Introduction to standards on electronic fee collection (EFC)

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Outline

1. **Introduction to standards**
2. **Introduction to EFC standardization**
    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

Annex – Published EFC CEN/ISO documents

1. Introduction to standards

1) Introduction to standards

What is a standard?

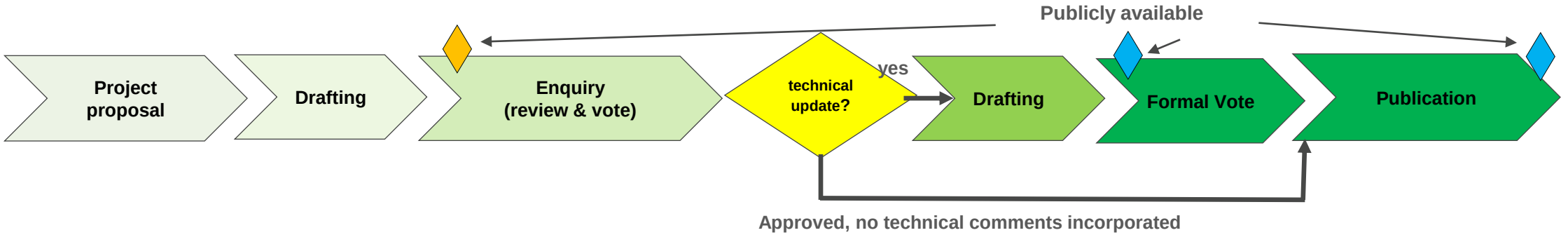
- A document approved by a recognized standardization body (CEN, ISO,..)
- Intended to be used repeatedly, creating synergies and reducing costs
- Transparency and broad consensus
- Rely mainly on voluntary contributions
- Maintained to keep abreast with market developments and technology advancements
- **Voluntary in application, supports agreements**

1) Introduction to standards

Role and benefits of standards

1) Introduction to standards

Development of standards follows structured and formal procedures



- **Proceeds directly to publication if approved at the Enquiry stage**
- **Formal Vote version is technically identical to the approved published version**

1) Standards, laws and specifications

Standards are not laws

- Facilitate agreements
- Sometimes referred in legislation
- For example, 8 CEN EFC standards are referred to in the EU legal acts on the European electronic toll service (EETS) (Directive, Delegated Act and Implementing Act)

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 standardization

2.1) Overall scope of EFC standardization

- **Fee collection (as opposed to fare collection)**
- **50+ published Standards, Technical Specifications and Technical Reports**
- **EFC system architecture, vocabulary, data dictionary**
- **Information exchanges for charging and compliance checking for systems using**
  - dedicated short-range communication (DSRC)
  - global navigation satellite system (GNSS) (aka autonomous-based systems)
  - automatic number plate recognition (ANPR) technologies
  - integrated circuit cards (ICCs)
- **Security of EFC systems and interfaces**
- **Test standards for conformance assessment and examination frameworks** - certification and homologation
- For overview: www.itsstandards.eu/its-application-areas/electronic-fee-collection/

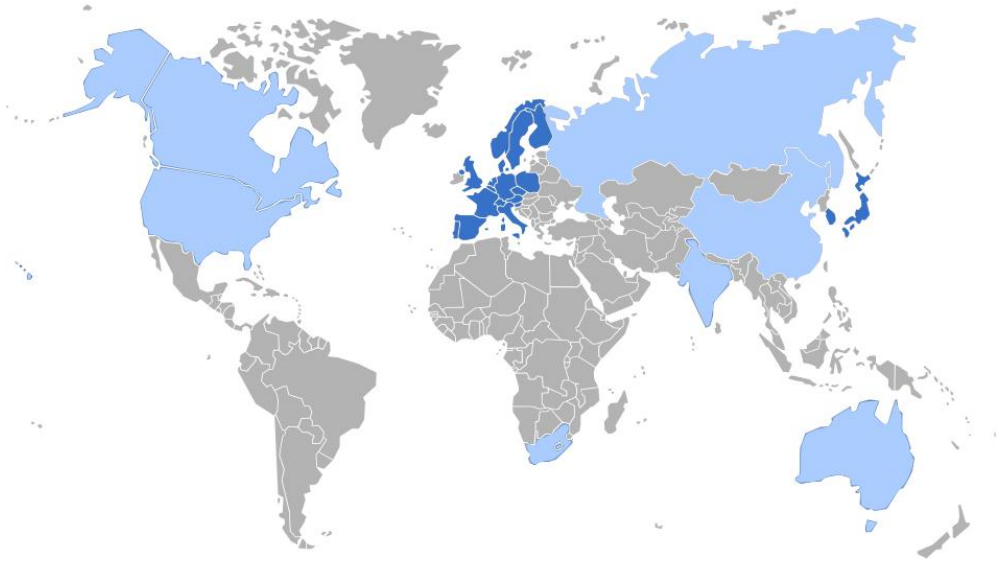
2.1) Principles for EFC standardization

- **Goal**
  - **Create and ensure the long-term stability of the EFC ecosystem**
  - **Support agreement, open market and interoperability**
- **Mainly technical standardization (not services)**
- **Focusing on interfaces between roles and sub-systems (not on the internal interfaces)**
- **Main differences between DSRC-based and GNSS-based EFC**
  - GNSS-based systems do not require fixed roadside infrastructure for the collection of road charges (but likewise require fixed or/and movable enforcement systems)
  - Greater variety between GNSS-based schemes in the allocation of functionality between on-board equipment (OBE) and back-office systems
  - Greater variety between GNSS-based schemes in the use of communication media between OBE and back-office systems

2.1) What kind of support do EFC standards provide?

- **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. EN ISO 14906 “Application interface definition (AID) for DSRC”
- **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. EN 15509 “Interoperability application profile (IAP) for DSRC”
- **Test standards**
  - Conformity evaluation of implementation to standard specification
  - E.g. EN 15876 test standard - “Evaluation of on-board and roadside equipment for conformity to EN 15509”
- **Maintenance of standards**

2.1) Who is involved in EFC standardization?



Joint Working Group
CEN/TC 278/WG 1
ISO/TC 204/WG 5

All key stakeholders actively involved

- Involved stakeholders: Toll Chargers, Toll Service Providers, Technology Providers and Public Authorities
- Active: Europe, Japan, South Korea, South Africa
- Ad-hoc : Australia, Singapore, India, China, Russia, US, …
- 35 active experts, 17 countries

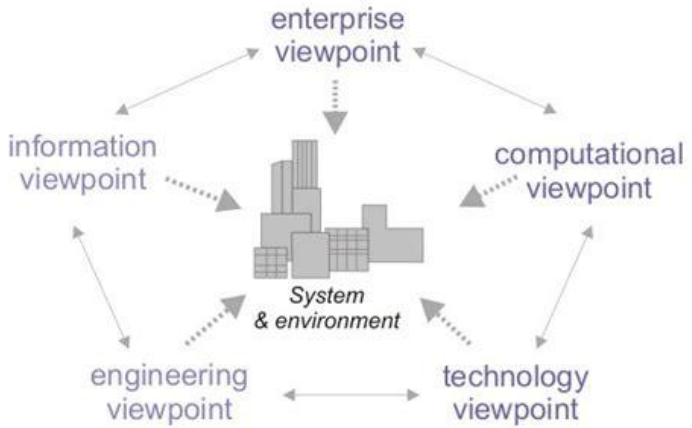
2.2) EFC system reference architecture – the 17573 series

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 around 240 terms
- Part 3: Data dictionary with around 130 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 5 — Axles

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

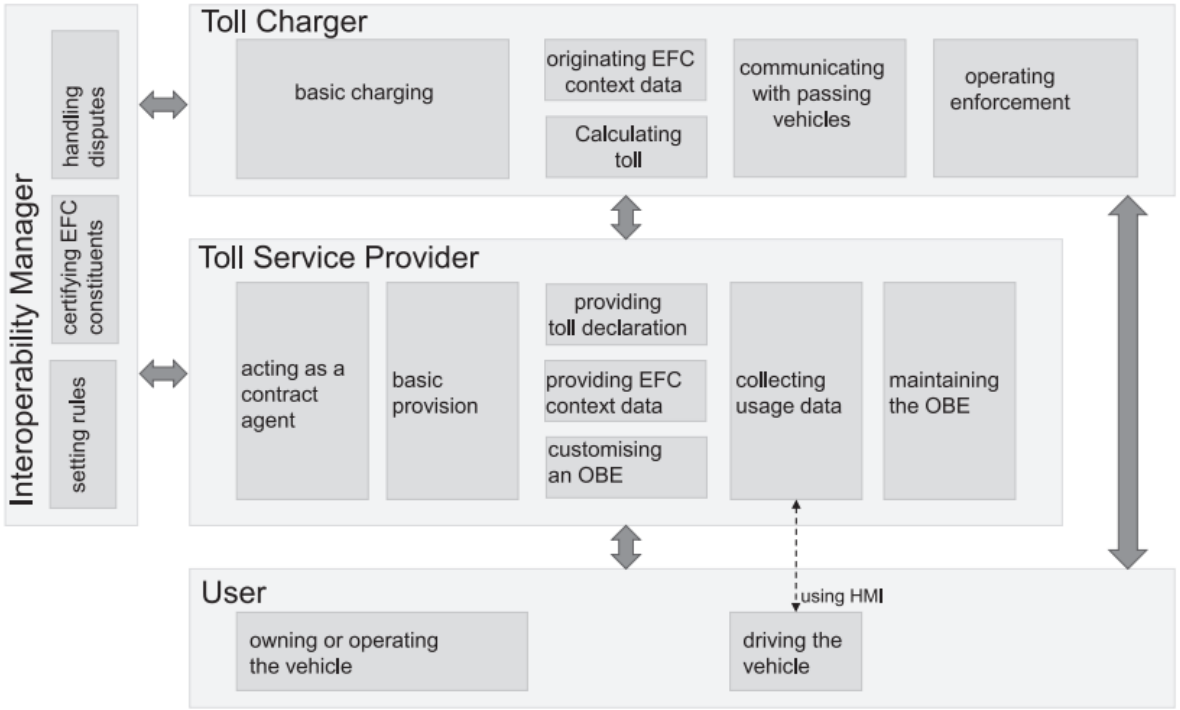
2.2) EFC system architecture (17573-1)

