Road Charging Interoperability

REPORT FOR ‘INTEROPERABLE ROAD CHARGING PROJECTS’ ON THE BASIS OF KEY FINDINGS ON TECHNICAL INTEROPERABILITY RCI

Dependencies between RCI technical architecture and procedural and contractual frameworks

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RCI is co-financed by the European Commission DG TREN
This document extracts the technical characteristics of RCI that may have implications on contractual interoperability to inform the rest of European projects that are working on the definition of these procedures for contractual interoperability and take it into account.

Objective for RCI is to contribute to advancing the technical architecture and specifications for the EETS in a manner that these constitute a technical framework that is consistent with the procedural and contractual frameworks.

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EXECUTIVE SUMMARY

The EC co-funds the Road Charging Interoperability (RCI) project to demonstrate and validate how RCI interoperable prototypes seamlessly and without user intervention adapt functional behaviour when crossing the border according to the rules that apply for the German, Swiss, French, Spanish, Italian and Austrian tolling schemes. This contracted RCI mission was to be based on specifications that would be provided by the EC-coordinated expert groups (EFC) and the European standardization committee (CEN).

Although the EFC and CEN have delivered a specification for a number of important elements of the EETS, there has not been a clear definition or architecture for the EETS and several of the specifications needed are still missing. RCI therefore defined itself a high level architecture for interoperability that is based upon work by the CEN and ISO standardisation committees and the ASECAP tolling operators and Member States’ Stockholm Group role model (CESARE III).

The RCI work, endorsed by the EC in February 2007, represents as such a first European technical reference for DSRC- and GNSS-enabled road charging solutions that is accepted by the principal stakeholders (suppliers, toll operators and toll service providers). Through demonstration, validation and consultation and awareness-increasing workshop, the RCI intends to contribute to the further work on the EETS specification and eventually standardisation and to help avoid future deployment of road charging systems will delay or block the introduction of interoperability.

The RCI architecture defines what technical interfaces must be implemented in interoperable road charging solutions to support the exchange of information between the different actors. It will be these interfaces through which one actor will receive or send information, will monitor or even enforce another actor. It will be therefore these interfaces that are crucial for the implementation of the procedural and contractual agreements made between the actors to ensure interoperability, with the objective to establish and keep common trust in the system and operation thereof.

Critical for the contribution that RCI can make to advancing interoperability of road charging services in Europe, is how it as technical reference is in support of the procedural and contractual framework that European stakeholders, more specifically the Member States and operators, are defining in the context of the EETS. This document extracts the technical characteristics of RCI that may have implications on procedural and/or contractual interoperability with the objective to ensure consistency between the technical RCI architecture and the other frameworks that are critical for interoperable road charging and the EETS.

In this context, the following key conclusions can be drawn:

1) The RCI architecture is consistent with and in support of the CESARE and EETS role model defining the allocation of the responsibilities for operation
and use of the EETS to the Toll Charger, the EETS Provider and the Service User.

2) The RCI architecture provides a sound basis for appropriate market conditions with respect to innovation (on the basis of the Front End concept), openness and competition (because of publicly available standards), catalysing new business (because the EETS Provider role is compliant to the open Telematics Service Provider role model) and economies of scale (through the Toll Context Data concept)- the terms ‘proxy’ and ‘Front End’ will be explained in chapter 4.

3) The RCI architecture shows 6 interfaces that are used for the exchange of information between different roles. For these 6 interfaces, standardisation would help the Toll Chargers, EETS Providers and Service Users to optimise the equipment that they buy, operate or use with respect to ease of use, ease of operation, costs and opportunity to achieve economies of scale. 3 of these interfaces reside between the Toll Charger and the EETS Provider and the standardisation of these 3 interfaces is critical for success of the EETS.

4) There is a limited number of assumptions with respect to procedural and contractual frameworks that could build upon the CESARE results that have an impact on the technical RCI architecture, namely that:

a) For DSRC-enabled tolling the Onboard Equipment communicates directly with the Toll Charger compliant to DSRC standards (EN15509 or UNI) who then generates the charge data; for GNSS-enabled tolling the OBE generates the charge data and sends this data to the EETS Provider who then (possibly after some additional processing) sends the charge data to the Toll Charger through a standardised interface. The events that need to be detected by the EETS Provider’s equipment and the corresponding actions that this equipment needs to carry out and that result in the charge data should be compliant to the Toll Context Data as defined by the Toll Charger.

b) Interoperability in a GNSS-enabled toll system requires that the EETS Provider keeps permanent control on the OBE; the charge data flow should therefore be able to go from the EETS Provider’s central equipment to the Toll Charger’s central equipment, and there should be no requirement for EETS Providers to have charge data sent from the OBE to the Toll Charger directly. For this reason it is crucial that the technical EETS architecture comprises explicitly the ‘proxy’ component as element, besides the OBE, in the ‘Front End’ (the terms ‘proxy’ and ‘Front End’ will be explained in chapter 4.

c) The EETS Provider would be responsible and pays for the communication of the charge data (also called use data) until received by the Toll Charger in case of GNSS-enabled road charging

d) The Toll Charger does not have the right/possibility to exchange information with the OBE except when making use of RCI interface 6 for enforcement or RCI interface 4 for event and augmentation signals (as one of the
consequences, the Toll Charger can not communicate black/grey listing to the OBE)

e) The meaning of HMI indications (such as a red light, green light, flashing display, etc.) for different tolled infrastructures will be harmonised on a voluntary basis by the industry. There can be differences between different brands of equipment.

f) The Toll Charger of GNSS-enabled tolled infrastructure will install and operate (localisation support) augmentation beacons that will send data to the OBE through RCI interface 4, if required to meet a European agreement on minimum performances.

g) Each Toll Charger of GNSS-enabled tolled infrastructure will define the Toll Context Data (TCD) for his tolled infrastructure in a fashion that is compliant to a European standard; European support and acceptance exist for the fact that the functionality of any new EETS-compliant tolling scheme can only be defined using the standardised TCD and is as such constrained by a European standard.

h) There are rules for the maximum frequency by which a Toll Charger can change the TCD as well as for the minimum delay for the EETS Provider to have the new or updated TCD implemented in the OBE (or proxy).

