#### CEN/TC 278/WG 1 & ISO/TC 204/WG 5 N 2824



# An introduction to standardization of electronic fee collection (EFC)

## 8 January 2021

Jesper Engdahl Convenor of CEN/TC 278/WG 1 & ISO/TC 204/WG 5 T +41 58 595 78 53

jesper.engdahl@rapp.ch



## 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 <u>European electronic toll</u> 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

8

- 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







#### 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, <u>Directive 2019/520</u>)
- Tachographs in road transport (<u>Regulation No 165/2014</u>)
- Max authorized dimensions and weights for road motor vehicles (<u>Directive 2015/719</u>)



## **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)







## 2.3) Interoperability application profile (15509)

#### **Objectives**

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

- 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)



- Data origin authentication, integrity and non-repudiation ٠
- Implementation conformance statement (ICS) proforma ۲

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

**Objectives** 

•

•

•

•



## 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

- 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

- 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	Х	Х	Х
trustObjectADU			
efcContextDataADU	Х	X1	Х
exceptionListADU	Х	Х	Х
reportAbnormalOBEADU	Х	0	0
retrieveTollDeclarationADU	-	-	-
tollDeclarationADU	-	Х	Х
billingDetailsADU	Х	Х	Х
paymentCliamADU	0	-	0
paymentAnnouncementADU	-	0	-
retrieveUserIdListADU	0	0	0
provideUserIdListADU			
retrieveCCCEventADU	_	-	-
reportCCCEventADU			
retrieveUserDetailsADU	Х	Х	Х
provideUserDetailsADU			
reportQAADU	-	-	-
contractIssuerListADU	X	0	0
Request / Acknowledge	Х	Х	Х
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

- 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

- 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 (17444 suite)

#### Objectives

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

#### Scope

36

- Charging performance metrics and examination framework
  - Charge reports
  - Toll declarations
  - Billing details
- Invoicing accuracy on the level of user accounts
- Part 1: Metrics
- Part 2: Examination framework

#### **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**

- <u>EU Directive 2019/520</u> on Interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees
- Commission <u>Implementing Regulation (EU) 2020/204</u> on detailed obligations of Toll Service Providers and Toll Charges
- Commission <u>Delegated Regulation (EU) 2020/203</u> 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	<u>CEN/TS 16986</u> Interoperable application profiles for information exchange between Service Provision and Toll Charging [ <u>WSDL</u> ]	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	<ul> <li>XXXXX Pre-study on the use vehicle license plate information and ANPR technologies</li> <li>17546 EETS gap analysis and roadmap</li> <li>16092 Pre-payment systems</li> <li>16152 First mount OBE</li> <li>16219 Value added services EFC OBE</li> <li>16690 EFC on ITS stations</li> <li>19639 Common payment schemes</li> <li>21190 Investigation of charging policies and technologies for future standardization</li> <li>TC278 N278 Integration of payment systems for transport services</li> <li>TC278 N780 Threats and Security Controls</li> </ul>	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
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

46

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/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

#### Jesper Engdahl, WG5/WG1 convenor

T +41 58 595 78 53 jesper.engdahl@rapp.ch

#### Frédérique Rigah, WG5/WG1 secretary T +33 1 60 52 32 49 frederique.rigah@cerema.fr

