3) IAP for DSRC

Relationship to toolbox standards



2.4) GNSS-based EFC



2.4) AID for GNSS-based EFC (17575 suite)

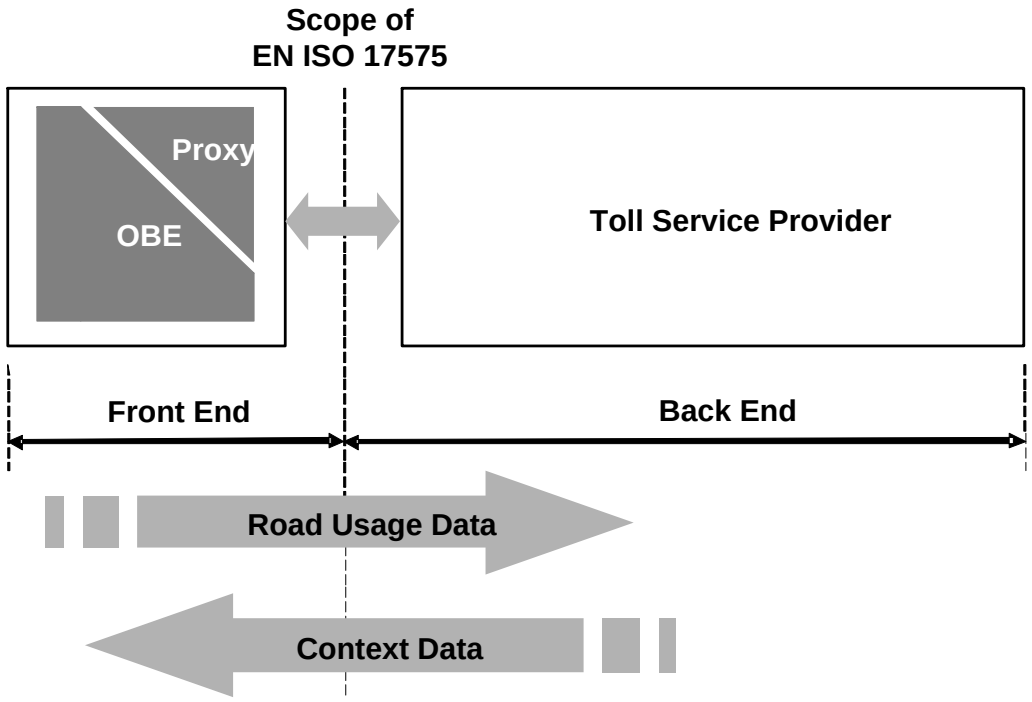
Objectives

- Support collection of charges for road usage - section, areas and cordon-based schemes - modulation of fees
- Support different scheme architecture (thin and smart OBE clients)

Parts

- Part 1: Charging
- Part 2: Communication and connection to the lower layers
- Part 3: Context data

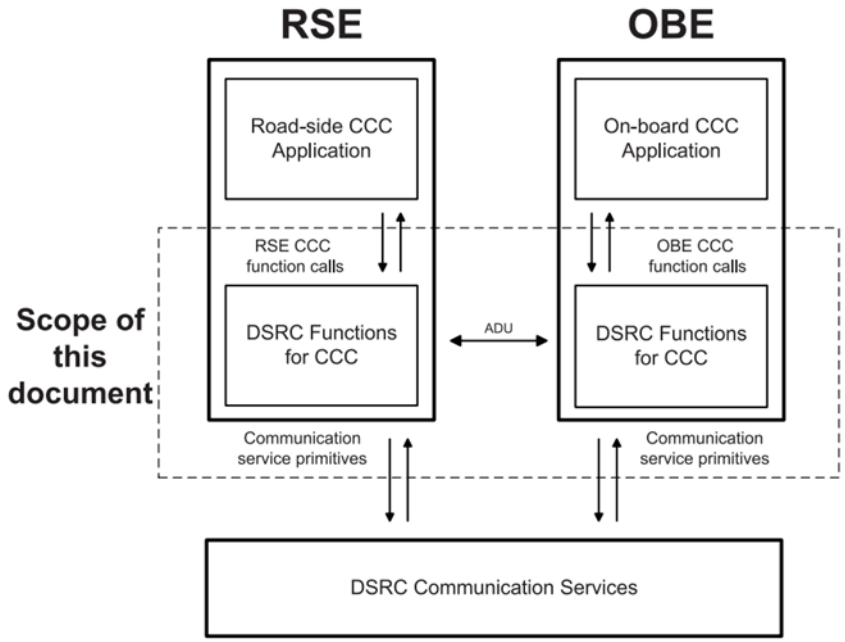
Limited relevance for the EETS as it specifies a Toll Service Provider “internal interface”



2.4) Compliance checking of the user (12813)

Objectives

- Compliance checking of the user
  - whether the OBE is mounted in the correct vehicle
  - the vehicle classification data transmitted by the OBE
  - the OBE working condition (technical and contractual)
- Support the EETS



Scope

- Data definitions according and in addition to the “EFC data dictionary” (17573-3)
- Security concept same as in “IAP for DSRC” (15509)
- Supports CEN DSRC, CALM, UNI DSRC and IEEE Wave comm standards
- Implementation conformance statement (ICS) proforma

The 13143-test standard can be used to evaluate the conformance of an implementation to 12813

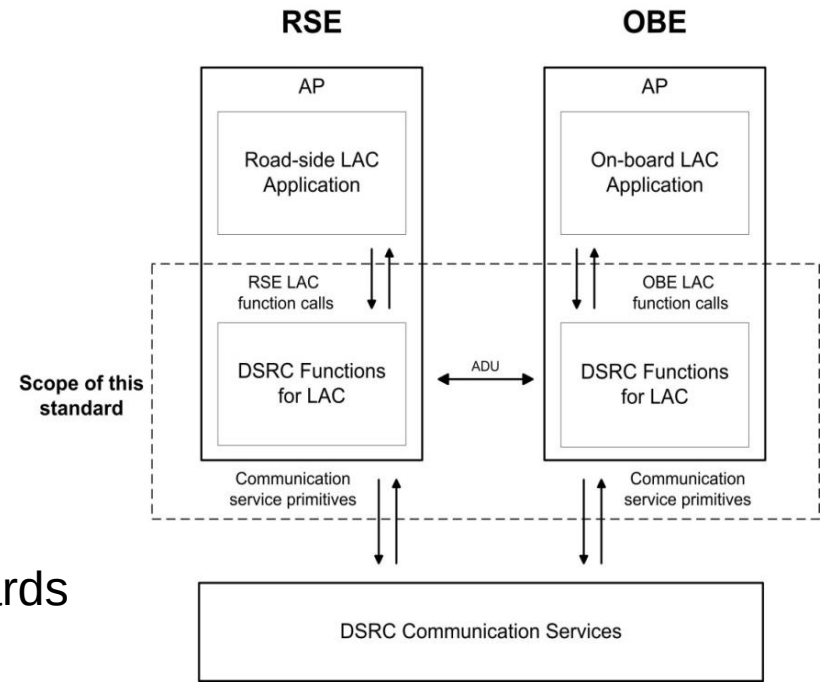
2.4) Localisation augmentation support (13141)

Objectives

- Localisation augmentation support
- Support the EETS

Scope

- Location reference data
- Data origin authentication, integrity and non-repudiation
- Supports CEN DSRC, CALM, UNI DSRC and IEEE Wave comm standards
- Implementation conformance statement (ICS) proforma



The 13140-test standard can be used to evaluate the conformance of an implementation to 13141

