EETS-SAM Domain Statement

Attachment C

Technical Requirements – DSRC technology

Version 2 - 14.10.2021

Document History

Version	Date	Content
1.00	14 September 2018	Document release
2.00	14 October 2021	Document release

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1 Introduction

This document provides the business and technical specification to be met by any EETS Provider who wishes to provide its customers with the possibility of paying the toll along the toll domain of the A4 motorway in Poland, operated by the concessionaire Stalexport Autostrada Malopolska (SAM) between the cities of Krakow and Katowice.

The overall business and technical concept is in line with the indications of the 2019/520 Directive (EU) on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union and of the Commission Implementing Regulation (EU) 2020/204 on detailed obligations of European Electronic Toll Service providers, minimum content of the European Electronic Toll Service domain statement, electronic interfaces, requirements for interoperability constituents and repealing Decision 2009/750/EC .

The document provides an overview on the business rules along which the electronic toll collection service is managed within the above-mentioned domain as well as the specifications for:

- the interface between the On-Board Unit (OBU) distributed by the EETS provider and the Roadside Equipment (RSE) operated by SAM on the two toll plazas of Brzęczkowice and Balice;
- the interface between the respective Back-Office Systems of both the EETS Provider and SAM for the exchange of configuration and operational data supporting the service.

They respect the characteristics of the tolling system that is currently operated by SAM along the A4 toll motorway.

Such specifications shall be used by the EETS Providers for the procurement and adaptation of their interoperability constituents, in order to be able to integrate with the tolling system operated by SAM.

2 Abbreviations and Glossary

The following terms and abbreviations are referred to along this document.

ACT	Actor Table
AID	DSRC Application Entity Identifier
AIT	Accepted Issuer Table
ANPR	Automatic Number Plate Recognition
ANSI	American National Standard Institute
APDU	Application Protocol Data Unit
AttrID	Attribute Identifier
AuKey_Iss	Issuer Authentication Key
BIN	Binary Identification Number, containing the identification of the issuer within the PAN
BST	Beacon Service Table
CCTV	Closed Circuit Television
CE	Conformity Declaration
CEN	European Committee for Standardisation
CI	Contract Issuer (synonym of TSP)
CS	Central System
DSRC	Dedicated Short Range Communication
EAcK	Element Access Key
EAuK	Element Authentication Key
EETS	European Electronic Toll Service
EFC	Electronic Fee Collection (synonym of ETC)
EID	Element Identifier
ETC	Electronic Toll Collection (synonym of EFC)
FTP	File Transfer Protocol

GDDKiA	Generalna Dyrekcja Dróg Krajowych i Autostrad
GSS	Global Specification for Short range communication
HGC	Heavy Goods Vehicle Confirmation
HGV	Heavy Goods Vehicle
KeyRef_CI	Key reference for TSP (CI) authenticator key
KeyRef_OP	Key reference for TC authenticator key
ID	Identifier
IIN	Issuer Identifier Number
L1	Layer 1 of DSRC (Physical Layer)
L2	Layer 2 of DSRC (Data Link Layer)
L7	Layer 7 of DSRC (Application Layer)
LED	Light Emitting Diode
LID	Link Identifier
LLC	Logical Link Control
LPN	License Plate Number
MAC	Medium Access Control
MAC	Message Authentication Code
MEAcK	Master Element Access Key
MEAuK	Master Element Authentication Key
MII	Major Industry identifier
MMI	Man Machine Interface
NAC	Not Accepted Table Confirmation
NAT	Not Accepted Table
OBE	On-Board Equipment (synonym of OBU)
OBU	On-Board Unit (synonym of OBE)
PAN	Personal Account Number

PDU	Protocol Data Unit
RFID	Radio Frequency Identification
RSE	Road Side Equipment
SAM	Stalexport Autostrada Malopolska
TC	Toll Charger (SAM)
TIC	Transaction Information File Confirmation
TIF	Transaction Information File
TS	Tolling Station
TSP	Toll Service Provider
TSPA	Toll Service Provider Agreement
TST	Toll Station Table
UI	User Interface (synonym of MMI)
UTC	Coordinated Universal Time
VAT	Value Added Tax
VPN	Virtual Private Network
VST	Vehicle Service Table

3 References

The following documents are referred to along this document.

[1] Regulation 661/2009: type-approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefor

[2] Directive 2014/30/EU: harmonisation of the laws of the Member States relating to electromagnetic compatibility

[3] ECE – R21: Agreement concerning the adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicle equipment and parts – Regulation No. 21: Uniform provisions concerning the approval of vehicles with regard to their interior fittings

[4] Directive 2019/520: on interoperability of electronic road toll system in the community

[5] Regulation 2020/204: detailed obligations of European Electronic Toll Service providers, minimum content of the European Electronic Toll Service domain statement, electronic interfaces, requirements for interoperability constituents and repealing Decision 2009/750/EC

[6] EN ISO 12855: Electronic fee collection – Information exchange between Service Provision and Toll Charging

[7] EN ISO 14816: Road transport and traffic telematics – Automatic vehicle and equipment identification – Numbering and data structure

[8] EN 15509: Electronic fee collection – Interoperability application profile for DSRC

[9] EN 13372: Road transport and traffic telematics (RTTT) – Dedicated short-range communication (DSRC) – Profiles for RTTT applications

[10] EN 12795: Road transport and traffic telematics (RTTT) – Dedicated short-range communication (DSRC) – DSRC data link layer: medium access and logical link control

[11] EN 12834: Road transport and traffic telematics (RTTT) – Dedicated short-range communication (DSRC) – DSRC application layer

[12] ISO/TS 17575: Electronic Fee Collection – Application interface definition for autonomous systems

[13] ISO 17573: Electronic fee collection – System architecture for vehicle related tolling

[14] EN ISO 14906: Electronic fee collection – Application interface definition for dedicated short range communication

[15] CEN ISO/TS 17575-1: Electronic fee collection – Application interface definition for autonomous systems – Part 1: Charging

[16] CEN ISO/TS 17575-3: Electronic fee collection – Application interface definition for autonomous systems – Part 3: Context data

[17] CEN ISO/TS 12813: Electronic fee collection – Compliance check communication for autonomous systems

[18] ANSI windows-1252: Chapter encoding

[19] ISO/IEC 7812: Information technology - identification cards – identification of issuers (part. 1 and part. 2)

[20] ISO/IEC 8859-1: Information technology – latin alphabet

[21] ISO 3166-1: International standard for country codes and their subdivision

4 High-Level System Architecture

4.1 Introduction

An open toll collection system is used along this motorway as the main source of financing, under the frame of a concession contract with the Polish Road Administration (GDDKiA). Users are required to pay a toll whenever they travel, in the two directions, through the toll plazas of Brzęczkowice and Balice.

A toll is due for all types of vehicles, independently from the travelled distance and of the day of passage. Toll is calculated only on the base of the vehicle category, differentiating the following categories:

Class 1: motorbikes and passenger cars with two axles;

Class 2: vehicles with two axles, at least one of which is equipped in twin tyres and vehicles with two axles with trailers;

Class 3: vehicles with three axles and vehicles with two axles, at least one of which is equipped in twin tyres with trailers;

Class 4: vehicles with more than three axles, vehicles with three and more axles with trailers;

Class 5: vehicles that do not fit within classes 1 through 4 and vehicles whose dimensions, axle load or weight are in excess of the standards set out in the road traffic regulations.

Both toll plazas are equipped with a significant number of toll lanes, where the following payment means are accepted:

- Cash
- Bank (Credit/Debit) Cards
- Fuel/Fleet Cards
- Pre-Paid RFID Proprietary Card (KartA4)
- ETC On-Board Units (OBUs)
- Toll based on the license plate recognition

An Electronic Toll Collection (ETC) service has been launched for both light and heavy vehicles in July 2016, allowing road users to make use of their OBUs to pay tolls on the A4 motorway by means of their OBU.

Two different ETC services are managed:

- on one side a local ETC service is provided to all vehicles (mainly local) by Stalexport Autostrada Malopolska itself, that issues and manage directly the Pre-Pay and Post-Pay OBUs; this service is referred to as A4GO;
- on the other side an interoperable Post-Pay ETC service is provided for heavy vehicles, with Stalexport Autostrada Malopolska accepting on its tolling facilities OBUs issued by other Service Providers (national and international).

ETC services are provided by means of ETC lanes deployed on both toll plazas and on both directions.

Two types of ETC lanes are operated by SAM and provide the road user with the possibility of using their OBU to pay the tolls:

- a so called “Stop & Go ETC” lane
- a so called “Stop & Go ETC dedicated” lane.

The “Stop & Go ETC” toll lane is a lane by which users may pay the toll by means of both ETC and more traditional payment means, such as those typically accepted within the manual lanes. A set of facilities installed within a toll booth enable in this case a toll collector to charge the users and to collect the toll by means of bank cards, fleet and fuel cards and RFID proximity cards. At the same time this type of lane is equipped with the devices necessary to communicate with the OBUs installed within vehicles.

ETC users have in this case to stop at the toll collection booth in order for the toll collector to clear the transaction. The toll collector then raises the exit barrier. A lane typology sign, installed on the canopy above the lane entrance, indicates to the road user the characteristic of the lane and in particular the type of payment means supported.

All categories of vehicles will be allowed to make use of OBUs (either Pre-Pay or Post-Pay) within this kind of lane.

The “Stop & Go ETC dedicated” toll lane is a lane by which users may pay the toll by means of ETC only (both Pre-Pay and Post-Pay OBU, automatic number plate recognition) stopping for a very short moment.

Each “Stop & Go ETC dedicated” lane is equipped with devices enabling fast and safe toll collection after the vehicle stops at the toll booth. The lane architecture is therefore provided with to communicate with the OBUs that are installed within vehicles, to validate the payment by means of OBUs and to handle all kind of exceptions. The vehicle category is determined by the toll collector or alternatively by a set of devices necessary to pre-classify the vehicles.

A lane typology sign, installed on the gantry in front of the lane entrance, indicates to the road user the characteristic of the lane and in particular the type of payment means supported.

4.2 System architecture

The provision of the ETC services is based on an articulated system including the following components:

- the roadside equipment, i.e. the equipment installed on the toll lanes and providing for the management of the transit of the ETC user (in both nominal and degraded mode);
- the toll plaza equipment, i.e. the equipment installed within each of the toll plazas and enabling SAM (and in particular the company operating the tolling system on its behalf) to monitor the operational status of the ETC system and to handle all exceptions;
- the central system, including all the data processing modules supporting the collection and management of the toll transactions, the issuing of payment means, the management of the customer relations, the interfaces towards the service providers and the payment handling providers and other support services;

- the accounting system, based on the IMPULS 5 system, maintaining and updating all financial information for the whole toll facility operation.

The following scheme outlines the different components of the system.

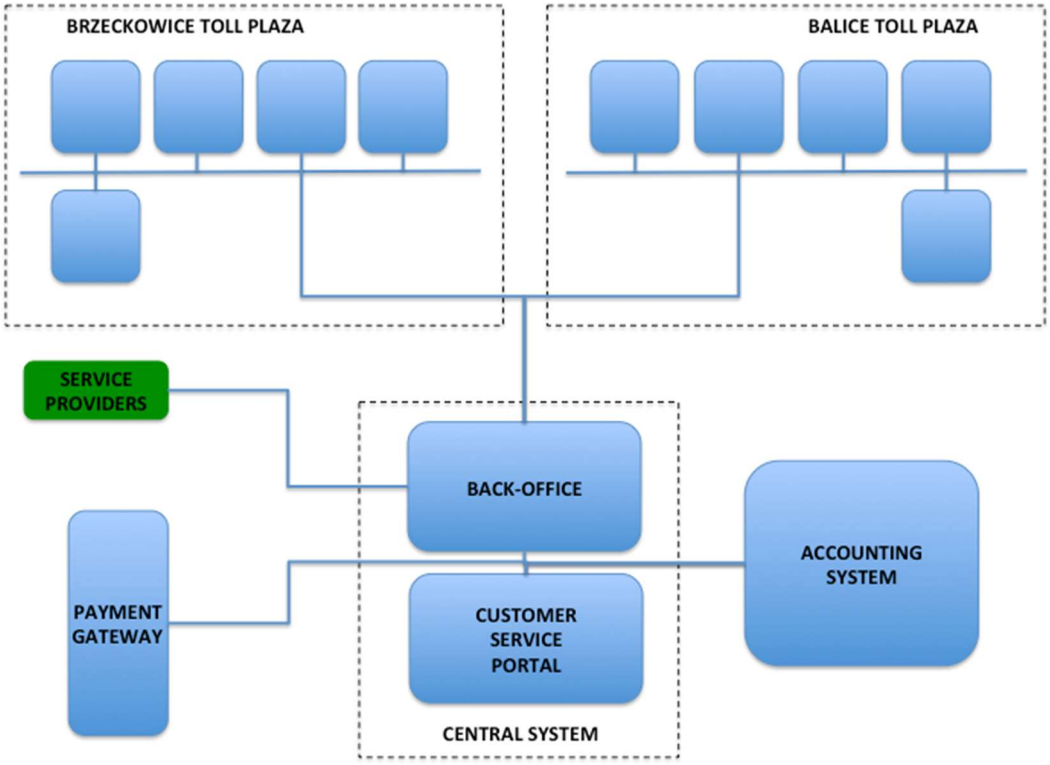


Figure 1: Overall System Architecture

All the centralised components of the system are based on a redundant architecture, with a Primary and a Disaster Recovery site located within the supervisory buildings of respectively the two toll plazas of Brzeckowice and Balice.

4.3 ETC lanes architecture

The configuration of the toll plazas of Brzęczkowice and Balice includes two types of lanes:

- the Manual + ETC “Stop & Go” toll lane;
- ETC “Stop & Go” toll lane.

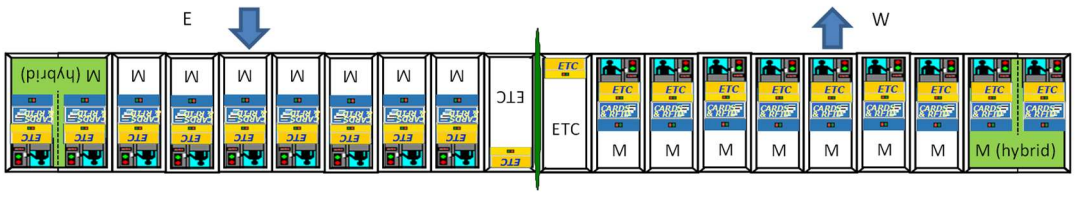


Figure 2: Configuration of the Brzeczkowice toll plaza

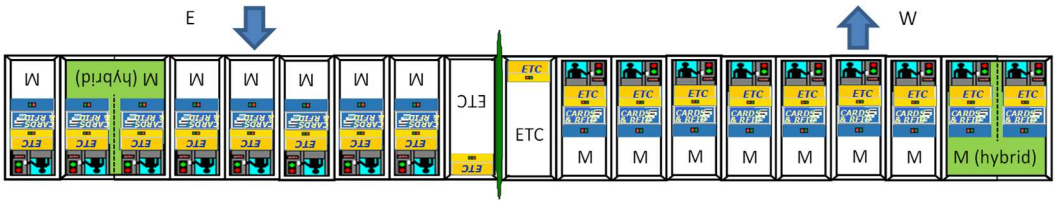


Figure 3: Configuration of the Balice toll plaza

The Manual + ETC "Stop & Go" toll lane is a lane by which users may pay the toll by means of both ETC and more traditional payment means, such as those typically accepted within the manual lanes.

