



Report of Expert Group 9

Working to support the European Commission
on the work on **Directive 2004/52/EC**

Specification of the EFC application based on satellite technologies

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1. Introduction and scope

1.1 Scope

This is the report of the expert group (EG) number 9, which was set up in response to the recommendations from EG5 to prepare outline functional specifications for Electronic Fee Collection (EFC) based on satellite technologies.

The focus of EG9 is the requirement to specify the functionality of the European Electronic Toll Service (EETS) as required in the European Directive 2004/52/EC (the 'interoperability directive'). This can be thought of as specifying for GNSS/CN-based systems the equivalent of the DSRC transaction to support the EETS. In practice it will involve a number of data exchanges or transactions.

In addition to the primary objective of preparing outline functional specifications for the EETS, the following specific EG5 recommendations are also mentioned in the remit of EG9:

1. The Commission should arrange for more detailed investigation of charge system definition limits.
2. The Commission should arrange for more detailed investigation of minimum HMI requirements for the EETS OBE.
3. The Commission should arrange for the validation and/or refinement of the position accuracy requirements contained in the first draft of the MISTER.
4. The Commission should arrange for investigation for the conditions for the deployment of a minimum set of safety services the EETS OBE should support in order to facilitate the deployment of ITS services using the opportunity of the EETS deployment in vehicles.
5. The Commission should strongly recommend the inclusion in the EETS OBE of at least those safety functions which do not significantly increase OBE cost. Further studies should be launched on this issue. MISTER should already start to include the required elements.

This introductory section discusses some of the key points of the EETS, and the way in which it might be expected to operate. It then introduces the structure of the remainder of the report.

1.2 What is the EETS?

The EETS is described in the interoperability directive, and the key phrase defining its scope is the following: "Operators shall make available to interested users on-board equipment which is suitable for use with all electronic toll systems in service in the Member States".

Thus there is *no* requirement on operators to modify the operation of their own EFC systems, only to be able to offer, and to support within their own systems, on-board equipment (OBE) which will be acceptable as an alternative to OBE already offered. There is no requirement for systems operators to replace their own OBE with EETS-compatible OBE, only to ensure that users can acquire and use EETS OBE if they wish to do so.

At the technical level (which is the level at which this report is addressed), the EETS therefore comprises the availability of suitable OBE which will operate in all European EFC systems. This will ensure that users of the EETS are able to have "one box per vehicle". This is not sufficient to ensure that there is only a single contract per vehicle; this is outside the scope of this expert group and is being investigated within the CESARE III project.

In order to complete the technical definition of the EETS it is necessary to specify exactly the minimum technical specifications of an EETS on-board equipment (OBE), and to define the technical and functional limits of any charge system with which the EETS OBE should operate. In other words, as well as defining the minimum technical specifications of the OBE, it is necessary to circumscribe some technical aspects of *any* EFC system in Europe. Clearly any restrictions which might follow from limiting the charge system definition should in an ideal world not entail any modification to the scope of any existing EFC system. For pragmatic reasons it may be desirable to introduce some additional requirements on system operators in order to be able to support EETS OBE, although these additional requirements should be kept to a minimum. Once the EETS definition is agreed and finalised within Europe, it will be necessary for any *new* EFC system to adhere to the restrictions which follow from the EETS definition.

1.3 Example of EETS operation

If a user has an EETS OBE he should be able to use it instead of any locally-issued OBE in any European EFC system. As the user's vehicle moves between different EFC systems in Europe the OBE will be capable of operating and generating whatever charge data and information is required in each of the EFC systems in force.

Thus the EETS OBE will have to have the technical capability of communicating with whatever roadside or central equipment is part of any European operator's system. In particular the EETS OBE will have to support the three technologies specifically identified in the directive (i.e. GNSS, 5.8GHz microwave and GSM/GPRS).

1.4 MISTER and ISO 17575

The Minimum Interoperability Specification for Tolling on European Roads (MISTER) is currently a draft document which was produced in 2004 by the contract team working for the Commission on the finalisation of the draft standard ISO 17575. This draft standard provides for a set of standardised transactions for communication between on-board and central equipment in an EFC system based on Global Navigation Satellite Systems (GNSS) and Cellular Network (CN) communication. The MISTER was intended as a first draft of the EETS specification, in particular of the EETS OBE.

The MISTER is currently an incomplete draft. It has been provided to the RCI project which is expected to modify and extend the current draft. The scope of EG9 includes a review of the modifications which need to be made to the current draft of the MISTER and liaison with RCI in order to recommend further work. Some considerable work has been carried out on the MISTER by one EG9 member to bring it into line with the EG9 recommendations contained within this report, and the result, MISTER version 2.8, is submitted to the Commission in parallel with this report. The document is not yet complete and still requires a significant amount of work to become fully accepted as the basis of the EETS definition,

In its final form, the MISTER should provide the basis of the technical specification for the EETS.

1.5 Practical considerations

The draft standard ISO 17575 provides a wide range of features which might be included in EFC systems. It would be possible to determine the specification of the EETS in order to include most or all of these features, but this would not be a practical proposition: such an OBE would be expensive and would require significant software and technical development. It might be more realistic to envisage an EETS OBE with a restricted set of features, for which technical specifications could be agreed and which could be produced at a realistic price. However, this might mean that European EFC operators might have to agree upon some restrictions on the performance and functionality of EETS OBE compared with OBE which they offered themselves.

The investigation of this potential level of compromise and its consequences is one of the key areas investigated by EG9 and covered in this report.

1.6 Structure of this report

EG9 members contributed a significant amount of material on the development of the EETS. This report is only a summary of the main findings and conclusions of the group; more detailed additional material is submitted to the Commission in annexes.

Section 2 discusses operational and high-level architectural requirements for the EETS, and relates them to the work on-going in the CESARE III project.