Objectives

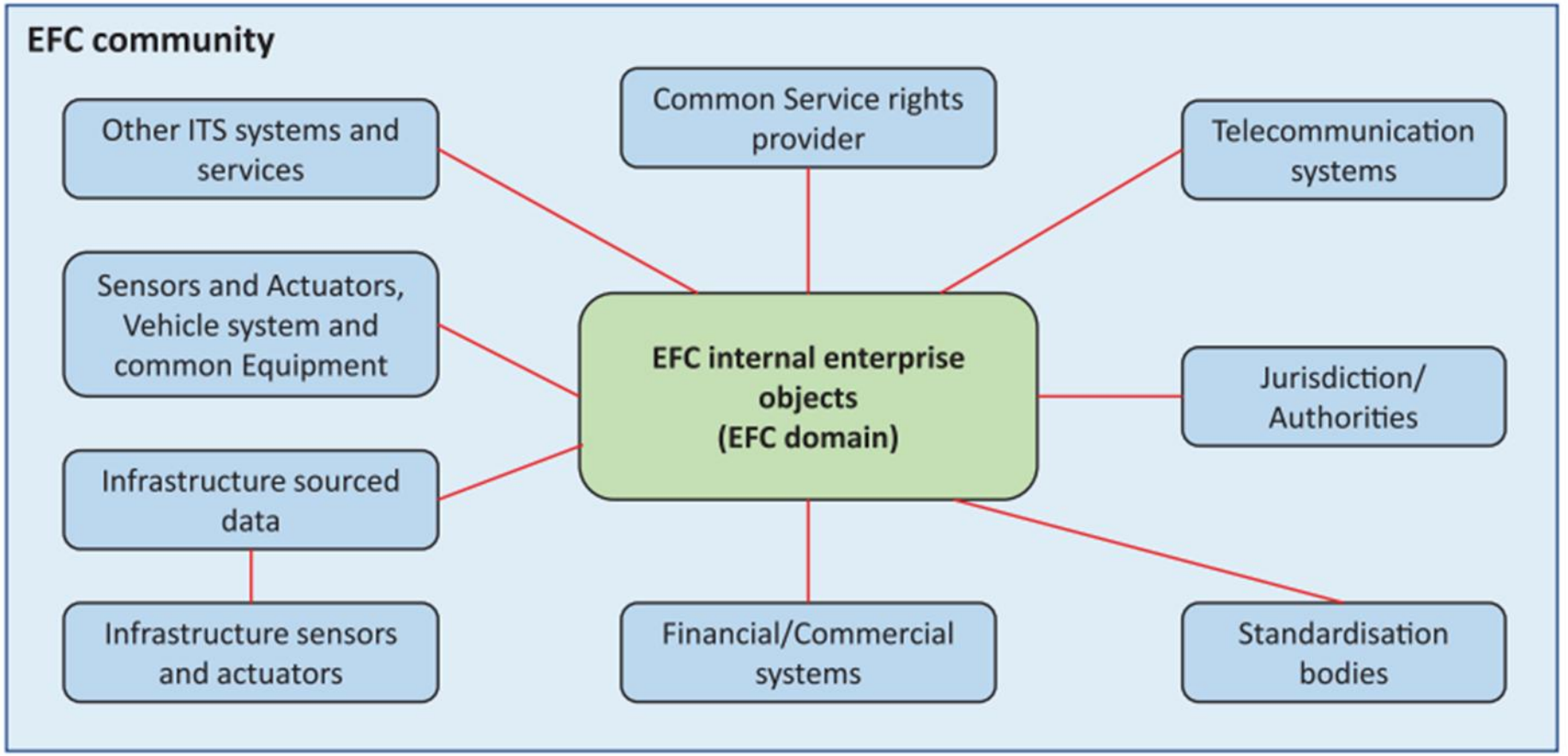
- Overall system reference architecture for EFC systems
- Common technical understanding

