TRANSPORT & MOBILITY LEUVEN
Your link to integrated analyses !

TRANSPORT & MOBILITY LEUVEN
VITAL DECOSTERSTRAAT 67A BUS 0001
3000 LEUVEN
BELGIUM

http://www.tmleuven.be/

TEL +32 (16) 31 77 30
FAX +32 (16) 31 77 39

Author: Tom Voge
Last modified: 1 October 2008

Flemish Km-Charging Scheme Phase 2

- Technology and Implementation Issues -

Abstract

This study into developing the implementation path for the planned road user charging scheme for heavy goods vehicles (HGV) in Flanders/ Belgium included an analysis of the impacts/ effects on congestion, air quality, etc. In addition, a separate report as a background document on the different technology options was produced. For this not only technologies for HGV road charging were considered, but also those for road user charging more generally. The general objective of this study related to producing a report for the Flemish Ministry of Finance that contains background information on road user charging systems in order to aid their decision making for the planned Flemish/ Belgian km-charging scheme. The information presented in this report relate mainly to existing systems, planned systems, and stakeholder involvement. More specifically, topics of particular interest are cost estimates and functional specification, including additional services. The methodology used to meet the aims and objectives of this study, relates mainly to 2 key activities, to carry out a literature review on existing and planned road user charging schemes and any related topics and issues, and to conduct a number of expert interviews with stakeholders representing the main user-groups of a road user charging schemes. The results and findings from these 2 activities were then analysed in view of their implications for the planned scheme in Flanders/ Belgium. For the literature review any recent project reports, academic papers, technical papers, working documents, etc. on road user charging schemes, which are in the public domain were reviewed. For the expert interviews a framework of main user groups that are involved in implementing, operating, and maintaining a road user charging scheme has been developed, with the aim of conducting interviews with experts that are representing all of the main user groups that have been identified. The methodology for this study followed a 3-step-process. The first step related to carrying out the main research activities, including literature review and expert interviews. The second step is to present the results from these research activities, including functions and architecture, and costs and funding. The third step is the analysis of these results to formulate recommendations for implementation.

Table of Contents

List of Figures

1. Introduction

The proposed phase 2 study into developing the implementation path for the planned road user charging scheme for heavy goods vehicles (HGV) in Flanders includes an analysis of the impacts/ effects on congestion, air quality, etc. In addition, a separate report as a background document on the different technology options will be produced. For this not only technologies for HGV road charging will be considered, but also those for road user charging more generally.

A first step will then be to review the state-of-the-art of technologies used for road user charging:

- Satellite positioning (GPS/ GNSS)
- Mobile communication (GSM/ GPRS)
- Short-range communication (DSRC)
- Automatic number plate recognition (ANPR)
- Practical issues of on-board unit (OBU)

A number of different scenarios and operating characteristics of the system could be considered:

- Distance travelled
- Weight of vehicle
- Vehicle type
- Emission class
- Time and/ or day

Based on this, costs (e.g. capital costs for the infrastructure/ technology components and the operating/ communication costs) from existing systems will be compiled and analysed in view of their implications for the Belgian situation. Furthermore, in addition to the capital/investment and operating costs for the system, other costs, including costs for the government and for the end-users will also be compiled based on structured interviews with the key stakeholders.

Other issues to be considered in connection with the study into HGV road charging in Belgium relate to potential compensation of national road hauliers and interoperability of the technology (particularly OBU) on international/ EU level. Whilst the technology is mainly targeted at frequent users of the scheme, it also has to cater for infrequent users, who will not have an OBU in the vehicle and for who, due to infrequent use, fitting of an OBU would not be economically viable.

The general objective of this study relate to producing a report for the Flemish Ministry of Finance that contains background information on road user charging systems in order to aid their decision making for the planned Flemish km-charging scheme. The information presented in this report relate mainly to existing systems, planned systems, and stakeholder involvement. More specifically, topics of particular interest are cost estimates and functional specification, including additional services.

In terms of a cost estimation, some first indications of the costs for the preferred implementation scenario for the Flemish km-charging scheme are an important issue at this stage of the process. The cost categories include implementation, operation, maintenance, and enforcement costs. These main categories can then be further broken down into sub-categories, e.g. the implementation cost can be split into individual amounts for specific system components and items of the physical architecture.

With growing importance of and political interest in distance-based road user charging schemes on an international / European level, interoperability of schemes is a key issue. It is particularly important for the haulage and logistics industry to have interoperable systems, in order to minimise the impact of using the scheme. The current approach to encourage the implementation of interoperable systems is the use of a common standardised functional architecture for road user charging schemes in Europe.

In addition to the core functions of a road user charging scheme, i.e. vehicle detection and tracking, calculation of fees, and processing of payments, a variety of additional services can be implemented as add-on services. These services include pay-as-you-drive (PAYD) insurance or international road charge agency (potentially also including road tax). PAYD insurance offers fairer fees based on actual mileage driven and road charge agencies are particularly interesting for the haulage industry.

The methodology used to meet the aims and objectives of this study, as described above, relates mainly to 2 key activities, to carry out a literature review on existing and planned road user charging schemes and any related topics and issues, and to conduct a number of expert interviews with stakeholders representing the main user-groups of a road user charging scheme. The results and findings from these 2 activities will then be analysed in view of their implications for the planned scheme in Flanders.

For the literature review any recent project reports, academic papers, technical papers, working documents, etc. on road user charging schemes, which are in the public domain will be reviewed. For the expert interviews a framework of main user groups that are involved in implementing, operating, and maintaining a road user charging scheme will be developed, with the aim of conducting interviews with experts that are representing all of the main user groups that have been identified.

The methodology for this study will follow a 3-step-process. The first step relates to carrying out the main research activities, including literature review and expert interviews. The second step is to present the results from these research activities, including functions and architecture, and costs and funding. The third step is the analysis of these results to formulate recommendations for implementation.

2. Analysis Activities

2.1 Literature Review

As described above, the first key analysis activity in this study is a review of recent literature on road user charging schemes, of particular interest are any information on experiences from existing schemes and the planning and implementation process of schemes that are currently under consideration. Findings from this activity will then be complemented by the expert interviews. The results from both these activities will be the input for the main analysis of this report.

In the following the analysis for the literature review will be summarised, including the general analysis framework, specifying the key issues to be covered, the main schemes and projects to be included and the contents and characteristics of the documents that have been reviewed. The literature review on road user charging schemes has to cover all the main topics and issues which are of interest to the Flemish Ministry of Finance at this stage of their decision making process for the planned implementation of a Km-charging system in Flanders / Belgium.

The key issues that have been identified for the purposes of this study include the following:

- Functional Architecture
- Technology and Systems
- Operating Characteristics
- System Interoperability
- State-of-the-Art of Schemes
- On-Board Equipment
- Infrequent Users
- Additional Services
- Haulage Industry
- Euro-Vignette Directive
- Capital and Operating Costs
- Public-Private Partnerships
- Misuse and Enforcement

Systems of particular interest are the existing systems in Germany, Austria, Switzerland, and the Czech Republic, and the planned systems in France, the Netherlands, and the UK (projects include AUTOPASS, ASFINAG, LSVA, TELEPASS, TIS, TOLL COLLECT, VIA-T, VIA VERDE, and LRUC). The CESARE III and RCI project are addressing interoperability. In the following brief summaries of the main findings, contents, and characteristics of the documents reviewed as part of the literature review carried out as part of the background review for the Flemish Ministry of Finance as a basis for their decision making on the implementation of a road user charging scheme will be given.

The ARENA project aims to develop a road user charging system for HGVs in Sweden. In order to create a system that takes the needs of all parties into consideration, the charging system is being developed in cooperation with authorities, researchers, road users and private enterprises. The project is planning an independent trial and demo with focus on interoperability. The way forward is to build networks with countries involved with road user charging for HGVs. Especially countries which currently plan or consider nationwide systems. Cooperation on an European level is crucial for the development of the EFC directive and to achieve the European toll service. Members of the project are represented in standardisation work and contribute to European development promoting innovative solutions.

The CESARE project aims at specifying, designing, developing, promoting and implementing a common interoperable Electronic Fee Collection System, allowing users to travel through the overall network and pay for tolls with a unique technical and contractual means, obtained by signing a contract with one of the possible providers, under an agreement signed by toll road operators referred to as Memorandum of Understanding. Users will have a unique interface to the service, referred to as payment mean issuer, providing a contractual and a technical instrument to access the service. The user shall be able to use such instrument throughout the network, receiving a periodical statement of the transits performed and invoice from the same issuer, charging on behalf of all operators. Recently recommendations were updated.

The Dutch Government intends to introduce a different form of payment for mobility. Not vehicle ownership will be the basis for payment, but the use of a vehicle. The government decision follows the broadly supported advice of the Platform Anders Betalen voor Mobiliteit: the introduction of a nationwide price per km on all roads, differentiated by time, place and environmental characteristics. One of the conditions of the government to the introduction of a km price is that implementation costs are considerably lower than the average cost of € 3 billion estimated in 2005. The operational and enforcement costs should be proportionate to the revenue, below 5%. This cost benchmarking analyses costs and features associated with a km price for time, place and environmental characteristics.

