An introduction to standardization of electronic fee collection (EFC)

26 October 2021

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Outline

1. **Introduction to standards**
2. **Introduction into 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 standard deliverables

1) Introduction to standards

What is a standard?

- A document approved by recognized standardization body (CEN, ISO,..)
- Voluntary in application
- Intended to be used repeatedly in products and systems, creating synergies and reducing costs

Benefits – support for agreements

- Interoperability of products and services
- Open and competitive market development
- Standards are more stable and enjoy broader market acceptance than project / industry specifications

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

2.1) 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 for**
  - DSRC-based systems
  - GNSS-based systems (also known as 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)
  - Degrees of freedom much higher
  - Potentially different media for communication with CS/proxy
- **Why we never were fully top-down (moving target)**
  - Technical developments
  - Evolution of the system architecture to support different scheme types
  - New operational model (from CESARE and EETS) - separation between the Toll charging and Service provision
  - Difficult to get consensus on things under development

2.1) What support do EFC standards bring?

Framework standards

- Common understanding, scoping, architecture, terminology etc

Technical toolbox standards

- Necessary but not sufficient basis for compatibility
- Why? Changing requirements, evolving or changing technology, lack of experiences, lack of common view, different stakeholder needs
- 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/defined by stakeholders
- E.g. "Interoperable application profile (IAP) for DSRC 15509"

Test standards

- Assessment of conformity to specification
- E.g. "IAP for DSRC conformity assessment 15876 suite"

Maintenance of standards

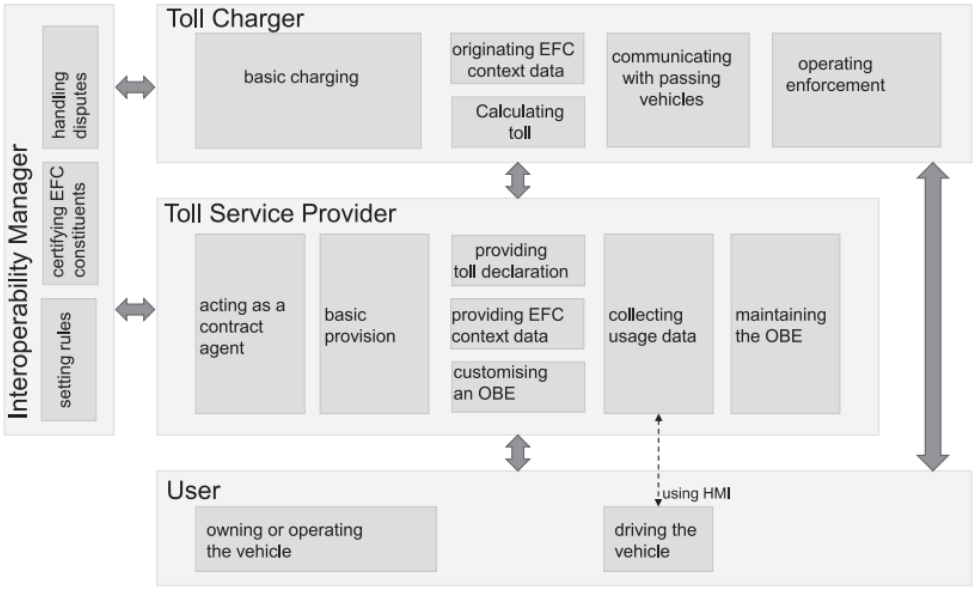
2.2) EFC system architecture (17573-1)

Objectives

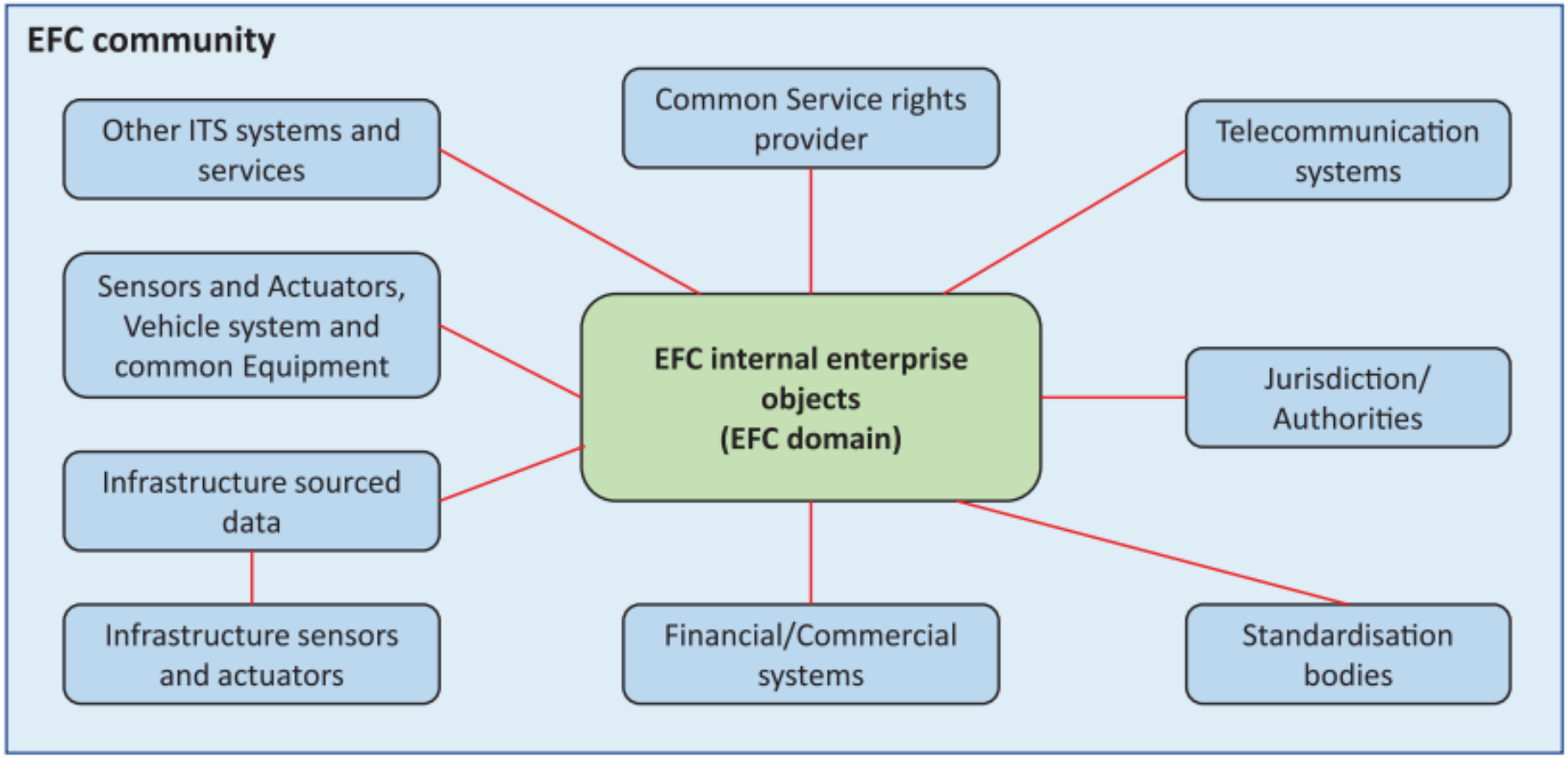
- Overall system reference architecture for EFC systems
- Common technical understanding

