SIEMENS

Anders Betalen Voor Mobiliteit

Phase 2 Market Consultation

Total Cost of System and Organization for KMP

Siemens response

Approval Record			
Customer Name:	Ministerie van Verkeer & Waterstaat	Siemens Representative Name:	Bart Vuijk
Representative Name:	Stefan Eisses		
Approval Date		Approval Date:	4.7.06 / valid

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

This document is the final document provided by Siemens for phase 2 of the market consultation "Anders Betalen Voor Mobiliteit" initiated by the Ministerie van Verkeer & Waterstaat. The document gives an overview of the solution proposed by Siemens and discusses all aspects requested within document [1] by the Ministry

1.2 Scope

This document

- describes the System characteristics which defines the basic approach for the solution (deliverable D2),
- describes the architectural solution for a tolling scheme according to the requirements issued by the Ministry "Memo Requirement Specification 0.2 (fase 2 market consultation).pdf". It details the Business Architecture and the System Architecture including the discussion of various views on the scheme (deliverable D3),
- provides information about the constitution of the relevant numbers comprised in the spreadsheet Cost Format phase 2_V3.0_(Siemens).xls ((deliverable D4a),
- provides information about the influence of requirements on certain design parameters which are not fixed at the moment (deliverable D4b),
- discusses migration scenarios and their consequences in terms of social influence, commercial influence and technical risks on an overview level (deliverable D5),
- provides a collection of risks identified by Siemens doing a risk assessment workshop (deliverable D6),
- comments on the 24 requirements within the document [3] (deliverable D7).

1.3 Validity

The document is only valid for this stage (phase 2) in the market consultation. Due to the current status of the project (e.g. many requirements are still in the preparatory stage, the necessary legislation has yet to be formalised), many assumptions have been made which might be subject to change in the future. Our response is based on current knowledge; future changes of the framework can potentially influence the conclusions drawn within this document.

1.4 Related documents

The document is related to:

- [1] Bijl1_Statement of work subject 1 19mei06.doc (V&W)
- [2] Bijl2_scope fase 2 marktconsultatie_bk_uk.doc (V&W)
- [3] Memo Requirement Specification 0.2 (fase 2 market consultation).pdf (V&W)
- [4] scenarios for pricing.doc
- [5] Tariff scenarios for phase 2 assignments v1.0.doc
- [6] Risk Inventory Assesment.doc
- [7] Cost Format phase 2_V3.0_(Siemens).xls
- [8] D6_Risk_evaluation_final.xls

2. MANAGEMENT SUMMARY

Introduction

Siemens was invited to deliver its expertise for Phase 2 of Cost Monitor, more notably for the "total costs of system and organisation for the KMP". This document contains 7 deliverables describing, 7 main aspects of the overall system description:

- D1. Project plan
- D2: Proposal of basic system characteristics
- D3: High-level system design description
- D4: Cost Estimates
- D5: Migration scenarios
- D6: Risk analysis
- D7: Comments on requirements specifications

Siemens Solution

Based on the Anders Betalen voor Mobiliteit (ABvM) requirements, Siemens proposes its satellite-based tolling solution which is ready to introduce Road User Charging for all vehicles on all roads. This solution is able to differentiate location, time and vehicle properties as required by the Ministry of Transport. Additionally, the solution is the platform for next generation value added traffic services.
Siemens is able to integrate all major components of the solution, based on its in-house expertise of all building blocks for Electronic Tolling:

- On Board Equipment
- Electronic Toll System
- Enforcement solution
- Central System

The solution has proven its reliability and feasibility around the world, being deployed in projects for the UK, Australia, Germany, the USA. and elsewhere. It is highly scalable, beyond 20 million users, and supports both "thin" and "fat" client scenarios. The Siemens solution thus provides the Dutch ministry with the flexibility to implement what it considers the most suitable dividing line for collecting data and calculating the tolling fees between the field components (OBU), and the back-end (central server). In the ABvM situation, Siemens recommends a thin client OBU scenario due to its high level of flexibility and efficiency with respect to operational costs.

Highlights of the Solution for ABvM as proposed by Siemens:

- It fulfils the needs of "Anders Betalen voor Mobiliteit" by providing a usage-based charging scheme which is secure, efficient, and reliable.
- Flexibility in the introduction of the scheme allows for the Dutch government to choose Road User Charging scenarios which will be most effective and most accepted by the public.
- High flexibility in tolling scenarios enabled by a centralised solution
- Cost-effective coverage of all roads without requiring expensive roadside installations for tolling
- Other schemes, such as Congestion charging and "versnellingsprijs" can be easily introduced

- Reduced risk and operational market introduction within 2 years, due to key in-house expertise and the ability to easily integrate third party components
- State-of-the-Art technologies will be deployed to guarantee system accuracy and prepare interoperability with other tolling schemes (both domestic and foreign)
- Easy integration of all user types enlarges acceptance of new system
- User-friendly system, making it easy for all citizens to participate in the scheme and providing the opportunity to provide new services for all users (for example, to reduced congestion or to improve traffic safety)
- Guaranteed availability by separation of Central Office building blocks and Trusted Third Parties

Price overview

Based on current cost calculations, Siemens estimates the total project costs are:

CAPEX	OPEX (annual)	Depreciation (annual)
2.192M EUR	398M EUR	60M EUR

Conclusion

Siemens is highly committed to contribute to the success of Anders Betalen voor Mobiliteit. Hence, we are pleased to conclude that the Anders Betalen voor Mobiliteit goals of the Dutch ministry of Transport in our view can be realised within cost budget and time frame as postulated by the Ministry, by deployment of Siemens' Electronic Tolling solution. Our advise is based on our in-house expertise, proven technology and the global system integration power of Siemens.

3. SYSTEM CHARACTERISTICS

3.1 System Environment

The party selected by the Authority will get the contract for implementation and operation of the Road User Charging Scheme in Netherlands.
The major roles of the Road User Charging Operator in the Netherlands are:

- to provide easy access for all eligible users to the scheme
- to capture the distances driven by all eligible users
- to calculate charges according to the rules provided by the Authority
- to do the invoicing process (and follow ups) for all users of the scheme
- to provide an enforcement solution that minimises non-compliant behaviour and fraud
- to ensure reliable and robust operation

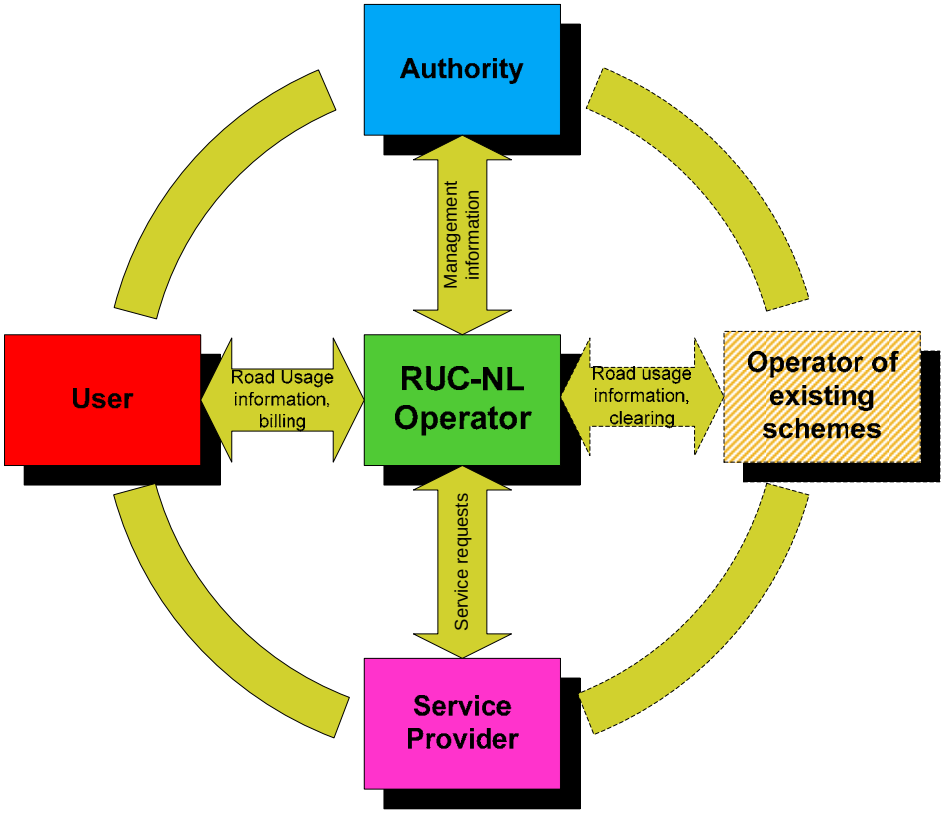
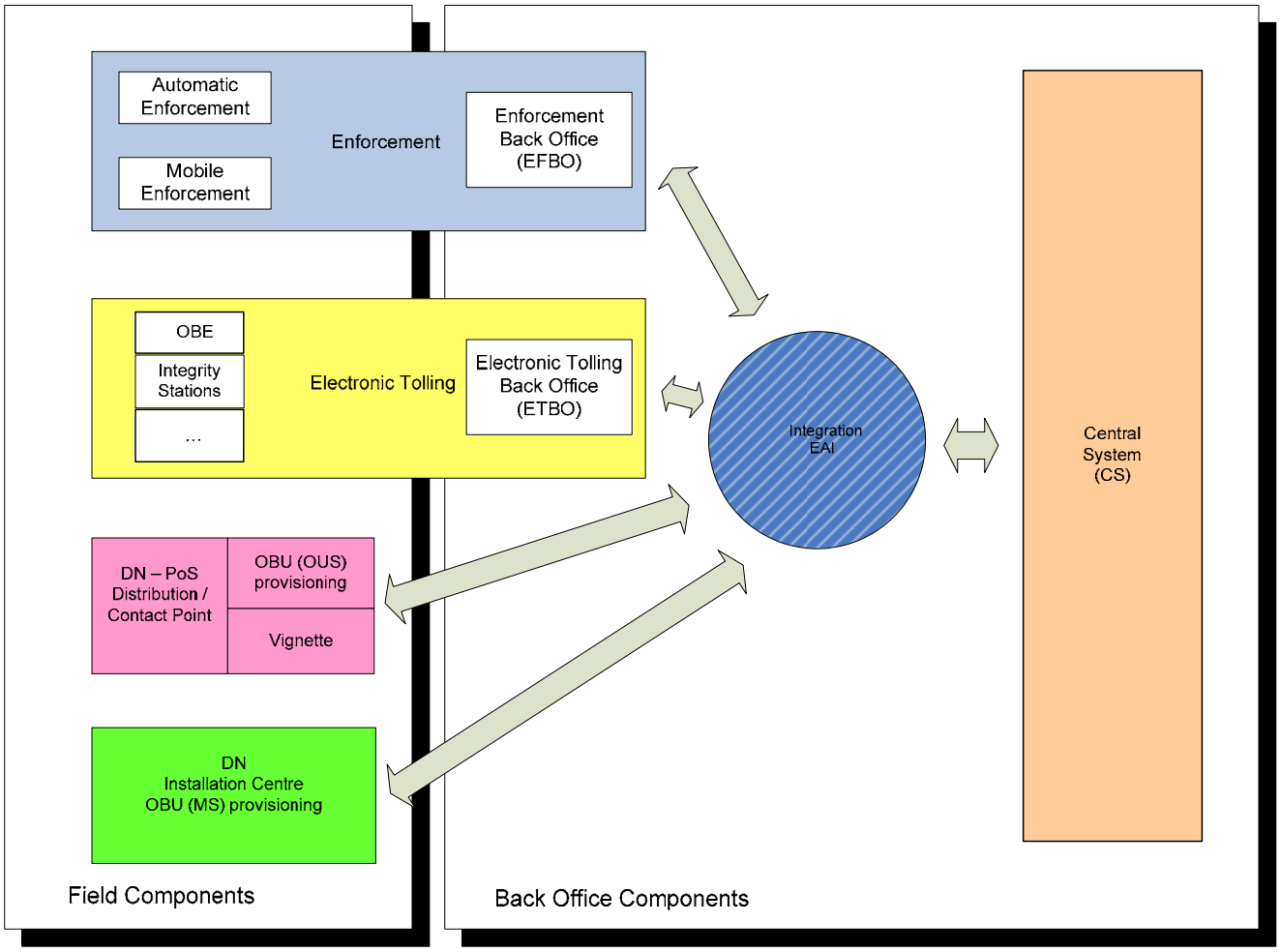


Figure 1: RUC Netherlands Operator Environment

In order to provide the service for Road User Charging, the operator might use services provided by other companies. Further on, based on the activities performed by the European Union it is intended to provide the European Toll Service - and therefore interfaces to other toll operators will appear. In terms of roll out scenarios it also might be necessary to integrate already existing national toll roads, operated by other companies under the contract of the Authority.

3.2 System Overview



OUS...Occasional user scheme
MS.....Main user scheme

EF Enforcement
ET Electronic Tolling
CS Central System
DN Distribution Network

Figure 2: System Overview

The major components of the system include the entities for:

- Electronic Tolling
- Enforcement
- Central System
- Distribution and Installation network

The interaction and functions provided by the different elements is detailed in the following chapters.

3.3 Business Actors

The following picture shows the most important actors of the scheme and the related system entities for interaction.

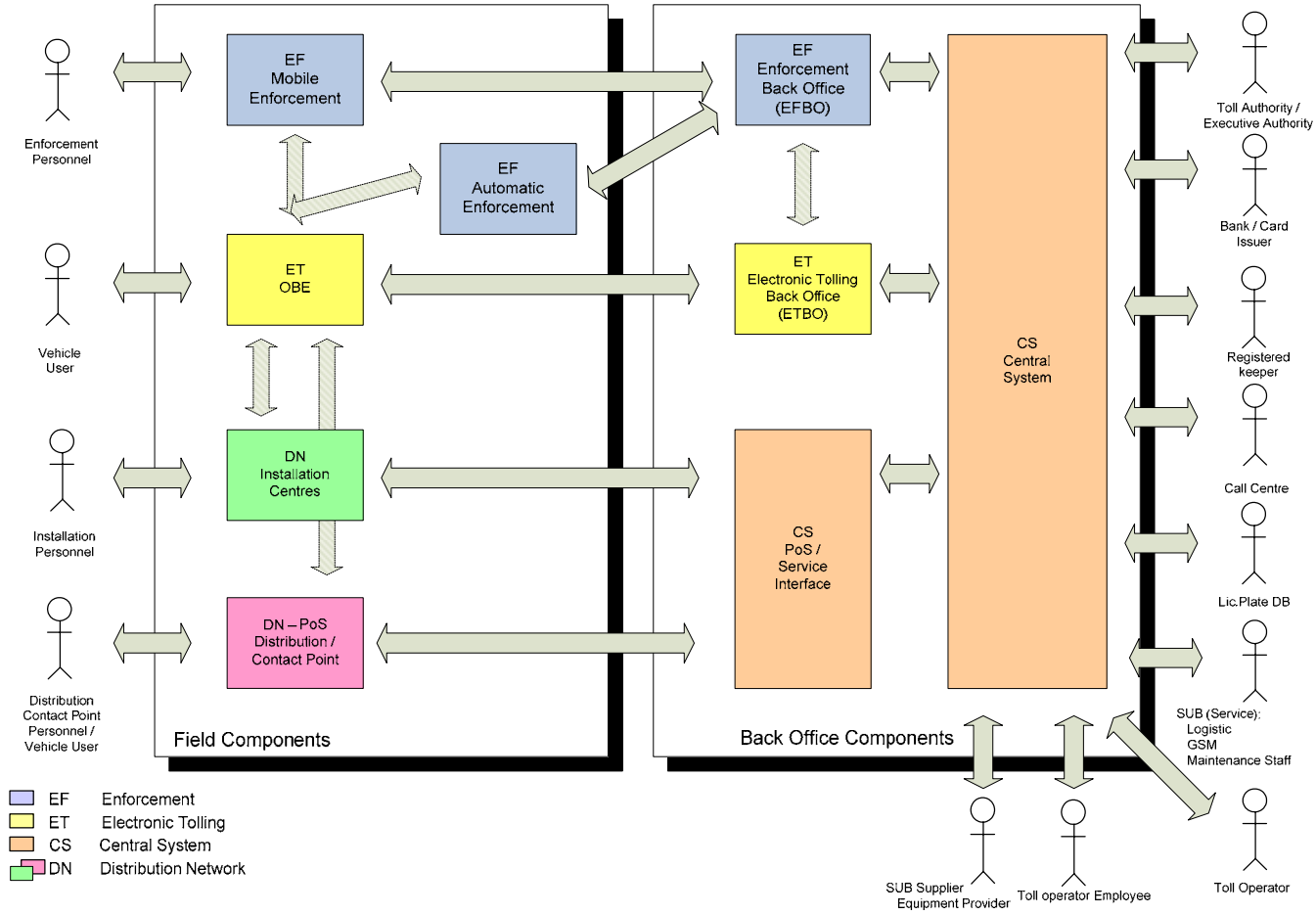


Figure 3: Business Actors

Enforcement personnel

The enforcement personnel is required to execute mobile enforcement. They are responsible to:

- Check compliant behaviour of users
- Issue fine for non-compliant behaviour on behalf of Executive Authority
- Track down foreign toll offenders caught by automatic enforcement before they can leave the country

Vehicle user

The vehicle user - the person who drives the eligible vehicle - is the active user of the scheme and is responsible to act compliantly according to the legislation.

Installation personnel

Offers a subset of services on behalf of the toll operator

- Provide information about tolling scheme
- Provision/installation of On Board Units (OBUs) for the Main Scheme
- Perform OBU checks (regular- e.g. annually or on operator's demand)

Distribution / Contact Point personnel

Offers a subset of services on behalf of the toll operator

- top up of pre-paid account
- issue and retraction of Low Use On Board Units (LOBUs) for an Occasional Scheme
- information
- contract issues
- trip information

Toll Authority

Legal entity or Authority that authorises the toll operator to the set up and operate of the toll system. Toll Authority defines the tolled road network and the tariffs.

Executive Authority

Legal person who is responsible for persecuting and punishing of toll violators.

Bank

Partner banks used by the toll system for use for financial settlement.

Card Issuer

Companies issuing cards used for payment of electronic tolling charges, e.g. credit cards and tank cards when the financial settlement is done directly.

Registered keeper

A legal or natural person responsible for fee payment for using a particular vehicle in a charged area. Vehicle owners either have a contract with the toll operator (explicit in case of post-payment or implicit in case of pre-payment) for toll charging or are treated as toll violators.

Call Centre Agent

Channel for persons who like to get various kinds of information and support about the tolling system and environment. This means:

- legal aspects,
- toll costs,
- toll roads
- equipment usage.

License Plate DB

Provides the service to allocate vehicle details to legal persons

Sub Contractor

Summarising all service provider that provide services for set up and operation of the tolling scheme

Toll Operator

Legal entity that runs the toll system. Note: Toll operator is sometimes referred to as 'service provider' (e.g. in standards)
This actor is responsible for e.g.

- Corporate Communication
- Procurement
- Billing / Clearing
- Operation of the toll system
- Financial Accounting
- Provisioning of OBU

Toll Operator Employee

Responsible for specific operational tasks of the HW and SW tolling environment. Has to ensure

- availability,
- updates and upgrades,
- shut-downs,
- migrations,
- maintenance tasks,
- communication and control towards (already embedded) service providers

or responsible for specific administrative tasks such as:

- operational contact to authorities
- road network updates,
- administrating geodata
- tariff definition
- distribution of tariffs

Sub Supplier

This actor represents all suppliers for a toll system - including hardware and software suppliers.

3.4 User Access

In order to comply to the scheme it is foreseen that all eligible vehicles are equipped with an On Board Equipment (OBE). The collection of road usage data is supported by OBE. This equipment is available in two different versions:

- the Main Scheme OBU
- the Occasional Scheme Low Use On Board Unit (LOBU)

Main Scheme / On Board Units

The Main Scheme OBU is available after successful registration for the scheme including the determination of the payment means. Successful registration means, that the user is willing to act:

- users give up their anonymity to the system
- the check of the registration details is passed positive and
- the check of credibility is passed positive

Rules for validation of registration details may differ for domestic and foreign users.
This type of OBU is installed in authorised installation stations.

Occasional Scheme / Low Use On Board Units

The LOBU for the Occasional User Scheme can be obtained in a shop of the distribution network. The distribution network consists of Point of Sales and Contact Points. The user related information required for this type of system access is very limited but only pre pay can be selected as a payment method. This type of OBE is self-installable.

Occasional Scheme/ Vignette

Nevertheless, another possibility for users to access the scheme in a compliant way is a Vignette with limited validity in terms of duration. It is intended to use a flat rate model and provide this as a service to all users of motorcycles and e.g. old-timers, one time visitors etc.
The vignette is bound to a specific vehicle, therefore the License Plate information has to be registered whilst provisioning of the vignette. It is not intended to provide a physical sticker therefore the terminus “virtual vignette” is used.

3.5 Electronic Tolling

The following picture indicates the distribution of functionality between the system components involved in the electronic tolling subsystem:

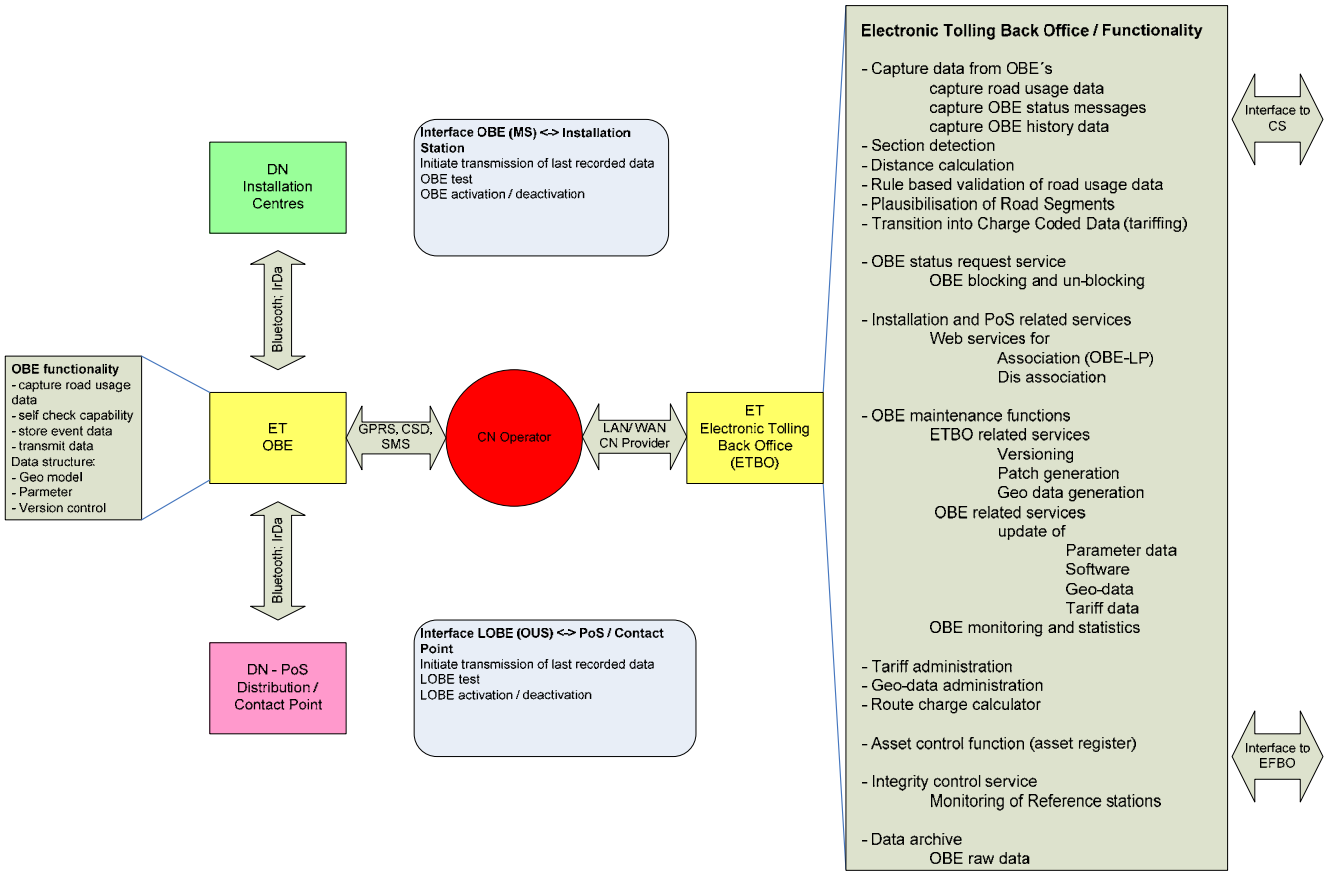


Figure 4: System functionality "Electronic Tolling"

The On Board Equipment captures road usage information and transmits the corresponding data in a secured way to the Electronic Tolling Back Office. This method is named “Thin Client Solution”.

3.5.1 On Board Equipment (OBE)

The following list sets out the main characteristics of the units:

Main Scheme OBU

- Location information is based on internal GPS receiver
- For lorries / cars with trailers the classification information can be set manually (dependent on the different classes required)
- Communication with centralised components of the Electronic Tolling -Sub System with GSM using the service of GPRS. (fall back solution with Circuit Switched Data / CSD included) or similar high speed IP based data connection (e.g. UMTS - depending on availability and costs when the scheme is going to be implemented)
- Communication interface / short range communication standard (e.g. Bluetooth, IrDa) to provide access for authorised personnel
- Indication on failure

- Installation of an OBU has do be realised by authorised and qualified personnel (connection to power and ignition).
- Platform that enables extensibility for additional services like traffic management
- Platform that is able to fulfil the requirements for interoperability aspects in EU

Occasional Scheme LOBU

The functionality of this device is basically the same as for the Main Scheme OBU. The differences are listed below:

- Installation is simple and can be done by the driver (connection to power using the cigarette lighter).
- Internal sensors to provide reliable information about movement of the vehicle.
- Internal battery pack with the possibility to provide power to the LOBU for the duration of several days.

3.5.2 Electronic Tolling Back Office (ETBO)

The electronic tolling subsystem is the operational core of the toll solution. Its main task is to collect vehicle road usage information based on On Board Equipment. From the collected road usage information, the charges are calculated and applied, using a flexible tariff model which is capable of handling different tariffs dependent on location, date/time, vehicle categories and toll section. The accumulated charge information is provided to the Central System.
The road usage information is collected by use of GNSS (GPS) location information and geographical data (geodata). These data contain information about specific road sections, borders and other road usage relevant position data.

Main responsibilities

In summary, the Electronic Tolling subsystem is mainly responsible for:
Collection and processing of road usage information for each OBE equipped vehicle liable to toll
This means for example:

- Check the plausibility of raw data received
- Apply algorithm for Section Recognition (Section Recognition is the detection of certain motorway or other road segments)
- Perform distance calculation (based on GPS location data)
- Validate results according to rules engine result
- Calculate amount of toll and apply charge.
- Provide priced transactions to the Central System

Later on the Electronic Tolling Back Office needs to provide some support functions for ongoing operations, for example:

- Administrate tariffs, geodata and OBU master data
- Monitor the system components, especially the OBE
- Handle and distribute OBE software/data updates
- Provide a toll calculator service
- Provide data to the Enforcement System

3.6 Enforcement

Enforcement is used in order to detect non-compliant behaviour of users or fraud situations. The following picture demonstrates the distributed functionality:

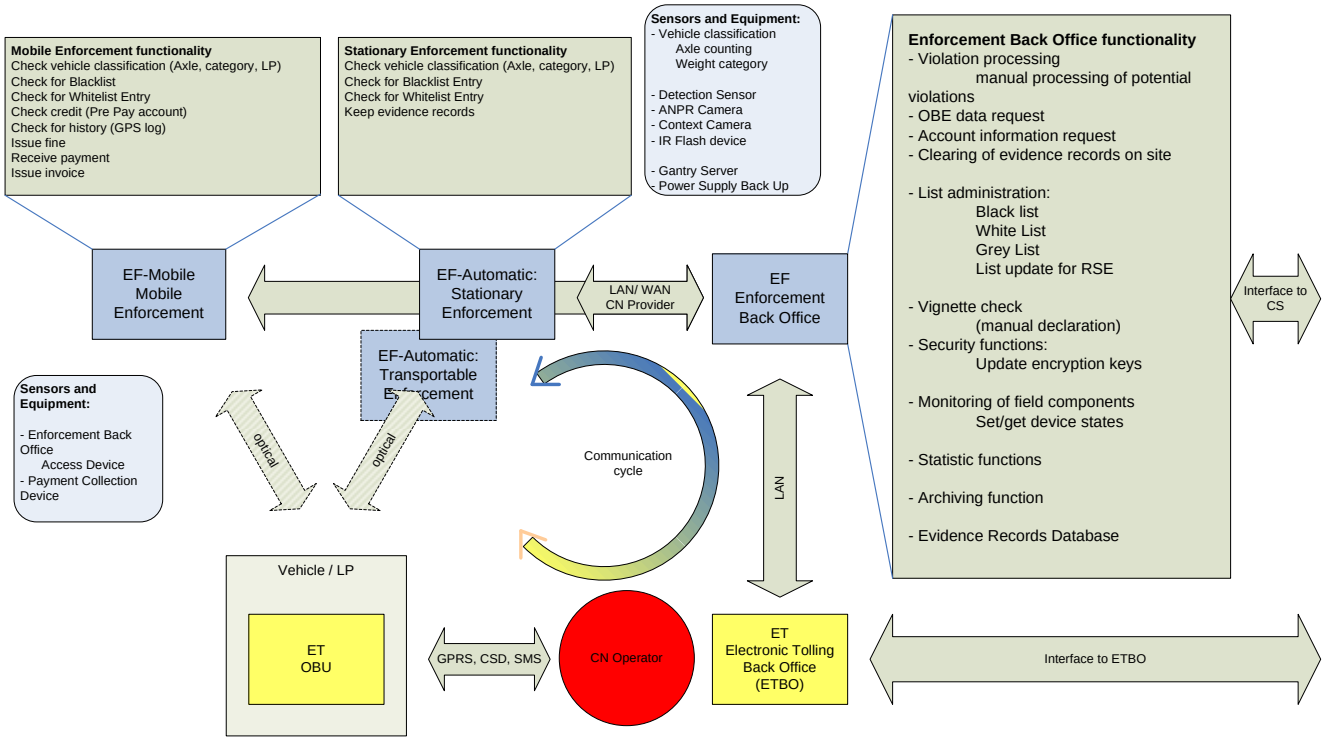


Figure 5: System functionality "Enforcement"

There are several elements that contribute to an effective enforcement. The main elements are:

- Mobile Enforcement
- Automatic Enforcement, which consists of
  - Stationary Enforcement
  - Transportable Enforcement

The strategy of enforcement shall enable the operator to achieve certain coverage of control over the chargeable network. Road users should realise that their behaviour is checked and non compliant behaviour is penalised.
In addition to the standard enforcement methods, some plausibility and functionality checks can also be added, e.g. recording the distance provided by the Odometer, checks of OBE during annual inspection of vehicles.
Since OBE is bound to vehicle licence plates, these LPs are also the basis for enforcement. This is valid for all variants of user access (i.e. OBU / LOBU / Vignette).

3.6.1 Mobile enforcement

Control vehicles containing electronic enforcement equipment can conduct random or systematic checks at arbitrary points of the road network.

Using the mobile infrastructure, OBE data is requested from the Electronic Tolling Back Office (related to the number plate of the vehicle under observation) and vehicle classification is performed manually by an enforcement officer.
This data collection takes place from specially equipped vehicles when passing eligible vehicles or at enforcement locations.
The mobile enforcement roadside equipment typically consists of several components such as an enforcement vehicle (car), ANPR equipment, a mobile enforcement server with display, keyboard, cellular network module, a printer for printing confirmation tickets in case of compensation payment including scanner functionality, a portable short range communication device (e.g. Bluetooth capable device) with display and keyboard to gather OBE information, credit card reader including printing functionality for collecting settlements, and others.

3.6.2 Automatic Enforcement

3.6.2.1 Stationary Enforcement

Stationary Enforcement is located at specifically designated points, eligible vehicles are automatically checked using electronic equipment (to detect vehicle registration, classification and payment status), toll offenders are identified, and legal evidence is collected (e.g. digital photos of vehicles that offend the tolling requirements).
Fixed enforcement is able to cover multiple lanes of road in each direction of a road, 24 hours a day, 365 days a year.
The enforcement roadside equipment typically consists of several components such as sensors for determination of the vehicle category (length, width, number of axles, trailers …), ANPR equipment for reading the license plate electronically, a gantry server for local processing of data, and others.

3.6.2.2 Transportable Enforcement

This type of enforcement is selected to get a high visibility of enforcement while checking the most significant parameters in order to determine compliant behaviour. Transportable enforcement is purely based on ANPR. Vehicle classification is excluded for this type of enforcement.

3.6.3 Enforcement Back Office (EFBO)

Toll violations in form of enforcement records are transferred from the roadside unit to the enforcement back office where violation processing takes place.

3.6.3.1 Violation Processing

Preparation of evidence records is done and the responsible Authority has to be informed about toll violations. A manual verification of enforcement records in the back office minimises wrong accusation and maximises the enforcement level.
Verified toll violations (evidence records) are forwarded to a unit for execution of penalties (violation processing).

3.6.3.2 System Monitoring

A central database provides information about faults and alarms of equipment and devices, system performance, and statistic data.
The central monitoring unit automatically obtains status and event information for all critical hardware and software components. Information is filtered according preferences, and is displayed in real time to the staff.
A report generation capability allows historical and statistic data to be summarised for subsequent analysis.
Detailed historical logs are maintained for all components.

3.7 Distribution Network

The distribution network consists of all required elements that are necessary to provide users with access to the scheme. This includes the logistic part of the system, the distribution locations as well as the stock management and the refurbishing procedure. In order to provide these types of equipment (OBUs and Vignette) to the users the following facilities are established:

3.7.1 Point of Sales / Contact Point

There are two different types of access points:

- Point of Sale
- Contact Point

The following picture indicates the services provided at these locations:

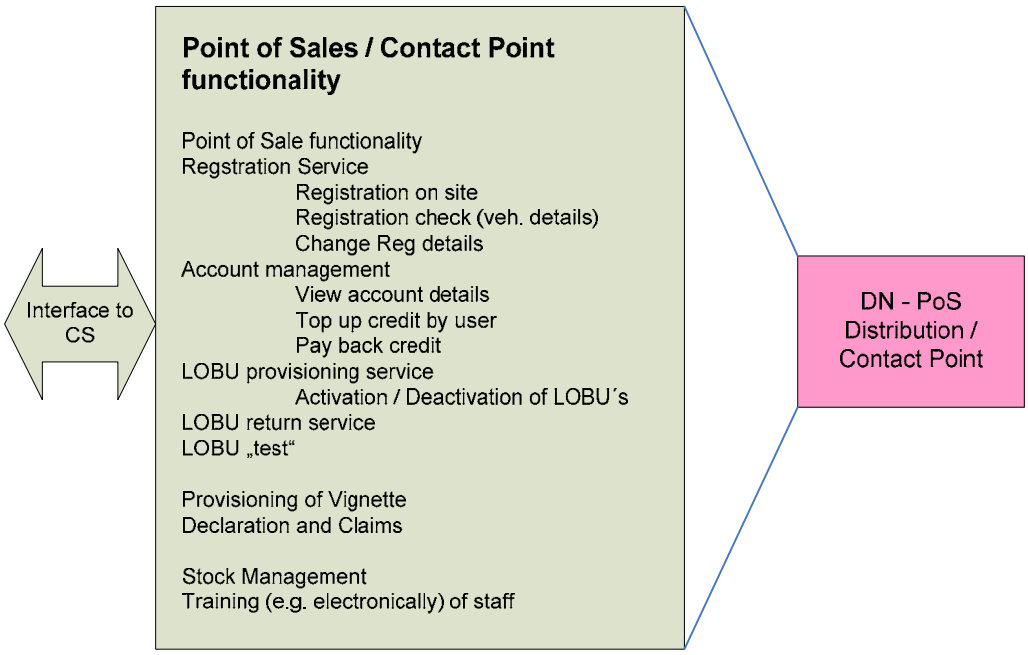


Figure 6: System functionality "PoS / Contact Point"

The services offered at PoS:

- Provisioning of OBUs for the Occasional User Scheme (LOBUs) including “LOBU test”
- Deposit handling
- Handling of payment for pre pay
- Account status information
- Top up pre pay account
- LOBU return service including refund of pre pay
- Provisioning of Vignette
- Provisioning of information material

Additional Services offered at Contact Points:

- Registration Service (including changes / cancelling etc.)
- Multilanguage Support
- Account Status information / Trip Information
- Claims / Declarations in terms of exceptions

3.7.2 Installation Centre

It is assumed that the density of the installation centre network is similar to the one of service stations for annual vehicle checks. The centre provides the facilities for installation of On Board Equipment. This Equipment can be obtained at the Installation Centre after successful registration. The equipment is mounted on the windscreen and connected to power and ignition.
It is also possible to install LOBUs in the same manner at this service station by request of a user.