5) There are some open questions derived from this report's analysis that concern agreements to be established between Toll Chargers and EETS Providers:

a) Interoperability means a clear definition of the interfaces, and certification, security and quality management processes that give trust to all the stakeholders. TC and EETSP have to rely on each other. Certification therefore is not confined to CE marking but involves end-to-end testing and a continuous performance monitoring by Toll Chargers and EETS Providers. What European standard will exist that defines the Key Performance Indicators that apply to the quality and performance of the Toll Charger’s service and of the EETS Provider’s service including the corresponding measurement methods?

b) Who is responsible (the Toll Charger or each EETS Provider) for the provision of geographic coordinates in a standardised geodetic model for all charge objects in a GNSS-enabled road charging scheme?

c) What are the minimum privacy requirements for the EETS (meaning that application of these minimum requirements allow certification for operation anywhere in Europe)?

d) What are the minimum security, tamper proof and installation requirements in Europe concerning the OBE and its installation and integration?

e) It is being assumed that European agreement will exist that exhaustively defines the minimum functionality of the HMI (RCI recommends the use of the
Toll Context Data); however, what are the minimum functional messages that the HMI implementation should support?
1 ABOUT THIS DOCUMENT

The main scope of this report is to identify dependencies between the RCI architecture and specifications and its impact on the contractual interoperability.

This document shows a brief description on the interoperability status in different European countries before the RCI project, the RCI high level architecture, the description of technical interfaces for real interoperability and the contractual considerations stem from technical basis established in the RCI project.
2 BRIEF DESCRIPTION ON THE INTEROPERABILITY STATUS BEFORE THE RCI PROJECT

Currently, there are national interoperable solutions for ETC and some agreements between different countries in local areas.

There are as well different regional toll chargers like bridge and tunnel or ferry operators sometimes working with other local providers, sometimes operating solely their own infrastructure.

However, in each case, we could find different actors and roles, contractual schemes and technical architectures.

This chapter wants to explain the interoperability status before the RCI project showing that there is much complexity both technologically and contractually.

2.1 NATIONAL ROAD CHARGING SYSTEMS

Actually, there are national solutions, in different countries, which have interoperable road charging systems between the different Toll Chargers. Some of these countries are Austria, Denmark, France, Germany, Italy, Spain and Switzerland.

Austria: GO-MAUT system

ASFINAG the Austrian motorway and expressway operator has introduced the GO-MAUT system, a nation-wide CEN TC 278 DSRC MW 5.8 GHz based tolling system for heavy vehicles above 3.5 tons.

The GO-Maut system is a free flow multilane system. The human machine interface of the GO-Box includes one button (declaration of category, prove of current status), 3 LEDs to display the current category, one LED to display the current status, and a buzzer for transaction feedback.

The issuing of customer-contracts and the system operation is provided by ASFINAG.

France: TIS system

The French motorway operators, members of ASFA, have deployed a nation-wide, interoperable system: TIS (meaning Télépéage Inter-Sociétés) working with toll gates and single ETC lanes based on DSRC compliant to CEN standards (5.8 GHz).
The implementation of the TIS-PL (truck dedicated version of TIS) is fully compliant with the CESARE III model implying three different groups of players: the motorway companies, the TIS-PL issuers and the users. A “commission télépéage” set by the concessionaires is playing partially the role of the Interoperability Manager.

And the contractual architecture is as follows:
- a memorandum of understanding (MoU) signed by all motorway companies;
- public agreement procedures for TIS-PL issuers and for TIS-PL compliance of OBE types
- bilateral contracts between each motorway company and each issuer; based on a reselling model where the issuer has the mandate to collect tolls on behalf of the concessionaire and is paying and guaranteeing payment to each concessionaires for the relevant toll charges due by its customers.
- single contract between the issuer and its own clients: the issuer is invoicing all tolls in its own name and on behalf of each concessionaires.

**Germany: TOLL COLLECT system**

The automatic EFC system is based on GNSS/CN technology. The OBE features additionally a DSRC IR interface for enforcement purposes and localisation support. A CEN TC 278 DSCR MW 5.8 GHz interface is integrated for future interoperability as well.

The German motorway network is operated and maintained by the Ministry of Transport, Building and Housing on behalf of the German state.

The issuing of customer-contracts and the system operation is provided by Toll Collect GmbH governed by a contract with the above mentioned Ministry.

The OBE is provided by Toll Collect as well.

For customers without a working OBE (either not installed or non-functional), there exists a manual tolling procedure via terminal spread all over Germany.

**Italy: TELEPASS system**

The system is composed by single ETC lanes based on UNI 5.8 GHz DSRC and on the UNI Transaction.
The Italian motorways are operated by a total of 24 concessionaries that have signed a MoU within Aiscat (Associazione Italiana Società Concessionarie), which allows full interoperability in a common network.

Autostrade per l'Italia is the EFC Operator of the whole Network and it acts as the only issuer of customer contracts, accepted by all EFC Operators.

Spain: VIA-T system

VIA-T is the interoperable system introduced in Spain, a nationwide interoperable CEN TC 278 DSCR MW 5.8 GHz based EFC system for all types of vehicles.

There is an agreement signed (about VIA-T) by all Spanish concessionaires with 3 entities (Servired, 4B and Euro6000), also known as SMPs (Sociedades de Medios de Pago), which represent all financial institutions, so any Spanish Bank or Savings.

In addition, every concessionaire has commercial agreements with every merchant. They are also agreements between the Spanish concessionaires and other non-financial issuers (Resa, Solred, etc).