Scope

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

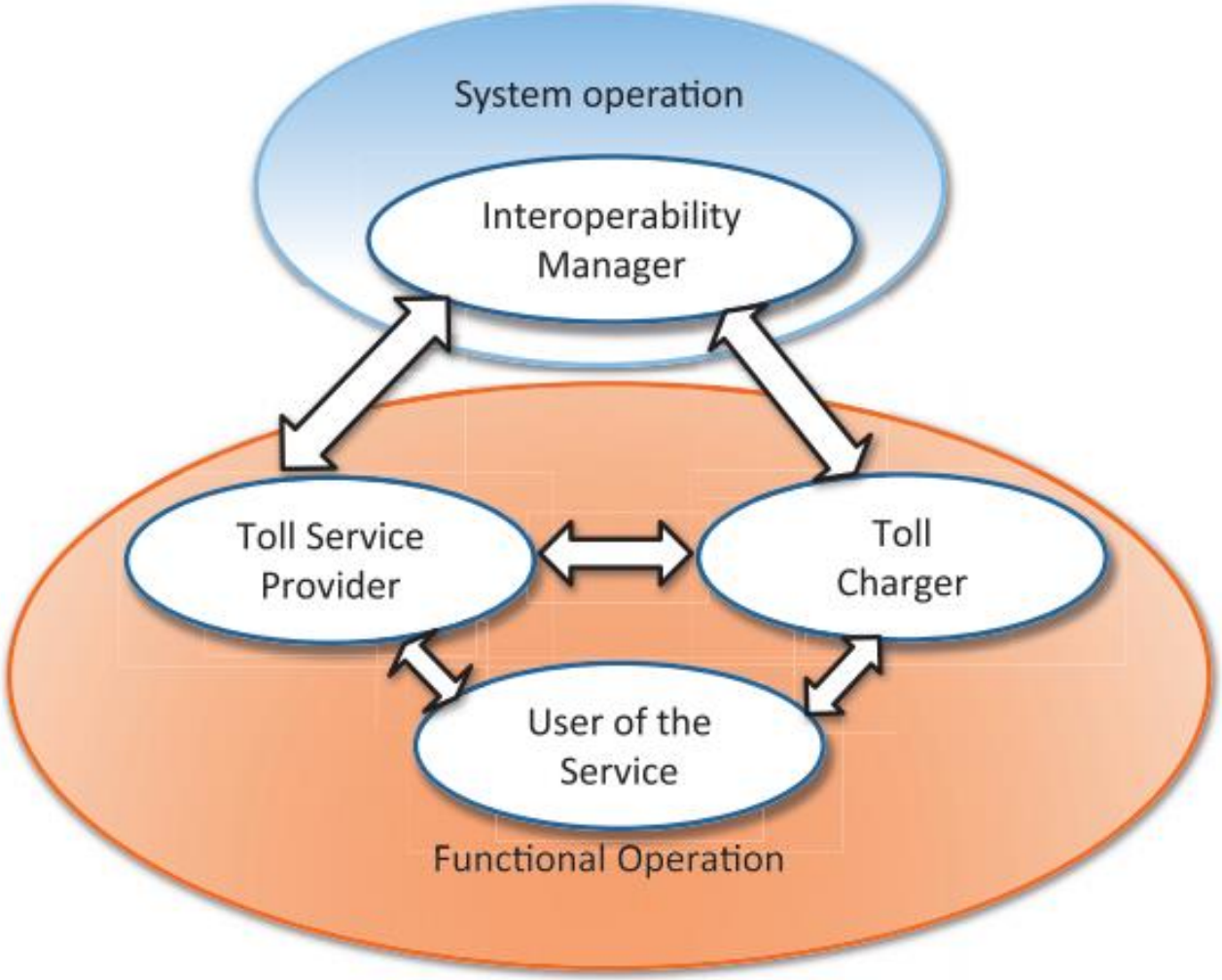


2.2) EFC system architecture – Enterprise objects

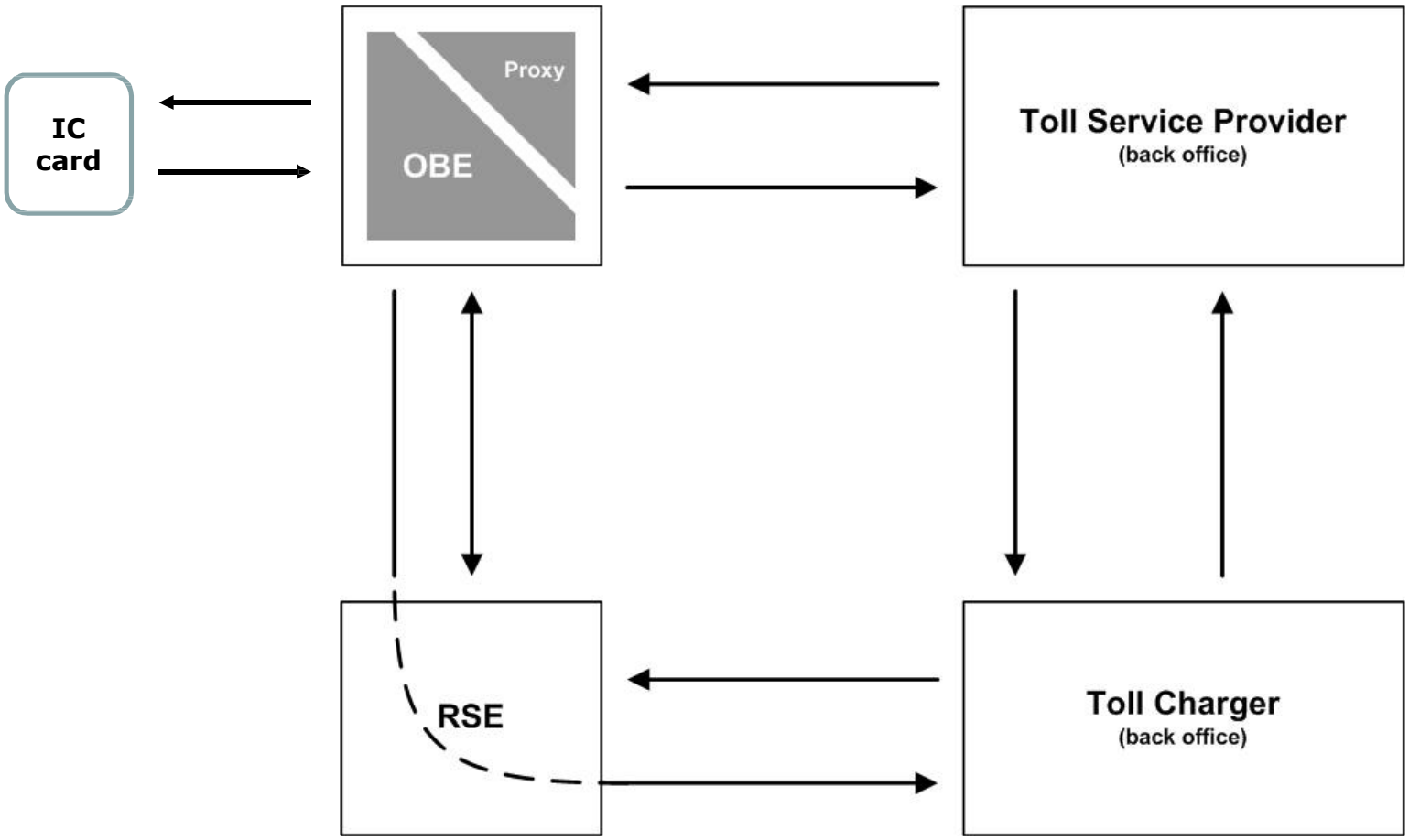


2.2) EFC system architecture – Enterprise viewpoint

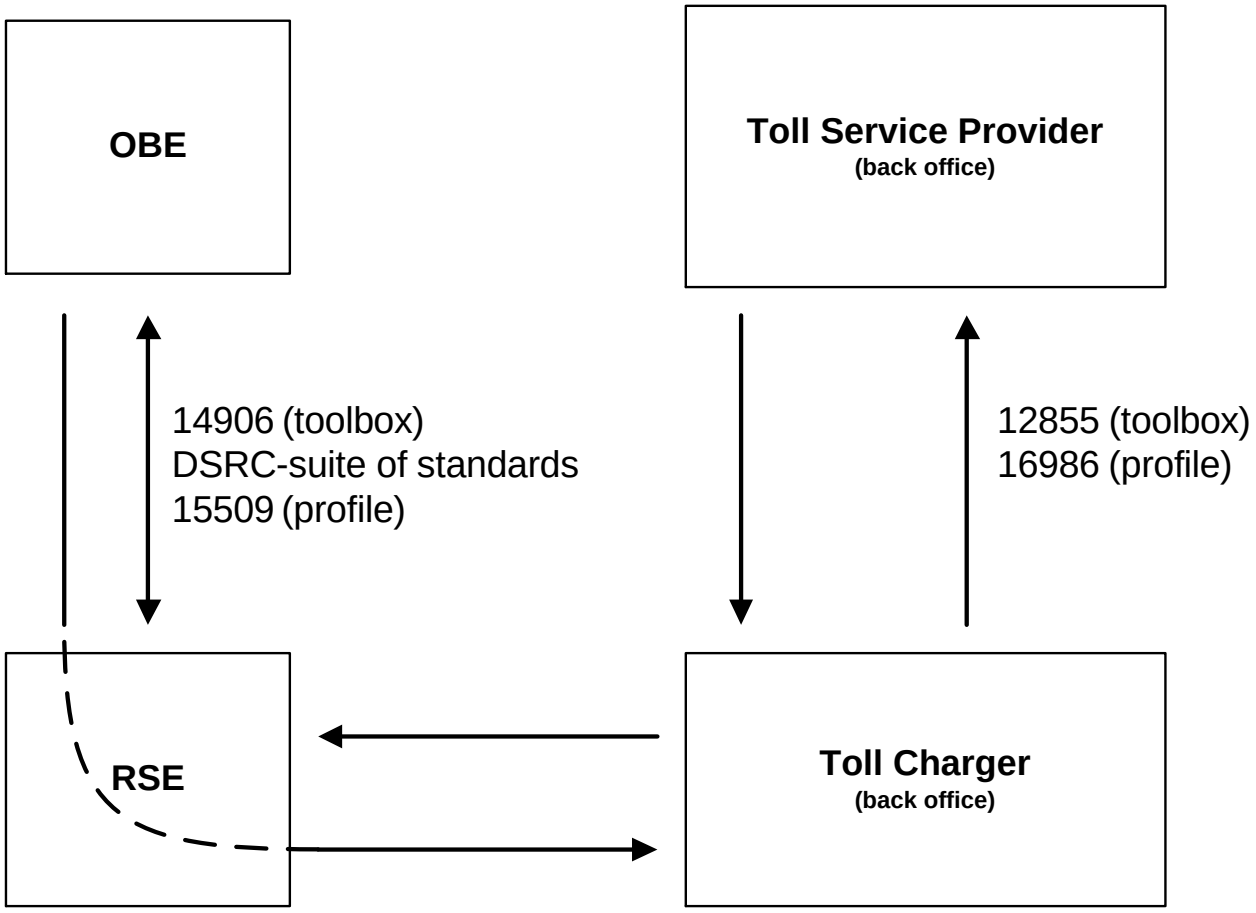
Basic roles



2.2) EFC system architecture – Engineering viewpoint



2.3) DSRC-based EFC



2.3) EFC AID for DSRC (14906)

Scope / properties

- 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

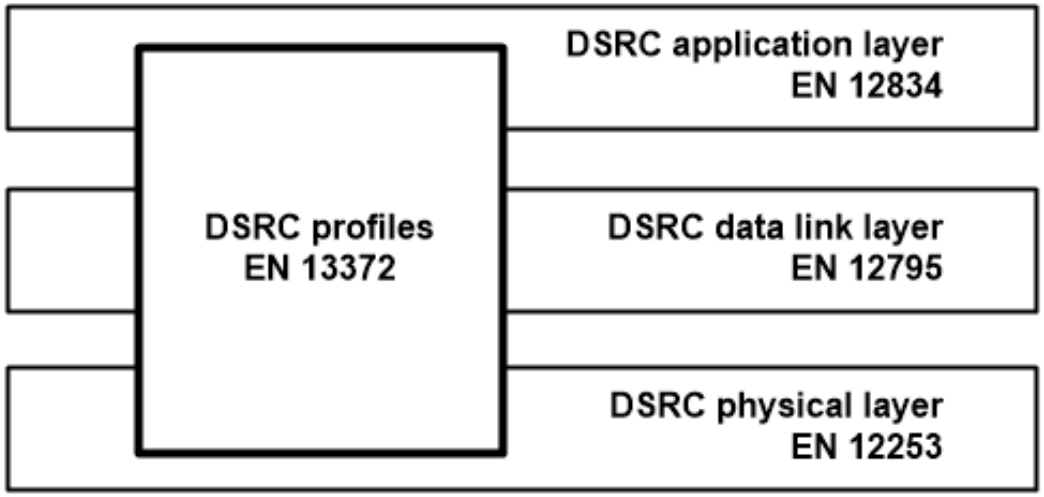
Impact

- 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

- Part 1: CEN DSRC-L1 conformance tests specification
- Part 2: DSRC equipment must meet the "essential" requirements to be placed on the European market (indicated by CE marking)