Scope

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

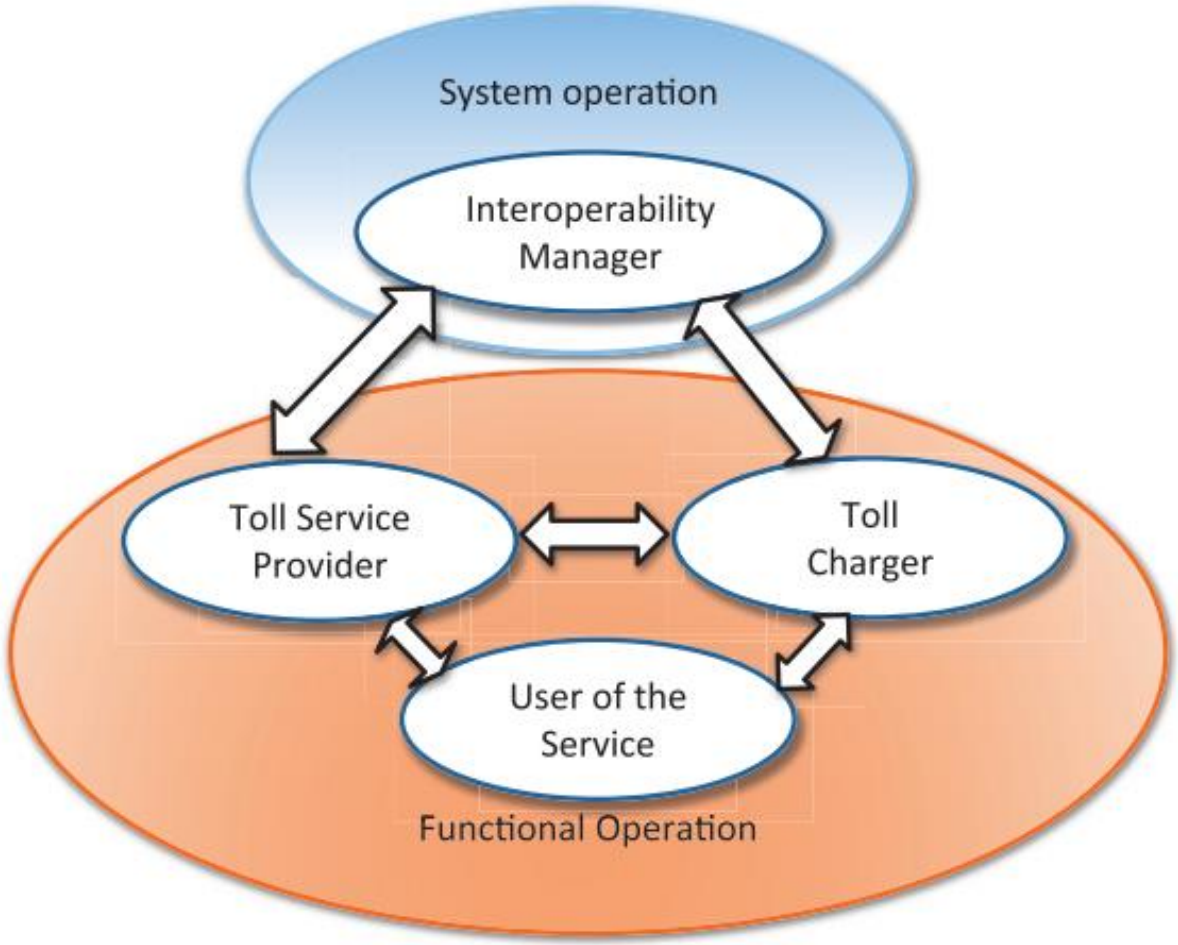


2.2) EFC system architecture – Enterprise objects

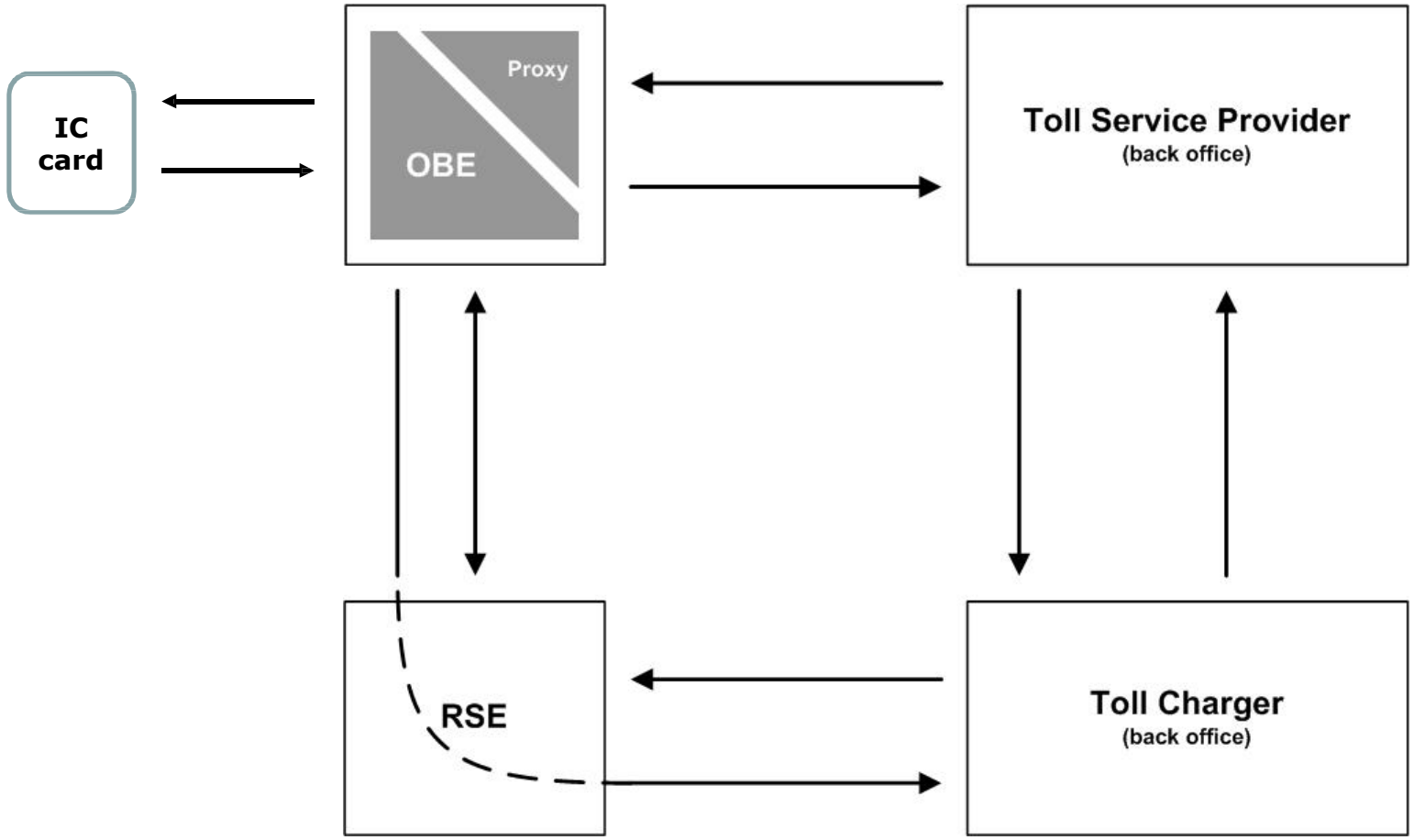


2.2) EFC system architecture – Enterprise viewpoint

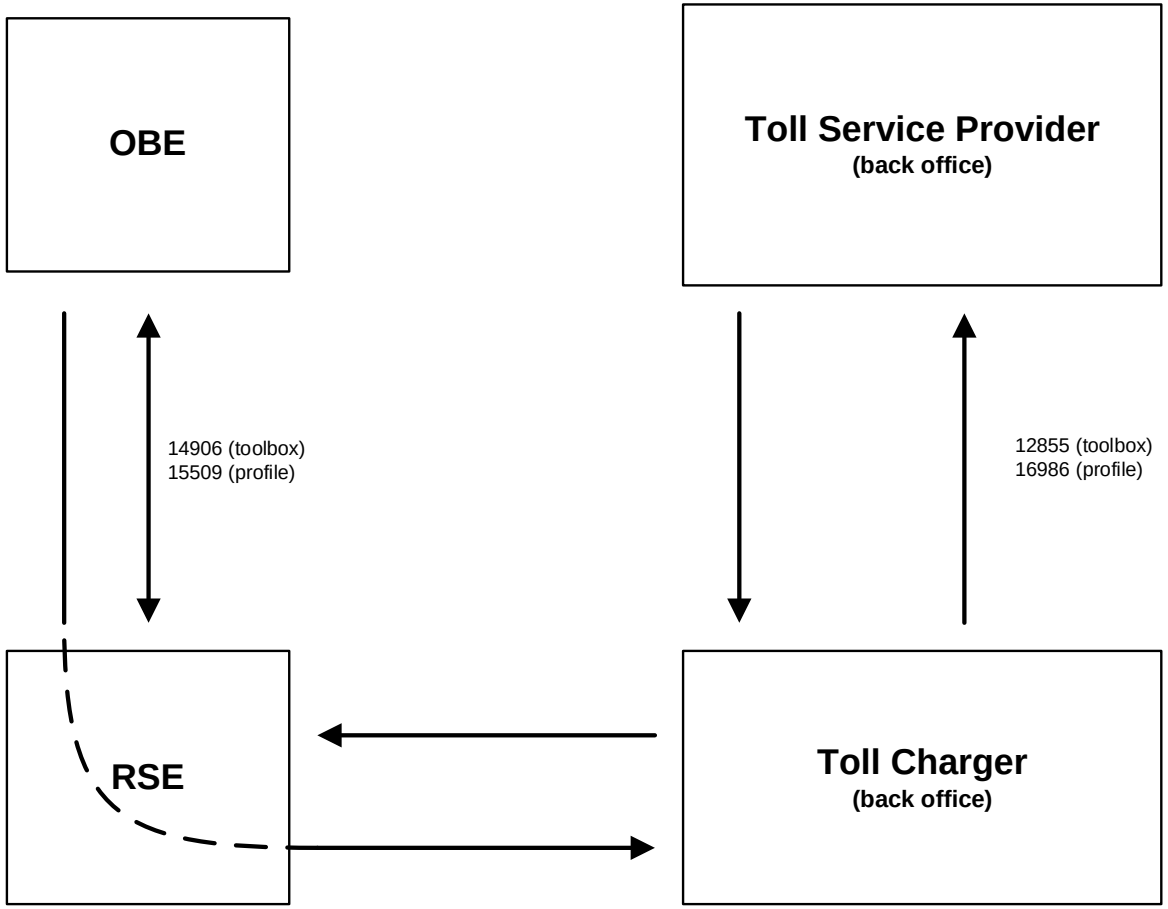
Basic roles



2.2) EFC system architecture – Engineering viewpoint



2.3) DSRC-based EFC



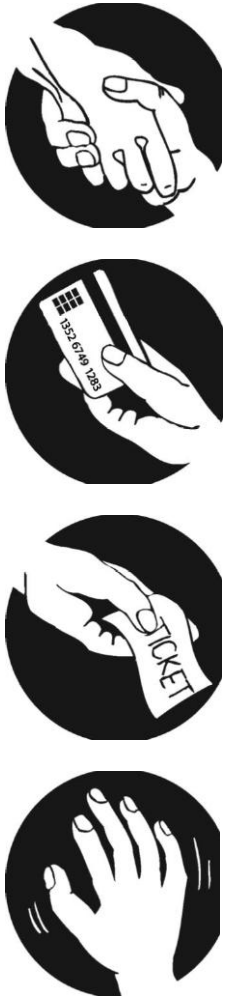
2.3) EFC AID for DSRC (14906)

Scope

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

Impact

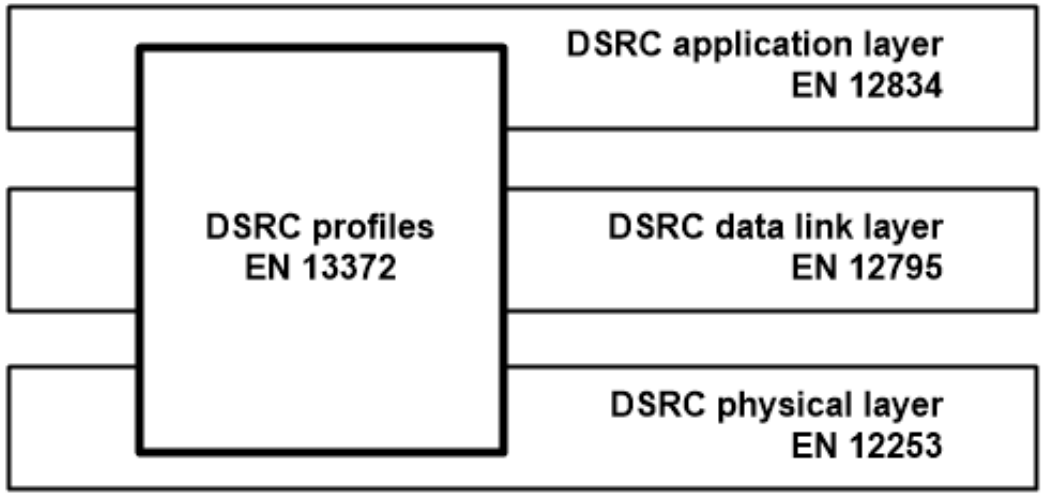
- Harmonized OBE, basis for national / international tolling service
- 200 million compliant OBE and 70 thousand RSE



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) European interoperability application profile (15509)

Objectives

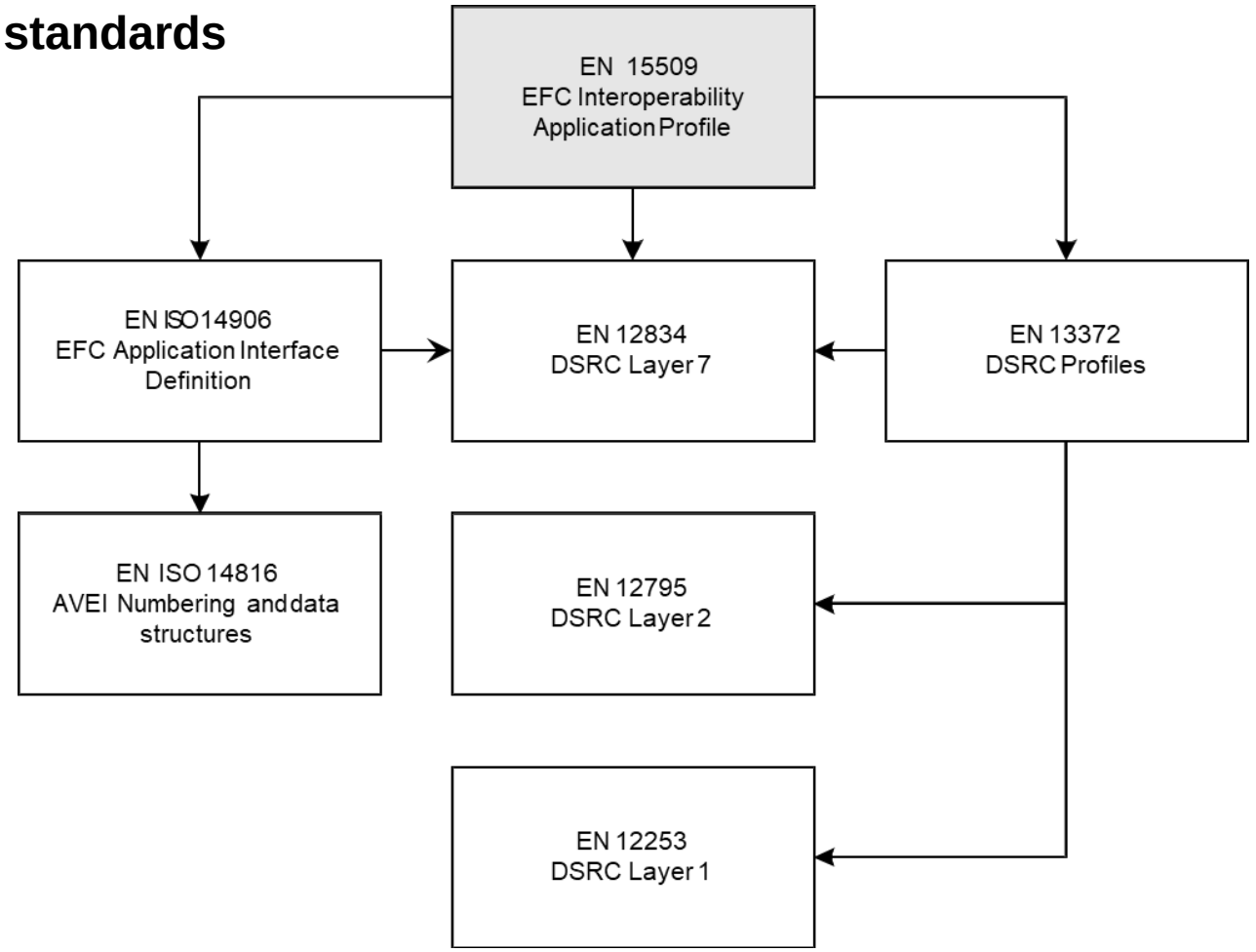
- Interoperability, equipment compatibility, best industry practice
- Support the European Electronic Toll Service (EETS) legislation