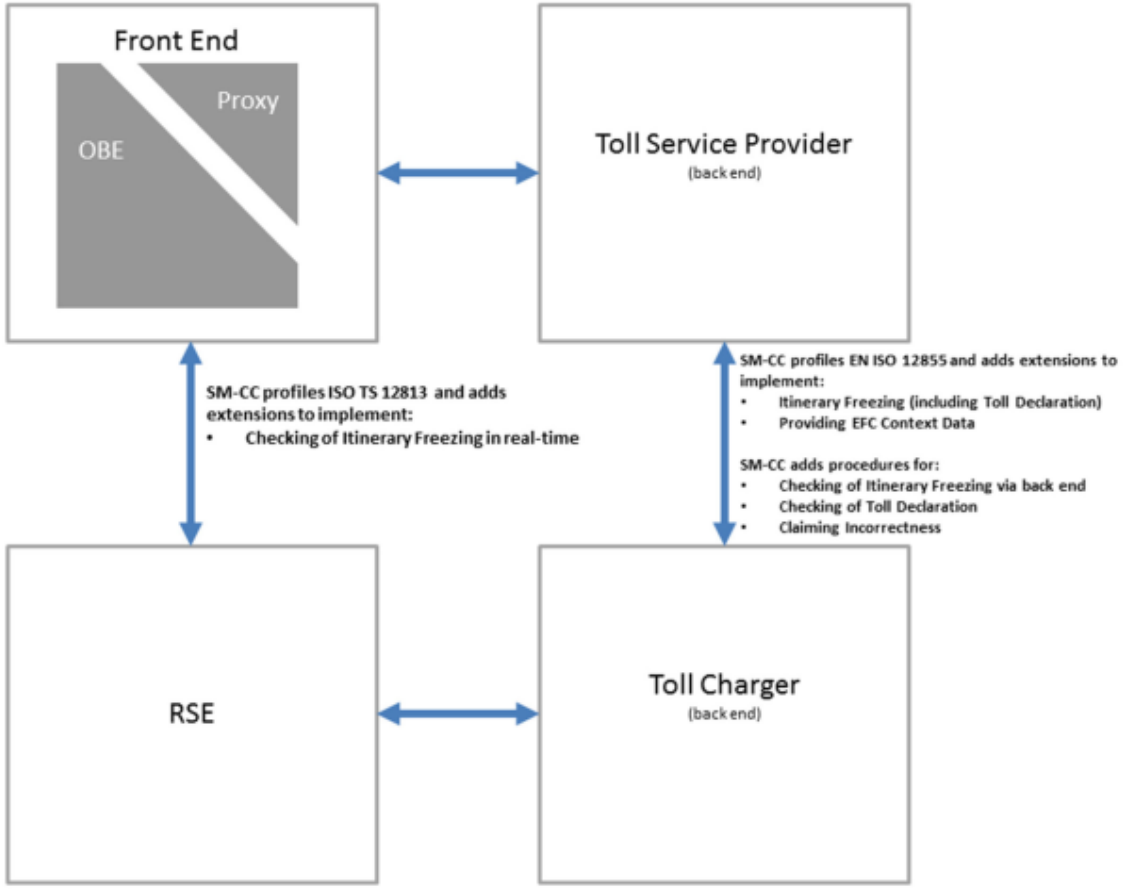
2.4) Secure monitoring - Compliance checking (16702-1)

Objectives

- Support for the Toll Charger to check the trustworthiness of the toll declarations from the Toll Service Provider whilst respecting the privacy of the user

Scope

- Secure monitoring concept
- Transactions and data
- Uses and builds onto other EFC standards (12813, 12855, 17575-1...)



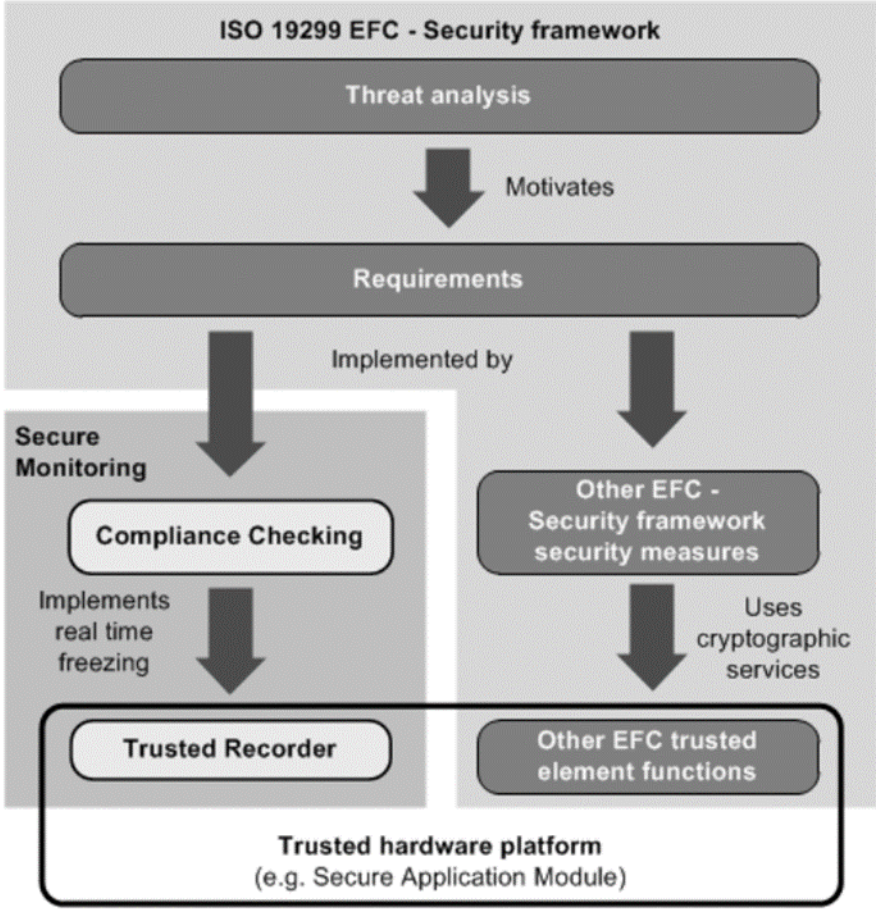
2.4) Secure monitoring - Trusted recorder (16702-2)

Objectives

- Support for the Toll Charger to check the trustworthiness of the toll declarations from the Toll Service Provider whilst respecting the privacy of the user