	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

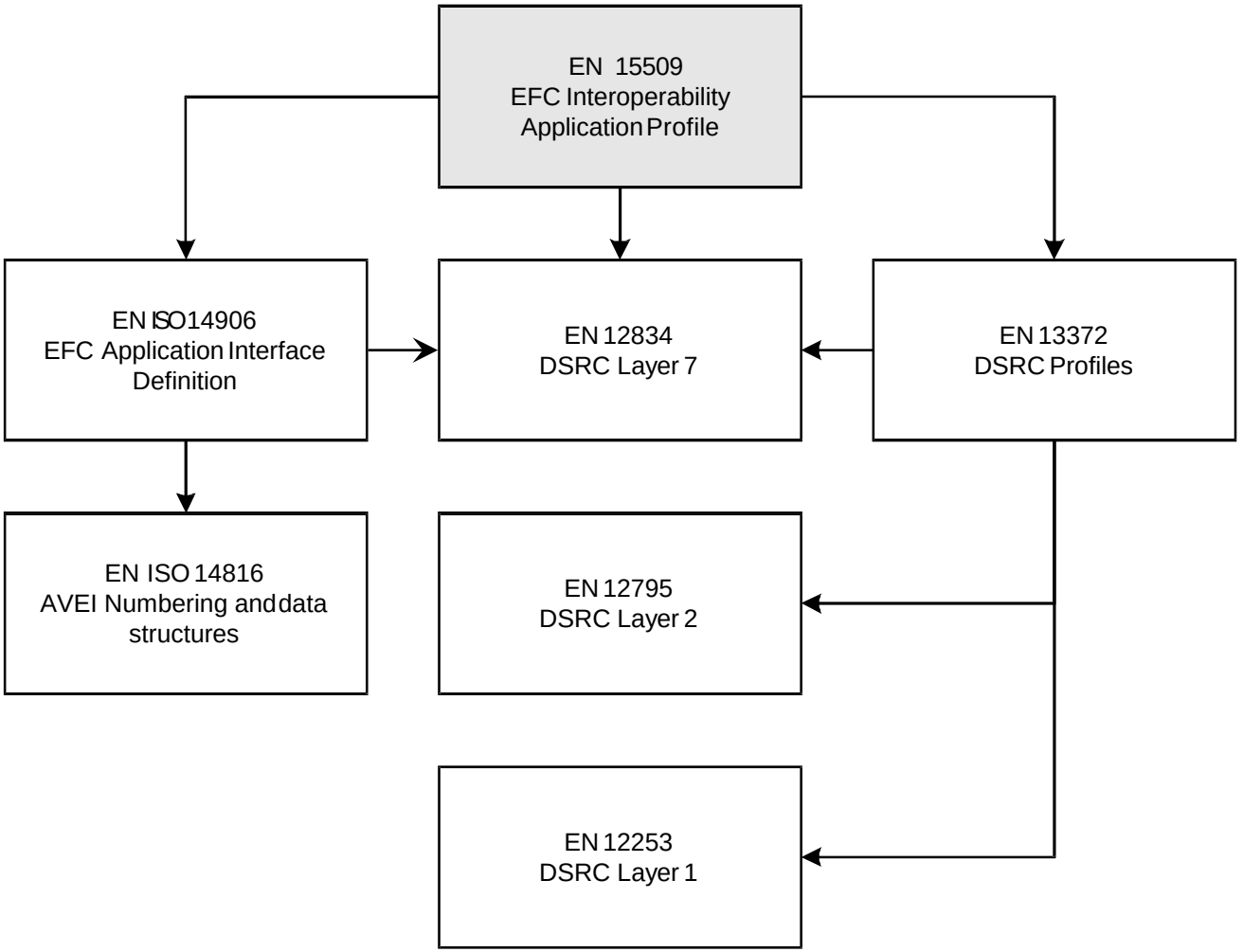
- Interoperability, equipment compatibility, best industry practice
- Support the European Electronic Toll Service (EETS) legislation

Scope

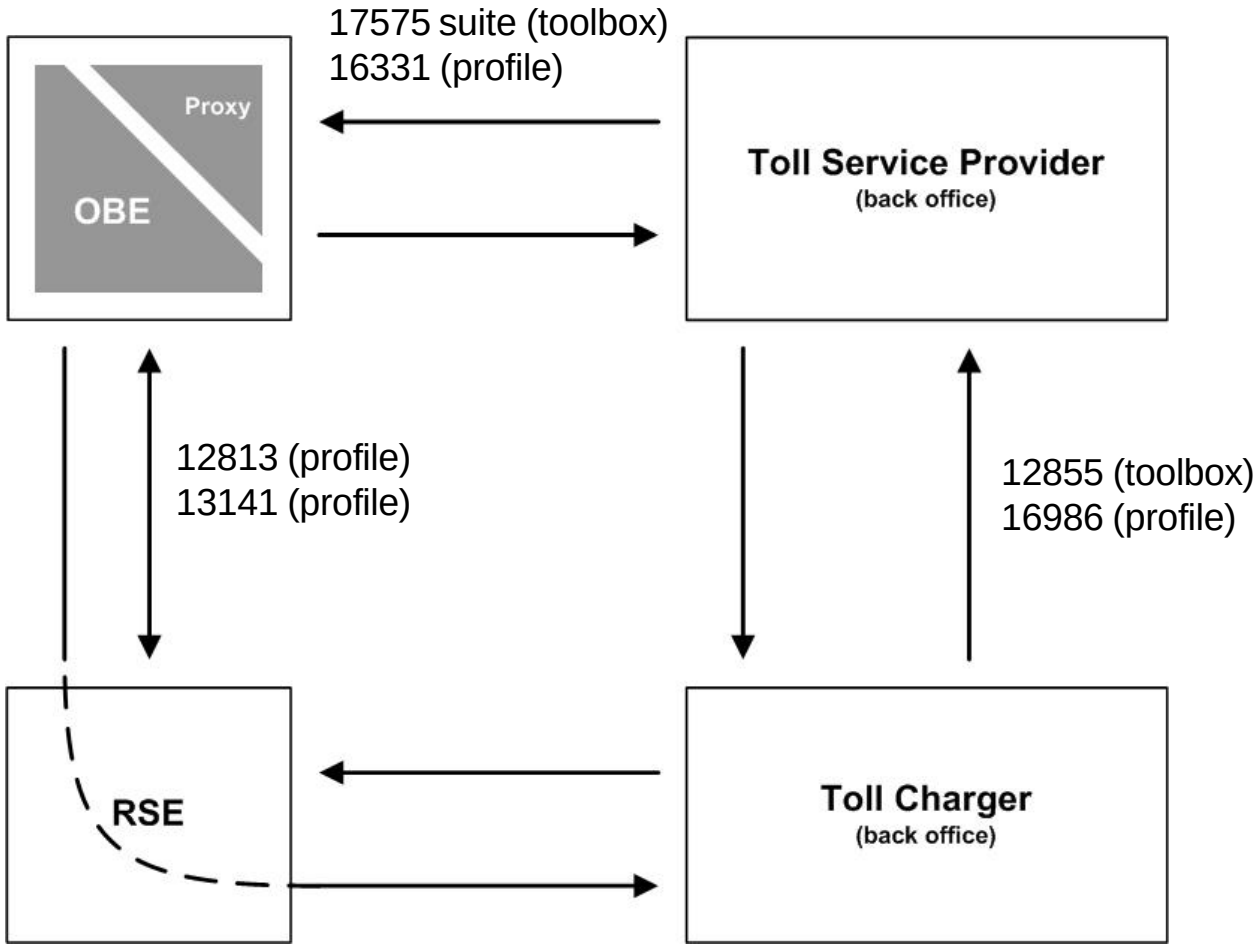
- DSRC requirements
- EFC functions, data and security
- Implementation conformance statement (ICS) proforma
- Use of this standard for the EETS, incl relationship to the requirements of EETS legislation

2.3) IAP for DSRC

Relationship to toolbox standards



2.4) GNSS-based EFC



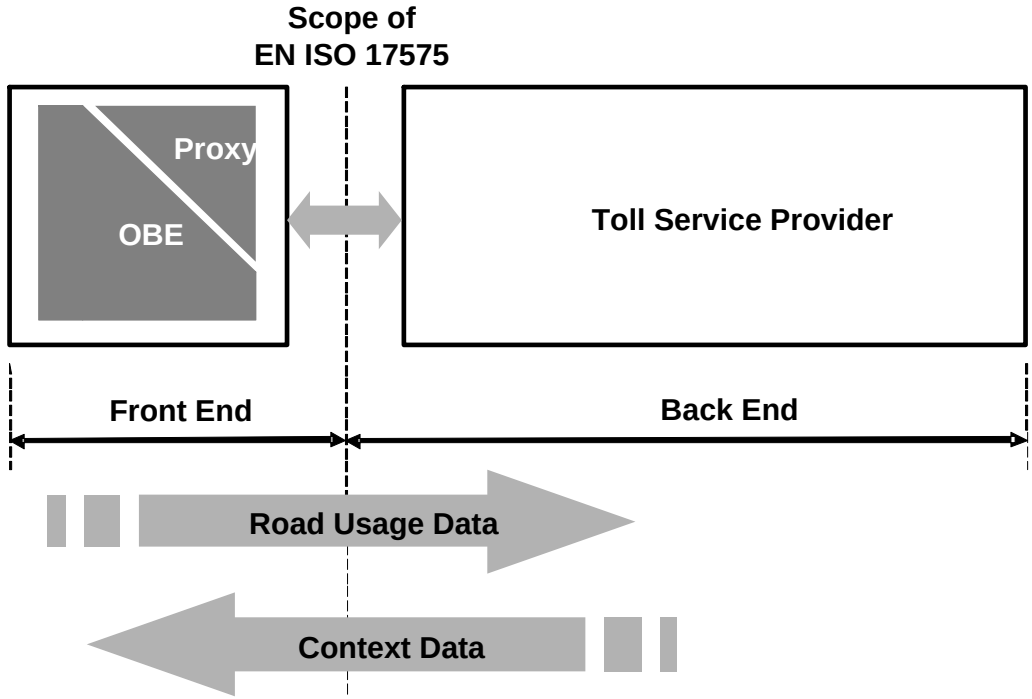
2.4) AID for GNSS-based EFC (17575 suite)

Objectives

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

Parts

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



2.4) IAP for GNSS-based EFC (16331)