Scope

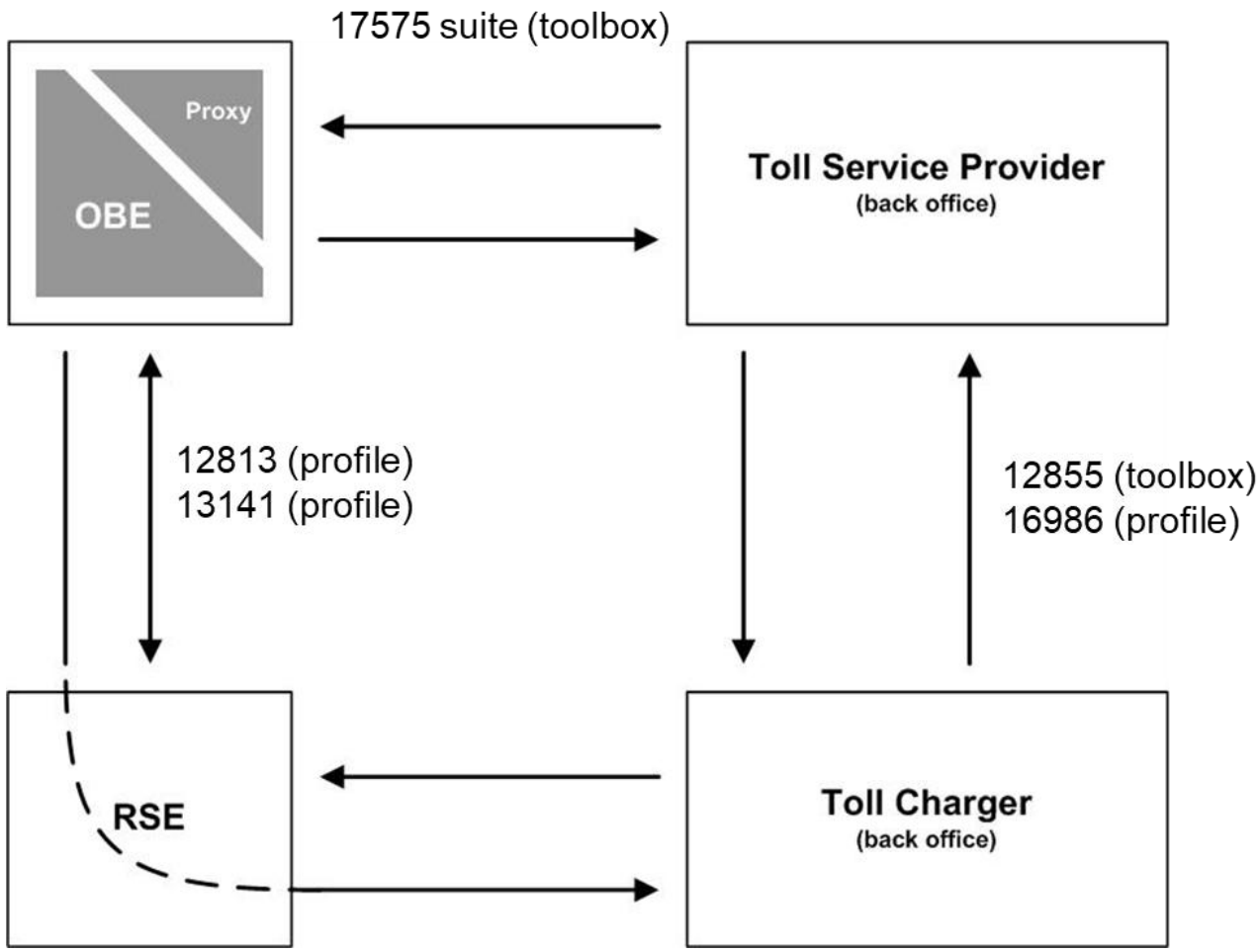
- DSRC requirements
- EFC functions, data and security
- Implementation conformance statement (ICS) proforma
- Use of this standard for the EETS, incl relationship to the requirements of EETS legislation

2.3) IAP for DSRC

Relationship to toolbox standards



2.4) GNSS-based EFC



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

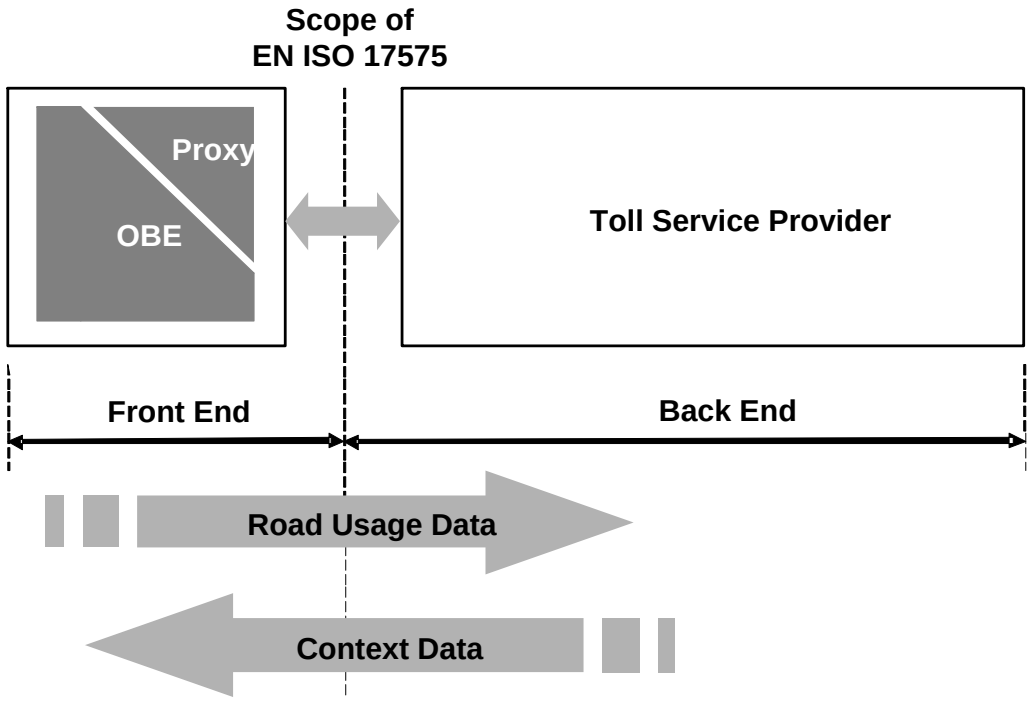
Objectives

- 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

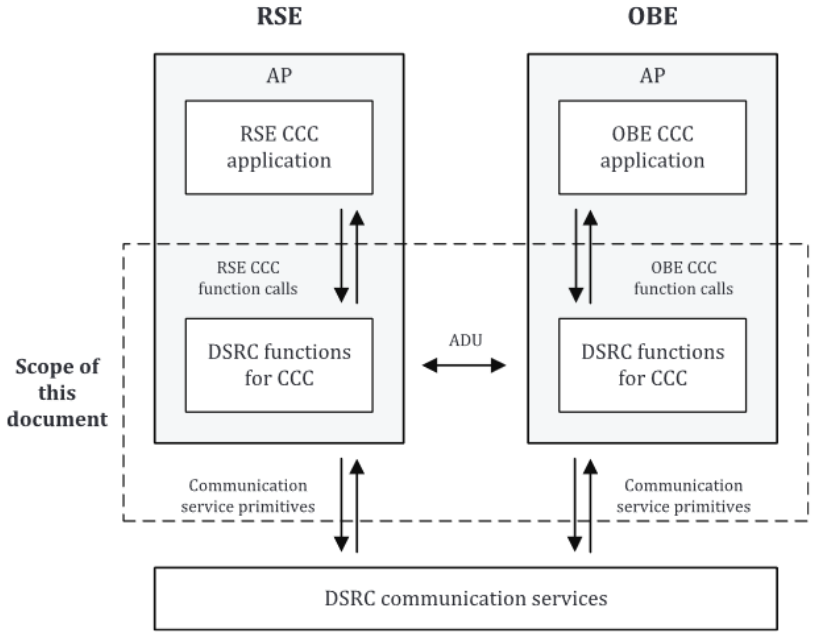
Limited relevance for the EETS as it specifies a Toll Service Provider “internal interface”



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

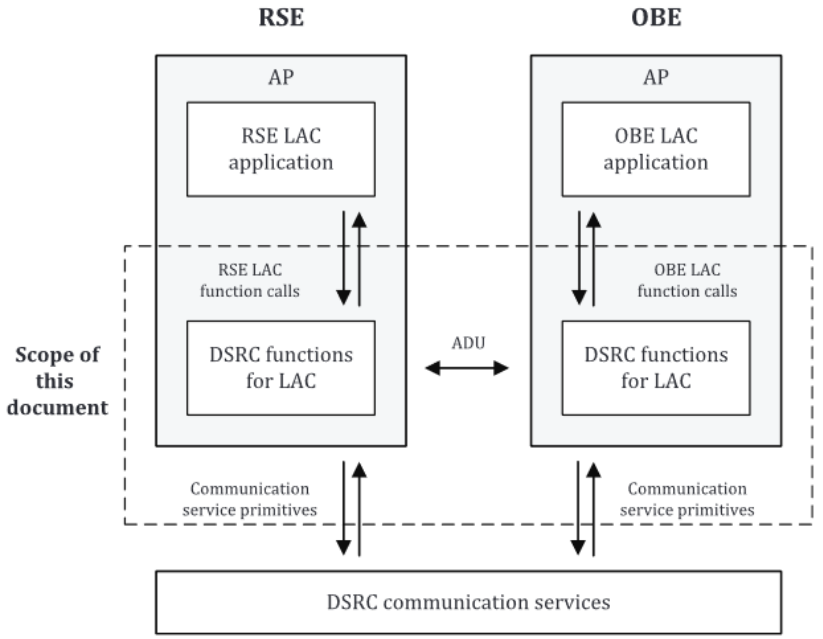
2.4) Localization augmentation support (13141)