Section 3 discusses the charge system definition limits which will need to be agreed in order to define the EETS.

Section 4 identifies the key choices which must be made in order to define the EETS and presents a choice of high level functional solutions.

Section 5 describes the assessment framework with which the EETS functional solutions have been assessed, describes the advantages and disadvantages of the three most preferred options, and identifies the single preferred option, the “intelligent client”.

Section 6 presents the key elements of the recommended “intelligent client” solution.

Sections 7, 8 and 9 present the expert group’s recommendation on HMI, positional accuracy and additional services such as safety services.

Finally, section 10 summarises the EG9 conclusions.

2. Organisational architecture and operational requirements

2.1 Organisational architecture

CESARE III is expected to produce a high level model, based on the requirements of the EETS. EG9 has based its work on the model understood to have been drafted within CESARE III, illustrated in Figure 1 below. This does not define entities, but rather roles to be performed by actors. It is accepted that there are different organisational arrangements in each country and that these roles might be performed in different ways.

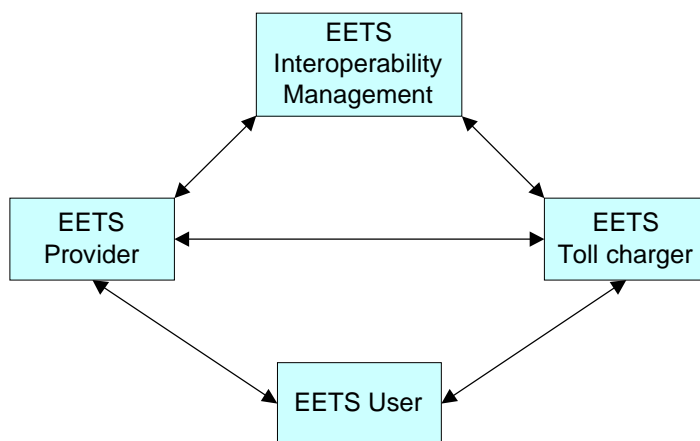


Figure 1: Assumed organisational model (from CESARE III)

At the highest level, there will need to be a management framework governing the EETS service. This management process will deal with all matters that are beyond the scope of an individual EETS provider or Toll Charger and that need to be agreed by all involved to provide the service.

EETS providers will enter into agreements with each EETS toll charger, through the common arrangements established by the Interoperability Management. This essentially means that there will be contractual relationships between all EETS providers and all EETS toll chargers. These contracts will have common service requirements, but the commercial arrangements might vary.

EETS providers will have agreements with EETS users and will need to guarantee to pay each EETS toll charger the tolls properly incurred by their clients.

2.2 Using the EETS

Users wishing to use the EETS will select an EETS Provider, who will require the user to sign a contract setting out the obligations of the parties. The user will be required to provide an acceptable payment means.

The EETS Provider provides the user with an OBE. The OBE will be personalised by the EETS Provider or his/her agent, involving some details of the contract and also some characteristics of the vehicle onto the OBE in a secure way. Once the OBE is installed in the vehicle it can be commissioned and is then ready for use.

As the vehicle travels around Europe, it will encounter different toll schemes. Depending on the exact functional solution for the EETS, the EETS OBE will automatically communicate with the central equipment (CE) of the local Toll Charger, or of the EETS provider, or of both.

The OBE may be requested to provide the Toll Charger with data which is required for calculating the charge. This might include some vehicle characteristics which are stored in the OBE and which are required by the Toll Charger. The OBE will collect data to support the required charging information and the Toll Charger will receive data as required by his charging application. This may include some security mechanism to be used by the EETS Provider in verifying the claim. The OBE may be required to include a digital signature.

The Toll Charger will collect information on the charges due for each user. These will be sorted according to EETS Provider. A claim for payment will be sent to each EETS Provider according to the terms and conditions in the contract between them. Typically, there will be a daily claim sent.

The EETS Provider will then pay the Toll Charger for the charges incurred by the user.

The EETS Provider will ask the user for payment. The user will be issued with a statement of charges covering all toll schemes. The user will pay using the agreed payment means, under the terms and conditions of the contract with the user.

If the EETS Provider encounters problems with the user, or a Toll Charger encounters problems with specific OBE, then the contract can be blacklisted. Lists of blacklisted contracts would be distributed, probably on a daily basis by the EETS Providers to all Toll Chargers. Once the user has been blacklisted, use of the contract will not be allowed, probably indicated to the driver by means of an audio/visual signal.

Each Toll Charger will have a local enforcement system, which may require the EETS OBE to be able to communicate directly with enforcement equipment which may be located at the roadside or in mobile enforcement vehicles.

3. Charge system definition limits

This section describes the charge systems which should be supported by the EETS. The EETS should be able to work with a variety of existing and future electronic tolling systems.

From a policy objective the major types of scheme to be considered are:

- Distance toll
- Location toll
- Link-based toll
- Congestion toll
- Cordon toll
- Area toll
- Time-based toll

An analysis of the requirements of each of these types of scheme led to the following functional structure, which is illustrated in Figure 2.

The basic types of scheme to be supported by the EETS OBE are:

- Measured distance toll: vehicles are charged for kilometres driven in a tolled zone. The distance is the distance of the actual vehicle track as recorded in the OBE. There may be several zones having a different fee per kilometre. The existing Swiss "LSVA" is of this type.
- Road segment toll: this toll is levied for driving on specific segments of roads. The segments may be isolated like for a bridge or tunnel toll, or be parts of a specific road or road network. With the toll being proportional to the length of the road segment, this scheme leads to a second type of distance toll. But here the distance is the sum of the predefined lengths of the road segments the vehicle used, rather than the measured length of the vehicle track. A different toll for different lanes of the same road segment is excluded. But the toll may be different for the two driving directions of the segment. The existing German "LKW Maut" is of this type.
- Closed network toll: a fee is levied for driving on a road network and depends only on the points where the vehicle enters and leaves the network.
- Cordon toll: a fee is charged when a vehicle enters or leaves a tolled zone, or in both situations. Fees may be the same in both directions, or may be different. There may be some specific combinations of entry and exit which are charged differently.
- Area toll: Vehicles are tolled for driving in a tolled zone, independent of the number of kilometres and the number of times they enter within a given time interval (for instance one day).
- Time-based toll: vehicles are charged on the basis of time spent within a zone or on a network.