Objectives

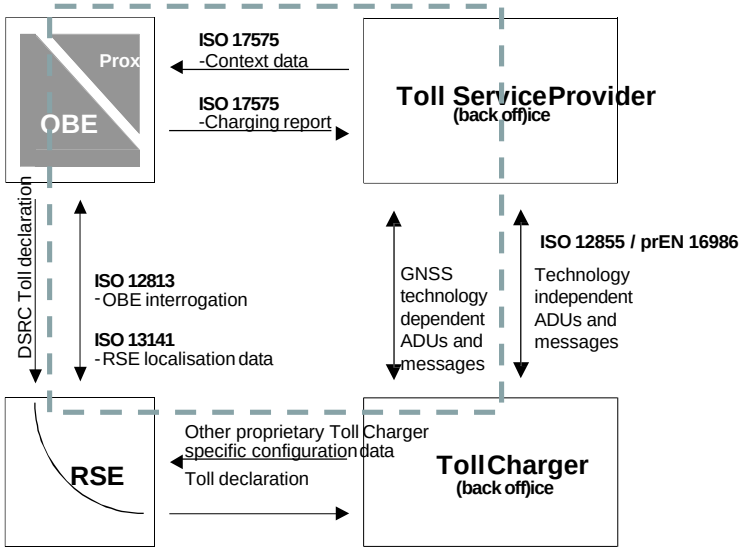
- Support interoperability
- Support the EETS

Scope

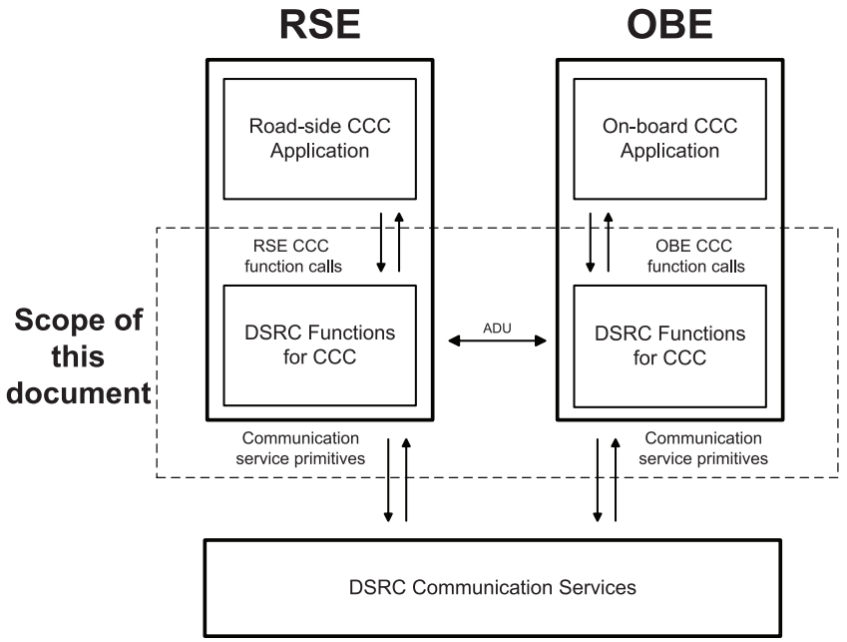
- AID for GNSS-based EFC systems (17575 suite)
- Info exchanges between TC and SP (12855 / 16986)
- CCC (12813)
- LAC (13141)

IAPs

- **Sectioned** roads tolling
- Sectioned roads tolling or **distanced-based area** charging pricing
- Overlapping sectioned roads tolling or distance or **time-based** area pricing
- Overlapping sectioned roads tolling or distance or time-based area or **cordon** pricing



2.4) Compliance checking of the user (12813)



Objectives

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

Scope

- Data definitions, according and in addition to "AID for DSRC" (14906)
- Supports CEN DSRC, CALM, UNI DSRC and IEEE Wave comm standards
- Lower layers make use of and reference existing standards
- Security concept same as in "IAP for DSRC" (15509)
- Implementation conformance statement (ICS) proforma

The test suite 13143-1/2 can be used to evaluate the conformance of an implementation to 12813

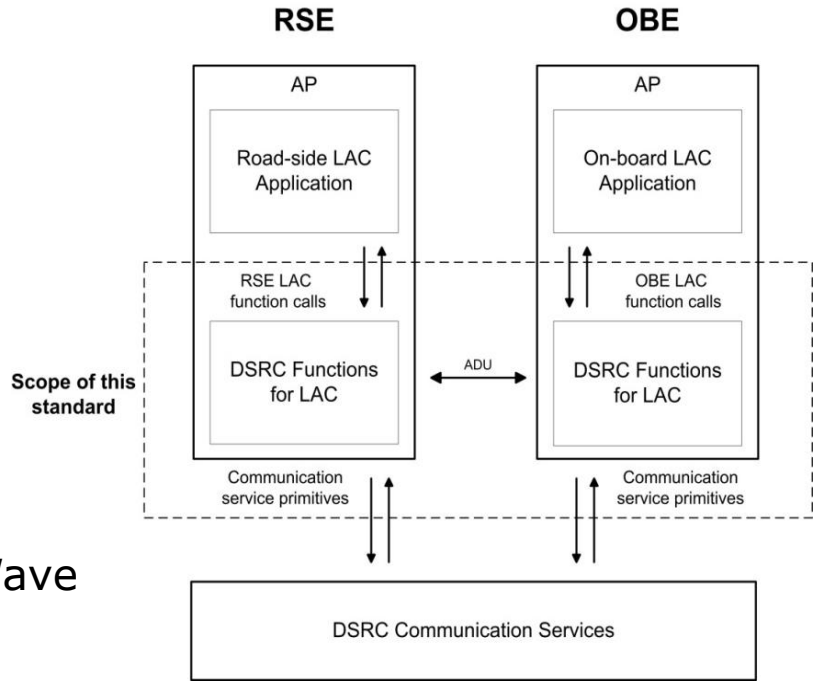
2.4) Localisation augmentation support (13141)

Objectives

- Localisation augmentation support
- Support the EETS

Scope

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



The test suite 13140-1/2 can be used to evaluate the conformance of an implementation to 13141

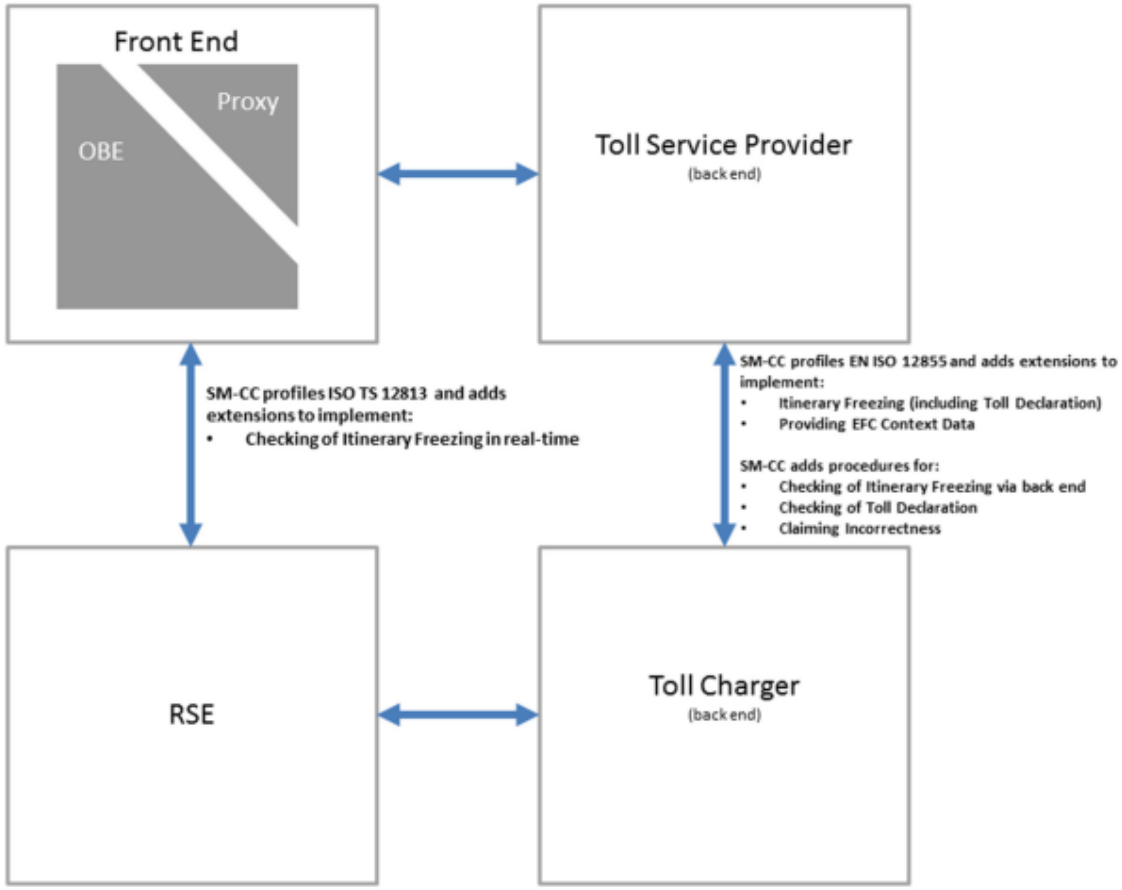
2.4) Secure monitoring - Compliance checking (16702-1)

Objective

- 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...)