The main OBE issuers are banks and saving banks but the there are other non-financial issuers as petrol cards. Toll operators do not issue OBEs.

Switzerland: LSVA system

The Swiss Customs Authority is in charge to operate the LSVA system. No issuing of Customer-contracts is made, as the distance related fee is a legal duty.

The Cantonal Road Offices and Communities are the Transport Service Provider.

The LSVA system is based on OBE (mandatory to Swiss users) that records the kilometres driven on Swiss and FL territory from the tachograph, supervised by a satellite positioning system (GPS) and a movement sensor. A CEN Standard DSRC link (5.8 GHz) is used to switch the recording of the driven kilometres on or off when passing the border and for reading out the data stored on-board for equipped foreign vehicles.
2.2 INTEROPERABLE SOLUTIONS BETWEEN COUNTRIES

In this section there is a little explanation of two interoperable solutions agreed between different countries; MEDIA and NORITS.

MEDIA

MEDIA stands for “Management of EFC DSRC InteroperAbility”. It is an interoperability initiative of tolling operators from the Alpine countries Austria, France, Italy, and Slovenia. MEDIA has the objective to find and implement a concrete solution to enable that tolls for heavy vehicles in the participating fee collection systems can be paid electronically and in an interoperable way.

MEDIA will not define a single technical product, but a set of requirements.

The following actors are defined for the MEDIA project: Transport Service Provider (EETS Provider), EFC Operator, Contract Issuer (CI), Payment Service Provider (PSP), Customer (Service User) and the MEDIA OBE.

In MEDIA, every Service User has a contract with a service company, named the Contract Issuer.

The contractual architecture of MEDIA consists of 3 main documents:

MEDIA Association Statutes: is a co-operation between MEDIA EFC-Operators that define the regulatory level of MEDIA.

MEDIA Memorandum of Understanding: is a binding agreement in the form of a contractual framework between the MEDIA EFC Operators and the MEDIA Contract Issuers.

Bilateral contracts: between the EFC Operators and the Contract Issuers for issues which can't be covered with the MEDIA Statutes or Memorandum of Understanding.

In April 2008 the MEDIA EFC Operators agreed that some open issues (e.g. certification of OBEs, the status of Contract Issuers in the different participating toll domains, the creation of a significant market for the MEDIA Toll Service,…) which have to be dealt with to establish interoperability are not mainly in the area of the competence of the MEDIA Association. Therefore it was decided to reduce the common activities for the time being and concentrate on solving these crucial issues more effectively by the individual members of the MEDIA Association.

This decision does not limit the possibility of bilateral agreements between the original MEDIA EFC Operators to establish any kind of interoperability.

NORITS
NORITS is a service offered to all users of existing toll collection systems in the Scandinavian countries. The service makes it possible for any user to pay the toll fee of any toll collection system in this area with the on-board unit already received from his local issuer / toll operator. The NORITS service includes toll operators and some ferry companies.

The main actors and roles are Issuer, Operator and User.

NORITS operates with the following agreements:

- Joint Venture Agreement: The operators taking part in NORITS signs an agreement, which states the conditions of the cooperation. This agreement is referred to as the Joint Venture Agreement (JVA).

- Issuer agreement: All companies issuing payment means accepted by NORITS operators must sign an issuer agreement with the NORITS operators.

- User agreement: New paragraphs must be added in the issuer’s contract with the individual user describing the conditions under which the user can use his OBE as payment means in all NORITS facilities.

**LSVA / ASFINAG**

The LSVA implementation with the OBU is fully interoperable with Austria. The OBU works in the ASFINAG context as well. The user only needs to sign a contract with ASFINAG for the use of the LSVA OBU.
3  RCI NOTION OF INTEROPERABILITY

Interoperable road charging solutions in line with the Directive 2004/52/EC mean for the EU citizens: a service based on one contract using one on-board equipment (OBE) for electronic road tolling and -taxing anywhere in Europe.

Figure 1: RCI concept for interoperable road charging

In the remainder of this document, specifications of functionality and interfaces that such a service needs, are called EETS specifications referring to the envisaged technical specification of this future European Electronic Tolling Service. The term interoperable solution then means that the implementation is compliant to this EETS specification. The RCI specification is meant to contribute to the further work on the EETS specification and eventually standardisation.

3.1 DIFFERENT TYPES OF TOLLED INFRASTRUCTURE

Interoperability means that one EETS OBE works for different tolled infrastructures. In the RCI architecture two charging principles for a tolled infrastructure are supported:

A. DSRC-beacon based tolled infrastructure. Charging data are generated in a real-time DSRC communication between the OBE and roadside microwave beacons. The data are further processed by the toll charger. The OBE serves as a data storage device, and allows reading data from it and writing data into it via the DSRC air link. The same set of data in the OBE serves the need of all DSRC-beacon based tolled infrastructures.
B. GNSS-enabled tolled infrastructure. Charging data are collected autonomously in the OBE. Further processing according to the requirements of the local Toll Charger can take place in the EETS Provider's proxy. This depends on the implementation that the EETS Provider is using and the proxy therefore is optional and if being used, probably physically being part of the EETS Provider's back end. The processed data are recorded and packets thereof are made available to the toll charger periodically. The assembled grouping of all objects that are subject to tolling or taxing is called the tolled infrastructure. For a specific tolled infrastructure, the parameters defining the collection and processing of the charging data (the toll context data definition) are defined by the Toll Charger and made available to each EETS Provider. It is the responsibility of the EETS Provider to implement this toll context data definition in the OBE (and optionally in his proxy) that his service user his using. The geographic area in which this collection and processing is activated is called the domain of that tolled infrastructure and GNSS, DSRC and mileage counters (odometer or tachograph) are the main technologies available for generating charging data. GSM/GPRS and DSRC may be used to exchange data between the OBE and fixed equipment. However (see assumption later in this report) in case of GNSS-enabled solutions, this communication will be under responsibility of the EETS Provider and the communication of charge data (also called use data) between the EETS Provider and the Toll Charger is expected to make use of the cheapest and most reliable means, in general this would be a fixed and wired connection.