Each Manual + ETC "Stop & Go" lane is equipped with devices enabling fast and safe toll collection after the vehicle stops at the toll booth. The lane architecture is provided with the device necessary to communicate with the OBUs that are installed within vehicles.

ETC users have to stop at the toll collection booth in order for the toll collector to clear the transaction. The toll collector is responsible to define the vehicle category and then, once the transaction has been correctly completed.

A lane typology sign, installed on the gantry in front of the lane entrance, indicates to the road users the characteristic of the lane and in particular the type of payment means supported.

All categories of vehicles are allowed to make use of OBUs (either Pre-Pay or Post-Pay) within this kind of lane.

The "Stop & Go ETC dedicated" toll lane is a lane by which users may pay the toll by means of ETC only (both Pre-Pay and Post-Pay OBU, automatic number plate recognition) stopping for a very short moment.

Each "Stop & Go ETC dedicated" lane is equipped with devices enabling fast and safe toll collection after the vehicle stops at the toll booth. The lane architecture is therefore provided with to communicate with the OBUs that are installed within vehicles, to validate the payment by means of OBUs and to handle all kind of exceptions. The vehicle category is determined by the toll collector or alternatively by a set of devices necessary to pre-classify the vehicles.

A lane typology sign, installed on the gantry in front of the lane entrance, indicates to the road user the characteristic of the lane and in particular the type of payment means supported.

5 Operating Procedures

5.1 Introduction

This section provides a description of the functional behaviour of the tolling system, with particular attention to the processes that involve the Toll Charger and the EETS Provider and the relevant interfaces.

The following area of interests are detailed by the following sections:

- Exchange of toll-related parameters,
- Exchange of trust objects,
- Exchange of validation lists,
- Nominal vehicle's transit within the lane,
- Degraded vehicle's transition within the lane,
- Handling of toll violations,
- Exchange and validation of the toll transactions.

The schemes below outline shows the sequence of the above mentioned processes.

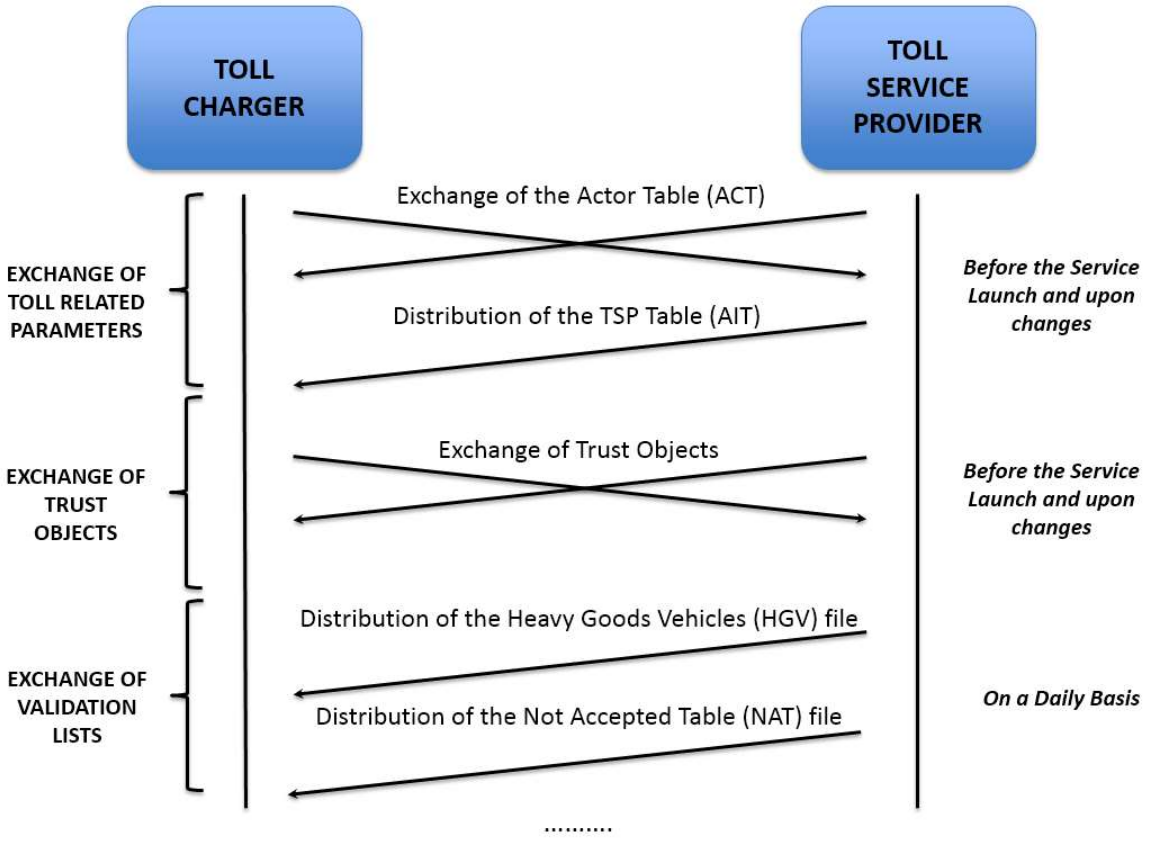


Figure 4: Operational flow and data exchange (part 1)

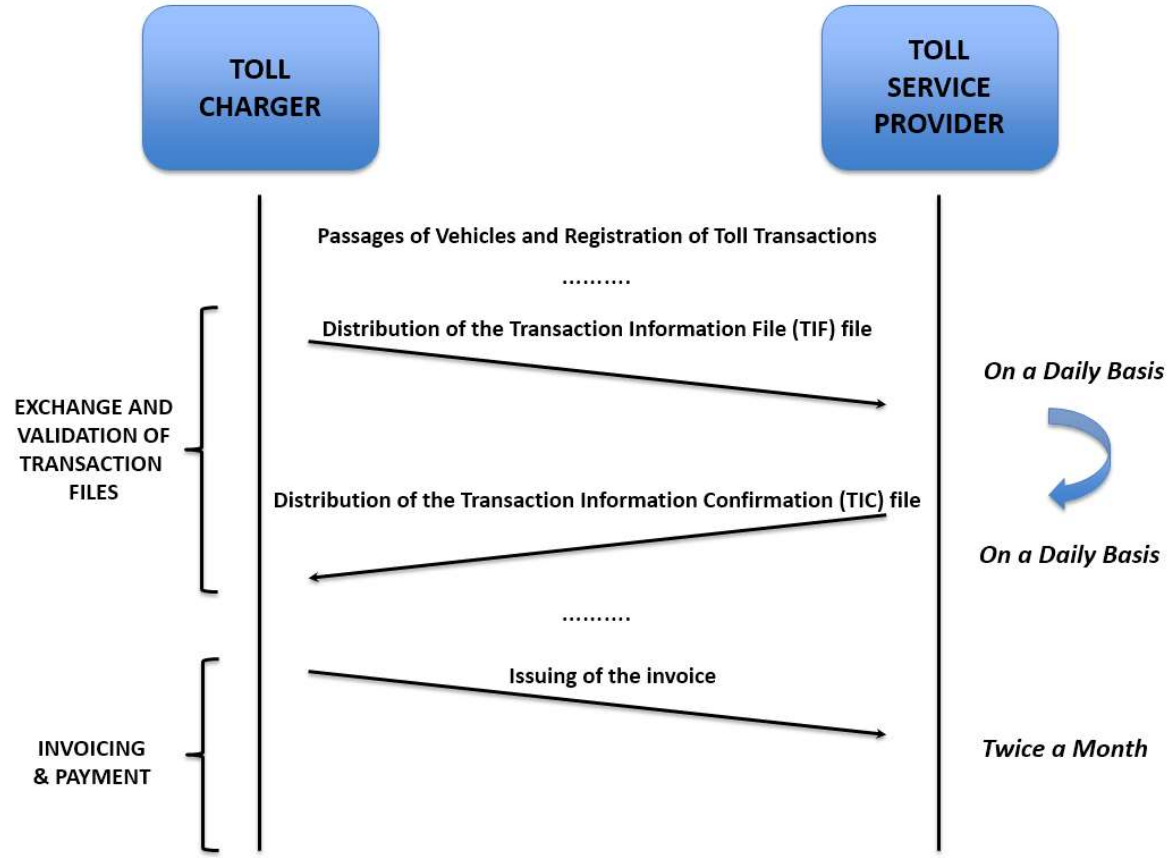


Figure 5: Operational flow and data exchange (part 2)

In the following sections are provided further details on the different steps constituting the processes.

5.2 Exchange of toll-related parameters

5.2.1 Generalities

In order to properly configure the systems of the Toll Charger and of the EETS Provider, a set of information shall be exchanged between the parties. This information constitutes the ETC context data.

Different files are exchanged between the Toll Charger and the EETS Providers before the launch of the service as well as where changes occur, in particular:

- the Actor Table (ACT);
- the Toll Station Table (TST);
- the TSP Table (AIT).

5.2.2 Actor Table (ACT) file

The ACT contains the information characterising of the actors involved into the system operation and in the provision of the electronic toll collection service, namely the Toll Charger and the Toll Service Provider. The content is also the basis for establishing the ledger accounts for the Toll Charger and the Toll Service Provider and invoicing of the use of the EETS services(s) to the service users.

This table shall be created by both the Toll Charger and the Toll Service Provider according to the detailed specification as provided within the chapter 10 of this document, and distributed to the other party in order to process any information. The ACT contains necessary data needed when processing other files types. The relevant ACT tables shall contain a unique identifier for the sender (ActorID) together with all contact and identification details.

The information concerning a specific actor can be sent either by mail or as an ACT file containing all the data of the sender. The receiving party shall verify the correctness of the structure and of the content of the ACT table and will report it to the sender, if applicable.

If the ACT data of a TSP changes, the process is initiated by sending an updated "local" Actor Table (ACT) to the interoperability interface of the Back-Office of SAM.

All changes shall result in a transfer of an updated Actor Table file to the relevant actors. The data in the Actor Table is used to verify that all partners are authorized.

Both the Toll Charger and the Toll Service Provider shall be able to implement the information from the ACT table in their central system interfaces according to the specification (e.g. to use VAT number, to create necessary debtor and creditor accounts, …).

5.2.3 Toll Station Table (TST) file

The TST contains a description of the charging points operated by the Toll Charger and it is used for the provision of human readable billing details to be provided to the users, so to allow the verification of the transaction points.

If the existing toll domain is changed (for example a new charging point is added) a process for updating the information by sending out a new TST is initiated by the Toll Charger (responsible for the toll domain). The Toll Charger shall update his Toll Station Table (TST) and distribute such "local" EFC context data by means of the interoperability interface of the its back-office system.

The distribution of the TST is not scheduled – meaning it will be sent only when changes of the charging points are reported by SAM. The data referring to the ActorID, the Station Code and Lane identification shall be unique.

The TSP shall be able to download the last valid TST from his Out/New folder. Any other previous correct version may be disregarded.

The TSP shall be able to implement the information by his interoperability interface according to the correct specification (e.g. to use the relevant data to produce a correct invoice to the Service Users, ...).

The TSP shall correct any errors in his own data by uploading a new updated "local" TST file to his In\Temp folder according to the schedule for data exchange and move it to his In\New folder initiating a new update procedure.

5.2.4 TSP Table (AIT) file

The TSP Table (AIT) contains the information regarding the On-Board Units (OBUs) accepted within the specific ETC toll domain and issued by a specific Toll Service Provider.

This table shall be created by the Toll Service Provider according to the detailed specification as provided within the chapter 10 of this document, and distributed to the Toll Charger. It shall contains the data characterising of all the OBUs that are allowed to be used on the toll domain, among those issued by the Toll Service Provider; the OBUs are in particular identified by means of their PersonalAccountNumber (PAN) and other elements of the context mark.

This information shall be sent as an AIT file to the Toll Charger. The receiving party shall verify the correctness of the structure and of the content of the AIT table and will report it by sending an alarm message to the originator of the file, if applicable.

All changes shall result in a transfer of an updated TSP Table file from the respective Toll Service Provider.

The Toll Charger shall be able to implement the AIT information in the central system according to the specification (e.g. to limit the accepted OBUs on the RSE, …). It shall ensure that only the OBUs listed within the AIT table will be accepted as valid payment means by the roadside equipment in the toll plaza.

5.3 Exchange of trust objects

5.3.1 Generalities

In order to ensure security in the data exchange between the interoperability constituents of the Toll Charger and of the Toll Service Provider, specific trust objects shall be exchanged between the parties before the launch of the service.

Both the Toll Charger and the Toll Service Provider shall generate and provide to the other party the necessary trust objects, among which the Public Key (by which decrypting messages encrypted by the corresponding Private Key) and – only in the case of the Toll Service Provider – the DSRC key to be used by the roadside equipment to interact with the OBUs.

Currently, the toll collection system uses Security Level 0. The requirements described below for being referred to Security Level 1 are given for the case of future system development.

For some types of OBUs, identified by specific EFC Context Marks, a Toll Service Provider (TSP) could require the handling of EN 15509 Security Level 1 on DSRC transactions on Toll Chargers' RSEs.

In such cases, the TSP will exchange the following trust objects with SAM Central System (CS) for those EFC Context Marks :

- the SAM Public key to be sent to TSP and used by him to Encrypt DSRC ion Master Keys before sending to SAM(MSmEncKey);
- the DSRC master keys:

- TSP's EFC Authentication Master Keys (EFC-MEAuKI1, EFC-MEAuKI2, EFC-MEAuKI3, EFC-MEAuKI4); used in Level 0;
- TSP's EFC Access Credential Master Key (EFC-MEAcK); used in Level 1

The following Fig. 6 outlines the key exchange process between the TSP and SAM (the Toll Charger "TC"):

1. a private/public couple of 2048-bit RSA keys is generated by the TC (SAM), who gets it a X.509 -certified by a Certification Authority;
2. the TSP receives the public key from SAM in an XML document, along with its X.509 certificate;
3. if the certificate, the public key and its validity period are positively verified, then the TSP encrypts the DSRC Master keys with SAM's public key, calculates the corresponding KVCs and sends them to SAM within an XML document;
4. SAM imports those keys into its own security modules (where they are decrypted with the private key, and KVC are verified).