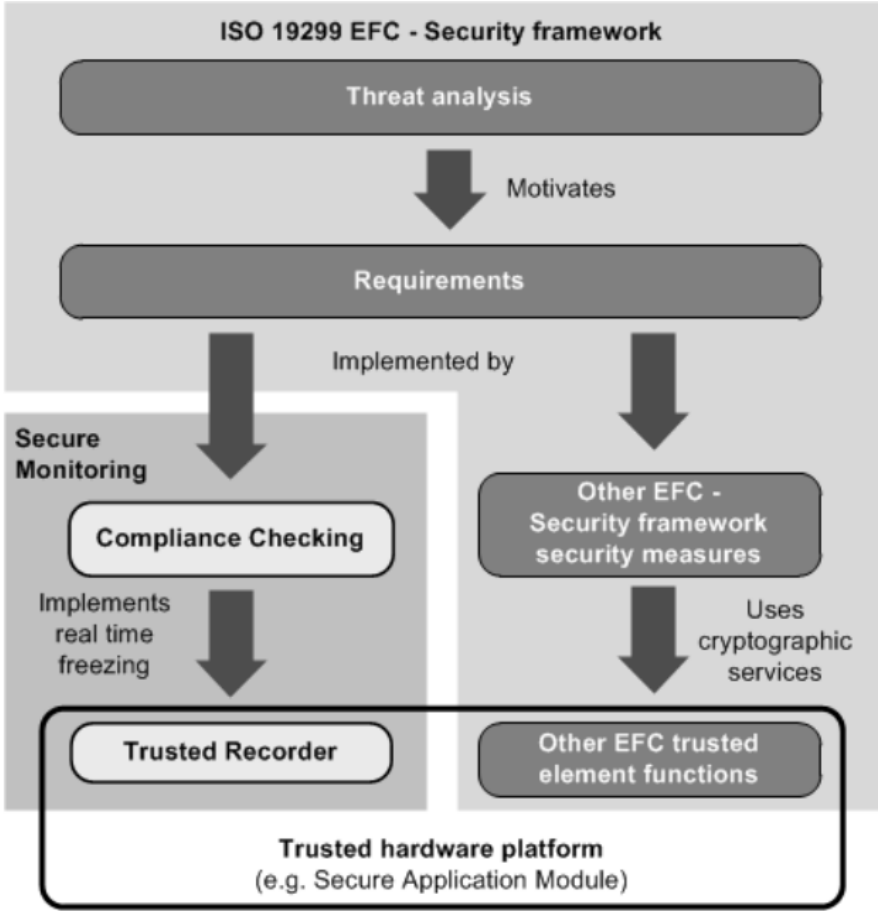
2.4) Secure monitoring - Trusted recorder (16702-2)

Objective

- 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

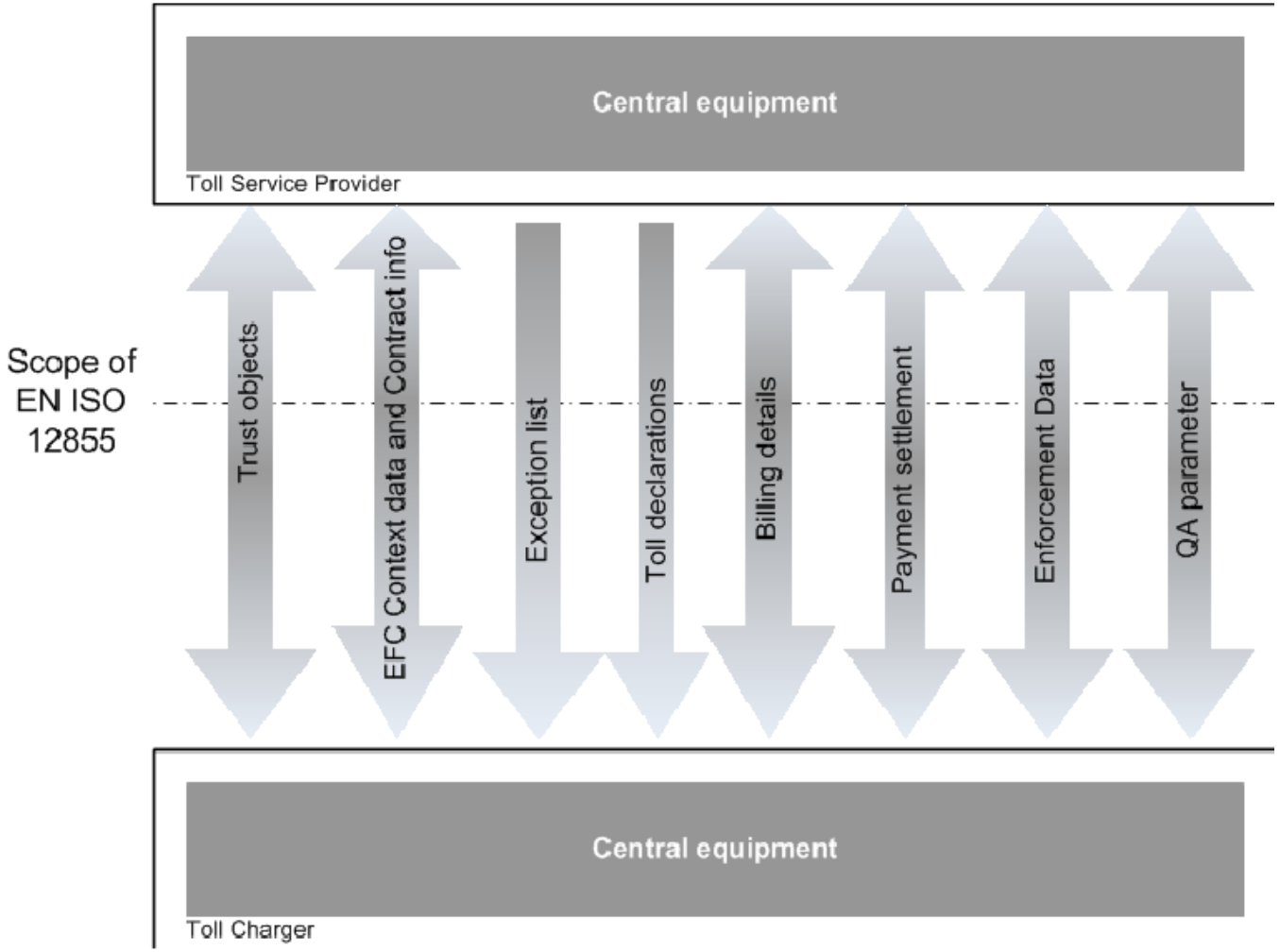
Scope

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

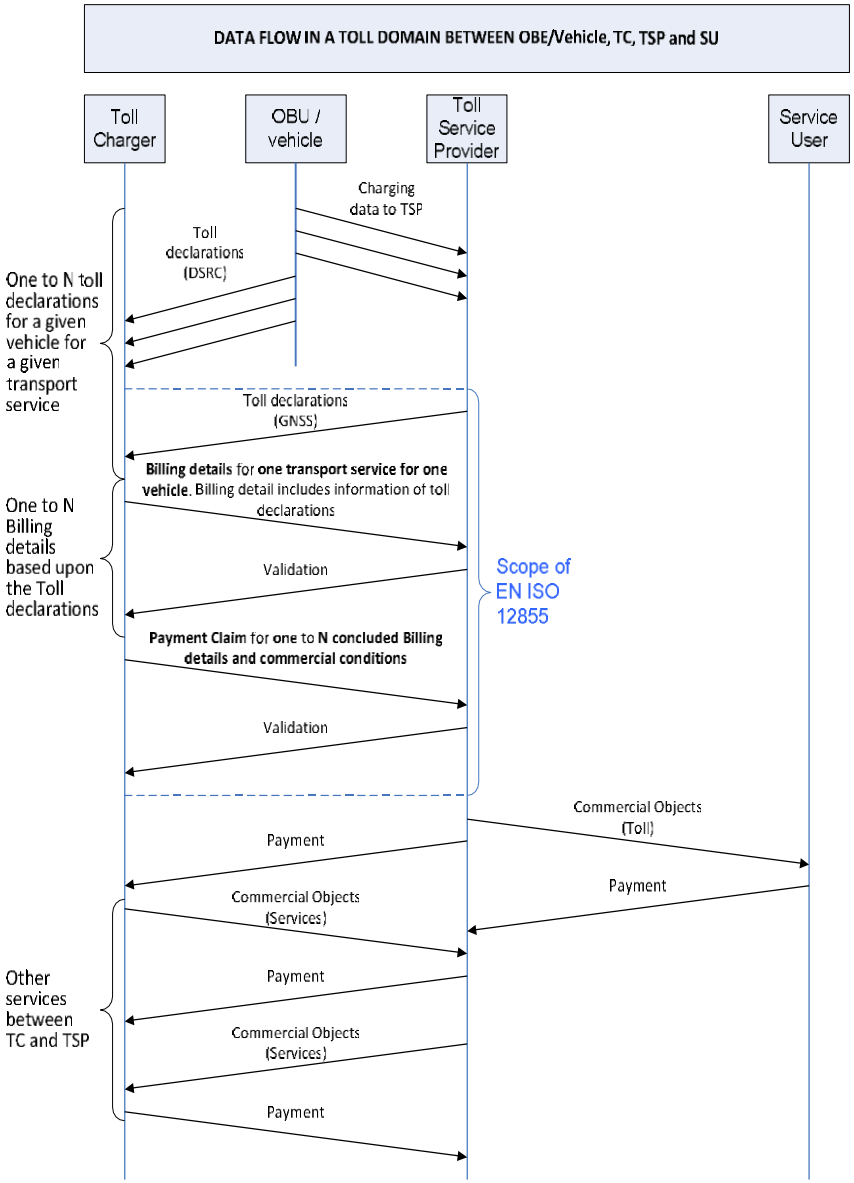


2.5) Info exchanges between SP and TC (12855, toolbox)