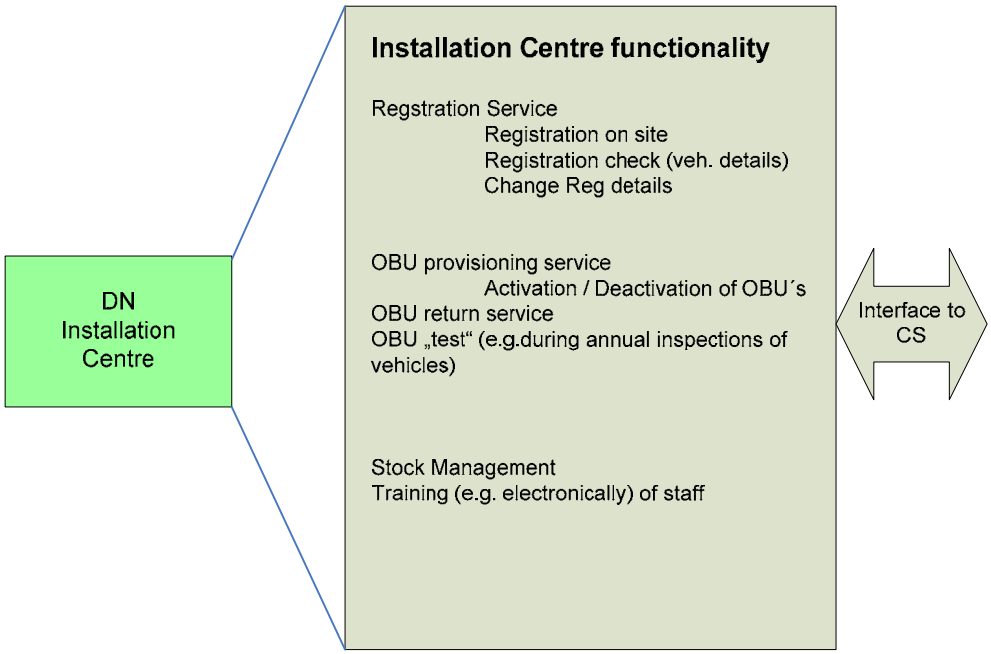


Figure 7: System functionality "Installation Centre"

The services offered at Installation Centres:

- Registration Service
- Installation of OBEs including test
- Provisioning of information material
- Check of OBEs e.g. during annual inspections of vehicles or on demand
- Exchange of defect OBUs

3.8 Central System

The Central System is the core entity of the tolling system for all user related interactions and provides several services to the operator. The picture below shows the main building blocks of the Central System:

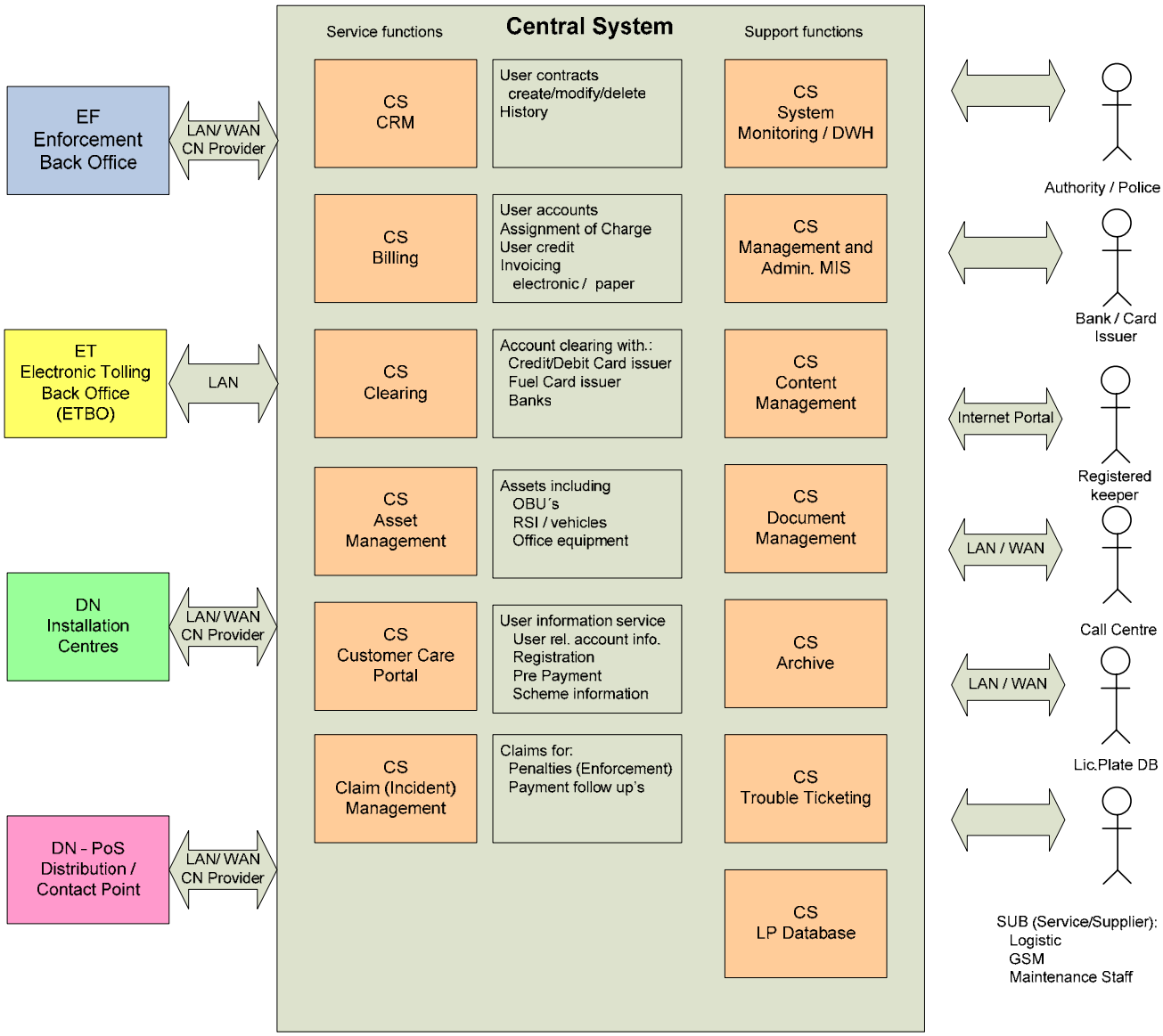


Figure 8: System Functionality "Central System"

These building blocks are basically elements of functionality and not necessarily representative for the functional boundaries of the implemented applications.

3.8.1 Service Functions:

A brief description of the main building blocks is given below:

3.8.1.1 Customer Relationship Management (CRM)

The CRM system is the core of the solution responsible for managing

- Contracts (including assignments of OBEs to vehicles)
- Sales (tolling products offered, sales channels)
- Campaigns
- Service (information, complaints)

The CRM system supports several customer contact channels mostly both inbound and outbound (telephone, fax, mail, internet, point of sale, and possibly in contact centres).

3.8.1.2 Billing and Payment

The billing system manages pre-paid and post-paid accounts. Pre-pay accounts are recharged at the point of sales locations or over the internet.

3.8.1.3 Clearing

A clearing mechanism between different providers of e.g. credit cards, debit cards, fuel cards and other payment means needs to be implemented. Especially from the perspective of an interoperable European Tolling Scheme clearing between Toll Operators is an important issue that is handled herein.

3.8.1.4 Asset management

All assets in the ownership of the toll operator are registered and tracked through this system element. Especially the OBEs but also other decentralised equipment shall be observed during the whole supply chain until the equipment is destroyed. This system element is directly related to the financial sub system of the operator.

3.8.1.5 Customer Care Portal

This system element provides online access for users in order to

- retrieve information about e.g:
  - Tolling scheme structure
  - How to comply with the scheme
  - Distribution network / contact information
  - News, FAQ´s
- Online registration
- Information about account status

3.8.1.6 Claim Management

In order to solve all incoming claims related to e.g.

- Incorrect payment
- Enforcement claims

It is assumed that mainly manual processing is involved in order to clarify open issues, but this needs to be supported by a system that provides data like evidential records or payment details / history to the personnel resolving these kinds of conflicts.

3.8.2 Common Support Functions

The following common horizontal functionality is necessary as a base for the higher level business functionality:

- Enterprise Portal
- Workflow
- Identity Management
- Document Management
- Content Management
- Trouble ticketing system
- Mail / Calendar / (MS Exchange - functions)
- Security
- Archive
- Desktop Client Management

These functions are not described here in detail and will be analysed later on with respect to their contribution to the cost evaluation.

4. D3 HIGH LEVEL SYSTEM DESIGN - SYSTEM OVERVIEW

The system described below is the design resulting from discussions between Siemens and the Ministerie van Verkeer and Waterstaat (and other parties) about the implementation of a nationwide Road User Charging Scheme for the Netherlands. The system design is derived by analysing the draft requirements provided by the ministry [3] and considering the input from various sources within Netherlands.
Siemens assumes that this system will be implemented as a tax-scheme.
The proposed System is based on GNSS (Global Navigation Satellite System, for example based on the existing NAVSTAR_GPS system or on the GALILEO system currently being implemented) technology in combination with Cellular Network communication technology. Vehicle is equipped with an On Board Equipment, meeting the requirements described in the EC directive EC 52/2004.

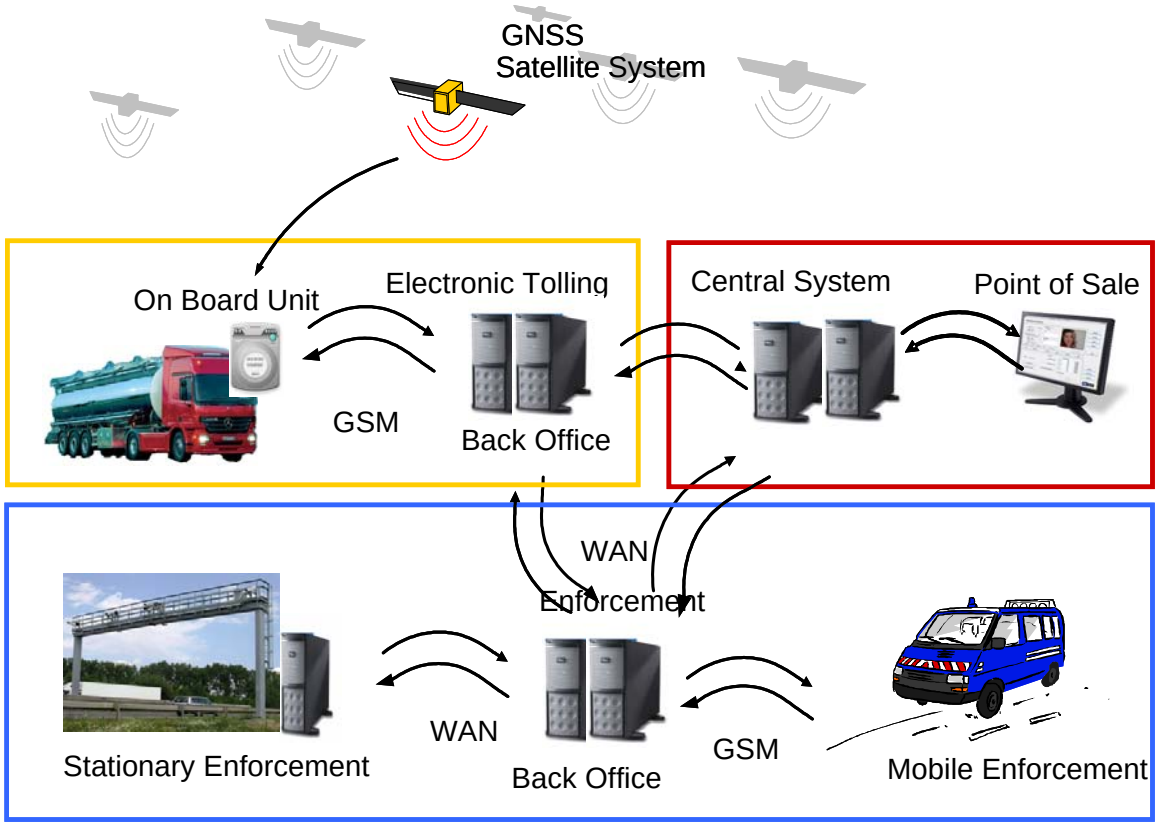


Figure 9: System Overview

5. D3 - BUSINESS ARCHITECTURE

5.1 Introduction

The Business Architecture details the structure of the business in relation to customers, markets, channels, partners and suppliers. It also covers the factors like resources (assets, personnel, skills) and intellectual capital. The business architecture has implications for the required information to manage the enterprise and the necessary systems to support its proper functioning.
The business architecture is derived from the requirements of [3] and the proposed tolling scheme which was developed based on those requirements, consisting of two sub-schemes:

1. Main Scheme:
   The main scheme is intended for all regular vehicles[1] of domestic users. Based on the assumption that these vehicles are subject to tolling during their whole lifetime, the main scheme consists of an On Board Unit (OBU) which is permanently mounted to a vehicle during its entire lifetime[2] . Foreign users of regular cars can also participate on the main scheme under certain conditions
2. Occasional Scheme
   The occasional scheme is intended for foreign users or citizens with non regular vehicles (e.g. old-timers, motorcycles). The occasional scheme consists of two approaches:
   - Low Use On Board Unit (LOBU) which is a self-installable version. This LOBU is bound to a vehicle until it is returned to the operator (and reused).
     It is available to domestic users for non regular vehicles under the same conditions as the main scheme.
     Further on the LOBU is offered to foreign users based on a refundable deposit, and in combination with specified payment methods (i.e. prepayment or via credit cards).
     The deposit is refunded after the LOBU is returned to the operator. The user can remain anonymous in the case of prepayment.In order to avoid difficulties with registration and enforcement the complexity of vehicle characteristics for foreign vehicles should be set to a level where classes can be distinguished either by automatic enforcement equipment or manually. Such classes might be: motorcycles, passenger cars, lorries in different categories, busses, vehicles with or without trailers etc...
   - Vignette[3]: The vignette offers a flat rate charge for the usage of the road network for restricted time period. The flat rate is calculated in a way that it is more expensive as dedicated toll payment based on on-board equipment (OBE).

5.2 Business Actors

This chapter reviews the key business actors, their assumed responsibility and their relationships. It is intended to use an abstraction level appropriate for the current conceptual formulation.
Primary Business Actors:

[1] Regular vehicles are all vehicles except old-timers and all kinds of motorcycles (i.e. where it is not suitable to install an OBU).
[2] An exception is foreseen for foreign vehicles and vehicles which are exported out of the Netherlands.
[3] Vignette is the name of a concept which works like a vignette system but doesn't actually require a physical vignette.

- Toll Authority:
  has the governance over the toll scheme, defines the rules for the scheme, such as the tolled road network, tariffs, enforcement regulations, and service levels for the operator. The rules are based on the legislation. The authority authorises and supervises the toll operator for the set up and operation of the toll system.
- User:
  legal entity or individuals, domestic or foreign owning vehicles liable for tolling. The vehicle user must be compliant to rules of the scheme and the relevant legislation.
- Toll operator (Road User Charging Netherlands Operator – RUC-NL Operator):
  operates the toll system on behalf of the Toll Authority, based on the rules defined by the Authority, and delivers the income generated by the toll scheme.
- Toll operators of existing schemes (domestic and foreign):
  Operators of existing domestic schemes should be integrated in the overall toll solution. Foreign operators could offer interoperable OBUs which can be used in the domestic scheme. Domestic OBUs should also be interoperable with foreign schemes.
- Service providers:
  organisations providing services on behalf of the toll operator (e.g. communication network providers, logistics, third party sales channels, etc.).
  Authorised third parties could also supervise and / or operate the Electronic Tolling Back Office and the Enforcement Back Office on behalf of the authority.

Secondary business actors operating on behalf of the toll operator and interacting with the client:

- Distribution Points (e.g. fuel stations, vehicle driver clubs):
  offer information about the tolling scheme, the sale of LOBUs, ability to top up of prepaid accounts, and the sale of vignettes4;
- Contact Points (e.g. post offices, customer service offices):
  offer all functions of a distribution point, but also provides further information about the status of the user, handles complaints and the registration and termination of OBU assignments to vehicles;
- Authorised Technicians:
  installation and demounting of OBUs;
- Call Centre (possibly outsourced):
  all customer service and support functions where no direct interaction with the customer is needed.

Important subsidiary business actors operating on behalf of the toll operator or the authority which interact with the client:

- Mobile Enforcement

Important service providers operating on behalf of the toll with high potential impact on costs:

- Communication Network Providers (GPRS, UMTS, WAN)
- Logistics Providers

Other important internal actors of the toll operator:

- System Administration and Maintenance
- Security Governance

[4] For declarations additional shops are conceivable which offer only this product.

- Business Intelligence

There are several other internal actors necessary to run the common processes of the toll operator which are common to companies responsible for enterprise resource planning (financial, controlling, human resources, asset accounting, and service), quality assurance, etc. These common areas are not further reflected in this document.

5.3 Business Process View

5.3.1 Introduction

The business process view describes the important business processes and functions necessary for the operation of a country wide tolling system.

5.3.2 Overview

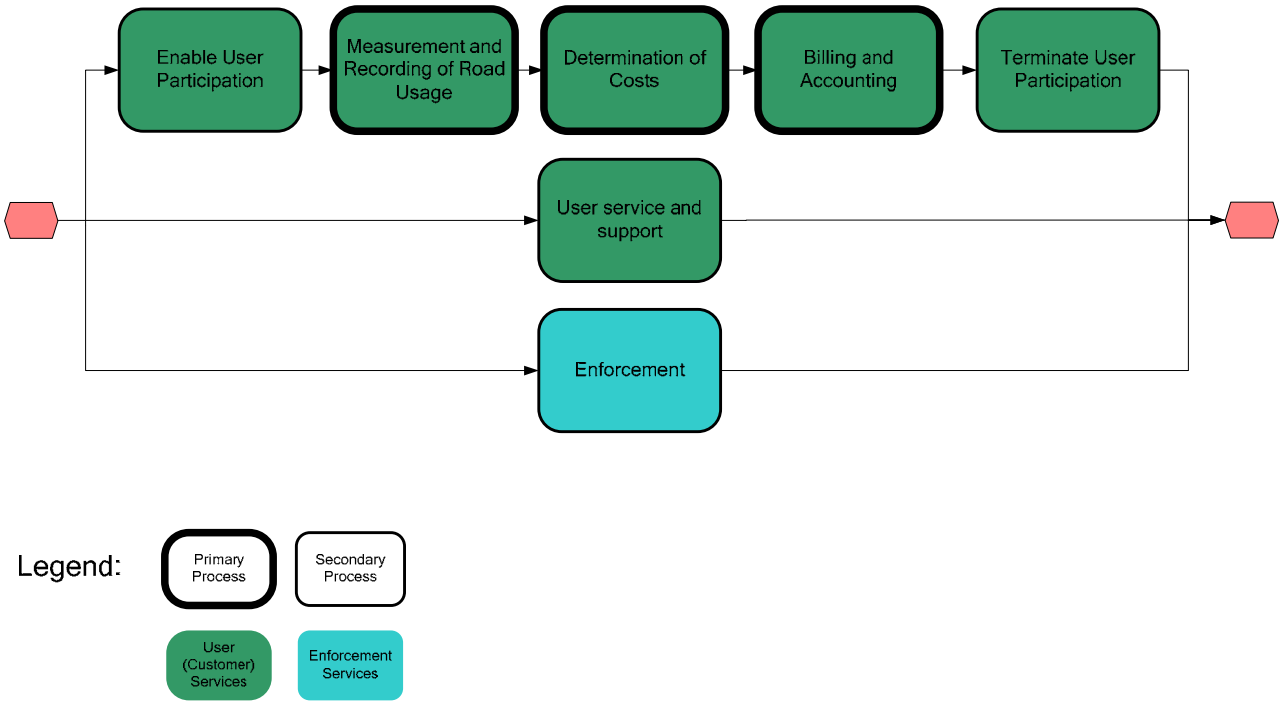


Figure 10 : Most important business processes

The primary processes of the system are:

- Measurement and recording of road usage;
- Determination of costs; and
- Billing and accounting

Important secondary processes are:

- Enable user participation;
- Terminate user participation;

- User service and support[5]
- Enforcement, and
- Tariff administration.

Secondary processes based on the proposed tolling technology (GNSS, CN):

- Provision of geographical data; and
- Provision of communication.

A further important secondary process is due to the amount of assumed outsourced services the management of business partners.

5.3.3 Process Description

The business processes can slightly differ, depending on the type of user (domestic or foreign) and the used sub-schemes. When this is the case, a unigue description per sub-scheme and per user type is provided.

5.3.3.1 Primary Processes

5.3.3.1.1 Measuring and recording road usage

Main scheme

1. Determination of location and time is based on an OBU which uses GNSS for location detection. GNSS localisation detection delivers sufficiently accurate information regarding location and time.

2. Determination of vehicle class is based on the national vehicle registration database and on additional information provided by the users when necessary (e.g. trailer status, towed and carried).

3. Recording raw data is achieved by transferring raw data about road usage to the Electronic Tolling Back-Office (ETBO) using a mobile communication network. The data can be transferred anonymously, since only the OBU can be identified with no direct association to the user).

4. Determination of road usage is based on the recorded raw data and appropriate geographical data (GIS data).

Occasional schemes

LOBU
The measurement and recording of road usage is done based on a low use on-board unit (LOBU) and is equal to that of main scheme.

Vignette
The vignette offers only a flat rate for the usage of the road network for a period of time (it is recommended to set a limit for the maximum time of the period – e.g. 2 weeks). The exact road usage is not measured and recorded.

[5] User service and support is more a function than a process where 'enable user participation' and 'terminate user participation' could be also seen as associated processes. Nevertheless the classification had been done in a way to make an appropriate description of the particular part possible.

5.3.3.1.2 Determination of costs

Main scheme

Costs for road usage are determined based on the measured and recorded data about road usage (see 5.3.3.1.1). The definition of appropriate toll objects and tariffs is essential for determining the costs.

Toll objects are the different entities of the road network which have to be distinguished to be able to calculate toll, e.g. areas, road sections, bridges, tunnels, etc. These objects are defined based on geographical data (geodata). The overhead necessary to provide this data depends on the required granularity of the toll objects.

Tariffs define the costs for all vehicle liable for toll, depending on the category and the time of day. The number of different tariffs and the amount of tariff changes determine for tariff administration overhead.

From a technical point of view, it is also possible to include additional parameters in tariffs like data about actual traffic conditions. Furthermore, is it possible to react on user behaviour over a larger period of time (e.g. provide discounts based on certain rules).

Occasional schemes

LOBU

The determination of costs for road usage is equal to that of the main scheme.

Vignette

The vignette offers only a flat rate for the usage of the road network for a period of time. The flat rate is based on the vehicle category.

5.3.3.1.3 Billing and payment

Main scheme, domestic users

The process for billing is designed based on the assumption that the tolling scheme is a tax system. Invoices are generated (monthly) and can be distributed over several channels (e-mail, internet, post) depending on the choice of the user, and are accepted receipts for tax refund purposes. Payment is possible by several methods (post office, bank transfer, direct debit, credit cards, and debit cards[6]). Contract accounting is necessary due to the fact that manual payment methods are accepted (over- and under-payment of invoices). It is assumed that following up on non-payment consists of one reminder and one warning. Thereafter, if the user doesn't pay within a certain period of time, the case is forwarded to the Authority.

Main scheme, foreign user

It is assumed that foreign users are accepted to the main scheme only if they pay with a credit card, since the main credit risk is carried by the card issuer and no follow up processes are required. Receipts (in acceptable format for tax refunds) can be distributed over several different channels depending on the choice of the user. The validity of credit cards are checked on a daily basis. OBUs associated with a black-listed credit cards are locked (i.e. they signal the driver that tolled roads cannot be used any more).

[6] Credit cards and debit cards are a technical option due to the requirement for foreign payers and for pre-payment. However, direct debit probably will be cheaper by citizens of the Netherlands and should therefore be encouraged.

Occasional scheme, domestic users (identified)

LOBU
The same process as for the main scheme for domestic users is applied.

Vignette
The vignette is provided over the defined sales channels based on prepayment. Available payment methods depend on the possibilities of the given sales channel. The user is issued a receipt according to the used sales channel (e.g printable PDF document via download or e-mail). Clearing is handled by business partners at distribution points and other resellers for both LOBUs and vignettes.

Occasional scheme, foreign users

LOBU
A prepayment solution can be offered with additional payment methods (e.g. internet payment methods, mobile payment, bank transfer). In case of prepayment, billing is performed internally in short time periods to calculate the current value of the prepaid account.
It is recommended to offer post payment via credit cards only, in order to minimise the credit risks for the toll operator.

Vignette
See the description above for declaration in the occasional scheme for domestic users.

5.3.3.2 Secondary Processes

5.3.3.2.1 Enable User Participation

The process to enable user participation can differs slightly for domestic users and foreign users (i.e. by limiting credit risk for foreign users).

Registration

Main scheme, domestic user

1. Installation and binding of an OBU to a vehicle must be done from an authorised technician. Both registered and unregistered vehicles (i.e. new or imported) must be supported. Owners of registered vehicles can arrange a date for OBU installation with an authorised technician. Unregistered cars can have installation and registration done in parallel (whereby car sellers could also act as authorised technicians).

2. The vehicle owner or user registers for participation in the main scheme. The toll operator should have access to all available data on registered vehicles (and car owners) from the national registration database. The user must also specify the desired payment method and provide the associated data (e.g. bank account number), the channel for invoices and the associated data (post address, e-mail address, etc.) and contact details. The user can optionally specify additional data necessary for appropriate user services (available via internet or mobile devices).

Main scheme, foreign user
In the main scheme for foreign users, the OBU is bound to the vehicle. Ideally, payment is only accepted based on credit cards. A refundable deposit should be also required. Also a handling fee could be charged to avoid installation in vehicles having low usage (where installation costs would be higher than the actual income).

1. Registration of user and vehicle for installation of an OBU:
   Foreign users register for participation in the main scheme, providing the required personal data (contact details, vehicle data, payment data), at contact points or via internet. After the defined checks are validated (e.g. payment method) the user gets an authorisation for OBU installation.

2. Installation and activation of OBU:
   The authorised technician checks whether the identity of the user and the vehicle data of the registration match the real vehicle (e.g. vehicle papers), installs and activates the OBU.

Occasional scheme, domestic user

LOBU
The LOBU can be acquired over the available sales channels (internet, post, distribution points) and mounted by the user. The user must own a non-regular vehicle to which no LOBU is currently assigned.

Vignette
For domestic users, the vignette is intended especially for motorcycles and for other non-regular vehicles which are rarely used or where LOBUs cannot be installed. It should be possible to order a vignette for a longer time period (e.g. several months up to a year). This option should not be offered for other vehicle types or for foreign users (where LOBUs should be used). The user must specify the licence plate number and the usage period. The static vehicle category can be acquired from the national registration data base, additional dynamic vehicle category (e.g. a trailer) must be specified by the user.

Occasional scheme, foreign user

LOBU
For foreign users, the LOBU is intended for users driving more than a defined amount of kilometres in the Netherlands. The LOBU should only available based on prepayment, and a refundable deposit should also be required. A handling fee should be charged to avoid the use of LOBUs by very occasional users (due to the refurbishment costs which are associated with each use). The user has to register the necessary vehicle data (licence plate number, vehicle type, year of manufacture, serial number). The user gets the LOBU and installs it. Before the LOBU can be used, the associated prepaid account has to be topped up (initially, this can be done during the acquisition).
An improvement of the process could be achieved through access to foreign vehicle registration databases (preferable online). This would probably allow a better check against static vehicle categories and prevent fraud.

User support for defect OBEs, lost and stolen OBEs, stolen vehicles

Processes should be established to assist the user with all problems regarding the participation in the scheme which are not caused by the user (see also 5.3.3.2.3). Particularly, the exchange of defect OBEs, alternative devices for lost and stolen OBEs, and stolen vehicles where OBUs are also lost, can become cost-intensive without efficient processes in place.
It is assumed that the user pays the costs for a lost or stolen LOBUs (the deposit will be not refunded). In the case of a defect OBE, it lies in the discretion of the particular agent handling the case to distinguish a regular defect from a defect caused by misuse or vandalism. In the case of misuse or vandalism, the user must be charged for the OBE or the deposit will not be returned.

5.3.3.2.2 Terminate User Participation

Main scheme, domestic user

In the main scheme for domestic users, user participation ends when the vehicle owner changes. The vehicle participation ends when the vehicle is exported or the vehicle is decommissioned (although exceptions could be introduced).
If the vehicle owner changes within the country, the procedure is similar to the registration of the vehicle. The user which terminates the participation has to report the termination. After reporting the user gets a final invoice which includes all open items till the reported date of termination. After successful payment, the user account is closed regarding the concerned vehicle. The new owner cannot register the vehicle until the old owner has reported the termination.
If the vehicle is decommissioned, the participation of the user and the vehicle is terminated. It is assumed that the termination of the vehicle participation accompanies the deregistration of the vehicle. If the OBU is younger as a certain age, the OBU can be refurbished. If the vehicle is exported, the same rules can be applied as for decommissioning.

Main scheme, foreign user
A foreign user pays a refundable deposit for the OBU. The foreign user makes an appointment with an authorised technician for dismounting the OBU. After the dismounting of the OBU the user gets back the deposit (credit over credit card used for payment). The termination of the participation can be done in parallel over several channels.

Occasional scheme, domestic user

LOBU
When a domestic user of the occasional scheme terminates participation in the scheme, the LOBU must be returned through the defined channels (distribution points, post, etc.). The user will be charged for the LOBU if it is not returned after a certain number of days after the termination.

Occasional scheme, foreign user
A foreign user pays a refundable deposit for the LOBU. After the LOBU is returned and checked for vandalism, the deposit is refunded. The credit of the prepaid account is also refunded once the user data is examined (to avoid fraud). Refunds are only transferred to the defined bank account. The return of the LOBU terminates the participation for the user.

5.3.3.2.3 User Services and Support

User services and support consist of customer care and customer relationship management. One major goal of the toll operator should be to provide the best services for the users in order to achieve the highest level of user satisfaction. Consequently, constant process improvement of user services and support should be realised, based on the experience of user behaviour, to improve user comfort and minimise costs.

User types
In general the system has to distinguish and offer functionality for the following user types:

- Private users (having either one or only a few vehicles);
- Companies (particularly large fleets; having a high number of vehicles; different roles of contacts within the client)

There is a second differentiation necessary for both mentioned types:

- Domestic users (fully identified; access to several registries like the national vehicle registry RDW; easy access in legal cases)
- Foreign users (subcategories like EU and non-EU; to some extend anonymous; probably hard access in legal cases; different languages)

Functions
User services and support offers functions for

1. User service:
   a. User questions:
      this includes common information and questions about the scheme (e.g. how to participate, tariffs, toll preview, etc.) and also questions about an individual participant (e.g. actual status of account, toll transaction list);
   b. Administration of user attributes (e.g. contact details, billing details);
   c. Exchange of defect OBE
   d. User complaints:
      handling of various types of user complaints; and
2. Marketing (Campaigns):
   they will be necessary mainly during the migration phase of the system.

Enabling and termination of user participation in general can be seen also as a part of the functional group “user services and support”. These processes are described separately, due to the fact that they are significant cost drivers. Nevertheless, these processes also use the flexible channel structure available for “user services and support” (see channel management).

Billing and payment functionality regarding the interaction with the user is also offered over the functional group “user services and support” (invoices and invoice details, access to the contract account).

Channel management

Channel management provides friendly, flexible and efficient interaction with customers. The system supports both inbound and outbound customer contact, with the following contact channels:

- Internet (including mobile devices);
- Telephone (including interactive voice response, IVR);
- E-mail;
- Fax;
- Correspondence by posted letter; and
- Face to face at customer service centres (also called contact points), distribution points (points of sale), and authorised technicians (in every case an inbound contact only by its nature).
  Distribution points and authorised technicians offer limited and special user services (e.g. at authorised technicians questions regarding the OBU can be answered but probably questions regarding payment methods or tariffs can’t). Contact points don’t offer LOBUs.

There are restrictions about the availability of channels regarding the type of service (e.g. installation or demounting of OBU) and available sub options (e.g. particular payment methods like cash payment).

To minimise costs, customer self services such as internet services should be made widely available for all processes requiring client interaction. Nevertheless, a toll operator agent should be available whenever the client requires help.

It is assumed that “user services and support” functions have to be offered in several languages, thus requiring a flexible channel architecture to minimise the requirements for staff with skills less common foreign languages.

All customer self-care channels are available 24 hours a day, 7 days a week. Contact points, distribution points, and authorised technicians are generally only available during regular working

hours. Nevertheless, an adequate number of distribution points which are available 24 hours a day, 7 days a week (e.g. fuel stations at highly frequented motorways).

5.3.3.2.4 Enforcement

5.3.3.2.4.1 Automatic Enforcement

Automatic enforcement equipment is used to check the compliance of road users while driving without immediate human intervention. Stationary and transportable setups are possible.
Photographs are taken of each checked vehicle, and automatic number plate recognition (ANPR) equipment determines the vehicle identification. The license plate number is sent to the enforcement back office (EFBO), along with location and timestamp, which checks all available information (enforcement and usage records) for consistency. Optionally, the ETBO can also request data from the OBE of the vehicle under scrutiny. This can include the latest usage records, tracking data and status reports to verify the result of the investigation. The ETBO sends a notification to the EFBO declaring the enforcement case to be ok or a possible violation. The EFBO reports back to the enforcement RSE, either requesting the evidential records or instructing the field equipment to discard all data related to compliant users.