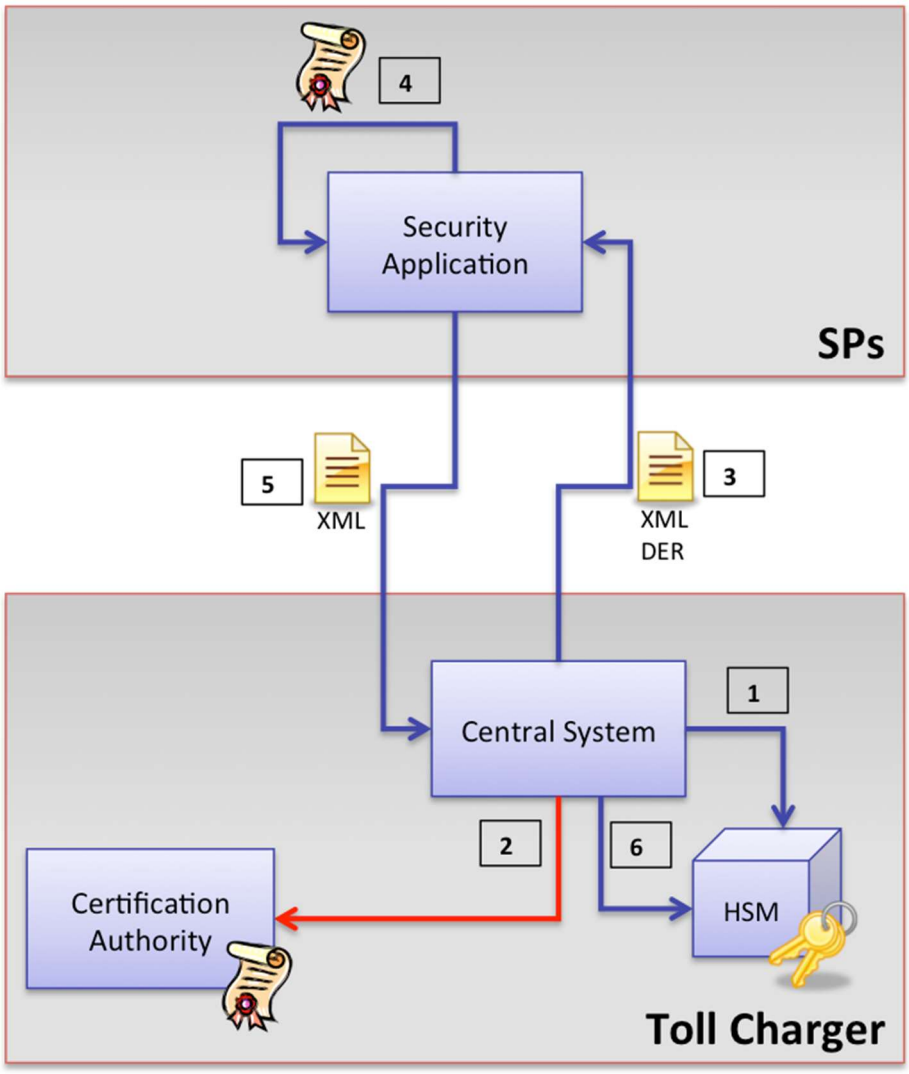


Figure 6: TSP Trust Objects Import Mechanism

5.4 Exchange of validation lists

5.4.1 Generalities

During the service provision, the Toll Service Provider shall distribute on a regular basis to the Toll Charger a set of validation lists to be used as a basis to validate the acceptability of a certain OBU (and the corresponding account) when detected by the roadside equipment in the toll lane.

These validation lists include:

- the Heavy Goods Vehicle (HGV) file, referred also to as White List;
- the Not Accepted Table (NAT) file, referred also to as Black List or Exception List.

5.4.2 Heavy Good Vehicle (HGV) file

The HGV file has the following purposes:

- to identify the OBU based on the licence plate on the HGV list when the OBU has not been read at the charging point (this will enable the Toll Charger to charge the user via his OBU instead of via his license plate, even if the OBU has not been read);
- to identify the responsible Toll Service Provider for a licence plate to request address data from him for an enforcement process.

This table shall be created by the Toll Service Provider according to the detailed specification as provided within the chapter 10 of this document, and distributed to the Toll Charger.

The file is constituted by a sequence of records, each one referred to a specific OBU. Each OBU is identified by a set of information that include:

- PersonalAccountNumber (PAN)
- OBU Identifier
- Vehicle's classification parameters
- Emission class
- License Plate Number

Upon reception, the Toll Charger shall validate each received HGV according to the general validation rules; the breach of these rules will result in either a total rejection of the HGV file or a partial rejection of the failing records, depending on the detected problem.

The Toll Charger shall produce a HGV confirmation file (referred to as HGC – HGV Confirmation) for each received HGV based on the result of the validations above and shall provide it to the originating Toll Service Provider.

If necessary, the Toll Service Provider shall initiate a proper error handling and correction process and then distribute a new and updated HGV file to the Toll Charger.

5.4.3 Not Accepted Table (NAT) file

The NAT (or non-accepted table) file contains the list of the contract identifiers of OBUs issued by the Toll Service Provider that are not valid on the toll domain operated by the Toll Charger. Each contract is identified by a Personal Account Number (PAN) of max 19 digits and by an OBU ID of 18 characters. The relation between the PAN number and the issuing Toll Service Provider is defined within the AIT file.

The Toll Service Provider generates periodically (usually daily but according to the agreed sending schedule) a NAT file, allowing the verification on the acceptability of the PersonalAccountNumber and/or OBU ID as read within the toll lanes (or in manual lanes if an extended mode procedure is applied).

The NAT file shall be distributed to the Toll Charger that replaces the existing NAT file in its system. For each PAN or OBE ID the action to be taken by the Toll Charger with respect to a specific PAN and/or OBU ID and the reason of non-acceptance is also included.

A NAT list is always transferred as a full update. Incremental updates are not used.

Each time a Toll Charger receives a new NAT file from the Toll Service Provider the structure and the content of the file are checked, to ensure that the general content and number of records are according to specification. If the Toll Charger detects any error both an alarm and an e-mail is sent to the Toll Service Provider.

In any case a confirmation file (NAC – NAT Confirmation) is produced and re-sent to the Toll Service Provider. This file contains the information on whether the file was accepted or if and where the failure has occurred.

Both these two files shall be provided by the Toll Service Provider on a daily basis, with the Toll Charger being required to distribute them towards the roadside equipment in the toll plazas and to activate them within a specific time limit.

5.5 Passage and toll transaction registration (nominal case)

The ETC road users, equipped with an OBU issued by the Toll Service Provider, shall be enabled to make use of the ETC toll lanes within the toll plazas of Brzeckowice and Balice, namely the so called “ETC Stop & Go” lanes identified by the marks and logos described within the chapter 6 of this document.

During the transit of the vehicle across the toll plaza, the following steps will be undertaken:

- the vehicle - upon which the OBU issued by the Toll Service Provider is installed – shall be classified and associated to one of the vehicle categories of the applicable tariff scheme;
- the OBU shall be detected by the roadside equipment and the necessary information retrieved and validated;
- the road user will confirm its willingness to make use of the detected OBU for the payment of the toll.

Each vehicle, independently from the payment means selected by the user, does access the lane and proceeds towards the toll booth where the vehicle is classified, a payment means is selected and validated, and where a toll transaction is registered.

A front picture of the vehicle is automatically taken when the vehicle approaches the toll lane. License plate number is automatically recognized by means of the ANPR mechanism integrated within the camera.

The toll collector, when a vehicle arrives, starts a new transaction, which is concluded once he pushes the executed payment button.

The vehicle's classification – according to the applicable tariff scheme - is performed directly by the toll collector within the booth. The content of the OBU will therefore not be used for vehicle's classification purposes. Once the toll collector enters the category, the amount due for the particular category of vehicle is displayed, then the system enables all the peripherals involved in the processing of the types of payment supported (namely the DSRC beacon) and the management of all the payment procedures the collector is responsible for.

As soon as the toll collector types in the vehicle category, the lane equipment activates a DSRC Beacon installed overhead on the canopy; the DSRC Beacon eventually detects the presence of an OBU installed on the windscreen of the vehicle (according the distributed user manual – installation requirements section) and reads out the content of the OBU in order to retrieve its identification and trigger the validation of the payment means against white and black lists.

The DSRC beacon establishes a communication with the OBU installed within the vehicle along with the EN 15509 standard (both security level 0 and 1 are supported). The DSRC beacon provides for the retrieval of the following attributes inside the OBU:

- EFCContextMark (attribute # 0)
- LicensePlateNumber (attribute # 16)
- EquipmentOBUId (attribute # 24)
- PaymentMeans (attribute # 32)

The user is allowed to decide whether using the OBU or other means to pay the toll; the toll collector is informed by the user of its decision and coordinates the validation of the selected payment means and the registration of the transaction.

In case the OBU has been detected and the specific data exchange has been completed within the toll lane, the roadside equipment validates the acceptance of the OBU as a valid payment means, on the base of the retrieved information and on the content of the white and black lists (properly updated in accordance with the latest received HGV and NAT files, and reports accordingly to the toll collector.

A user's information display panel indicates to the users all information concerning the toll transaction, in particular the typed-in vehicle category and the toll amount.

A transit lights (green and red) also indicates to the users whether the transaction has been positively completed or not, and whether is it allowed to leave.

In the case of successful payment, the system goes to a pending release status, disabling all payment peripherals and authorizing the user to leave the gate; in this case the transit barrier is raised and the transit light is switched to green. A toll transaction is registered and transferred to the back-office for further processing.

A post-classification unit, able to measure the number of axles and to detect the presence of the twin wheels, is integrated within the lane architecture, right after the

transit barrier; it provides for an offline verification on the behaviour of the toll collector. Such unit shall detect the actual vehicle's category, which should match the one typed in by the toll collector.

5.6 Passage in degraded mode and exception handling

The toll lanes supporting payment by means of ETC integrate specific operating procedures for the handling of all exceptions that may occur in such kind of environment, including the management of violations.

The lanes within the toll plazas where ETC services are provided to the road users operate on the assumption that a vehicle entering the lane is equipped with a valid and operational OBU, issued by a Toll Service Provider with whom interoperability agreements exist, that such OBU is correctly identified by the lane system and that the OBU is considered as valid and acceptable.

All situations that divert from such nominal case result in a vehicle being stopped within the lane, causing traffic congestion and requiring an intervention of the Operator for the management and the solution of the issue.

Exceptions handling and enforcement are key elements of any tolling operation, in particular for electronic toll collection schemes.

The system has been designed and implemented in a way:

- to maximise the number of vehicle's passages resulting in registered toll transactions;
- to provide users with alternative means of payment;
- to detect potential violators and provide the Employer and the Operator with means to manage them.

The following exceptional situations may occur on the ETC toll lane:

- a vehicle crossing the lane without being equipped with an OBU;
- a vehicle crossing the lane with an OBU issued by a provider with whom no interoperability exists;
- a vehicle whose driver refuses to pay the toll;
- a vehicle crossing the lane with a valid OBU that has not been registered by the lane;
- a vehicle crossing the lane with an OBU that is in black list;
- vehicles passing by tailgating.

The "Stop & Go ETC" (de facto "*Manual*" + "*Stop & Go ETC*") lane, as previously mentioned, is a manual lane where the user can proceed to the payment of the toll by means of a valid OBU in alternative to other more traditional payment means, with the toll transaction being performed and registered with the vehicle stopping by the toll collector inside the toll booth.

The specific business processes and procedures that shall be implemented for the handling of exceptions and of violations, with the dominant role of the Operator, are detailed here below.

- Vehicle passing without an OBU

Whenever a vehicle is passing through the lane without being equipped with an OBU, the lane does (obviously) not detect the presence of an OBU and therefore no ETC transaction may be occur in the "*ETC Stop & Go*" lane.

The user is offered with the possibility of paying the due toll by means of alternative payment means. The toll collector realizes that a payment by means of an OBU is not possible (as no OBU have been detected) and therefore offers the user with the possibility of paying the toll by one of the other accepted payment means (cash, debit card, credit card, fuel card, fleet card or RFID card).

In case no alternative payment means may be used by the road users, the Toll Collector prepares the form including personal data (i.e. name, ID number) as well as the vehicle information collected from the registration document and handle to the driver such form with all the collected information.

The form contains detailed transaction data and the toll amount to be paid that the driver must settle within a short period, through bank transfer to the Operator's bank account.

Moreover the vehicle is recorded by the CCTV system and the vehicle's number plate recognized via the ANPR camera.

The transit barrier is finally raised and the vehicle be let going.

- Vehicle passing with an OBU issued by a provider with whom no interoperability exists

The procedure should be used as in the case of a passage without an OBU.

- Vehicle passing whose driver refuses to pay the toll

If the driver refuses to pay, the Toll Collector prepares the form including the personal data (i.e. name, surname, address, ID number, ..) as well as the vehicle information collected from the registration document.

A form (payment refused) with all collected information is required to be signed by the driver. One copy of the receipt is for the driver, another one is prepared for the toll collector and used as basis for the reimbursement of the due amount.

The form contains transit details and the due amount.

Moreover the vehicle is recorded by the CCTV system and the vehicle number plate recognized via the ANPR camera.

- Vehicle passing with an OBU that is not registered by the lane

Even if the vehicle is correctly equipped with a valid OBU, it may happen that the OBU is not detected and recognized by the ETC lane system because:

- the OBU has a malfunction (e.g. low battery, ..),

- the OBU it is not properly installed (e.g. not in the valid area in the windscreen, ..).

As mentioned by the previous cases, the system does not register any toll transaction and therefore the vehicle is not allowed to pass by. In principle the user is offered with the possibility to pay the toll by means of alternative payment means (debit cards, credit cards, fuel cards, fleet cards or RFID cards). The user, interacting with the toll collector, may indicate and reinforce its intention to pay by means of the OBU installed within the vehicle.

In this case the system provides to register the vehicle's license plate number (by means of ANPR camera) and verifies whether the valid OBU associated to that specific vehicle. Such verification is performed on the base of the white list (HGV file) as provided by the relevant Toll Service Provider.

In case a valid OBU account is associated with that specific vehicle, the system allows registering the toll transaction on the base of the vehicle's license plate number, as if the OBU had been properly detected and recognized.

In case no valid OBU account is associated with that specific vehicle, the user is informed in situ by the toll collector and the same procedure detailed in the previous sections is implemented.

In both cases, the transit barrier is finally raised and the vehicle be let going at the end of the procedure.

➢ Vehicle passing with an OBU in black list

Whenever an OBU is detected within the passing vehicle, the lane equipment verifies its validity against a black list that is maintained within the lane equipment and regularly update on the base of the information provided by the different OBU issuers (namely the NAT file as distributed by the Toll Service Provider).

The OBU's_identifier, as retrieved by reading the content of the OBU itself, is verified against the actual content of the Black List, in order to verify whether the OBU is acceptable or not.

OBUs whose identifier will not be found being part of the Black List are accepted as a valid payment means, provided that the same OBU identifier is part of the White List.

In case it is detected to be part of the Black List, the OBU cannot be accepted as a valid means of payment and the toll collector proposes the user to proceed to the payment of the toll with alternative payment means, as for the above-referred case of "Vehicle passing without an OBU".

➢ Vehicle passing by tailgating

In the case of a tailgating violation, the toll collector is responsible for registering the additional transaction (for the vehicle that escaped) that will be the basis for the reimbursement of the amount due. This additional transaction is registered without opening the barrier and a fiscal ticket is printed.

The vehicle is recorded by the CCTV system and the vehicle number plate recognized via the ANPR camera.

Moreover the system stores the information about the reason of the payment default of the transaction (transaction in the mode of the payment obligation, transaction in the mode of payment refused, or the transaction in the mode of the tailgating violation).

5.7 Exchange and validation of transaction files

5.7.1 Generalities

The toll transactions that have been performed by using OBUs issued by the Toll Service Provider shall be collected within the back-office of the Toll Charger and transferred to the Toll Service provider on a daily basis.

Toll transactions shall be transferred by means of the following file:

- Transaction Information File (TIF)

5.7.2 Transaction Information File (TIF)

The Transit Information File (TIF) contains the information concerning the toll transactions performed by the road users on the toll facilities managed by the Toll Charger. All transactions stored in the system of the Toll Charger which can be connected to a Toll Service Provider based on the field “Actor ID of TSP” in the transaction record, will be transferred via TIF file towards the Toll Service Provider.