Objectives

- Localization 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

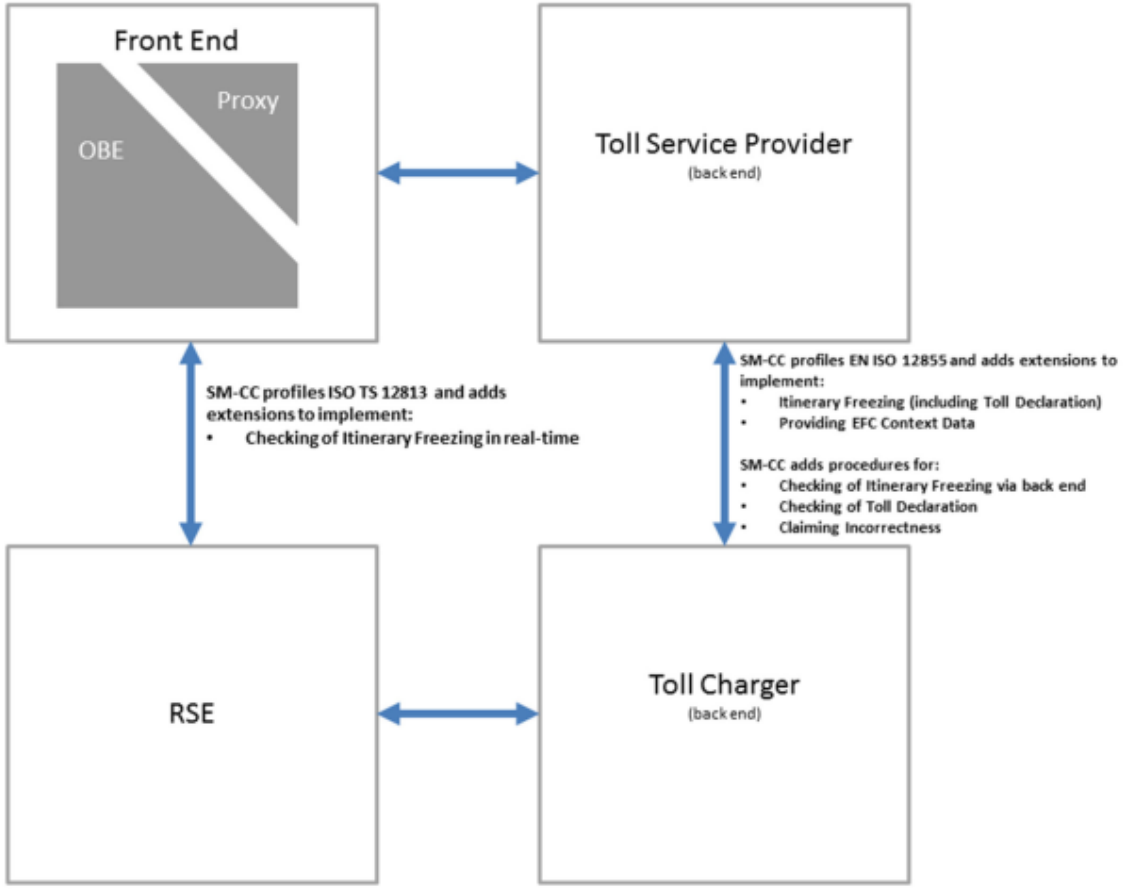
2.4) Secure monitoring - Compliance checking (16702-1)

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...)



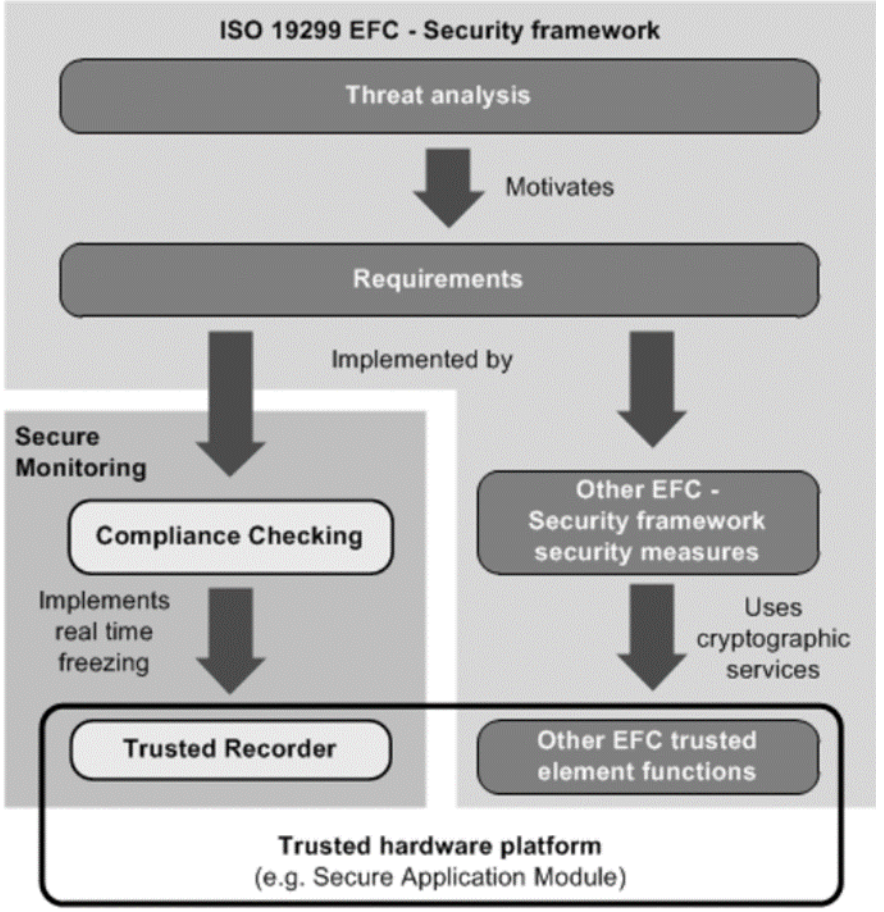
2.4) Secure monitoring - Trusted recorder (16702-2)