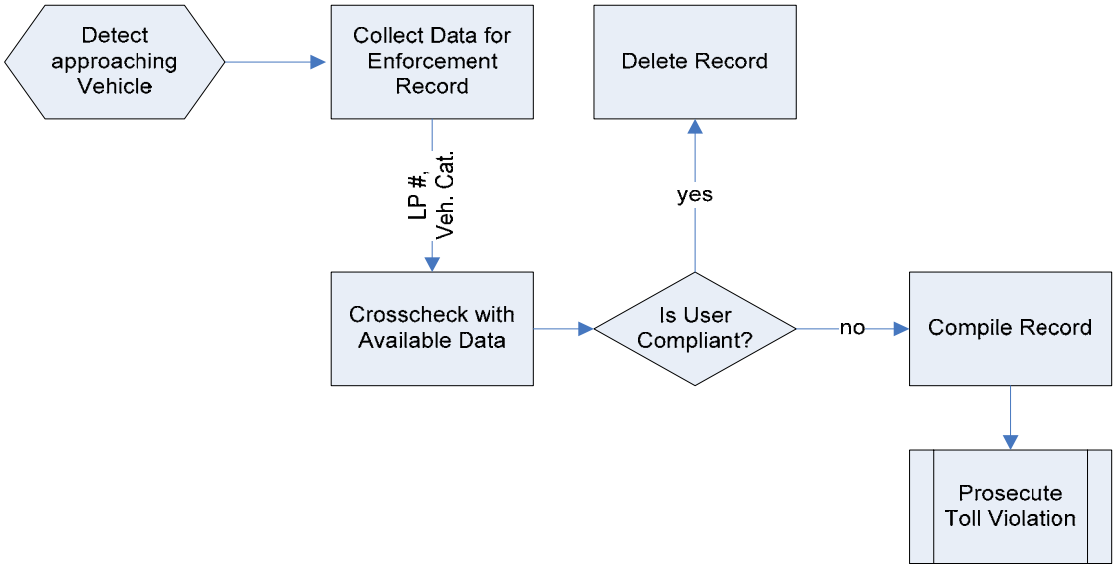


Figure 11: Automatic enforcement

Performance of the system depends on the intervals of usage data transmissions from OBE to the ETBO. The more frequently this is done, the more current the information in the ETBO will be. The economic feasibility of transmission depends heavily on the communication network properties. For real-time display of tariffs (e.g. for congestion control), frequent communication (i.e. every few minutes) is desirable.
It is difficult to predict future network parameters, but until 2012 telecommunication services should become more flexible, available bandwidth should increase, and roundtrip delays as well as connection setup times should decrease. Data in the central system should thus be up to date for plausibility checks (i.e. comparing current position with latest reported fixes).

Stationary

The most prominent (optional) addition for fixed enforcement is automatic vehicle categorisation equipment. This is not recommendable for transportable units, because of the complex setup and adjustment procedures necessary for reliable operation of automatic categorisation. On the other

hand, the additional information can help to detect incorrect declarations of vehicle category (e.g. axle count, trailers), or misuse of OBE (e.g. in other vehicle than registered).
Fixed enforcement installations are most useful on high category roads, where high traffic density results in need for high throughput, and where it is difficult to avoid passing the check point. The permanent installation enables optimisation of equipment and communication facilities, ensuring good coverage on high traffic frequency locations. The downside of fixed enforcement is the known location, making it easier for toll offenders to evade.

Transportable

The equipment for this kind of setup can be moved to arbitrary road locations. Functionality is identical to stationary equipment, but with reduced throughput and lane coverage and with diminished categorisation capability.
Optionally, mobile enforcement stations can be equipped with reduced classification functionality. While this will only work for the rightmost lane, it is sufficient for smaller roads. Therefore, vehicles using trailers without correct declaration can be detected. Such vehicle trains are usually found in the rightmost lane anyway, because their setup and driving behaviour is not in favour of high speeds or overtaking.

5.3.3.2.4.2 Mobile Enforcement

While for manual enforcement the operational costs are higher due to salaries to be paid, there are several advantages warranting the additional effort:

- The moment of surprise is high, it is impossible to predict for offenders where and when they are checked.
- Not only driving but also parked vehicles can be checked. Enforcement can approach to the vehicle, not only the other way round.
- Foreign users can be stopped and forced to pay a fine immediately, avoiding the risk of escape.

Manual enforcement works in the following way (as shown in figure Figure 12): The enforcement personnel are equipped with terminals, which are portable computers (e.g. PDAs – Personal Digital Assistants) with a wireless communication link to the central system. For checking a vehicle, the license plate number is either entered manually or read by ANPR equipment installed in the enforcement vehicle. The terminal retrieves all relevant information from the EFBO, which requests checking from the ETBO just like in automatic enforcement. The enforcement personnel can check if the data are consistent (user account history, vehicle category, user status etc.) with what they find on the road. This can be done while driving (enforcement vehicle as well as vehicle under scrutiny) or e.g. on parking lots. Possible offenders are stopped and checked more closely, fines are collected; in extreme cases the vehicle could be impounded (e.g. to avoid the risk of leaving the Netherlands without paying, etc.). Therefore this process is also effective for foreign vehicles from countries not having legal agreements with the Netherlands.

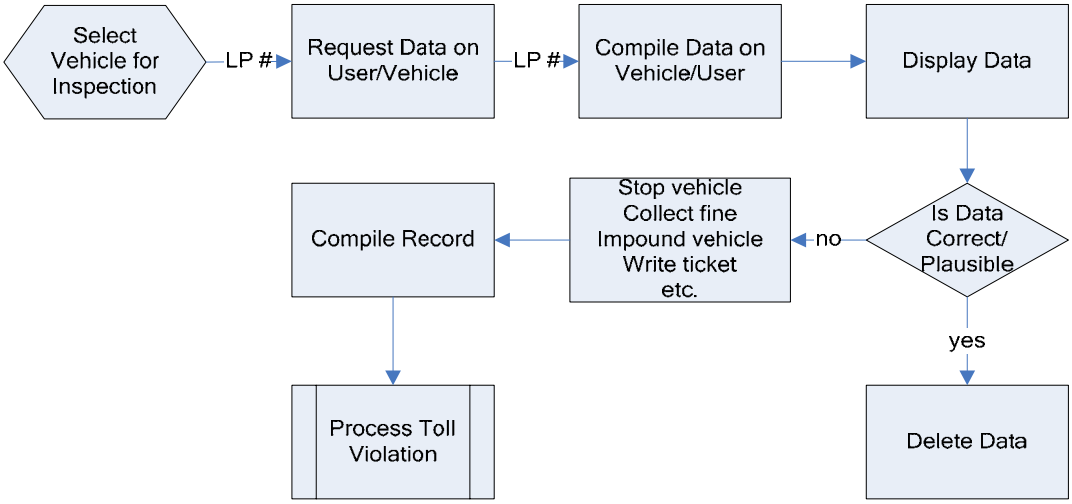


Figure 12: Mobile enforcement

Enforcement Post-Processing

This process is shown in Figure 13.

Due to the high number of vehicles in the system, it is important to avoid manual processing as far as possible. In the first step it is determined whether a vehicle with its recognised license plate is in violation. The matching of the ANPR-information with the payment information is done on basis of raw ANPR-data, irrespective the reliability level. This could even be with one character of the LPN not read (wild card) or misread. Since also date/time and location position are taken into consideration for the matching rule, the chance to detect an unjustified violation is very low. In the second step the violation is checked, where the reliability of the ANPR-result is taken into account. Violator-LP numbers that are read and classified with a high reliability will be processed fully automatically. Violator-LP numbers that are read with low reliability or that cannot be classified automatically will be processed manually.

The violators are offered access to the violations database via internet with a dedicated entry code to check the correctness of their violation by looking at the picture made. This feature reduces the load on the call centre considerably.

Collection of fines is easier if the toll is levied in the form of a tax. The same procedures as for other tax offences are applicable.

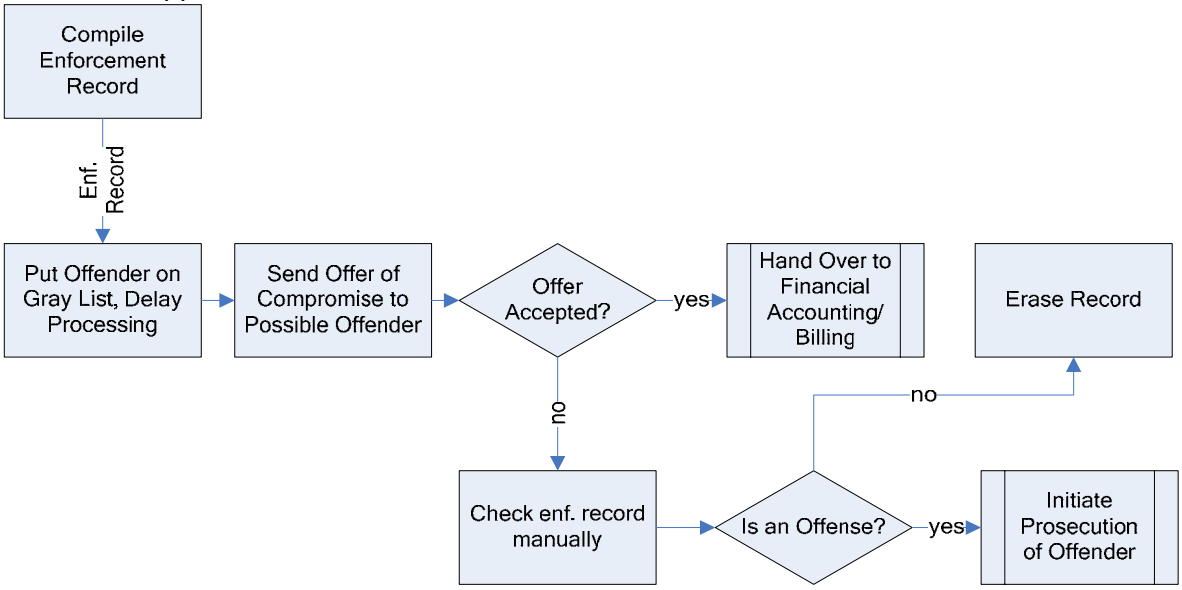


Figure 13: Enforcement post-processing

Foreign vehicles entering the Netherlands on smaller roads probably need to drive a certain distance before they can register for the toll system. For accommodating this scenario all detected offences are listed in a “gray list” for a given amount of time. If the road users set up participation within this time limit, the enforcement records are erased. Otherwise the standard process resumes.

5.3.3.2.5 Distribution, Logistics, and Refurbishment

This functional group deals with distribution and logistics regarding OBEs. It addresses also important questions about refurbishment. A part of distribution namely the distribution to the user was mentioned in the processes of enabling and termination of user participation.

Distribution of OBUs:
OBUs need to be distributed from a main storage to authorised technicians according to their local stock requirements. The authorised technicians will ideally plan their OBU stock and order their forecasts (the initial stocks are planned from the toll operator based on the migration strategy). The system will control the stock including all participating parties (main store, stores of authorised technicians), initiate orders to the OBU manufacturers and redistributions if the stock of an authorised technician is too high. This requires a very flexible system design which allows easy adoption of the used process and the underlying assumptions. One important goal is the possibility to integrate different logistics providers (post, private specialized logistics provider) optimised for the type of authorised technician according to the respective forecasts for the OBU stock and the project phase (during the migration phase probably a much higher amount of OBUs has to be distributed).
Clients owning large fleets could optionally become as authorised for their own stock.

Distribution of LOBUs to distribution points
LOBUs have to be distributed from at least one central store to contact points and distribution points. For the necessary logistics in principle the same rules have to be applied as for OBUs.
LOBUs are activated when they were mounted into the vehicle.

Direct distribution of LOBUs to the user
LOBUs can be ordered also over customer self services (internet). In this case the LOBU is sent using an appropriate logistics provider (e.g. post) directly to the user.

Refurbishment of OBEs
Demounted OBEs independent of the case go back to the central storage. In the central store certain parameters decide if the OBE goes further into the refurbishment process or into the disposal process. If the OBE is still working correctly and its age is beneath a certain level, it enters the refurbishment process. Otherwise it goes into the disposal process.
It is assumed that the refurbishment process is executed at the central store itself. During the refurbishment the technical state of the OBE is checked (first part to decide if refurbishment makes sense). Possibly the case of the OBE is exchanged (depends on the status). The OBE is repackaged and inserted into the distribution process.

Disposal of OBEs
OBEs which are identified for disposal are returned to the manufacturer. The manufacturer is responsible for the disposal (cost for disposal are included in the OBE price).

5.3.3.2.6 Administration of Tariffs

Tariff administration is necessary to support the process of determining costs. The software solution offers provides the appropriate tools for tariff administration. Nevertheless, updates have to go through a quality assurance process before they can be applied to the productive system.

5.3.3.2.7 Provision of Geographical Data

Differentiation of road types is done on section basis where algorithms based on a predefined geographical model detect the passage of a vehicle of a “virtual gantry”. Geographical data (GEO data) need to be created for locations having a different tariff structure than the standard tariff.
Provision of appropriate geographical data is necessary to support the process of measurement and recording of road usage. The amount of GOE data necessary depends on the granularity of the toll objects (areas, sections, size of sections). The effort to keep the GEO data in a current state depends also highly on the granularity of the toll objects. A higher granularity usually also leads to a higher frequency of updates necessary. Updates have to go through an appropriate quality assurance process before they can be applied to the production system.
Basic GEO data about the road network can be obtained in a standardised form from an appropriate provider. Nevertheless normally additional information has to be added (special areas, type information for sections, etc.).
In the concrete case it is assumed that comprehensive geographical data is necessary regarding all sections and areas where peak tariffs are applied. For all sections and roads which are based only on the flat tariff in principle no additional geographical data is necessary.

5.3.3.2.8 Provision of Communication

Communication infrastructure and services are necessary in several parts of the system. Cost-effective provisioning of wireless network services for communication between the OBEs and the Electronic Tolling Back office (ETBO) is essential to efficient system operation. Based on the amount of units it is assumed that several GSM providers of the Netherlands will be foreseen for providing the required network services.
GPRS is typically used for communication between the OBEs and the ETBO. By 2012, UMTS and HSDPA mobile communication networks will most likely be readily available, providing the necessary network coverage and improved performance (e.g. reduced network latency compared to GPRS).
The wireless network providers are integrated into the system over appropriate B2B interfaces for optimized SIM pre-activation and activation and for the usage and cost reconciliation.

5.3.3.3 Tertiary Processes

5.3.3.3.1 Systems management and maintenance

Systems management performs functions that allow for adequate, continuous and safe operation of the system. This includes assessment of the availability and performance of subsystems and components and taking appropriate measures in case of malfunctioning or degraded performance.
System management processes will be based upon IT Infrastructure Library (ITIL) service management procedures.

5.3.3.3.2 Determine tariffs (measure effects and adjust tariff parameters)

Anonymous road usage data and appropriate statistics regarding road usage in relationship with tariffs can be supplied to the authority.
This data should allow the authority to derive further statistics and findings regarding implication of tariffs. Further it should be possible to compute what-if scenarios regarding the implication of tariffs based provided and derived data.

5.3.3.3.3 Supervision

Supervision is made on activities to verify that measures still adhere to applicable legislation and rules for accounting and personal data protection.

Auditing

Reports containing management and financial information are generated to inform the Authority. Permission may be granted to the Authority to get access to relevant data in the system.

Financial accounting

Full compliancy is provided for Nominal Ledger accounts packages, allowing standard profit & loss and balance sheet reports to be generated, and reconciliation of the information stored. Financial transactions may be exported to the Authority's accounting package.

Security

Security systems will be applied dedicated to assess the integrity of the data. System design will be built around the security architecture. Full compliance to ISO 17799 is guaranteed.
Security mechanisms for access control, history logging, encryption, intrusion detection and prevention systems, authentication, authorization, external and internal firewalls, auditing and single sign-on will be provided.
Internet access will be accompanied by the highest possible security level.

Data protection

Adequate measures will be taken to protect user data in accordance with Dutch privacy regulations (Wet Bescherming Persoonsgegevens) and the European directive 95/46/EC.

6. D3 SYSTEM ARCHITECTURE

6.1 Principles

The major goals of the system architecture are:

- the system should be designed to enable change (improvements and extensions);
- the system should be designed to enable integration of new standards and of new desirable technology solution;
- the system should be scaleable to support evolving requirements;
- the system should be reliable;
- the system should be designed to enable the implementation of the required availability;
- the system should be simple and easy to use at every level; and
- the system should deliver appropriate information about the execution performance at every level which can be used as base for further improvements at every level (e.g. process improvement);

The following basic principles are applied at the highest level of the architecture to address the major goals:

- modular system approach;
- service orientation;
- event-driven approach;
- process orientation (i.e. according to human workflow);
- multi-channel solution;
- use of standards on every level if appropriate;
- use of proven technology; and
- use of appropriate commercial-off-the-shelf products.

Regarding the design of the modular system approach, the following basic principles are applied:

- separation of subsystems, services, components and orthogonal issues like security, configuration, and operation;
- Good interface design to enforce clean separation of subsystems for fostering flexibility;
- loose coupling of subsystems, services and components (to maximise independence of availability);
- strict layering concerning the overall architecture, also within subsystems and services, to foster flexibility regarding reuse and extendibility;
- standard integration technologies are used to exchange of information services through established interfaces.

In our opinion, a flexible integration solution is an important success factor in achieving the necessary flexibility to enable the implementation of modified requirements or to adjust the system due to operational experiences. The integration of internal and external partners should be realised on several levels (also the process level), permitting the appropriate levels of security and the separation of the individual subsystems even in separate security domains (e.g. in different organisations).

To improve overall performance, these subsystems are decoupled where appropriate over an intermediate service and process-oriented integration solution. This integration principle is also used within the Central System to enable a process oriented multi-channel architecture for all business support services. The integration solution is based on standards for service-oriented architectures (e.g. first and second generation protocols for web services)

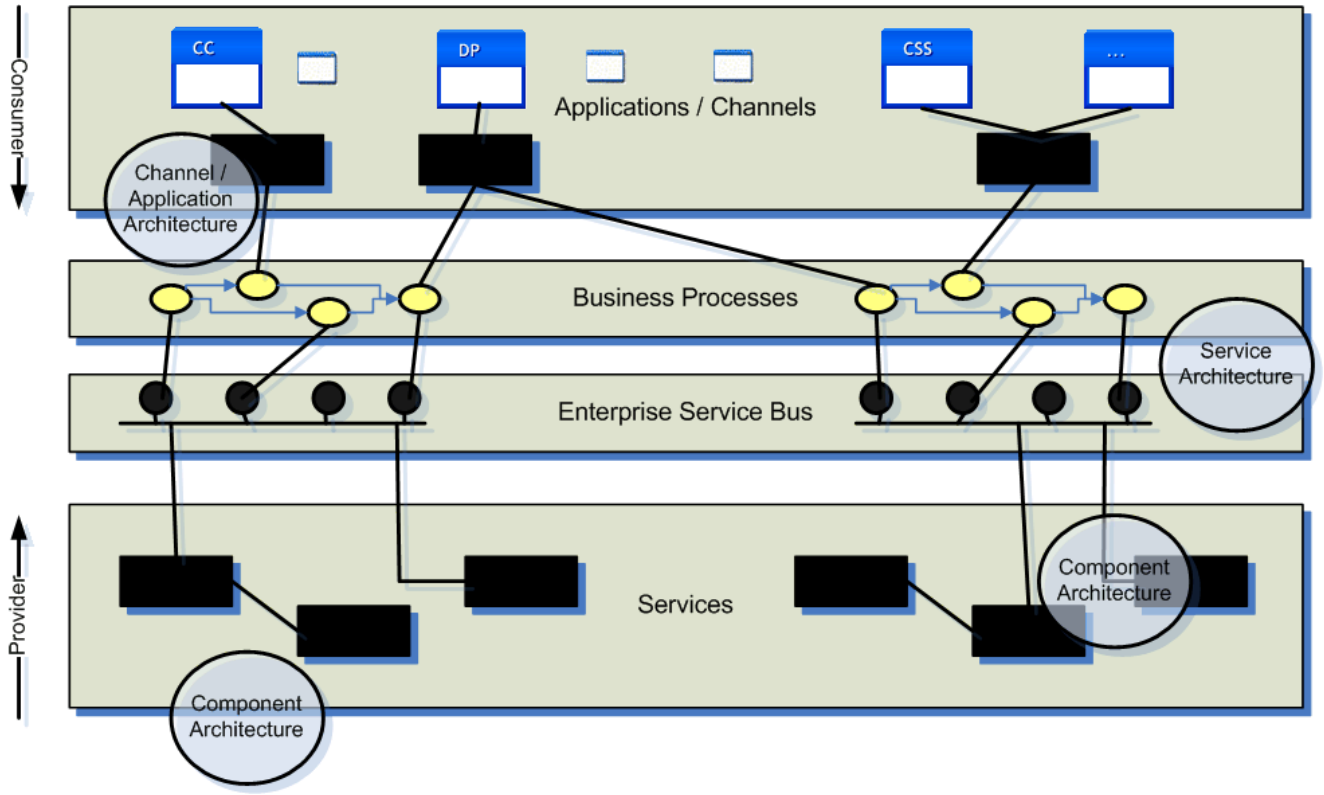


Figure 14: Overall architectural perspectives

The figure above shows a high level of abstraction on enterprise level about the overall architectural perspectives[7]:

- Channel / Application Architecture:
  this business –oriented solution uses services from one ore more providers and integrates them into the business processes.
- Service Architecture:
  provides a bridge between the implementation and the deployed applications, creating a logical view of sets of services which are available for use.
- Component Architecture:
  describes the various environments supporting the implemented applications, the business objects and their implementations.[8]

The electronic tolling subsystem and the distribution of logic between On Board Equipment (OBE) and the Back-Office (ETBO) is the centrepiece of the overall architecture. The available management functionality allows for changes in functionality distribution between OBE and ETBO, even in a

[7] The mentioned subsystems classify mainly components and their offered services. Channels and applications are mainly a part of the Central Services or an overall part.
[8] Coarse-grained components like CRM, billing, and ERP components, providing services relevant on the enterprise level.

deployed system. Nevertheless, a thin client approach reduces maintenance, update efforts, and risks due to the high amount of OBEs.

6.1.1 Information Security

The system architecture must support the implementation of appropriate levels of information security such as:

- Confidentiality – to protect against unauthorised access of data
- Integrity – to assure the completeness and correctness of information and the functions that process them (to prevent malicious or accidental alteration of data)
- Availability – to assure unrestricted access to data by authorised personnel

Security is implemented on the system, subsystem, and component levels for all communication channels. Flexibility is needed since actual security requirements are defined through an ongoing risk analysis process in which new threats can be detected and handled appropriately..
Functionality which must be addressed in the architecture includes:

- Authentication and authorisation, including identity management
- Access control
- Auditing
- Encryption
- Digital signatures
- Approaches to ensure transactional integrity in a distributed environment (ACID)
- Approaches to ensure non-repudiation (e.g. based on digital signatures)
- Protection against malicious software and denial of service attacks

The necessary functionality must be provided with the required level of security (e.g. strong, certified components in critical areas). Further, it must be possible to enhance the level of security in the future if requirements increase (e.g. length of used keys).
The architecture supports the use of hardware security modules for several reasons (e.g. use of digital signatures in OBEs) which offer strong security and are certified according to ITSEC (at least at level E3).

Data Protection

Tolling
The thin client solution requires trip data processing in a centralised system to determine charging data. The privacy aspect requires special attention for this solution. In order to guarantee a sufficient level of privacy of the road users additional organisational and technical measures are taken. A dedicated entity, called ETBO, is foreseen to collect all trip data from road users and to transform this into the charging data (Charge Coded Data).
The ETBO is rather isolated from the other subsystems and its operation is controlled by a Trusted Third Party, which provides regulation and assessment of all data handling.
Based upon the Dutch privacy regulation, the following principles are applied:

- Only information is collected, which is required to calculate the Charge Coded Data, such as the OBU ID, date, time, and position data as well as the corresponding License Plate Number for enforcement purposes. Within the ETBO, no information about the OBU keeper or vehicle owner is known.
- Information is not stored longer than necessary.
- Collected information is used exclusively to calculate the Charge Coded Data.

- Road users are informed about which information is stored and what it is required for.
- OBU owners shall be provided access to the data stored about themselves. This can be combined with a service to give the OBU owners access to their trip data and check their invoices (whereby sufficient security measures are deployed).

Since the Charge Coded Data do not contain privacy-sensitive information, it can be used within the Central System without additional measures.
The OBU trip data, without OBU ID and therfore anonymous, will be used as a basis for statistical section trip time calculation. Such data may be be provided as statistical data to support Traffic Information Services.
All OBU data is subject to data mining processing in the ETBO for detecting weak points within the GNSS network. GNSS quality information is then used to improve the quality of the service.
Data mining processing can also detect malicious or suspicious behaviour of a certain OBU. When detected, all data of the concerned OBU is reported to the enforcement entity.

Enforcement
For enforcement, similar principles are applied as for tolling. All vehicles passing are photographed and these digital images are stored in the roadside equipment. The License Plate Number with date, time, and position data is sent to the EFBO. As soon as the EFBO determines that user is compliant to the scheme, the corresponding image is deleted. In case of violation, the image is collected to the EFBO for further processing.

6.1.2 Interoperability

Within the timeframe for implementation of this system, it is expected that developments for achieving interoperability between European electronic fee collection (EFC) systems will have progressed considerably. Today interoperability is implemented on a bilateral basis only, while in the next five years the European Electronic Toll System (EETS) is scheduled to be operational at least for heavy goods vehicles.
The solutions Siemens proposes and delivers are prepared for interoperability scenarios on several levels because of several independent strategies and measures:

1. The system and business architecture we propose is designed to offer a maximum degree of flexibility. The system is modular; the interfaces are well defined and can be published to partners outside the system. The processes are also defined and designed in a way to ease accommodation of changes and integration of external partners.
2. Siemens monitors and participates actively in standardisation and in the definition of the EETS. Therefore we are well positioned to cover all developments and influence all decisions to make sure that stable standards cover the needs of technical and procedural interoperability in a down to earth way.
3. Extensive research and development efforts at Siemens make sure that we assert our technical leadership in the field of electronic tolling. Our flexible system and process design makes it easy to integrate new developments and solutions. Therefore we can deliver best value for money, covering all emerging needs. This is especially true for interoperability issues.
4. Siemens is not in the same position as an operator of a single system. We are open to all kinds of solutions without any bias. Therefore we not only can deliver the optimum solution for each customer, but we can also provide interoperable solutions on an impartial basis without tendencies to favour certain implementations for reasons like protection of our earlier investments.

6.2 Logical View

The logical view describes the functions performed by the system components and the interfaces between those components.

6.2.1 Overview

The toll system proposed in this document contains the main logical parts or subsystems:

- Electronic Tolling System
- Central System
- Enforcement System

The electronic tolling system provides the main functionality for the primary business processes and is responsible for measuring and recording road usage and for determining costs. The routes driven by all registered vehicles are recorded; the data is processed and transferred, prepared for the final billing of the accumulated costs for each user of the tolling scheme.
The central system is mainly responsible for the contact with the participants, enabling the participant to conclude a contract, providing necessary devices (e.g. OBEs) for using the toll scheme. The central system enables billing, payment and all other financial services for the participants as well as supporting key components of the business processes needed for distribution and logistics.
The enforcement system determines whether the all vehicles subject to the scheme are compliant.
All three subsystems are reliably working together via defined interfaces.

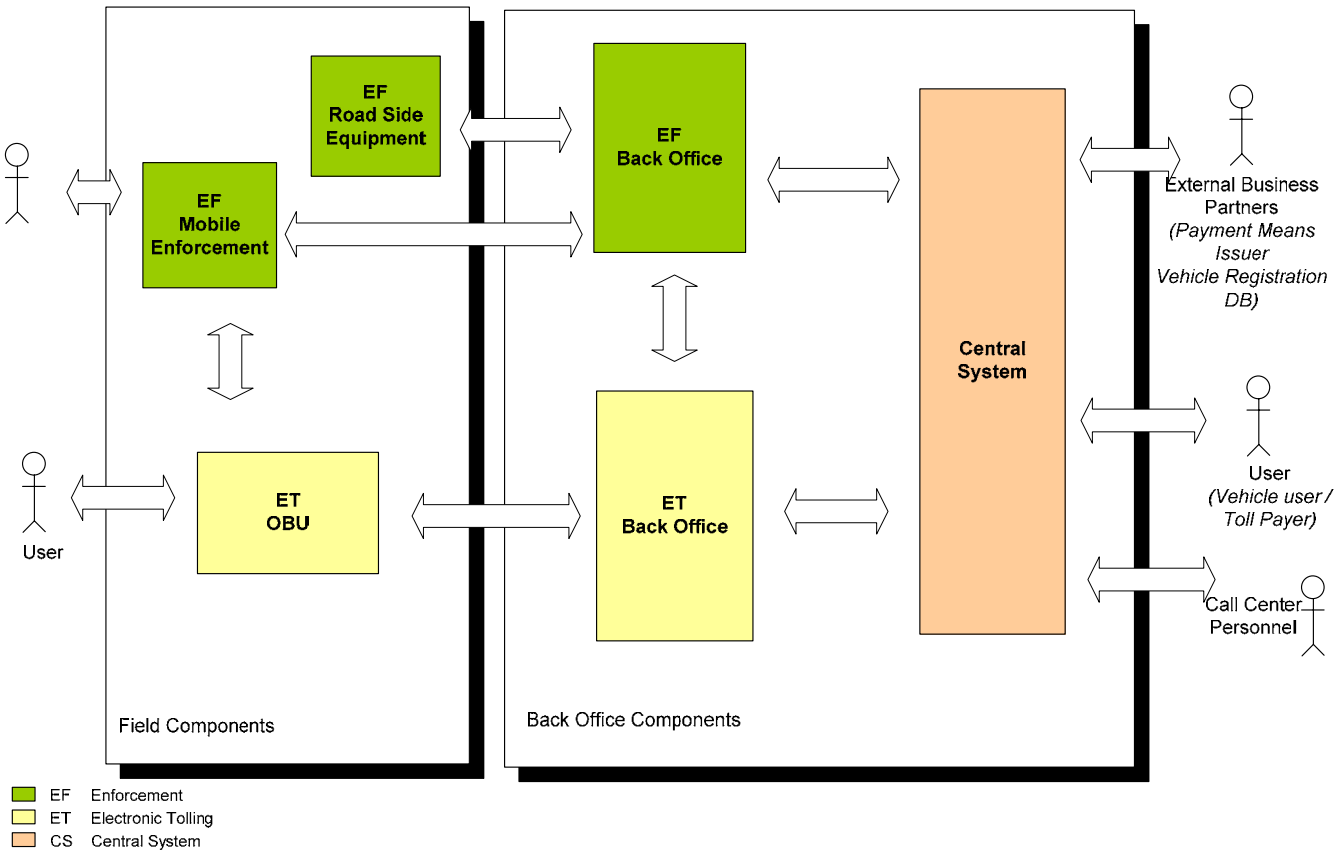


Figure 15 Subsystems of the toll system

6.2.2 Electronic Tolling

6.2.2.1 Solution Description

The electronic tolling (ET) subsystem collects vehicle road usage information, with which charges are calculated and applied (depending on daytime, date, location, and vehicle category. The subsystem is also responsible for:

- Collect road usage information
- Determining road usage costs
- Providing priced transactions for further processing
- Administration of OBUs, tariffs, geodata
- Monitoring the system components, especially the OBE
- Handling and distributing OBE Software/Data updates
- Providing toll calculator
- Providing data to the Enforcement System

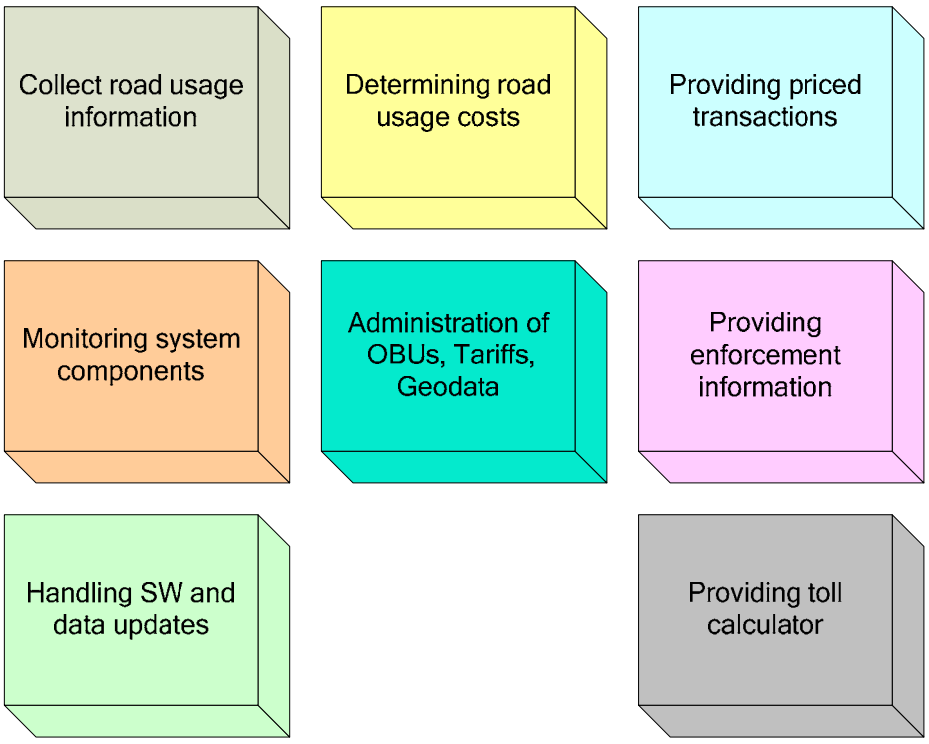


Figure 16 Main Responsibilities Electronic Tolling

Base technology: GNSS/CN

The proposed system is based on Global Navigation Satellite System (GNSS) technology in combination with Cellular Network (CN) communication technology. Each vehicle is equipped with an On Board Unit, fulfilling the demands described in the EC directive EC 52/2004.

Vehicle location data based on GNSS is collected; an algorithm is applied to identify the presence of a vehicle on road subject to tolling. The collected data is stored durable in the OBE and transmitted to the ET Back Office at regular intervals via CN.

GNSS and CN technologies provide a number of advantages for a nationwide road toll solution:

- **Flexibility and expandability:** Changes and extensions of the tolled road network are easily possible, even on short notice.
- **Minimum roadside infrastructure:** Collecting road usage information doesn't require any roadside infrastructure and does not disturb any road maintenance activities.
- **Ease of use especially for occasional users:** LOBUs are based on the "Plug and pay" approach: request LOBU, mount LOBU and go. If the account is running low, top up the account by call or via internet.
- **Fair use:** The costs for adding tolling areas is minimal, both section-based and mileage-based tolling objects are can be defined.
- **Wide range of telematic services:** Traffic control, traffic analysis, improvement of road safety, and vehicle tracking are easily possible with the deployment of OBE in all vehicles.
- **Future-oriented solution:** Compliant with the EC directive EC/52/2004 for interoperability, the GNSS/CN approach is the basis of future automatic toll solutions.

Charge data handling

The main purpose of the ET subsystem is the measurement and recording of road usage and determination of costs. These processes include several steps, which are done automatically:

- **Recording of vehicle location:** The vehicle position is received and recorded.
- **Data transmission:** The recorded vehicle localisation data is transmitted from the On Board Equipment to the ET Back office.
- **Road Identification:** The presence of the vehicle on specific tolled roads is recognised.
- **Distance Calculation:** Driven distances are calculated (e.g. where flat fee is applied).
- **Data validation**: The vehicle localisation data is validated for duplicate or redundant data, missing data and plausibility.
- **Data storage:** This component deals with backup and archiving.
- **Toll amount calculation:** Based on the applicable tariff model, the toll amount is calculated and assigned to the toll transaction.
- **Provision of toll transaction data for further processing:** The toll transaction data is provided to the Central System (i.e. for account updates and invoicing). The Enforcement subsystem requires the data for enforcement purposes.