The actual charge scheme of an EFC system may be a superimposition of several of these basic schemes. For instance a distance toll with a higher toll level on certain roads may be implemented in superimposing a measured distance toll and a road segment toll.

All charge rates in all schemes are potentially variable by time of the day and day of the week. It is possible for the Toll Charger to change the charge rate at short notice, for instance to reflect the level of congestion on a specific road, or the level of pollution. The charge rate also depends on vehicle characteristics as defined by EG2.

Figure 2 is a proposed categorisation system for identifying different types of charge system.

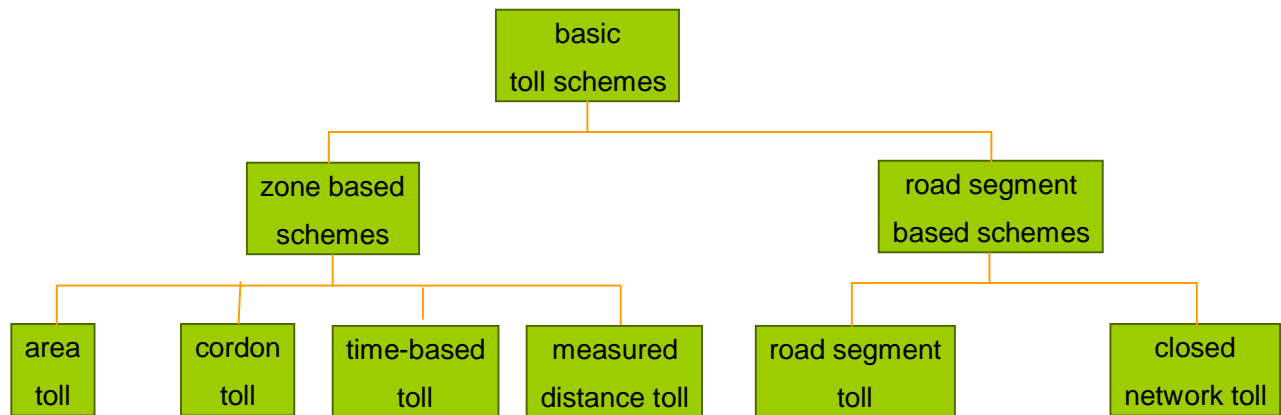


Figure 2: Proposed EFC scheme categorisation

It is proposed that the EETS should be capable of supporting all the schemes listed above and indicated in Figure 2.

There is a possibility that charges could be dependent upon vehicle occupancy (e.g. HOV¹, HOT² lanes). Potentially charges could be levied differentially by lane (e.g. surcharge for outside lane usage), although there has as yet been no specific proposal for such a scheme. It is proposed that standard EETS OBE should *not* be required to support such systems.

4. Functional solutions

4.1 Introduction

A basic requirement is that the Toll Charger must receive data from which it is possible to charge the user, via the EETS provider, the correct charge for the user's usage of the roads.

There are two fundamental issues in the EETS technical definition:

- With which entity(ies) does the EETS OBE communicate? The OBE could communicate with the Central Equipment (CE) of the Toll Charger in whose toll domain the OBE is operating, or it could communicate with CE of the EETS provider with whom the User has a contractual agreement.
- What data does the EETS OBE report to the CE? Essentially there are three levels of data, which are dependent upon the capabilities of the OBE and the requirements of the Toll Charger: the OBE could communicate simple location data; it could calculate usage data based on the recognition of geo-objects (e.g. it could identify specific road links used, or toll cordons crossed); or it could calculate actual charges incurred and communicate this to the Toll Charger

¹ High Occupancy Vehicle

² High Occupancy and/or Toll

EG9 identified four main solutions, two of which were sub-divided into further main choices, to give a set of seven feasible functional solutions for the EETS.

In each solution, there is an exchange of information between the EETS Provider and the Toll Charger to provide payment information and to support the Toll Charger's claim for payment from the EETS Provider.

The EETS OBE must provide an enforcement interface for use in any Toll Charger's regime. This is the case whichever of the feasible functional solutions is selected.

4.2 The seven feasible functional solutions

Solution 1: Permanent location reporting of the OBE to the EETS Provider's CE. The specific action is triggered at the CE. The CE, as a minimum, has to find out when the vehicle is in the (geographic) domain of a local Toll Charger and has to report to this Toll Charger. This solution leaves flexibility in what the CE reports to the Toll Charger.