The figure above shows how one service-user can travel from one tolled infrastructure to another, seamlessly and without any user intervention and both including DSRC microwave beacon-based infrastructure and GNSS-enabled tolled infrastructure. The dotted line in the figure indicates the option of adding additional EETS tolled infrastructures in Europe.

It is mentioned that within this concept, 2 or more tolled infrastructures (or the domains of such infrastructures) could overlap. It is also noted that DSRC-based tolled infrastructure could be deployed anywhere, including inside the domain of GNSS-enabled tolled infrastructure.

3.2 TOLL CHARGERS’ FREEDOM VERSUS EETS PROVIDERS’ STABLE DESIGN REQUIREMENTS: TOLL CONTEXT DATA

Within the interoperability concept, those imposing and receiving the tolls or taxes should be free to define the charging in their tolled infrastructure even in case this local system is to be EETS compliant. This freedom in defining the charging for tolled infrastructure cannot be without limits in order to ensure that an existing base of operational OBEs could operate correctly for tolled infrastructure that did not exist when these OBEs were being manufactured. This freedom should however be sufficient not to constrain toll chargers and/or Member States in defining new charging policies for tolled infrastructure.
The RCI architecture supports such freedom to toll chargers while ensuring feasibility for the implementation and potential for “horizontalisation” of the market of road charging solutions towards the EETS Provider and its suppliers.

For DSRC based tolled infrastructure, the required freedom for toll chargers is defined within the specifications of the EN15509 standard and is realised through implementation at the roadside and central equipment of the toll charger.

For GNSS-enabled tolled infrastructure this toll charger’s freedom is reached through an agreed specification of the “toll context data” (TCD). TCD are transferred from the toll charger to the EETS provider, to inform the EETS provider about the tolled infrastructure on the following:

1. Communication of the charging data - when the EETS Provider needs to send charging data to the Toll Charger and what data elements should be included (e.g. if a certain list of charge records must be communicated or counter values)

2. Generation of the charging data - the triggers and actions that are relevant for the generation of records with charging data and for the handling of counters, in other words the core functionality of that specific road charging service (e.g. if the entry to a zone or the attachment of a trailer requires recording)

This TCD specification therefore exactly describes how any toll charger can define how he wishes to toll his infrastructure. It does however not define how the EETS Provider needs to implement the corresponding procedures; instead maximum flexibility to development and industrialisation is given in a fashion that the EETS provider can ensure that its existing stock of Front Ends will behave appropriately in any tolled infrastructure without the immediate need for replacement of software or hardware.

### 3.3 EETS Provider Implementation Options; Onboard versus Off Board Charge Object Detection: Front End

As mentioned, the TCD does not specify how the EETS Provider needs to implement the procedures imposed by these data. The EETS Provider is allowed to optimise his implementation independently of the local characteristics of different tolled infrastructures. He has several alternatives on how to implement the Front End including the following ones:

- Distribution and allocation of processing across a proxy in the central equipment of the EETS provider and the OBE
- How sensor-data is used to determine “in reality” when events are being triggered
- How the charge objects are being represented and stored in the memory of the OBE and/or proxy in the central equipment of the EETS provider

RCI as such brings two approaches together. An OBE that:
A. Sends most of its sensor data to a proxy as part of the central equipment of the EETS provider that processes this data in order to detect the charge objects and to prepare the charging data;

B. Processes itself most of the sensor data, detecting the charge objects and events and storing charging data records in its memory.

Both approaches include one interface towards the toll charger for the exchange of the charging data and this interface should be specified by the EETS standard for interoperability. To include both solutions in the RCI architecture, the term “RCI front end” is used to refer to the OBE in conjunction with an optional proxy. It is emphasized that the Front End is a concept and not a physical component. In the context of the EETS, the use of an OBE is unavoidable; the use of a proxy however is optional.

The choice what approach to follow for commercial implementations of the Front End relies on a decision made by the manufacturers and the needs of the EETS providers. Competition in an open market will be the best guarantee for further research and development by industries for more functionality and flexibility and lower prices; surely this support for two different approaches is a better guarantee for the success of the EETS than imposing one approach far before industry has had a chance to optimise and industrialise its solutions.

The RCI architecture as such, keeps maximum freedom both at the implementation side by the EETS Providers as at the functional side at the Toll Chargers.
4 RCI ARCHITECTURE

The RCI technical architecture has been built upon the role model definition of Cesare III.

RCI applies this organisational model, which includes the four main actors as roles: Interoperability Manager, Toll Charger, EETS Provider and Service User.

The Interoperability Manager is not involved in the operation for the interoperable road charging service and therefore outside the scope of RCI. From this model the RCI architecture has been defined.
The RCI architecture defines what technical interfaces must be implemented in interoperable road charging solutions to support the exchange of information between the different actors. It will be these interfaces through which one actor will receive or send information, will monitor or even enforce another actor. It will be therefore these interfaces that are crucial for the implementation of the procedural and contractual agreements made between the actors to ensure interoperability, with the objective to establish and keep common trust in the system and operation thereof.