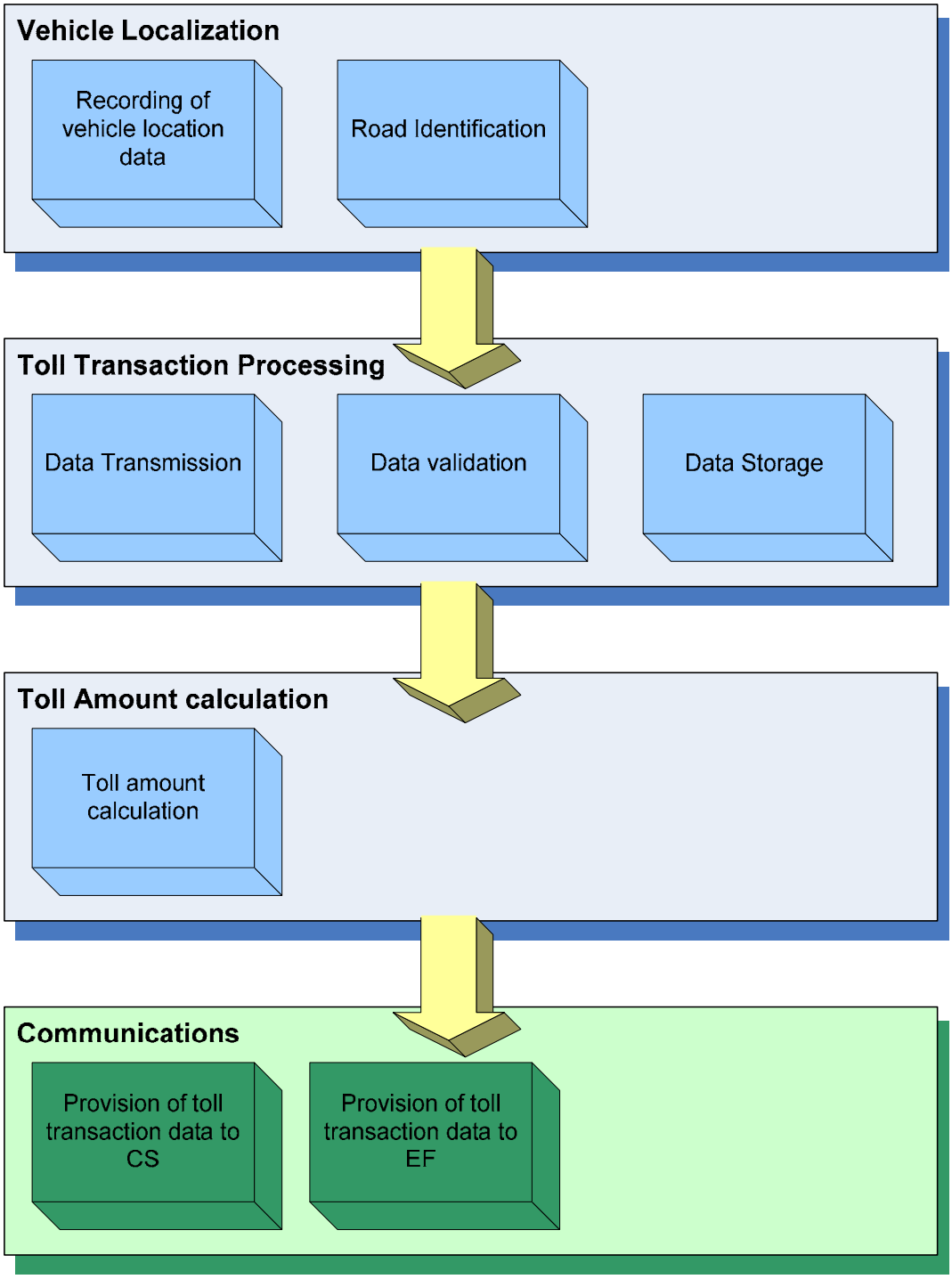


Figure 17 Charge Data Handling

6.2.2.2 Components & Services

6.2.2.2.1 Components

Physically, the ET subsystem consists of 2 components:

- **On Board Equipments**
- **ETBO (duplicated due to availability reasons)**

Logically, the ET subsystem consists of several components which are exchangeable modules, independent of their real physical deployment (On Board Equipment or ETBO), Supporting system flexibility.
The following services are provided as part of the ET subsystem:

- **Vehicle Localisation:** records location data, identifies the presence on a tolled road network and stores this information.
- **Toll Transaction Processing:** localisation information is collected, validated and stored in a central database.
- **Toll Amount Calculation:** price for each toll transaction is calculated, dependent on the toll area, the time and the vehicle categories
- **Toll Calculator:** provides the capability to pre-calculate costs for a given trip start and destination on user request.
- **Master Data Administration:** provides administration capabilities for master data such as tariff data or geodata.
- **Software and Data Update:** provides update mechanisms for OBE software or data.
- **OBU Management:** provides the administration capabilities for deployed OBE.
- **Monitoring and Analysis:** analyses data and monitors OBE, especially for detecting and reporting faults or suspected fraud.

The On Board Equipment
The On Board Equipment automatically powers on and off, automatically records and transmits the road usage data and automatically detects leaving and (re-)entering the country. The driver needs only to configure the dynamic properties of the vehicle which cannot be detected automatically (i.e. trailer on / off, towed and carried). This system is adequate for all kind of participants, no matter whether frequent, occasional, domestic or foreign.
Electronic Tolling Back Office
The ET is structured into several applications to divide the system into easy manageable parts with clear interfaces. This modular design ensures good maintainability. This is based on the principles of application coherency where each application of the system deals with related functionality and data.
This leads to the following services within the Electronic Tolling Back Office (ETBO):

- Tolling transaction processing
- Toll amount calculation
- Route and toll calculator
- Master data administration
- Software and Data Update administration
- Monitoring and Analysis
- OBU Management

6.2.2.2.2 Services

The following figure shows the Electronic Tolling subsystem with its services and the main interfaces to the Enforcement and Central System subsystems.

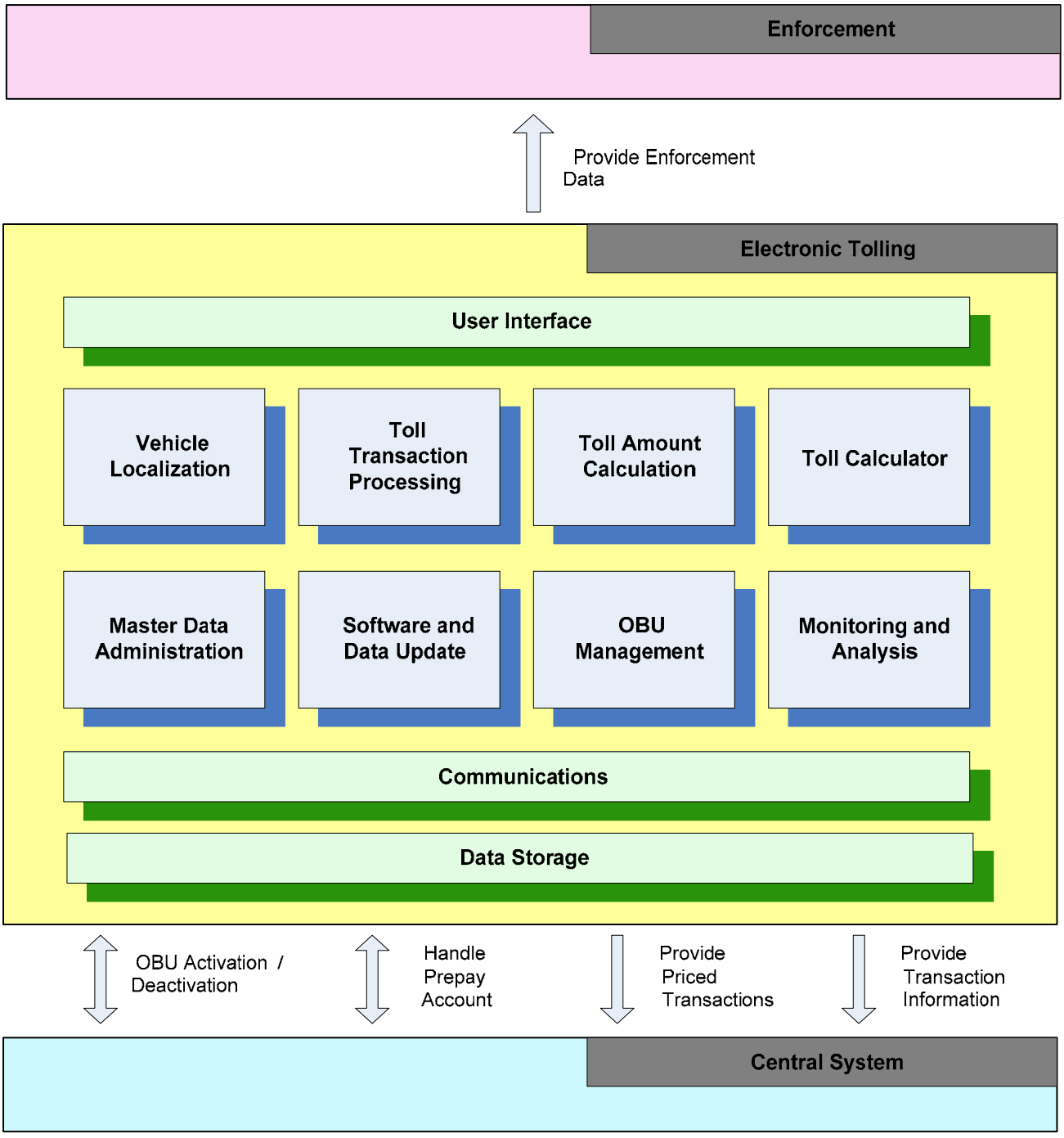


Figure 18 Electronic Tolling Services and Interfaces

The services provided by Electronic Tolling are described below.

Vehicle localisation
A special algorithm identifies where an eligible vehicle has travelled, determines the corresponding tolled areas, and stores this event (with a time stamp and the declared category). The driven distance of the vehicle is also recorded. Additionally, passing of boarders of the tolled area is detected and the OBE can be activated or deactivated (for creating and storing toll transactions).
Since the amount geo data stored in OBE is limited in a thin client approach, tariff indications (e.g. low, middle or high tariff) can still be displayed on the OBE during a journey.

Toll transaction processing
Routes detected and stored by the application Vehicle Localisation are transmitted and stored as toll transactions in a central database. The accuracy of the stored routes is checked by rule-based validations. Charge data records are created for section-based, mileage-based and zone-based tolling. Toll transactions are prepared and aggregated periodically, and are transmitted to the Central System. In case ad-hoc invoices are requested by the Central System, the toll transactions are prepared, aggregated and transmitted to the Central System immediately.

Toll amount calculation
The toll transactions are priced using the defined data model for the toll calculation. In case of prepayment, the account is handled in the system and is updated by this service.

Toll calculator
The calculation is performed in the ETBO but is implemented as a service for the Central System. It calculates the toll for a given trip or it calculates the route and the toll for this route for a given start and endpoint, a given vehicle category and for a given time period.

Master data administration
This application provides services to manage all the data which is needed by the OBE and by the applications “Vehicle Localisation” and “Toll Amount Calculation.” Administration is performed on OBE and system parameters, as well as geographical and tariff model data. The latter are usually prescribed by an external actor like the Authority, for which specific processes are defined. All these data have defined periods of validity; all changes are documented so that a full history of all approved data is available.
The system should enable that data and parameters to be changed and updated, and supports a formal process of review and introduction of new versions into service. When new data or software is ready to be introduced into service, an automatic update process (including distribution over CN to OBE) will be initiated by an authorised ET operator to distribute the data or software.

Software and data update
It is possible to update the OBE via the GSM network at almost any time without physical contact with the OBE. The distribution of a complete package is done over an extended period (following the update decision) to avoid problems with GSM network capacity. Of course in urgent cases, an update of parts of the data can be done within a short period following an accelerated process. The ETBO schedules the update process for all OBE and informs the individual OBE about a pending update. The ETBO has the complete status of software- and data update at any time. This is necessary to avoid risks out of inconsistency in integration and operation phases.

OBU Management
Administration of the OBE device register and the activation and deactivation of an OBE is provided. An entry for an OBE is created by request by the Central System when an OBE is associated to a vehicle. The activation process is then initiated in the ETBO. Only OBE which are activated in the ETBO are switched to the normal operation mode and are ready for tolling after a first connection to the ETBO via CN. The OBE is deactivated in the ETBO (via request from the Central System) and

with the next OBE communication, all outstanding data are sent from the OBE to the ETBO and the OBE is switched to the non-tolling mode.

Monitoring and analysis
This functionality is necessary for reporting, system analyses and data mining (e.g. for fault detection, fraud detection and for statistical measures needed for system optimisation). An off-line database can be queried without increasing the load on the operational database. Analyses are mainly used for internal purposes, to evaluate the quality of data certain components.

6.2.3 Central Services

6.2.3.1 Solution description

Central Services (CS) handles back office processing. Whereas usage data and enforcement data flows into the system, the CS produces invoices and fines, and provides means for customer interaction to the system. A Management Information System provides the necessary data to account for its performance.
The customer relationship management (CRM) module is an integral part of CS. Vehicle data can be verified through an interface to the vehicle registration database. The customer registration includes the type road usage charging (use of OBU, LOBU or Vignette). Vignette users are included in a white list of vehicles that do not use OBE and therefore do not store any usage data in the system. The white list is an important exception category in the enforcement of the road usage charging.
The financial data includes the payment channel that the customer wants to utilise to pay the invoices. CS provides the billing engine that aggregates usage data into periodic invoices. The billing engine interfaces to the accounting system, which relates sent invoices to received payments. Next to road usage invoices the billing engine sends out fines for violators of the road usage charging.
The usage data is fed into CS from the electronic tolling back office (ETBO) which aggregates the usage data into Charge Coded Data. The ETBO therefore shields the privacy sensitive road usage data from CS which only exists to facilitate the administrative processes. The enforcement back office (EFBO) feeds violation data into CS; the EFBO directly interfaces to the ETBO to verify from the registered usage data if a vehicle has registered its road usage. From CS the white-list of Vignette users is exported to the EFBO. White-listed vehicles are filtered from the lists of possible violators by the EFBO.
The CRM system also provides an interface to the users for obtaining information about the system, such as viewing invoices from the web interface. Also, the CRM system supports complaint handling and exemption approval. An integral part of CS's interfaces are automatic contact channels: web interface, voice response, SMS, points of sale.
The picture below sketches the overall architecture of Central Services. Central Services consists mainly of standard products.

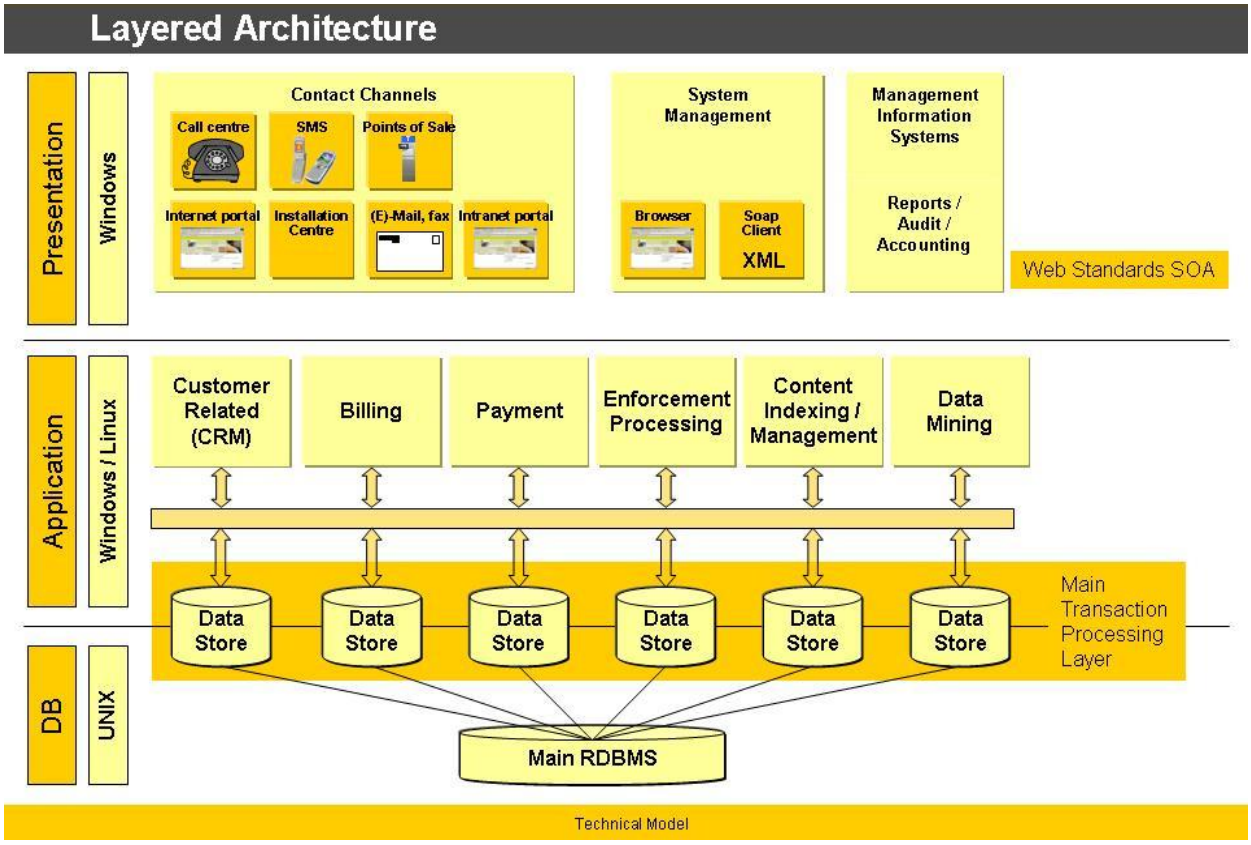


Figure 19: Central Services Overview

6.2.3.2 Components

The central services are built around standardised Central System Products. There are two redundant systems on physically separated sites that can take over each other to guarantee 100% availability and to exclude data loss.

6.2.3.3 Services Description

Below the contact channels, system management and MIS functions from the presentation level are described first followed by the components of the application level.

6.2.3.3.1 Contact channels

The contact channels define the possible access to the system for the different type of users. Not all channels can be used by all users. The channels that are supported are:

- User Internet Portal
- Points of sale/contact points
- Installation centres
- Call Centre
- Fax, e-mail, mail
- SMS Alerting
- Intranet Portal

At the high level, the following services use the contact channels:

- Provide general information
- Provide Account and Transaction information
- Registration, Account Modification and Termination
- OBU distribution, repair and return
- Vignette distribution
- LOBU distribution and return
- Payment and Refund
- Queries and Complaints

The mapping of these services on the Contact channels is discussed below.

User Internet Portal

The internet is a very powerful and economical contact channel. Therefore much effort is made to maximize the usage of this channel by the users. Users can use the website as a fully self contained channel, however if they run into difficulties they can switch to the Call Centre without losing the information supplied up to that point.
The following services are provided through the user internet portal.

- Provide general information using a public website (www.kilometerprijs.nl) with tariffs, maps, procedures, location of contact points, Toll Calculator, etc. General information is provided in major European languages.
- Provide Account and Transaction information restricted to user account holders. The user account details contain the preferences of the user, all payment information, invoice data and other services. The user account is secured with username and password.
- Provide enforcement information after violator verification (channelled to the EFBO). This gives the violator insight in the violation data, a.o. the violation images can be consulted.
- Provide trip data information after user account verification (channelled to the ETBO). This gives the user insight in the trip data, in case of invoice checking.
- Account modification for OBU and LOBU accounts.
- LOBU Registration and Termination (supported by mail facilities).
- Purchase and payment of Vignettes using common internet payment methods.
- Payment, reloading and refund for LOBU prepaid accounts using common internet payment methods.
- Purchase and payment of Vignettes using common internet payment methods.
- Submit queries.
- Submit complaints.

Points of sale/contact points

The points of sale and the contact points use an entry via the internet portal. So therefore they offer similar functionalities.
The following services are provided through the points of sale/contact points.

- Provide general information (brochure) on tariffs, maps, procedures, location of contact points, etc. General information is available in major European languages.
- Provide Account and Transaction information only after user account identification.
- Account modification for OBU and LOBU accounts upon user request after user verification.
- LOBU Registration and Termination (supported by mail facilities).
- Purchase and payment of Vignettes.
- Payment, reloading and refund for LOBU prepaid accounts
- Answer queries, including reply services by phone, mail or e-mail when questions cannot be answered directly.
- Register complaints, follow up is either by mail or by e-mail

Installation centres

Installation centres are dedicated to OBU installation. Therefore the number of services offered is limited to:

- Provide general information (brochure) on tariffs, maps, procedures, location of contact points, etc. General information is available in major European languages.
- OBU Installation, Repair and Decommissioning
- OBU account Registration, Modification and Termination. This is directly related to vehicle ownership and therefore a direct relationship is foreseen with the vehicle ownership registration process which is done at the post office network in the Netherlands.

Call Centre

The Call Centre operates 24 hours per day, 7 days per week. Call Centre operations are critical to the successful delivery of good customer service. Staff training and development is important, as well as the deployment of leading edge Call Centre technology, including a call-back service.
Services are available in the most common languages and are supported by a highly automated process of call handling. Interactive Voice Response (IVR) and operator support are used to ensure efficient use of time for both caller and the call centre.
The following services are provided through the call centre:

- Provide general information about tariffs, procedures, location of contact points, etc.
- Provide Account and Transaction information only after user account identification.
- Provide enforcement information after violator verification
- Account modification for OBU and LOBU accounts upon user request after user verification;
- LOBU Registration and Termination (supported by mail facilities);
- Payment and reloading for LOBU prepaid accounts; LOBU's are distributed after the payment is received, reloading by using credit card payment methods.
- Purchase and payment of Vignettes, using credit card payment methods
- Answer queries, including call back services when questions cannot be answered directly.
- Register complaints, follow up is either by mail or by e-mail.

Fax, e-mail and mail

Electronic mail is accepted and directly linked to the user account before either an automatic or personalized response is generated. Electronic outbound communications are used as an alternative to mail when the customer has provided e-mail or fax details as their preferred channel. If the communication requires a printed response for legal reasons then mail is used.
Users are given the choice to use mail, fax or e-mail as their communication channel. All correspondence is electronically attached to the user account. For this purpose mail is scanned in a document handling centre.
The following services are provided through this contact channel.

- Provide general information about tariffs, procedures, location of contact points, etc.
- Provide Account and Transaction information only to the user account contact details;
- Account modification for OBU and LOBU accounts upon user request after user verification followed by confirmation to the user account contact details;
- LOBU Registration after receipt of a payment;
- LOBU termination and refund for LOBU prepaid accounts; refunds only to a specified bank account after receipt of the LOBU;
- Purchase of Vignettes, after receipt of a payment;
- Send tolling invoices
- Send enforcement invoices (mail only)
- Answer queries;
- Handle complaints;
- E-mail can also be used to alert prepaid user accounts that a minimum level of credit is reached.

SMS alerting
SMS alerting is used:

- to alert prepaid user accounts that a minimum level of credit is reached;
- to confirm account modification for OBU and LOBU accounts
- to alert users that their vehicle has entered a specific tariff zone
- to alert users to a non-compliancy of their OBU or LOBU

This service is provided optionally to the user's mobile phone upon his request.

Intranet Portal
The Intranet Portal provides the GUI for the internal Toll Operator personnel. Dependent on the personnel account access privilege level, the following services can be made available:

- Account Management including reporting on Inactive Accounts, Debtors, Listed Accounts (White List, Black List, Grey List)
- CRM services, Help Desk, Customer Management etc.
- OBU and LOBU distribution support, providing reporting on supply chain.
- Vignette services
- MIS Business Intelligence reports & Analysis reports. Providing a flexible reporting layer for management.
- Financial Reporting. Including reports developed for the Authority

- Fraud Analysis. Specific data analysis reporting for Enforcement purposes.
- Fault reporting. In addition to the standard alert monitoring, there are map based error reporting tools for equipment in the field, etc.
- Facility to view and download internal documents and information
- Workflow Management GUI.
- Enforcement Processing
- Central Monitoring and Control
- Service Management
- Etc

6.2.3.3.2 Systems management

Systems management performs functions that allow for adequate, continuous and safe operation of the Central System.

Interfacing

Systems management provides the interfacing to other subsystems and external systems, amongst which:

- ETBO
- EFBO
- Banks
- Other operators (interoperable systems)
- Vehicle Registration Authority
- Authority

Security

The following security mechanisms form the basis of the security concept:

- authentication & authorisation: who are you & what are your access rights
- confidentiality: protect the privacy of the users
- integrity: keep data intact and unchanged
- non-repudiation: prevent later denial of actions

Design of security systems is made to ensure that every aspect of this basic mechanism is sufficiently guaranteed. Overall security is a combination of network, presentation level and application level security.
All subsystems are separated into security zones based on the behaviour of the system.
All communication between zones is checked by at least one security device. Communication is allowed or denied by these security devices based on defined communication schema. If communication is between different “system blocks”, everything is encrypted using a standardised encryption system.
Technologies provide access security, encryption, intrusion detection and prevention systems, authentication, authorisation, audit and single sign-on.
Special attention is given to Internet as an anonymous network zone. Internet space is responsible for most attacks on computer systems. To protect our systems from these threats we apply the highest possible security level. This combines integrated solution of firewalls and intrusion detection systems with encrypted tunnels termination devices.

Back office systems are separated by internal firewalls. Back office communication is also validated by intrusion detection system. Every communication is also validated through defined security policy. None of the back office servers are accessible directly from internet. Traffic from the internet portal is sent (via security systems) to load balancers and then to application servers. Application servers communicate with database servers via internal security systems. This way protects all internal servers from invalid access.

Systems maintenance

The solution architecture is built around a multilayer architecture with distributed service systems, running on different servers to jointlydeliver the complete application.
A robust approach to systems management in the Central Services is required in order to keep all the systems online and running at peak performance.
A Central Monitoring and Operational Control (CMOC) system is responsible for continuous monitoring of all key components of our solution. This includes:

- Central system components
- Electronic Tolling Back Office
- Enforcement Back Office
- Enforcement Roadside Components
- Communication Network infrastructure

Redundant computer systems are monitored in parallel. All hardware and software components are covered. Logs from different sources are collected, aggregated and analysed for providing security alerts and activity reports.
Furthermore, helpdesk services are included as the first line support to internal users. The CMOC system has processes in place for the secondary and tertiary level support.
The CMOC system also performs operational systems monitoring and generate internal management reports on system performance, availability, incidents etc.

Miscellaneous processes

Miscellaneous processes that are covered within systems management are

- Data protection management
- Service delivery management
- Asset management
- Logistics

6.2.3.3.3 Management Information Systems and Accounting

Accounting

The Central System provides an interface to a Nominal Ledger accounting package used for internal accounting. This allows standard profit & loss and balance sheet reports to be generated, and reconciliation of the information stored in the Central System.
All financial transactions are stored individually in the Accounts Receivable Ledger. These transactions may be periodically exported and imported into the Authority's accounting package in order to justify the financial pay over of the money collected to the Authority.

Reporting

A full, configurable, reporting suite is included within the CRM-system. This allows all types of reporting to be generated both for Toll Operator internal management information processes as for reporting facilities towards the Authority.

6.2.3.3.4 Customer Relationship Management

The philosophy behind Customer Relationship Management (CRM) is based upon a high level of customer satisfaction in the operation of key business processes. This improves both the level of acceptance and reduces the costs of operation as most customer contacts are managed in one transaction process and with minimal delay.
All previous described contact channels are supported and these are integrated in a unified approach, which means that if a customer begins a registration process in one channel and has difficulty, a call centre operator can immediately view the details submitted so far and smoothly continue the transaction. In this way, customer satisfaction is enhanced and the amount of re-work minimised, with benefits for all parties.
The kernel of the CRM system is built around a standard platform with fully integrated:

- ACD (Automatic Call Distribution) for multi-channel queue & agent monitoring
- IVR (Intelligent Voice Recognition) enabling call management enhancement
- Integrated voice, e-mail, fax, SMS & Chat to the agents desktop
- Contact Management database for customer, account, activity & interaction history
- Suite of management tools to enable intelligent skills hunting and speech recognition
- Real time and historic reporting capabilities
- Call quality management tools

6.2.3.3.5 Billing

Tolling
The billing process collects the Charge Coded Data from the ETBO. This is done once a day for each active OBU account. Stored billing information includes the details of Charge Coded Data:

- Time/date zones
- Road types
- Vehicle characteristics

The user has access to the stored billing information either via the call centre operators or using the Internet Portal.
Invoices are produced monthly for all OBU accounts and sent to the OBU account holders using the contact channels.

Enforcement billing
Based upon the data from the enforcement process enforcement bills are added to the OBU user account. If it is not possible to allocate violations to an OBU or LOBU account, a separate violation record is created.

Debt monitoring
As part of the billing processes, the Billing system monitors all accounts for levels of debt, in order to manage user debts in a controlled manner. The billing system identifies those accounts considered in and collates information on those accounts including:

- Debt amount;
- User information;
- Reason for debt, if known;
- Type of debt (road usage charge, penalty, interest etc.); and
- Age of debt.

Information on accounts in debt are also passed to the Authority and are available to the Authority at all times.
In case the debt monitoring exceeds certain levels (age of debt, height of debt) the corresponding OBU account ID and the vehicle License Plate number is handed over to the enforcement process.

6.2.3.3.6 Payment

The Payment System is responsible for processing all payments made and received. When a user registers a means of payment is established as part of the registration process. Validation of the payment details is through the payment portal.
The payment system is connected with the payment systems of the financial institutions. It takes care of the necessary format conversion, authorisation and buffering in case of temporary non availability of one of the systems involved.
The following payment possibilities exist:

OBU accounts of domestic users
The registration process connects the OBU account to the 'Burger Service Nummer'[9] of the client. The toll operator executes the invoicing and financial settlement. The client may choose for the following methods of payment:

- Monthly post paid automatic debiting from bank account
- Monthly post paid bank transfer using "acceptgiro"

In case of non-payment the client first receives a reminder for the original amount and then, if he still does not pay, a reminder with a tariff increase to cover the administrative load of the Toll Operator.
Since this scheme collects road tax, the Taxation office can, in case of persistent payment avoidance by client, put severe means into place in order to collect the amount of toll to be paid. Therefore persistent defaulters are transferred to the taxation office.

OBU accounts of foreign users:
It is assumed that foreign users are accepted to the main scheme only if they pay with a credit card, since the main credit risk is carried by the card issuer and no follow up processes are required. Receipts (in acceptable format for tax refunds) can be distributed over several different channels depending on the choice of the user. The validity of credit cards is checked on a daily basis. OBUs associated with a black-listed credit cards are locked (i.e. they signal the driver that tolled roads cannot be used any more).

LOBU accounts
LOBU's are used by occasional users typically, like old-timers and foreigners. For Dutch citizens the payment method for the OBU accounts may be used, but for foreigners this payment method is not possible. Therefore the LOBU account can also be purchased (also for Dutch citizens) using a credit card account or by taking a prepaid account at the Toll Operator. In case of a credit card the credit card company needs to guarantee the credit card, and in addition to this every day a credibility check of the credit cards at the credit card company is performed.

Vignettes
Vignettes need to be purchased and paid in advance in the Points of Sale using usual payment means.

[9] Client registration number at the Tax Office

6.2.3.3.7 Enforcement processing

It is assumed that the enforcement processing is a responsibility of the Toll Operator. However, it will be possible to isolate this process and to have it executed by a separate entity.

Violations
The enforcement process collects the Enforcement Data from the EFBO. This is a continuous process. Enforcement data include:

- Location of passage
- Time/date of passage
- Type of violation, e.g. claims regarding due to OBE malfunctioning, or vehicle class discrepancies, or no OBE detected.
- OBE account id (if present)
- Vehicle License Plate Number
- Vehicle Nationality

Then either the OBU account user is fined with the applicable fee through the billing process or access is made to the Vehicle Registration Office (RDW) to retrieve information on the vehicle owner, after which the vehicle owner is fined using the billing process.

Black, white and grey listing
Within the enforcement processing a black list is created of OBU account and/or License Plate Numbers that are in high debt or that have not paid penalties or for which fraudulent behaviour is detected. The black list may be used by the mobile enforcement systems to stop road users.
A white list is maintained for the occasional users that have purchased a vignette. The white list is forwarded to the EFBO.
A grey list is created for vehicle license plate numbers of occasional users that have not yet registered but from whom registration will be expected within the next 24 hours. If after this time period no registration is made the vehicle license plate number is transferred to the black list.

6.2.3.3.8 Content / indexing management

The content and indexing management system supports the capture, processing, archiving and distribution of all business information. This includes documents, records, e-mail, Web content, images, reports, and digital assets. The content management system will enforce the business rules to ensure that all content is properly reviewed and approved.

6.2.3.3.9 Data mining

Effective fraud detection is crucial for the proper functioning of the system. This requires constant vigilance for new approaches to avoid payment. Using off-the shelf data mining tools to search for unusual patterns in the databases of Central Services is an important method to detect potential cases (and places) of fraud.
Other examples where data mining are applied are:

- Checking if patterns exist in the corrections made by the enforcement staff. The aim is twofold: to optimize the enforcement process and finding possible fraud cases.
- Checking which areas of the road network require special attention from either transportable enforcement units or mobile units.

The methods of fraud may change in time. This also applies to the patterns that reveal them. Therefore the fraud detection system provides facilities that enable staff to adapt the search methods to cater for new patterns that arise for changed behaviour of cars attempting to evade toll. Such facilities have shown to be quite effective to disclose otherwise hidden forms of fraud in other fields.

Therefore fraud detection based on extensive experience in both toll collection and data mining result in an effective approach to catch toll evaders.

6.2.3.3.10 Data storage

At the highest level the RDBMS requires the provision of a data storage and management solution which allows the following business objectives to be met:

- Online data storage for 1 year, near line storage for 3 years and offline archived history up to 20 years
- A fully extensible solution that allows expansion, for both expected and unexpected growth, without impacting on operations
- A data management solution that minimises the cost of storage whilst maximising the investment made in data storage.

Internal structure of the RDBMS is divided into two main parts, the Operational data store and Data Marts (DMs). The operational data store is tuned for massive insert operations. There are set up sufficient constraints to check data consistency.

RDBMS

The RDBMS uses standard database solutions being proven in similar billing environments for e.g. telecom operations.

6.2.4 Enforcement

6.2.4.1 Solution Description

The system discussed in this document is quite different to electronic fee collection systems already deployed. These peculiarities result in new solutions and concepts being necessary or advantageous. The major aspects of this system, the combination of which makes new approaches recommendable, are the following ones:

a). High number of participants

b). All vehicles subject to toll

c). All roads subject to toll

d). Barrier-free tolling

The combination of those aspects leads to the following effects:

3. **The enforcement process must have high throughput:**
   the high number of participants results in the need for a highly automated enforcement process. Manual processing steps result in slow processing (threat of cumulative backlog), threat of high error rate (false positives, user acceptance!) and in high operational costs.

4. **OBU cost must be as low as possible:**
   Due to the high number of OBUs needed, the costs of those are one of the major factors in implementation. Therefore it is necessary to reduce the functionality of the OBU as much as possible. The concept drafted here avoids OBU components such as DSRC and the associated costs.