The Toll Charger shall generate one TIF file for each Toll Service Provider for all transactions between the roadside equipment of the Toll Charger and the OBU issued by the Toll Service Provider. The Toll Charger shall claim periodic payments from the Toll Service Provider for those transactions.

In case of both Debit and Credit transactions to a Toll Service Provider, these transactions shall be divided into two separate transaction list to be sent to the Toll Service Provider. A list shall only contain transactions in the same currency. Each transaction file shall contain only one transaction list in the file.

Each time a Toll Service Provider receives a new TIF list from the Toll Charger, the structure and the content of the file are checked and a confirmation list (Transits Information Confirmation or TIC) is produced and sent back in a file. Each TIF list shall be confirmed by exactly one TIC list. This file also contains the transactions, which are refused by the Toll Service Provider. Each TIF list shall be confirmed by one and only one TIC list.

6 ETC Lane Identification

An appropriate signing strategy has been defined and agreed with the GDKKiA in order to allow each of the customers to understand which lanes support the electronic tolling service (ETC) and for which categories of vehicles.

The generic signs indicating the possibility to perform the ETC transaction within a lane is the following:

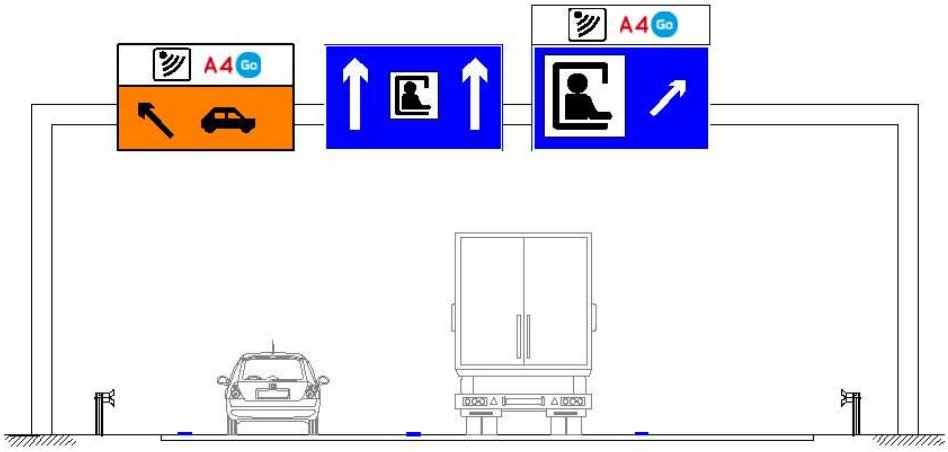
This sign has been used for the development of the specific signage installed above each lane access.

The specific signs indicating the ETC dedicated lanes:

1) Dedicated for cars:

2) Dedicated for cars and trucks:

The location of the ETC dedicated lane on the toll plaza is also indicated by following signs on the gantries located at the approaches to the toll plaza, as indicated by the following picture:



Such vertical signage are intended to help customer to identify the positioning of the relevant lane within the toll plaza and therefore to move their vehicles on the right side of the carriageway.

7 OBU Requirements Specification

7.1 Introduction

The scope of these specifications is primarily for use within the A4 toll domain in Poland, but it is intended also to enable the interoperability with the European Electronic Toll Service - EETS.

It should be emphasized that this section only specifies the overall principles and requirements for technical interoperability of the On Board Equipment (OBU) with the Road Side Equipment (RSE). To enable implementation of the individual EFC-application the detailed specification of these applications must be included.

All vehicles equipped with a valid OBU (an OBU emitted by a certified EETS Provider and having a valid contract) are able to realize ETC transaction.

When an OBU enters the communication zone of the beacon it is awakened (normally it sleeps to increase the battery lifetime) and responds by transmitting its credentials (who am I, who has issued me etc.).

The communication between OBU and RSE must be completed within a limited time while the vehicle is inside the communication zone of the beacon.

The interoperable EETS OBU, by the selection of the right EFC application profile, should be able to perform ETC transactions in conformity to the specific requirement of the system (A4 toll domain transaction model requirement).

This section shall provide a detail of the functional and technical requirements to be fulfilled by the OBUs distributed by the EETS Provider (intended to be used on the concerned toll domain).

7.2 Data sets in OBU

All the data elements used in the communication between RSE and OBU are compliant with the EN ISO 14906 standard. These data, also called attributes, shall be defined and initialized during the personalization process of the OBU.

Attributes are addressed by means of the Attribute ID identifier (AttrID). The list of attributes used in the frame of the A4 toll domain is provided by the table below.

Both Security Level 0 and Security Level 1 mechanism are supported.

Attribute ID		**EFC Application**
Attribute Name	**ID**	
Contract (*Information associated with the service rights of the TSP of the EFC service)*		
EFC Context Mark	0	Yes
Vehicle (*Identification and characteristics of the vehicle*)		
Vehicle License Plate Number	16	Yes

Equipment (*Identification of the OBU and general status information*)		
Equipment OBE ID	24	Yes
Equipment Status	26	Yes
Payment (*Data identifying the Payment means and its validity*)		
Payment Means	32	Yes
Receipt (*Financial and operational information associated with a specific session*)		

Table 1- EFC list of used attributes

This document contains a summary description of some of the most essential data elements involved in the communication. These elements are shortly described in the following:

- Vehicle Service Table: The Vehicle Service Table (VST) is a data structure that is sent by the OBU in the initialisation phase of a DSRC communication.
- EFC-ContextMark: According to CEN standard EN ISO 14906 a contract is identified by the *EFC-ContextMark* that is contained in the VST. The EFC-ContextMark is used to select the EFC Application – and thereby the protocol - to be used in the communication. The *EFC-ContextMark* contains the following elements:
- ContractProvider: The element *ContractProvider* identifies the OBU issuer (TSP). Each TSP has been assigned a unique identifier that consists of a country code and a number that is assigned nationally and unique in Europe. The *ContractProvider* identification system is defined according to EN ISO 14816. In other words, the EN ISO 14906 base standard has indirect references to the EN ISO 14816 on numbering and data structures.
- TypeOfContract: *TypeOfContract* is the element that identifies certain contractual that is available with each TSP's *ContractProvider* data. This element must be in accordance with content of OBU stated by the OBU issuer.
- ContextVersion: *ContextVersion* identify certain technical choices available with each TSP's *ContractProvider* data and in accordance with content of OBU stated by the OBU issuer.
- PersonalAccountNumber: "*PersonalAccountNumber*" or PAN is the attribute used to identify the OBU account. The *Payment Means* attribute (ID = 32) contains such information.

The RSE must be able to select the correct attribute depending on the protocol to be selected.

7.3 Response times

The OBU must be able to communicate correctly and reliable with the beacon for vehicle speeds from 0 to 240 km/h, even under multilane free flow conditions. A precondition for this requirement is that the roadside equipment does not limit the communication sequence.

7.4 Environmental and physical requirements

The OBU shall comply with EMC directive 2014/30/EU (formerly 2004/108/EC) with subsequent amendment and guidelines.

The OBU should have a function for setting a flag for "low battery" when the battery is subject to discharge. This status flag may be reported to the RSE in the subsequent transactions.

With regards to size and weight, the OBU shall be compliant with regulations 661/2009 and ECE-R21 wherever relevant.

7.5 DSRC Interface

7.5.1 Generalities

The TS must be conform to the standard EN 15509, this implies compliance with the relevant DSRC standards for Profiles, L1, L2 and L7 as detailed elsewhere in the document.

Compliance to the GSS specification is also required (e.g. state transitions) must be processed compliant to the GSS specification and to the standard EN 15509 by TS.

Furthermore it is pointed out that TS shall be compatible with OBU both with and without slow response.

7.5.2 Layer 1

Downlink and Uplink Parameters are given in Table 5 and Table 6 below respectively. All 4 downlink channels shall be supported (D1).

Table 5 - Layer 1, Downlink Parameter

Item No.	Parameter	Value(s)	Remark
D1	Carrier Frequencies	Downlink channel 1: 5,7975 GHz Downlink channel 2: 5,8025 GHz Downlink channel 3: 5,8075 GHz Downlink channel 4: 5,8125 GHz	
D1a	Tolerance of Carrier Frequencies	within ± 5 ppm	-

D2	RSU Transmitter Spectrum Mask	1) Out band power: see ETSI EN 300674-1 2) In band power: ≤ +33 dBm 3) Unwanted emission for unmodulated carrier wave shall be less than: Co-channel uplink at 1,5 MHz: ≤ -27 dBm in 500 kHz. Co-channel uplink at 2,0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -47 dBm in 500 kHz. 4) For in-band unwanted emission with modulated carrier wave, class C is to be used: ***Class C:*** Co-channel uplink at 1,5 MHz: ≤ -27 dBm in 500 kHz. Co-channel uplink at 2,0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -47 dBm in 500 kHz.	Class A should not be used in new installations. Equipment complying with the different classes will result in different re-use distances.
D4	Maximum E.I.R.P.	+33 dBm	**-**
D4a	Angular E.I.R.P. mask	Q ≤ 70°: ≤ +33 dBm Q > 70°: ≤ +18 dBm	Perpendicular to road surface
D5	Polarisation	Left hand circular	-
D5a	Cross-Polarisation	XPD: In bore sight: RSUt ≥ 15 dB At -3 dB area: RSUt ≥ 10 dB	
D6	Modulation	Two level amplitude modulation.	—
D6a	Modulation Index	0,5 ... 0,9	—
D7	Data Coding	FM0 "1" bit has transitions only at the beginning and end of the bit interval. "0" bit has an additional transition in the middle of the bit interval compared to the "1" bit.	
D8	Bit rate	500 kbit/s	—
D8a	Tolerance of Bit Clock	better than ± 100 ppm	—
D9	Bit error ratio for communication	≤ 10-6 when incident power at OBU is in the range given by [D11 a to D11b].	
D11	Communication zone	Spatial region within which a bit error ratio according to D9 is achieved	—
D12	Cut-off power level of OBU	-60 dBm	Applicability of this parameter is subject to profiles and sets defined in EN 13372
D13	Preamble	Preamble is mandatory.	—

D13a	Preamble Length	16 bits ± 1 bit	—
D13b	Preamble Wave form	An alternating sequence of low level and high level with pulse duration of 2 µs. The tolerance is given by D8a	
D13c	Trailing Bits	The RSU is permitted to transmit a maximum of 8 bits after the end flag. An OBU is not required to take these additional bits into account.	

Table 6 - Layer 1, Uplink Parameter

Item No.	Parameter	Value(s)	Remark
U1	Sub-carrier Frequencies	The RSU shall support both 1,5 MHz and 2,0 MHz	
U1a	Tolerance of Sub-carrier Frequencies	within ± 0,1%	-
U1b	Use of Side Bands	Same data on both sides	-
U5	Polarisation	Left hand circular transmitted when left hand circular received	-
U5a	Cross Polarisation	XPD: In bore sight: RSUr ≥ 15 dB At -3 dB: RSUr ≥ 10 dB	-
U6	Sub-carrier Modulation	2-PSK Encoded data synchronised with sub-carrier: Transitions of encoded data coincide with transitions of sub-carrier.	-
U6b	Duty Cycle	50% ± α, α ≤ 5%	-
U6c	Modulation on Carrier	Multiplication of modulated sub-carrier with carrier	-
U7	Data Coding	NRZI	-
U8	Bit Rate	250 kbit/s	-
U8a	Tolerance of Bit Clock	Within ± 1000 ppm	—
U13	Preamble	Preamble is mandatory	—
U13a	Preamble Length and Pattern	32 µs to 36 µs modulated with sub-carrier only, then 8 bits of NRZI coded "0" bits.	
U13b	Trailing Bits	The OBU is permitted to transmit a maximum of 8 bits after the end flag. A RSU is not required to take these additional bits into account.	

7.5.3 Profiles

Table 7 below specifies the DSRC Profiles (0 and 1) that, according to the EN 13372 standard, shall be supported.

Table 7 - Profiles

Parameter		Profile 0	Profile 1

D12	Cut-off power level of OBU	-60 dBm	-60 dBm
U1	Sub-carrier Frequencies	1,5 MHz	2,0 MHz
U4a	U4a Maximum Single Side Band E.I.R.P. (bore sight)	-21 dBm	-21 dBm
U12a	Conversion Gain (lower limit)	1 dB for each side band Range of angle: Circularly symmetric between bore sight and ± 35°	1 dB for each side band Range of angle: Circularly symmetric between bore sight and ± 35°
U12b	Conversion Gain (upper limit)	10 dB for each side band	9 dB
N1	Length of private link address (LID)	4 Byte	4 Byte
N2	Maximum number of octets in frame in downlink window	128 Byte	128 Byte
N3	Maximum number of octets in frame in private uplink window	128 Byte	128 Byte
N4	Maximum number of octets in frame in public uplink window	9 Byte	9 Byte
N5	Number of simultaneously allocated public uplink windows	3	3
N8	Max value for „Random Delay Counter“	3	3
N12	Max private medium response time	1	1
T1	Minimum uplink to downlink turn around time	32 µs	32 µs
T2	Minimum downlink to downlink window time	0 µs	0 µs
T3	Downlink to uplink turn around time	160 µs	160 µs
T4a	Maximum time to start of transmission in private uplink window	320 µs	320 µs
T4b	Maximum time to start of transmission in public uplink window	32 µs	32 µs
T5	Time duration of public uplink window	448 µs	448 µs
N13FE	Acknowledgement time for RSE	1	1
N13ME	Acknowledgement time for OBE	1	1

7.5.4 Layer 2

The TS shall conform to EN 12795 standard and to the GSS specification. Supported frame combinations for Downlink is given in Table 8 and for Uplink in Table 9 below.

Table 8 - Supported combinations for Downlink

No	LID	MAC	LLC	APDU	Remark
1	Private	20/28	None	None	Private Uplink Window Allocation
2	Broadcast	A0	03	INIT.request (BST)	Broadcast UI command with window allocation
3	Private	80	03	SET. request, mode = 0 ACTION. request, mode = 0	Private UI command no window allocation
4	Private	80	03	EVENT_REPORT. request (RELEASE), mode = 0	Private UI command no window allocation

5	Private	A0/A8	67/E7	SET. request, mode = 0 ACTION. request, mode = 0	Private AC command mit p = 0 with window allocation
6	Private	A0/A8	77/F7	GET. Request SET. request, mode = 1 ACTION. request, mode = 1	Private AC command mit p = 1 with window allocation

Table 9 - Supported combinations for Uplink

No	LID	MAC	LLC	LLC status	APDU	Remark
1	Private	60	None	None	None	Private Uplink Window Req. (in public uplink window only)
2	Private	C0	03	None	INIT.response (VST)	Private UI command no window request
3	Private	C0	03	None	GET. response, SET. response, ACTION. response	Private UI command no window request
4	Private	D0	67/E7	40	None (APDU not requested)	Private ACn response f = 0 no window request
5	Private	D0	77/F7	30	None (APDU not available)	Private ACn response f = 1 no window request
6	Private	D0	77/F7	00	GET. response, SET. response, ACTION. response	Private ACn response f = 1 no window request

7.5.5 Layer 7

The TS shall conform to EN 15509 standard (this implies indirect reference to EN 12834), implementation shall follow the GSS specification, as applicable. The following T-APDU are supported:

- Initialisation
- Get
- Set
- Action
- Event-Report

According to EN 15509 standard the following DSRC layer 7 features shall be supported:

- **Concatenation** of multiple consecutive T-APDU fragments in one L2 frame (i.e. LLC-service) with and without chaining, if the size constraints for the LLC-frames are not violated (i.e. fit into 1 L2 frame);
- **Fragmentation** header length: 1 octet;

Valid combinations of APDUs are listed in EN 13372 standard.