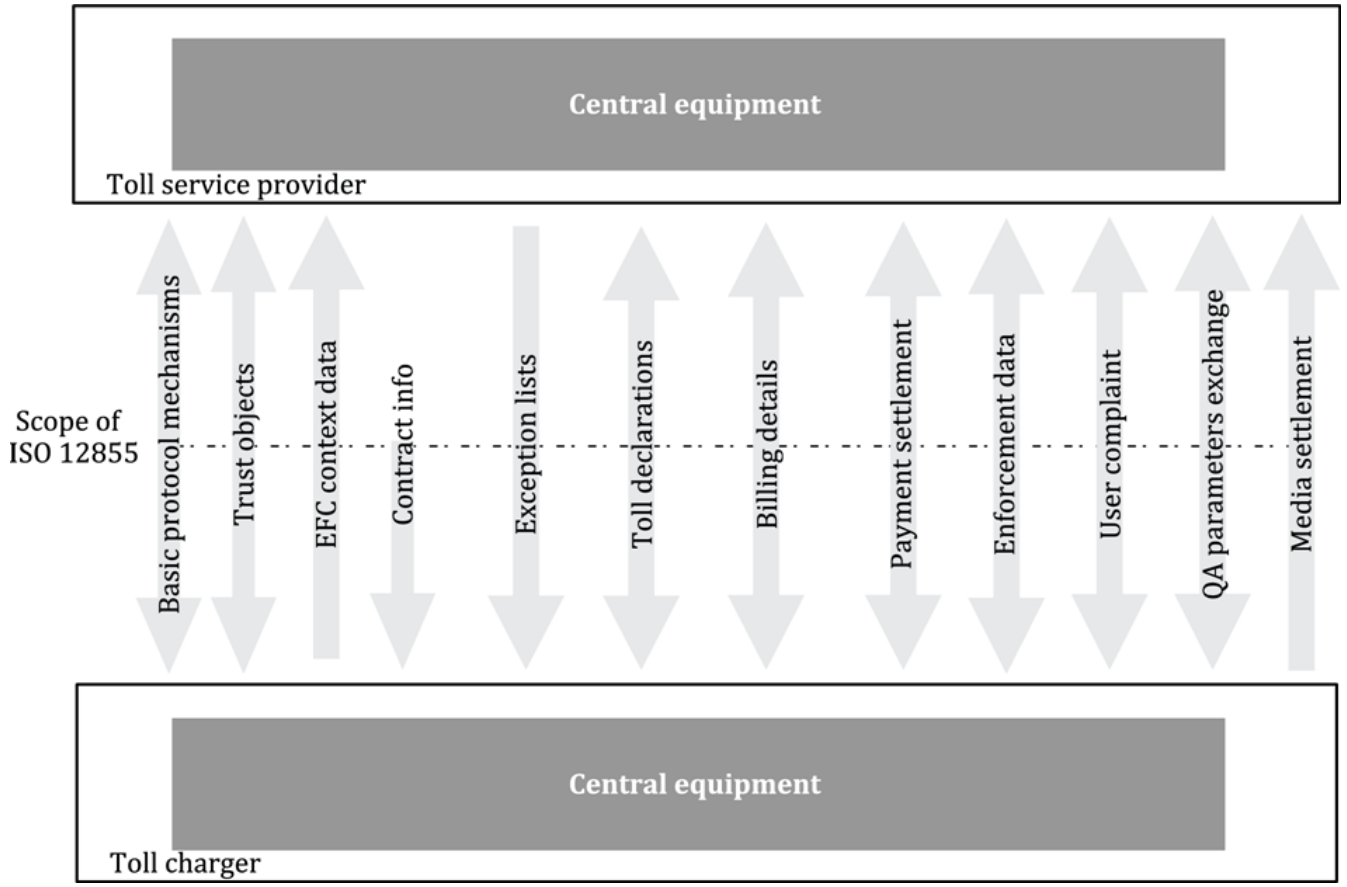
Scope

- Secure monitoring concept and stake holder requirements
- Transactions and data
- Uses and builds onto other EFC standards (16702-1, 19299, 12813, 12855, 17575-1...)

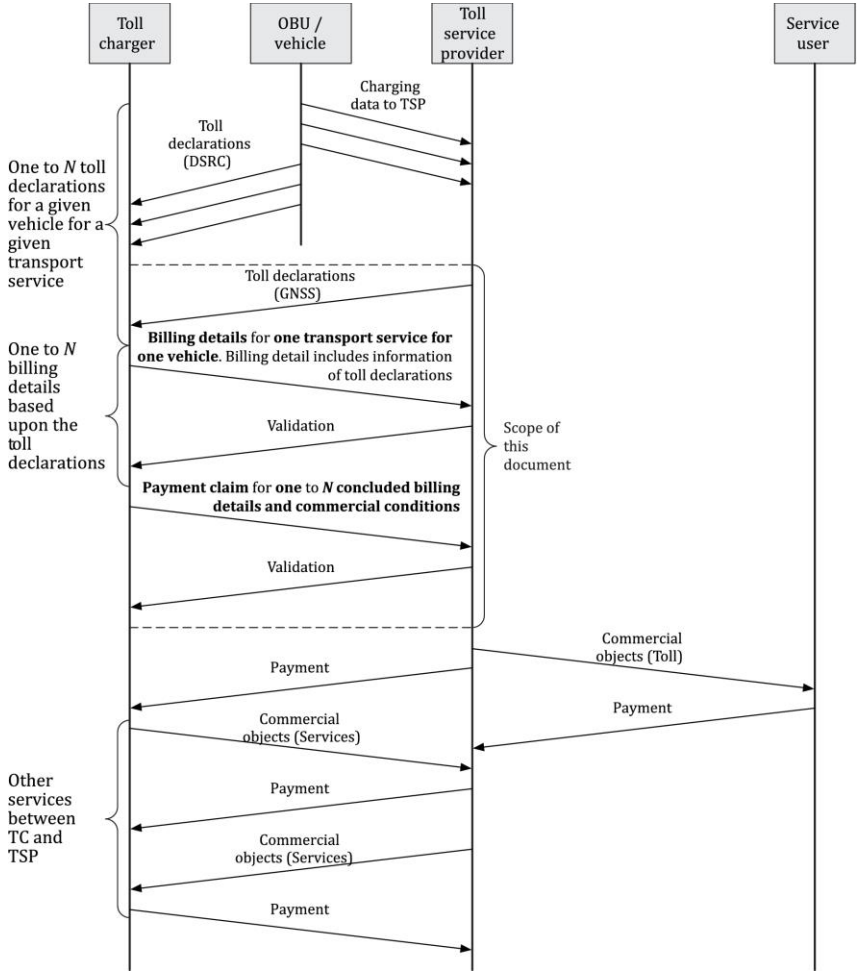


2.5) Info exchanges between SP and TC (12855, toolbox)

Objectives: Support for cost-effective integration of back-office systems



2.5) Example of data flow based on 12855 (toolbox)



2.5) Interoperable profiles for info exchanges between SP and TC (16986)

Objectives

- Support interoperability and the EETS

Scope

- Definitions of profiles (by coherent selection of choices in the underlying 12855 toolbox standard
  - Section discrete profile
  - Section autonomous profile
  - Meshed discrete profile
  - Area distance autonomous profile