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

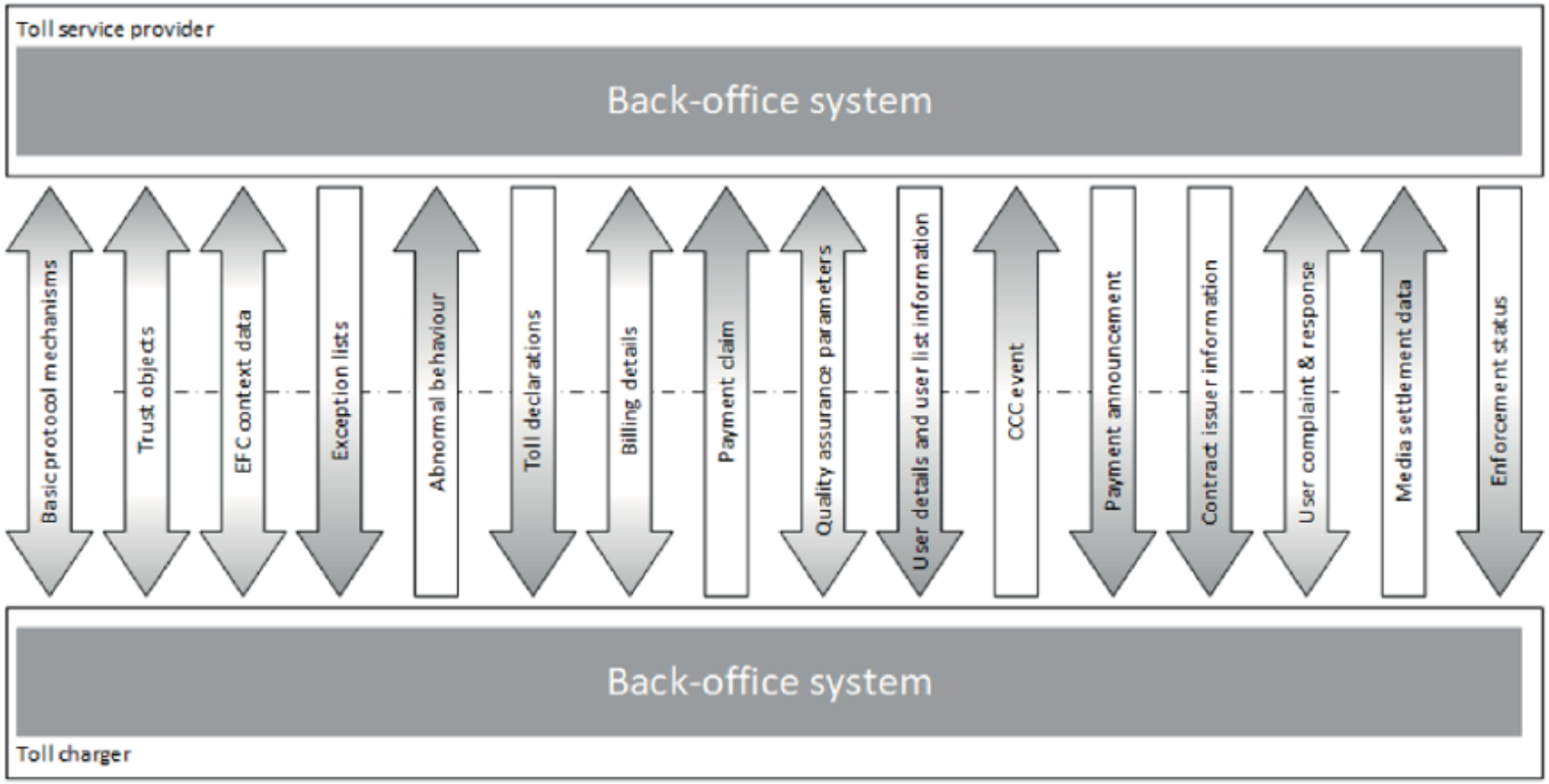
Scope

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

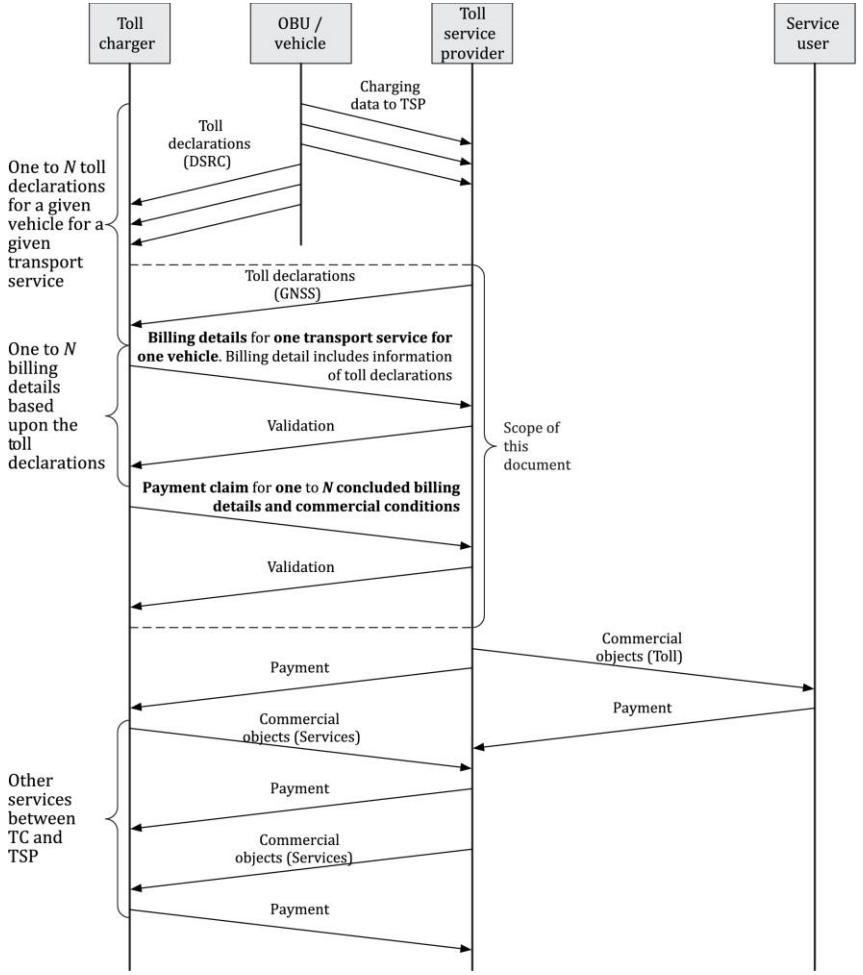


2.5) Info exchanges between Toll Service Provider (TSP) and Toll Charger (TC) (12855, toolbox)

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



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



2.5) European interoperability profile for info exchanges between TSP and TC (16986)

Objectives

- Support interoperability and the EETS

Scope

- Specification 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

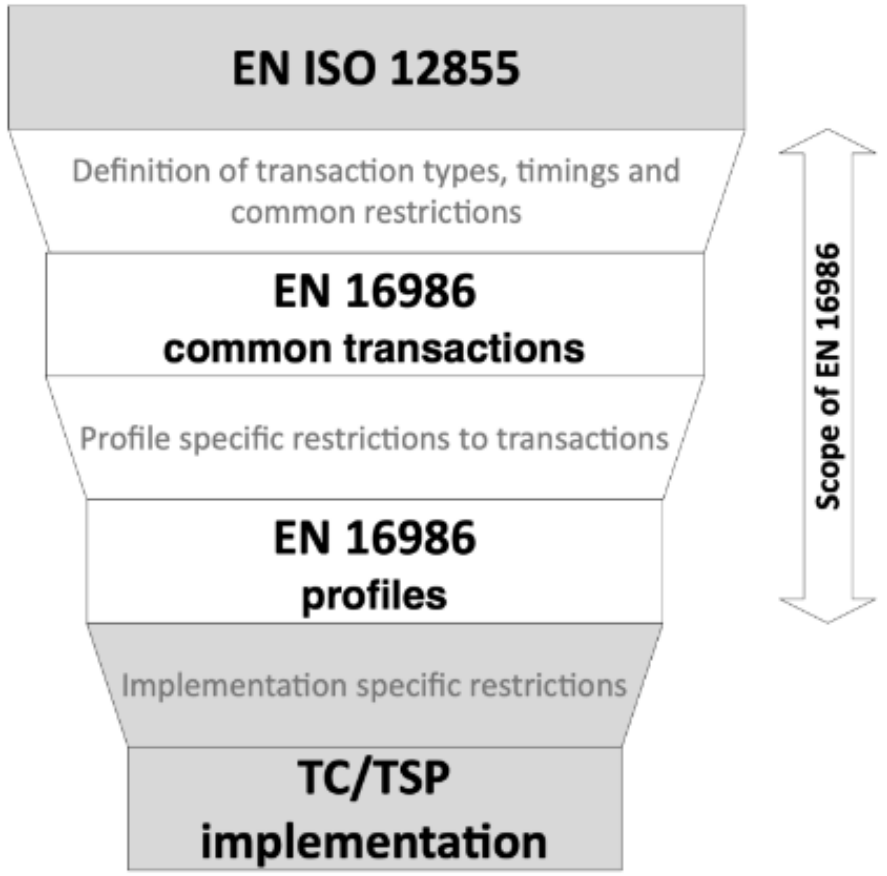
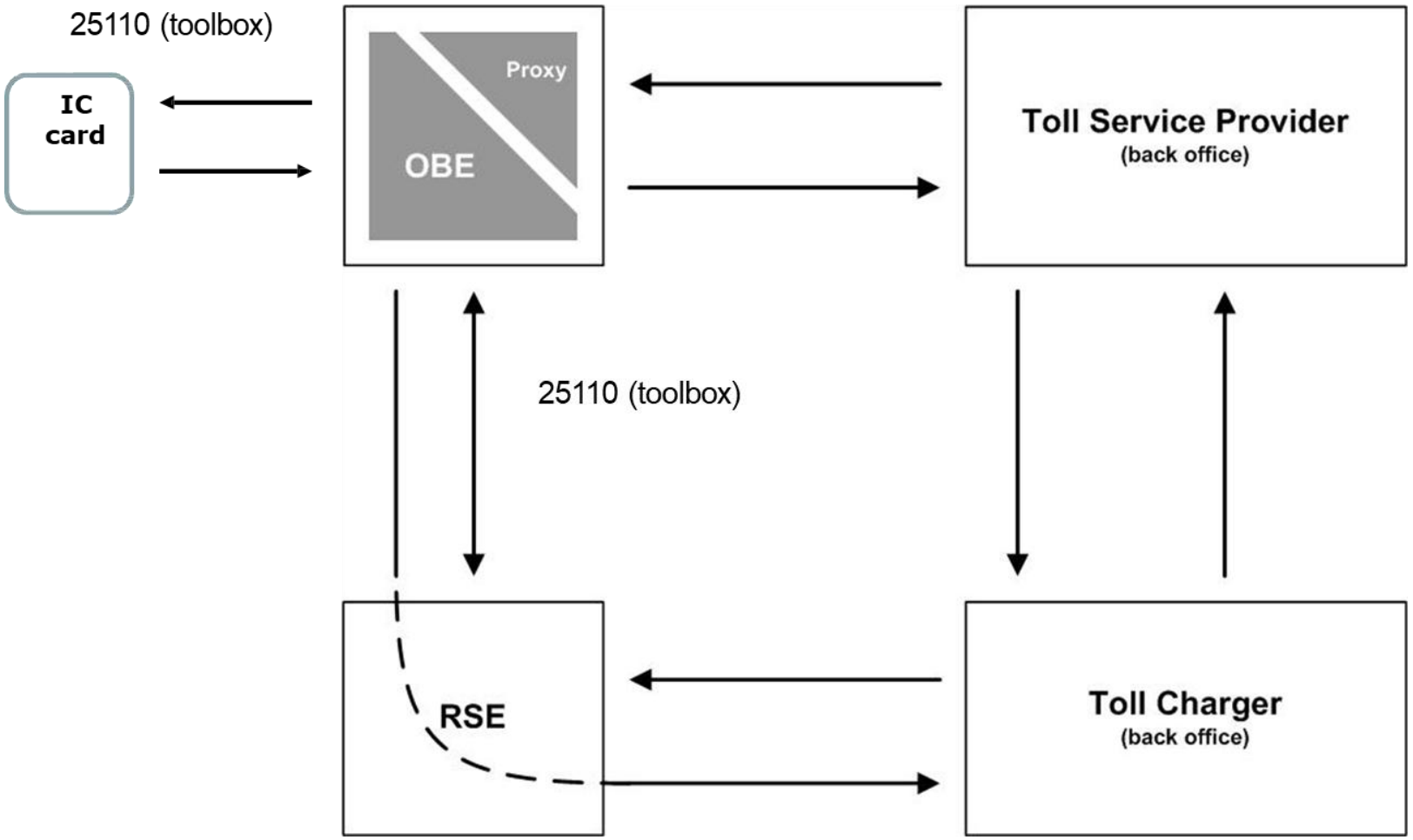