7.5.6 Application Interface for EFC

Table 10 below specifies the EFC Functions that are supported according to EN 12834 and EN ISO 14906 standards as Actions:

Table 10 - Action Functions

Name	Action Type	Action Parameter	Response Parameter	Remarks
Get_Stamped	0	GetStampedRq	GetStampedRs	Retrieves data with an authenticator from the OBE
Get_Instance	4	GetInstanceRq	GetInstanceRs	Retrieves a number of entries out of an attribute's multiple instances
Get_Nonce	6	-	Octet String	Reads a random number generates by OBU Optional, not used in the system
Set_MMI	10	SetMMIRq	-	Invokes an MMI function (e.g. signal Ok via buzzer)
Echo	15	Octet String	Octet String	OBU echoes received data

The AccessCredentials parameter is supported in the following functions:

- Get
- Get_Stamped
- Get_Instance
- Set

The data field EFC-ContextMark is supported.

Due to ambiguities in previous versions of the standards the TS shall send SET_MMI.request command with ActionParameter (Container Type) "0" ("Integer") as well as "45"(hex)/"69"(dec) depending on the corresponding entry in the TSP List.

7.5.7 Security features

The DSRC transaction integrates the following security features, as specified by the EN 15509 standard:

- Transaction counter, increased by the RSE, allowing detection of transaction sequencing anomalies in the Central System.
- Authentication to the TSP, i.e. challenge-response of PaymentMeans data using the GET_STAMPED function with the TSP Key
- Authentication towards SAM (the TC), i.e. challenge-response of PaymentMeans data using the GET_STAMPED function with the Operator Key (TC key)
- Protected access to the OBU data, through the implementation of Access Credentials. The Access Credential are not needed to access the OBU's data when Security Level 0 applies.

8 OBU Personalization, Configuration and Operating Data

8.1 Generalities

This section details the data content and the right use of this data for the personalization of the interoperable OBU for the use on the A4 toll domain in Poland.

The table below indicates the list of attributes by which each OBU should be – as a minimum – configured and personalized, in order to be accepted for the ETC service along the A4 motorway.

The addressing of the EFC system and application data shall conform to the rules defined EN ISO 14906:2011.

ATTRIBUTES (EID>0)	AttrId	Type	Length (bytes)	Read	Write	Remarks
CONTRACT						Information associated with the service rights of the Toll Service Provider (TSP=CI)
EFC Context Mark	0	32	6	Yes	No	Contains the TSP Identification (transmitted as part of the VST)
PAYMENT						Data associated with the Payment transaction.
PaymentMeans (including PAN)	32	64	1 4	Yes	No	Includes: • the Personal Account Number, including the Payment Means Issuer (identified by the IIN), • The PAN Expiry Date • The payment means Usage Control
VEHICLE						Information pertaining to the identification and characteristics of the vehicle.
EQUIPMENT						Information pertaining to the OBU.
EquipmentOBUId	24	56	5 (=4+1)	Yes	No	Length of EquipmentOBUID is fixed to 4+1 bytes as specified in EN 15509
RECEIPT						Information associated with a specific session, including both financial and operational data.

Table 2 - Overview of the OBU EFC application data

8.2 Attributes

The following sections provides a description of the attributes that will be processed along with the DSRC communication between the RSE and the OBU, and that therefore are to be personalized and configured within the OBU.

The EFC Attributes are used to transfer the EFC application-specific information and are composed of one or more data elements. To each EFC Attribute, an AttributeID is associated. The AttributeID enables to unambiguously identify and address an EFC Attribute.

8.2.1 Attribute 0: EFC-Context Mark

The EFC-ContextMark denotes a specific EFC context in the OBU, comprising the organization that issued the contract, the type of contract and the context version. EFC-ContextMark data is transmitted in VST as part of the Attribute EFC-ContextMark to

enable the RSU to select the suitable EFC application as well the appropriate OBU data element, if the OBU is presenting more data elements.

Data element	Definition	Mandatory/Optional
ContractProvider	Identifies the organisation that issued the service rights given in the Contract, i.e. the Toll Service Provider. Numbers shall be assigned on a national basis. It is outside the scope of this standard to identify the data that specify the service rights.	M
TypeOfContract	ContractProvider-specific designation of the rules that apply to the Contract. It allows for the determination of the tariff or designating the type of purse associated with the contract.	M
ContextVersion	ContextVersion denotes the implementation version of the concerned contract within the context of the given ContractProvider, value assigned at the discretion of the ContractProvider. The ContextVersion may also be used as a security key reference.	M

To differentiate test contracts and operational user contracts, different data are provided; differentiation in EFC-ContextMark for OBU from different manufacturers for the same TSP is required.

8.2.2 Attribute 16: VehicleLicensePlateNumber

This attribute is holding information about the vehicles license plate number (LPN) and the registering country. The usage is according to EN 15590 but more specific and limited in its scope. Claimed LPN of the vehicle, the length of the padded LPN is fixed to 14 octets (i.e. 17 octets including the country code, alphabet indicator, length determinant and the LPN). The LPN information always shall be padded with NUL characters after the last significant character to achieve the total length of 14. The LPN information can have up to 14 octets according to the EN 15509 standard, but for compatibility reasons only up to 10 octets can be used for identification, because in some systems only the first 10 octets will be processed after RSE.

EFC Attribute	Data element	Definition	Type
VehicleLicence PlateNumber	*VehicleLicence PlateNumber*	*Claimed licence plate of the vehicle*	*LPN*

In the personalization process, for the LPN attribute, shall be used only latinAlphabetNo1 and upper case letters, numbers (without any spaces and hyphens!). Non Latin-1 characters are to be coded as lower case letters applying a translation table acc. to ISO/DIS140906:2008.

8.2.3 Attribute 32: PaymentMeans

The attribute *PaymentMeans* incl. *PersonalAccountNumber*: Points to a user account held at the *ContractIssuer* (which is already known from the initialisation phase).

The account held at the issuer of the contract is identified through the personal account number. The personal account number points to exactly one customer account held with a Contract Issuer in Europe. The attribute PaymentMeans holds contract data as PAN, ExpiryDate and UsageControl.

EFC Attribute	Data element	Definition	Type	Length in octet	Value range	Mandatory / Optional
PaymentMeans	PersonalAccount Number	Coded according to financial institutions, it consists of the Major Industry Identifier (MII), the Issuer Identifier Number (IIN, including the MII), the account number and a check digit (calculated with the Luhn algorithm).; acc. to ISO7812	Personal Account Number	10		M
	PaymentMeans Expiry Date	Expiring date of payment means. Payment means expires at 24 h of PaymentMeans ExpiryDate.	DateCompact	2	[01.01.1990].. [31.12.2117]	M
	PaymentMeans UsageControl	Indicates issuer's specified restrictions on the geographic usage and services allowed for the applications	OCTET STRING (SIZE(2))	2		O

PaymentMeans ::= SEQUENCE {

personalAccountNumber PersonalAccountNumber,

paymentMeansExpiryDate DateCompact,

pamentMeansUsageControl OCTET STRING(SIZE(2))

}[1]

8.2.4 Attribute 24: EquipmentOBU ID

The EquipmentOBUId shall be a unique identification number assigned to OBU by the manufacturer during the production process.

[1] i.e.EN ISO 14906 extract

EFC Attribute	Data element	Definition	Type	Mandatory / Optional
EquipmentOBUId	EquipmentOBUId	Unique Identification number of OBE within the context of the associated manufacturer.	OCTET STRING	M

Table 3 - EquipmentOBUid

If the attribute EquipmentOBUId is shorter than 4 Byte (+1 Byte length indicator), it is right padded with 0'B to achieve the desired length of 4 Bytes before being inserted in the RSE's database.

ATTRIBUTES (EID>0)	AttrId	Type	Length (in octets)	Read	Write	Mandatory / Optional
EquipmentOBUId	24	56	5 (=1+4)	YES	NO	M

Table 4 AttrId24 of the OBU EFC application data

8.3 Operating and configuration parameters

8.3.1 ManufacturerId and EquipmentClass

Manufacturer identifier (ManufacturerId) and EquipmentClass are written by the manufacturer to the OBU and are included in the process of *Identification of OBU*. This information is submitted in VST (as showed after) and can be used at RSE e.g. to select transaction operating parameters suitable for this OBU.

Data element	Definition	Type	Value Range	Mandatory / Optional
ManufacturerId	Value assignment see ENV ISO 14816 Register of manufacturers.	INTEGER	*(0..32767)*	M
EquipmentClass	Shall be used to show different OBU versions from same manufacturer	INTEGER	*(0..65535)*	M
obeStatus	*obeStatus shall always be present. Bit nr 5 of the first octet may indicate the -- status of the battery: 0 indicates OK, 1 indicates low (xxxB xxxx'H)*	INTEGER	*(0..65535)*	O

8.3.2 SetMMI

The device-independent addressing mechanism uses a set of commands, which describe a certain functionality, which can be performed by various OBE components. The EN 14906, the operating system of the OBE will address the corresponding components. The EFC function SET_MMI supports this functionality.

SET_MMI is used to perform device-independent MMI functions.

SET_MMI.request shall request to control the MMI in a device-independent way. The *ActionParameter* shall contain the MMI function that is to be invoked, e.g. signaling of a successful operation (such as a successful EFC transaction), a non-successful operation or signaling to contact the operator.

In different versions of EN14906 different *ActionParameters* for SetMMI were defined. To retain compatibility with existing OBE (future OBE), in this operating environment the RSE may accept SET_MMI with any value of the EID, and with Container type = 69(dec).

8.3.3 Use of AccessCredentials

The access credentials are used in transactions, in order to protect against non-authorised access to sensitive user data and against (commercial) use of the OBU by not-authorised operators. *AccessCredentials* element shall be used to manage access to attributes. Different access conditions can apply for different attributes, and if so different access credentials should be associated with these access conditions.

8.3.4 KeyReferences

The key reference range for TSP Authenticator (CI authenticator, KeyRef to be used in the first GET_STAMPED.request) is 111 to 114. The key reference range for TC Authenticator (Operator authenticator, KeyRef to be used in the second GET_STAMPED.request) is 115 to 118.

9 DSRC Transaction

9.1 Introduction

This section shall provide the details of the interface between the RSE of the Toll Charger and the end-users OBUs emitted by the Toll Service Provider over the DSRC 5.8GHz link, including (among others) the transaction model, the sequence of exchanges between the peer entities, the security mechanisms and the detailed specification of the data elements (attributes) to be exchanged.

This specification provides the definition for the DSRC transaction used in the specific tolling context according to EN15509.

This specification applies for post-pay transactions, and in particular for the communication between OBU and the roadside tolling equipment installed within the toll lane facilities at the toll plazas operated by the Toll Charger.

In general, the transaction is based on the "pick what you like" idea, i.e. it is up to the toll charger to select which attributes must be read upon the passage of the OBU in order to allow correct charging. This section provides for an exemplary definition of the DSRC transactions to be implemented between the OBU issued by the Toll Service Provider and the RSEs in the A4 Katowice-Kraków toll motorway context.

9.2 Attribute overview

The following table provides an overview of the attributes involved in the data exchange performed over the DSRC interface between the RSE and the OBU at the tolling facilities along the A4 toll motorway in Poland, when using interoperable OBUs in the frame of the A4GO tolling context.

These are the attributes that are retrieved by the RSE when dealing with one of the OBUs that are accepted within the context.

ATTRIBUTES (EID>0)	AttrID	OBU
		Tolling
EFC Context Mark	0	X
LicensePlateNumber	16	X
EquipmentOBUId	24	X
PaymentMeans	32	X

9.3 Tolling DSRC transaction

Whenever a vehicle equipped with one of the OBUs issued by the Toll Service Provider, the RSE shall implement an articulated exchange with the OBU in order to retrieve data elements which are stored within the OBU and to analyse them with the object to validate the OBU, to calculate and apply a toll (depending on the km travelled in the tolling network and on the category of the vehicle) and to register the toll transaction.

As specified by the EN 15509 standard, the DSRC transaction shall be organised into four different phases:

Initialisation Phase

The initialisation phase can be seen as a switch where the RSE decides which path to follow. During the initialisation phase, the RSE and the OBU will exchange the messages referred to as Beacon Service Table (BST) and Vehicle Service Table (VST) in order to:

- indicate to the OBU the application (in this case an ETC application coded by an AID equal to "20") that the RSE wants to implement;
- verify whether the OBU is issued by a Toll Service Provider with whom the Toll Charger has an agreement;
- select the payment product to be used for the payment of the toll.

The RSE shall for this purpose issue a BST towards the OBU, indicating that the RSE supports a DSRC-based application identified by the Application Identifier "20" (i.e. an EFC application).

The OBU, under the assumption that it supports the EFC application, will reply to the RSE by sending back a VST containing:

- the EFC Context Mark, identifying the issuer of the OBU (referred to as Contract Provider) and other parameters that allows (under the sole responsibility of the TSP) to distinguish different types of payment products,
- the OBE Configuration, identifying the manufacturer of the equipment and providing indications on its actual operational status.

An OBU might in principle provide back a list of more EFC Context Marks, each one regarding electronic fee collection products for which he has an agreement with the issuer (e.g. a local and an interoperable product).

On the base of the information sent back from the OBU within the VST, the toll lane equipment shall decide whether such OBU is supporting at least a valid payment product, issued by a Toll Service Provider with whom an agreement with the Toll Charger exists. The content of the EFC Context Marks that will be accepted at the toll facilities is specified within the section 2 of this document.

If however, the RSE cannot accept one of the EFC contracts presented by the OBE, the transaction will be terminated. As no information regarding the identity of the user has been exchanged at this point.

The different EFC Context Marks will be verified against the information stored within the RSE; the RSE configuration will have been prepared on the base of the information received – among others – from the Toll Service Provider within the AIT file.

As long as at least one EFC Context Mark will be considered as acceptable, the lane will proceed to the next phase. Otherwise the lane will proceed directly to the Receipt Phase, by indicating the OBU of the fact that it has not be accepted as a valid means of payment.

Presentation Phase

In order to know which tariff to apply and which account to charge, the RSE requires some additional information from the passing OBE. The RSE obtains this information via

"read commands" sent over the DSRC link. During this phase, the RSE retrieves from inside the OBU the information that are required to identify the payment means (and therefore the account of the user) as well as the identification OBU and of the vehicle (namely the license plate number).

The payment means is identified by retrieving the attribute referred to as *PaymentsMeans*, that includes the *PersonalAccountNumber* (PAN) by which the TSP identifies the user account. This attribute is retrieved (as indicated by the EN 15509 standard) by means of the GET_STAMPED action but, in this particular case, without the associated authenticator being validated by the RSE.

At the same time, the RSE, by means of a GET action, retrieves during this phase:

- the OBU identifier, by means of *OBUEquipmentID* attribute,
- the vehicle identifier, by means of the *VehicleLicensePlateNumber*.

The OBU replies providing the required information.

These information are used to validate the payment means against the Black List (NAT) and the White List (HGV) if necessary. These information, together with the other information that are collected directly from the RSE (such as the date stamp, the vehicle category, the location and the tariff) are used to produce the transaction record.