5. **It is almost impossible (i.e. very expensive) to achieve 100% enforcement coverage for a given road cross-section**
   For very busy roads such as highways, the frequency of vehicles passing is too high to check them all. The equipment can only sample road user behaviour.

6. **Good coverage is not achievable with fixed enforcement only:**
   A large part of the OWN (Other Way Network) consists of small roads, which form a dense network with numerous intersections. Therefore it is easy to avoid fixed enforcement equipment locations. Nonetheless, stationary installations are still useful on high priority roads and in other hot spots which are difficult or cumbersome to circumnavigate.

7. **Vehicle categorisation is not that important for enforcement:**
   Since all vehicles are subject to toll, it is not necessary to single out certain vehicle categories. Whoever is driving on a road must participate in the toll system.

8. **Good enforcement coverage is vital to the system:**
   There are no locations where vehicles are stopped by default (no barriers) if toll fees aren't paid correctly. Therefore sufficient control mechanisms must ensure road user compliance.

These considerations have resulted in an enforcement concept which deviates considerably from presently implemented solutions. It is designed to maximise coverage, sporting a streamlined design and therefore maximum throughput and level of automation and minimum costs without sacrificing efficiency.
Of course the feasibility of this concept depends on the underlying legal framework. In this early stage this is not considered a downside, because the legal background for the system must be created anyway, making it possible to adapt laws and regulations to fit the chosen solution. We consider the advantages of this concept to outweigh possible problems by far.

The enforcement scheme operates with automatic number plate recognition (ANPR) as the primary input from the roadside, with evidential photographs taken simultaneously. The success rate of the ANPR can be increased by crosschecking with the toll registration database. Therefore readings with one uncertain character (e.g. “D” or “O”) can be corrected. The license plate numbers are the basis for requesting all relevant data from the central system. If everything is in order, all evidence is discarded. Otherwise an enforcement notice with invoice is generated and sent to the vehicle owner.
Since the concept developed in this document foresees a registration including the licence plate number for all participants of the system, it is not relevant for enforcement which kind of system access a road user has chosen. Even for vignette users the procedure remains the same. This is also due to the fact that the controlling entity doesn’t need to access OBE memory contents immediately. The resulting simple succession of tasks is more or less the same for all kinds of system access.

6.2.4.1.1 Additional Measures

On top of conventional enforcement procedures, there are other strategies for identifying suspicious road users. These methods cannot provide proof of illegitimate behaviour, but plausibility checks and similar measures can single out road users whose behaviour points toward toll offences. These participants can be taken under special scrutiny, for example by temporarily switching their OBE to a special tracking mode. Furthermore a list of possible offenders can help enforcement personnel to focus on these users until they are cleared of suspicion.

6.2.4.1.1.1 Data Mining

Information collected in the central system can yield suspicious patterns. Sudden reductions in road usage, gaps in tracking data and other types of behaviour can be an indication that toll offenses are committed.

6.2.4.1.1.2 Checking of OBE History

The OBE can hold a history of status and usage records. Tracking information (with higher granularity) held in the OBE might be checked during enforcement, on contract cancellation, in the course of the regular vehicle inspection or on filling up the pre-pay account. This information can lead to indications of offensive behaviour.

6.2.4.1.1.3 Comparision of Odometer Reading with Toll Records

In the course of the regular vehicle inspection, or during manual enforcement, an odometer reading can be taken and compared with the mileage registered in the toll system. The OBE is able to count mileage also outside the Netherlands. In this case the OBE switches back to a pure kilometre counting mode, avoiding interference with foreign systems and roaming fees. Geofencing for recognising the borders of Netherlands is necessary anyway, so the mileage driven abroad can be determined, but not charged. Therefore a consistency check is possible, while probably not convincing enough for direct prosecution.

6.2.4.1.1.4 Comparision of Toll Registration and Vehicle Registration

Since all vehicles are liable to toll in the Netherlands, the registration databases of the toll system and the national vehicle register (RDW) can be compared. Registered vehicles who are not participation in the toll system are most probably toll offenders, and therefore separate investigations are justified.

6.2.4.2 Components and Services

6.2.4.2.1 Components

The enforcement system consists of components in the central system and of those distributed in the field. A general overview is given in Figure 20.

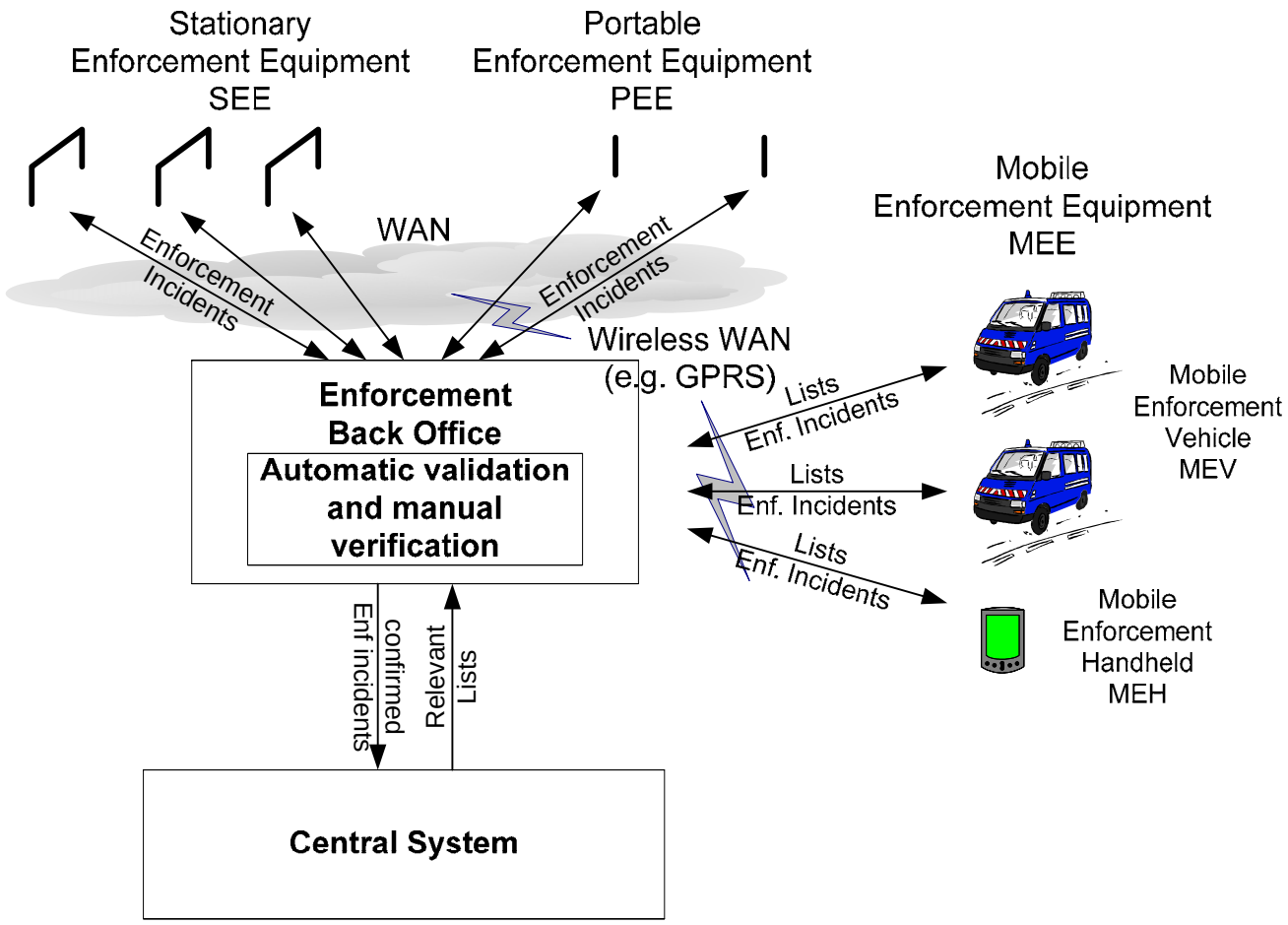


Figure 20: Overview of the enforcement system

Stationary enforcement equipment is mounted on gantries on main roads and in hot spots which cannot be evaded easily. It is connected to the central components by fixed WAN connections. It performs automatic checking of compliance including categorisation. This is done with high throughput.
Transportable enforcement components deliver the same functionality but with restricted categorisation (axle counting only). Due to the lack of a fixed high bandwidth data connection to the central system the throughput is lower than for fixed installations.
Mobile enforcement needs human intervention for operation. Therefore throughput is much lower than for automatic enforcement installations. On the other hand it offers higher mobility and on the spot prosecution, improving the effectiveness with foreign too offenders.
The enforcement back office (EFBO) consists of the central components responsible for supporting the enforcement field components. It handles all data transfer, retrieving needed information from the central system, compiling and delivering enforcement records to CS and the enforcement post-processing centre. It distributes black lists to the field components and collects messages about blacklisted OBUs and vehicles.

6.2.4.2.2 Services

The enforcement subsystem offers the three services described in the subchapters below.

6.2.4.2.2.1 Delivering Enforcement Records

All information (photos, license plate numbers etc.) of a suspected violation are compiled and delivered to the central system automatically. No manual checks are performed.

6.2.4.2.2.2 Checking of Enforcement Records

In the case of disputes or for other reasons it is sometimes necessary to perform further checks on some enforcement records. The enforcement subsystem offers support for these tasks including delivery to manual enforcement back office terminals, where manual checks help to validate the correctness of suspected violations.
The original record plus a summary of the checking conclusions are delivered as the result.

6.2.4.2.2.3 Procecustion of Blacklisted Vehicles and OBEs

Additionally to collecting enforcement records, the equipment also serves for tracking down offenders. To facilitate that, lists of vehicles and OBEs are distributed to the field components (automatic and mobile units). These (and the personnel involved) are therefore able to look out for suspects. Alarms are triggered and transmitted as the result of this service as soon as blacklisted vehicles or OBUs pass enforcement equipment.

6.3 Deployment View

This section describes the way the system is implemented physically. It lists the hardware components and the interconnections between those. The implementation cost calculation heavily depends on this information.

6.3.1 Common Central Infrastructure

The design of the technical architecture of the common central infrastructure is determined by the following key drivers:

- To meet the assumed service level requirements, the technical design for the service must provide high levels of intrinsic availability (24/7), coupled with the ability for rapid recovery from any failures.
- To meet the assumed requirements for business continuity (no loss of data and continuous service in case of disaster) the technical design for the service must replicate the central components in two separated locations, and provide rapid and transparent switching between the locations. All data must be replicated over both locations so that even in the case of a disaster no data is lost. This applies also to backup and archive data.
- There are implicit requirements for performance, both for throughput and response time required on specific transactions without compromising the value for money of the solution. To meet these requirements the service must be designed to easily meet the initial workload while being easily and cost effectively scalable to meet future increasing workload.
- To meet the requirements for security.

A common central infrastructure is introduced for the subsystems Electronic Tolling, Central System, and Enforcement. This infrastructure is distributed over two separated data centers. All major external physical interfaces have redundancy built into each data centre. The data centres themselves are connected over communication lines with additional redundancy. A common security architecture is implemented, which assures the fulfilment of the assumed security needs.
The choice of components, configurations and design approaches for the service is guided by the following design principles:

- The technical infrastructure is implemented in a layered and tiered architecture, reflecting the architecture of the Information Systems.
- All elements of the service adhere to the appropriate standards and legal requirements.
- Wherever possible, systems are built from tried and tested, industry standard components.
- The design makes use of industry standard techniques, such as parallel and redundant networking components, and clustering of servers. Applying these techniques ensures the necessary levels of availability and performance.
- Physical data are held in a highly available enterprise storage infrastructure based on redundant Storage Area Network (SAN) distributed over both locations.

Conceptual model

The logical subsystems Electronic Tolling, Central System, and Enforcement share a common central infrastructure which is distributed over 2 separated highly secure data centres. All external physical interfaces have redundancy built into each data centre. The data centres themselves are connected over redundant lines.

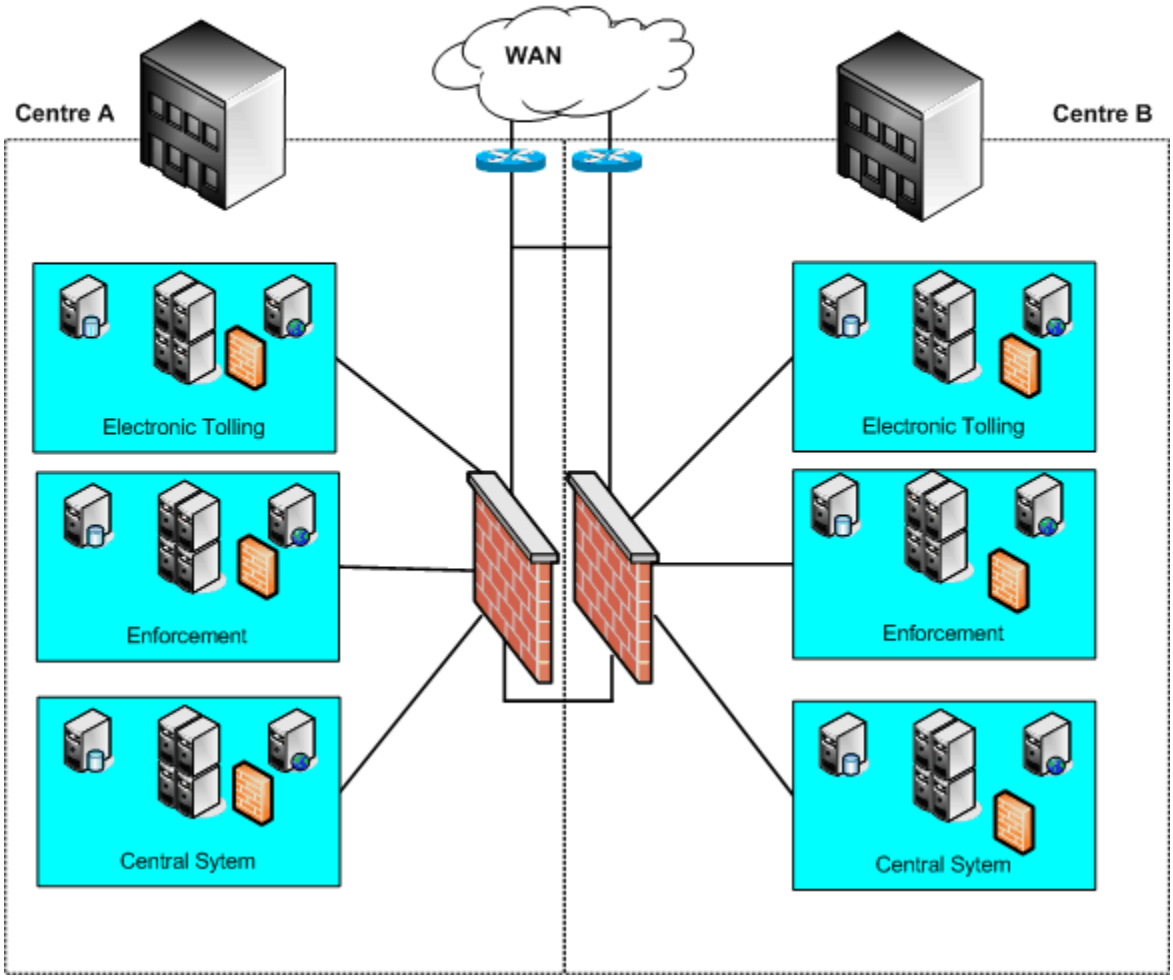


Figure 21: High level overview: Common central infrastructure

Common principles are used to ensure high availability, security, safety, and maintainability. The details depend on the respective hosted application and their requirements.

Several necessary application domains are defined for the Subsystems. Application domains share the common infrastructure but are completely separated through firewalls and private Virtual Local Area Networks.

This allows the sharing of expensive common infrastructure even if the applications are strongly separated from a security point of view (the overall solution would also permit a physical separation of subsystems if required). The operation of the security domains can be done from different legal entities (e.g. trusted third parties for ETBO and EFBO). Staff for the necessary basic operation for the common infrastructure will have no access to domain specific data (e.g. appropriate security solutions will be used to control root access).

In general site spanning load sharing solutions, or cluster solutions are deployed in the application domains appropriate to the respective application requirements to ensure high availability. The bases

for all of these solutions are redundant high available network components and firewalls on both sites. Using one of these solutions all applications are deployed in a redundant way over both sites.
In the case of load sharing, the components of both sites are active under normal operation. The underlying mechanism guaranties transparent takeover of failed components or a whole failing site.
Cluster solutions are also used for site spanning. In this case only one site is active under normal operation. The underlying mechanisms guaranty a smooth takeover of the functionality from the active site to the remaining site in the case of a failure in a short, defined time span which fulfills the requirements of the tender.
The infrastructure of the individual sites is designed in a way so that it can handle the whole load in the case of one site failing completely.
One central part of the overall infrastructure used from the individual domains is a site spanning storage solution based on a redundant storage area network and appropriate storage components for online and offline storage. (Offline storage is used for backup and archiving purposes.) This storage solution guarantees not only a highly available storage accessible from all components from each site but also an appropriate mirroring solution which guarantees no significant loss of data in the case of a disaster at one of the sites.
Both sites are controlled and surveyed by a System Management Center (SMC). This center is connected to both sites by redundant lines. On both sites an additional management LAN is deployed which ensures management tasks for all components autonomous from the production LAN.
The total infrastructure of the sites consists of the production environment and also of the necessary test environments.
The architecture of the infrastructure for the individual application domains is designed based on best practices and best of breed solutions.

6.3.2 Field Components

Figure 22 shows an overview of the field components of the system. At least two geographically separated data centres provide all functionality required centrally. The centres are running in parallel (e.g. in hot standby mode) and are connected with redundant high speed data connections. The data centres are protected physically and logically against any kind of attack, misuse or disaster.

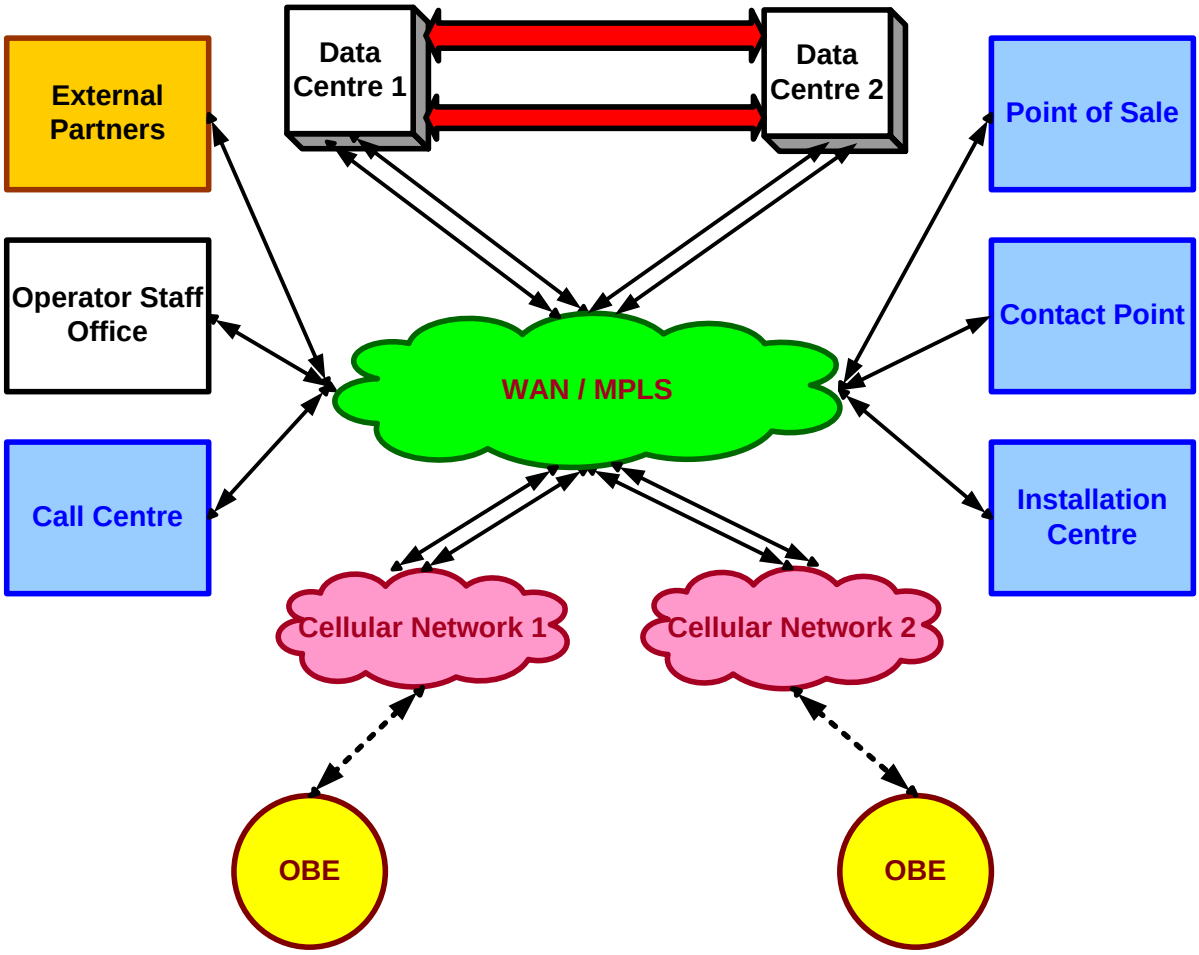


Figure 22: High level overview: Deployment of field components

The OBEs, transportable enforcement stations and mobile enforcement terminals are connected to the data centres via CN networks. At least two separate providers provide for redundancy, if the contractual arrangements are feasible.
All other field equipment, being terminals for points of sales, contact points and installation centres as well as the offices for operator staff, call centre and external parties are connected to the data centres via fixed line high speed data connections.

6.3.2.1 Electronic Tolling

Integrity Stations

The tolling scheme uses a system for location determination that is not under control of the operator. The system currently available is the Global Positioning System (GPS) operated by Navstar and will be in future Galileo (EC/ESA). Since these systems are in use for e.g. aviation, seafaring and other critical applications a certain reliability and availability is required - and also guaranteed by the operators.

In order to monitor the availability, reliability and integrity of satellite information (provided via GPS or Galileo) some reference stations are deployed within the country. These stations can be deployed by the operator of the RUC scheme or the information can be bought as a service from other organisations (e.g. EGNOS has also reference stations in use). This information can be used to do some parameterisation or corrections during post processing of location related data.

Handheld Devices

The handheld device is a rugged device (equivalent to PDA) that is used by authorised technicians at installation centres to check successful installation. It uses standard interfaces for communication to OBE (e.g. Bluetooth). This kind of device can also be used by mobile enforcement to do further analysis on the OBE (e.g. read out of history information during a check on the spot). The usage of these devices is limited to authorised personnel within a defined security environment.

6.3.2.2 Enforcement

The enforcement system consists of components in the field (roadside, in enforcement vehicles) and of centralised components (central system, post-processing).

Stationary Enforcement

Figure 23 shows the roadside equipment for stationary enforcement.

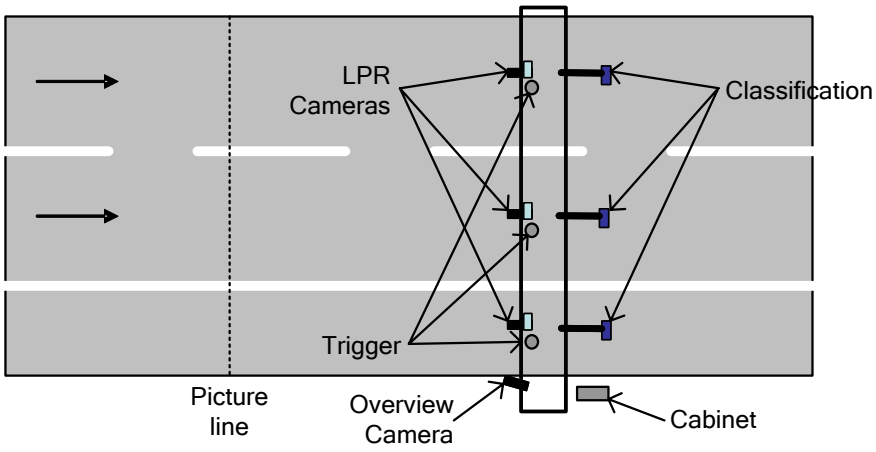


Figure 23: Stationary enforcement

The equipment is mounted on gantries or on existing infrastructure, if possible. It consists of cameras for taking evidential photographs and for ANPR, of classification equipment, laser trigger, and a cabinet containing the gantry server. This is a computer handling communication, storing evidential records until evaluated and controlling the other devices on the gantry.

Transportable Enforcement

The transportable enforcement equipment consists of a compact setup which can be placed at the roadside. A pole carries cameras for taking evidential photographs and for ANPR, and a laser trigger. The base of the pole contains the gantry server and infrastructure components (e.g. power supply). Optionally the setup also contains axle counting equipment for categorisation.
The equipment is designed and dimensioned to operate autonomously for several days. After that data must be transferred to the central system for further processing and the power supply must be recharged.

Mobile Enforcement

Dedicated staff is operating the mobile enforcement units. Those consist of vehicles equipped with ANPR cameras and a terminal for accessing road user data in the central system. The terminal can

be a personal digital assistant (PDA) or some other device. The communication uses a wireless WAN connection.
If required, the enforcement vehicle also holds equipment for payment (e.g. cash register, credit card reader). It depends on the legal situation and the business processes chosen if money is collected directly or later on. Training and supervision processes ensure reliable and fair demeanour of the enforcement personnel.

Enforcement Post Processing

For a certain percentage of the enforcement records collected manual post-processing is inevitable. For this task workplaces must be set up and equipped with the necessary data access and support features. This equipment is basically a terminal for accessing and editing enforcement records and retrieving related information. Training and supervision processes ensure reliable and fair demeanour of the enforcement personnel.

6.3.3 Installation Centers, Points of Sales, Contact Points

On these sites standard PC equipment provides access to the central system via web based applications. If required by the processes implemented, a handheld or fixed terminal makes access to the OBU possible using a service interface.

7. D4A - COST ESTIMATES

The costs used as a basis for this financial calculation have taken the development of market prices and the evolution of technology into consideration. Since the introduction of the scheme is anticipated in 2012, the assumption has been made that technological improvements and reduced cost of major system components has a positive impact on the overall price relative to today's levels.
The initial overhead for rollout at the introduction of the scheme (i.e. the transition phase during the first year of operation) has been regarded on a more global level. Thus, additional costs for system ramp-up have been calculated within the investment costs.
The operational expenses for the scheme are based on anticipated price levels at 2012, when the scheme is actually introduced. Therefore, it is assumed that evolving operational efficiency and technological improvements will allow the costs of operation to decrease over time.
The parameters and unit costs provided by the Ministry within the document "Cost Format phase 2 v2.0.xls " remain unchanged, pink and blue values have been used as required.

7.1 OBU

7.1.1 Cost Sheet results:

On-Board Unit development & production:

Invest	All costs related to OBU and LOBU (HW, SW licenses) at operators price of sale. Costs are related to the initial number of users
Operation	Costs are related to the number of annual replacements or new users (i.e. increase of traffic, replacement of broken…)
Depr.	Costs are related to the number of annual replacements of OBUs and LOBUs

On-Board Unit distribution & registration

Invest	All costs related to distribution from manufacturing site to locations for OBU provisioning - initial volume. Costs for establishment of OBU registration service (Installation Centre) including registration equipment Cost for RDW data base access (initial volume)
Operation	Maintenance of equipment, network costs, registration procedure costs, ongoing logistic service, ongoing RDW access, LOBU refurbishment cost

On-Board Unit installation in vehicle

Invest	Costs for installation of OBUs at Installation Centres (initial)
Operation	Annual additional installation costs / replacement costs (including also tests of OBUs on the spot)

The installation of On Board Equipment is performed at an authorised Installation Centre. The procedure includes

- Registration of user
- Installation of OBU
- Test of installed OBU

It is estimated that the average time for the whole procedure takes about 1 hour, installation centres are paid accordingly (67,50 EUR per user excl. VAT and excl. IEM).
Annual replacement of OBUs (estimated by 4% p.a.) also require registration and test, it is assumed that in most cases the existing cabling can be reused. Therefore the costs for service provisioning are estimated lower (25 EUR per user per replaced OBU excl. VAT and exc. IEM)

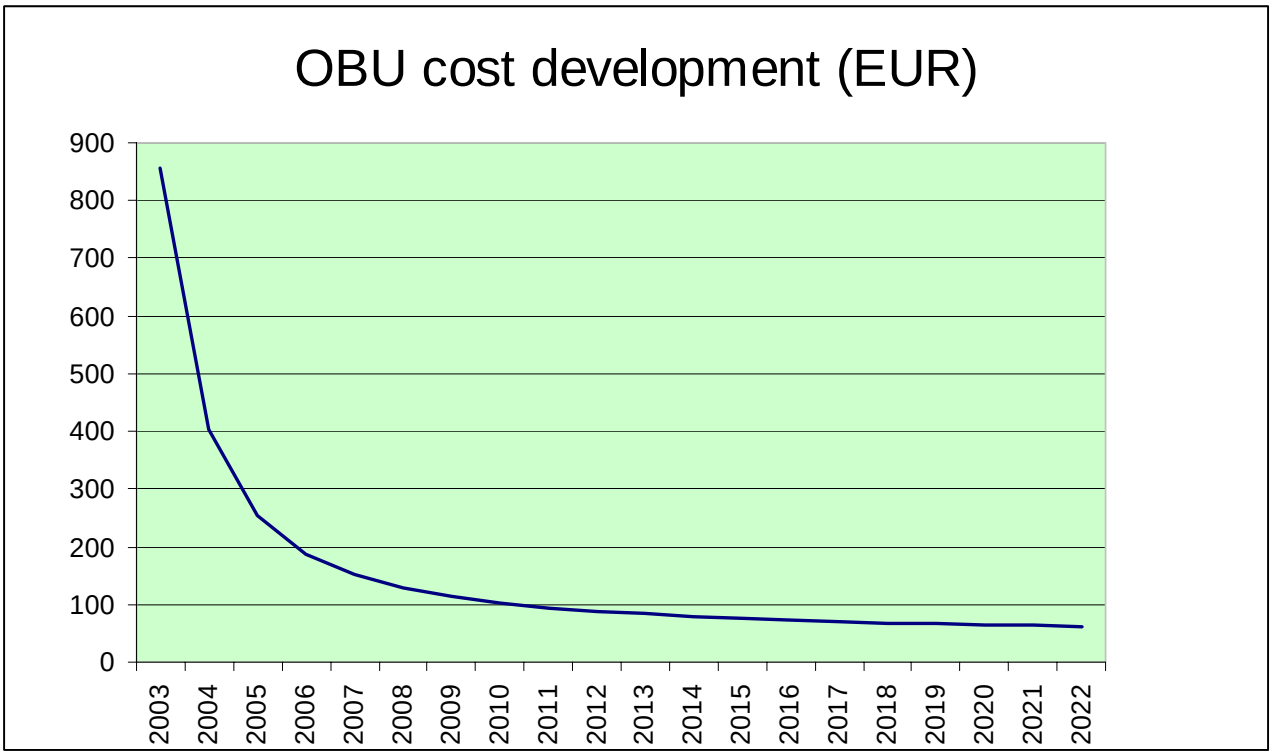
7.1.2 Calculation base / expected number of users

Number of OBUs	8.000.000
All NL registered vehicles within category: • Passenger cars • VAN • HGV (lorries and special vehicles)	7.968.000
Frequent travellers to NL (HGV + passenger cars)	32.000
Number of LOBUs	150.000
Foreign visitors	1.000.000
• Percentage acquiring LOBU (Rest: virtual vignette)	20%
Old timers and vehicles for export	301.000
• Percentage acquiring LOBU (Rest: virtual vignette)	30%
-> Number of LOBU users	300.000
Percentage of concurrent LOBU users	50%
Additional number of OBUs per annum (average)	920.000
Increase of number of OBU users per year • Traffic increase, new cars: • OBUs broken:	 7,5% p.a. 4% p.a.
Additional number of LOBUs per annum (average)	30.000
Increase of number of LOBU users per year • Traffic increase: • LOBUs broken:	 3% p.a.

	17% p.a.
Installation time OBU including registration	1 hour
Annual LOBU refurbishment volume	150.000

7.1.3 OBU cost calculation

Siemens is the major supplier of On Board Units for the German truck tolling scheme. The contract was awarded in 2003. In addition Siemens has a contract in Switzerland (LSVA) and a contract in India for OBU delivery. All OBUs are developed especially for the respective systems. The development department and production site for these units is SiemensVDO located in Villingen / Germany. SiemensVDO has a long track record in design, development and manufacturing of automotive products (in vehicle instruments, sensors, control units, tachograph (analogue, digital) etc.). Further on SiemensVDO has developed and produced similar telematic devices for passenger cars and the haulage industry and is therefore well positioned to estimate prices for On Board Equipment fulfilling the functionality of the proposed solution.
For cost calculation of the OBU a Bill of Material (BoM) was created, current costs for the elements were identified, and the expected price development of components over the next years were considered. A certain influence on the GPS costs by enabling Galileo and further integration of technology (GSM or UMTS) was assumed. Production costs and miscellaneous other relevant factors were considered as well.
For plausibility check the resulting costs were compared to the history of price development for OBUs and similar industrial products.



The resulting OBU price is the average price calculated over a 10 years period.

7.1.4 Impact of deviations with respect to assumptions

This part of the calculation is dominated by the number of On Board users. Deviations of the number of users influence OBU costs and Installation cost linearly.
The proposed solution foresees some mechanisms to keep the number of LOBU users low since the LOBU approach is not cost effective. LOBU costs vary linearly with the number of LOBU users, but also costs for refurbishment of equipment and fee for PoS are influenced.

7.2 Declaration and customer care

7.2.1 Cost Sheet results:

OBE declaration / communication

Invest	
Operation	Includes communication costs OBU-Back Office. Maintenance and hosting as well as operation of Back Office components (including processing of data into costs) is included within 2.3.1

Occasional User System

Invest	All provisions foreseen to handle occasional users. Includes costs for provisioning stations for “virtual vignette”, and Stations where changes of contracts can be carried out. Equipment for Contact points, Point of Sale equipment, IT preparation invest, Signs etc.
Operation	Annual costs for operation of provisioning stations at Contact Points and Point of Sale
Depreciation	Annual costs for replacement of equipment at Point of Sales, Contact Point and Installation Centres

Customer Care

Invest	Infrastructure costs are calculated within the Invest of 2.3.1
Operation	This cover personnel costs. Maintenance costs are covered within operation of 2.3.1

7.2.2 Calculation input

Number of Vignette users	1.010.000
Foreign visitors	1.000.000
• Percentage acquiring virtual vignette (Rest: LOBU)	80%
Old timers and vehicles for export	301.000
• Percentage acquiring LOBU (Rest:virtual vignette)	70%

OBE communication • Annual Subscription fee (including defined data vol.) • Data Volume fee	 7,5 EUR 0 EUR
Annual number of contacts using the different contact channels • Internet • PoS / Contact Point Queries • Call Centre calls	 7.350.000 2.750.000 3.650.000
Number of PoS/Contact Points	850
PoS/Contact Points • Filling stations (operation window 24*7) • Post Shops (usual opening times), used as CP	 250 600
Number of Authorised Installation Centres • Initial phase (ramp up): extra personnel required • Steady state: standard personnel	4.000

7.2.3 Impact of deviations with respect to assumptions

Cost driving element within this part of the system is the data transmission cost for On Board Equipment. Since we assume a subscription fee that includes the transmission of a certain amount of data volume changes in the behaviour of road users will not have any impact. The number of users (OBU and LOBU users) contributes to this item.
In order to investigate influences of changes for certain parameters, the spreadsheet “060629_parameters_V1_2.xls” can be used.