The GNSS based charging process for the part that is within the scope of RCI, consists of three functions: the GNSS charging process, the GNSS charge data transmission and the compliance monitoring and enforcement.
Figure 4: CESARE role model with RCI interfaces

The GNSS charging process is the collection and processing of the charging data that according to RCI is carried out by the OBE, but possibly with the help of a proxy. To assure this option is left open to industry; RCI states that the GNSS charging process takes place in the Front End. It is noted that if a proxy is being used by an EETS Provider, physically the proxy is likely to be part of the back end, logically however it is dealing with processing charge data that the OBE generates into the format that is required by the Toll Charger. The interface between the OBE and the optional proxy is under responsibility of the EETS Provider and the EETS does not require standardisation of this ‘internal’ interface. The GNSS charge data transmission to the Toll Charger for the determination and/or verification of the fee will make use of an external interface 4, which should be standardised.
Figure 5: RCI architecture and interfaces

Enforcement of GNSS-enabled OBE takes place on the basis of the transmission of the OBE status and parameter declaration data, related to the road usage to be enforced, from the OBE to the enforcement equipment of the Toll Charger, possibly in combination with information that is being sent from the EETS Provider’s proxy to the enforcing Toll Charger (see later in open questions interface 6). Compliance monitoring and enforcement therefore makes use of an ‘external’ interface 6, which needs to be standardised.

In the DSRC charging process the charging data is generated in a transaction between the OBE and the roadside equipment, and is immediately available at the Toll Charger. No extra data have to be transmitted for enforcement, as all relevant data are included in the charging transaction. The DSRC charging process therefore is making use of external interface 4.

In order to operate on GNSS-enabled tolled infrastructure, the EETS Front-End should be operational and provided with the up to date Toll Context Data. As mentioned and explained in chapter 3.2, this TCD is being defined by the Toll Charger and published to the EETS Provider in a standardised manner and making use of ‘external’ interface 5, which needs to be standardised.

Interoperability also requires subscription by a Service User to an EETS Provider, an installed OBE in the vehicle provided with contractual data, vehicle data and the appropriate software. It is the users’ responsibility to only use a tolled infrastructure if the OBE informs him that the status is OK. Via the human-machine interface (HMI) the Service Users are informed on the status of the OBE and via this interface he
can change those settings and declarations that are under his control. The HMI interface is interface 3.

The RCI architecture defines the technical detail of the interfaces for road charging systems that are interoperable in a manner that they correspond to the interfaces between the business entities that together operate the service: the Toll Charger, the EETS Provider and the Service User.

We can also see that only two contracts are necessary:

- one between the Toll Charger and the EETS Provider
- and other between the Service User and the EETS Provider

These contracts will have to contain the roles and responsibilities aligned to technical interfaces specifications and characteristics.
5 RCI INTERFACES AND ASSUMPTIONS ON CONTRACTUAL FRAMEWORK

This chapter enumerates and explains assumptions and open questions that need to be considered in the context of further development of the EETS, when ensuring consistency between the technical and contractual frameworks.

5.1 INTERFACE 1: SERVICE INTERFACE

Interface 1 provides an in-vehicle access point for the servicing and maintenance of road charging OBE.

In-line manufacturing by Original Equipment Manufacturers of this service interface that allows access to the road charging OBE could improve the access to the OBE that service engineers have and potentially reduce the cost of the manufacturing of the OBE. However, the standardisation of vehicle-provided access points for the servicing and maintenance of road charging OBE is not considered critical for interoperability and therefore outside the scope of RCI.

5.2 INTERFACE 2: VEHICLE INTEGRATION INTERFACE

Interface 2 defines how the OBE can be installed in the vehicle. Since the operation of road charging services requires a tamper-proof fitting of the OBE, it can require exchange of data through microwaves through a special open window in the metallised windscreen, and it could require access to in-vehicle data (tachograph and/or other in-vehicle systems), the standardisation of interface 2 has great advantages for reduction of installation time and costs. However, this interface is not considered critical for interoperability and therefore not in scope of EETS.

5.3 INTERFACE 3: HUMAN MACHINE INTERFACE

Interface 3 provides access to the OBE for human interaction. A very important function of this interface is to enable the road charging application to indicate to the service user if the OBE is operational and correctly functioning or not.

Standardisation of the HMI interface could comprise 2 elements that are essentially different:

1) Specification of what messages/information (a) the OBE at the minimum is supposed to be capable of providing to the service user and (b) the OBE at the minimum should allow the service user to provide to the OBE.

2) Specification of how these messages/information should be expressed (visual text, coloured LEDs, speech, keyboard, buttons, …)

It is noted that bullet 1 concerns the minimum functionality supported by the HMI. This minimum functionality is being defined in the Toll Context Data through the definition of what parameters can/should be specified on a dynamic basis and through the definition of under what conditions and events, the OBE is expected to generate a notification to the service user.
Concerning bullet 2, it is noted that that most drivers will use one type of OBE for a relatively long period and will become familiar with the HMI interface of that specific OBE and that standard even if there is no standard that defines how the ‘formatting’ and layout of the HMI.

As a conclusion the standardisation of the Human Machine Interface of the OBE is not considered critical for interoperability (functional HMI behaviour can be specified through interface 5 as part of the Toll Context Definition).

5.3.1 Assumptions with respect to the procedural/contractual framework:

It is assumed that before deployment of interoperable road charging at the European level, a standard or agreement is available that specifies (and limits) the functionality of the HMI (RCI recommends the use of the Toll Context Data).

The Service User has to declare changes of vehicle properties at the OBE for toll domains where such a declaration is foreseen. The variation in information that the service user is expected to configure through the HMI (e.g. vehicle classes) as well as the messages sent to the service user by the OBE through the HMI, needs to be limited and defined exhaustively through a standard or European agreement.

This standard should also without any ambiguity or contradiction specify if the OBE can or cannot be switched off and should or should not always remain in communication with the EETS Provider proxy. Since the OBE can be in operational mode for 2 or more different toll contexts simultaneously, these features should be harmonised at the European level.

RCI considers the Toll Context Data a suitable concept for standardisation of this functional HMI capability.

It is assumed that the meaning of specific HMI indication such as a red light, green light, flashing display, etc.. is not being standardised but decided upon by the EETS Provider and/or manufacturer of the equipment.