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



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

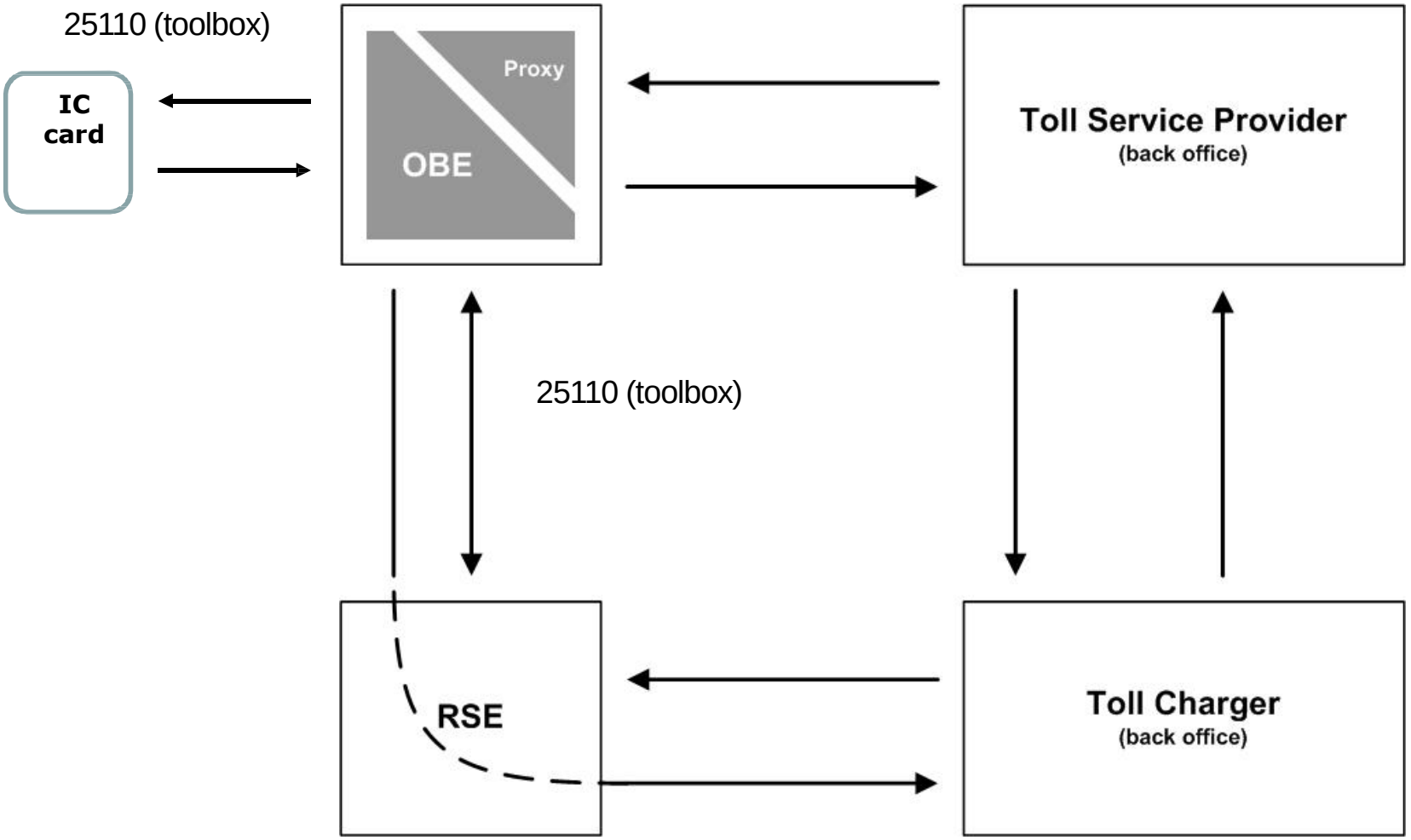


2.5) Info exchanges between SP and TC (16986, profile)

Objectives: Support interoperability and the EETS

ADU	DSRC	GNSS, TSP dominant	GNSS, TC dominant
retrieveTrustObjectADU trustObjectADU	X	X	X
efcContextDataADU	X	X[1]	X
exceptionListADU	X	X	X
reportAbnormalOBEADU	X	O	O
retrieveTollDeclarationADU	-	-	-
tollDeclarationADU	-	X	X
billingDetailsADU	X	X	X
paymentCliamADU	O	-	O
paymentAnnouncementADU	-	O	-
retrieveUserIdListADU provideUserIdListADU	O	O	O
retrieveCCCEventADU reportCCCEventADU	-	-	-
retrieveUserDetailsADU provideUserDetailsADU	X	X	X
reportQAADU	-	-	-
contractIssuerListADU	X	O	O
Request / Acknowledge	X	X	X
statusADU	-	-	-

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



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

Objectives

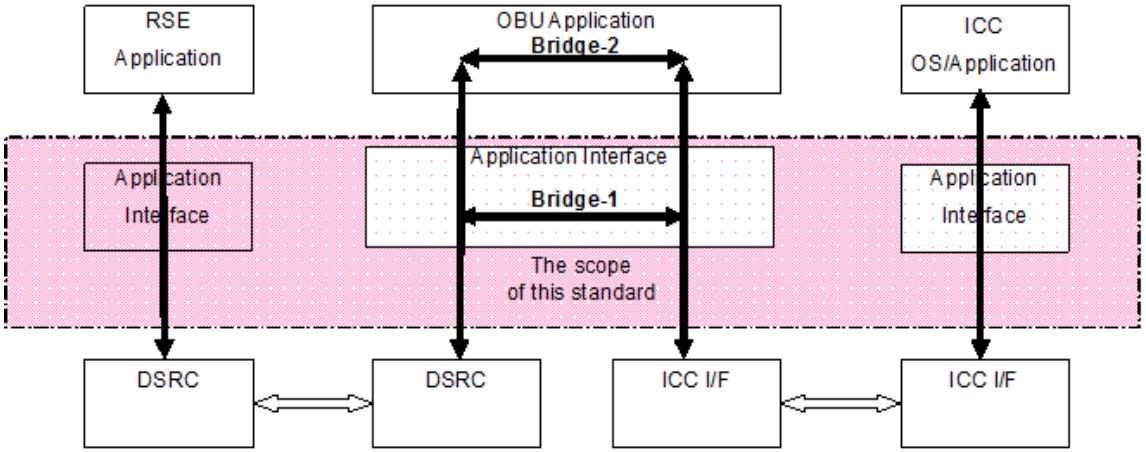
- Support EFC on-board account charging using ICC

Scope

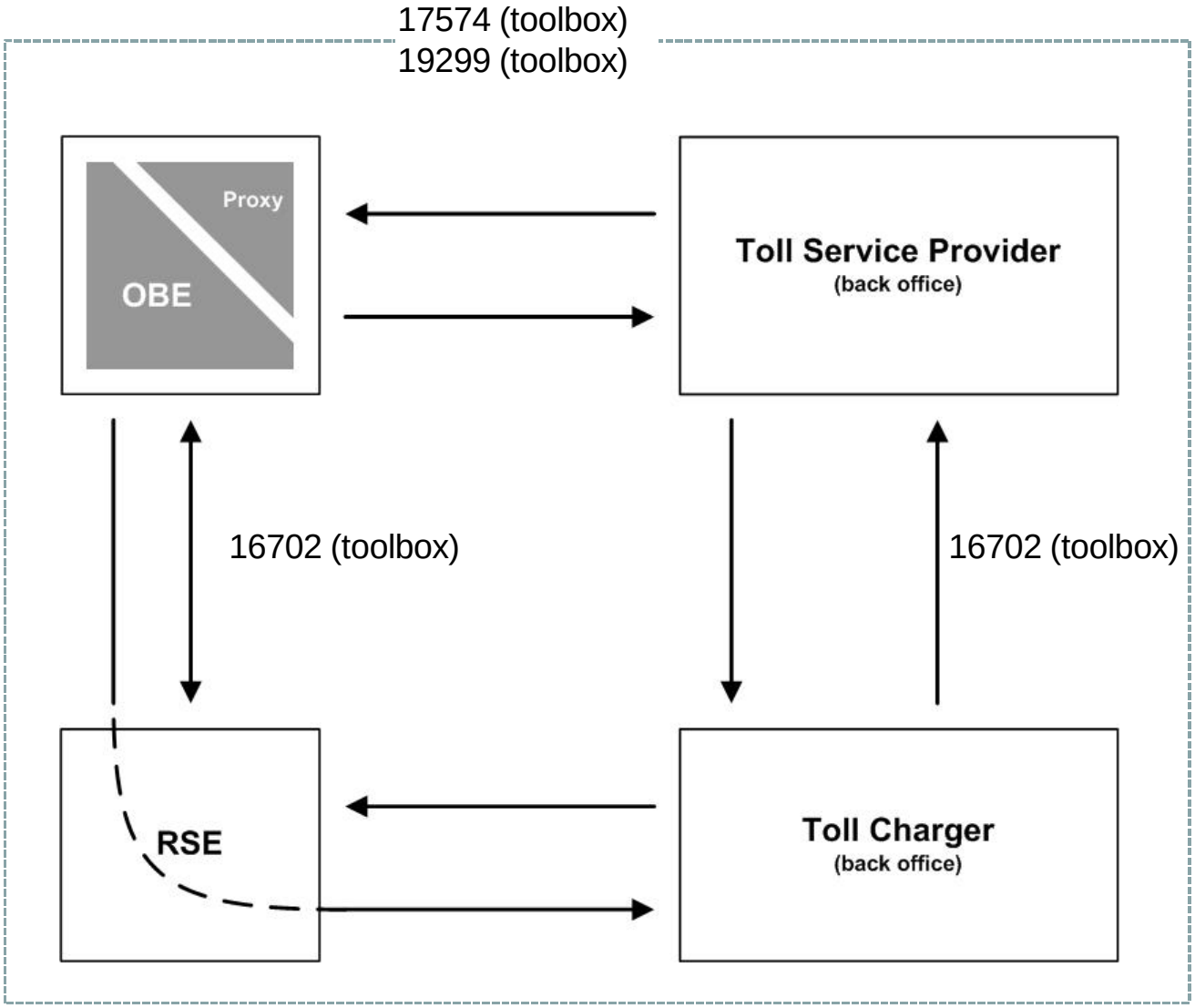
- DSRC – ICC interface protocol bridge / ”extension of 14906”
  - Transparent and buffering type (bridge 1)
  - Cashing type (bridge 2)
- Reference model for on-board account system
- Command definitions – RSE – OBE