Receipt Phase

During this phase the RSE provides the user with an indication about the result (positive or negative) of the transaction.

By invoking the SET_MMI_request action, the RSE send the indication to the OBU that translate this information to the user, on the base of the MMI characterising the OBU.

Closing Phase

This is the last phase of the process. The RSE, at the end of the transaction, close the transaction by invoking the EVENT_REPORT_request and releases the OBU.

This phase is optional as, depending on the size of the communication area as well as on the speed of the vehicle and on the way the OBU is installed, the OBU might leave the communication area before actually receiving this message. The OBU will in any case close the session after a pre-defined time.

The following table specifies the structure and the sequence of exchanges occurring between the RSE and the OBU at the tolling facilities along the A4 toll motorway, when using interoperable OBUs in the frame of the A4GO tolling context.

The following tolling transaction is performed at A4GO tolling stations for the purpose of charging the due A4G0 tolling fee.

Phase	*Roadside Equipment*		*On-board unit*	*Remarks*
	INITIALISATION.request (BST)	→		RSE sends BST.

Initialisation (BST – VST)		←	**INITIALISATION.response (VST)** ● EFC-ContextMark **(M)** ● AC_CR-KeyReference (optional) ● RndOBE (optional) ● obeConfiguration **(M)** -EquipmentClass -ManufactuteId -ObeStaus	A newly arrived OBE answers with VST. AC-CR-KeyReference is the reference to the Access Credential Keys to be used by the RSE in case of security Level1. RndOBE is a random number that the RSE uses when calculating the Access Credential in case of security Level1.
Presentation	**GET_Stamped.request** ● PaymentMeans, including Personal Account Number (RndRSE, KeyRef_CI) **GET.request** ● EquipmentOBUId ● LicencePlateNumber	→		Read PaymentMeans (including Personal Account Number) and request the OBE to calculate the CI authenticator Read EquipmentOBUId and LicensePlateNumber
		←	**GET.response**	OBU responds with the requested data
Receipt	**SET_MMI.request**	→		Signal the transaction result via the OBU's MMI. E.g. transaction = ok (Set_MMI code =0).
		←	**SET_MMI.response**	
Closing (optional)	**EVENT_REPORT.request (Release)**	→		RSE closes transaction and releases OBU.

10 EETS Back-Office Interface Specification

10.1 Introduction

This section of the document specifies the requirements to be fulfilled by the back-office infrastructures of SAM and of the TSP respectively along with the provision of the ETC interoperable service along the A4 motorway in Poland.

10.2 Overview of managed data files

10.2.1 Generalities

3 types of data files are basically exchanged between SAM and the TSP:

- Parameter lists
- Validity lists of users
- Transaction lists of users

In this section there is the description of the general rules for processing and validating the files. The format and semantics of these 3 types of data files are described in detail in another part of the document.

10.2.2 Parameter lists

The first type of data files that shall be managed and exchanged by the back-offices of SAM and of the TSP refers to as “Parameter Lists”; this category of data files include those data elements that are exchanged with the aim of properly configuring the system before the ETC is actually provided.

For the sake of the specific ETC service along the A4 motorway in Poland, this category of data files include:

- Actor Table (ACT…)
- Accepted OBU intervals from TSP (AIT…)

10.2.3 Validity lists of users

The second type of data files that shall be managed and exchanged by the back-offices of SAM and of the TSP refers to as “Validity Lists of Users”; this category of data files include those data elements that are continuously exchanged between SAM and the TSP in order to maintain a common information base upon the users that are allowed to make use of the service.

For the sake of the specific ETC service along the A4 motorway in Poland, this category of data files include:

- Black list (NAT...)
- Black list confirmation (NAC...)
- White list (HGV…)
- White list confirmation (HGC…)

10.2.4 Transaction lists of users

The third type of data files that shall be managed and exchanged by the back-offices of SAM and of the TSP refers to as "*Transaction Lists of Users*".

this category of data files include those elements that are continuously exchanged between SAM and the TSP in order to record (and further process) the toll transactions that have been registered.

For the specific ETC service along the A4 motorway in Poland, this category of data files shall include:

- Transaction Information File (TIF…)
- Transaction Information Confirmation (TIC…)

10.3 Overview of the data exchange process

10.3.1 Data exchange principles

Data exchange between SAM and the TSPs is based on an FTP transfer through an encrypted VPN tunnel. The public internet is used as the underlying communication media. The central systems of SAM and of the TSPs shall be connected to the Internet with the capacity and security architecture that is required to perform a smooth and secure operation.

An FTP HUB is used to exchange files between SAM and the TSP; on this HUB both SAM and the TSP have a dedicated area (with different directories) where files can be uploaded or downloaded.

SAM and the TSPs are responsible for delivering files to the In\New folder of the peer partner.

Transferring files to the FTP HUB shall be performed along this sequence of tasks:

- an actor (either SAM or a TSP) logs on to the FTP HUB with its username and password;
- the actor uploads any file he wishes to transmit to his own In/Temp folder;
- the actor moves the file to his own In/New folder when the upload is finished;
- the actor logs off from the FTP HUB.

On the other hand, retrieving files from the FTP HUB shall be performed along this sequence of tasks:

- an actor (either SAM or a TSP) logs on to the FTP HUB with its username and password;
- the actor downloads any file he wishes to retrieve to his own Out/New folder;
- the actor deletes the file to his own Out/New folder when the download is finished;
- the actor logs off from the FTP HUB.

Every time a file is received by either SAM or the TSP, the receiving partner is responsible to validate that the received file is correct and that it can be accepted.

The folder structure is as detailed by the following Fig. 7.

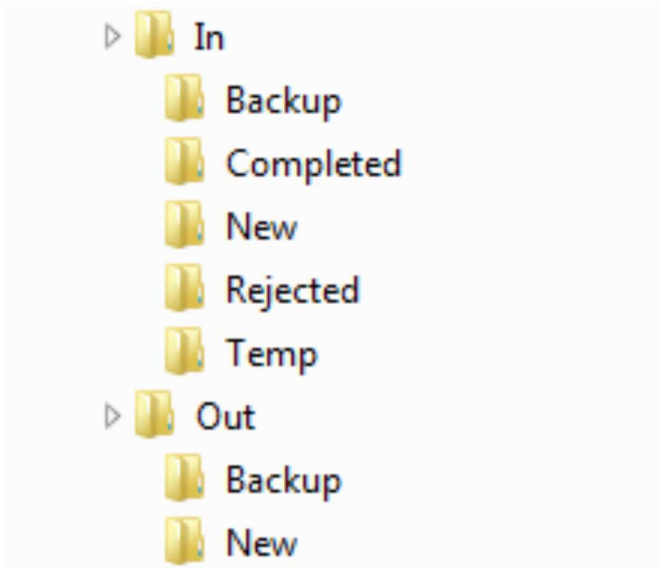


Figure 7: FTP HUB Folder Structure

10.3.2 Data exchange specification

The back-office supports a number of sub-interfaces to exchange data with all the TSPs, namely:

a. the exchange of toll declaration data between Toll Service Providers (TSP) and SAM (in particular, presentation and validation of requests for the payment of tolls on the basis of debit transactions performed via DSRC);

b. the settlement (SAM's periodic preliminary detailed payment claim reports are sent to TSPs, acceptance/dispute reports are correspondingly received and SAM's final payment claims are issued);

c. the exchange of information supporting the management of violations in DSRC systems (e.g., additional parameters for billing details, that are not stored within the OBUs; payment guarantee for an inferred object; compliance check communications to TSPs for monitoring and customer caring);

d. the exchange of TSPs' OBU blacklists and information on technical reliability of detected OBUs;

e. the exchange of Trust Objects;

f. the sending of Toll Context Data from SAM to TSPs (based on the CEN ISO/DTS 17575-3 standard, and including the definition of SAM's tolling domain, the nature of toll and levy principles, the liable vehicles for tolling, the vehicle classification parameters with their mapping into the Toll Charger's tariff structure, the required toll declarations).

The following table summarizes the flows between the TSP and SAM:

Table Acronym	Content Description	Sender	Receiver	Timing
AIT	Accepted Issuer Table	TSP	SAM	On Demand

Table Acronym	Content Description	Sender	Receiver	Timing
HGV	Heavy Goods Vehicle list (White list)	TSP	SAM	Daily
HGC	HGV Confirmation	SAM	TSP	Daily
NAT	Not Accepted Table (Black list)	TSP	SAM	Daily
NAC	NAT Confirmation	SAM	TSP	Daily
TIF	Transit Information File	SAM	TSP	Daily
TIC	TIF Confirmation	TSP	SAM	Daily

The Accepted Issuer Table (AIT) is generated by the TSP to inform SAM about the code identifiers of the issued OBUs which have to be accepted on SAM toll lanes. Since the content of this file change very rarely, the exchange may be manually performed whenever necessary.

The White list (HGV) associates the Personal Account Number (PAN) and the license plate to every single *valid* OBU: it allows the identification of the customer if any problem occurs in the communication between the OBU and the lane. According to a configurable schedule, the TSP shall upload (push) this list in the SAM Servers on a daily basis (e.g. every day by 21:00 at the latest).

The Black list (NAT) enumerates the contract identifiers of the TSP' OBUs which are not valid for use. For example, in this list an item can identify the OBU of a customer that is not interested to use it on the SAM toll domain, or a stolen/lost OBU. According to a configurable schedule, the TSM shall upload (push) this list in the SAM Servers on a daily basis (e.g. every day no later than by 20:00 at the latest).

SAM shall validate those files not later than 30 minutes after receiving them, generate the HGV confirmation file (HGC) and made it available in SAM Servers, ready to be downloaded by the TSP (pull).

Within a configurable deadline (e.g. by 06:00 at the latest), SAM shall:

- process the received HGV and NAT lists;
- store them onto the relevant database;
- prepare the lists to be dispatched to the lanes;
- send these to the lanes;
- ensure that all the lanes have activated them.

The Transit Information File (TIF) reports about the Debit or Credit transactions (as registered by SAM within the lanes) that shall be charged to the TSP. This file shall be generated and pushed onto the SAM servers on a daily basis, within a configurable deadline (e.g. no later than 06:00).

On a daily basis (e.g. not earlier than 06:30 and not later than 09:00), the TSP shall download these files (pull) and process them. The TSP shall then (e.g. by 09:30 at the latest) upload a TIF Confirmation file (TIC) to SAM servers for each of the TIF files. The TIC file lists the transactions that are rejected by the TSP, according to the agreements in force.

The TIF and TIC lists provide the basis for the calculation of the account statements from SAM to the TSP with the amount of toll due with regards to a specified period: the payment for the transactions takes place on the base of this account statement. It is important to note that the amounts in the TIF and TIC files are inclusive of VAT for services that are subject to VAT.

The earliest and the latest time by which the different files shall be exchanged are defined within the agreement between SAM and the TSP.

10.3.3 General validation rules

The general validation rules involve the following checks of each file received:

- File name shall be correct
- File name shall be unique (File has not been sent previously)
- List name to a specific recipient is unique (List not sent previously)
- File name and list header shall contain correct and authorized Actor IDs of originator and recipient
- Version information in header shall be either the current version or the previous version during transition time
- File header, body and footer records shall be syntactically correct according to the specific format definition
- The ActorID of the originator in the header record of the file shall be the same as the ActorID of the originator indicated in the file name
- The ActorID of the recipient in the header record of the file shall be the same as the ActorID of the recipient indicated in the file name (if applicable)
- The ActorID of the originator in the header record of the file shall be defined
- The ActorID of the recipient in the header record of the file shall be defined
- The field ”number of records” in the header shall be in accordance with the actual number of body records in the file
- The field ”Number of transactions” in the header of a TIF or TIC file is in accordance with the actual number of transactions in the body (only if the value in the header for the number of transactions is filled with a value different from 0)
- The Date and sequence number in header specified in the fields “List Sequence” and “Previous List Sequence” shall have a valid syntax. If it is detected that the previous list has not yet been received, the recipient shall issue a warning to the originator of the file. However, the file with the list shall be accepted and processed. If a TIF or TIC file out of sequence is processed at a later time, it will

not be rejected but will be processed. Any other file (especially NAT and HGV files) sent out of sequence will be rejected.

- The content of the field "PAN" is in an allowed range according to the current AIT (if applicable)

If the recipient detects an error during the general validation of a file according to the rules stated above it is rejected and an alarm message shall be sent to the originator of the file indicating the rejection of the file and the reason for the rejection.

In case of a HGV or NAT file, a corresponding HGC or NAC file shall be generated informing the originator about the rejection of the file and the reason for the rejection.

10.3.4 Actor specific validation rules

The responsibility for the correctness of files and their content is always placed on the originator. The procedures and rules of handling the files at the originator and at the recipient are different for each file type and are described below.

The format of each file name and list name is described in a later section of this document. In each section only the actor specific validation rules are described, which need to be performed by the actor in addition to the general validation.

10.4 Parameter tables

10.4.1 Introduction

The following procedures describe the handling of the ACT and of the AIT between the originator and the recipient.

10.4.2 ACT

The following procedure describes the handling of the ACT between the originator and the recipient.

- SAM and TSP shall report any changes in their data either manually by email or producing an ACT containing his own data;

SAM and TSP shall validate the data before providing it to the recipient according to the following validation rules:

  - The fields Currency 1 to Currency 4 shall be unique
  - All mandatory fields shall contain valid data according to the specification
  - All specified email addresses shall be verified (e.g. by sending a test email)
  - All specified phone numbers shall be verified (e.g. by placing a call)
- SAM and TSP shall provide a successfully validated ACT in his In\Temp folder or send the data by email to the recipient according to the foreseen schedule for data exchange;
- SAM and TSP shall move an uploaded ACT from his In\Temp folder to his In\New folder, when the upload is completed;

- SAM and TSP shall validate the correctness of the format and the content of their own data in the body records of the "global" ACT;

The following rules shall be applied during validation:

- All obligatory fields shall be filled according to the specified format version
- The number of characters in each field shall be according to the format description
- The fields Currency 1 to Currency 4 shall be unique
- All mandatory fields shall contain valid data according to the specification

Any breach of these rules has a total rejection of the ACT as a consequence

- The recipient shall move the ACT from the In\New folder of the originator to the In\Completed folder if the validation was successful;
- The recipient shall report any errors in the manually entered data or ACT by sending an alarm message to the originator and move it from the In\New folder of the originator to the In\Rejected folder;
- SAM and TSP shall be able to implement the information from the ACT in their central system according to the specification (e.g. to use VAT number; create necessary debtor and creditor accounts …).

10.4.3 AIT

The following procedures describe the handling of the AIT between the originator and the recipient.

- A TSP shall be able to produce an AIT according to the format version defined later in this document and upload it to his In\Temp folder of the recipient according to the foreseen schedule for data exchange;
- The TSP who initiated the update of the AIT shall validate the correctness of the format and the content and their own data in the body records of the AIT; the following rules shall be applied during validation:
  - all obligatory fields shall be filled according to the format version
  - the number of characters in each field shall be according to the format description
  - BIN (+ BIN ext.) + context mark shall be unique

  NOTE 1: The BIN field is obligatory. The BIN ext. field is optional. If not filled, the BIN + context mark shall be unique.

  NOTE 2: The BIN is the first 6 digits of the PAN number and is used to identify the TSP. The values in the optional BIN ext. field may be used to limit the interval of valid OBU from a TSP as an alternative to include it in the NAT list i.e. returned series of OBE or series of initialized OBE in stock if this is bilaterally agreed between SAM and TSP. The information in the BIN ext. field can be ignored by SAM if the use is not agreed.