It is expected that the EETS Provider will ensure that an OBE will show uniform and consistent HMI behaviour across the different EETS-compliant tolled infrastructures in Europe.

More specifically it is expected that, an HMI indicating in one country that the OBE is not operational will use the identical HMI message as for indicating in another country that OBE is not operational. However the OBE of brand x can use a flashing LED while the OBE of brand y could use a red LED.

It is assumed that it will become part of a standard if the OBE must be capable of indicating the tariff to the service user; however, it is noted that this feature would be a potential cost driver and potentially in conflict with the allocation of the responsibility that the Toll Charger has for determining the tariff.
IF3 shows that only information present in the OBE can directly be visualised to the service user. The indication of tariff to the service user inside the vehicle therefore has significant consequences on the design of the overall road charging system.

It is furthermore noted that the Toll Charger does not have access to the OBE for sending information that is provided to the service user through the HMI. Including the functional requirement that tariff information can be given to the service user through the HMI furthermore suggests that the EETS Provider has a legal basis for providing this information which would be contradictory with the contractual framework as set out by CESARE and the EETS. The CESARE role model allocates the responsibility of the tariff calculation and approving to the Toll Charger.

5.4 INTERFACE 4: CHARGE DATA EXCHANGE / TOLL DECLARATION

This interface enables sending toll charge data (also called use data) from the EETS Provider’s Front End to the Toll Charger’s back office. This IF can also be used for localisation support via (augmentation) support beacons but only if the operation of location support beacons is considered the responsibility of the toll chargers (see assumptions)

The illustration below clearly shows a fictive example, from the perspective of a French national Toll Charger, on how European interoperable road charging involves each Toll charger receiving charging data from several different brands of Front Ends.

![Map Illustration](image)

**Figure 6: Each Toll Charger receiving charge data from multiple different EETS Providers**
It is clear that the manner through which a Front End sends its data to a Toll Charger must be standardised. It is also clear that if a Toll Charger operates a network of location support (augmentation) beacons, this interface for the exchange of location support data between the beacon and the OBE requires standardisation.

It is noted that the situation for GNSS-enabled road charging is fundamentally different to the one for DSRC-based solutions. For GNSS-enabled road charging the charge date as generated by the OBE will first be sent to the EETS Providers and (possibly after some processing) be forwarded to the Toll Charger. The interface in this case that requires standardisation is interface 4 between the EETS Provider's Front End and the Toll Charger's central equipment. For DSRC-based road charging it will be the OBE that directly communicates with the Toll Charger. This communication takes place between the OBE and the RSE beacons and does not require wireless cellular communication. For DSRC-enabled road charging, interface 4 is therefore standardised by EN 15509.

5.4.1 Assumptions with respect to the procedural/contractual framework:

It is assumed that the EETS Provider is responsible and pays for the communication of the charge data (also called use data) to the Toll Charger in case of GNSS-enabled road charging.

The RCI architecture puts the interface between the OBE and the proxy fully under the responsibility of the EETS Provider and assumes this is consistent with the CESARE role model. The EETS Provider is expected to own the communication contract and control all software and behaviour of the OBE and proxy.

It is assumed that in case of GNSS-enabled road charging, the EETS Provider will forward charge data (also called use data) that is generated by the Front End (OBE, Proxy may be used) to the Toll Charger.

For GNSS-enabled road charging it depends on the implementation choice of the Front End if the EETS Provider needs a proxy or not to ensure that the OBE-generated data is meeting the Toll Charger's requirements. In case the OBE is generating data that requires further processing by the EETS Provider, the EETS Provider will receive the OBE-generated data in his proxy, have it processed and send it then to the Toll Charger over the most reliable and cheap communication channel that he has access to (in general a fixed and wired connection). In case the OBE generates exactly those charge data records that the Toll Charger requires, no further processing by the EETS Provider is needed. Even in this case, the EETS Provider will need to know this charge data and never allow the OBE sending this data directly to the Toll Charger without having a copy. The EETS Provider therefore will receive first the data from the OBE, make a copy and then forward the data over a the most reliable and cheap communication channel that he has access to (in general a fixed and wired connection) to the Toll Charger.
It is assumed that the interface for sending charge data in case of GNSS-enabled road charging from the EETS Provider to the Toll Charger will NEVER make use of wireless communication technologies; the Toll Charger therefore is not required to operate gateways that connect to one or more mobile telecommunication networks.

Reasons: see directly above

It is assumed that the EETS Provider has the responsibility to generate and communicate charging data (also called use data) to the Toll Charger compliant to the Toll Context Data as specified and provided according to a European standard by the Toll Charger to the EETS Provider.

The RCI architecture is based on the assumption that a European standard for this exist and that this standard is being used by each Toll Charger to specify the required functional behaviour on his tolled infrastructure, the events and conditions that lead to charge object identification and the format for communicating these charge data records. RCI calls that standard the Toll Context Data standard which is IF 5.

It is assumed that for DSRC-road charging, the Toll Charger has the responsibility to operate roadside equipment to collect charging data in transactions between any OBE that is EN 15509 compliant and his RSE equipment.

The RCI architecture is based on the assumption that the interface between the EETS Provider (Front End) and the Toll Charger is standardised and allows the manufacturer to have his OBE equipment certified for use in any EETS-compliant tolling scheme.

It is assumed that the Toll Chargers and EETS Providers will agree on an appropriate interface for the communication of DSRC-enabled charge data (also called use data) from the Toll Charger to the EETS Provider.

RCI architecture includes all interfaces needed to generate the charge data, have it delivered to the Toll Charger and allowing the Toll Charger to apply compliance monitoring and enforcement. The clearing and data streams for justification between the back offices of the EETS Provider and the Toll Charger are beyond the scope of RCI.