A review of Public Private Partnerships was carried out by PWC. In order to bridge the growing gap between the cost of the infrastructure needed and the resources available, and to ensure that the infrastructure is delivered as efficiently and cost-effectively as possible, the key question is how to deliver cost-efficient investment. In this context, PPPs are a growing element of public sector procurement across Europe. PPP procurement is only one of several options for procuring infrastructure. Consideration must be given if a project is suited to a PPP structure, and if there is strong political support for PPP. The principal reason for using PPPs is that, where the project is suitable, they can deliver better value for money. Arguments for/ against PPPs must be considered in view of the overriding objective.

The aim of the Expert Groups EG1 and EG2 is to provide a view of the functional architecture of the onboard unit solutions, to express the conditions for their feasibility, and to list the remaining technical questions that need to be solved prior to their development. All new electronic toll systems brought into service on or after 1 January 2007 shall, for carrying out electronic toll transactions, use one or more of the following technologies: satellite positioning, mobile communications, using the GSM-GPRS, and 5.8 GHz microwave technology. 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 using the technologies which are suitable for use in all types of vehicle, thus enabling EU-wide interoperability.

An EU wide revue of road user charging schemes was carried out. This paper aims to provide a comprehensive overview of the current activities in the area road user charging (RUC) for heavy goods vehicles in Europe, more commonly known as Lorry Road User Charging (LRUC). The paper includes descriptions of the road user charging activities in the countries that have already implemented, as well as bringing together information on those who are either currently undertaking a procurement exercise or who are showing interest in the future adoption of such a system. The paper also considers what can be learnt from the trend towards LRUC and the developments by the EC, national road authorities and road operators towards achieving some level of interoperability between the systems and the technology.

The Danish Ministry for Transport and Energy is investigating the effects of replacing the existing Eurovignette cooperation with Sweden, Holland, Belgium and Luxemburg with a distance based Heavy Goods Vehicle charging scheme for Denmark. In 2006 a study has been conducted for estimating the financial effects on the costs and income corresponding to alternative charging scenarios. Four Scenarios have been determined using two alternative technologies, network charging with satellite positioning technology and tag and beacon technology, and area charging with distance charging based on tachograph impulses and charging based on driving time using motion sensors. Estimates of costs and revenues were compared with the benchmark figures from other European HGV charging systems.

A Pre-study for a Road User Charging (RUC) scheme in Finland has been commissioned by the Finnish Ministry of Transport and Communication and by the Road Administration Authority in the autumn of 2005. Finland does not yet apply road user charges (expect general vehicle taxes). However, the environment is changing as other European countries apply or plan to introduce RUC especially for Heavy Goods Vehicles and European Transport Policy favours taxation of road use rather than of vehicle taxation. The main results of this pre-study are a general overview on the general principles and constraints for RUC, the existing and planned RUC-systems in various European countries and the starting points, possibilities, and potential impacts for the implementation of such a scheme in Finland.

The experiences from the German scheme are described. After many delays, technological problems, and renegotiations between the government and the system operator Germany has successfully introduced a satellite based tolling system HGVs in January 2005. Since then the system is running smoothly. Currently the toll applies only to state motorways (the so called Autobahnen) but there are plans to extend it to the secondary level of federal long-distance roads (the Bundesfernstraßen). This paper describes the political and economic background of the introduction of the HGV-toll in Germany. The paper sketches the history of the implementation process, describes the major structural elements of the toll, and discusses current problems and possible future developments. Some policy related conclusions are drawn.

An essay on the future of road charging based on numerous projects and events coordinated with the support of European organisations in the fields of telematics, road charging and preventive safety was written by ERTICO. It analyses the relation between the markets for road charging and other vehicle-related services, the expected developments and how these markets can be influenced by interaction between public authorities and industry. It is concluded that the evolution towards an open and competitive horizontal market for road-charging, that shows synergies with the telematics and ADAS market can not be driven by industry alone. It needs PPPs and Member States intending to procure national road charging to take an early decision to give preference to proposals based on open standards.

The RCI project will develop an open, integrated framework enabling road charging interoperability at the technical (and related procedural) level based on the key existing and planned road charging deployments in Europe (AUTOPASS, ASFINAG, LSVA, TELEPASS, TIS, TOLL COLLECT, VIA-T and VIA VERDE). It will implement and test this framework in field trials at 6 sites, namely Austria, France, Germany, Italy, Spain and Switzerland. The aim is to specify the basic concepts for operation, the functional behaviour, the external interfaces, the security concept and any further technical aspects. The specifications and recommendations are split into 3 deliverables: operational procedures architecture, minimum architecture for interoperability, and security architecture for interoperability.

A review of HGV road user charging schemes was carried out to analyse which impacts the implemented systems have had on route choice, modal choice, choice of vehicles and logistics. Another aim is to investigate how regional impacts were considered when the road charging was designed and, how they influenced system design. Distance based road user charging for HGVs is on the political agenda in Sweden as well as in Europe. Charging for the use of infrastructure is not a new concept. New, however, is the increased ability to reflect the socio-economic marginal costs and contribute to achieving general transport policy objectives. The aims for implementation vary between, infrastructure financing, reducing congestion, increasing efficiency and influencing mode choice.

A review of the planned system in the UK was carried out. There is a growing view among British road hauliers that, under the pretext of taxing foreign truck, the government is about to implement a complex tolling system that will be expensive to set up and is mainly aimed at creating an additional revenue stream. A comparison of the tax income from foreign vehicles with the likely costs of operating the system confirms that the scheme cannot be justified solely as a means of creating a fairer cost distribution with foreign logistics companies. The case for introducing road user charging for HGVs is much less pressing in the UK than in central European countries. If LRUC is to be adopted, it implementation should be delayed until it can be applied to all vehicles and common standards are established.

The experience from the system developed in Germany has been reviewed after the first 2 years of operation. A motorway network is a “living” object, with many sections being added or modified each month. Thus, when comparing tolling techniques for such a network, one should measure the investment over many years. Flexibility in a tolled network is very important. In each case, only a remodelling of the network software, not an investment in new infrastructure, was required. The component costs of the network have followed the normal pattern of a product’s life cycle. Within less than 10 years, the investment costs will be reduced fivefold. If this technology were extended to private cars, the economies of scale would be even greater and the costs could then be reduced even more.

The FRAME project was aimed at developing an European ITS Framework Architecture. Functional Architecture defines and describes what functionality needs to be included in a System that can fulfil the requirements of User Needs. This document describes the Functional Architecture in detail and also covers the methodology used. It shows how the Architecture links to the outside world through terminators and how it has been divided into Functional Areas. The way in which these have been divided into Functions is also included, together with diagrams for all the Areas. These diagrams show how the Functions relate to each other, to Data Stores and to the terminators through Data Flows. Details of the Information Architecture are provided through the description of Data Flows and Data Stores.

2.2 Expert Interviews

As described above in the objectives and methodology sections a number of expert interviews were carried out. These interviews were conducted with the main stakeholders involved in planning, funding, operating, maintaining, enforcing, and using a road user charging scheme. These main user groups will be identified and their roles will then be defined in more detail in the section below. The aims and objectives of these expert interviews were to gather the views of experts representing the main user groups for road user charging. This will enable a sound background analysis of themes and topics to consider for a successful system implementation. This information together with results from the literature review will form the main input for the state-of-the-art and the impacts analysis.

The following key user groups for a road user charging scheme were identified:

- Haulage and logistics
- Technology provider
- Industry / businesses
- Environmental lobby

Most road user charging schemes a either solely or at least for the implementation phase targeted at heavy good vehicles, which also represent the vehicles with the highest emissions and most wear and tear of the road surface. Thus the haulage and logistics industry is heavily affected by such a system resulting in higher costs for them. This can partly be addressed by improved efficiency, i.e. less running of empty vehicles, but exemption or discounts for national / local companies is another issue.

Setting up a road user charging scheme relates to the implementation a variety of system components and technologies for e.g. detection, communication, location information, billing, databases, etc. For this a number of technology providers have to be involved for setting up, operating, maintaining and enforcing the scheme. For them this has to be a profitable business, but topics such as interoperability of systems, additional services, and standards and certification are also very important issues.

In addition to specific technology providers for road user charging systems the haulage and logistics industry specifically, industry and businesses more generally are also affected by and want to have an input into the implementation of a road user charging scheme. Again, as described above, for them such a scheme can be both a challenge (being adversely affected by extra costs) and an opportunity (providing product and services directly or indirectly connected to a road user charging scheme).

Most road user charging schemes are directly targeting the internalisation of externalities of road traffic (Euro-Vignette), getting road users to pay the full price for maintaining the road infrastructure and for any environmental damage, and to have a fair allocation of costs to users based on usage and emissions. Therefore the environmental lobby and NGOs play an important role in influencing decisions on defining the operating characteristics of a road user charging scheme to be implemented, in terms of magnitude of charges and when and according to which characteristics they are applied.

As already mentioned above, in addition to the core business of running a road user charging scheme, the operation, maintenance, enforcement, and payment processing, a number of additional services can be implemented. Therefore general service providers are another important user groups, as they can exploit the additional business opportunities of such a scheme through the implementation of add-on services, such as e.g. pay-as-you-drive insurances, or international fee collection.

Finally, maybe the most important user group are the systems end-users and/ or the general public. The implementation of a road user charging scheme will affect this user group most directly. The scheme will mean additional direct (km-based charge) and indirect costs (compliance cost for obtaining information on the scheme, making payments, buying/ installing on-board unit) to them. Therefore effective communication of all aspects of the scheme to the public is key to its success.