7.3 Payment and billing

7.3.1 Cost Sheet results:

Processing and billing costs

Invest	These costs cover all infrastructure costs for back office data processing, SW development and license costs, HW-infrastructure, network, security infrastructure etc. excluding enforcement infrastructure
Operation	Costs to process and deliver periodic invoices (paper bills) / account overviews HW hosting and maintenance for all Back office equipment (excluding enforcement HW infrastructure) Ongoing development for new releases (SW maintenance).
Depr.	Annual re-invest for HW

Payment collection costs

Operation	Costs related to payment handling or payment services by third parties (banks)

Follow-up costs

Operation	Costs for personnel that handle customers failing to pay in time (manual processing e.g. payment reminder)

7.3.2 Calculation input

Annual number of Invoices / bills • Number of monthly electronic invoices / bills • Number of monthly paper invoices / bills	96.000.000 67.000.000 29.000.000
Annual number of claims (follow ups)	2.900.000
Annual number of non payers (follow ups)	2.400.000

7.3.3 Impact of deviations with respect to assumptions

It is assumed that payment is done on a monthly basis and bills are issued if requested. The number of requests can vary and therefore influence the postage costs, which is currently the price driving factor in this section.
In order to investigate influences of changes for certain parameters, the spreadsheet “060629_parameters_V1_2.xls” can be used.

7.4 Enforcement

7.4.1 Cost Sheet results:

Fixed enforcement stations & labour

Invest	Includes all costs related to fixed enforcement stations Equipment, Engineering and Construction, Installation
Operation	Annual Maintenance costs, power and communications cost
Depr.	Annual costs for re-invest of equipment

Transportable enforcement stations & labour

Invest	Includes all costs of equipment relating to transportable enforcement stations Vehicles for transportation of equipment are calculated within mobile enforcement
Operation	Labour relating to transportable enforcement stations, maintenance costs, energy and communication..
Depr.	Annual costs for re-invest of equipment (vehicle re-invest included at mobile enforcement)

Mobile enforcement equipment & labour

Invest	Includes costs of equipment relating to enforcement from/with vehicles Equipment, Installation of equipment, vehicles
Operation	labour for decentral enforcement services, operating cost for vehicles, maintenance costs
Depr.	Annual costs for re-invest of equipment and vehicles

Enforcement Back Office costs

Invest	These costs cover all Back Office infrastructure costs for Enforcement including visualisation terminals for Enforcement Back Office staff, SW development and license costs, network costs, security infrastructure.
Operation	labour for enforcement post processing (verification of incidents) and maintenance of equipment
Depr.	Annual costs for re-invest of equipment

7.4.2 Calculation input

Number of enforcement stations • Number of fixed enforcement • Number of transportable enforcement • Number of locations foreseen for transportable enforcement	 107 179 2327
Number of enforcement vehicles (including spare cars) • Mobile enforcement vehicles • Vehicles for transportation of transportable enforcement	 13 14
Personnel Staff for mobile enforcement	96
Personnel Staff for transportable enforcement	42
Personnel staff for enforcement post processing	13

7.4.3 Impact of deviations with respect to assumptions

The number of fixed, transportable and mobile enforcement is now presented with formulas in the spreadsheet. For invest and depreciation the impact of deviations is linear to the number of enforcement elements: Operations costs are dominated by the costs for staff and need to be calculated in a different way.
In order to investigate influences of changes for certain parameters, the spreadsheet "060629_parameters_V1_2.xls" can be used.

7.5 Miscellaneous

7.5.1 Cost Sheet results:

Project costs

Invest	Costs calculated automatically (specified by ministry)
Operation	
Depr.	Costs calculated automatically (specified by ministry)

Marketing & communication

Invest	Costs calculated automatically (specified by ministry)
Operation	Costs calculated automatically (specified by ministry)
Depr.	Costs calculated automatically (specified by ministry)

Generic office and facilities costs

Invest	Set up premises for operation (SPC), ramp up support, insurance costs etc.
Operation	Rental costs, ongoing insurance costs etc.

Infrastructure/equipment related costs not covered elsewhere

Invest	
Operation	Office workspace (Desktop, SW, Helpdesk, Internet, ….) for Special Purpose Vehicle employees

Operational costs not covered elsewhere

Operation	

Labour costs not covered elsewhere

Invest	System integration and test environment for total scheme implementation
Operation	Labour costs for Special Purpose Vehicle employees (e.g. tariff structure maintenance, Data Mining, HR, finance, payroll etc.)

Anders Betalen voor Mobiliteit
VARIANT 5: KMP
SIEMENS

Project costs markup	3%	Depr term project costs & comm m
Communication markup, initial	1%	
Comm markup, annually	0%	
IEP	15%	
VAT	19%	

	Total	Per annum	Per annum
OBU	*Initial costs*	*Operational costs ex depreciation*	*Depreciation*
On-Board Unit development & production	€ 672.375.000	€ 49.500.000	€ 28.875.000
includes OBU	€ 660.000.000	€ 49.500.000	€ 26.400.000
LOBU	€ 12.375.000		€ 2.475.000
On-Board Unit distribution & registration	€ 102.693.750	€ 17.435.250	€ -
includes distribution	€ 86.593.750	€ 10.093.750	
equipment and fee for data requests	€ 16.100.000	€ 3.591.500	
LOBU refurbishment		€ 3.750.000	
On-Board Unit installation in vehicle	€ 540.000.000	€ 48.500.000	€ -
Other	€ -	€ -	€ -
Sub total	€ 1.315.068.750	€ 115.435.250	€ 28.875.000
IEP	€ 197.260.313	€ 17.315.288	€ 4.331.250
Total ex VAT	€ 1.512.329.063	€ 132.750.538	€ 33.206.250
VAT	€ 287.342.522	€ 25.222.602	€ 6.309.188
Total incl VAT	€ 1.799.671.584	€ 157.973.140	€ 39.515.438
Total as percentage of Grand Total	82,1%	39,7%	65,8%

Declaration and Customer Care	*Initial costs*	*Operational costs ex depreciation*	*Depreciation*
OBU declaration / communication		€ 61.125.000	
Occasional User System	€ 3.825.000	€ 9.284.436	€ 3.165.000
includes Equipment for PoS and CP	€ 3.825.000		
operation PoS and CP		€ 8.621.436	
maintenance PoS and CP		€ 663.000	
Customer Care		€ 6.900.000	€ -
Other	€ -	€ -	€ -
Sub total	€ 3.825.000	€ 77.309.436	€ 3.165.000
IEP	€ 573.750	€ 11.596.415	€ 474.750
Total ex VAT	€ 4.398.750	€ 88.905.851	€ 3.639.750
VAT	€ 835.763	€ 16.892.112	€ 691.553
Total incl VAT	€ 5.234.513	€ 105.797.963	€ 4.331.303
Total as percentage of Grand Total	0,2%	26,6%	7,2%

Payment and Billing	*Initial costs*	*Operational costs ex depreciation*	*Depreciation*
Processing and billing costs	€ 59.500.000	€ 52.883.025	€ 1.500.000
include Central System SW and HW	€ 35.000.000	€ 9.687.500	
include Electronic Tolling SW and HW	€ 24.500.000	€ 6.900.000	
include Postage Costs		€ 36.295.525	
Payment collection costs	€ -	€ 19.197.500	€ -
transaction costs		€ 16.737.500	
data request cost		€ 2.460.000	
Follow-up costs , includes Personal Costs	€ -	€ 5.120.000	€ -
Other	€ -	€ -	€ -
Sub total	€ 59.500.000	€ 77.200.525	€ 1.500.000
IEP	€ 8.925.000	€ 11.580.079	€ 225.000
Total ex VAT	€ 68.425.000	€ 88.780.604	€ 1.725.000
VAT	€ 13.000.750	€ 16.868.315	€ 327.750
Total incl VAT	€ 81.425.750	€ 105.648.918	€ 2.052.750
Total as percentage of Grand Total	3,7%	26,5%	3,4%

Enforcement		Initial costs		Operational costs ex depreciation		Depreciation
Fixed enforcement stations & labour	€	53.756.265	€	2.535.425	€	3.714.131
includes Lane Equipment cost	€	37.141.305				
includes Infrastructure cost	€	16.614.960				
Transportable enforcement stations & labour	€	17.479.171	€	1.521.068	€	1.401.536
includes Electronics	€	7.007.671				
includes Infrastructure	€	10.471.500				
Mobile enforcement equipment & labour	€	1.659.520	€	2.910.000	€	358.466
includes Electronics for vehicles	€	315.770				
includes Installation	€	162.500				
includes vehicles	€	1.181.250				
Enforcement backoffice costs (SW and HW)	€	10.062.500	€	1.300.000	€	750.000
Other			€	-	€	-
Sub total	€	82.957.456	€	8.266.493	€	6.224.133
IEP	€	12.443.618	€	1.239.974	€	933.620
Total ex VAT	€	95.401.074	€	9.506.467	€	7.157.753
VAT	€	18.126.204	€	1.806.229	€	1.359.973
Total incl VAT	€	113.527.279	€	11.312.696	€	8.517.726
Total as percentage of Grand Total		5,2%		2,8%		14,2%

Miscellaneous		Initial costs		Operational costs ex depreciation		Depreciation
Project costs	€	61.746.274	€	-	€	3.087.314
Marketing & communication	€	20.582.091	€	393.171	€	1.029.105
Generic office and facilities costs	€	18.350.000	€	2.857.143	€	-
Infrastructure/equipment related costs not covered elsewhere			€	2.571.429	€	-
include Infrastructure costs for the SPC			€	2.571.429		
Operational costs not covered elsewhere	€	-	€	-	€	-
Labour costs not covered elsewhere	€	40.000.000	€	7.010.000	€	-
includes Systemintegration and management	€	40.000.000				
includes other Personal cost for SPC			€	7.010.000		
Other	€	-	€	-	€	-
Sub total	€	140.678.365	€	12.831.743	€	4.116.418
IEP	€	21.101.755	€	1.924.761	€	617.463
Total ex VAT	€	161.780.120	€	14.756.505	€	4.733.881
VAT	€	30.738.223	€	2.803.736	€	899.437
Total incl VAT	€	192.518.343	€	17.560.241	€	5.633.318
Total as percentage of Grand Total		8,8%		4,4%		9,4%

OVERVIEW		Initial costs Totals		Annual operational costs Totals		Annual depreciation Totals
OBU	€	1.799.671.584	€	157.973.140	€	39.515.438
		82,1%		39,7%		65,8%
Declaration and Customer Care	€	5.234.513	€	105.797.963	€	4.331.303
		0,2%		26,6%		7,2%
Billing and Payment	€	81.425.750	€	105.648.918	€	2.052.750
		3,7%		26,5%		3,4%
Enforcement	€	113.527.279	€	11.312.696	€	8.517.726
		5,2%		2,8%		14,2%
Miscellaneous	€	192.518.343	€	17.560.241	€	5.633.318
		8,8%		4,4%		9,4%
Grand Total		**2.192.377.468**		**398.292.958**		**60.050.534**

8. D4B - SCENARIOS FOR PRICING

The following chapter shall give an overview and rationale for the developed system design - corresponding to the questions raised by the Ministry within the document [4], “scenarios for pricing”.

8.1 User groups

8.1.1 Dutch / Foreigners

Equal treatment	Different treatment
Vehicles with Dutch licence plates and foreigners will the treated equally within the same system	*Vehicles with Dutch licence plates and foreigners can be treated on different ways to achieve cost benefits*

A basic policy of a Road User Charging Scheme is that all users participating in the scheme are treated equally - equal charge for equal service. In order to generate equal charges for road users travelling the same route, an identical approach for charge calculation is required.
Apart from technical, commercial and PR related issues there are legal issues to consider about system access. The non-discriminatory principle established in the EU requires member states to offer equal and fair access to the toll systems. That means that for legal reasons all participants must be offered a solution resulting in equal charges for equal service provided.
Following the discussion during the 2nd interactive meeting with the ministry “equal treatment” is interpreted in technical terms - and not in global terms (i.e. the resulting charging for domestic and foreign users).
The basic intention is to automate data collection from road users as much as possible. This should be envisaged for all groups of users, domestic and foreign. Policy regulations can force domestic users to participate in the automated scheme while foreign users shall also be provided with this possibility. Equivalent (or similar) business processes reduce the complexity of a scheme and mitigate risk of failure.
However, certain aspects need to be visited:

Vehicle classification:
An automated access to detailed information about vehicle characteristics is only available for domestic users. This information can be retrieved from the central vehicle registration database. Thus the vehicle classification for the tariff scheme for domestic users can have the same granularity as the current tax scheme without additional effort.
Detailed data related to vehicles with foreign license plates (which are not registered within NL) cannot be retrieved automatically (e.g. electronically). This information needs to be requested from the vehicle driver that registers to the scheme. This complicates the registration procedure since the foreign user might not know the requested classification information, leading to time consuming registration procedures and annoyed users. In addition such information cannot be verified, leading to additional potential for fraud. Therefore, it is strongly recommended to limit vehicle classification for foreign users to the parameters that can be verified with the foreign vehicle’s registration certificate.
With respect to enforcement, correct categorisation is complicated for foreign users when applying complex classification. Therefore, it is advised to reduce the complexity of vehicle characteristics for foreign vehicles to a level where classes can be distinguished either by automatic enforcement equipment or manually. Such classes might be: motorcycles, passenger cars, lorries in different categories, busses, vehicles with or without trailers etc...
Limitations to vehicle categories for foreign users eliminate complex registration procedures and therefore result in cost reductions.
Vignette solutions:

Simple manual solution based on "virtual vignette"
Foreign users occasionally visiting the Netherlands (infrequently or only for short periods) should be offered a simple access to the scheme by a "virtual vignette". It is virtually since no actual stickers will be handed out; the vehicles are just registered in the system. The Licence Plate Number, the vehicle category and the validity period are the basic parameters requested for the vignette system. Actual road usage is not calculated, the vignette price is a fixed amount per day.

Complex manual solution (e.g. manual booking of routes)
A manual scheme which takes actual road usage of foreign users into account does not seem feasible. Foreign users will probably neither know their destination nor the exact route in advance. Asking foreign users to enter trip details into the system threatens user privacy, significantly increases (foreign) user discomfort and would requires a considerable overhead of support personnel. Siemens thus advises against deploying such manual scheme.

Commercial implications:
The number of foreign users has been estimated as being about 10% of all users of the scheme. It is assumed that only a small number of these foreigners are regular users of the Dutch road network (frequent foreign users). These regular users will be offered the possibility to use a Low Use On Board Unit (LOBU) or main scheme OBU. Infrequent foreign users may acquire a vignette. The incentive for the infrequent user to get a vignette should be the ease of purchase (e.g. in advance via internet or quickly at border crossings).
Frequent users should be provided with economical incentive to purchase an OBE (OBU or LOBU). Therefore, from the view of pricing strategy, the cost level for foreigners using an OBE should be lower than the cost of a vignette.
Commercially, the provision of a LOBU is quite costly. In addition to the cost of equipment, additional overhead is required for distribution, issuing and refurbishment of the LOBU. Therefore additional measures need to be taken to limit the number of LOBUs issued, i.e. making it unattractive for infrequent users to obtain a LOBU. In addition, an incentive is required to motivate the foreign user to return the LOBU after usage. Two mechanisms should be implemented to encourage this:

- Deposit on provisioning of LOBU
- Handling fee for the provisioning service

The deposit is only paid back (total amount) if all elements provided with the LOBU are returned (i.e. charging element, battery, cable, LOBU…) without obvious signs of damage.
The handling fee requested from each user should be in relation to the refurbishment costs incurred due to the effort for test, logistics, and packaging (to get a new, complete bundle) of the used equipment.

8.1.2 Dutch

Equal treatment	Different treatment
All vehicles with Dutch licence plates will be treated equally within the same system	*Vehicles with Dutch licence plates can be treated on different ways to achieve cost benefits*

The equal treatment of all vehicles with Dutch licence plates introduces the following special cases which have to be examined in more detail:

- Vehicles which are driven only a limited amount of kilometres (e.g. old-timers, campers, motor cycles).

- Vehicles which require a great effort or high costs for installing an OBU or even LOBU (e.g. old-timers with limitations regarding power supply, motor cycles)

There may be several situations where the cost for the OBE and the installation costs can exceed the income generated (in some cases even very significantly).
For some of the mentioned vehicles the installation procedure will be more complex. For others special OBE is necessary with higher unit costs. In many of these vehicles the LOBU solution is possible.
In general, the following pro's and con's apply:
Advantage:

- Higher acceptance by the majority of Dutch users is likely
- Less exceptions would simplify the overall scheme (equal treatment of all vehicles in any case, e.g. also regarding enforcement procedures)
- Less problems expected with EU legislation (based on the non-discriminatory principle)

Disadvantage:

- Cost to support special kinds of vehicles is higher than the actual income
- Some exceptions will probably exist in any case
- Other solutions are most likely necessary for certain vehicles anyway. For these cases, the vignette scheme is an option. Exempt vehicles can be treated like vehicles with vignette without expiration date.

Motorcycles
Motorcycles require special attention due to the special environmental conditions applicable to the OBE. Although it should be possible to develop a dedicated Motorcycle On Board Unit (MOBU) this is currently not foreseen. Aspects which need to be solved in this case are weatherproof design, installation procedures, size, operation with gloves and theft prevention.

Solution design:
In our proposed solution, we assume the majority of the vehicles to adhere to the main scheme. For low frequency users, the LOBU solution is provided. Occasional users (and motorists) are offered the possibility to acquire a vignette. These three modes of system participation offer a high level of flexibility to serve the different types of users. The assignment of users to the best type of equipment should be determined considering political, financial and practical reasons.

8.2 Distance travelled:

- *the use (kilometres) of the public roads (not the private roads)*
- *all the kilometres (number of kilometres) driven on all the roads in The Netherlands*

The solution Siemens proposes is based upon the variant "all the kilometres driven on all roads in the Netherlands".
Applying the scheme only to public roads would require a high effort to provide and maintain the necessary geographical information in the required accuracy. Otherwise public and private roads cannot be distinguished. Our experience from field trials based on detailed geographical road graphs shows that the effort to provide and maintain geographical information of the entire Dutch road network for discerning public and private roads is overwhelming.
We propose that for an efficient solution only road segments should be modelled in the geographical data, which require special treatment regarding the application of tariffs (e.g. peak tariffs). All roads where the standard tariff applies need not to be modelled in the geographical data because this is not necessary for the calculation of distances driven. This approach requires less geographical data and thus reduces administration efforts.

Although more complicated from a technical point of view (in terms of application of algorithms), charging only public roads is also possible. The feasibility of this solution depends on the availability of accurate and current geographical data. The Siemens approach regarding map matching in the Electronic Tolling Back Office (thin client solution) has the advantage that changes regarding the geographical data can be implemented much more easily. Additionally, omissions and changes in the geographical data can be recognised based on the data of several participants or historical data by appropriate algorithms (e.g. changing one-way streets).

8.3 Tariff differentiation on the basis of location accuracy:

- *Differentiation on the basis of location with an accuracy of 10 metres in urban areas*
- *Differentiation on the basis of location with an accuracy of 50 metres in urban areas*
- *Differentiation on the basis of location with an accuracy of 10 metres on highways/expressways*
- *Differentiation on the basis of location with an accuracy of 50 metres on highways/expressways*

Siemens has performed several trials regarding tariff differentiation on the basis of GNSS location information. The overall accuracy achievable doesn't depend on GNSS accuracy alone. It also depends on the toll objects which must be recognized and the type, granularity and accuracy of geographic data available.
For example, if the entrance into a specific area needs to be detected, the accuracy would depend predominantly on the precision of the GNSS location detection. If specific road sections need to be detected, appropriate geographical data could be used to improve system accuracy. (With a thin client solution, this is easily possible.)
Our trials have shown that the current accuracy of GNSS systems and commercially available receivers is sufficient for most applications. One known problem is the accuracy in detecting the entrance into a specific area. For example, there are limitations regarding special surroundings with low GNSS accuracy, where even correction mechanisms (such as differential GPS) cannot help. Situations like these can be avoided by choosing the border lines of the area in a way avoiding spots of bad accuracy.
However, as mentioned above, our trials have shown that this is not a problem to determine driven road segments due to the possible corrections based on intelligent road network algorithms.
Further improvements regarding accuracy and reliability of GNSS location detection will be available with EGNOS and Galileo.

8.4 Tariff Structure:

- *A structure of tariffs with 3 different kinds of prices*
- *A structure of tariffs with 20 different kind of prices*
- *a structure of tariffs with more than 550 different kind of prices*

From a technical point of view our solution has no limitations of relevance regarding the number of prices within the structure of tariffs. Furthermore there are no limitations regarding changes in the tariff structure.
Nevertheless, a complex tariff structure requires more administration efforts and is less comprehensible to the user. The provision of adequate information about the scheme is of course more complex. Bills are also more complex which probably leads to more questions and complaints by the users and therefore to a higher load on the service organisation.
The number of different vehicle categories has little impact as long as they are well known by the participants and can be derived from the national vehicle registration database (although they are a concern regarding foreign vehicles).

8.5 Tax Refund

Inclusion of receiving money through the system besides paying for mileage: Is it possible to give discount on the prices per kilometre or to pay back a part of the taxes that have already been paid on new cars, but which have not gone through the full depreciation cycle yet?
From a technical point of view, the fulfilment of this requirement is possible by defining appropriate rules in the billing system.
Nevertheless, such option again complicates the transparency of the tariff structure and is difficult to explain to the road users. Especially during the introduction phase of the system, users will have difficulties with understanding the scheme anyway. So this introduces additional risks in user acceptance and leads to a higher load on the call centre and points of sales personnel.

8.6 Dynamic Traffic Management

Are there additional costs when there is an additional requirement (25) that all the ownership of all traffic information remains with the Dutch government? Are there additional costs to structure the traffic information to make it useful for dynamic traffic management?
Position information regarding individual vehicles is available in the electronic tolling back office (ETBO). In our solution, a vehicle transfers the accumulated data to the ETBO in blocks with an average interval of about 20 minutes. The data also includes the current position of the vehicle. All in all this data is sufficient to derive high quality real-time traffic information.
In the ETBO, this data is only used for

- Measuring and recording of road usage and determining the costs
- Data mining for detecting fraud
- Statistical analysis and data mining operations to improve the system performance
- Statistical analysis to provide system performance data to the government
- Provision of statistical traffic information

For data protection reasons, the ETBO will be operated from a trusted third party. Statistical analysis is done on data that is made anonymous (e.g. OBU and vehicle identifications are removed).
To distribute the system load, most of the operations in the ETBO are not necessarily done in real-time. Only operations regarding processing of single OBUs are done in real-time. The statistical analyses don't require the latest available data, and is therefore not processed in real-time.
The usage of the available data for dynamic real-time traffic management requires a dedicated real-time process providing this information. Due to the nature of data transmission (uniformly distributed in time and location) between OBE and ETBO, it is expected that the percentage of current data available in the ETBO is sufficient to derive real time traffic information. Therefore, it is not necessary to decrease the communication interval between OBE and ETBO. This would result in higher costs due to increased overhead data transmitted. It is obvious that additional functionality requires additional resources and introduces additional costs.
Dynamic traffic information based on the amount and accuracy of data collected by the system is of high value and quality and therefore represents a considerable economic value. A toll operator may put this information at the disposal of the Dutch Government, but may also commercially exploit it. In the latter case the income retrieved by the operator could partly contribute to exploitation cost and therefore would result in a reduction of the general scheme exploitation cost.

8.7 Presentation of tariff information within the vehicle

Siemens proposes a solution where the OBU operates autonomously, without needing a permanent connection to the Back Office. Therefore - to be able to indicate the charge - the tariff model has to be located in the OBU which could be a simplified model, depending on the requirements of the final system. Tariff indication without absolute values (i.e. cheap, middle, most expensive) is provided on the On-Board Equipment.

Additional costs arise from changes in the tariff model, if these changes influence the tariff indication to the driver. The costs resulting from updating tariffs (and possibly also geo-data) of every On Board Equipment and are related to transmission costs. Otherwise, only changes in the central equipment are necessary. On top of that, the data distribution to more than 8 million users can be very time-consuming. Changes in the network and tariff structure should therefore be kept to a minimum.
In principle it is possible for information exchange regarding tariffs and geo data to be realised during every transmission from OBU to back office, but the implementation of such a process could considerably increase the system complexity.
Giving the complexity of the matter, the following issues need consideration:

- Tariff indication increases the cost of the solution
- Information for the driver always gives an indication about the current tariff but not about possible routes and associated costs. (The driver does not get information directly about what to do to reduce fees)
- It is intended to have minimum complexity in terms of the man machine interface (MMI). (since distraction of the driver could impact road safety)
- Information presented must be clear and concise. Misinterpretation can cause a disproportionate increase of inquiries at Call Centre / Customer Helpdesk, especially about charge issues.

9. D4B - TARIFF SCENARIOS

Siemens is requested to present the view on each of the different tariff scenarios indicated within the document [5]. The following chapters will give a brief indication about the influence of the solution, costs and risks are not analysed in detail.

9.1 Scenario I: Flat rate

This scenario assumes a flat rate per km, i.e. not depending on time or location.
A scheme that is related only to distance driven can be handled with On Board Equipment for an automated solution or without any kind of equipment resulting in a manual solution or by fuel taxation (public acceptance!).

Solution with On Board Equipment:
Within an automated solution the OBE is foreseen to collect location data for distance calculation. These data can be processed either within the OBE (distance accumulation) or sent back as raw data for distance calculation within the Back Office. Data transmission can be foreseen in different ways:

- Transmission of data using cellular network capability
- Transmission of data by user interaction
- Transmission of data in hot-spots (e.g. points of sales, gas stations)

Transmission of data to the Back Office in an automated way requires a communication unit within the OBE. Communication costs using a Cellular Network are considered within our proposed solution, the major part of costs is related to the subscription fee.
Data transmission can also be initiated by the user: A removable memory device (part of the OBE) that stores road usage data can be connected to a terminal (private terminals or self service) for sending data to the Back Office. This solution would require discipline by the users; a potential risk for fraud has to be considered. Further on the costs for the memory devices, the fluctuation and probably the postage cost will have a negative cost impact.
A third possibility is data transfer in hot-spots. This is done using short range communication technology (e.g. WLAN). Problems are anticipated with limited OBE memory, dwell time in communication range, unpredictable transmission intervals, accumulation of large amounts of data which need to be transferred before crossing the border etc. Nonetheless this is an option to reduce cellular network load.
Distance calculation can be based on GPS distance measurement or on sensor information provided by the vehicle (e.g. derived from speed sensor signal). Implications of accuracy or availability of sensor information are discussed within the chapter 1313. Siemens trials have proven the practicality of GPS mileage counting: in general the accuracy exceeds that of odometer readings.
Foreign users have to declare on arrival in and departure from the Netherlands. This could be solved in different ways: Self service terminals, Internet declarations or human interaction at borders.

Manual Scheme
Due to the existing feature that is already installed in a car the kilometre information presented by the odometer can be used for charging. The recording of distances driven can be integrated into the periodic vehicle check but can also be extended by interim self declaration (e.g. via internet) equivalent to solutions for utilities currently in place.
Travelling abroad and returning would also require a declaration and could be handled equivalently to foreign users. Here it is expected that potential fraud can occur since it is hardly possible to verify these declarations.
Since no On Board Equipment is required for this solution the costs for equipment, installation, roll out and re-invest could be saved. It has to be considered that device presenting the kilometres driven is not calibrated and not protected against fraud. Manipulation is easy especially for devices within older

cars but it has to be assumed that a certain effort will be spent to find methods avoiding payment of tax.

9.2 Scenario IA: Flat rate plus tolls

This scenario is similar to scenario I, but with additional charges on a limited number of toll roads, bridges and tunnels. Tolls will only be implemented on new (to be realized) infrastructure (and possibly some closely related roads nearby).
Assume that the tolls can be implemented with 50 point charges (a fixed amount is charged for passing a charging point in a certain direction). Assume that toll amounts are in the order of 1 € (passenger cars) and 2 € (HGV).

The technology implemented for this scheme can be equivalent to the solution described within section 9.1 where an On Board Unit based on GPS distance calculation is already in place. The functionality of the Back Office will be enhanced, recognizing also the few dedicated toll sections. The discussion about thin and fat client is not covered here. With this solution the costs and risks are the same as proposed for scenario I.
On Board Equipment supporting distance calculation based on sensor information would need to be enhanced by the functionality of DSRC, automatic number plate recognition (ANPR) or equivalent location determination equipment on specific road sections (infrastructure based solution in addition).
It is worthwhile to mention that a communication mechanism e.g. on basis of Cellular Networks needs to be implemented in the OBE anyway since periodical invoices shall be generated and issued.
The manual solution mentioned within chapter 9.1 could also be implemented here which would then be extended by a DSRC On Board unit responsible for the detection of dedicated links. This solution can be provided to domestic as well as foreign users. Beside recording of location data at specific segments it still requires the declaration on a manual basis when entering or leaving the Netherlands.
Alternatively a manual solution augmented by ANPR offers a solution without OBE for this scenario. Since additional toll is expected primarily for locations of high traffic, the requirements and load on the ANPR system is considerable and feasibility must be investigated.
Due to the fact that the number of locations is limited it is expected to cover this scenario most effectively with DSRC OBE remembering all implications in terms of flexibility and extendibility.

9.3 Scenario II: Uniform peak off-peak

This scenario has a tariff that does not depend on location or type of road. Certain fixed time-blocks on working days are assigned the higher peak-tariff, which applies to all roads/locations.

Since no location dependent differentiation is required, only distance measurement in combination with a time-module needs to be implemented here. In order to have data for invoicing available periodically a communication link is also required. Therefore the necessary On Board device, independent of functions like location determination already reaches a level of complexity which covers more involved schemes, too. Resulting technological risks and costs are similar to e.g. those identified for the proposed solution.
A combination of distance and peak / off peak times can not be supported by any manual scheme since it would require the user to determine the different classes and no control measure could be applied.

9.4 Scenario III

9.4.1 Peak tariff on congested segments (III)

In this scenario the major part of the network only has a flat off-peak tariff (yet depending on vehicle characteristics). Designated parts of the road network have different tariffs for peak and off-peak time blocks.

The technological approach resulting from this tariff scenario is identical to the proposed solution. The solution is not influenced by location dependent variation of tariffs.

9.4.2 9.4.1 with different peak tariffs + apportionment (IIIA)

This scenario is largely similar to scenario III. Two differences exist:

- *- the peak tariff markup has 4 levels (assume 3, 8, 13, 18 cpkm) to reflect differences in average congestion levels between locations. The peak tariff markup will differ between regions/cities, but will not vary within a city/region.*
- *it shall be possible to apportion (part of) the KMP-income to the authority of the region where the kilometers are driven. Assume 19 different regions (12 provinces + 7 conurbations)*

The technological approach resulting from this tariff scenario is identical to the proposed solution. The solution is not influenced by location dependent variation of tariffs.

9.4.3 9.4.1 with different peak mark-ups + tolls (IIIB)

This scenario is similar to scenario IIIA but also includes toll charges as described in IA.

As recommended by the ministry this scenario has been selected for costing of the proposed solution. The following table reflects Siemens understanding of scenario IIIB which shall be the basis for costing of the Scheme:

Scenario	***Network***	***Tariff Structure***	***Tariff***
III (A,B); I	Flat off peak tariff for major part of the road network:	Flat, dependent on vehicle characteristics	= 1-10ct (weighted average: 3.5cpkm)
III	Designated parts of road network Peak / off peak tariff		
III		Off Peak	= 1-10ct (weighted average: 3.5cpkm)
IIIA		Peak (time blocks: morning, evening or morning and evening; segments differ for morning and evening), dependent on location	= Off peak + 3 cpkm 8 cpkm 13 cpkm 18 cpkm
IIIB=IIIA + IA	Additional charges on a limited number of toll roads 50 point charges	Flat (per passing)	1 EUR PC 2 EUR HGV

Constitution of charge:

Major part of network:

- Measurement of distances, the summation of kilometres is independent of time.
- Apply charge according to flat tariff structure

Designated part of the road network:

- Section detection for all defined sections intended for the application of specific tariffs (detection does not care about time)
- Apply charge for specific detected sections, dependent on location and time

Additional charges on limited number of toll roads:

- Section detection for all sections within toll roads
- Apply charge according to flat rate model

Summation of charges:

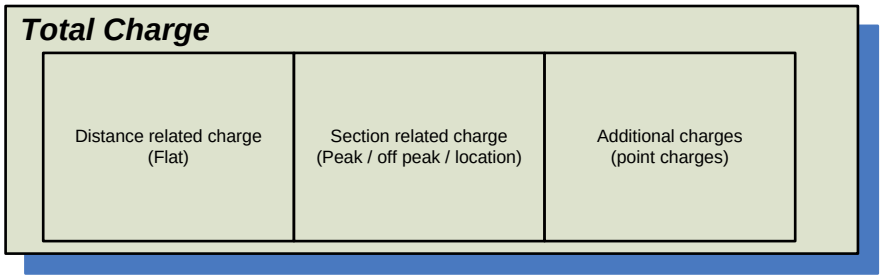


Figure 24: Calculation of total charge

9.5 Scenario IV: urban-interurban

This scenario has no time-dependent tariff component. A higher tariff applies within designated cities.

- *The city tariff has a maximum of three different levels (depending on city, but fixed for a given city).*
- *Assume that the city tariff boundary is set at the major ring roads (including or excluding).*

Assuming that still distance related charging is required a certain mechanism for distinguishing of the areas needs to be in place. This can be realised with a cordon based approach: while existing cordon solutions use DSRC (e.g. Stockholm) this can also be integrated using geo-fencing into the GNSS solution proposed by Siemens without additional costs.

9.6 Conclusions

All scenarios described can be covered by the solution proposed by Siemens. Scenario I and IA can also be implemented by solutions without or simplified OBE. Scenarios II, III and IIIA require OBE of similar complexity as the Siemens solution proposes.

10. D4B - THIN VERSUS FAT CLIENT APPROACH

This chapter gives a rough comparison of the thin and fat client approach within GNSS based tolling solutions. Our recommendation for the nationwide Road User Charging Scheme in Netherlands is the thin client approach. Nevertheless we would like to mention that Siemens is able to supply a fat client solution, too.[10]

Fat client - definition

The processes for measurement and recording of road usage and probably also the determination of costs are implemented in the On Board Equipment (OBE). Comprehensive geographical data and tariffs must be available in the OBE. The interface between OBE and back office is extensive and complex due to this fact. This results in higher development costs and times, in complex specifications and certification and therefore presents considerable barriers for the emergence of a free market of OBE.

Thin Client - definition

OBE acts like a simple sensor providing position information. Only simple and determined geographical data is necessary in the OBE e.g. for detecting different tolling areas such as countries (geo-fencing). The interface between OBE and the electronic tolling back-office is rather simple.

Current trends in distributed systems support the decision for the thin client. Internet applications e.g. are mostly implemented using web-applications on the client side. That means that the client runs a simple browser application, while all the functionality is provided by the server side. This approach simplifies the requirements on the client side, which exists in large numbers and in a badly controlled, heterogeneous environment. Hardware, low level software, communication infrastructure and other aspects crucial for reliable operation vary widely. Therefore it is advantageous to mask all those aspects, and to locate the functionality where it is controlled, updated and protected easily and properly. The whole industry agrees on this fact. Even if the user interfaces for thin client applications are becoming more complex (Web 2.0, AJAX) this is done only in several small steps.