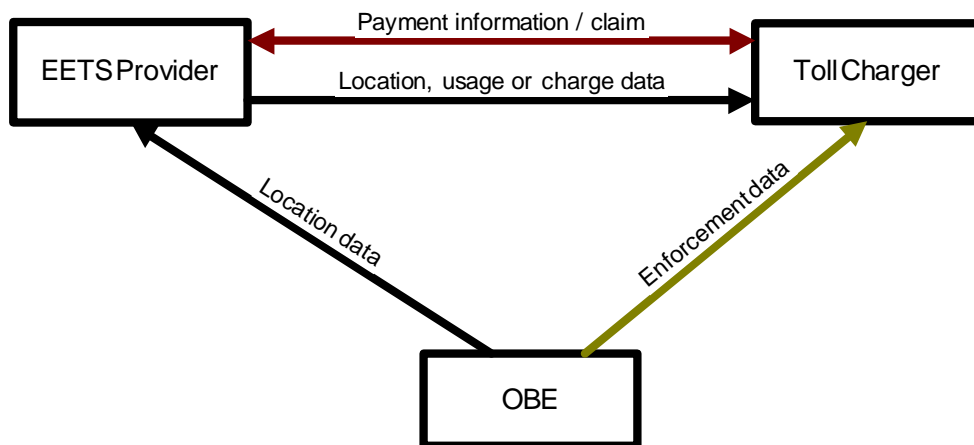


Figure 3: Main data flows for option 1

Solution 2: For all local EFC systems the part of the processing assigned to the OBE is the same. The OBE transmits the result of this processing directly to the CE of the local Toll Charger, where any remaining processing steps are performed. The CE of the local Toll Charger confirms the reception of the processed data. Depending on the processing steps assigned to the OBE, the CE (of the local Toll Charger or of the EETS provider³) may transmit specific parameters to the OBE on how the processing has to be executed.

- a) The processing at the OBE is restricted to the determination and recording of the vehicle position at predefined times (for instance every second) and possibly the times of changes of the vehicle properties relevant for the fee calculation. The records are accumulated and the complete set of accumulated records is sent to the CE from time to time. The specific parameters to be transmitted to the OBE may include the time criteria for the position determination and for sending the accumulated records as well as the changes in the vehicle properties to be recorded.

³ There are commercial issues over whether the toll context data is transmitted from the CE of the Toll Charger or of the EETS provider; these are outside the scope of EG9, since the technical solutions proposed support either approach. One of these approaches must be selected for the EETS.

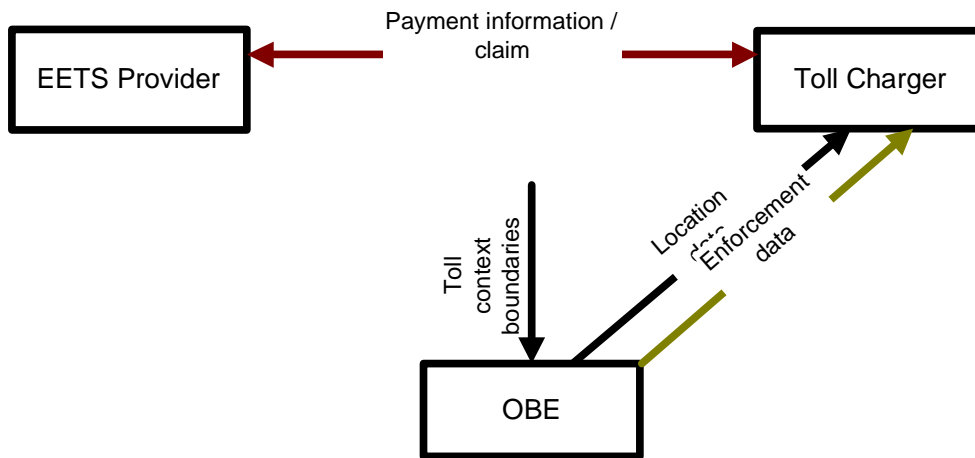


Figure 4: Main data flows for option 2a, “Thin client”⁴

- b) The OBE determines all events relevant for the fee calculation, records them and transmits the accumulated records from time to time to the CE. The events may include the use of a part of the road network subject to fee, times of changes of the fee rate and changes of vehicle properties relevant for the fee calculation. Along with the event additional values are recorded like for instance the identifier of the part of the road network used, the mileage since the last event at the time the fee rate changes, or the new vehicle properties. The specific parameters to be transmitted to the OBE include the geographic properties of the parts of the road network subject to fee, the criteria triggering the events, what to record on each type of event and the time criteria on when to send the accumulated records. In this solution the data transmitted by the OBE is referred to as usage data.

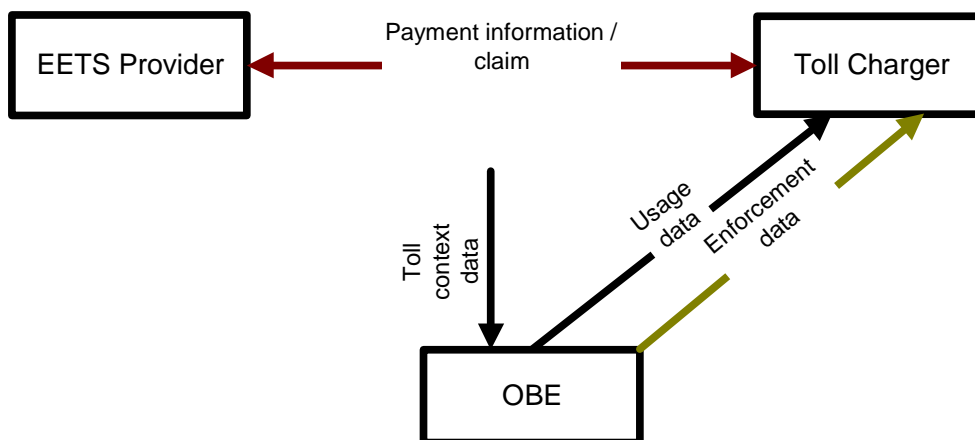


Figure 5: Main data flows for option 2b

- c) The OBE calculates the fees at times of relevant events according to the rules set out in the tariff, aggregates the fees and from time to time sends the sum to the CE or subtracts the fees from an EFC operator specific account at the OBE, with this account being reloaded from time to time in a data exchange with the CE. Along with the fee it may be necessary to send reports on the determined values relevant for fee calculation, as set out in solution 2b, or some characteristics allowing the identification of the correctness of these values later on. The specific parameters to be transmitted to the OBE are those listed in solution 2b and the tariff. The data transmitted by the OBE in this solution is referred to as charge data.