In order to have a sound background for the state-of-the-art and impacts analysis in the following sections the expert interviews were carried out with stakeholders representing all main user groups identified for a road user charging scheme and as described above. A total of 7 expert interviews were carried out. In order to be able to compare outcomes of these interviews, they were conducted in a structured and consistent manner. At the beginning of each interview a brief presentation on this project and the main objectives of the interview was described, followed by a number of key topics.

These key topics covered in the interview included, but were not restricted to, functional architecture, technology and systems, operating characteristics, system interoperability, on-board equipment, infrequent users, additional services, haulage Industry, Euro-Vignette Directive, capital and operating Costs; Public-Private Partnerships, and misuse and enforcement. The main results of these interviews will be summarised in the following sections and form input for the main analysis.

The expert interviews carried out were with the following organisations and companies (with the main user group being represented by them described in brackets):

- ERTICO - ITS Europe (Industry/ business)
- Satellic/ TollCollect (Technology provider)
- Federation for Transport and the Environment T&E (Environmental Lobby)
- EuroCommerce (Haulage and Logistics)
- Logica (Technology provider)

In the following the results from all expert meetings will be briefly summarised. For this the outcomes will be described under the heading of each of the interview participants.

ERTICO generally are representing a Europe-wide membership base of industry partners in the area of intelligent transport systems and telematics. More specifically they are project coordinators of the EC-funded RCI project. The RCI project is aimed at EU wide system interoperability of road user charging schemes and has developed a standardised functional architecture. The efforts of ERTICO/ RCI partners in this area are currently de-coupled from the Euro Vignette Directive. Main activities relate to interoperability in terms of standardisation, certification, and architecture. At this stage only demonstrations of the concept were carried out and the recommendations are not mandatory. Work on future 2nd generation systems planned.

Satellic/ TollCollect are part of the Deutsche Telekom group and are heavily involved in the German motorway HGV road user charging scheme. Whereas TollCollect is the operator of this scheme in Germany, Satellic acts as a technology provider using the systems and functionalities as developed for this scheme to provide similar road user charging concepts elsewhere. The importance of a standardised system architecture has been discussed. In terms of operations of the system, a single body should be in charge, in order to have clear responsibilities. Mandatory on-board units will further simplify operation. Easier to implement starting with 12t HGVs on motorways and main road, then different vehicle classes and increase of charged network.

T&E is the EU-level representation of all major environmental non-governmental organisations (NGOs) active in Europe in the field of transport. Generally their main aim is to lobby decision makers on transport related environmental topics. More specifically, they were the authors of the 'A Price Worth Paying' document, a guide on the new EC Euro Vignette Directive. A high proportion of the income of existing road user charging schemes is currently spent on operating the systems, particularly on catering for infrequent users and on fraud detection and enforcement. Discussion of Euro Vignette versus distance-based charging. Move from HGV on motorways to all vehicles on all roads. Potential for added services, e.g. insurance industry.

EuroCommerce is the EU-level representation of national/ regional chambers of commerce and large businesses, aimed at lobbying work in the European institutions on their interests. Road charging schemes are seen by many of their members; especially by those who in or connections to the logistics industry, as additional income for the government from the already heavily burdened road freight transport sector, without any direct benefits from them. Issues of particular interest for them are EU-wide interoperability and user-friendly systems to minimise any work disruption. Furthermore re-invest of revenues into upgraded transport infrastructure should be a legal requirement for the government when implementing charging schemes.

Logica is a consultancy and system integration company heavily involved in road charging schemes internationally, both in a consulting role, as well as as system designers in the planning phase and as back office operators after the implementation. Issues discussed included addressing the requirements of infrequent users, detecting fee evaders and enforcement, and practical topics in view of on-board equipment. Furthermore the need for the use of satellite technology (rather than DSRC-based beacon systems) due to the complexity of a system covering all roads was stressed. They also reported on their experience and finding from being involved in the planning and operation of other road user charging schemes in Europe.

3. Specific Results

3.1 Functional Specification

In the following a basic functional specification for the kilometre pricing system will be developed, based on the outcomes of the literature review and the expert interviews, as described above:

i. The kilometre price should be based on the distance travelled with a heavy good vehicle (HGV) on the public road network* within Belgium.

> *) If the charges are applied to the whole road network it might lead to very large system costs, in actual practice it might be more appropriate to define 95% of the network (motorways, A roads, and B roads), which can achieve the same general objectives, but at much lower costs.

ii. The kilometre pricing system should be designed/ implemented in such a way that an upgrade to an operation where all vehicles (i.e. not only HGVs) are charged can be implemented.

iii. The kilometre pricing system should be suitable for differentiation based on time (i.e. according to pea/ off-peak traffic).

iv. The kilometre pricing system should be suitable for differentiation based on place (i.e. according to e.g. road type or congestion hotspots).

v. The kilometre pricing system should be suitable for differentiation based on vehicle characteristics (i.e. according to e.g. vehicle or emission classes).

vi. The kilometre pricing system should be able to function in 'free-flow' traffic conditions, without the need for vehicles to stop.

vii. The combined charge based on distance travelled and location and vehicle characteristics should have an accuracy* of at least ??%.

> *) It might be a policy objective to reach almost 100% for the system accuracy, but experience has shown that if a parameter very close to 100% is implemented, the costs for this will increase disproportional, therefore choose appropriate level, e.g. 90% or 95%.

viii. The kilometre pricing system should be sufficiently flexible to cope with changes in tariff parameters for time, location and vehicle characteristics (as described in iii to vi).

ix. If a solution is selected where tariff data is stored in the On-Board Unit* (OBU), timely updating of the new tariff parameters in free-flow and everyday conditions has to be enabled.

*) Two basic principles exist, 'thin client' or 'thick client', i.e. an OBU that only collects data and then communicates them to the back office, or an OBU which stores data, but also carries out calculations, either have advantages/ disadvantages and less/ more costs for individual aspects, e.g. less hardware cost, but more communication costs for a thin client, etc.

x. The kilometre pricing system should have possibilities/facilities to also apply pricing to non-regular users*.

xi. The kilometre pricing system should have possibilities/facilities to also apply pricing to users with foreign license plates*.

*) Providing a separate payment channel for infrequent users or those who choose not to install an OBU can be very costly, therefore a mandatory OBU might be considered (particularly given the decreasing hardware costs), enforcement/ fraud detection could also be addressed by this.

xii. The kilometre pricing system should comply with the European Interoperability Directive (EU-directive2004/52/EC).

xiii. The kilometre pricing system should comply with the European EuroVignette Directive (EU-directive1999/62/EC).

xiv. The minimum required accuracy* of the kilometre pricing system is ??% of all monthly invoices/bills.

*) It might be a policy objective to reach almost 100% for the system accuracy, but experience has shown that if a parameter very close to 100% is implemented, the costs for this will increase disproportional, therefore choose appropriate level, e.g. 90% or 95%.

xv. The 'Mean Time Between Failure'* (MTBF) of the On-Board Unit (OBU) for the kilometre pricing system should be ?? years.

*) As described above performance parameters are often directly correlated with costs, often in a disproportional way, there choose these values carefully.

xvi. Sufficiently reliable to avoid substantial loss of income due to unavailability of the system or parts of it. System availability* >??%. Service window 7x24h (=??% of income guaranteed).

*) As described above performance parameters are often directly correlated with costs, often in a disproportional way, there choose these values carefully.

xvii. The user gets insight in the applicable tariffs, and the license plate holder has the possibility to see detailed data, the actual tariff should be visible inside the vehicle*.

*) If in-vehicle real-time display of tariff/ billing information is specified (which will be a policy decision, as this is neither strictly necessary, nor has it been implemented in all other systems), then either a thick client is necessary, or the required amount of communication will be drastically increased, and a display on the OBU is needed, all of which can result in higher costs.

xviii. The kilometre pricing system should be sufficiently safe and should offer sufficient user comfort without additional driver workload to avoid dangerous behaviour or social exclusion.

xix. The kilometre pricing system should have sufficient facilities to prevent, detect and correct/ enforce fraudulent behaviour by system users, detection/ enforcement rate ??%.

*) It might be a policy objective to reach almost 100% for the system accuracy, but experience has shown that if a parameter very close to 100% is implemented, the costs for this will increase disproportional, therefore choose appropriate level, e.g. 90% or 95%.

xx. The kilometre pricing system should be designed/ implemented in such a way that integration with add-on services can be enabled.

xxi. The kilometre pricing system should be designed/ implemented in such a way that use of data for traffic management (i.e. ‘floating vehicles’) can be enabled.

3.2 Cost Implications

Estimating both the capital costs as well as the operational costs of the planned km charging application in Flanders/ Belgium is very difficult. The scope of the system, i.e. charging on all roads (and including a provision of charging all vehicles at a later stage) is too different from existing systems to be able to use values available for these systems. Furthermore, even for existing systems information on costs is difficult to obtain. The companies involved in building and operating the system often see this information as confidential. Some studies were carried out to compile cost information for various existing road user charging systems, but findings differ and are not confirmed by industry.

Therefore the cost estimation will not be based on data from existing systems, but on the information available for the planned system in the Netherlands. This system is very similar in scope and is being planned in close cooperation with the Flemish/ Belgian system. But as the system is not implemented yet, only estimates of cost exist. For the planned HGV road user charging scheme on all roads in the Netherlands 2 studies have been carried out in order to estimate the costs for implementing and operating the system. In each case a wide range of costs has been estimated. In the second study various individual sums were specified based on estimates from technology providers.