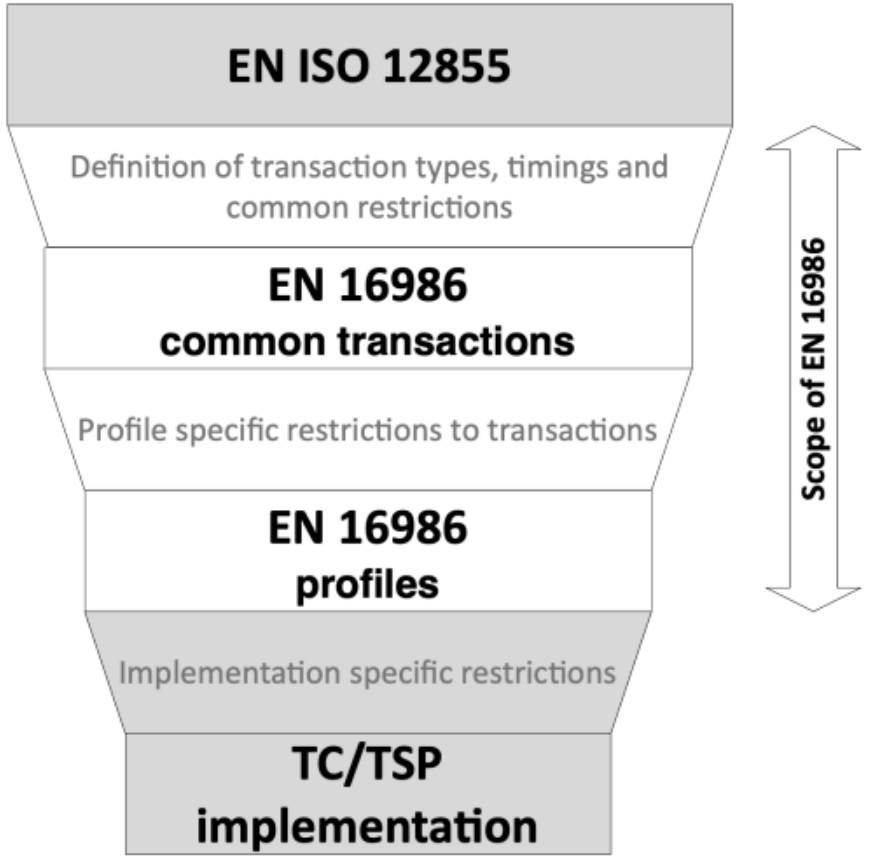
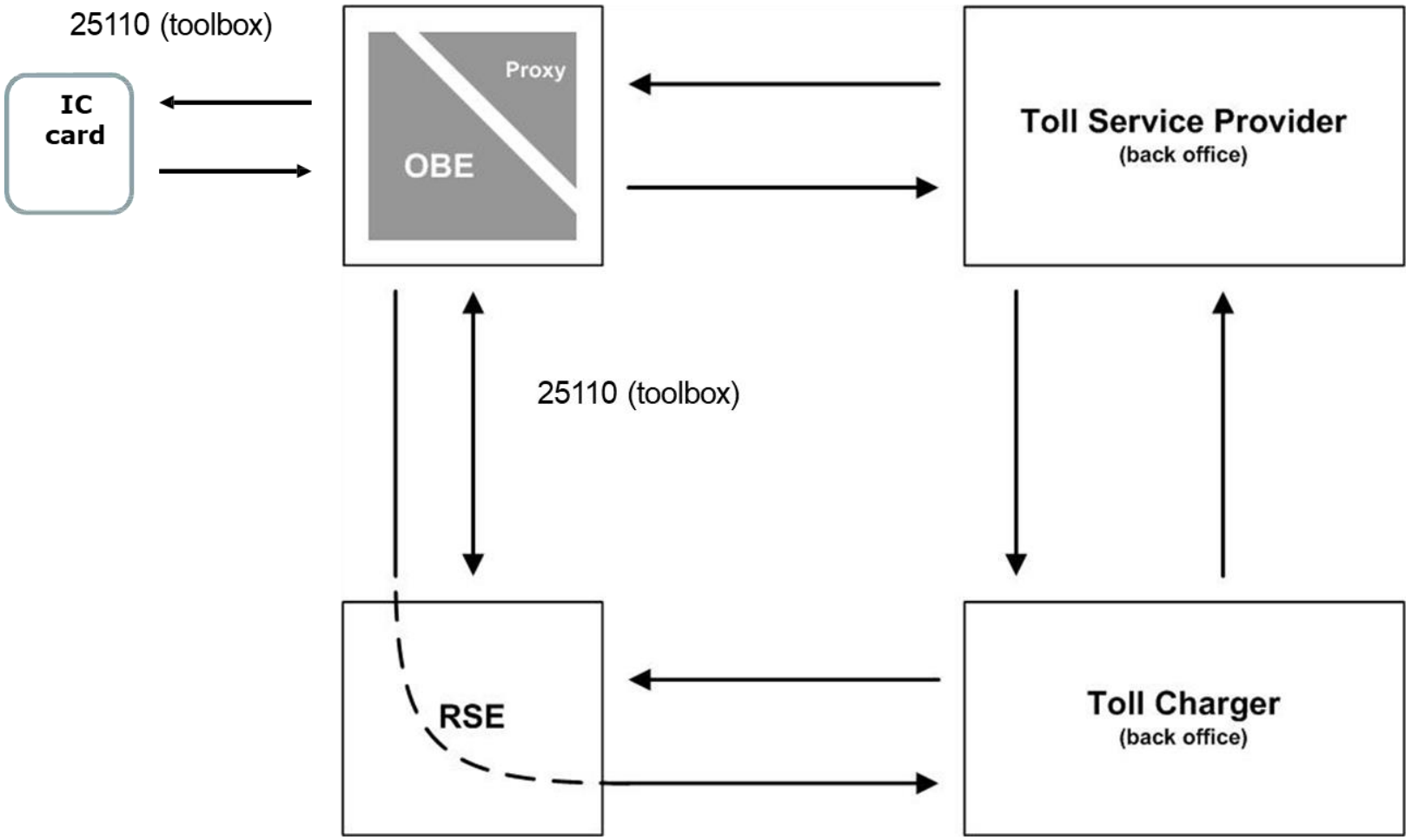


Figure 5 — Restrictions to the base standard

2.6) EFC integrated circuit(s) cards-related standards



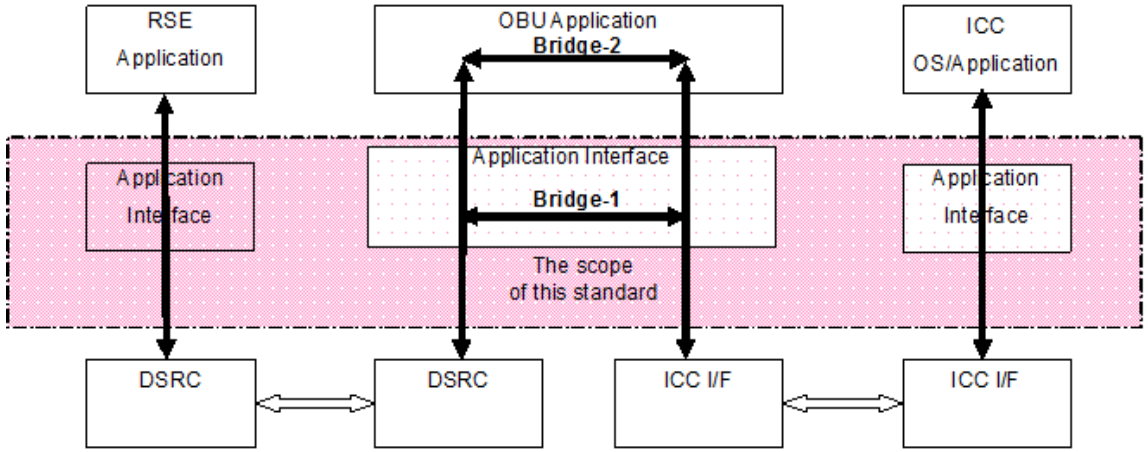
2.6) Interface for on-board account using ICC (25110)