Figure 5 — Restrictions to the base standard

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



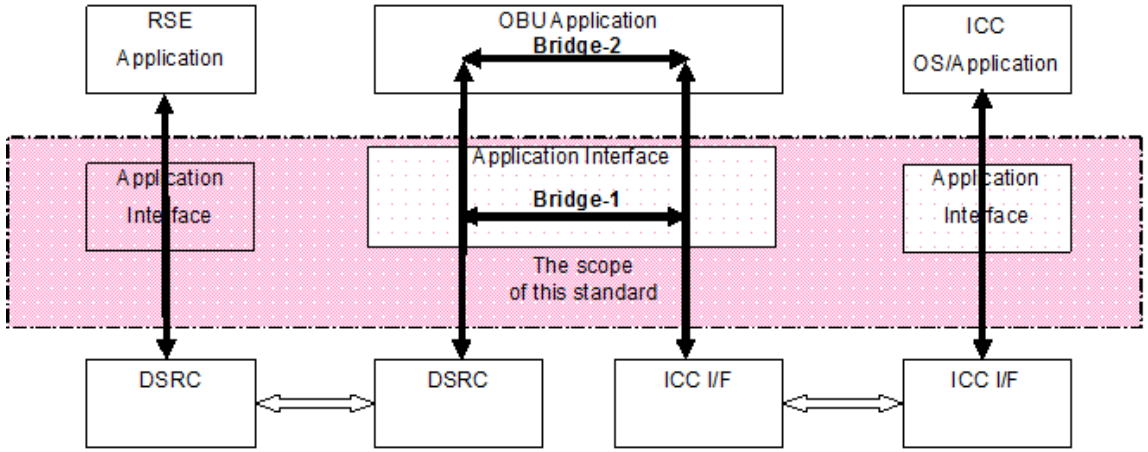
2.6) Interface for on-board account using an ICC (25110)

Objectives

- Support EFC on-board account charging using ICC

Scope

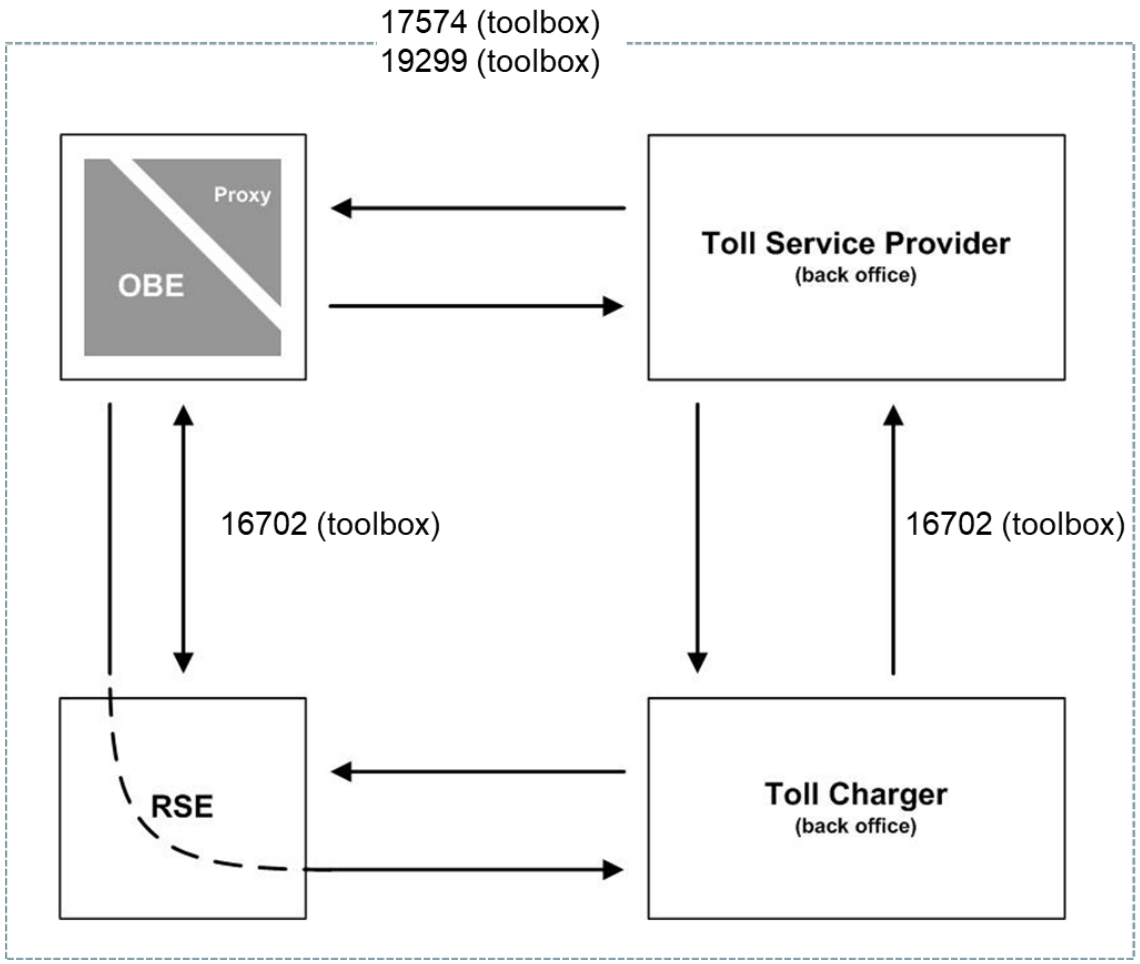
- DSRC – ICC interface protocol bridge / ”extension of 14906”
  - Transparent and buffering type (bridge 1)
  - Cashing type (bridge 2)
- Reference model for on-board account system
- Command definitions – RSE – OBE



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



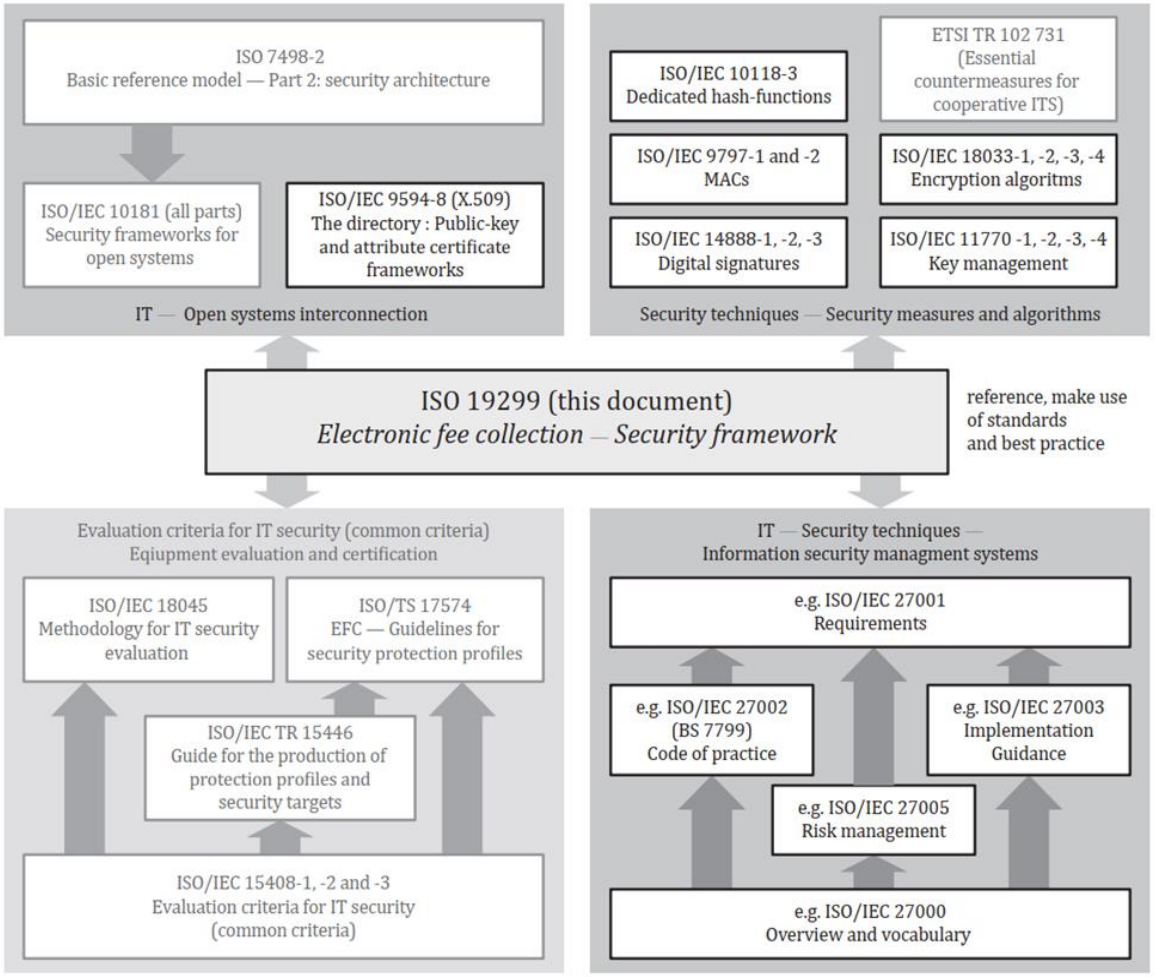
2.7) Security framework (19299)

Objectives

- Security framework
- Support for the EETS

Scope

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



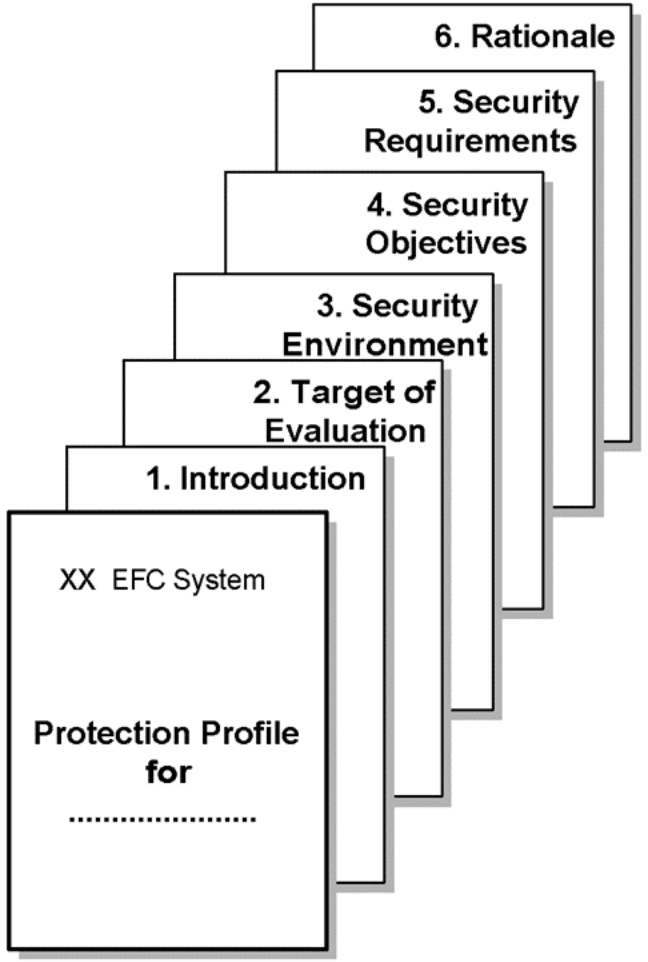
2.7) Guidelines for security protection profiles (17574)