Between the 2 studies the values overall differ by a factor of 3 for the capitals costs and 4 for operating costs, ranging from 1400 million EUR to 4100 million EUR for the capital costs and from 275 million EUR to 1100 million EUR for the operating costs. But it is generally accepted that the second study has produced more accurate values. Therefore for the purposes of this analysis only the results from the second study will be considered. The estimated costs from this study differed by a lower factor of 2 for capital costs and 3.5 for operating costs. The capital costs range from 1400 to 2750 =2075±675 million EUR. The operating costs range from 275 to 925 =600±325 million EUR.

The average values for capital and operating costs estimated in the second study carried out for the Dutch kilometre charging systems, as quoted above, will be used as a basis for a first estimate of costs for the Flemish/ Belgian system. These values will consequently be scaled up/ down from the results of the Dutch study in order to obtain a first estimate of costs for Belgium/ Flanders reflecting differences in the network (e.g. overall length and length of motorway network) and the traffic (e.g. overall numbers, composition, percentage of HGVs) of these 3 regions. The figure below shows the network information and traffic data used for the following estimation of costs for Flanders/ Belgium.

		Netherlands	**Belgium**	**Flanders**
Network Length (All Roads)	[Km]	134218	152256	70195
Network Length (Motorway)	[Km]	2291	1763	883
HGV Traffic (All Roads)	[10^9 Veh Km]	6.18	8.69	5.37
HGV Traffic (Motorway)	[10^9 Veh Km]	3.54	4.62	2.85

Fig. 1: Network and Traffic Data

Based on the network information and traffic data for the 3 regions, the Netherlands, Belgium, and Flanders, as described in the figure above, the cost ranges, both for capital costs and operating costs, can be calculated in relation to the following 4 main scenarios:

- Scenario 1a: Main Cost Driver is Network Length (All Roads)
- Scenario 1b: Main Cost Driver is Network Length (Motorway)
- Scenario 2a: Main Cost Driver is HGV Traffic (All Roads)
- Scenario 2b: Main Cost Driver is HGV Traffic (Motorway)

The figures below show an estimation of capital costs and operating costs respectively for Belgium and for Flanders based on the cost ranges of the previous estimation for the system in the Netherlands and network/ traffic data in relation to the 4 scenarios described above.

	Estimation of Capital Costs [Million EUR]		
	Netherlands	**Belgium**	**Flanders**
Scenario 1a	1400 - 2750	1590 - 3120	730 - 1440
Scenario 1b		**<u>1080 - 2120</u>**	**<u>540 - 1060</u>**
Scenario 2a		1970 - 3870	1220 - 2390
Scenario 2b		1830 - 3590	1130 - 2220

Fig. 2: Estimation of Capital Costs

	Estimation of Operating Costs [Million EUR]		
	Netherlands	**Belgium**	**Flanders**
Scenario 1a	275 - 925	310 - 1050	140 - 480
Scenario 1b		210 - 710	110 - 360
Scenario 2a		390 - 1300	240 - 800
Scenario 2b		**<u>360 - 1210</u>**	**<u>220 - 750</u>**

Fig. 3: Estimation of Operating Costs

In figures 2 and 3 above the results based on the most likely scenario identified for capital and operating costs can be seen in bold and underlined. For capital costs the main cost driver is assumed to be network length (motorway), and for operating costs HGV traffic (motorway).

As can be seen in the network information and traffic data described above, the overall road network in Belgium is larger than that in the Netherlands, but due to a denser parallel network of A roads and B roads in Belgium, the length of the motorway network is smaller in Belgium, despite the overall road network being smaller in the Netherlands.

For the estimation of capital costs for a system implementation in Belgium and in Flanders respectively, scenario 1b (main cost driver is network length motorway) was identified as the most likely, as it was assumed that, as this mainly relates to infrastructure and technology, costs will be a function of the size of the network, particularly motorway.

For the estimation of operating costs for system implementation in Belgium and Flanders respectively, scenario 2b (main cost driver is HGV traffic motorway) was identified as the most likely, as it was assumed that, as this mainly relates to communication, billing, enforcement, costs will be a function of the amount of traffic, particularly motorway.

Costs estimated are therefore 1600±520 million EUR (Belgium) and 800±260 million EUR (Flanders) for the capitals costs and 785±425 million EUR (Belgium) and 485±265 million EUR (Flanders) for the operating costs. But it has to be noted that this is only a first estimate, based on another estimate (rather than existing data) and on broad assumptions.

A more detailed cost estimation lies out of the scope of this study. Furthermore, as e.g. the study commissioned for the planned road user charging system in the Netherlands has shown, due to the very innovative characteristics of these systems, even larger and more detailed studies have so far failed to produce more accurate estimates of the costs involved.

In addition to the overall capital and operating costs, another cost factor that was identified by the Flemish Ministry of Finance to have implications for their decision making processes on the implementation of a kilometre charging scheme in Flanders/ Belgium, related to a number of specific issues in view of the on-board unit (OBU).

The OBUs used for such a scheme can have 2 main characteristics, thin client or thick client. The main difference between these options are the capabilities and features of the OBU, i.e. thin client having only the basic features with the main ‘intelligence’ being in the back-office, and thick client having more features with the main ‘intelligence’ being in the OBU.

In terms of costs, thin client OBUs are currently priced at approximately EUR 20-50, the main characteristics is a low one-off fee (hardware) and high recurring fee (communication). Thick client OBUs are currently priced at approximately EUR 250-500, the main characteristics is a high one-off fee (hardware) and a low recurring fee (communication).

OBU costs are between EUR 20–500 depending on capabilities. With one of the functionalities of the planned system in Flanders/ Belgium being that the OBU should give information on billing and user account, a thick client solution would be more likely, also the OBU would require a display, therefore costs are likely to be at the higher end of the cost range quoted.

The choice between car and owner-specific OBU can also have an effect on costs, but no specific data is available. Price development over the next years and the number of units required will also have an effect. It also has to be decided who pays (user or operator) and if the OBU is voluntary or mandatory. There is also an opportunity for creation of a new market similar to the mobile phone industry.

Furthermore, providing a separate payment channel can incur large proportion of overall system operating costs, e.g. for the German system this is estimated at up to 1/3, which would amount to an annual cost of approximately EUR 200.000.000, but very little reliable cost data is in the public domain. Furthermore, another important cost factor is the impact of performance indicators.

As described before in the section on functional specification, system performance parameters include e.g. accuracy, reliability, mean-time-between-failures (MTBF), and enforcement (and various other) rates. Experience has shown that in most cases the costs involved increase disproportional when close to 100%, therefore estimate effects before decision then decide appropriate levels.

There is also an opportunity for integration of the charging system with various other add-on-services. These include pay-as-you-drive (PAYD) insurance, logistics and fleet management, route guidance, setting up a cross-border service agency, etc. This has the potential for cost reductions and incentive to improve acceptance, but as this has not been implemented yet, no experience is available

There is also an option of integrating the charging system with traffic management. This could involve the use of all participating (charged) vehicles as ‘floating vehicles’ to collect real-time traffic data. This could lead to redundancy of other data collection measures, leading in turn to cost reduction for traffic management, but again this has not been implemented yet, so no experience is available.

4. Conclusion

This study into developing the implementation path for the planned road user charging scheme for heavy goods vehicles in Flanders/ Belgium included an analysis of the impacts on congestion, air quality, etc. In addition, a separate report as a background document on the different technology options was produced. For this technologies for road user charging more generally were considered.

The general objective of this study related to producing a report for the Flemish Ministry of Finance that contains background information on road user charging systems in order to aid their decision making for the planned Flemish/ Belgian km-charging scheme. The information presented in this report relate mainly to existing systems, planned systems, and stakeholder involvement.

Topics of particular interest were cost estimates and functional specification, including additional services. The methodology used related mainly to 2 key activities, a literature review on existing and planned road user charging schemes and a number of expert interviews with key stakeholders. The findings from these activities were then analysed in view of the implications for the planned scheme.

In the following a set of recommendations for the planned kilometre pricing system in Flanders/ Belgium will be developed for 6 key areas that have been identified in the context of this study. These key areas include system design and operation, foreign and infrequent users, on-board equipment/ unit, funding and add-on services, misuse and enforcement, and privacy and legal issues.

System Design and Operation

i. Functionalities of the scheme should be the starting point, not the technology/ systems/ solutions to be used, these should be defined later in the process.

ii. In some cases specific functionalities limit the choice of technologies, e.g. if whole road network is to be covered, satellite technology might be most appropriate.

iii. A staged introduction can simplify the process, e.g. first on motorways, then on the whole network and/ or first only HGVs, then all other vehicle classes.

Foreign and Infrequent Users

iv. Provide interoperability within the EU, particularly with neighbouring countries, also coordination with planned systems in the Netherlands and France.

v. Simplify user-interface, registration/ billing, and any formalities, in order to minimise additional workload, particularly in view of the haulage industry.

vi. Providing separate payment channels can dramatically increase operating cots, other solutions should be considered, especially as OBU costs decrease.

On-Board Equipment/ Unit

vii. OBU not legally mandatory, but if interoperable internationally, low costs (full cost or deposit), simple user interface, and easy operation, acceptance could increase.

viii. Enable integration of various add-on services (e.g. insurance, logistics services, fleet management, etc.) in OBU, without need for any additional devices in the vehicles.

ix. OBU costs are decreasing generally, but licensing of technology to different providers (like mobile phones) might stimulate the market for better products/ lower costs.