⁴ Note: in options 2 and 3 toll context data may be transmitted directly to the OBE by the toll charger, or by the EETS provider (see footnote 3).

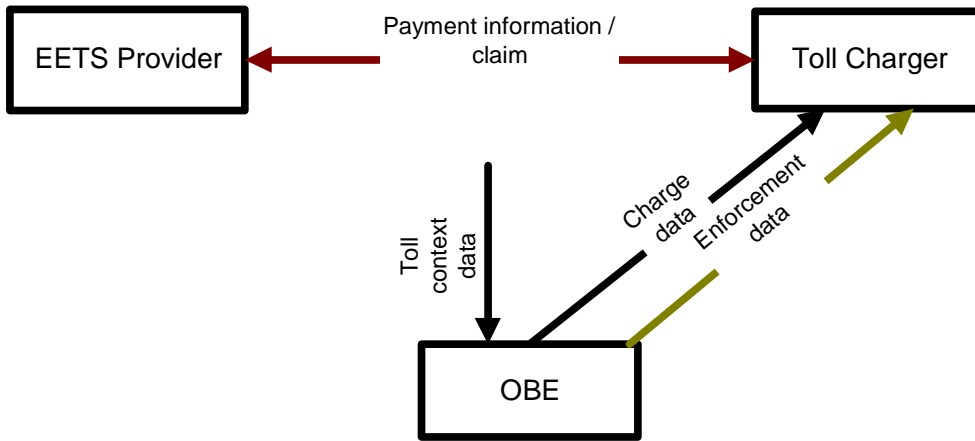


Figure 6: Main data flows for option 2c

Solution 3: Each local Toll Charger specifies for his EFC system the part of the data processing assigned to the OBE. As in solution 2, this may be transmitted by the CE of the Toll Charger or of the EETS Provider. The OBE has the capability to send the result of the data processing at different processing steps, depending on the local Toll Charger’s specification.

- a) To initialise the processing in the OBE the CE sends parameters (toll context data) to the OBE indicating what processing has to be executed there and how this has to be done. The OBE has a generic EFC application with multi-client capability – this means that the local Toll Charger can select which of the three levels of data (as in solution 2 above) his CE should receive. For each local EFC system one client is parameterised.

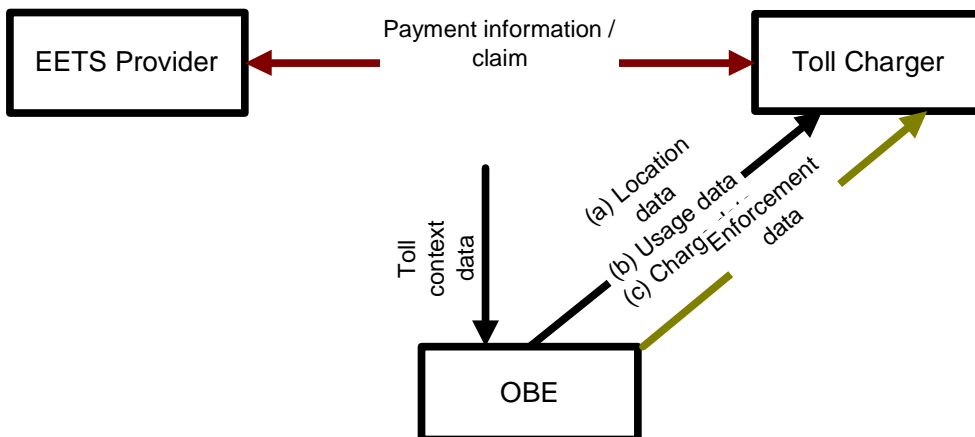


Figure 7: Main data flows for option 3a, “Intelligent client”

- b) Each local Toll Charger offers a specific software (and data) module for download from his CE to the OBE. At the time the vehicle enters the Toll Charger’s geographic domain, the software module is started to take on all necessary processing and to control the data exchange with the CE. The OBE has a generic software platform that allows executing several software modules in parallel and provides all necessary resources (like for instance vehicle positions) to each of the modules. The software platform may also include some EFC specific support functions like for instance a fee calculator.

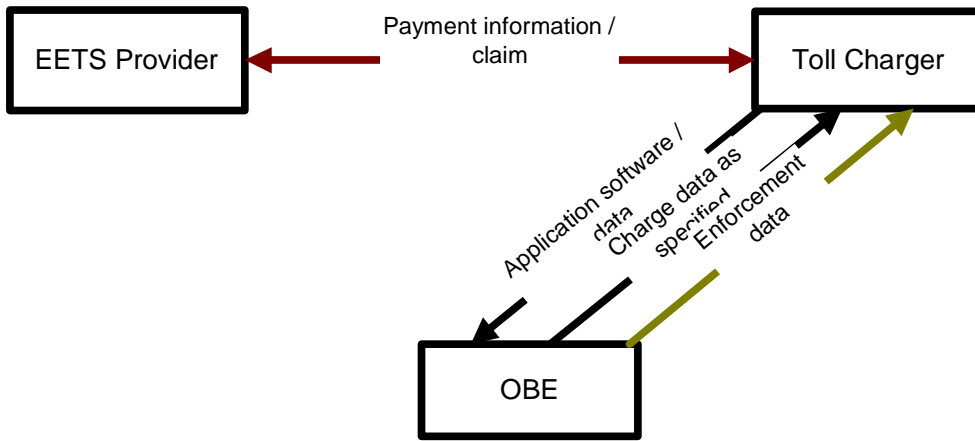


Figure 8: Main data flows for option 3b

Solution 4: The EETS OBE communicates primarily with its EETS Provider. The EETS provider has his own CE, which is able to communicate with all OBE assigned to him and with the CE of the local Toll Chargers. The local Toll Chargers define the part of the processing assigned to the OBE or to the CE of the EETS Provider, but the EETS Provider is free to decide which part of this processing takes place on board and which part centrally. In any case the task to identify the part of the road network used is assigned to the OBE/EETS Provider side. For this the local Toll Chargers forward lists of road sections and areas subject to fee to the EETS Provider. Based on these lists the EETS Provider generates the appropriate road database suitable for the specific type of OBE or CE (depending on where the identification of the road sections used is performed).