- A TSP shall move an uploaded AIT from his In\Temp folder to his In\New folder, when the upload is completed;
- The TSP shall provide the new AIT according to the foreseen schedule in the Out\New folder of SAM;
- The recipient shall validate each received AIT according to the following validation rules in addition to the general validation rules:
  - The BIN (+ BIN ext.) + context mark shall be unique

  NOTE 1: The BIN field is obligatory. The BIN ext. field is optional. If not filled, the BIN + context mark shall be unique.

  NOTE 2: The BIN is the first 6 digits of the PAN number and is used to identify the TSP. The values in the optional BIN ext. field may be used to limit the interval of valid OBUs from a TSP as an alternative to include it in the NAT list (e.g. returned series of OBUs or series of initialized OBUs in stock) if this is bilaterally agreed between SAM and TSP. The information in the BIN ext. field can be ignored by SAM if the use is not agreed.

Any breach of these rules has a total rejection of the AIT as a consequence;

- The recipient shall report any errors in the AIT by sending an alarm message to the originator of the file and move it from the In\New folder of the originator to the In\Rejected folder
- The recipient shall move the AIT from the In\New folder of the originator to the In\Completed folder if the validation was successful
- The TSP shall correct any errors in his own data by uploading a new updated AIT file to his In/Temp folder on the recipient according to the foreseen schedule for data exchange and move it to his In\New folder initiating a new update procedure
- SAM shall be able to implement the information in the AIT in its central system according to the specification (e.g. to limit the accepted OBUs on the RSE …)
- SAM may ensure that only those OBU are accepted for transactions where the PAN is included in the BIN+BIN ext. range of the “global” AIT

10.5 Validity lists of users

10.5.1 NAT

The following procedures describe the handling of the black list (NAT) between the originator and the recipient and the shift of risk between SAM and the TSP in connection with them.

A NAT shall be sent whenever a TSP needs to revoke the payment guarantee for an OBU issued to a user. The conditions and the periods of time when the acceptance of an OBU within a toll regime are limited are solely in the responsibility of the TSP that issued the OBU. Any such decision to revoke the validity of an OBU leads to a new entry in a NAT;

A TSP shall be able to produce a NAT according to the specified format version and upload it to the In\Temp folder of the addressed recipient;

The TSP shall validate the correctness of the format and the content of the NAT; the following rules shall be applied during production:

- all obligatory fields shall be filled according to the specified format version
- the number of characters in each field shall be according to the format description
- the ActorID in the NAT shall be the same as the ActorID of the originator
- the ActorID in the NAT shall be defined
- the PAN and the context mark in the NAT shall be defined in the BIN (+ BIN ext.) + context mark fields in the AIT.

The TSP shall move an uploaded NAT from his In\Temp folder to his In\New folder, when the upload is completed.

SAM shall validate each received NAT according to the general validation rules; Any breach of these rules have a total rejection of the NAT as a consequence;

SAM shall additionally validate each received NAT according to the following validation rules:

- The PAN and the context mark in the NAT shall be defined in the BIN (+ BIN ext.) + context mark fields in the AIT; OTHERWISE the line is removed;

NOTE 1: The BIN field is obligatory. The BIN ext. field is optional. If not filled, the BIN + context mark shall be present

NOTE 2: The BIN is the first 6 digits of the PAN number and is used to identify the TSP. The values in the optional BIN ext. field may be used to limit the interval of valid OBU from a TSP as an alternative to include it in the NAT list i.e. returned series of OBU or series of initialized OBU in stock if this is bilaterally agreed between SAM and TSP. The information in the BIN ext. field can be ignored by SAM if the use is not agreed.

- The PAN and/or OBU ID shall be unique. In case of identical information one of the lines shall be removed from the NAT. In case of one PAN for two OBU IDs only the first line with of the duplicate entries shall be kept, the second line shall be removed. In case of two PANs for the same OBU ID both lines shall be removed before compiling the NAT.
- The PAN shall be within the range allowed by the AIT of the TSP and the number of digits shall be correct. If not, the line shall be removed.
- Any breach of these rules has a partial acceptance of the NAT as a consequence, where the lines that are non-conformant are removed before processing it further
- SAM shall move the NAT from the In\New folder of the originator to the In\Rejected folder if the validation led to a total rejection;
- SAM shall move the NAT from the In\New folder of the originator to the In\Completed folder if the validation was fully or partially successful;
- SAM shall produce a NAT confirmation file (NAC) for each received NAT based on the result of the validations above and shall provide it in the Out\New folder of the originator of the NAT;
- The TSP shall provide the new NAT according to the foreseen schedule for data exchange in the Out\New folder of the recipients;
- SAM shall be able to download the NAT from his Out\New folder according to the foreseen schedule for data exchange;
- SAM shall delete the NAT from his Out\New folder after the download;
- SAM may validate the correctness of the format and the content of the NAT; the following rules shall be applied during validation:

  - The NAT shall be delivered according to the foreseen schedule for data exchange
  - All obligatory fields shall be filled according to the specified format version
  - The number of characters in each field shall be according to the format description
  - No entries shall be present that should have been filtered according to the business rules of the A4GO domain
  - SAM may include a validation on the allowed change in the size of the NAT in his system and may stop the processing if the change in the size exceeds a certain limit
  - SAM may include a validation on the number of OBU blocks resulting from the processing of the NAT in his system and may stop the processing if the number of OBU blocks exceeds a certain limit
- SAM may report any errors in the file by sending an alarm message to the originator
- SAM shall activate the received NAT according to the foreseen schedule for data exchange defining the end of the grace period for SAM to block any blacklisted OBU; The liability for any toll transactions with blacklisted OBU is transferred from the TSP to SAM after the end of the grace period (i.e. the payment guarantee of the TSP ends).

10.5.2 NAC

The following procedures describe the handling of the black list confirmation (NAC) between the originator and the recipient.

- SAM shall be able to produce a NAT confirmation file (NAC) for each received NAT;

NOTE 1: The NAC shall contain only the header and footer records in case of a total rejection of the “local” NAT

NOTE 2: The NAC shall contain only the rejected lines in case of partial acceptance of the “local” NAT indicating for each line the reason of rejection

- SAM shall provide the NAC according to the foreseen schedule for data exchange in the Out\New folder of the originator of the NAT (TSP);
- The TSP shall be able to download the NAC from his Out\New folder;
- The TSP shall delete the NAC from his Out\New folder after the download;
- The TSP shall initiate an appropriate error handling (e.g. solve the detected errors in his central system, send a new correct “local” NAT …).

10.5.3 HGV

The following procedures describe the handling of the white list (HGV) between the originator and the recipient.

- A TSP shall be able to produce an HGV according to the specified format version and upload it to the In\Temp folder of the addressed recipient (the TSP);

The following rules shall be applied during production:

- All obligatory fields shall be filled according to the specified format version

  - The number of characters in each field shall be according to the format description
  - The ActorID in the HGV shall be the same as the ActorID of the originator
  - The ActorID in the "local" HGV shall be defined
  - The PAN and the context mark in the in the HGV shall be defined in the BIN (+ BIN ext.) + context mark fields in the AIT
  - Only valid, non-blocked OBU shall be included in the HGV (OBE not included in the NAT list from the TSP)
  - If applicable the TSP may include a validation on the allowed change in the size of the HGV list in his system
- A TSP shall move an uploaded HGV from his In\Temp folder to his In\New folder, when the upload is completed
- SAM shall validate each received HGV according to the general validation rules; any breach of these rules have a total rejection of the HGV as a consequence;
- SAM shall additionally validate each body record of a received HGV according to the following validation rules:
  - The PAN and the context mark in the HGV shall be defined in the BIN (+ BIN ext.) + context mark fields in the AIT; otherwise the line is removed

  NOTE 1: The BIN field is obligatory. The BIN ext. field is optional. If not filled, the BIN + context mark shall be present

  NOTE 2: The BIN is the first 6 digits of the PAN number and is used to identify the TSP. The values in the optional BIN ext. field may be used to limit the interval of valid OBU from a TSP as an alternative to include it in the NAT list i.e. returned series of OBUs or series of initialized OBUs in stock if this is bilaterally agreed between SAM and TSP. The information in the BIN ext. field can be ignored by SAM if the use is not agreed

  - Only valid, non-blocked OBUs shall be included in the HGV; if a blocked OBU from a corresponding NAT is found on the HGV, it shall be removed
  - The PAN and/or OBU ID shall be unique. In case of identical information one of the lines shall be removed from the HGV; in case of one PAN for two OBU IDs only the first line with of the duplicate entries shall be kept, the second line shall be removed. In case two PANs for the same OBU ID both lines shall be removed before compiling the HGV
  - The PAN shall be within the range allowed by the AIT of the TSP and the number of digits shall be correct; otherwise the line shall be removed
- Any breach of these rules has a partial acceptance of the HGV as a consequence, where the lines which are non-conformant are removed before processing it further;
- The Back-Office interface shall move the HGV from the In\New folder of the originator to the In\Completed folder if the validation was fully or partially successful

- SAM shall produce a HGV confirmation file (HGC) for each received HGV based on the result of the validations above and shall provide it in the Out\New folder of the originator of HGV
- The TSP shall provide the new HGV according to the foreseen schedule for data exchange
- SAM shall be able to download the HGV from his Out\New folder in accordance to the foreseen schedule for data exchange
- SAM shall delete the HGV from his Out\New folder after the download
- SAM may validate the correctness of the format and content of the HGV

The following rules shall be applied during validation:

  - The HGV shall be delivered according to the foreseen schedule for data exchange
  - All obligatory fields shall be filled according to the specified format version
  - The number of characters in each field shall be according to the format description
  - No entries shall be present that should have been filtered according to the rules of SAM, if any
  - SAM may include a validation on the allowed change in the size of the HGV in his system and may stop the processing if the change in the size exceeds a certain limit
  - SAM may include a validation on the number of OBU blocks resulting from the processing of the HGV in his system and may stop the processing if the number of OBU blocks exceeds a certain limit
- SAM may report any errors in the file by sending an alarm message
- SAM may implement the received HGV in his central system and use it for his purposes

10.5.4 HGC

The following procedures describe the handling of the white list confirmation (HGC) between the originator and recipient.

- SAM shall be able to produce a HGV confirmation file (HGC) for each received HGV

NOTE 1: The HGC shall contain only the header and footer records in case of a total rejection of the HGV

NOTE 2: The HGC shall contain only the rejected lines in case of partial acceptance of the HGV indicating for each line the reason of rejection

- The TSP shall provide the HGC according to the foreseen schedule for data exchange in the Out\New folder of the originator of the HGV (TSP)
- The TSP shall be able to download the HGC from his Out\New folder

- The TSP shall delete the HGC from his Out\New folder after the download
- The TSP shall initiate an appropriate error handling (e.g. solve the detected errors in his central system, send a new correct "local" HGV …)

10.6 Transaction lists of users

10.6.1 TIF

The following procedures describe the handling of the Transaction Information File (TIF) between the originator and the recipient.

- SAM shall be able to produce a new TIF according to the specified format version and upload it to his In\Temp folder of the addressed recipient;

The following rules shall be applied during production:

  - The central system of SAM shall have the capability to review transactions that come from the roadside, split them in transactions for local contracts and for foreign contracts (passages made with OBU issued by the TSP) according to schedule for foreseen data exchange
  - SAM shall produce a TIF according to the specified format version for each TSP separately
  - Pricing of each transaction and calculation of VAT shall be done by SAM either in his central system or at the RSE
  - All OBU transactions shall be checked against the NAT and AIT list and be found valid at the time of passing before they are included in the TIF
  - Separate TIFs shall be generated for debit and credit transactions
  - A TIF with credit transactions shall always be generated with a lower sequence number than the corresponding TIF with debit transactions to keep the sequence for partial refunds (R2→C3)
  - The business rules for the TIF described later shall be observed
  - SAM shall ensure that the transactions are sent to the correct TSP
  - SAM shall have the ability to store transactions locally for a minimum period of 30 days in order to avoid any loss of transactions if no connection to the TSP can be established
  - SAM shall have the ability to manage incomplete transactions and enrich the data in order to send them as valid transactions in a TIF when data is insufficient
- SAM shall move an uploaded TIF from his In\Temp folder to his In\New folder, when the upload is completed
- The TSP shall validate each received TIF according to the following validation rules in addition to the general validation rules:
  - The PAN and the context mark in the in the TIF shall be defined in the BIN (+ BIN ext.) + context mark fields in the AIT

NOTE 1: The BIN field is obligatory. The BIN ext. filed is optional. If not filled, the BIN + context mark shall be present

NOTE 2: The BIN is the first 6 digits of the PAN number and is used to identify the TSP. The values in the optional BIN ext. field may be used to limit the interval of valid OBUs from a TSP as an alternative to include it in the NAT list i.e. returned series of OBEs or series of initialized OBEs in stock if this is bilaterally agreed between SAM and the TSP. The information in the BIN ext. field can be ignored by SAM if the use is not agreed

- Any breach of these rules has a total rejection of the TIF as a consequence

- The TSP shall report any errors in the TIF by sending an alarm message to the originator of the file and move it from the In\New folder of the originator to the In\Rejected folder;
- The TSP shall move the TIF from the In\New folder of the originator to the In\Completed folder if the validation was successful but shall not send any confirmation;
- SAM shall provide the TIF according to the foreseen schedule for data exchange in the Out\New folder of the addressed recipient (TSP);
- The TSP shall be able to download the TIF from his Out\New folder;
- The TSP shall delete the TIF from his Out\New folder after the download;
- The TSP shall process the downloaded TIFs in an ascending order (observing date and sequence number) and validate the correctness of the format and the content of the received TIF;

The following rules shall be applied during validation:

- All obligatory fields shall be filled according to specifications
- The number of characters in each field shall be according to the format description
- Each transaction may be checked against the NAT and AIT list to determine if they were valid at the time of passing
- If the OBU was valid at the time of passage, the TSP shall accept the transaction
- The TSP may decline the transaction if the OBU was invalid at the time of passage
- The TSP may accept any transaction without any precedence, when the OBU was invalid at the time of passing but has become valid in the mean time

- The TSP shall produce a TIF confirmation file (TIC) based on the result of the validation and process it according to chapter 3.4.2

10.6.2 TIC

The following procedures describe the handling of the Transaction Information Confirmation (TIC) between the originator and the recipient.

- A TSP who received a TIF shall produce a corresponding TIC; the following rules shall be applied during production:
  - One TIC is produced for each TIF received from the Toll Charger
  - The TIC shall reference the original TIF
  - The accepted number of transactions and amount (due) and rejected number of transactions and amount including VAT shall be stated in the header or footer record
  - Each rejected transaction shall be included as a body record including the reason of the rejection
  - If no transaction is rejected the TIC shall only contain a header and a footer record
- A TSP shall upload the TIC to his In\Temp folder according to the foreseen schedule for data exchange;
- A TSP shall move an uploaded TIC from his In\Temp folder to his In\New folder, when the upload is completed;
- SAM shall validate each received TIC according to the general validation rules; any breach of these rules has a total rejection of the TIC as a consequence;
- SAM shall report any errors in the TIC by sending an alarm message to the originator of the file and move it from the In\New folder of the originator to the In\Rejected folder ;
- SAM shall move the TIC from the In\New folder of the originator to the In\Completed folder if the validation was successful;
- The TSP shall provide the TIC according to the foreseen schedule for data exchange in the Out\New folder of the addressed recipient (TC);
- SAM shall be able to download the TIC from his Out\New folder;
- SAM shall delete the TIC from his Out\New folder after the download;
- SAM may validate the correctness of the format and the content of the received TIC; the following rules shall be applied during validation:
  - All obligatory fields shall be filled according to specifications
  - The number of characters in each field shall be according to the format description
  - The reason for each rejected transaction shall be stated
- SAM shall correct any rejected transaction if possible or explain it to the TSP and resend it in a new TIF;
- The TSP shall invoice any non-rejected transactions to the user.