Objectives

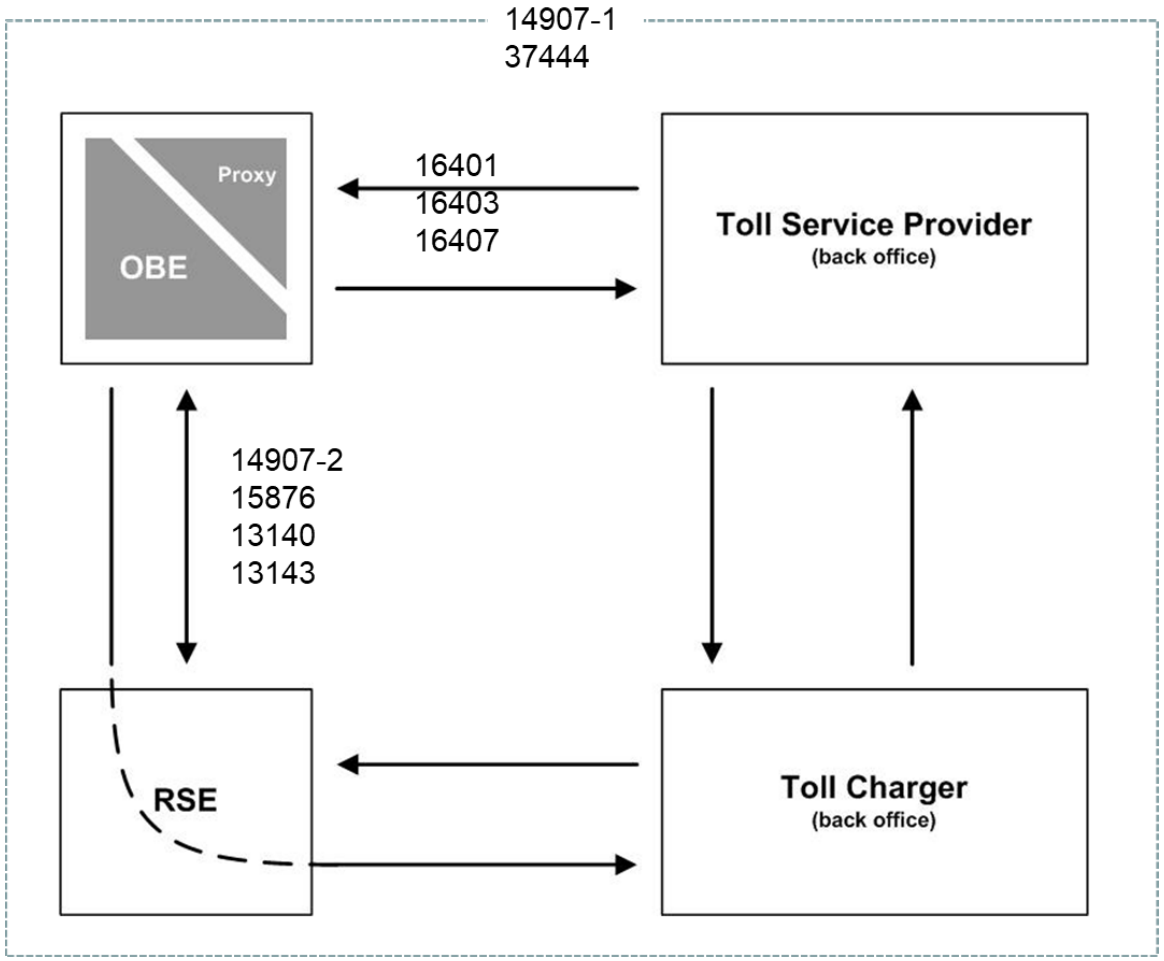
- Preparation and evaluation of security requirements
- Based on IT security standards
  - Evaluation security criteria 15408
  - Protection profiles 15446
- Product-oriented

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

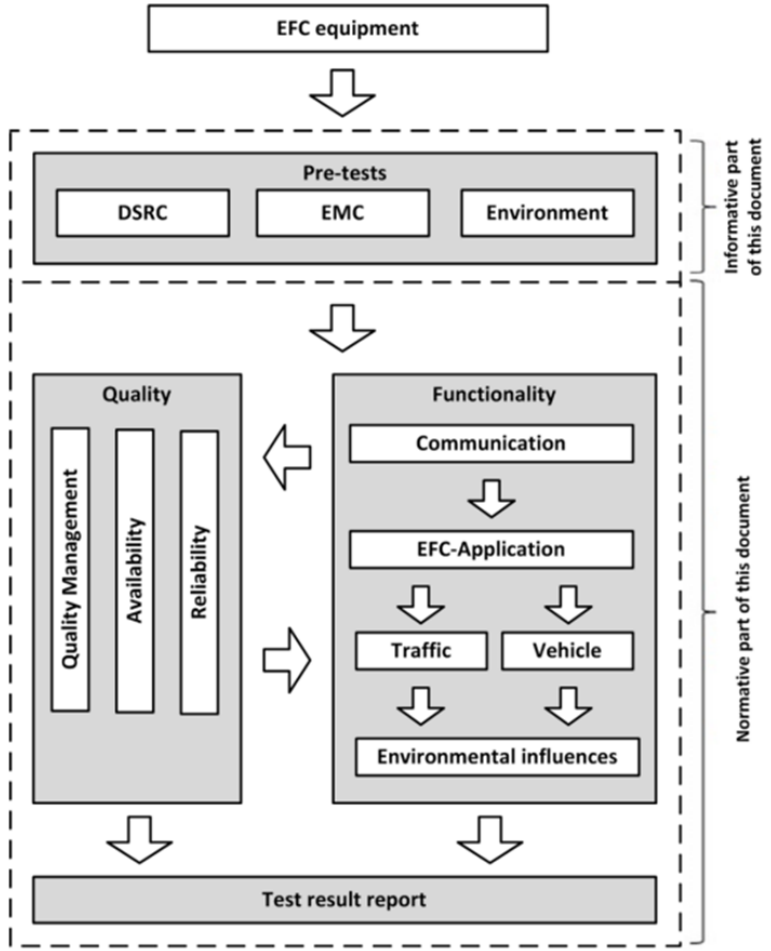
Test standards

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

Current focus

- Revision of interoperable application profile standard for back-office exchanges (16986)
- 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

Annex – Published EFC CEN/ISO documents

Annex - Overview of EFC Standards and Technical Specifications

	DSRC & image-based EFC	Technology independent	Autonomous EFC
Frameworks	CEN ISO/TS 21719-1 OBE personalization	EN ISO 17573-1 Reference architecture ISO/TS 17573-2 Vocabulary EN ISO 17573-3 Data dictionary CEN ISO/TS 17574 Security profiles EN ISO 19299 Security framework	
Toolboxes	EN ISO 14906 DSRC application interface 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 CEN ISO/TS 37444 Charging performance ISO/TS 21192 EFC for traffic management ISO/TS 21193 EFC using common media	ISO 17575 Application interface definition for autonomous systems CEN/TS 16702 Security monitoring
Profiles	EN 15509 Interoperability application profile for DSRC	EN 16986 Interoperable application profiles for info exchange between Service provision and Toll charging	EN ISO 12813 Compliance check communication (CCC) EN ISO 13141 Localization augmentation communication (LAC)
Tests	EN ISO 14907-1 Test procedures for user and fixed equipment EN ISO 14907-2 Tests against 14906 EN 15876 Tests against 15509 CEN/TS 18078 RLAN interferences to DSRC	CEN/TS 17154-1 Tests against 16986	ISO 16407 Tests against 17575-1 ISO 16410 Tests against 17575-3 EN ISO 13140 Tests against 13141 EN ISO 13143 Tests against 12813

Annex - Overview of EFC Technical Reports

DSRC & image-based EFC	Miscellaneous	Autonomous EFC
CEN/TR 16040 Urban DSRC CEN/TR 16968 Security assessment ISO/TR 25221 Image-based tolling systems – Measurable characteristics CEN ISO/TR 6026 Pre-study on the use vehicle license plate information and ANPR technologies TC278 N318 DSRC requirements	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 TC278 N779 ICC requirements	ISO/TR 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
EN ISO 17573-3:2024	EFC - System architecture for vehicle-related tolling - Part 3: Data dictionary
EN ISO 12855:2025	EFC - Information exchange between service provision and toll charging
EN 16986:2024	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 ISO/TS 37444:2023	EFC - Charging performance framework
EN ISO 19299:2020	EFC - Security framework

Annex - Published EFC documents (2) - Technology independent

ISO/TS 21192:2024	EFC - Support for traffic management
ISO/TS 21193:2024	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 14906:2022	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 15509:2023	EFC - Interoperable application Profile for DSRC
EN 15876:2025	EFC - Evaluation of on-board and roadside equipment for conformity to EN 15509
ISO/TS 16785:2020	EFC - Interface definition between DSRC-OBE and external in-vehicle devices
CEN/TS 18078:2024	EFC – Measurement of interferences on tolling and tachograph devices from RLAN devices operating in the 5,8 GHz frequency range - Test suite structure and test purposes
ISO 25110:2025	EFC - Interface definition for on-board account using an integrated circuit card (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) – Image-based EFC

CEN ISO/TR 6026:2022	EFC - Pre-study on the use of vehicle licence plate information and automatic number plate recognition (ANPR) technologies
ISO/TR 25221:2025	EFC – Image-based tolling systems – Measurable characteristics

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

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

Annex - Published EFC documents (6) - Autonomous-based EFC

EN ISO 12813:2024	EFC - Compliance check communication
EN ISO 13143:2025	EFC - Evaluation of on-board and roadside equipment for conformity to ISO 12813
EN ISO 13141:2024	EFC - Localization augmentation communication
EN ISO 13140:2025	EFC - Evaluation of on-board and roadside equipment for conformity to ISO 13141
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?

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