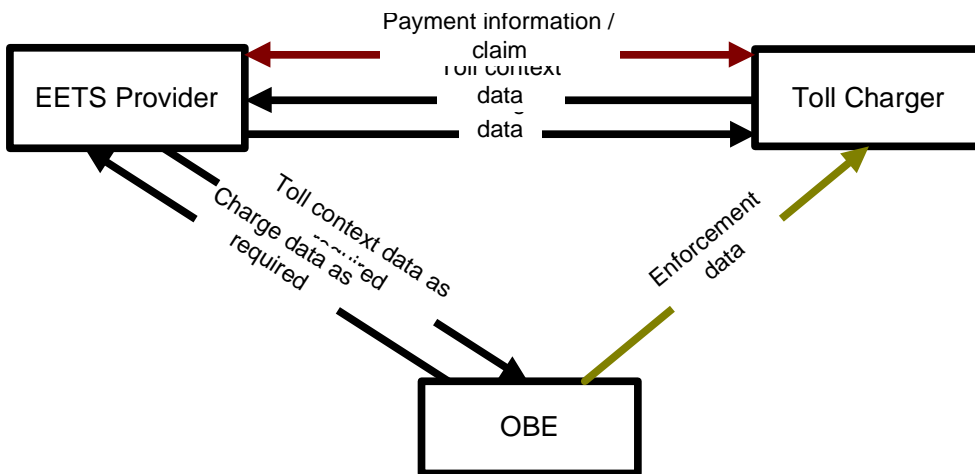


Figure 9: Main data flows for option 4, “OBE proxy”

The local Toll Chargers may install enforcement to be able to identify and prosecute violators. The enforcement system needs data from the EFC system to be able to find out if fees are collected for a specific vehicle using the road section on which the enforcement takes place. There may be the need to stop vehicles of violators on the spot and therefore to get the data from the EFC system immediately. Depending on the application, the data relating to the road section may not be available in the CE at the time of enforcement. One viable solution is to use the DSRC interface of the OBE to get the data. The type of data to be received from the OBE not only depends on which solution is selected, but also on the type of charging regime in which the enforcement takes place and on the specific enforcement requirements of the local Toll Charger. If there is no need to stop the vehicles on the spot (as the violators may be prosecuted later on), then it might be acceptable to wait until the relevant data processed at the OBE is forwarded to the CE and to take it from there. In this case the

type of data to be provided to the enforcement system could be the correct identification of the fee due for the road section on which the enforcement took place.

5. Assessment of functional solutions

EG9 conducted an assessment of the seven feasible solutions described in section 4. The following assessment criteria were taken into account:

- Supporting competition
- Supporting value-added services
- OBU using standard in-vehicle components
- Privacy protection
- Integration with other parallel toll services
- Supporting many modes and technologies for communication
- Supporting many modes and technologies for positioning
- Volume-efficient communication
- Avoiding system complexity
- Subsidiarity principle (flexibility in defining the toll scheme)
- Economically efficient
- Charging accuracy
- System reliability
- Maintainability
- Openness to technical progress
- Consistency of business model
- User friendliness
- Fraud resistance
- Enforcement flexibility
- System control
- Assignment of financial risks
- Update effort
- Ability to adapt to changing requirements
- Time for standardisation
- Testability
- IPR

Annex A to this report contains a description of the assessment process that was undertaken.

Although all seven solutions would be feasible, it was felt that four of them would impose too great a set of restrictions or additional requirements on existing and future Toll Chargers; the initial assessment therefore eliminated these four solutions, leaving three identified as the most suitable. These were the following:

- 2a: Location reporting to toll charger: identified as the “Thin Client” approach
- 3a: Flexible reporting to toll charger, identified as the “Intelligent Client” approach
- 4: Flexible reporting to EETS provider: identified as the “OBE proxy” approach

A more detailed assessment of these three solutions was conducted. Table 1 summarises the key advantages and disadvantages of each of these approaches.

Solution	Advantages	Disadvantages
<p>Thin client (2a)</p> <p>Location reporting to toll charger</p>	<p>Simpler OBE software and certification</p> <p>OBE maintenance easier (based on greater simplicity of OBE)</p> <p>Few toll data downloads (only need toll context boundaries)</p> <p>Toll chargers do not need to provide detailed toll data</p> <p>Simple to change toll schemes without downloads</p>	<p>Consequences for existing and future toll chargers and their operations (i.e. they must implement CE-based charge calculation)</p> <p>Higher communication upload volume needed</p> <p>No real time information for the driver</p> <p>Privacy issues (i.e. toll charger's central equipment will receive itineraries of EETS-equipped vehicles)</p> <p>Enforcement and dispute settlement issues – complexity of roles (i.e. OBE records do not show directly whether or not the charging and location data are consistent)</p> <p>Limits opportunities for taking advantage of certain possible advances in future in-vehicle technology (e.g. on-board road link identification)</p>
<p>Intelligent Client (3a)</p> <p>Flexible reporting to toll charger</p>	<p>Supports all existing and envisaged EFC schemes</p> <p>Minimal requirement for toll chargers to modify existing systems</p> <p>Enables the toll charger to tune EETS operation to his exact requirements</p> <p>Supports privacy requirements (i.e. depending on the toll charger's scheme, detailed location data need not be transmitted to the toll charger)</p> <p>Real-time driver feedback possible (i.e. the OBE has the capability to provide information to the driver according to the toll charger's requirements)</p> <p>OBE capable of supporting toll chargers' enforcement requirements</p> <p>High level of overall system reliability due to distributed system (i.e. the OBE has autonomous capability and can continue to</p>	<p>More complex OBE software (OBE must include range of capabilities based on standard EFC transactions as defined in MISTER and ISO 17575)</p> <p>Possibly higher development and certification costs</p> <p>Need for timely toll data download (when operating other than in location-reporting mode the OBE must have received full and up-to-date toll data from the current toll charger)</p>