Objectives

- Support EFC on-board account charging using ICC

Scope

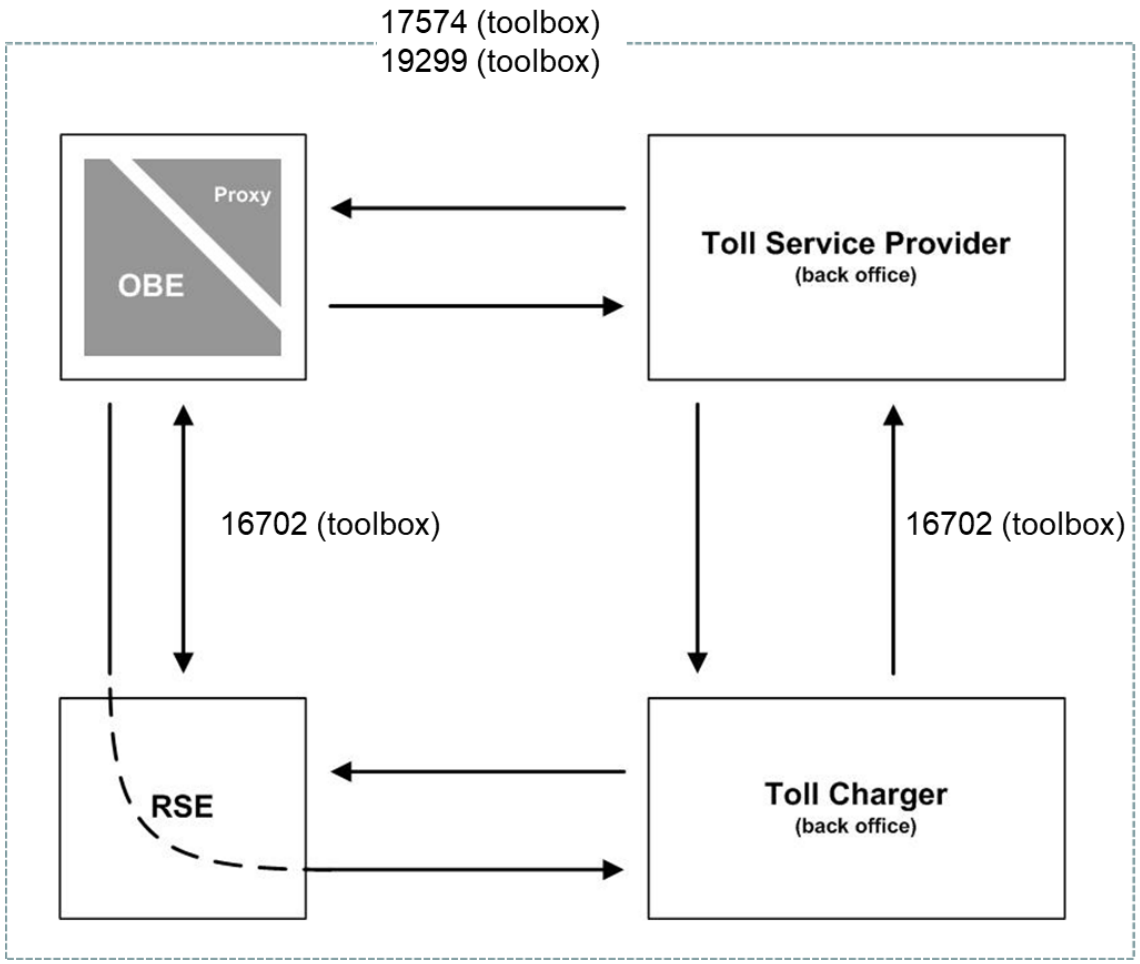
- DSRC – ICC interface protocol bridge / ”extension of 14906”
  - Transparent and buffering type (bridge 1)
  - Cashing type (bridge 2)
- Reference model for on-board account system
- Command definitions – RSE – OBE



Referenced toolbox standards

- EN ISO 14906 (EFC API)
- ISO 7816 suite (contact card)
- ISO 14443 suite (contactless card)
- EN 1545 suite (surface transport applications - data elements)

2.7) EFC security



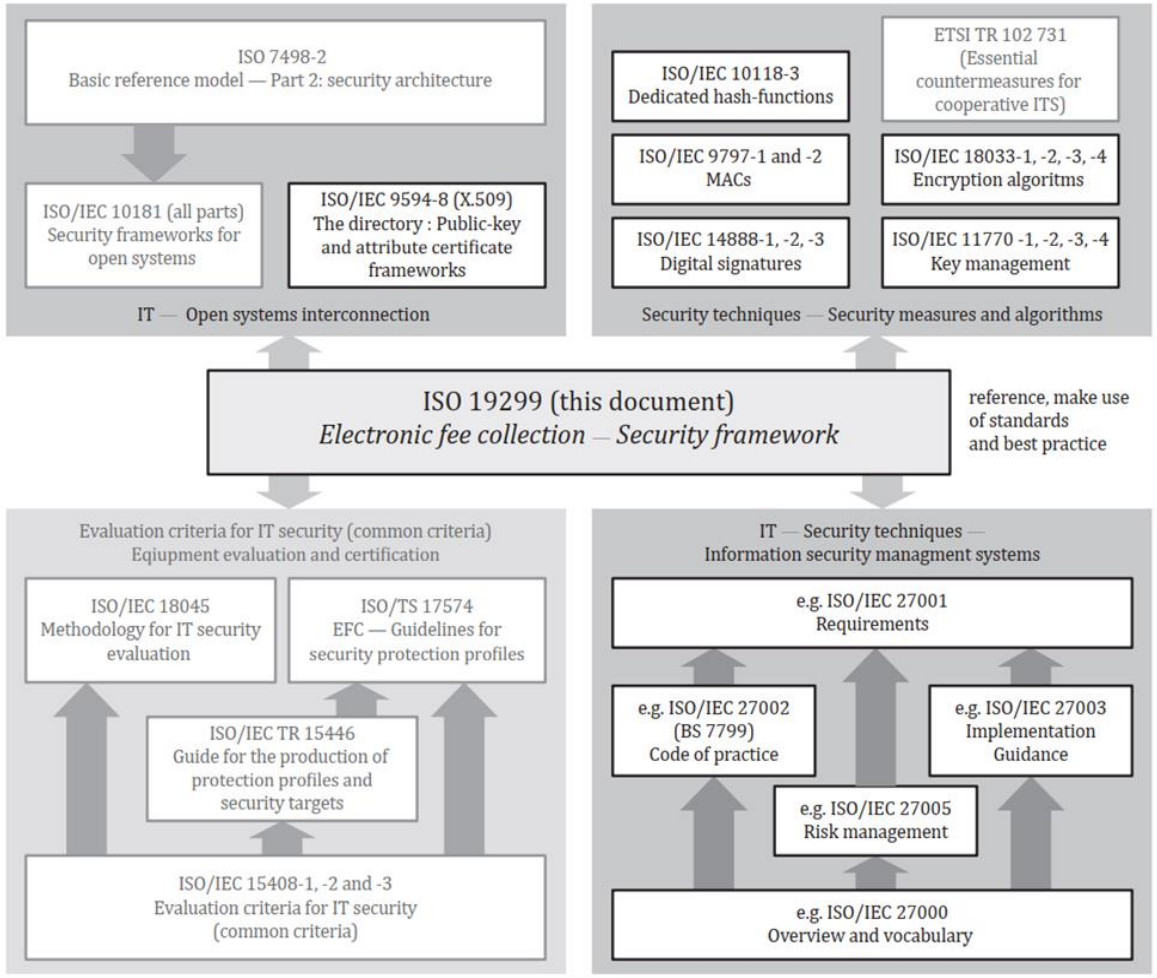
2.7) Security framework (19299)

Objectives

- Security framework
- Support for the EETS

Scope

- Threat analysis – asset-based and attack-based assessment
- Requirements specification
- Security measures focusing on the interoperable interfaces
- Trust model and basic key management requirements



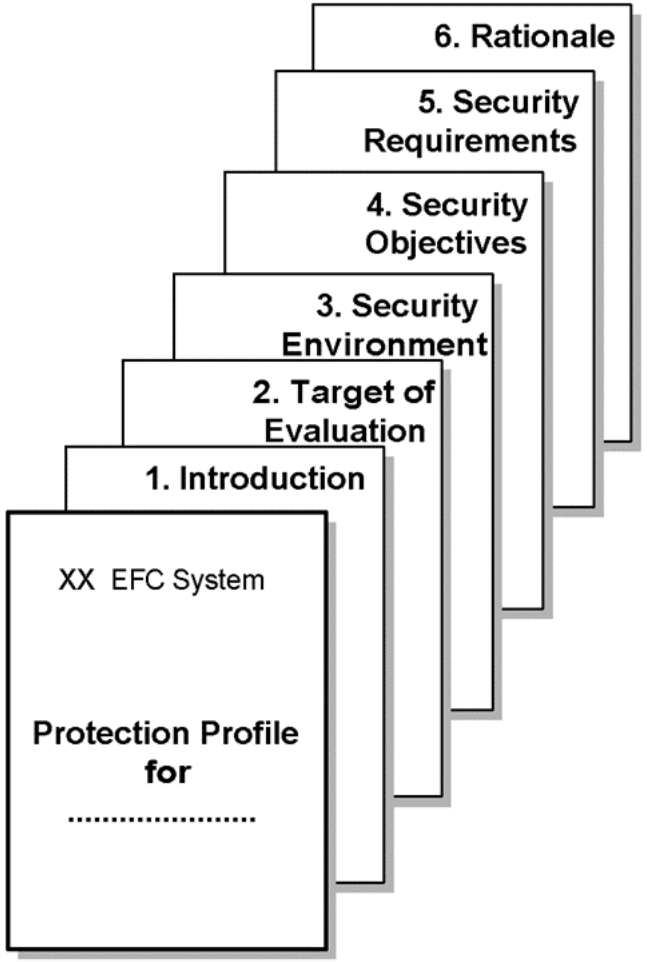
2.7) Guidelines for security protection profiles (17574)