It is assumed that the Toll Charger does not have the right/possibility to exchange information with the Front End except when using the standards for IF4 or IF6.
The EETS Provider is completely responsible for the correct operation of the Front End. As a result, access to the Front End will be controlled by the EETS Provider and the Toll Charger cannot directly access the Front End unless making use of IF6 for enforcement or IF4 for DSRC-enabled solutions and/or GNSS location support data.

This raises the following additional issue: in a GNSS environment the EETS Provider has the responsibility to indicate to OBE if it is blacklisted or grey listed. If the OBE is not informed of this, there is no possibility of informing the Service User of any black- or grey-listing; consequently, the Service User cannot be held responsible for stopping the use of tolled infrastructure being subject to EETS when he is not allowed (i.e. the EETS Provider still guarantees the payment to the Toll Charger).

**It is assumed that the Toll Charger can not communicate black/grey listing to the OBE.**

Reasons: see directly above.

**It is assumed that this interface allows localisation support beacons that are operated by the Toll Charger to send data to the OBE.**

The Toll Charger or the EETS Provider has the responsibility to operate roadside equipment supporting the identification of tolled road links in the EETS Front End (so called localisation beacons) at locations with an expected or measured insufficient success rate of the EETS Front End with respect to the correct link identification, taking into account required service levels by the Toll Charger.

If the EETS Provider would be responsible for operation of location support beacons, each EETS Provider would need to install a complete network of such beacons for one and the same tolled infrastructure. This would be an extremely expensive solution and not scalable into a European level.

RCI recommends that the responsibility for installing and operating augmentation beacons should be allocated to the Toll Charger on the basis of harmonised Key Performance Indicators and corresponding measurement methods. Access to augmentation beacons should be provided on a non-discriminatory basis to all EETS Providers by the Toll Charger. However, there should be no mandatory requirement for an EETS Provider to use augmentation beacons even if a Toll Charger provides them: as long as the EETS Provider’s equipment successfully identifies charge objects with the accuracy required by the Toll Charger, it does not matter how he achieves this.

**It is assumed that before deployment of the EETS, there will be a European agreement on harmonised Key Performance Indicators and corresponding measurement methods**
Reasons: see directly above.

Open question: what are the minimum privacy requirements?

European guide is required to ensure privacy for the service user concerning what data may and what data may not be communicated between the EETS Provider and the Toll Charger. RCI identifies the risk that different Member States could apply different requirements or increase requirements over time as such disturbing the market of possibly hundreds of thousands or even millions of in-vehicle systems.

Note this issue also applies to the proprietary IF between the OBE and the Proxy. Not all data present in the OBE perhaps may be communicated with the proxy because of privacy constraints. European agreement on this will drive industry’s design decisions with respect to thin or thick clients.

5.5 INTERFACE 5: TOLL CONTEXT DATA PUBLISHING

This interface enables the exchange of the specifications that define the specification of the Toll Chargers’ tolled infrastructure (Charge Objects, Tariff structure) and the expected behaviour of the EETS Providers systems, when transmitting data (Events, Charge data format, Service Levels). This definition is being called Toll Context Data (TCD)\(^1\). The EETS Provider has the obligation that the behaviour of its Front End is compliant to this Toll Charger’s definition. Figure 6 shows that deployment of the EETS requires that the manner any Toll Charger can define his TCD must be standardised and describes clearly and exhaustively all variety that the Toll Charger has when defining his TCD.

(Interface 5 also hosts the back office transactions/clearing between the Toll Charger and the EETS Provider as well as the communication of invalidated OBEs which is outside the scope of RCI)

It is assumed that each Toll Charger will define the Toll Context Data for his tolled infrastructure which is compliant to a European standard.

The RCI architecture is based on the principle that within the interoperability concept, those imposing and receiving the tolls or taxes should be free to define the charging in their tolled infrastructure even in case this local system is to be EETS compliant. This freedom in defining the charging for tolled infrastructure cannot be without limits in order to ensure that an existing base of operational OBEs could operate correctly.

\(^1\) It is being noted that the RCI project elaborates the Toll Context Data interface only to the extent needed for the interoperability during the generation and exchange of the charge data; information with respect to configuration data such as vehicle classes and/or tariff information, etc., are out of scope of the RCI TCD but might be further elaborated in standardisation activity under CEN278. For this reason the RCI TCD applies to GNSS-enabled road charging solutions and not to DSRC-enabled systems.
for tolled infrastructure that did not exist when these OBEs were being manufactured. This freedom should however be sufficient not to constrain toll chargers and/or Member States in defining new charging policies for tolled infrastructure.

The RCI architecture supports such freedom to toll chargers while ensuring feasibility for the implementation and potential for “horizontalisation” of the market of road charging solutions towards the EETS Provider and its suppliers.

For GNSS-enabled tolled infrastructure this toll charger’s freedom is reached through an agreed specification of the “toll context data”. Toll context data are transferred from the toll charger to the EETS provider, to inform the EETS provider about the tolled infrastructure on the following:

1. Generation of the charging data - the triggers and actions that are relevant for the generation of records with charging data and for the handling of counters (e.g. if the entry to a zone or the attachment of a trailer requires recording) -

2. Communication of the charging data - when a specific front end of the EETS Provider needs to send charging data to the Toll Charger and what data elements should be included (e.g. if a certain list of charge records must be communicated or counter values) -

This toll context data specification therefore exactly describes how any toll charger can define how he wishes to toll his infrastructure. The EETS Providers have to implement the toll context updates at the EETS Front-End of their EETS subscribers. They have to guarantee that the toll context data are up-to-date when the corresponding vehicles are using the tolled road network of the context, such that the correct charge data and enforcement data are generated. The TCD therefore does not define how the EETS Provider needs to implement the definitions; instead maximum flexibility to development and industrialisation is given in a fashion that the EETS provider can ensure that its existing stock of Front Ends will behave appropriately in any tolled infrastructure without the immediate need for replacement of software or hardware.