	<p>operate even if the central system is unavailable)</p> <p>Provides a method for each toll charger to migrate his system (flexibility of OBE allows for system upgrades)</p>	
<p>OBE proxy (4) Flexible reporting to EETS provider</p>	<p>Allows maximum flexibility in system design (toll charger provides specifications to EETS provider)</p> <p>Toll chargers do not have to make any modifications to their local systems for charging</p> <p>Greater provision for competition between EETS providers</p> <p>No need for standardisation of OBE-CE interface for EETS units (each EETS provider can implement his own interface, which may be proprietary)</p> <p>Open to advances in location technology (EETS providers can implement new technology as it becomes available)</p> <p>Easier to add value-added services</p>	<p>Enforcement issues – OBE data available for enforcement depend on solution chosen by the EETS Provider, so toll chargers may have to implement additional processes</p> <p>EETS providers may have high local implementation and/or operational costs; each EETS provider will have to provide full European coverage</p> <p>Need to define interfaces (possibly complex) between toll chargers and EETS providers</p> <p>Single point of EETS provision failure may increase risk to toll charger (outside his control)</p>

Table 1: advantages and disadvantages of the three most suitable functional solutions

Based on the advantages and disadvantages listed in Table 1, EG9 concluded that the optimum solution for the EETS is the “Intelligent Client” solution. This imposes the least additional requirement on toll chargers’ systems and is the most likely to be able to support toll chargers’ enforcement regimes without significant modification.

Section 6 below therefore describes the Intelligent Client solution in more detail. Although this is the recommended solution of the EG9, the group nevertheless considers that other solutions *are* feasible, in particular the Thin Client and OBE proxy⁵. However, *one* of the solutions must be selected as the basis of the EETS.

6. Overview of recommended ‘Intelligent Client’ solution

6.1 Introduction

The MISTER has been updated within EG9 to reflect the recommendation for the Intelligent Client solution, although it is not yet complete. (Previous versions of the MISTER were based on solutions which allowed Toll Chargers to download software to the OBE, which corresponds to the solution 3b identified in section 4.)

One key advantage of the Intelligent Client solution is the flexibility that it offers to Toll Chargers whilst the EETS Provider, who bears responsibility for ensuring that payment is made for charges correctly incurred, retains control of the OBE.

A major factor in the EETS definition is the division of charge processing between the OBE and the CE. The Intelligent Client solution allows the Toll Charger to specify this level, as indicated in Figure 10 below.

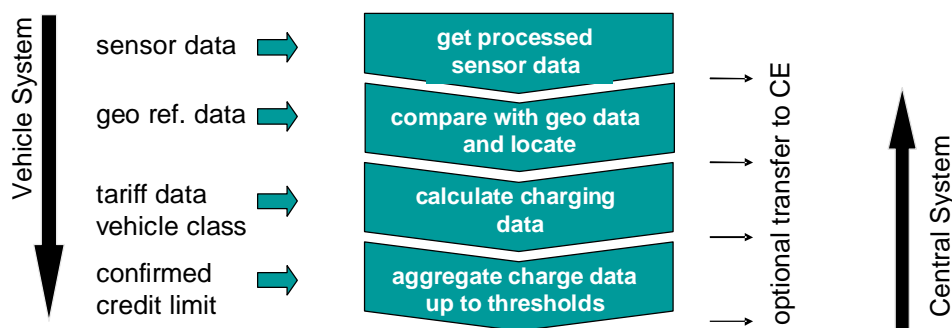


Figure 10: Range of possible charge processing division between OBE and CE

Consideration of both technical and commercial aspects led to EG9’s conclusion that it would be advisable to leave in the EETS definition some freedom for different implementations. This should include keeping the general architecture of the Swiss system (2 out of 4 process steps as illustrated in Figure 10) and the German EFC system (4 out of 4 process steps) inside the definition of EETS as well as to allow the “location reporting” mode (1 out of 4 process steps) to allow scheme definitions which may not be configurable with the EETS tariff schemes of the higher process steps.

⁵ A separate document is submitted independently to the Commission in parallel with this report which discusses the advantages of the Thin Client approach. It was submitted to the group, but does not represent the majority view within the group.

This will also allow the highest level of privacy implementation if the “4 out of 4 process steps” mode is used, when the total charges incurred but not the detailed location data are transmitted to the CE.

The draft standard ISO 17575 provides for all the messages necessary to support the range of processing options required by the Intelligent Client solution.

The recommended solution supports both on-board and central accounts and hence both pre- and post-payment.

6.2 Security

EETS is used to pay for a service. The underlying security policy is comparable with that of money transaction among banks. With that a clear policy must be defined in EETS - who trusts whom or what?

The proposed general EETS security concept assumes that the only element of the OBE the Toll Charger trusts is a simple secured device called the “Provider Identification Module” (PIM). The PIM identifies the EETS Provider having issued the OBE and makes sure that the Toll Charger can rely on the result of the enforcement, as the basis to prosecute violators. The EETS Provider and the user have the full responsibility on the proper functioning of the OBE, knowing that any attempt of fraud could be detected in the enforcement.

With that it is further assumed that the contractual relations between the Toll Charger and the EETS Provider will define the technology, processing capabilities and trust level of the PIM. It is anticipated that the currently available low-cost security modules fulfil these requirements.

6.3 Enforcement

The Intelligent Client solution, as defined in the MISTER, ensures that EETS OBEs will be able to respond to local enforcement communication requests in the same way as OBE issued by the local Toll Charger.