10.7 Validation rules at transaction level

10.7.1 Introduction

The Parameter Tables and the Validity Lists of users are valid from their availability for download until new ones are provided for download.

Based on an agreed schedule for data exchange, it is determined which Parameter Tables and Validity Lists of Service Users are valid at the time of passing. These lists are used to determine if each transaction is valid or not.

The responsibility of SAM not receiving payment for transactions usually lies either with a TSP or SAM himself.

10.7.2 The validation of OBUs at the charging points

SAM shall reject a transaction with an OBU when:

- The OBU is not issued by a registered and valid TSP (identified through the EFC context mark on the AIT file);
- The OBU is found on the NAT file valid at the time of the passage.

SAM shall note in the TIF file for each transaction which NAT file has been used when validating and accepting the OBE (zeros (“0”) are filled in if no NAT file has been used).

It is not a requirement to use a NAT file to carry out a transaction, but SAM must be aware that he bears the responsibility if the TSP rejects the transaction. The TSP cannot, however, reject the transaction if the OBU was valid at the time of passage.

The transaction is valid if:

- The OBU is issued by a registered and valid TSP (identified through the EFC context mark on the AIT file);
- The OBU is not found on the NAT file valid at the time of the passage;
- The transaction is forwarded from SAM within the time limit defined for each type of transaction.

10.7.3 Incorrect rejection by the toll charger

In some cases an incorrect rejection may occur at the charging point when for example a wrong NAT file has been used. Incorrect rejections may be divided into the following cases:

- Passage has been paid by other means: At charging points with barriers a rejected user will be able to pay by other means. At charging points without barriers a rejected user will be able to make a retroactive payment by any accepted means, if applicable.
- A violation has occurred (passage without payment): At charging points without barriers, most incidents will be passages where no payment has been received. The user will then receive a penalty / violation fee (or invoice). If the violation fee was issued due to an error, it should be reimbursed.

10.7.4 Verification of the TIF file by the TSP

The TSP shall not reject a valid transaction received in the TIF file. The verification of the transaction is done in the TSP's central system and he may reject a transaction if one of the following criteria is met:

a. The OBU is on the NAT file valid at the time of passage
b. The transaction is sent to the TSP after the time limit defined for each type of transaction
c. The BIN + BIN ext. + context mark of the OBU is not on the AIT valid at the time of passage
d. The transaction in the TIF contains a syntactic or semantic error
e. Full or partial credit of a transaction not previously received by the TSP
f. The transaction has already been received

10.7.5 Handling of rejected transactions

Rejected transactions shall be included in the TIC along with a specification of the reason of the rejection. SAM shall check the rejected transactions and may make the necessary corrections to any errors or explain the reason of the transaction being sent in this manner and resend the transactions.

Rejected transactions shall be handled and resent by SAM as soon as possible. If a transaction is rejected for a second time, SAM and the TSP shall agree to a new resending in advance to avoid further automatic rejections.

10.8 TIF-related business rules

10.8.1 Introduction

In order to facilitate the different invoicing requirement it has been necessary to introduce a number of types of transit for the distinction of transaction lines in the TIF. The Cx and Dx codes are used for debit transaction and the Rx and Sx codes respectively are used for credit transaction, where x is always a number with a value from 1 to 9.

The Cx and Dx codes of debit and Rx and Sx codes of credit transactions are used as follows:

1. If all information regarding a billing detail (transaction) can be given in one line (including VAT) only one record using the code Cx is used for debit transactions and the code Rx for credit transactions.
2. All information regarding a billing detail (transaction) with mixed VAT rates shall be divided in several lines to cover the different VAT rates for each part of the transaction. In these cases there will be one record with the code Cx and additional record(s) with the code Dx containing the parts of the transaction with different VAT rates.

The Cx-record shall have a unique ActorID, Entry/Exit Station codes, Lane identification, Date and Time of transit for a transaction and Type of Transit. Each Cx-record shall have a unique TC-transaction identification pr. Actor ID. The remaining services with one or

more different VAT rates will be included in separate Dx-records which shall have the same ActorID, Entry/Exit Station codes, Lane identification, Date and Time of Transit, Type of Transit and TC-transaction identification as the corresponding Cx-record. Each Cx and Dx line shall be represented as a separate line on an invoice.

The codes Rx and Sx are used for crediting such transactions in the same manner stating the ActorID, Entry/Exit Station codes, Lane identification, Date and Time of Transit, Type of Transit and TC-transaction identification of the original Cx-record. All records of a transaction with mixed VAT rates shall be credited together and shall be represented as a separate line on an invoice.

10.8.2 C1/D1 record

The following business rules apply for the handling of the C1 and D1 records.

A *C1* record is used to transmit a normal successful DSRC billing detail registered by the RSE from SAM to the TSP. All information regarding this transaction can be given in one line (including VAT).

Information regarding a billing detail with mixed VAT rates shall be divided in several lines to cover the different VAT rates for each part of the transaction. In these cases there will be one record with the code C1 and additional record(s) with the code D1 containing the parts of the transaction with different VAT rates.

Non-acceptance by TSP: If a TSP concludes that the sent C1/D1 record(s) are not correct, he may decline them by the use of the TIC file. All C1 record(s) and D1 record(s) belonging to the same Billing detail shall be rejected together if an error in one part is detected. In this case the reason for the rejection shall be included in the field “Reason of rejection”.

Refund: There are two cases to distinguish if billing details transmitted through C1/D1 record(s), which were not declined by a TSP, need to be refunded at a later time:

- For a full refund of a billing detail the C1/D1 record(s) shall be refunded by R2/S2 record(s) (C1/D1 → R2/S2)
- For a partial refund of a billing detail the C1/D1 record(s) shall be refunded by R2/S2 followed by a new corrected transaction C3/D3 (C1/D1 → R2/S2 → C3/D3)

Resending: If SAM needs to resend previously rejected C1/D1 record(s), he shall issue C3/D3 record(s). If any changes were agreed between SAM and the TSP (e.g. changed amount) they have to be applied in this step.

10.8.3 C2/D2 record

The following business rules apply for the handling of the C2 and D2 records.

A C2 record is used to transmit a manually keyed-in billing detail registered in the lane as a fall back solution from SAM to the TSP. All information regarding this transaction can be given in one line (including VAT).

Information regarding a billing detail with mixed VAT rates shall be divided in several lines to cover the different VAT rates for each part of the transaction. In these cases

there will be one record with the code C2 and additional record(s) with the code D2 containing the parts of the transaction with different VAT rates.

Non-acceptance by TSP: If a TSP concludes that the sent C2/D2 record(s) are not correct, he may decline them by the use of the TIC file. All C2 record(s) and D2 record(s) belonging to the same billing detail shall be rejected together if an error in one part is detected. In this case the reason for the rejection shall be included in the field "Reason of rejection".

Refund: There are two cases to distinguish if billing details transmitted through C2/D2 record(s), which were not declined by a TSP, need to be refunded at a later time:

- For a full refund of a Billing detail the C2/D2 record(s) shall be refunded by R2/S2 record(s) (C2/D2 → R2/S2)
- For a partial refund of a Billing detail the C2/D2 record(s) shall be refunded by R2/S2 followed by a new corrected transaction C3/D3 (C2/D2 → R2/S2 → C3/D3)

Resending: If SAM needs to resend previously rejected C2/D2 record(s), he shall issue C3/D3 record(s). If any changes were agreed between SAM and the TSP (e.g. changed amount) they have to be applied in this step.

10.8.4 C3/D3 record

The following business rules apply for the handling of the C3 and D3 records.

Use: A C3 record may be used to transmit a corrected billing detail where changes had to be applied (e.g. changed amount) to get it accepted. All information regarding this transaction can be given in one line (including VAT).

Information regarding a billing detail with mixed VAT rates shall be divided in several lines to cover the different VAT rates for each part of the transaction. In these cases there will be one record with the code C3 and additional record(s) with the code D3 containing the parts of the transaction with different VAT rates.

Non-acceptance by TSP: If a TSP concludes that the sent C3/D3 record(s) are not correct, he may decline them by the use of the TIC file. All C3 record(s) and D3 record(s) belonging to the same billing detail shall be rejected together if an error in one part is detected. In this case the reason for the rejection shall be included in the field "Reason of rejection".

Refund: There are two cases to distinguish if already corrected billing details transmitted through C3/D3 record(s), which were not declined by a TSP, need to be refunded at a later time:

- For a subsequent full refund (= cancellation) of a Billing detail the C3/D3 record(s) shall be refunded by R2/S2 record(s) (⋯ → R2/S2 → C3/D3 → R2/S2)
- For further partial refunds of an already corrected Billing detail the C3/D3 record(s) shall be refunded by R2/S2 followed by a new corrected transaction C3/D3 (… → R2/S2 → C3/D3 → R2/S2 → C3/D3 …)

Resending: If SAM needs to resend previously rejected C3/D3 record(s), he shall issue C3/D3 record(s). If any changes were agreed between SAM and the TSP (e.g. changed amount) they have to be applied in this step.

10.8.5 C4/D4 record

The following business rules apply for the handling of the C4 and D4 records.

Use: A C4/D4 record is used to transmit a virtual (artificial) billing detail generated in the central system of SAM. All information regarding this transaction can be given in one line (including VAT).

Information regarding a billing detail with mixed VAT rates shall be divided in several lines to cover the different VAT rates for each part of the transaction. In these cases there will be one record with the code C4 and additional record(s) with the code D4 containing the parts of the transaction with different VAT rates.

Non-acceptance by TSP: If a TSP concludes that the sent C4/D4 record(s) are not correct, he may decline them by the use of the TIC file. All C4 record(s) and D4 record(s) belonging to the same billing detail shall be rejected together if an error in one part is detected. In this case the reason for the rejection shall be included in the field "Reason of rejection".

Refund: There are two cases to distinguish if billing details transmitted through C4/D4 record(s), which were not declined by a TSP, need to be refunded at a later time:

- For a full refund of a Billing detail the C4/D4 record(s) shall be refunded by R2/S2 record(s) (C4/D4 → R2/S2)
- For a partial refund of a Billing detail the C4/D4 record(s) shall be refunded by R2/S2 followed by a new corrected transaction C3/D3 (C4/D4 → R2/S2 → C3/D3)

Resending: If SAM needs to resend previously rejected C4/D4 record(s), he shall issue C3/D3 record(s). If any changes were agreed between SAM and TSP (e.g. changed amount) they have to be applied in this step.

10.8.6 C8/D8 record

The following business rules apply for the handling of the C8 and D8 records.

Use: A C8 record is used to transmit a billing detail that was not registered as a transaction in the lane at the time of passing but is based on the relation between license plate and OBU number on the HGV list. The license plate, which was registered during the passage by other means as a DSRC transaction (e.g. video), will be transformed to an ordinary transaction using the OBU from the HGV list. All information regarding this transaction can be given in one line (including VAT).

Information regarding a billing detail with mixed VAT rates shall be divided in several lines to cover the different VAT rates for each part of the transaction. In these cases there will be one record with the code C8 and additional record(s) with the code D8 containing the parts of the transaction with different VAT rates.

Non-acceptance by TSP: If a TSP concludes that the sent C8/D8 record(s) are not correct, it may decline them by the use of the TIC file. All C8 record(s) and D8 record(s) belonging to the same billing detail shall be rejected together if an error in one part is detected. In this case the reason for the rejection shall be included in the field "Reason of rejection".

Refund: There are two cases to distinguish if billing detail transmitted through C8/D8 record(s), which were not declined by a TSP, need to be refunded at a later time:

- For a full refund of a Billing detail the C8/D8 record(s) shall be refunded by R2/S2 record(s) (C8/D8 → R2/S2)
- For a partial refund of a Billing detail the C8/D8 record(s) shall be refunded by R2/S2 followed by a new corrected transaction C3/D3 (C8/D8 → R2/S2 → C3/D3)

Resending: If SAM needs to resend previously rejected C8/D8 record(s), he shall issue C3/D3 record(s). If any changes were agreed between SAM and the TSP (e.g. changed amount) they have to be applied in this step.

11 Quality and Performance Management

11.1 Introduction

The quality of the service provided by the Toll Service Provider is measured along with the operation by means of specific Key Performance Indicators. The KPIs are designed to measure the quality of the interoperable constituents and of the processes established by the Toll Service Provider.

11.2 Key Performance Indicators

The following Key Performance Indicators (KPIs) have been defined and shall be regularly measured on the base of the actual operation in order to assesse the quality of the service provided by the Toll Service Provider.

- DSRC OBE Error Rate
- OBE Personalisation Quality

The exact scope, the responsibilities, the target value and the way each of the above mentioned KPI shall be measured is detailed within the following sections.

11.3 DSRC OBE Error Rate

This KPI is intended to measure the quality of the OBE as distributed by the Toll Service Provider to its respective customer, in particular their capacity to correctly communicate with the roadside equipment deployed and operated by the Toll Charger and complete a toll transaction.

If the quality of the OBEs distributed by the Toll Service Provider fall under a certain level, the fluidity of the traffic across the toll plazas will be affected and SAM (or the Operator on its behalf) will be obliged to intervene and handle the transaction in a degraded mode with a consequence in terms of higher operating expenses for SAM.

From the OBE perspective, the reasons for a toll transaction not being completed regularly may be the following:

- the OBE is not correctly mounted;
- the OBE is not working correctly (technical problem or battery discharged.

It is part of the responsibility of the Toll Service Provider to ensure that the OBEs are properly installed on the windscreen of the vehicles of its customers and that they work properly.

In order to measure the quality of the OBEs distributed by the Toll Service Operator, an analysis is performed on a monthly basis in order to identify – out of all toll transactions that have been registered with the customers of the Toll Service Providers – all those transactions that have been correctly registered.

The toll transactions for which a degraded mode process and/or a manual intervention have been necessary will be deeply analysed in order to understand the specific background.

Out of all the registered transactions, the “DSRC OBE Error Rate” KPI is calculated by means of the ratio between the toll transactions that have been correctly registered (along the nominal process) and the overall number of toll transactions.

A target level of 99,2% is defined for this KPI.

11.4 OBE Personalisation Quality

This KPI is intended to measure the quality of the process implemented by the Toll Service Provider to personalise/configure the OBEs being distributed to its customers and to feed the corresponding information within the HGV data file.

In order to ensure that the correct toll amount is paid, it is necessary that the data upon which the toll is calculated is correct.: such data include:

- the data by which the OBE are personalised;
- the entry of a vehicle data within the HGV data file;
- the installation of the correct OBE within the right vehicle.

The OBE Personalisation Quality is measured on a spot-check basis, by identifying (out of the OBUs being detected passing by during a month):

- the number of OBE personalised with erroneous content by the Toll Service Provider;
- the number of HGV-file entries with erroneous content;
- the number of vehicles with wrong OBE.

A target level of 1 % is defined for this KPI.