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



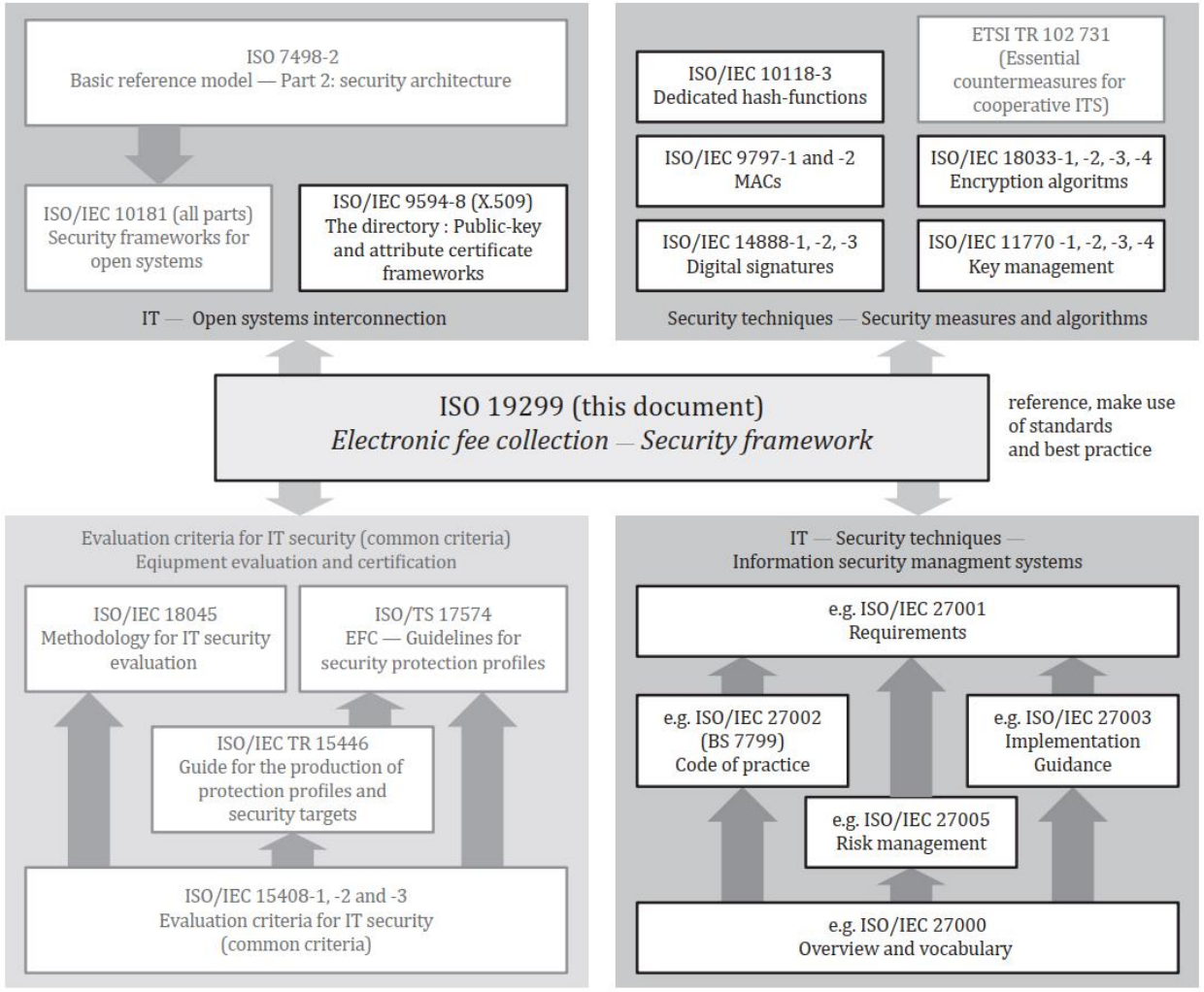
2.7) Security framework (19299)

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 reqs



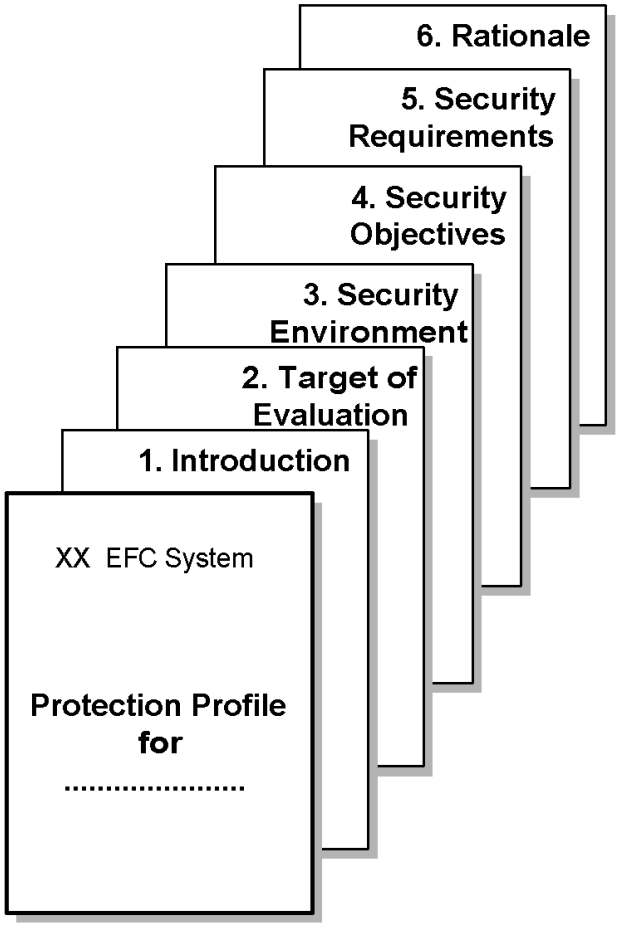
2.7) Guidelines for security protection profiles (17574)

Objectives and properties

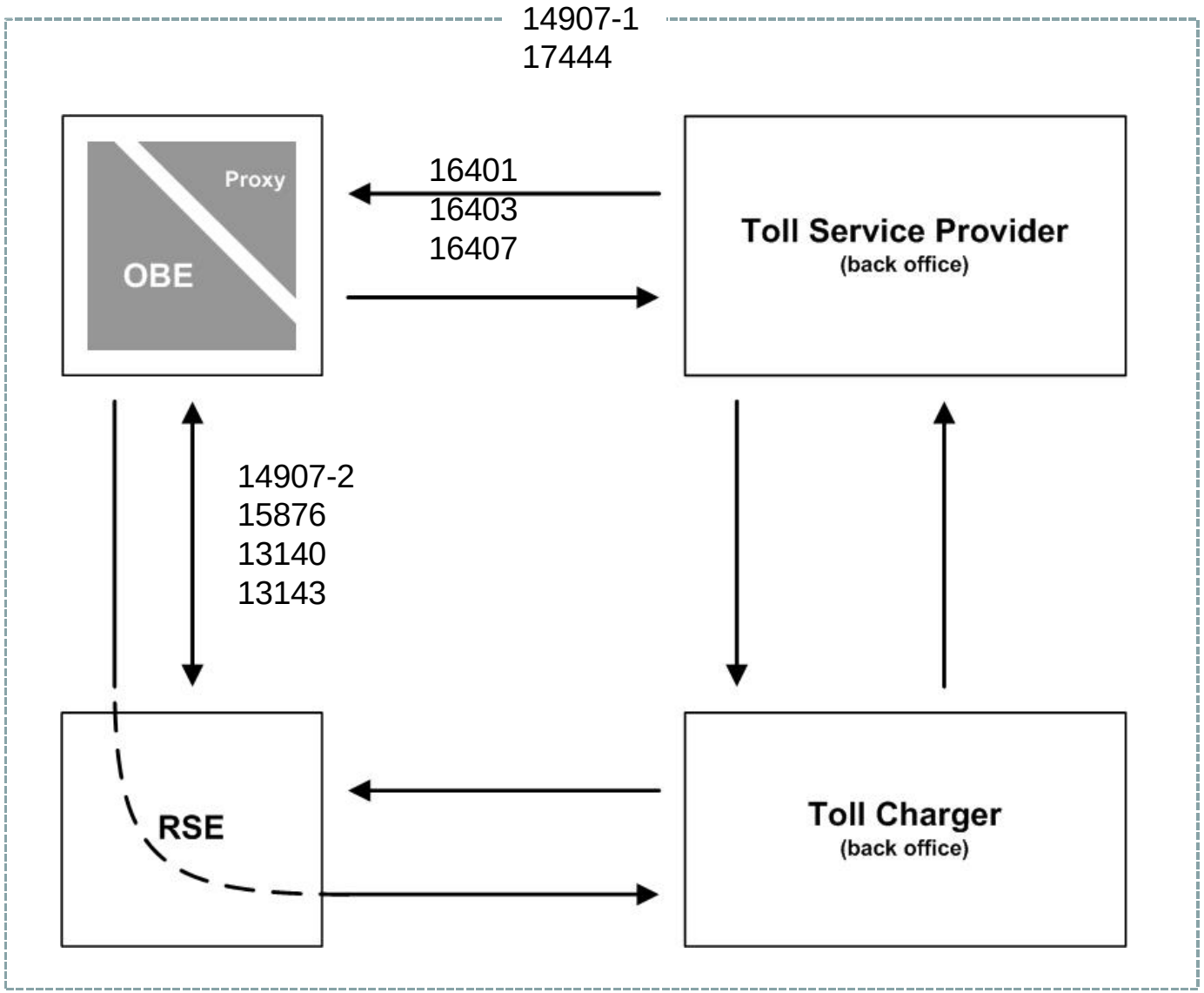
- Preparation & evaluation of security reqs
- Based on IT security standards
  - Evaluation security criteria 15408
  - Protection profiles 15446
- Product-oriented

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

A test suite generally entails

- Part 1: Test Suite Structure and Test Purposes ("human-readable part")
- Part 2: Abstract test suite ("machine-readable part")