Objectives

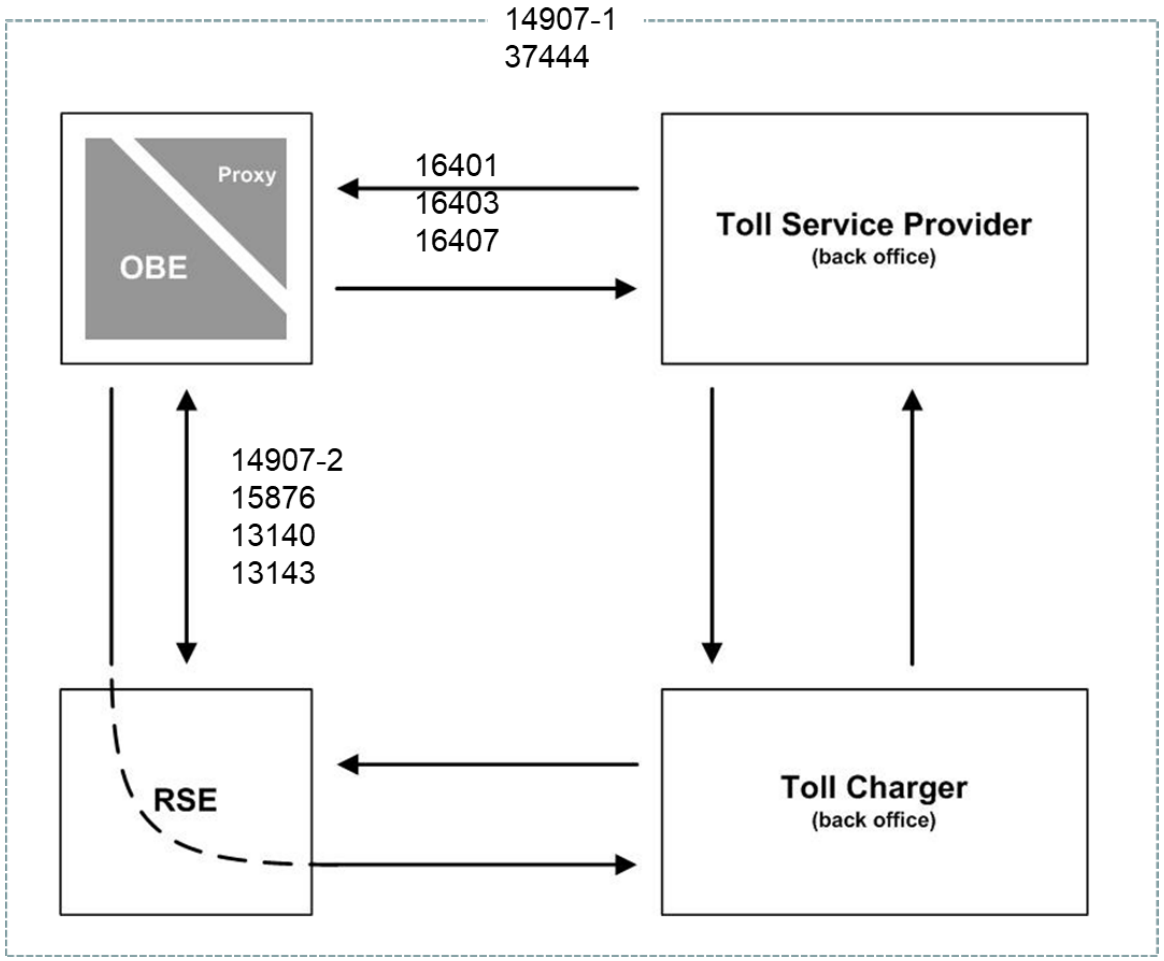
- Preparation & evaluation of security requirements
- Based on IT security standards
  - Evaluation security criteria 15408
  - Protection profiles 15446
- Product-oriented

Scope

- Guide operators to prepare their PP
- “Best practice” through international registrations of PP
- Japanese OBU used as an example



2.8) Test standards and examination frameworks



2.8) Test suites for conformity assessment

Objectives

- Support evaluation of implementation for conformity assessment to the associated requirements standards
- Comparability of results from tests performed at different places and times
- Facilitate communications between parties

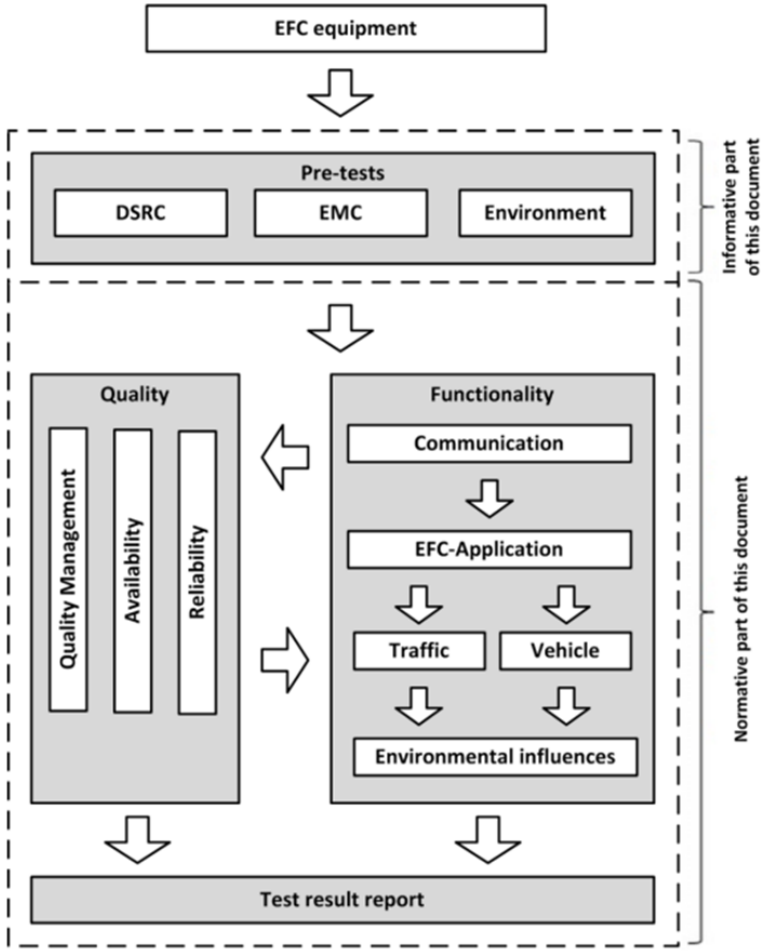
Test standards

- 14907-2: OBU testing against 14906 (“AID for DSRC”)
- 15876: OBE and RSE testing against 15509 (“IAP for DSRC”)
- 13143: OBE and RSE testing against 12813 (“CCC”)
- 13140: OBE and RSE testing against 13141 (LAC)
- 16407, 16401 & 16410 test suites: Testing against 17575 (“AID for GNSS-based EFC systems”)

2.8) Test procedures user and fixed equipment (14907-1)