For further illustrating the advantages of the thin client solution, it might also help to consider the experiences with cell phone standards showing interesting analogies to the electronic tolling situation: The GSM standard, which is undoubtedly a success story, started out with minimum functionality required for operation. After successful introduction, extensions were added step by step (SMS, GPRS, EDGE, etc.), improving performance and offering new services. The UMTS standard on the other hand was designed to cover a huge range of functions from the very beginning. The result was an accumulation of problems in the technical implementation as well as in the market introduction of the system. These problems are mostly overcome by now, but some of them still remain unresolved.

These examples demonstrate clearly that it is advantageous to start out with a streamlined solution. This is especially true for the user terminals, in the case of a tolling system the OBE. Following the thin client approach ensures low price, short time to market and thus increased competition (free market), robustness in operation and minimum complexity of operation (e.g. by avoiding frequent updates).

In our opinion there are several additional serious drawbacks regarding a fat client approach worth mentioning. One of the major disadvantages effects interoperability. We recommend a thin client approach for the European Electronic Toll System (EETS). One of the obvious reasons is that measurement of road usage and determination of costs will be different within different local toll operators participating in the EETS. Different use cases which depend on the granularity and the necessary amount of geographical data and the granularity of tariffs will also require different

[10] From a technical point of view we are able to shift functionality between back-office and on board equipment even in a running system, if the equipment (especially OBE) offers the necessary resources.

algorithms for determination of the used toll objects and calculating the appropriate usage fee. It introduces very high risks or very high limitations to deploy this functionality in the OBE. Another problem for some use cases is the obviously necessary high update rate of geographical data to reach the required accuracy. In addition the format of the used geographical data differs between the different vendors to save space and to allow the application of specially tuned algorithms for special use cases. All these problems are much easier to solve transferring location data and some additional events between OBE and back-office and deploying all the functionality which requires high variability or high data update rates in the central system. Additionally a simple OBE with a simple interface is much easier to certify due to lower complexity and functionality. Our experience shows that the communication additionally necessary compared to the fat client approach is no issue due to available proper compression approaches regarding the location data. Our experience shows that there are no essential cost savings regarding communication costs in a fat client solution due to the basic cost for provisioning communication which are there in any case and which represent a major part (if not all: flat rate). The location data in the back-office can also be used as evidence data in case of complaints and in an anonymous form as input for traffic control systems. Nevertheless several available security features ensure that these data is not used for purposes other than intended. (In the electronic tolling back-office, where this kind of data resides, no link to the number plate of the vehicle or to the owner is necessary.)
One drawback of the thin client solution worth mentioning is that it is not feasible to provide current tariff information with high accuracy for a system with a complex tariff structure depending on the underlying road network. But in our opinion a high accuracy for this feature is not so important compared with the accuracy for the calculation of costs (which benefits from the complexity possible in the central system). Additionally providing this information has of course negative influence on safety (changing information on a display distracts the driver from the traffic).
Summary of advantages of the thin client solution[11]:

- Simple OBE decreases risks and lowers maintenance costs (best practice for solutions with a huge number of clients derived also from experiences on internet applications).
- The preferable approach regarding interoperability of comprehensive GNSS based solutions (EETS).
- Higher flexibility (no OBE updates necessary) regarding changes in the tolling approach, complex tariff structures, different approaches for tolling regarding different areas (some of the problems of interoperability on a smaller scale), and updates of tariffs and geographical data.
- Enables the possibility to continuously advance the system.
- Enables a low risk step by step adoption approach regarding the complexity of the scheme (e.g. from a simple flat rate to a complex tariff structure in several small steps).
- Data available in the electronic back-office provided in an anonymous form can be used for automated traffic management.
- Higher flexibility regarding the implementation of telematic services

Summary of disadvantages of the thin client solution:

- Output of the current tariff or current accumulated costs currently not feasible with high accuracy, but tariff indication (estimate) possible.
- Probably higher security efforts necessary for data communication and within the electronic tolling back-office.

[11] Some of the mentioned issues are perhaps possible also with a fat client solution but only with very high risks and probably much higher costs.

- Probably increased communication volumes (the difference to the fat client approach is not a major cost driver).
- More processing power necessary in the electronic tolling back-office.

11. D5 - MIGRATION SCENARIOS

11.1 Overview

One of the most crucial parts within "Anders Betalen voor Mobiliteit" is the choice of a good migration scenario. Migration is the term used for turning the existing tax scheme (BPM, MRB) into KMP. This chapter describes several of the possible scenario's, in order to ensure a system in which all components are rolled-out in time so that the system runs stable and reliable.
Siemens has identified 5 different major scenarios, called Big Bang, Smooth Migration, Vignette, Big Smooth and Open market Approach. These scenarios are described shortly in the table below. Section 2 describes the scenarios in more detail.

Scenario	Variant	Pros	Cons
Big Bang (the taxes are set out of duty immediately at system's start)		- All vehicles will be equipped until the official start - Quick and cannot be misinterpreted - applies to all citizens equally	- As a consequence this will take at least 12 months (we assume roughly 16 months roll-out time) - very risky - hardly any control in case of system failure, e.g. a loaded system test
Smooth Migration (the taxes are set out of duty stepwise)	- voluntarily	- hardly any protest to be expected - no incentive necessary as the new system itself is the incentive	- loss of revenues, as those who drive below average km/yr. will be the first to choose the new system (percentage estimated 70:30 → 70% are below the average yearly km amount)
	- new vehicles only (after a certain fixed deadline e.g. start of ABvM)	- phase in approach - incentive for those who drive less than average but want to own a new car	- Those who drive more than average will try to buy used cars; this will cause a delay of the whole implementation - old cars longer in use: this could be a safety issue - negative impact on new car sales
	- by class of vehicle	- defined and clear approach - accepted by the majority of vehicle owners - phase in approach	- passenger cars are still the biggest group → the real implementation issue will not be solved - restricted competitiveness

			especially for business vehicles
	- per region (either county or special region like Randstad)	- busiest regions first will mean high revenue from the beginning - could lead to positive economic effects within these regions - the load on the overall system will increase stepwise	- relocation of vehicle registrations - effect could be torpedoed by commuters coming from outside the region - politically dangerous due to high influential potential, which might turn the whole system into negative headlines → discrimination - in certain regions lack of infrastructure - competitiveness of these regions might be affected
	- by number plate (AA22BB) [Year; class, …]	- could be consecutive by year; formally just, if you start with oldest cars first - positive impact on economy, as new cars with lower tariffs might be bought	- still very slow roll-out time; might to have the need to be sped up
	- randomly	- hardly any impact on tricky solutions by the citizens - most "correct" way in our opinion	
Vignette solution (The taxes are set out of duty immediately)		- A vignette could be distributed and obtained in the shortest time possible - A vignette gives time to build the system and then switch it - A large-scale role out might change the driver behaviour even before the final system has been started	- A measure, which allows average assumptions only - Those who drive much are not charged in the same way as those who drive less - the citizens might ask why they still need a highly sophisticated solution like the proposed one
The Big Smooth (The taxes are set out of duty stepwise)	Mixture of Big Bang and Smooth Migration	- a stepwise Big Bang, users are randomly selected to have their vehicle equipped up to one year in advance and then randomly selected starting 4 months in advance to actually participate in the system - No revenue loss for the	-Back Office system needs to be available early to generate virtual bills -Cost for (virtual) billing will start to incur up to 12 month prior to full system operation

		government as the old tax system gradually ramps down and the new system gradually ramps up with randomly selected users - In the period between installation and start of participation the user receives a virtual bill and gets used to his personal financial effects - teething problems can be easily solved in the period the system generates virtual bills.	
Open market approach		existing solutions of certified equipment providers can be integrated in the solution: ensures redundancy, enables competition in terms of Equipment provisioning, accelerated roll out	- supervision of devices operated by other providers - liability

11.2 Detailed description of Scenarios

11.2.1 Big Bang

In order to have the best results out of the proposed system it could make sense to set off the taxes immediately and switch on the system at once. Then, as all vehicles will be equipped with OBUs or LOBUs or Vignettes until the official start, the so called "Big Bang" would be a effective approach as from one day to the next, taxes are dependant on driver's behaviour and income is ensured. Introducing the tolling scheme in the quickest possible way will require a tremendous marketing effort to reach the proposed 8.2 million vehicle owners. Consequently the assumed 12-16 months for the roll-out will have to be absolutely in time, there must not be any delay. This might drive the costs significantly, since the deadline is fixed. As there will be mainly system tests with simulated loads prior to operation, the operator has virtually no control of scalability issues. Politically, this approach could lead to public criticism (as was the case with the German Toll Collect system) in the case of delays.

11.2.2 Smooth Migration

The second proposed alternative foresees the stepwise replacement of the tax system. The so-called "Smooth Migration" is divided into 6 different variations, which could either be chosen individually or offered jointly.
A general discussion n to be raised about terminating the various taxes currently applied to car users. It is expected that the MRP can be replaced when the user participates in the new scheme without any major influence. The more sensitive part of the tax is the replacement for the BPM. How ever the migration scenario concept is defined, it will influence the users in a way that cannot be easily predicted.

11.2.2.1 Voluntarily Smooth Migration

Users could be motivated to be amongst the first to use the system through incentives. Especially those who drive less than average could be among the first to take part in the roll out of the scheme. When properly communicated, the incentive will clearly be the financial savings for using the roads, which would allow for a slow but gradual system start (without protests from the users). Since the involvement of politics is necessary for establishing financial incentives, it is doubtful whether this migration can be done within a reasonable period of time. Furthermore, the anticipated revenue will be below estimations since statistics indicate that the vast majority of users drive less than average. Since the system rollout requires a period of time, this approach would provide enough time to load and test the system and all its components.

11.2.2.2 Migration by New Cars First

Within this scenario it is foreseen that every new car sold in Netherlands has to take part on the distance based tolling scheme. It is assumed that the average time of usage for a vehicle in Netherlands is between 7 to 10 years. This fact leads to an equivalent roll out time of OBE until all vehicles are equipped with an OBU.
The incentive is intended for users who own an old vehicle but drive less than the average travelled distance. Since the majority of all vehicle owners drive less than the average amount of kilometres anticipated, there could be some positive effect on the economy. From the perspective of politics and generated revenue side, this approach would be less than satisfactory. Especially those who drive more than average will try to remain with their car as long as possible with the consequence that the income from this system does not develop as anticipated. Once again, there would be advantages to steadily increase the number of participants in the scheme.

11.2.2.3 Migration by Class of Vehicle

This stepwise phase-in approach has the advantage to test all the relevant components with the increasing system load. Should commercial vehicles be charged first, the system introduction might be more widely accepted (politically). Nevertheless, the disadvantage lies in the fact that the anticipated group of vehicles represent less than 10% of the total amount. Thus, neither would the revenue increase, nor would public awareness be generated.

11.2.2.4 Migration by Region

The advantage of this stepwise proposal lies in the ability to generate income from those working and living in the busiest regions (such as Randstad), first. Nevertheless, there are a few pitfalls in this approach. Vehicle owners might simply change the address in order to have their car registered in a non-charged region. Furthermore, the commuter traffic might torpedo the effect of revenue as the system might charge those who do not necessarily burden the road network capacity. Certain interest groups may also generate negative headlines for the whole system, arguing that their region is unfairly burdened (and has competitive disadvantages to other regions not yet in the scheme).

11.2.2.5 Migration by Number Plate

In order to have a fair and clear solution, a consecutive implementation according to the age of the car could be proposed. By first starting with older vehicles, there might be a positive influence on economy (i.e. more new cars might be sold). On the other, hand many different types of old cars are in use and therefore the installation complexity is given from the very beginning (since the installation may vary slightly depending on the vehicle type). This solution is easily understandable and could be easily communicated to the public. Nevertheless, the subsequent prolongation of system rollout would lead to lower revenues than anticipated.

11.2.2.6 Migration by Randomly Selected Vehicle Owners

Another way to ensure a timely roll-out while reducing public protest of "fairness" would be a migration concept based on randomly chosen vehicle owners. Legislation must be designed which

not only ensures correctness of this form of implementation, but also ensures the enforcement of those users unwilling to take part of the scheme. This approach ensures a timely roll out and constant growth of system growth. Once again, the subsequent prolongation of system rollout would lead to lower revenues than anticipated

11.2.3 The Vignette Solution

In order to achieve a fast shift of the tax burden related to road usage (mobility) the introduction of a vignette system could be considered. On the positive side, a variety of vignettes (with a unique pricing structure) could be used to motivate change in drivers' behaviour before the electronic tolling system is introduced. Since vignettes are an element of the final scheme proposed, the necessary distribution channels can be introduced (and tested) in full scale, later being integrated into the final scheme. On the other hand, the anticipated revenue will unlikely meet projected forecasts, and the issue of fairness may be raised since those who drive more have an advantage over those who drive less. Furthermore, criticism might arise as users experience a simpler scheme and question the necessity of a highly complex and sophisticated RUC scheme. The vignette can provide a gradual system build, ensuring a continuous roll-out.

11.2.4 The Big Smooth

The next recommendation is a combination of a smooth migration scenario with randomly selected vehicle owners and the Big Bang scenario. In this case, vehicle owners are randomly selected to mandatory have their vehicles equipped with an OBU in a period up to 1 year before the system is completely life. Once OBUs are installed they start to collect and transmit data to the back office. Users receive virtual invoices enabling them to get used to the financial effects of the system. In a short period of less than 4 months before the system is completely life, equipped users are again randomly selected to actually migrate to the system. For them existing taxes are terminated as soon as the vehicle owner starts to be charged for road usage. The proposed 12 to 16 months implementation period could be used for the proof of concept and a reliable continuous roll-out to assure the system starts on time. The political message, that the scheme is not merely an additional tax burden, could be easily underlined since drivers can directly compare the virtual KM-price with the taxes they are actually paying. From a technological point of view, a steady increase on the system load is guaranteed and supports a smooth ramp-up and testing phase. In addition because of the random nature of selecting the “to be equipped” and “to be migrated” customers, the gradual system start up will not be perceived as being unfair or rendering undue (dis-) advantages for larger groups of users.

11.2.5 Open market approach

This scenario differs to the aforementioned approaches because it introduces a scheme that is based on various sources for data delivery. The resulting solution is similar but not identical to the proposed solution.
A centralised solution for toll transaction processing offers the possibility to integrate data from different sources, for example data provided by fleet management devices or other tracking devices. There are some minimum requirements on the content of the data provided but usually the types of data required for a centralised tolling application are available.
Providers of telematic services can get a certificate passing an approval procedure for provisioning of road usage data. The requirements for approval can be defined by the authority and the operator of the tolling scheme and include tests of e.g. reliability, accuracy, privacy, security, protocol etc. The execution of the approval process should be carried out by an independent organisation.
The advantage of this approach is the resulting competition of telematic service providers and redundancy for provisioning of equipment. This accelerates the roll out process since systems are already available and distribution might also be in the interest of the user. Further on interoperability to other EU countries can be ensured as well as the integration of existing toll roads or toll objects. The business aspects for this solution are not developed today - it is assumed that there are some

ways to share the costs for equipment. Further, issues like supervision of quality of service and liability, have to be elaborated more deeply in such a scenario.

12. D6 - RISK EVALUATION

Risk Event	Risk Source	Consequence	Proba-bility.	Conse-quences w/o mitigation	Severity Index	Project Phase	Mitigation Measure	Risk Owner	Comment
Negative public attitude	social acceptance	- boykott of scheme - loss of income	4	4	16	Implemenatation	Joint marketing group and sufficient marketing budget, public awareness has to be there in an early stage, smooth migration scenario	public	Pre-Sales activities and lobbying have to be done by all parties interested in the smooth operation of the scheme
Insufficient penetration of installed OBUs at start of operation	politics and policy	Not all vehicles have installed OBUs at system start, causing delay of system start	4	4	16	operation	well structured roll out scenario / migration concepts / incentives for early installation	public	
Risk related to insufficient specifications- especially at interfaces to other operative organisations / definition of services and Service levels	technology	Acquisition of additional services, changes / improvement of design Delay in start of operation	3	4	12	Implementation and operation	definition of clear responsibilities and management of interfaces between participating parties, establishment of overall project lead for integration and ramp up	private&public	In case it is intended by the government to split up the service contract (e.g. as UK-LRUC) or to establish some parallel providers that should be interoperable related to governmental interface definitions
Time period between contract award and Start of Operation less than 2 years	politics and policy	Short time to market: insufficient equipment available, late start of operation, loss of income	3	4	12	Implementation	Realistic timelines for design, development/construction and integration/test; pilot phase with representative number of users	public	Time period too short (timeline between tender and SoP): not completely tested applications late roll out / insufficient coverage
Insufficient preparation of installation centres and distribution points (training of staff, installation and testing of equipment)	other	Installation centres and Distribution points are not capable to handle the required job Delay in start of operations	3	4	12	Implementation	various channels for training, early involvement of PoS, IC, user friendly design of equipment and system access	private	
Risk related to general changes in national legislation	politics and policy	Changes in the system design upfront or during operation	3	3	9	Implementation and operation	Close relationship to polititcs in order to keep the decisionmakers well informed	public	Adaptation is possible if it is announced in time
Risk related to transparency of scheme	social acceptance	Too complex structure (i.e. tariff scheme) might lead to unexpected volume of contacts, less acceptance, high rate of payment disputes	3	3	9	operation	Clear and transparent information for users (tariff model)	public	
Risk of delayed implementation of enforcement due to lack of legislation	politics and policies	late start of enforcement might lead to bad press information, increase numbers of non-payers	3	3	9	Implementation	early start of legislation procedure	public	
Risk of delayed implementation of enforcement due to lack of building permissions	politics and policies	late start of enforcement might lead to bad press information, increase numbers of non-payers	3	3	9	Implementation	early decision about locations, choice of enforcement concept: minimum infrastructure, usage of existing infrastructure	public	
Enforcement: power and data not availbl in time	politics and policies	late start of enforcement might lead to bad press information, increase numbers of non-payers	3	3	9	implementation	early decision about locations, choice of enforcement concept: minimum infrastructure, usage of existing infrastructure	public&private	

Risk related to unexpected user behaviour e.g. changes in consuming behaviour	market development	Influences on different indusrial sectors (e.g. less new passenger cars sold...)	4	2	8	operation	Broader market analysis when scheme operation starts, early reaction on business procedures / tariff scheme. Information to users, flexible system design	public	consequences of user behaviour and the secondary effects r(elated to the tax refund as well as the migration into the nation wide RUC scheme) are hard to estimate
Risk related to inefficient and ineffective Cooperation between involved parties	other	Delay of start of operation, loss of income	2	4	8	Implementation	Clear pre-defined governance structure (not oversized), escalation procedures	private&public	Inefficient governance structure on participation parties could cause delays in implementation
Risk related to unexpected market development of e.g components costs, costs for services	market development	changes in the cost level for services and equipment	2	3	6	Implementation and operation	avoid single source for equipment and services / enable market competition	private	
Risk related to ongoing changes in policies and international standards.	politics and policies	Re-design of processes and system elements in order to comply with new regulations.	2	3	6	Implementation and operation	close follow up of standardisation activities, information about policies in early stage required	public	E.g. harmonisation of european law
Risk related to accuracy of charge	technology	social acceptance decreased: if charges are inaccurate /overcharging, claims of customers will be the consequence	2	3	6	operation	Implementation of "Bias" related to charge.	private	
Risk related to underestimation of total system load	technology	Insufficient dimensioning of system, problems in stability and reliability resulting in loss of income	2	3	6	operation	Usage of up to date statistics, survey (public opinion poll) related to usage of access channels etc., Buffering mechanism to mitigate load peaks	private	
Risk of volumes changes of user behaviour over time e.g. unexpected increase of traffic/number of users	social acceptance	Equipment for participation not available in time, loss of income	3	2	6	Implementation and operation	Careful balancing of stock issues	private&public	
Risk of delayed implementation of enforcement system	social acceptance	late start of enforcement might lead to bad press information, increase numbers of non-payers	2	3	6	Implementation	If problems occure: maybe staged approach (mobile enforcement first)	private	
Risk related to late interoperability - legislation	politics and policies	Changes in the system design upfront or during operation	2	3	6	operation	Close relationship to polititcs (national and EU) in order to get information early, active participation in definition of EETS	private&public	Currently hard to estimate about the future of the european toll service and the related interoperability requirements
Risk related to special requirements for distribution / installation stations (availability / coverage)	social acceptance	Insufficient coverage stresses the acceptance of scheme, more coverage increases the costs of the scheme	2	3	6	Implementation and operation	Careful trade off related to requirements	private&public	Additional personnel might be required for distribution, especially at the start up phase of the scheme.
Risk related to shared infrastructure (usage of existing infrastructure e.g. post office, installation centres terminals)	technology	Incompatibility and failure of system compnents leading to inavailability of parts of the system	3	2	6	operation	Usage of standard interfaces, clear responsibilities, long testing phase	private&public	a) who bears the risk for breakdown of shared infrastructure b) who is responsible for maintenance c) who takes the risk about compatibility d) who is responsible for updates for such components e) who does the integration
Difficulties in the integration of On Board Equipment into old cars	others	difficulties due to non-standard installation procedure	3	2	6	operation	Preparation of installation guidelines available for most common old cars within NL	private	

Risk related to metallised windscreen and avilability of HF-signals (GNSS; uW DSRC...)	technology	signal strength weak for location detection and/or enforcement	4	1	4	operation	Special installation procedure for vehicles that are identified as problematic. Avoid uW DSRC for Enforcement	private	
Risk related to inefficient security / data integrity concept	technology	quality of evidence records is not accepted as leagal evidence: redesign of system and loss of income	1	4	4	operation	threat analysis in early stages, usage of standard methods (certified and approved)	private	Risk that operator can´t produce legally acceptable evidence records: huge consequences in order to fix this (otherwise all charge payers could claim which would result in shutting down the system).
Risk of fluctuations of employees regarding the operator / Access points for users	indirect politics and policy	Increased training effort for the operator	4	1	4	operation	Attractive contracts for employees	private	Risk of high effort for training
The scalability of system elements is not as planned.	technology	Delay for implementation, Redesign of system elements, eventually loss of data	1	4	4	Design,implementation and operation	Architectural principle: Buy over build; usage of prooven technologies	private	Dimension of system is within a dimension that is not really proven yet (especially the combination of servises according to the intended scale)
Ongoing development of used technologies evolve different than assumed, e.g. - annual increase of processing power much lower than past years - Network development of Cellular Network providers (i.e. capacity, transmission speed) much lower than expected) - different (new) technologies providing different services than required get better developed than these required for such a scheme	technology	Development of RUC scheme could require changes in architecture, business processes in order to provide a compliant solution. Use of new technologies (not prooven for such an application) require more time and effort to reach market quality.	1	4	4	Design, Implementation and operation	flexible design and close follow up of market activities n terms of technology development, considering fall back/back up solution	private	Siemens does not expect fundamental changes in the technology sector for critical components. Influencing factors could be: - further delay / termination of Galileo - European legislation changes mind and requires different technologies for european toll service - network provider change GSM or UMTS focus / technology not longer available
Risk related to agressive competition, restructuring of Industrial sector	market development	Low margins and underestimated risk can lead to underestimated costs.	1	4	4	Implementation	choose consortium based on stable partners	private	Agressive pricing might lead to unrealistic prices for implementation and / or operation of system which could cause bankruptcy of operations company. Choosen solution might not be capable of handling task
Risk of insufficient classification performance on site	social acceptance	Incorrect PCN issued	2	2	4	operation	clear classification rules, avoid too complex scenarios	private	The more complex the requirements (tariff structure) the more critical this issue
Lack of definition and preparation of call center functions versus technical support	other	Loss of time for fixing problems, negative appearance to consumers and partners (e.g. point of sales)	3	1	3	operation	preparation of FaQ´s in advance, large pilot phase to get most significant questions	private & public	
Risk related to poor quality of system design	technology	Problems in stability and reliability resulting in loss of income	1	3	3	operation	Realistic timelines for design, development/construction and integration/test; pilot phase with representative number of users	private	Poor test upfront start of scheme (delayed development or to less time foreseen for tests)
Low participation of foreign users due to weak information policy	social acceptance	Acceptance low / violations of foreign users could raise	3	1	3	operation	Marketing campaign also with partner institutions abroad	private&public	
Risk of volumes changes of user behaviour over time e.g. unexpected increase of traffic/number of users	technology	System dimensioning too small (probably loss of data, loss of income)	1	2	2	operation	Usage of up to date statistics, flexible scalable system design	private	Who bears the risk of the assets
Loss of transactional and user related data	social acceptance	Problems in e.g. billing of certain users	1	2	2	operation	training of exceptional situations (especially within data centre operation), technical measures (redundancy, communication protocols...)	private	Risk due to updates (new releases), sabotage or general fault situations: it might be necessary to reload data from recovery system: this is the most likely szenario, where data could get lost (manual interaction/unexperienced personnel)
GNSS availability - local jamming	technology	Local interruption of location detection	1	1	1	operation	Intelligent algorithms avoiding loss of data due to loss of signal (within a local area)	private	Local jamming can be compensated without any major influence on accuracy
GNSS availability - faliure of service	technology	general interruption of location service	1	1	1	operation	Probably use of back up: GPS versus Galileo	public&private	when it comes to a general falure of GNSS other critical market segments are also influenced (Aviation, Sea-traffic etc.)

13. D7 - REQUIREMENTS ANALYSIS

13.1 Requirement [1]

Road user charging shall be based upon the **distance travelled** with a vehicle in the Netherlands.

Rationale

All distance travelled driven will be charged. This is the basis of the road pricing system.

Question

Organisations are requested to present their views upon the relationship between an accurate measurement of the distance travelled and the associated costs.

Organisations are encouraged to present alternative methods for measuring distance travelled, e.g. with different levels of accuracy, and to specify the (financial) benefits of the alternatives.

Answer:

a) Measurement based on GPS: no additional costs required for a GPS-based solution which deploys distance calculation algorithms.

Trials have already shown that the accuracy of a GPS-based distance measurement solution is within the range of other distance measurement approaches. All technical solutions deliver results within a degree of tolerances, based on physical limitations or jitters in GNSS signals. GPS-based distance calculation is also not free of tolerances but delivers excellent results.

Dependent on the status of the GPS receiver (cold, warm, hot - related to the shut down time of the OBE) the start up time (Time to first fix TTFF) might vary. In case of vehicle movements prior to determination of the location after restart of the OBE, the Electronic Tolling Back Office calculates the distance from the last known position (previous trip) to the first valid location (actual trip) by interpolation.

The TTFF can further be reduced by use of additional services like Assisted GPS (A-GPS), where satellite status data (almanac, ephemerid) are transferred from a service provider (e.g. Cellular Network Provider) to the On Board Equipment on start up of the OBE.

b) Measurement based on GPS / Map matching procedure: this cannot be realised within the On Board Unit; there are cost implications regarding the performance of Back Office system and Map Data Maintenance.

Map matching in the Back Office is a reliable technology, but requires enhanced processing power compared to other algorithms. Nevertheless, maintenance of the data base used for distance determination requires a significant effort since changes in the road network, construction works on streets, diversions, one way road changes etc. have to be captured virtually in real time and updated within the system. This is necessary to achieve a level accuracy which would be socially acceptable. Thus the reliable measurement of travelled distance is best accomplished by the integration of GPS location data. Map-Matching should only be utilised for those road sections that exhibit deviating rate structures.

c) Connection to speed sensor signal: significant implication on installation costs; especially complex for passenger cars.

The speed sensor signal delivers a reliable indication about distance travelled but is also not free of tolerances. In addition, this information is usually present in lorries while passenger cars might not provide such a signal easily. Sensor information provided by the vehicle might be influenced by tyre pressure, tread of wheels and sensor signal tolerance. The accuracy of the positioning of the OBU thus needs to be seen within the constraints of automotive applications. The tachograph has an inaccuracy of 3 – 5% whereas typical car odometers have an inaccuracy of 2 - 3% . Within this environment, the GNSS positioning algorithm performs significantly better (1 - 2%) than the reference data that are at the disposal of the road user.

13.2 Requirement [2]

Road user charging shall be differentiated on the basis of **time.**

Rationale

The charge per distance travelled will vary during the time of day and/or on specific dates.

Question

Relationship between an accurate measurement of the time in relation to road usage and the associated costs.

Organizations are **encouraged** to present alternative methods for charging based on time differentiation, e.g. with different levels of accuracy or time intervals, and to specify the (financial) benefits of the alternatives.

Answer:

Differentiation based on time and date does not cause a major impact on the costs of a GNSS-based system. The system will be designed to be customer friendly, adaptations in the tariff structure is a supported feature.

On non-motorway roads, the accuracy of time differentiation is within the magnitude of seconds.

The accuracy (for a cost-effective solution) on motorway roads is related to the current road segment.

13.3 Requirement [3]

Road user charging shall be differentiated on the basis of the location of the vehicle.

Rationale

The charge per distance travelled will vary based upon the location of the vehicle. This requires an accurate positioning of the vehicle on all different roads in the Netherlands. The combined charge based upon distance travelled, see requirement 1, and location shall have an accuracy of at least 99%.

Question

Organisations are requested to present their views upon the relationship between an accurate measurement of the location of the vehicle and the associated costs. Organisations are encouraged to present alternative methods for charging based on location differentiation, e.g. with different levels of accuracy, and to specify the (financial) benefits of the alternatives.

Answer

a) Location determination based on GPS provides the most flexible solution with high accuracy (i.e. >99%) for section recognition on motorway segments.

Location determination based on GPS is used all over the world within many types of applications. It has been proven that this technology is reliable, stable and permanently available. GNSS is superior over DSRC particularly when a large number of roads need to be included in the scheme. Location determination based on GSM is to highly inaccurate and is thus not reliable for the operation of a charging system, even when the size of cells is further reduced in the future.

In the near future, when Galileo is in operation, GNSS provides redundancy and therefore it is ideally suitable for location determination.

13.4 Requirement [4]

Road user charging shall be differentiated on the basis of vehicle characteristics.

Rationale

The charge per distance travelled will be based upon the environmental vehicle characteristics, e.g. environmentally friendly vehicles will be charged less. New vehicle characteristics may be added in the future for further differentiation in road user charging.

Question

Organisations are requested to present their views upon the relationship between charging based on a classification of environmental vehicle characteristics and the associated costs.
Organisations are encouraged to present alternative methods based on a classification of environmental vehicle characteristics and to specify the (financial) benefits of the alternatives.

Answer:
Environmental vehicle characteristics are used within the back office for charging purposes. Therefore this parameter causes no additional costs from the technical perspective. Costs are related to validity check of presented parameters / check during enforcement procedures.
Classification according to emission class can only be treated as declared characteristics since there is no plausible means to actually measure emission class. This implies that at the time of registration, the vehicle class also needs to be registered and verified with the RDW. In addition, a means needs to be found to verify the tie between license plate and vehicle during operation.
Furthermore, an addition button for the declaration of trailers is possible on the OBU, and can be verified by the enforcement system, since the presence of a trailer is easily determined. However, this means of self-declaration is prone to error and fraud. In addition, this button may add some cost to the OBU (button and display of status).
Keeping a very complex table for vehicle classification in mind (according to the current tax-scheme), this does not necessarily influence the costs of the system. If this type of granularity should also be applied to foreign visitors, it could complicate the registration procedure and therefore increase the costs (additional paperwork provisioning of documents upfront, more exception handling, etc.). For foreign visitors, a system that sets the granularity of vehicle classes down to automatically identifiable characteristics would be preferable.

13.5 Requirement [5]

Road user charging shall be introduced on all roads in the Netherlands.
Rationale
The objective of the road pricing system is charging on all roads in the Netherlands, including roads on private territory.
Question
Organisations are requested to present their views upon the relationship between an accurate measurement of the distance travelled in combination with an accurate positioning of the vehicle on all roads in the Netherlands and the associated costs.
Organisations are encouraged to present alternative methods for charging distance travelled with the required location accuracy and to specify the (financial) benefits of the alternative.
Organisations are encouraged to present alternative implementation scenarios for road user charging on all roads and to specify the (financial) benefits and risks of the alternatives.

Answer:

a) The combination of distance measurement and location determination can best be based on GNSS. Such a system does not need connection to sensors within the vehicle.

b) Any solution that requires manual declarations by the drivers is possible but causes significant fraud potential. System elements that are not supported by an automated process usually require human interaction that decreases the reliability and increases the operational costs.

It is obvious, that coverage of all roads with a DSRC based system requiring an extensive Road Side Infrastructure is probably an impossible solution for any country.
Charging of roads will have a traffic management influence: a scheme that requires all roads to be charged offers the possibility to do a steering by varying the charge per road. This requires a tariff model where differentiation for types of roads or specific areas takes place.

13.6 Requirement [6]

The road pricing system shall have adequate flexibility in its design to allow changes in the parameters for road user charging as mentioned in requirements [1] to [5].

Rationale

The road pricing system will be durable and will be able to cope with changes in the parameters on which the charge is based. The system to be developed shall be able to react to such changes in a flexible and efficient way.

Question

Organisations are requested to present their views upon the relationship between the required flexibility in design and the associated risks and costs.

Answer:

GNSS based system is by nature flexible for changes in parameters on which the charge is based. Especially in a thin client based system where map matching and pre-billing is effected in a (intermediate) back office, a change of charging parameters is merely a change in road type tables and rate tables. It is important however to, certainly in the beginning of the scheme, keep the rate system simple and understandable for the road user.

Extension / Modification of Road Network can be effected at nearly no additional costs (Thin Client Solution) since it is only an addition to the rate tables.

In terms of the road network and all related differentiation criteria's therefore a GNSS based solution offers a great playfield to modify the scheme according to authorities view in a short and cost effective manner - an infrastructure based solution provides minimum flexibility and long reaction times.

13.7 Requirement [7]

The road pricing system shall be **'free-flow'**.

Rationale

The road pricing system shall not require stopping or slowing down the vehicle for charging.

Question

Organisations are **requested** to present the characteristics of a free-flow system with the required flexibility in design and the associated risks and costs.

Answer:

A GPS based solution is a barrier free and flexible solution without restrictions to the normal behaviour of road users (e.g. lane changes).

The main characteristic of a free flow scheme is, that users participating in this scheme are not forced to slow down or stop during the journey to support the toll transaction. This is also valid in terms of multilane conditions, where the driver is free to choose a lane or cross lanes during the journey. There are several technologies possible, with or without OBUs supporting an electronic toll collection system with Multilane Free Flow capability

- GNSS based systems (supported by GPS / WAAS / EGNOS, Galileo)
- GSM based systems (positioning services)
- Infrastructure based systems (Microwave DSRC 5.8 GHz, TC278 compliant)
- Optical based systems (OCR recognition)

Nevertheless, for a nationwide system as required in Netherlands a GNSS based system is the only feasible solution since Road Side Infrastructure based systems require a too high investment and GSM based systems have insufficient accuracy to successfully meet the system requirements. In addition a GNSS based system meets the requirements of the European directive 2004/52/EC.

13.8 Requirement [8]

All road users shall be charged for road use.

Rationale

Road users are defined as drivers of motor vehicles with number plates, comprising motorcycles, cars, trucks and buses.

Question

Organisations are requested to present their views upon the relationship between charging of all road users and the associated costs.

Organisations are encouraged to present alternative implementation scenarios for road user charging of all road users, e.g. first trucks and buses, followed by cars and motorcycles in a later stage with the possibility to make exceptions for special vehicles, and to specify the (financial) benefits of the alternatives.