Funding and Add-On Services

x. Different funding schemes should be considered, but according to existing experience public private partnerships provide good value for money and spreading of risk/ costs.

xi. Add-on services (e.g. PAYD insurance for private cars, or logistics functionalities for the haulage industry) can improve acceptance of the scheme if communicated in the right way.

xii. There is also scope for the implementation of international service providers in charge of e.g. user registration and billing for charging (also potential for integration of road tax).

Misuse and Enforcement

xiii. Detection rate of fee evaders of 100% might result in extremely high costs, therefore more realistic targets for misuse and enforcement should be specified

xiv. A variety of techniques for detection of misuse should be used, including video detection on gantries, manual detection through floating vehicles, and OBU.

xv. The on-board equipment/ OBU should be resistant to misuse (disabling communication) and also carry out checks on vehicle parameters (speed, distance, location).

Privacy and Legal Issues

xvi. Specify legal framework prior to implementation, considering existing binding requirements and any changes necessary, particularly taxation as part of tolling law.

xvii. Implications of privacy issues at an early stage, develop as part of overall legal framework, particularly important as system users from different countries/ cultures.

xviii. Committing all or parts of the revenue to transport infrastructure improvements can improve public perception, consider as part of overall tolling legal framework.

Acknowledgements

This report on the technology and implementation issues for the Flemish Kilometre Charging Scheme Phase 2 has been funded by the Flemish Ministry of Finance. Furthermore the author would like to thank all organisations and individuals that were contacted for the expert interviews for their cooperation, for providing references and information, and for their active involvement in this study.

References

- Appel, K. and Jordi, P., 'Road User Charge for Finland - Prestudy', Proccedings of the 13th World Congress on Intelligent Transport Systems and Services, London, 2006

- CIT, 'The Impact of Congestion Charging on Specified Economic Sectors and Workers', Commission for Integrated Transport United Kingdom, London, 2003

- DfT, 'London Congestion Charging Scheme - Impacts Monitoring, Second Annual Report:', Department for Transport United Kingdom, London, 2004

- DfT, 'Regulatory Impact Assessment - Lorry road-user charge', Department for Transport United Kingdom, London, 2005

- EC, 'CESARE III Project Deliverable D1.1 Documentation on Revision Process', European Commission, Brussels, 2006

- EC, 'Directive 2004/52/EC on the interoperability of electronic road toll systems (Euro Vignette)', European Commission, Brussels, 2004

- EC, 'FRAME Project Deliverable D3.1 European ITS Framework Architecture Functional Architecture', European Commission, Brussels, 2002

- EC, 'Synthesis of the Reports of the Expert Groups 1 and 5 on Microwave Satellite Technologies for Electronic Tolling', European Commission, Brussels, 2005

- ERTICO, 'Towards a next generation of road-pricing - The state of play in Europe and the need for PPPs to achieve standardisation for sustainable deployment of road charging systems', ERTICO, Brussels, 2006

- Estiot, A. and Springer, J., 'GNSS-Based Tolling in Germany - Lessons Learned after Two Years of Operation', Tollways, Isssue on Building Strategic Alliances, 2007

- Forss, M. and Gustafsson, I., 'ARENA - Development of a National Road User Charging System', Working Document from the Swedish Government, 2007

- Gustafsson, I., Cardebring, P. W., Fiedler, R., 'Road User Charging for Heavy Goods Vehicles - Overview of Regional Impact', Region Blekinge, 2007

- Gustafsson, I., 'Tango Collect - Differentiated kilometre charges as a driving force for implementing telematics for heavy goods vehicles', Region Blekinge, 2004

- McKinnon, A., 'Lorry Road User Charging - A Review of the UK Government's Proposal', Proceedings of the Commercial Vehicles Conference, Birmingham, 2004

- Ministerie van Verkeer en Waterstaat, 'Cost Benchmark for kilometre pricing in the Netherlands - English translation of the report Kostenmonitor Kilometerprijs', 2006

- PWC, 'Delivering the PPP promise - A review of PPP issues and activity', PriceWaterhouseCoopers International Limited, 2005

- Rapp, M. and Hansen, P. S., 'Evaluation of Different Scenarios of a HGV Charging Scheme in Denmark', Proceedings of the European ITS Congress, Aalborg, Denmark, 2007

- RCI, 'Minimum Architecture for Interoperability', Road Charging Interoperability Project, European Commission, Brussels, 2007a

- RCI, 'Operational Procedures Architecture', Road Charging Interoperability Project, European Commission, Brussels, 2007b

- RCI, 'Security Architecture for Interoperability', Road Charging Interoperability Project, European Commission, Brussels, 2007c

- Schelin, E., Gufstaffsen, I. and Blythe, P., 'An Analysis of Road User Charging in Europe', Proceedings of the 13th World Congress on Intelligent Transport Systems and Services, London, 2006

- Sean D. Beevers, S. D. and Carslaw, D. C. 'The Impact of Congestion Charging on Vehicle Emissions in London', Atmospheric Environment, 2004

- Wieland, B., 'The German Heavy Goods Vehicle Toll', Journal of European Transport / Trasporti Europei, no. 31, 2005

Annex: Background Information

System Functionalities and Architecture

Road User Charging Standards and Guidelines

A number of standards and recommendation have been developed for architectures of ITS applications generally. Some of the functionalities within these standardised architectures relate to road user charging schemes, as discussed above. But given the complexity of the issue, it was necessary to develop architecture guidelines specifically for road user charging. The EC-funded RCI project was mainly involved in enabling the EU-wide interoperability of existing and planned road user charging schemes through the development of a standardised functional architecture for these systems.

The figure below gives an overview of the core functionalities of road user charging, which have been identified. These core functionalities include:

- Enforcement
- Human-Machine-Interaction
- Security
- GNSS Context
- DSRC Context
- Operation

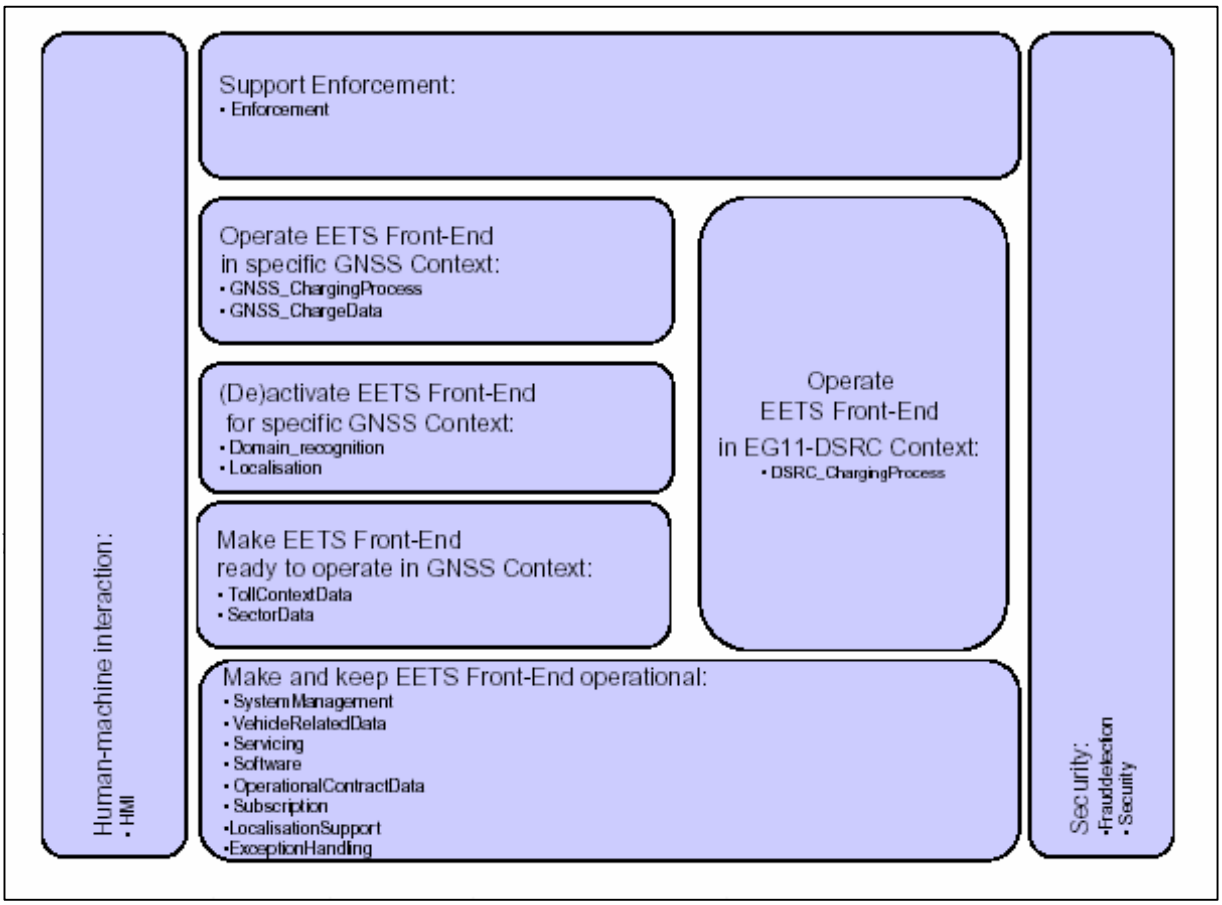

Fig. 4: Core Functionality Overview

Architectures for Existing Systems

In addition to reviewing standards developed for road user charging schemes generally, either for interoperability, or just as a guideline document, the architectures that have been developed for existing systems are part of the literature reviewed for this study and also have implications for the decision making processes for the planned km-charging scheme in Flanders.