Scope and usage

- Defines test procedures and a test plan
- Useful when defining
  - Type approval tests
  - System acceptance tests
  - Prototype tests
- Outside the scope
  - Equipment in the central system and all equipment used for enforcement (e.g. detection, classification, localization and registration)
  - Benchmark figures



2.8) Charging performance framework (37444)

Objective

- Evaluation of charging performance for discrete and continuous charging schemes to support procurement and service level agreements

Scope

- Charging performance metrics and examination framework
  - Charge reports
  - Toll declarations
  - Billing details
- Invoicing accuracy on the level of user accounts
- **Outside the scope**
  - Specific numeric performance bounds, average and worst-case error bounds
  - Evaluation of the expected performance of a system based on modelling

2.9) Summary

50+ CEN/ISO EFC standard deliverables

- DSRC-based EFC standards
- GNSS-based EFC
- Information exchanges between Service Provision and Toll Charging

Current focus

- Revision of standards for back-office exchanges (12855 / 16986) – extension to support ANPR
- Pre-studies and Technical reports - analysis of emerging needs, trends and road maps
  - Integration with related ITS-areas (common payment, traffic management ….)
- Maintenance of standards. Widespread use of EFC-standards in systems -> plenty of feedback to update standards. Support relevant activities to ensure long-term suitability of DSRC tolling technology

3. The European electronic toll service and CEN EFC standards

3) Recast of the European electronic toll service legislation

- EU Directive 2019/520 on Interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees
- Commission Implementing Regulation (EU) 2020/204 on detailed obligations of Toll Service Providers and Toll Charges
- Commission Delegated Regulation (EU) 2020/203 on obligations of users, classification of vehicles, requirements for interoperability constituents and NBs
- **8 CEN EFC standards** (dated editions) are referred to in the EETS legal acts

- CEN/TC 278/PT 142 (aka SA 2018-08) provided standardization support related to the recast of the EETS legislation

3) Recast of the EETS legislation – main changes

Main changes compared with previous version (Directive 2004/52/EC and Decision 2009/750/EC)

- Cross border enforcement has been added
- Separation of EETS Heavy Duty Vehicles and EETS Light Vehicles
- Clarification of responsibilities (for EETS providers)
- Efforts to remove market entry barriers (e.g. regional EETS) and to promote competition
- ANPR added as an accepted EETS charging technology
- Harmonization of back-office interfaces based on CEN/TS 16986
- Enhanced service definition through references to standards
- The standards explicitly mentioned in the legal acts make them legally binding as part of the legislation

3) EFC standards and the EETS

Not the same scope

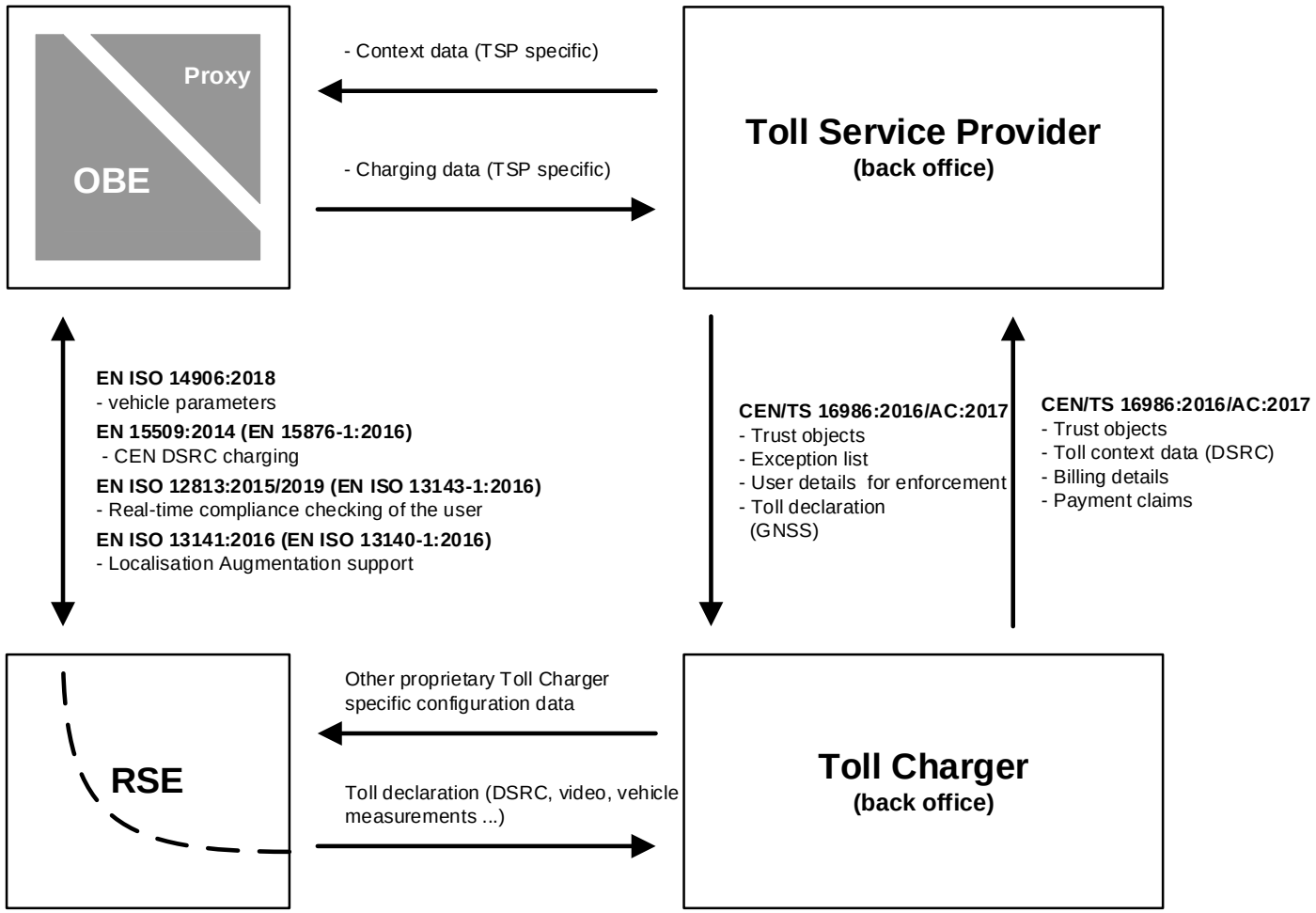
- EETS is a single service : Users are free to take advantage of the local and/or the European service
- EFC standards support broader technical needs: used in 50 countries, 140 systems, 150 million vehicles

EFC standards support the EETS

- by providing technical building blocks…
- … but does not have the task to deliver ”tailor-made” specifications for the EETS
- ... this is up to the owner of the EETS
- non-technical aspects are outside the scope of CEN

Legislator decides on the legal status of standards

3) EFC standards and the EETS



- The EETS legislation refers to dated versions of standards
- The legislator decides whether to refer to (updated) standards in legislation. Updated versions of referenced standards are not automatically adopted in the EETS legislation
- Some of the dated referenced standards have been updated (see Annex – Published CEN/ISO documents). Other are being updated