6.4 The EETS compatible OBE

The EETS OBE processing capabilities and its external interfaces have to be specified in detail based on the basic settings listed hereafter. The current version of MISTER is input to this and all the relevant existing and draft standards may be referenced. In some cases profiles have to be defined if the standards provide several options.

The OBE serves as a platform with a generic application supporting all GNSS/CN based charging systems. Each charging system is implemented in the generic application as a context with specific settings and data, not interfering with other contexts. The platform performs a measurement and evaluation process, records the results and reports them to external entities as appropriate according to the context settings. The contexts are configured by parameters either being stored in the OBE from the time of production or downloaded via GSM GPRS. Downloads are required if the validity of the parameters has expired or if needed for operational reasons (e.g. limited memory of the OBE). A specific "roaming" procedure guarantees that up-to-date parameters are available in the OBE at the time the toll collection process of the context in question is active. The communication addresses to get new configuration parameters are part of these parameters.

Operation in a DSRC based charging system is completely independent of the GNSS/CN platform in the OBE. But DSRC may be used by the platform as communication medium to transmit enforcement data or to get localisation data from "augmentation beacons" helping to identify used road links under conditions where GNSS is expected not to be reliable enough.

7. HMI

The definition of the EETS OBE will leave as much as possible open for individual implementations. This includes the HMI. Vehicle manufacturers in particular will apply their own “look and feel” when integrating the EETS functionally into the vehicle dashboard.

However, there is a minimum HMI requirement for the OBE to be able to interact with the driver when the driver has to initiate some immediate or short-term actions and to allow pursuance of fraud.

The HMI should allow for the declaration of vehicle characteristics in case they change because of a trailer being attached or detached. It may also provide warnings if a discrepancy between the declared and detected trailer status is found.

The HMI should indicate to the driver OBE states that require specific action:

1. do nothing – the OBE operates and will continue to operate correctly as required
2. the OBE operates as required but will not operate in the EFC domain being approached. In that domain react as if the OBE is switched off
3. the OBE has no technical problem but the associated payment process is interrupted. React as if the OBE is switched off and contact your EETS Provider
4. the OBE has functional problems but will possibly recover on its own. React as if the OBE is temporarily switched off
5. the OBE has functional problems and will not recover on its own. React as if the OBE is switched off and contact a qualified service station.

It is up to the OBE or dashboard electronic manufacturer how to represent these messages to the driver. Whatever means are selected the attention of the driver while driving shall not be interrupted more than absolutely necessary.

All messages transmitted by the OBE to the enforcement interrogator or to the Toll Charger should indicate if the OBE is in one of the degraded states as indicated above.

8. Positional accuracy

The first draft of the MISTER identified a proposed OBE locational accuracy requirement. EG9 has investigated this requirement in more depth and proposes three separate positional accuracy requirements which should be input to the certification process for EETS OBE. For the recommended functional solution, the intelligent client, all three positional accuracy requirements must be satisfied; for other functional solutions for the EETS it may be acceptable to meet fewer requirements.

The first requirement is the recognition of geo-objects. It is necessary to define a specific set of test conditions in which test geo-objects are guaranteed to be successfully recognised with a success rate of at least 99.99%. False recognition of a geo-object should be less than 1 in 10^6 .

The second requirement is absolute locational error based on a test set of road conditions. MISTER sets out a proposed accuracy probability distribution. Work is needed to be done in defining suitable test conditions which can be used to verify location performance as part of the certification process.

The third requirement is distance measurement. EG9 recommends that the EETS OBE should be certified to provide distance measurement accurate to within 2%. As for location requirements, it is necessary to define suitable test conditions which can be used to verify distance measurement performance. GNSS may be used to detect the measurement being outside the accuracy limits and to initiate a re-calibration.

9. Integration with other ITS applications

EG9 specifically considered requirements for EETS OBE to be able to provide additional services, in particular emergency services and hazardous goods (or livestock) monitoring.

The recommended EETS solution should be capable of supporting both these types of service.

In the case of e-Call, EG9 recommends that it will be a role of the EETS Interoperability Management (see Figure 1) to provide relevant e-Call numbers to EETS Providers. The EETS Provider will then be able to offer an emergency call service, ensuring that OBEs are able to call the correct number and provide vehicle and location details in the event of emergency.

For special fleet monitoring, a similar approach should be adopted: EETS OBE should have the capability of providing location information to a monitoring centre whose access details are provided, via the EETS Provider, by the EETS Interoperability Management.

EETS Providers will be able to offer additional services as part of their commercial offerings.

10. Conclusions

The work of EG9 was predicated by the CESARE III recommended high-level architecture involving the four main actors: the user, the EETS provider, the toll charger and interoperability management.

The EETS should support all current and anticipated types of EFC scheme; EG9 has proposed a categorisation scheme for EFC systems.

Based on these assumptions, *the following are the key conclusions of EG9:*

- 1. The recommended functional solution for the EETS is the 'Intelligent Client', which will provide and support all the requirements for the EETS*
- 2. EETS OBE should include a trusted security module*
- 3. Minimum HMI provisions for EETS OBE are proposed*
- 4. Minimum locational accuracy requirements are proposed*
- 5. e-Call, hazardous goods monitoring, livestock management and other ITS applications can be provided by EETS Providers, with some support from the overall EETS interoperability management.*

The proposed EG9 solution can be used as the basis of the EETS technical definition, As some of the currently open procedural issues are finalised, it will be possible to refine the EG9 solution further.

More investigation is needed on how the implementation of the EETS may be affected by existing IPR.

Resources are needed to specify the EETS OBE in detail, based on the recommendations in this report and on the MISTER and ISO 17575, both of which also need resources to be completed. There is also a need for test specifications to be developed for testing EETS OBE.