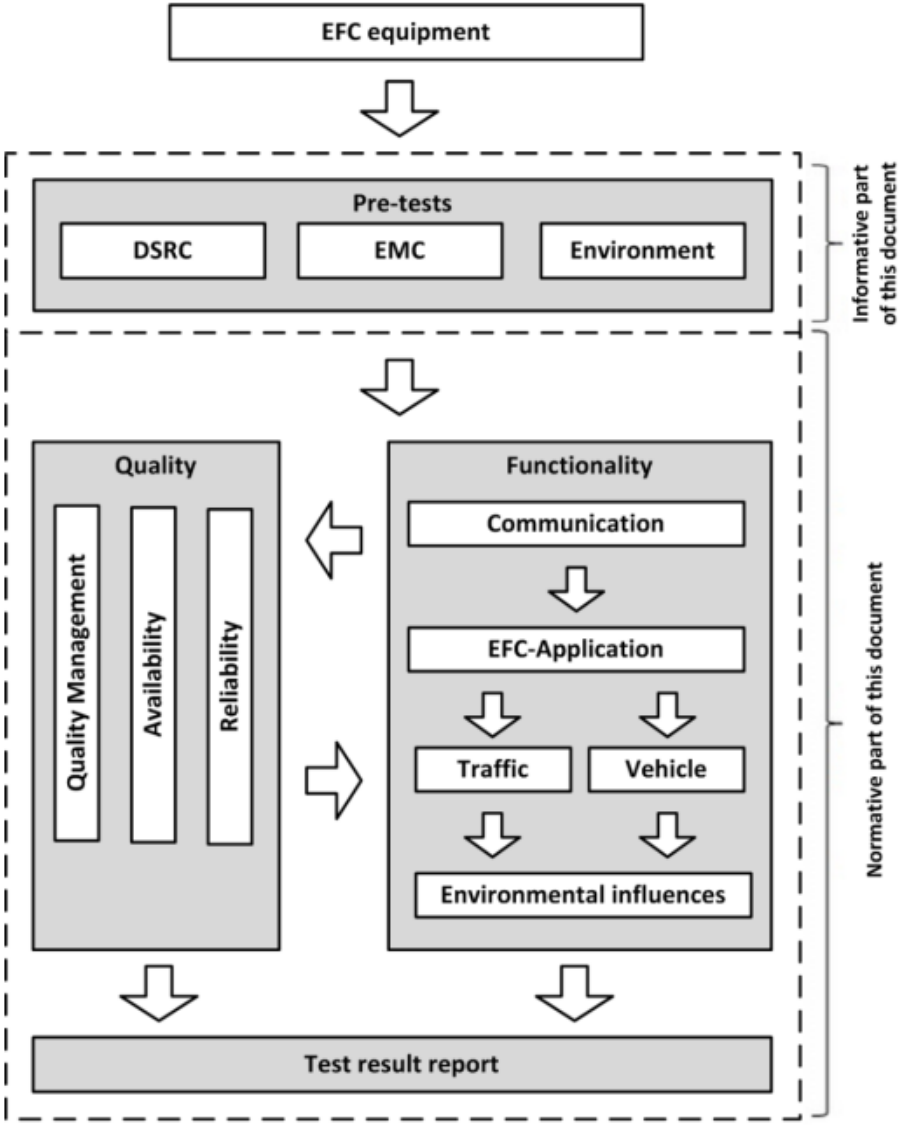
Suites available to evaluate conformity to

- AID for DSRC (14906) - 14907-2 (1 part only, no machine-readable part)
- IAP for DSRC (15509) – test suite 15876
- AID for GNSS-based EFC systems (17575 suite) – test suites 16407, 16401 & 16410
- CCC (12813) – test suite 13143
- LAC (13141) – test suite 13140

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 (17444 suite)

Objectives

- 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, or average or worst-case error bounds in percentage or monetary units
- Evaluation of the expected performance of a system based on modelling and measured data from trial at another place

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)
- **Revision of profile-standards** for GNSS-based EFC
- **Studies and Technical reports** - analysis of emerging needs, trends and road maps
  - Pre-study on the use of vehicle licence plate information and ANPR technologies
  - 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) Recast of the European electronic toll service legislation

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 / ISO EFC standards** are referred to in 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

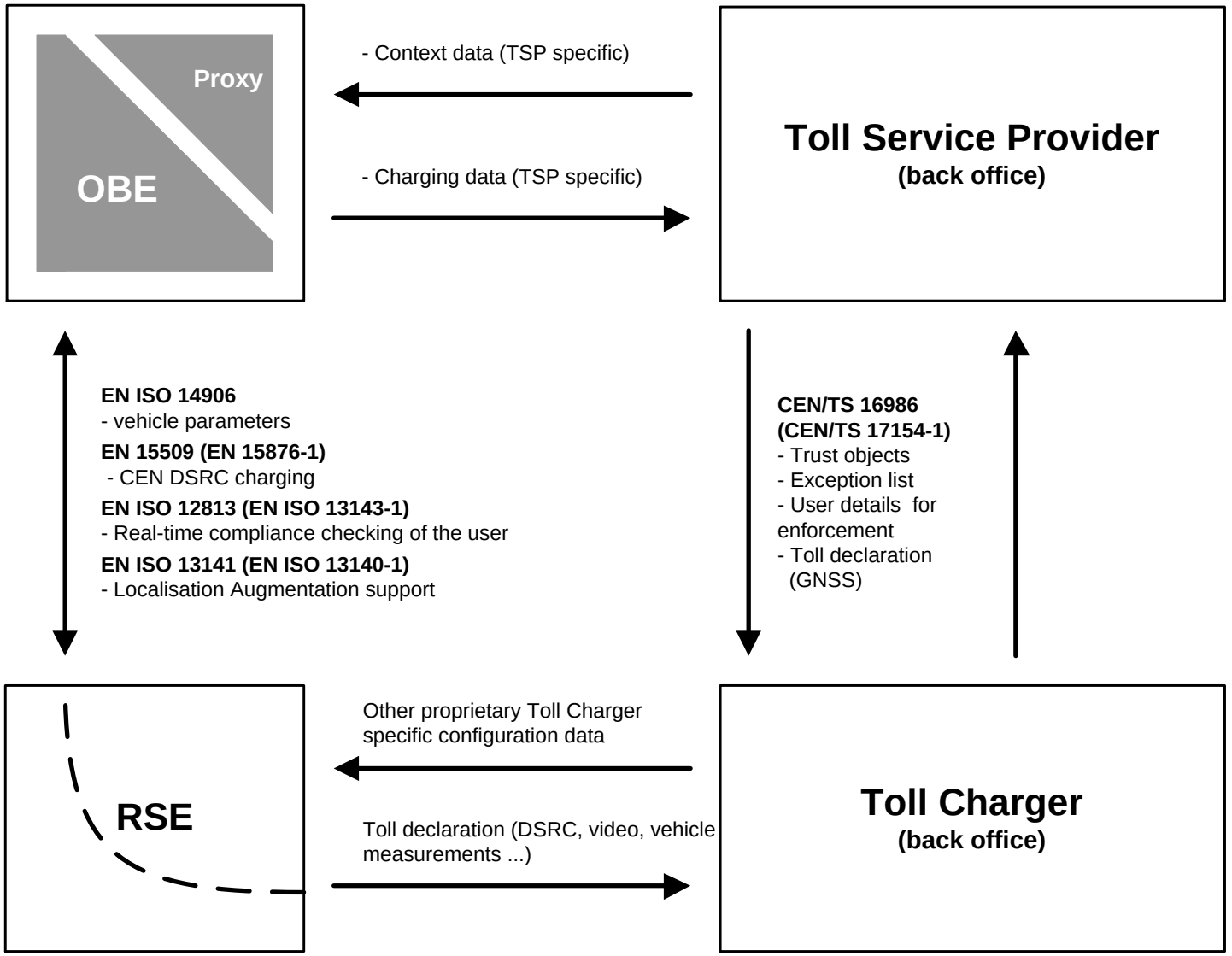
- EETS is a single service : Users are free to take advantage of the local and/or the European service
- EFC standards support broader technical needs: used in 50 countries, 140 systems, 150 mio vehicles

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

Legislators decide on the legal status of standards

3) EFC standards and the EETS



Annex - Overview of Standards and Technical Specifications

	DSRC-based EFC	EFC technology independent	Autonomous-based EFC
Frameworks	CEN ISO 21719-1 OBE personalization	EN ISO 17573 -1 Architecture ISO/TS 17573-2 Vocabulary CEN ISO/TS 17573-3 Data dictionary CEN ISO/TS 17574 Security profiles EN ISO 19299 Security framework	
Toolboxes	EN ISO 14906 DSRC application interface [ASN.1] EN SO 25110 ICC application interface ISO/TS 16785 Interface between DSRC-OBE and external in-vehicle devices [ASN.1] CEN ISO/TS 21719-2 OBE personalization using DSRC	EN ISO 12855 Information exchange between Toll Service Providers and Toll Chargers [ASN.1] CEN ISO/TS 17444 Charging performance [part1][part2] ISO/TS 21192 EFC for traffic management [ASN.1] ISO/TS 21193 EFC using common media [ASN.1]	EN ISO 17575 Application interface definition for autonomous systems [part 1][part 2][part 3] CEN/TS 16702 Secure monitoring [part 1] [part 2] [ASN.1]
Profiles	EN 15509 Interoperability application profile for DSRC	CEN/TS 16986 Interoperable application profiles for information exchange between Service Provision and Toll Charging [WSDL]	CEN/TS 16331 Interoperable application profiles for autonomous systems EN ISO 12813 Compliance check communication (CCC) [ASN.1] EN ISO 13141 Localisation augmentation communication (LAC) [ASN.1]
Tests	EN ISO 14907-1 Test procedures for user and fixed equipment EN SO 14907-2 OBU tests against 14906 standard EN 15876 Tests against 15509 standard [part 1][part 2] [TTCN]	CEN/TS 17154 Tests against 16986 standard [part1][part2][TTCN]	EN ISO 16407 Tests against 17575-1 standard [part 1][part 2][TTCN] EN ISO 16410 Tests against 17575-3 standard [part 1][part 2][TTCN] EN ISO 13143 Tests against 12813 standard [part 1][part 2][TTCN] EN ISO 13140 Tests against 13141 standard [part 1][part 2][TTCN]

Annex - Overview of Technical Reports

DSRC & SRD-based EFC	Miscellaneous	Autonomous EFC
16040 Urban DSRC **16968** Security assessment **TC278 N318** DSRC requirements **TC278 N779** ICC requirements	***6026*** *Pre-study on the use vehicle license plate information and ANPR technologies* **17546** EETS gap analysis and roadmap **16092** Pre-payment systems **16152** First mount OBE **16219** Value added services EFC OBE **16690** EFC on ITS stations **19639** Common payment schemes **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	**16401-1/2** Tests against 17575-2 **TC278 N798** Requirements for autonomous EFC systems

Black = ISO/CEN, Blue = CEN-only, green = ISO-only, *Italics = Working documents*

Annex – Architecture and technology independent (1)

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 12855:2015	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 suite structure and test purposes
CEN/TS 17154-2:2019	EFC - Conformity evaluation of implementation to CEN/TS 16986 – Part 2: Abstract test
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
CEN ISO/TS 17574:2017	EFC – Guidelines for security protection profiles
ISO/TS 21192:2019	EFC – Support for traffic management

Annex – Architecture and technology independent (2)

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 – 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
EN 15876-2:2016	EFC – Evaluation of on-board and roadside equipment for conformity to EN 15509 - Part 2: Abstract test suite
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 21719-2:2018	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 Dedicated Short-Range Communication

Annex – GNSS-based EFC (1)

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
CEN/TS 16331:2012	EFC – Interoperable application profiles for autonomous systems
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 – GNSS-based EFC (2)

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 1: Compliance checking - Part 2: Trusted recorder

Want to know more or participate?

Coordination of EFC standardization : ISO/TC 204/WG 5 and CEN/TC 278/WG 1

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