The figure below for example shows the system architecture for the TollCollect system.

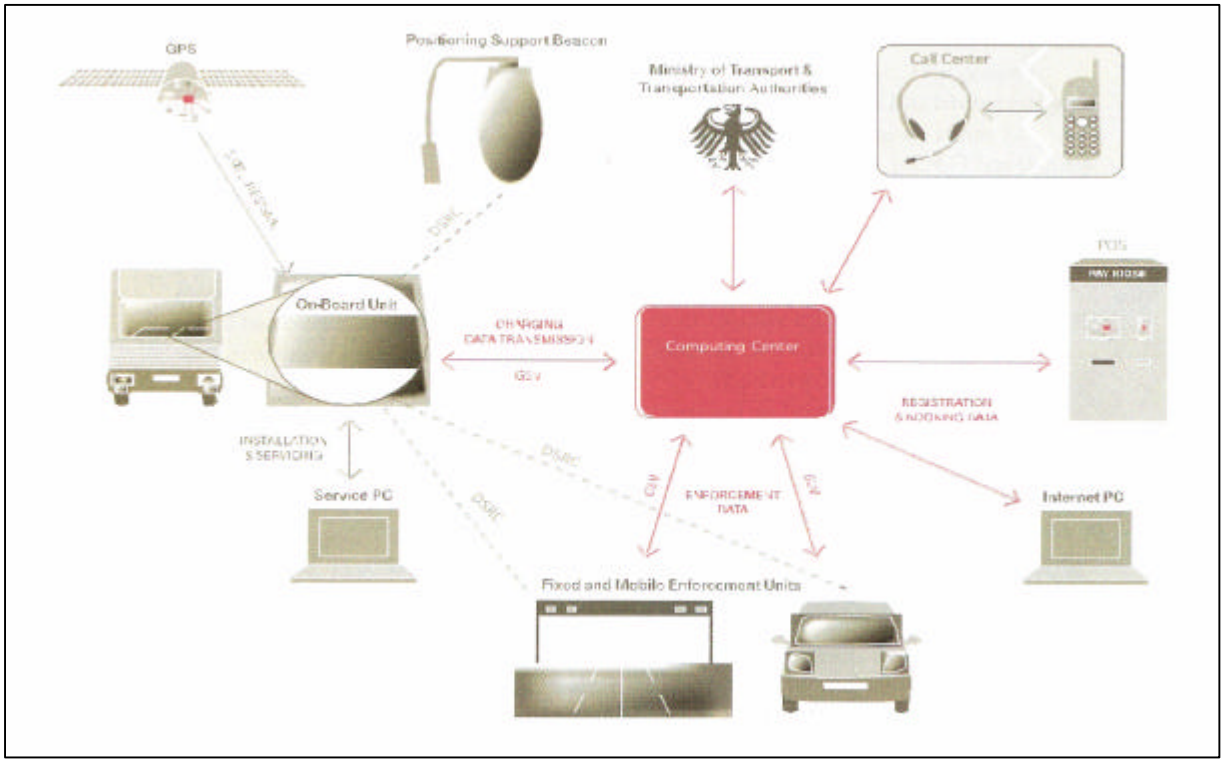

Fig. 5: TollCollect System Architecture

System Interoperability

As described before, most recommendation for standardised architectures for road user charging schemes have been developed in order to aid the implementation of interoperable systems. Interoperability of charging schemes (e.g. within the EU) will enable a user-friendly system, with minimum workload for drivers and minimum technology (ideally using one compatible on-board unit). The figure below shows the main actors and entities that have identified as relevant for enabling the interoperability of road user charging schemes as part of the RCI project.

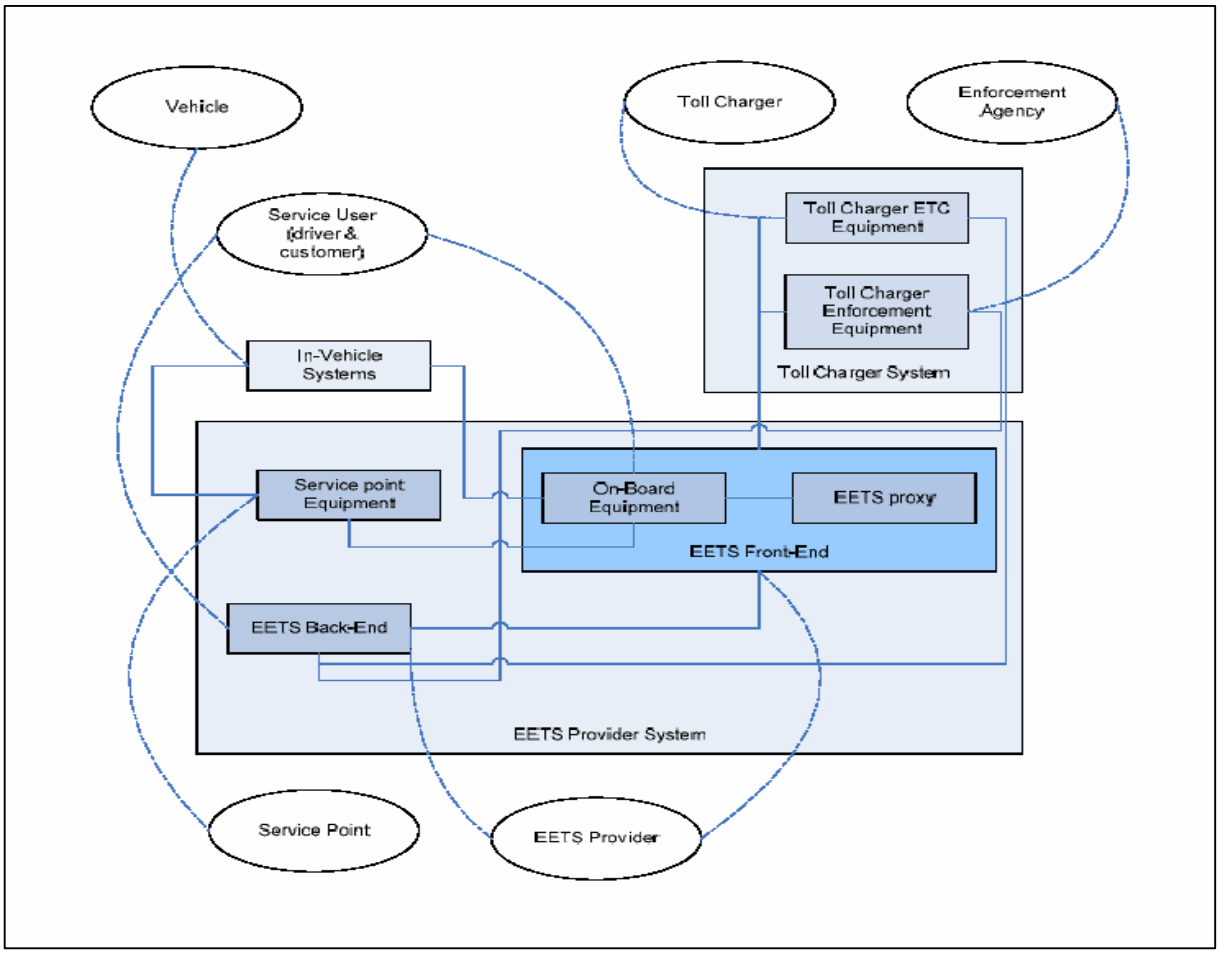

Fig. 6: Main Actors and Entities

The figure below shows the high-level standardised functional architecture that has been developed as part of the CESARE III project in order to address EU-wide interoperability of schemes.