RCI concluded that a European standard for this TCD must become available and that each Toll Charger should publish this TCD in a manner that any EETS Provider has easy access and is being informed on any changes.

It is assumed that there are rules for the maximum frequency through which a Toll Charger can change the TCD as well as for the minimum delay for the EETS Provider to have the new or updated TCD implemented in the Front End.

RCI IF5 shows that the processing of location data into charge data can be done either in the OBE or in the proxy. New charge objects that are part of the TCD need therefore to be known by the OBE or the proxy. European agreement on this will drive industry’s design decisions with respect to thin or thick clients as well as mechanisms through which the Front End’s software can be updated.
It is assumed that the format and exchange of Toll Context Data can not be object of bilateral agreements between EETS Provider and Toll Charger but need to be subject of one European standard.

Lacking a European standard for this toll context data and methods for certification could potentially block new EETS Providers from entering a market if there if no suitable and European version available for each Toll Charger Toll Context Data.

Furthermore a lack of a standard for the toll context data would result in the situation that existing Front End cannot be guaranteed to support new EETS schemes. As such it would block a European market development and decrease chances for economies of scale and related cost reductions.

It is assumed that there is European support and acceptation for the fact that the functionality of any new EETS-compliant tolling scheme can only be defined using the standardised TCD and is as such constrained by a European standard.

It is assumed – this needs validation when a standard would be drafted - that all functionality needed (from business or from policy perspective) is supported by the standardised European TCD. RCI showed how Toll Collect and LSVA could be translated into such a TCD.

Open question: who is responsible for the provision of geographic coordinates in a standardised geodetic model for all charge objects in GNSS-enabled road charging scheme?

The Toll Charger has the responsibility to define all charge objects as part of this TCD, but it needs to be clarified at what level of detail the charge objects have to be defined. If the Toll Charger is responsible for the provision of geographic coordinates in a standardised geodetic model, there could be a risk of lack of legal clarity in the event that the final performance by the Front End is not sufficient (is this because of the Front End itself or because of the inaccurate definition of the charge objects used?). If this is the EETS Provider then each EETS Provider will have to generate or buy a good implementation of these charge objects for each tolled infrastructure. This is a potential market killer. If this is being done on the basis of bilateral agreements between the Toll Charger and the EETS Provider this is a risk for free market entry and fair market. The issue is the distinction between the task of the toll charger to identify charge objects uniquely and that of the EETS Provider to ensure that charge objects are correctly recognised.

5.6 INTERFACE 6: ENFORCEMENT

This interface enables the Toll Charger to carry out enforcement and compliance checking transactions with the OBE.
Open question: is compliance monitoring and enforcement being carried out through interrogation of the OBE only or through a combination of interrogation of the OBE and the proxy?

For GNSS-enabled road charging it needs to be clarified if there is the obligation for the EETS Provider to enable the Toll Charger to communicate directly with the OBE all enforcement data, or if it is allowed that the Toll Charger retrieves specific data from the EETS Provider's proxy?

The RCI interface number 6 can drive design choice of industry for thin or thick client and urgently needs to be clarified. RCI experience shows that off-board processing of location data into charge data results in a ‘thin’ OBE that cannot fully meet existing enforcement requirements by Toll Collect and Swiss Customs; these systems would require some modification in order to accept thin OBE. It should be clarified if and how Europe can define the Toll Charger enforcement requirements to maximise industrial freedom for optimisation and to ensure Toll Charger interests and assets to be elaborated.

5.7 PROPRIETARY INTERFACES

It is being assumed that the EETS Provider has the responsibility to inform the Service User or to disable the OBE when in GNSS-enabled tolling infrastructure in case he withdraws his payment guarantee.

If the OBE is not informed on this, there is no possibility to inform the Service User on this hand and as a consequence, the Service User cannot be held responsible for stopping the use of tolled infrastructure being subject to EETS when he is not allowed.

It is being assumed that the EETS Provider has the capability for remote data and software update of the OBE through a proprietary interface.

5.8 GENERIC ASSUMPTIONS THAT APPLY

It is assumed that a sound European standard will exist that defines the Key Performance Indicators and measurement methods that will provide the cornerstone for establishing trust and confidence between the Toll Chargers and EETS Providers.

Critical for successful operation of the EETS is trust and confidence between and among Toll Chargers and EETS Providers. RCI experience shows that certification of the equipment is not sufficient. Instead, continuous certification of the quality and monitoring of the quality by the Toll Charger of the service as operated by the EETS Provider and vice versa is a fundamental process in operation of the EETS at the European level. At this moment CESARE is identifying what such contractual and procedural obligations for both roles are and how decisions in this domain can be taken; however the operation thereof and any decision-making process requires
cost-effective methods that can be proposed including a harmonized set of Key Performance Indicators as well as on the methods for measuring these¹.

RCI assumes that before GNSS-enabled interoperable road charging can be deployed, the contractual and procedural frameworks covering this aspect are in place as well as that the KPI and measurement methods have been harmonized and clearly specified at the European level.

¹ Example 1 monitoring EETS Provider’s service: How to measure the accuracy of the detection of charge objects by the EETS Provider and what is the European performance level that must be met. If different for all Toll Chargers, (1) industry cannot guarantee its products meet the requirements in the market of tomorrow, (2) EETS Providers will have difficulty understanding/negotiating/accepting all service level agreements and (3) Toll Chargers will have difficulty applying monitoring on the service of EETS Providers that are not operating frequently on their tolled infrastructure.

Example 2 monitoring Toll Charger’s service: the accuracy of how the TDL-based charge records are being created depends on the accuracy of the definition of the charge objects and on the availability and the performance of location support beacons. The accuracy of the definition of charge objects is expected to fall under responsibility of the Toll Charger but is (1) an important design- and cost-driver for manufacturing performing solutions as well as for (2) EETS Providers in identifying the need to install additional location support.