Annex – Published EFC CEN/ISO documents

Annex - Overview of EFC Standards and Technical Specifications

	DSRC & SRD-based EFC	Technology independent	Autonomous EFC
Frameworks	CEN ISO/TS 21719-1 OBE personalization	EN ISO 17573-1 Architecture ISO/TS 17573-2 Vocabulary prEN ISO/DIS 17573-3 Data dictionary CEN ISO/TS 17574 Security Profiles EN ISO 19299 Security framework	
Toolboxes	EN ISO 14906 DSRC application interface EN ISO 25110 ICC application interface ISO/TS 16785 Interface between OBE and external in-vehicle devices CEN ISO/TS 21719-2/3 OBE personalization using DSRC and ICC	EN ISO 12855 Info exchange between Service provision and Toll charging FprCEN ISO/DTS 37444 Charging performance ISO/TS 21192 EFC for traffic management ISO/TS 21193 EFC using common media	EN ISO 17575 Application interface definition for autonomous systems CEN/S 16702 Security monitoring
Profiles	EN 15509 Interoperability application profile for DSRC	CEN/TS 16986 Interoperable application profiles for info exchange between Service provision and Toll charging	EN ISO 12813 Compliance check communication (CCC) EN ISO 13141 Localisation augmentation communication (LAC)
Tests	EN ISO 14907-1 Test procedures for user and fixed equipment EN ISO 14907-2 Testing against 14906 EN 15876 Testing against 15509	CEN/TS 17154-1/2 Tests against 16986	EN ISO 16407 Testing against 17575-1 EN ISO 16410 Testing against 17575-3 EN ISO 13140 Testing against 13141 EN ISO 13143 Tests against 12813

Annex - Overview of EFC Technical Reports

DSRC & SRD-based EFC	Miscellaneous	Autonomous EFC
CEN/TR 16040 Urban DSRC CEN/TR 16968 Security assessment TC278 N318 DSRC requirements TC278 N779 ICC requirements	CEN ISO/TR 6026 Pre-study on the use vehicle license plate information and ANPR technologies CEN/TR 17546 EETS gap analysis and roadmap CEN/TR 16092 Pre-payment systems CEN/TR 16152 First mount OBE CEN/TR 16219 Value added services EFC OBE CEN/TR 16690 EFC on ITS stations ISO/TR 19639 Common payment schemes ISO/TR 21190 Investigation of charging policies and technologies for future standardization TC278 N278 Integration of payment systems for transport services TC278 N780 Threats and security controls	CEN/ISO 16401 Testing against 17575-2 TC278 N798 Requirements for autonomous EFC systems

Annex - Published EFC documents (1) - Technology independent

EN ISO 17573-1:2019	EFC - System architecture for vehicle-related tolling - Part 1: Reference model
ISO/TS 17573-2:2020	EFC - System architecture for vehicle-related tolling - Part 2: Vocabulary
CEN ISO/TS 17573-3:2021	EFC - System architecture for vehicle-related tolling - Part 3: Data dictionary
EN ISO 12855:2022	EFC - Information exchange between service provision and toll charging
CEN/TS 16986:2016/AC:2017	EFC - Interoperable application profiles for information exchange between Service Provision and Toll Charging
CEN/TS 17154-1:2019	EFC - Conformity evaluation of implementation to CEN/TS 16986 – Part 1: Test suit structure and test purposes
CEN/TS 17154-2:2019	EFC - Conformity evaluation of implementation to CEN/TS 16986 – Part 2: Abstract test suite
CEN ISO/TS 17444-1:2017	EFC - Charging performance - Part 1: Metrics
CEN ISO/TS 17444-2:2017	EFC - Charging performance - Part 2: Examination framework
EN ISO 19299:2020	EFC - Security framework

Annex - Published EFC documents (2) - Technology independent

CEN ISO/TR 6026:2022	EFC - Pre-study on the use of vehicle licence plate information and automatic number plate recognition (ANPR) technologies
ISO/TS 21192:2019	EFC - Support for traffic management
ISO/TS 21193:2019	EFC - Requirements for EFC application interfaces on common media
CEN ISO/TS 21719-1:2018	EFC - Personalization of on-board equipment - Part 1: Framework
CEN/TR 16092:2011	EFC - Requirements for pre-payment systems
CEN/TR 16152:2011	EFC - Personalisation and mounting of first mount OBE
CEN/TR 16219:2011	EFC - Value added services based on EFC on-board equipment
CEN/TR 17546:2020	EFC - EETS gap analysis and proposed standards roadmap
ISO/TR 21190:2018	EFC - Investigation of charging policies and technologies for future standardization
CEN/TR 16690:2014	EFC - Guidelines for EFC-applications based on in-vehicle ITS Stations
ISO/TR 19639:2015	EFC - Investigation of EFC standards for common payment schemes for multi-modal transport services

Annex - Published EFC documents (3) - DSRC-based EFC

EN ISO 14906:2018/A1:2020	EFC - application interface definition for DSRC
EN ISO 14907-1:2020	EFC - Test procedures user and fixed equipment - Part 1: Description of test procedures
EN ISO 14907-2:2021	EFC - Test procedures user and fixed equipment - Part 2: Conformance test for the on-board unit application interface
EN 15509:2014	EFC - Interoperable application Profile for DSRC
EN 15876-1:2016	EFC - Evaluation of on-board and roadside equipment for conformity to EN 15509 – Part 1: Test suite structure and test purposes
ISO/TS 16785:2020	EFC - Interface definition between DSRC-OBE and external in-vehicle devices
EN ISO 25110:2017	EFC - Interface definition for on-board account using ICC
CEN ISO/TS 21719-2:2022	EFC - Personalization of on-board equipment - Part 2: Using DSRC
CEN ISO/TS 21719-3:2021	EFC - Personalization of on-board equipment - Part 3: Using integrated circuit(s) cards
CEN/TR 16040:2010	EFC - Requirements for urban DSRC systems
CEN/TR 16968:2016	EFC - Assessment of security measures for applications using DSRC

Annex - Published EFC documents (4) - Autonomous-based EFC

EN ISO 17575-1:2016	EFC - Application interface definition for autonomous systems - Part 1: Charging
EN ISO 17575-2:2016	EFC - Application interface definition for autonomous systems - Part 2: Communication and connection to the lower layers
EN ISO 17575-3:2016	EFC - Application interface definition for autonomous systems - Part 3: Context data
EN ISO 16407-1:2017	EFC - Evaluation of equipment for conformity to ISO 17575-1 - Part 1: Test suite structure & test purposes
EN ISO 16407-2:2018	EFC - Evaluation of equipment for conformity to ISO 17575-1 - Part 2: Abstract test suite
CEN ISO/TR 16401-1:2018	EFC - Evaluation of equipment for conformity to ISO/TS 17575-2 - Part 1: Test suite structure & test purposes
CEN ISO/TR 16401-2:2018	EFC - Evaluation of equipment for conformity to ISO/TS 17575-2 - Part 2: Abstract test suite
EN ISO 16410-1:2017	EFC - Evaluation of equipment for conformity to ISO 17575-3 - Part 1: Test suite structure & test purposes
EN ISO 16410-2:2018	EFC - Evaluation of equipment for conformity to ISO 17575-3 - Part 2: Abstract test suite

Annex - Published EFC documents (5) - Autonomous-based EFC

EN ISO 12813:2019	EFC - Compliance check communication
EN ISO 13143-1:2020	EFC - Evaluation of on-board and roadside equipment for conformity to ISO 12813 - Part 1: Test suite structure and test purposes
EN ISO 13143-2:2016	EFC - Evaluation of on-board and roadside equipment for conformity to ISO 12813 - Part 2 : Abstract test suite
EN ISO 13141:2015/Amd 1:2017	EFC - Localisation augmentation communication
EN ISO 13140-1:2016	EFC - Evaluation of on-board and roadside equipment for conformity to ISO 13141 – Part 1: Test suite structure and test purposes
EN ISO 13140-2:2016	EFC - Evaluation of on-board and roadside equipment for conformity to ISO 13141 – Part 2: Abstract test suite
CEN/TS 16702-1:2020	EFC - Secure monitoring for autonomous toll systems - Part 1: Compliance checking
CEN/TS 16702-2:2020	EFC - Secure monitoring for autonomous toll systems - Part 2: Trusted recorder
CEN ITR	Application requirements for EFC systems based on GNSS/CN (CEN/TC278 N798, 1997-11)

Want to know more or participate?

Co-ordination of EFC standardization in ISO/TC 204/WG 5 and CEN/TC 278/WG 1

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