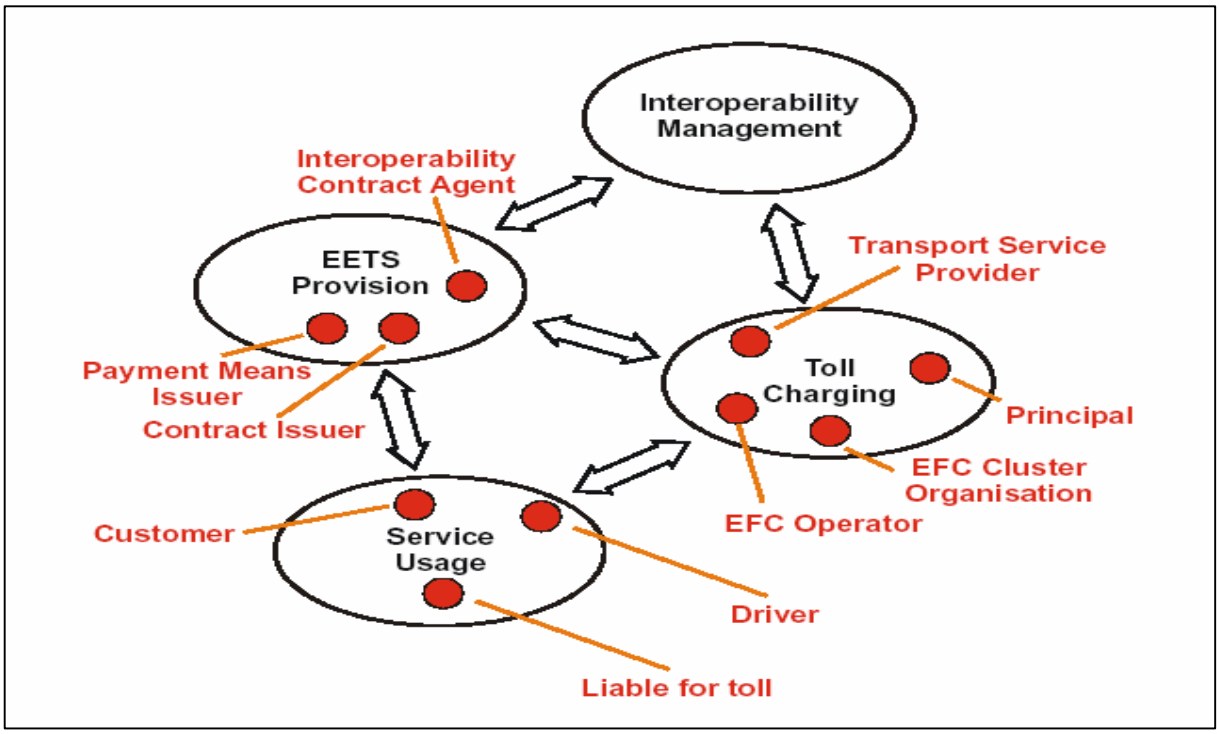

Fig. 7: Interoperability Architecture

Costs Analyses

Comparative Study

The table below shows a comparison of cost (one-off implementation costs at the start of the scheme and annual operating costs) and revenues for a number of existing road user charging schemes throughout the world (based on an internal study commissioned by Logica).

	Austria*	Germany*	Switzerland*	London***	Stockholm	Singapore
Investment costs	€ 370 m	€ 2 200 m	€ 200 m	€ 130 m Plus €144m trafic mgmt.	€ 190 m (Including operating cost)	€ 97 m (1998 figures)
Operating costs	€ 35 m/a	€ 620 m/a Toll Collect (incl. capital costs) € 50 m/a BAG	€ 35 m/a	€ 133 m/a	€ 40 m/a (€ 20 m/a estimate for permanent system)	€ 7 m/a
Personnel	ASFINAG 150 operations 120 enforcement	750 Toll Collect 540 BAG (enforcement)	120 Swiss Customs			
Average charge	€ 0.27 / km (40t truck)	€ 0.12 / km (40t truck)	€ 0.67 / km (40t truck)	€ 7.4 / day (now €11.8)	€ 2.7 / day	€ 0—2 per trip
Fee income	€ 770 m/a	€ 2 860 m/a	€ 800 m/a	€ 275 m/a	€ 80 m/a	€ 39 m/a
Operating costs as a % of revenues	9%	16% **	4%	48%	25%	7%
Annualised costs (incl. capital costs) as a % of revenues	12 %	23 % **	8 %	55 %	40%	40%

Fig. 8: Scheme Cost Comparison

In addition to the cost comparison as shown above, a number of additional analyses were carried out as part of the documents reviewed for this study for planned charging schemes (in the Netherlands and in Denmark). These are shown in the following pages.

This will then be followed by a section in funding of road infrastructure schemes generally and road charging schemes more specifically. This relates mainly to the redistribution of cost through setting up Public Private Partnerships (PPP) for system funding.

Studies for the Netherlands

The figure below shows investment and operating cost estimates as totals and in terms of composition from a number of technology providers.

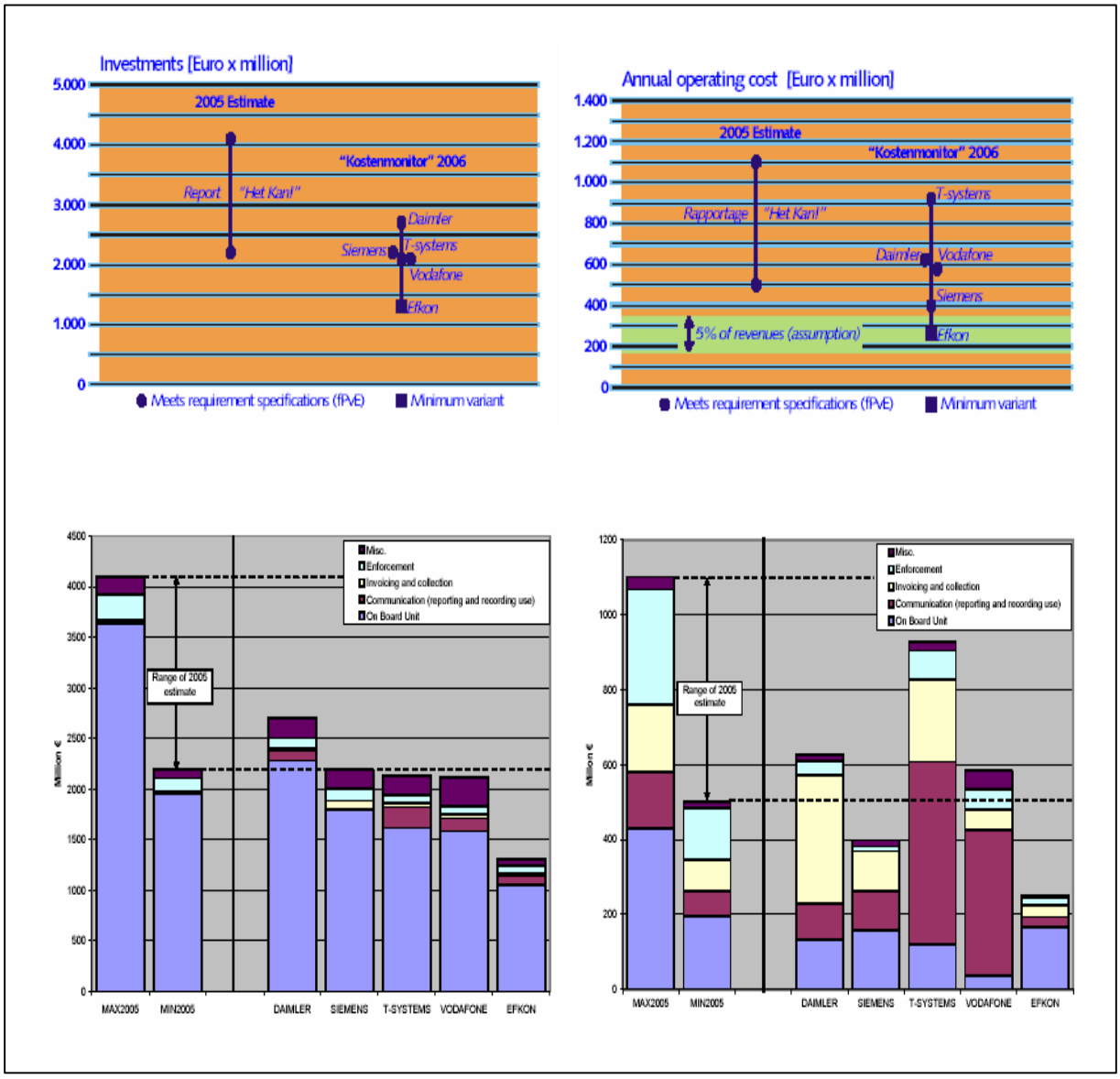

Fig. 9: Cost Totals and Composition

Study for Denmark

The figure below shows a cost estimation from a study for a road user charging scheme in Denmark, based on a number of operational and technology scenarios.

Costs Million DKK/year	Network charging		Area charging	
	Scenario 1A GNSS/CN Technology	Scenario 1B DSRC Technology	Scenario 2A Distance based area charging	Scenario 2B Time based area charging
Capital investments and implementation costs				
Charging services	350	1,941	242	85
Enforcement services	291	288	60	127
Central services	435	459	420	406
Total investment costs	**1,076**	**2,688**	**723**	**618**
Costs per year (including amortisation of investment costs)				
Charging services	136	197	64	26
Enforcement services	182	181	138	154
Central services	167	155	196	147
Total costs per year	**486**	**534**	**399**	**328**

Fig. 10: Cost Estimation for Danish Scheme

Funding Schemes

Definitions and Background

Public-private partnership (PPP) describes a government service or private business venture which is funded and operated through a partnership of government and one or more private sector companies. These schemes are sometimes referred to as PPP or P3. In some types of PPP, the government uses tax revenue to provide capital for investment, with operations run jointly with the private sector or under contract. In other types (notably the Private Finance Initiative), capital investment is made by the private sector on the strength of a contract with government to provide agreed services. Government contributions to a PPP may also be in kind.

Typically, a private sector consortium forms a special company called a "special purpose vehicle" (SPV) to build and maintain the asset. The consortium is usually made up of a building contractor, a maintenance company and a bank lender. It is the SPV that signs the contract with the government and with subcontractors to build the facility and then maintain it. A typical PPP example would be a hospital building financed and constructed by a private developer and then leased to the hospital authority. The private developer then acts as landlord, providing housekeeping and other non medical services while the hospital itself provides medical services.

The figure below shows a summary of public private partnership definitions.