Answer:

The charging of all vehicles implies that not only passenger cars, trucks, busses etc. will need to be charged, but in addition motorcycles and other vehicles where charging equipment is exposed to the environment. For those vehicles additional cost for the weatherproofing of OBUs will be incurred.

Charging occasional users i.e. antique cars, foreigners, etc. with an OBU may be cumbersome and costly. Therefore an electronic vignette system (bookings for a number of days through the internet) may be more applicable.

A Big Bang introduction, due to the complexity and the size of the system and the significant amount of vehicles to be equipped, seems a risky undertaking. Therefore a phased introduction would be a sensible approach.

Phased approaches to introduction of the scheme are possible in many ways, like e.g. starting with HGV and migrating to passenger cars, start region wise, start with new cars only, start voluntarily, start with lease cars, etc. However, all of these scenarios have their own implications as described in chapter 11.

One of the most critical issues in the introduction of a road tolling scheme is the roll out of equipment that belongs to the end-users. If there is too little awareness with the public or any resistance against such a scheme then the distribution and coverage with OBUs will get difficult. A clear and pro-active marketing and PR approach from all interested parties (authority and contractor) is absolutely necessary to avoid unmanageable peaks.

13.9 Requirement [9]

The road pricing system shall include possibilities/facilities to charge occasional road users.

Rationale

All distance travelled shall be charged, therefore additional facilities are needed for charging of occasional road users, not equipped with a compliant On Board Unit.

- Vienna convention: Non-equipped users must be admitted to the network.
- EU-legislation: equal treatment of all users (equipped end non-equipped) and no trade barriers.

Question

Organisations are requested to present their views upon their solutions for charging occasional users and the associated costs.

Organisations are encouraged to present alternative implementation scenarios for charging occasional users to specify the (financial) benefits of the alternative.

Answer:
From the cost and risk perspective a scheme works most efficient the more automatic processes can be performed. Most domestic and frequent foreign users should therefore be subject to automatic processing and have installed On Board Equipment (OBE).
For occasional users (foreign and domestic) alternative schemes should be made available:
Less frequent users should be offered the possibility of a Low Use On Board Unit (LOBU). The acquisition of an LOBU for this group should be made possible through a number of channels e.g. at border crossings, gas stations or sister organisation of the ANWB. In order to limit the excessive usage of LOBUs, the acquisition of an LOBU should require a deposit, a handling fee and a valid payment means for the charges due.
For very infrequent users a LOBU solution will not be cost effective and convenient. The alternative of a booking scheme based on specific roads and time of day is barely understandable for the road user and barely manageable since road users cannot always predict their road usage. Very infrequent users should therefore be offered the facility of an electronic vignette with a flat rate per day or multiples thereof.
Frequent foreign users that repeatedly apply for a vignette could be forced to acquire an OBE (controlled through the LPN).

13.10 Requirement [10]

The road pricing system shall include possibilities/facilities to charge road users with foreign number plates.

Rationale
Road users with foreign number plates include occasional road users (e.g. holidaymakers) and frequent foreign road users (e.g. business travellers). Road user charging in relation to the Eurovignet regulations for trucks will be taken into account.

Question
Organisations are requested to present their views upon their solutions for charging road users with foreign number plates and the associated costs.
Organisations are encouraged to present alternative implementation scenarios for charging road users with foreign number plates and to specify the (financial) benefits of the alternatives.

Answer:
It is intended to handle foreign road users within the Occasional User Scheme. Foreign users can either use the vignette system, use the LOBU scheme or enrol in the main scheme subject to the kilometres driven in Netherlands. At all times, when registering for the system, foreign users will have to submit their license plate number, their classification within the system and a valid payment means (e.g. credit card, fuel card or pre pay).
Please see also the related information within discussion of

- Requirement [4] (classes for foreign vehicles) and
- Requirement [9] (Access possibilities for the Occasional User Scheme)

In the future the interoperability activities forced by the European Union may require the provisioning of the “European Electronic Tolling Service” (EETS) compliant OBE.
As soon as there is a standard in place, operators of tolling scheme within the EC may require the provisioning or acceptance of an automated tolling procedure with On Board Equipment within the vehicle.
A solution that is prepared for above interoperability requirements ensures minimum risk when it gets migrated / extended to provide EETS.

13.11 Requirement [11]

The road pricing system shall comply with the European directive on the interoperability of electronic road toll systems (EU-directive 2004/52/EC)

Rationale
The European directive stipulates, amongst others, the technological solutions for carrying out electronic toll collections. One or more of the following technologies shall be used:

- satellite positioning
- mobile communications using the GSM/GPRS standard (GSM TS 03.60/23.060)
- 5,8 GHz microwave technology

Question
Organisations are requested to demonstrate that their proposed solution(s) comply with the European directive and to indicate the associated costs.
Organisations are encouraged to present theirs views upon the requirements as stipulated in the abovementioned European Directive.

Answer:
The proposed Siemens GNSS solution complies with the European directive 2004/52/EC.
Siemens core competence for electronic tolling is related to GNSS/CN solutions and therefore complies with the EU-directive 2004/52/EC.
It has to be recognised that the Directive and related documents (addendum) are living documents and might get changed in the future. Currently the directive requires technologies for tolling applications, but a similar regulative for enforcement does not exist at the moment. To be able to provide interoperable systems and services it is expected to get some directives in this direction - influencing local solutions - as well.

13.12 Requirement [12]

The road pricing system shall be sufficiently reliable to ensure correct and adequate road user charging.
Rationale
Correct and adequate functioning of the system increases user-friendliness of the system and improves user-acceptance. The reliability requirements are as follows:

- correct charging (within 1% accurate): >99% of all invoices
- over charging: < 0.1% of all invoices
- Mean Time Between Failure of the On Board Unit: 25 years

Question
Organisations are requested to present their views upon the reliability of their solutions and the associated costs.
Organisations are encouraged to present alternative reliability scenarios for their solutions and to specify the (financial) benefits of the alternatives.

Answer:
In principle Siemens understands the requested figures about correct charging and overcharging but the approach should be open for discussion. In addition it should be discussed how the reference is measured / how SLAs are proven.
However, these figures have to be broken down into the chain of system elements (availability criteria have also an influence on correctness of charge) and are influenced by:

- Accuracy of distance determination

The physical limitations of distance determination have to be taken into account. Sensor information provided by the vehicle might be influenced by tyre pressure, tread of wheels and sensor signal tolerance. The accuracy of the positioning of the OBU thus needs to be seen within the constraints of automotive applications. The tachograph has an inaccuracy of 3 – 5% whereas typical car odometers

have an inaccuracy of 2 - 3% . Within this environment the GNSS positioning algorithm performs better (1 - 2%) than the reference data that are at the disposal of the road user.
A serious threat in user acceptance arises when applying a more accurate mechanism like GNSS: the road user rather believes his (inaccurate) odometer if it displays less than the GNSS data. User dissatisfaction could be avoided by applying the Onroerende Zaak Belasting (OZB) mechanism: the number of kilometres driven as registered by the system is purposely kept low, whereas this is compensated for by a slightly increased tariff. This results in equal tax income for the Authority, but gives the road user the impression that he has a small advantage due to the fact that the system has registered fewer kilometres than indicated on his odometer.
In summary an accuracy of 1-2% thus exceeds the accuracy of the indicators the road user has learned to trust. In addition the GNSS-measured distance may seem to deviate from reality in short distances but is very accurate when integrated over more trips or a longer period. Therefore the requirement should not concentrate on an inaccuracy in the invoice per month (or even worse on wrong data per trip) but on the accuracy of the measurements over longer periods like the total distance driven over a year. Even then the user acceptance needs to be kept in mind and deviations that will occur between the relatively inaccurate odometer and the GNSS data need to be dealt with such that the usage data never exceeds the odometer data or else an overloaded call centre may be the result.

- Accuracy of tariffing (including accuracy of time, location and errors in the database)

Time information influences the tariff - the time information used needs to be synchronised within the whole system. However, it is planned to use the corrected GNSS based clock as the timing reference for the whole system which should preclude any inaccuracies due to timing errors.
The accuracy of location determination also influences the correctness of the charging in those systems where there is a location dependent charge level. Incorrect charges can occur when the system erroneously determines the vehicle position on a less or more expensive road (parallel roads) or when the rate of a section changes while the vehicle is within a section. In a thin client system the former cause is easily corrected since more powerful algorithms are available, history is available making plausibility assessments possible and data from other vehicles can be used as a comparison. For the latter cause procedures need to be implemented defining an appropriate allocation of the charges due.
The tariff table sets the pricing levels for different vehicle categories. Therefore the correctness of data within the vehicle classification information data base has a certain influence on the correctness of tariffing. However, the correct classification within the database is the responsibility of the vehicle owner.

- Accuracy of billing

Charging data are allocated to accounts. Errors within account data can lead to false charging of users. The probability of an incorrect charge when account data is correct is very low. Only when account data has been incorrectly submitted by the user errors are probable and certainly will occur at start of the system. These errors have to be treated as exceptions.
In addition the system has to cope with availability and reliability requirements:

a) The system needs to be designed to handle downtimes of components within the data processing chain without loss of data.

b) Loss of data might occur when, for example:

   - OBUs get destroyed
   - manual interactions during a recovery process in the Back Office.

c) Back Office can be designed based on redundant systems (Cluster / Hot standby / Cold standby) which cause - depending on type - different correction times on failure scenarios but also different cost for deployment and maintenance. Nevertheless any data should be replicated to at leased two different locations for business continuity in case of a disaster.

It is assumed that failures due to exceptions (e.g. data base mistake) will be treated different than principle false charging.

13.13 Requirement [13]

The road pricing system shall be sufficiently reliable to ensure correct and adequate road user charging. In particular:

- the road pricing service organisation shall be adequately protected against loss of income due to system failure

Rationale
Correct and adequate functioning of the system ensures that revenues are secured. The reliability requirements are therefore high:

- System availability: >99%
- Service window: 7x24h

These reliability requirements shall result in securing at least 99% of all possible revenues.
Question
Organisations are requested to present their views upon the reliability of their solutions and the associated costs.
Organisations are encouraged to present alternative reliability scenarios, e.g. with different service windows, for their solutions and to specify the (financial) benefits of the alternatives.

Answer:
The above requirement would seem a natural and obtainable target. The availability figure does not apply to each and any o the components but to the overall system and implemented measures that prevent loss of data and provide continuity of operation. Special measures to be taken in order to obtain the required performance are described below:
All interfaces will have to exhibit error recovery, storage facilities and data recovery mechanisms. This is valid for the OBU and its communication with the Electronic Tolling Back Office (ETBO), but also for the ETBO and its communication with the Central System. In addition the Central System should be designed as a double system with full data redundancy. In addition, dependent on the design of the ETBO, specific parts like e.g. the data storage need to be redundant. This of course adds to the implementation cost of the system; however these additional costs are usually compensated for by the prevention of the loss of income.
The design in general enables a cost effective solution if the provider has the flexibility to define the strategy for deployment and redundancy.

13.14 Requirement [14]

The road pricing system shall adequately protect its users against discomfort.
Rationale
A reliable system will enhance user-acceptance of the system and reduce operational costs. The reliability requirement in relationship to the discomfort of users is defined as follows:

- A justified claim by a single user, with respect to experienced discomfort, such as a required visit to a workshop or service call due to mal-functioning, shall (on average) occur no more than once every 10 years.

Question
Organisations are requested to present their views upon the reliability of their solutions and the associated costs.
Organisations are encouraged to present alternative reliability scenarios for their solutions and to specify the (financial) benefits of the alternatives.

Answer:

User Acceptance
An instrument to gain user acceptance is the provisioning of different information channels with optimized content. Information channels can be for example:

- Point of Sales / Contact points
- Internet
- Call Centre

The facilities in place shall guide the user according to his interests and provide sufficient information within an acceptable time to avoid discomfort.
If the user gets notified about any kind of incident (e.g. Penalty Charge Notice, device failure…) he shall have the possibility to use one of the different channels to clarify the situation. This can be supported by a personal account and user specific information.
Further more the user has the possibility to change the channel within a running process. This means for example he can switch from the internet to the call centre and already provided data will not be lost and immediately available for the processing call centre agent.

Solid design of the solution with easy to use On Board Equipment
The complexity of On Board Equipment shall be kept as slim as possible in order to avoid unexpected or false handling which could lead to malfunctions or situations that are interpreted as malfunctions.
Information provided to the user shall be clear and concise (e.g. constitution of bills) to avoid misinterpretation.

User's discomfort
User's discomfort can be caused to a number of reasons:

- Faulty OBU
- Incorrect invoice
- Incorrect enforcement

For each of these cases measures will have to be taken to prevent said user discomfort.
The reliability of the OBU needs to be sufficiently high so that there is no general dissatisfaction with users about reliability of the OBU (MTBF of 25: it means that a unit will fail only once in 25 years). It is important to decide whether equipment located in vehicles shall have a similar lifetime as the vehicles (the OBE remains within the vehicle equivalent to the number plate) or whether commercial equipment should be used. There is a significant difference in cost but probably also a difference in reliability.
An incorrect invoice could be generated for different reasons. Inaccurate data from the OBU, incorrect application of rate tables, data of wrong users is applied. For each of these error sources verification algorithms need and can be designed and implemented.
Incorrect enforcement can again be due to a number of reasons: incorrect processing of data resulting in wrong vehicle owner or usage data or false license plates. The former should be solved by stringent verification processes before issuing citations. The latter is not easily solved and in first instance the real owner of the license plate will receive a citation when his, by a third person, falsified license plate is registered. However, in due time through the system persons purposely utilizing falsified license plates can more easily be caught.

13.15 Requirement [15]

The actual costs for driving (road charge) shall be visible in the vehicle.
Rationale
A visible feedback of the actual charging tariff to the user will enhance awareness and user-acceptance of the system.
Question

Organisations are requested to present their views upon solutions for displaying the actual costs for driving in the vehicle and the associated costs.
Organisations are encouraged to present alternative solutions for offering charging information to road users and to specify the (financial) benefits of the alternatives.

Answer:
There are a number of pro's and con's to displaying tariff information in the vehicle. It increases the cost and complexity of the OBU, it reduces the flexibility of the systems for changes and in a thin client system it increases the complexity of the communication. Moreover the display of usage data in the vehicle might have an impact on road safety.
On the other hand it can be understood that there is a need to feed the actual usage data back to the customer or the road user. Without this feedback the intended effect on road users stimulating a reduced road usage might be reduced significantly. Thus it is our opinion that displaying tariff information in the vehicle within the constraints given by the programme should be encouraged.
Giving the complexity of the matter the following issues need further discussion:

- A display increases the cost of OBUs
- Information for the driver always gives an indication about accumulated costs and the current tariff and not about possible routes and associated costs
- It is intended to have minimum complexity in terms of the man machine interface (MMI) (display may decrease road safety)
- Information on the display must be clear and concise. Misinterpretation can cause (disproportionate) more incidents at Call Centre / Customer Helpdesk especially on charge issues.

13.16 Requirement [16]

The road pricing system shall be sufficiently safe and easy to use (human machine interaction) to avoid dangerous behaviour and social exclusion.
Rationale
The road pricing system should, amongst others, not decrease road safety. Therefore, the use of the system should not require or lead to dangerous behaviour of users. Social exclusion is, in this context, defined as a process that causes individuals or groups, e.g. elderly drivers or disabled drivers, not being able to participate in the road pricing system.
Question
Organisations are requested to present their views upon the safety and ease of use of their solutions and the associated costs.
Organisations are encouraged to present alternative scenarios with respect to safety and ease of use of for their solutions and to specify the risks and (financial) benefits of the alternatives.

Answer:

a) Equipment needs to be certified according to European standards (harmonisation in progress) in order to fulfil the health and safety requirements.

This includes also the position within the vehicle where the On Board Equipment is mounted. The visibility for the driver must not be influenced - therefore the form factor of the device should be as small as possible.

b) The man machine interface (MMI) should be as simple as possible (no interactions required from the driver) which increases the safety and avoids social exclusion as well.

Siemens experience is that a device / OBU have to be as simple as possible. This is valid in terms of functionality but also in terms of complexity of MMI. The "optimal device" would be a box where the

MMI is reduced to the minimal indicators with if necessary a facility to select some dynamic category (e.g. trailer attached) if the tariff scheme requires such a differentiation.
Ease of use of the system is also determined by the transparency of the rate system. This requires, certainly at the beginning, a very clear and concise rating system. Once the users have acquired an understanding of the system rating schemes with a higher complexity may be introduced. This in analogy with the introduction of mobile phone schemes where initially there was only one simple rating scheme and where customers now can choose from a multitude of complex rating schemes.

13.17 Requirement [17]

The costs for development and initial implementation of the road pricing system shall not exceed € 2,200 million

Rationale

The cost for development and initial implementation of 'variant 5' are estimated between € 2,200 million and € 4,100 million (estimate in 2005). The 'Nota Mobiliteit' states that these development costs should be significantly reduced.

Question

Organisations are requested to present their view upon the development costs of the total system.
Organisations are encouraged to present alternative solutions to reduce the development costs and to specify the alternatives both technically and financially.

Answer

The cost analysis of the scheme is done within chapter 7.

13.18 Requirement [18]

The annual costs for operation and enforcement of the road pricing system shall not exceed 5% of the system revenue

Rationale

The Dutch Parliament has required an efficient system with low operational costs. The target is that the costs for operation and enforcement shall not exceed 5% of the total revenue. The total revenue of the system is limited to the total sum of fixed taxes for vehicles. These taxes include ' Belasting van personenauto's en motorrijwielen' (BPM) and 'Motorrijtuigenbelasting' (MRB). This total revenue will range from 3,000M€ to 7,000M€ per year, depending on the amount of reduction of fixed taxes.

Question

Organisations are requested to present an overview of the annual costs of the system, as defined in the requirement specification.
Organisations are encouraged to present alternative cost scenarios for their solutions and to specify the alternatives both technically and financially. Implementation

Answer

The cost analysis of the scheme is done within chapter 7.
In general terms this number seems to be quite low. Compared to existing schemes in Austria, Suisse and Germany the range of relation between revenue and operational cost is between 12% and 25% - bearing in mind that these values are valid for schemes with much smaller size. The larger size of the Dutch scheme, however, allows for more efficient operations.

13.19 Requirement [19]

System developments for acceleration scenarios shall be able to migrate into the general road pricing system.

Rationale

The 'Nota Mobiliteit' describes implementations of local road pricing systems ('local toll') to finance improvements in the road infrastructure. These implementations, acceleration scenarios, will migrate into the national road pricing system.

Question
Organisations are requested to present their solutions for acceleration scenarios, the migration strategy for acceleration scenarios and the associated costs.
Organisations are encouraged to present alternative implementation scenarios, including acceleration scenarios, for their solutions and to specify the alternatives both technically and financially.

Answer:
The future Kilometerprijs system needs to be compliant or downwards compatible with then existing "versnellingsprijs" schemes. If these Versnellingsprijs schemes are realised as pilots for the main programme that of course becomes a very easy task. However if earlier schemes cannot be based upon GNSS technology to be used later in the Kilometerprijs schemes some care will have to be taken. In that case these schemes could be based on either video tolling or DSRC. The investments for these systems will only be partly lost once the introduction of Kilometerprijs commences since these systems can be reused or can also function as enforcement system. Kilometerprijs systems or OBUs installed in vehicles can be programmed to also charge the correct "Versnellingsprijs".
The design of systems provided by Siemens enables the possibility to integrate different schemes already in operation and/ or different types of technology by adding appropriate interfaces to the Electronic Tolling Back Office (ETBO) and the Central System (CS). That is also valid for future foreign schemes requiring interoperability with the Kilometerprijs system.

13.20 Requirement [20]

The road pricing system shall be designed, developed and built in such way that different implementation scenarios can be supported.
Rationale
Due to foreseen developments, it is essential that the road pricing system can be implemented taking into account the different competences and responsibilities of the administration in the Netherlands. Furthermore, different implementation scenarios may be used to enhance user acceptance of the system.
Question
Organisations are encouraged to present their views on implementation strategies (e.g. phases for implementation: certain users, certain regions, certain roads) and the related risks and costs.

Answer:
The back office and enforcement systems need to be designed in such a way that every implementation scenario can be supported.
A discussion about different implementation scenarios and the influences on cost versus risk can be found within chapter 11.

13.21 Requirement [21]

The road pricing system shall be designed, developed and built in such way that future developments can be incorporated.
Rationale
Due to foreseen developments, it is essential that the road pricing system is sufficiently 'future-proof'.
Question
Organisations are encouraged to present their views on possible future developments and how the design of their (parts of) the systems is/will be prepared for such developments.

Answer:
Future developments are defined by development of new technology, changes in the road infrastructure or charging rate schedules and/or standardisation and compatibility with developments in other countries. It is therefore important in the decomposition of the system design to choose the functionality of the components such that maximum flexibility is obtained. Therefore the functionality

in the OBU should be limited as far as possible. The ETBO and Central System should be designed such that not only changes within the Kilometerprijs system can be handled flexibly, but also such that added functionality from e.g. foreign OBUs or completely new data collection solutions can be easily interfaced and implemented.
A close relation between Road User Charging Scheme operator and technology provider enables a smooth integration of future developments. Changes within the legal framework and improvements of processes or upgrades on functionality might require new releases or features within the running system. Especially the deployment of these new elements bears certain risk but it can be mitigated having a reliable, trusted and good working relationship between the involved parties.

13.22 Requirement [22]

The road pricing system shall have adequate capacity to charge the road use of 8,159,000 vehicles
Rationale
The number of 8,159,000 million vehicles is stated in the document 'Nationaal Platform Anders Betalen voor Mobiliteit', and used for the initial cost calculations of variant 5.
Question
Organisations are requested to present their solutions based upon the number of 8,159,000 vehicles.
Organisations are encouraged to present their solutions based upon 10, 15 and 20 million users and to specify the costs in relation to these numbers.

Answer
The major parameters determining the complexity and cost of the back office systems are the number of users (contracts) and the number of transactions per day. In addition the number of operator employees having full access to the system determines the height of the license fee. Dependent upon the solution chosen the Kilometerprijs system will exhibit six to eight million users (contracts) and between 50 and 500 million transactions per day. In general it can be stated that doubling the capacity of the central system will lead to a multiplication of cost by approximately one and a half.
Back Office solutions handling the resulting transaction load are less complicated than Systems required today by telecom operators (especially mobile telco's). In addition there are criteria's for partitioning the system in a way which enable a very good scalability.
The design of the system and the Software Architecture can already be selected (without additional costs in the first phase) to handle the increasing number of users (up to several times more than at the beginning).
Charging 8 Million users is not only limited to the capacity of Back Office transaction processing power. Users participating in the scheme need to be enabled, supported and equipped.
The positive perception (by users) of a scheme is coupled to a number of factors for example:

- Understanding of
  - the reasons for implementation
  - the scope of the scheme
- Hassle free access - no waiting time at contact channels
- Transparency and clarity of information

All business procedures influenced by the large number of users have a certain visibility and therefore contribute to the global acceptance of the scheme. The exact behaviour of each user can't be predefined. A number of assumptions need to be in place for dimensioning the system. After the first operational years these assumptions might get approved - or tuned in order to improve the system.
In the common interest governmental organisations as well as the private sector have to do some joint preparation work in order to lead the implementation / migration of such a scheme to an overall success.

Positive perception enables a smooth, well controlled roll out - and this is necessary to distribute the load of the different contact channels (like Call Centre Contacts, Point of Sale visits, Installation Centre visits…) over a defined period.

13.23 Requirement [23]

The road pricing system shall have adequate security measures to:

- Prevent fraudulent use of the system
- Detect fraudulent use of the system
- Recover from fraudulent use of the system

Rationale
A high level of security of the system is required to ensure the correct functionality of the system. Protection against evasion of payment is foreseen as an important security measure. It shall not be possible to avoid payment in at least 99% of all transactions.
Question
Organisations are requested to present their views upon the security aspects of the system and the associated costs.
Organisations are requested to present their views upon the implementation of security measures to avoid evasion of payment and the associated costs.
Organisations are encouraged to present alternative security scenarios and to specify the alternatives both technically and financially, also taking into account the support for the system by the citizens

Answer:
The first step to handle system security is the threat analysis. It covers the whole range - from fraud activities driven by a single user to attacks on the Back Office. Based on this investigation a security concept is designed.
Data handling systems are designed such that data protection and data integrity are implemented throughout the system. This means that appropriate encryption and authentication mechanisms are used on all internal and external subsystems. In addition logging of usage changes by employees and audits should be implemented. The prevention of fraud, other than internal fraud prevented by the common in house security measures should concentrate on user behaviour In which three layers of prevention can be distinguished:

1. Detection of attempts with the OBU or its functions. Attempts to open the OBU and tamper with its contents or attempts to disrupt the GNSS reception or GPRS communication will be detected and reported at the first possibility to the back office

2. Data content in the ETBO and the Central System will continuously be analysed for discontinuities and irregularities indicating possible abuse of the system.

3. Enforcement systems will continuously and partly at random collect images of passing vehicles and verify proper settlement of charges due of the imaged vehicles

The design of a system proposed by Siemens considers the abovementioned requirements. In order to fulfil these security measures several solutions - but also procedures are in place.
It is absolutely required that sufficient convincing and reliable information (trip data) is present that unjustified claims against invoices do not lead to a success for the user. Nevertheless, data privacy has to be considered during the design of the system but this should not lead to any substantial methodology that enables users to avoid payment.

13.24 Requirement [24]

The road pricing system shall comply with national and international privacy regulations (Wet Bescherming Persoonsgegevens (WBP) and EU-directive 95/46/EC)

Rationale
The privacy of the road users must be adequately protected by the system. All (parts of) the system shall comply with privacy regulations. Starting point for the cost calculation of variant 5 is the requirement that data describing road use and behaviour of individuals should be communicated as little as possible. Therefore, variant 5 is based upon an OBU with adequate on-board data processing and security capabilities.

Question
Organisations are requested to demonstrate that their proposed solution(s) comply with national and international privacy regulations and the associated costs for this compliance.
Organisations are encouraged to present alternative solutions to meet the abovementioned requirement and to specify the alternatives both technically and financially

Answer
In order to protect the privacy of the users the following principles shall be applied to data pertaining specifically to the behaviour of individual users:

- Collect only that information that is required to calculate the trip data.
- Information shall not be stored longer than necessary.
- Collected information shall not be used for any other purpose than what it is collected for.
- Road users shall be informed about what information is stored and what it is used for.
- Road users shall have insight in their stored data.

The thin client solution is built around trip data processing in a centralised system. Such a solution requires special measures to guarantee the privacy of the user. The ETBO is a dedicated entity that collects all trip data from the road users and transforms this to Charge Coded Data to be sent to he Central System. The resulting Charge Coded Data does not contain any information about the actual position or date/time of the vehicle, but only provides information about road types driven and time zones used.
The ETBO will be separated from the other subsystems and its operation will be under control of a Trusted Third Party (TTP). Such TTP will provide the necessary rules about access to the data and will assess all data handling interfacing with the ETBO in order to protect the privacy of the users.
Road trip data that has been made anonymous may be used for purposes like Traffic Information and detection of weak spots in the GNSS network.

14. APPENDIX - PARAMETERS

Basic Parameters / assumptions					
	Total	**PoS**	**Internet**	**CC**	**IC**
Consultations		**2.745.100**	**7.353.633**	**3.647.367**	**8.920.000**
Vignette	1.517.000	455.100	910.200	151.700	
LOBU					
LOBU hand out	150.000	100.000	35.000	15.000	
LOBU top up account / annual	300.000	90.000	180.000	30.000	
(2*pro LOBU before refurbishment)					
LOBU return	150.000	100.000	35.000	15.000	
OBU					
Number of users (initial)	8.000.000				
# of new vehicles p.a.	600.000				
percentage of fault equipment	4%				
annual number of new installations	920.000				
Contracts					
Contract initiation					
change of contract details					
termination of contract					
initial	8.000.000				8.000.000
steday state	4.040.000	2.000.000	560.000	560.000	920.000
Bills	96.000.000				
electronic	67.200.000				
paper	28.800.000				
Bill related claims	2.880.000				
percentage of claims related to bills	3%				
# of claims	2.880.000				
clarification via internet	70%				
clarification via CC	30%				
# of clarific. Internet	2.016.000		2.016.000		
# of initial clarific. CC	864.000			864.000	
percentage of additional clarific. CC (problem not solved via Internet)	25%				
# of additional clarific. CC (problem not solved via Internet)	504.000			504.000	
generic calls (5% of all users)	483.350				
via internet	50%				
via CC	50%				
# of Internet access	241.675		241.675		
# of CC access	241.675			241.675	
percentage of additional generic calls CC (problem not solved via Internet)	15%				
# of additional clarific. CC (problem not solved via Internet)	36.251			36.251	
Payment					
annual number of payment transactions (non pre pay)	96.000.000				
percentage follow up due to non-payers	2,00%				
percentage follow up due to overpayment / underpayment (especially bank transfer)	0,50%				
# of follow ups p.a.	2.400.000				
Enforcement					
total distance travlled (km)	100.000.000.000				
percentage on Motorways:	50%				

Gantry spacing (km)	31				
Passage of gantries	1.621.212.121				
Passage of Transportable enforcement	66.666.667				
Potential violators:	2%				
violations detected	33.757.576				
Average distance per trip (km)	50				
passage of gantires per vehicles	1				
akkumulation of incidences: # of days acc.	7				
# of PCN per annum	4.822.511				
percentage of internet - user account verification	70%				
percentage of calls related to PCN	15%				
# of internet consultations related to PCN	3.375.758		3.375.758		
# of calls related to PCN	723.377			723.377	
percentage of additional consultations CC (problem not solved via Internet)	15%				
# of additional consultations CC (problem not solved via Internet)	506.364			506.364	

Service Institutions					
Number of Point of sale	250				
trained staff for this service (total)	750				
Number of Installation Centres	4000				
trained staff for this service (total)	8000				
Number of Contact Points	600				
trained staff for this service (total)	1200				

Enforcement calculation	
Road network	
Length of road network (km):	134.000
Length of Motorway network (km):	3.300
Average annual distance driven by car (km)	15.000
Number of MW segments	642
Avrage segment length on MW (km)	5,14
User beaviour	
Number of users in total	8.000.000
percentage driven on MW	50%
days of operation p.a.	300
percentage of users per day	82%
daily km driven on MW:	25
percentage of users driving between 08:00 an 18:00	70%
Number of different users per day	4.602.740
Stationary Enforcement (bidirectional coverage)	
stationary enforcement spacing (segments per # of station):	6
number of stationary enforcement:	107
Transportable Enforcement	
average spacing of TE on non-MW network (km)	750
Number of TE units	179
Transportable enforcement remains at location for X days	6,50
Time to move and set up transportable enforcement (days)	0,50
Movements of TE p.a.	52
Movements in total	9.316
1 team can do # of movements per annum	440
Teams required to do movement	21
employees per team	2
Vehicles required to do movement (7 days / week)	13
spare cars for TE movement	1
Mobile Enforcement	
Sampling rate:	0,10%
Number of sampels per day / 08:00 - 18:00	4.603
Samples per enforcement-car (08:00-18:00)	400
Number of cars reqiured (08:00 - 18:00)	12
# of shifts 08:00-18:00	1,25
day-shifts required p.a.	5.475
Number of sampels per day / 18:00 - 08:00	1.973
Samples per enforcement-car (18:00-08:00)	240
Number of cars reqiured (18:00 - 08:00)	8
# of shifts 18:00-08:00	1,75
night-shifts required p.a.	5.110
shifpts P.a. per person	220
Staff required for day operation	50
staff required for night operation	46
staff required in total for mobile enforcement	96
vehicles required for mobile enforcement	12
spare cars for mobile enforcement	1
Cars required in total:	**27**
Staff required in total (for field operation)	**139**
Enforcement post processing non recognised LPN	
estimated number of pictures p.a.	1.687.878.788
ANPR / classification success rate with low reliability (including wildcard)	99,5%
Annual # of pictures to check manually	8.439.394
Sample rate of pictures checked manually	10%
Minutes per picture for manuell check	0,25

Personnel staff				
General	**FTE**	**Calc.**	**Education**	**Comment**
shifts p.a. per person		220		
Call Centre				
Number of calls p.a.		3.647.367		
Duration of call (min)		4		
Total minutes of calls		14.589.466		
Calls per person per shift		360		
Efficiency factor for employee (peak / off peak ratio)		80%		
Call Centre Personnel	***230***		1	
Enforcement				
Field Staff	***139***		1	
Post Processing	***13***		1	
"Sanktionierungsbeamte"				
PCN p.a.		4.822.511		
expected percentage of claims		2%		
annual number of claims to handle		96.450		
Number of claims handled per shift		48		
Personnel required:	***9***		2	
Personnel for post processing of registration data				
Initial phase				
Initial Registrations+(Steady State/2)		10.020.000		
percentage of errors		2%		
annual number of errors to handle		200.400		
Number of errors handled per shift		48		
Personnel required:		19	1	Difference Initial Phase and Steady State not considered at this stage
Steady State				
Changes of Reg/ a		4.040.000		
percentage of errors		2%		
annual number of errors to handle		80.800		
Number of errors handled per shift		48		
Personnel required:	***8***		1	
Tariff structure: Maintain tariff beaviour analysis				
Staff required	***12***		2	Statistics according to traffic Design of new tariff scheme Analysis for expected influence of tariff scheme due to: changes in traffic behaviour commercial influence environmental influence politics
Data mining ETBO exceptional situations				
Staff required	***7***		2	Statistics for OBU beaviour (e.g. loss of signal / GSM / GPS) OBU Status analysis (e.g. in order to detect fraud) and following procedures Provisioning of Evidential Records (preparation for court-procedure)
Billing: maunual handling of claims				
annual number of claims		2.880.000		
expected percentage of claims for further processing		5%		
annual number of claims to handle		144.000		
Number of claims handled per shift		48		
Personnel required:	***14***		2	
Payment: handling of follow ups				
annual number of follow ups to handle		2.400.000		
Number of follow ups handled per shift		96		
Personnel required:	***114***		2	
Partner Managment				
Bill reconciliation				invoice verification from contractual partners
Staff required	***8***		2	
Contract Management				
Staff required	***4***		2	
Content Management				
Staff required	***3***		2	
Procurement				
Staff for tolling equipment related procurement	***10***		2	

Staff for other equipment related procurement	*4*		2	
Training				
Annual fluctuation of CC staff		50%		
Annual fluctuation of Enforcement Employee (field staff)		20%		
Annual fluctuation of Enforcement Employee (Back Office staff)		30%		
Annual fluctuation trained personnel Installation Centres		15%		
Annual fluctuation trained personnel PoS / IC		15%		
Personnel to train p.a.				
Call Centre		115		
Enforcement field staff		28		
Enforcement Back Office staff		4		
Installation Centre		1200		
PoS / Contact Point		293		
training cycles p.a.				
CC		25	5	persons to train per cylce
Enforcement		12	3	persons to train per cylce
Installation Centre / PoS / CP		110	14	persons to train per cylce (sessions on central points)
CC and Enforcement training team	*4*		2	
Installation Centre / PoS / CP training team	*6*		2	
Management overhead as a percentage of employees (Education 1)	*27*	7%	2	
Management overhead as a percentage of employees (Education 2)	*11*	5%	3	Minimum 7... See doc. D3 - Organisational Structure
Top level management	*6*		4	
Staff required for the following functions are calculated as a percentage of employees				
HR				
Finance				
Payroll				
Security				
Quality				
Legal				
IT helpdesk and maintenance				