Box 1 PPP Definitions

PPPs are aimed at increasing the efficiency of infrastructure projects by means of a long-term collaboration between the public sector and private business. A holistic approach which extends over the entire lifecycle is important here.
Source: German PPP Task Force, German Transport, Construction and Housing Ministry (Bundesministerium für Verkehr, Bauen and Wohnen)

The term public-private partnership ("PPP") is not defined at Community level. In general, the term refers to forms of cooperation between public authorities and the world of business which aim to ensure the funding, construction, renovation, management and maintenance of an infrastructure of the provision of a service.
Source: Green Paper on Public-Private Partnerships and Community Law on Public Contracts and Concessions presented by the European Commission, April 2004

Standard & Poor's definition of a PPP is any medium-to-long term relationship between the public and private sectors, involving the sharing of risks and rewards of multisector skills, expertise and finance to deliver desired policy outcomes.
Source: Standard & Poor's PPP Credit Survey 2005

PPPs are long-term partnerships to deliver assets and services underpinning public services and community outcomes. Optimal structuring links private sector profitability to sustained performance over the long-term, yielding robust and attractive cash-flows for investors in return for delivering better value for money to the taxpayer.
Source: John Laing plc

'Public-Private Partnership' is a generic term for the relationships formed between the private sector and public bodies often with the aim of introducing private sector resources and/or expertise in order to help provide and deliver public sector assets and services. The term PPP is, thus, used to describe a wide variety of working arrangements from loose, informal and strategic partnerships, to design build finance and operate (DBFO) type service contracts and formal joint venture companies.
Source: European Investment Bank, The EIB's role in Public-Private Partnerships, July 2004

Fig. 11: Summary of PPP Definitions

The figure below shows a comparison of funding schemes between traditional government procurement and PPP procurement.

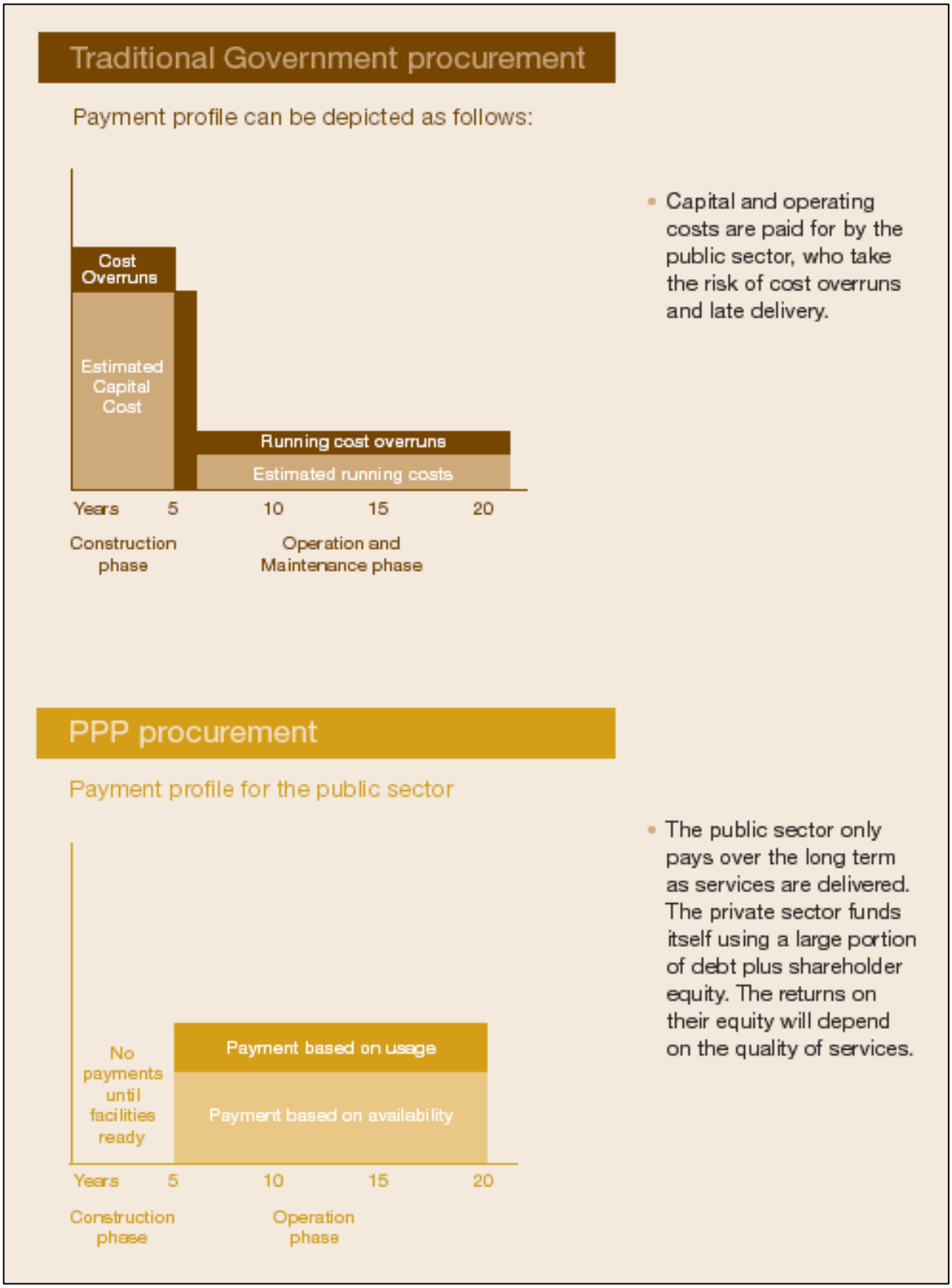

Fig. 12: Funding Scheme Comparison

Variations of PPP Principle

There is a variety of different ways of implementing a public private partnership in terms of the proportion of public and/ or private funding for a scheme. The table below show a comparison of different PPP principle variations.

	Tendering	Mix certification and tendering	Certificering
100% Public funding	Public organisation	*Not relevant*	*Not relevant*
Mix of public and private funding	*Not relevant*	Certified OBE and Public BO	*Not relevant*
100% private funding	Single Service Provider (DBFMO)	Certified OBE and Private BO	Multiple Service Provider

Fig. 13 PPP Principle Variations

PPP for Existing Systems

In addition to reviewing PPP schemes, the principles that have been developed for existing systems are part of the literature reviewed for this study. The figure below for example shows the PPP principle for the TollCollect system.

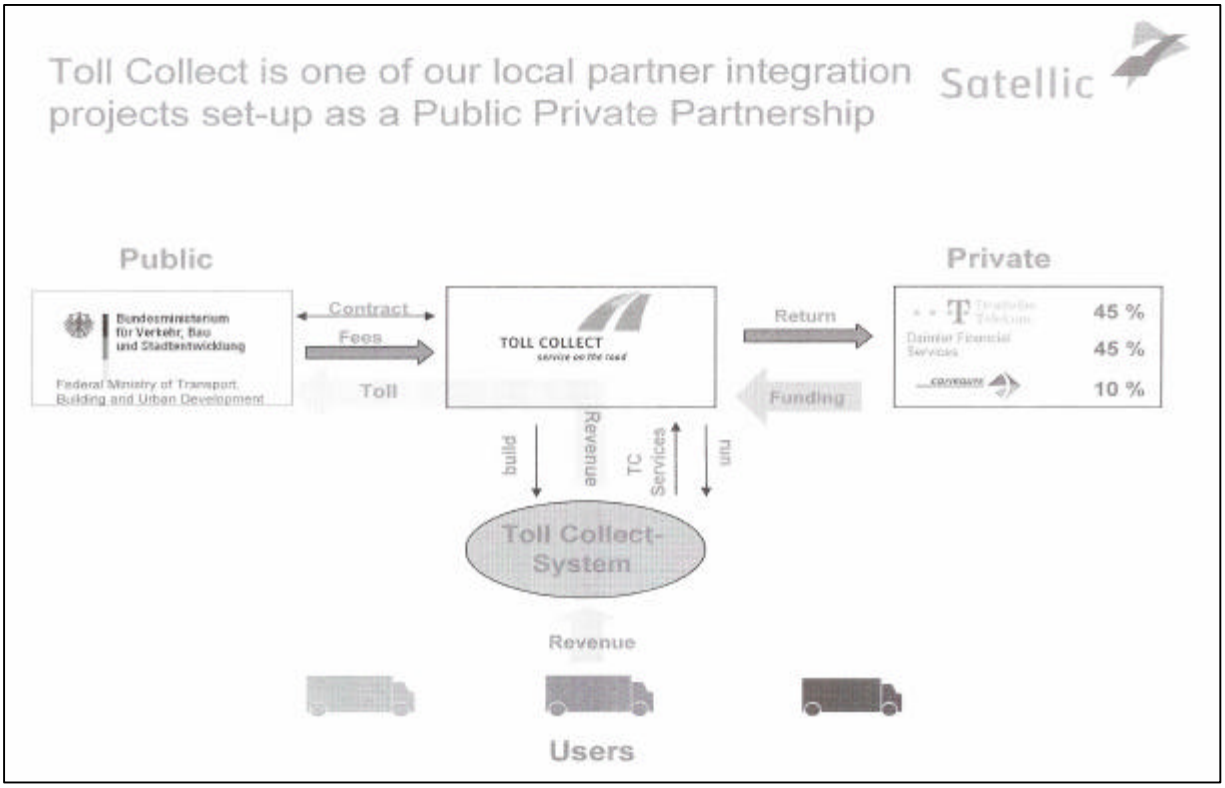

Fig. 14: TollCollect PPP Principle