# KMP in The Netherlands

Report of T-Systems Satellic
as contribution to the Market Consultation (Phase 2)
for the “Ministerie van Verkeer en Waterstaat”


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# Introduction

T-Systems Nederland b.v. was invited by the Ministerie van Verkeer en Waterstaat of The Netherlands to participate in Phase 2 of the KMP Market Consultation and jointly conducted a study with T-Systems Satellic. With this report we submit the findings of this study.

The report covers the topics requested in the structure given in the documents "Scope Description Phase 2 Assignment: "Anders betalen voor Mobiliteit", the "Statement of work subject 1", the "Cost Format Phase 2 V 1.0" and the "Format for Reporting Risk Inventory & Assessment, Consultation Phase 2". It is also based on the results of the three Interactive Meetings held in June and August 2006 and further background documents made available through the internet page "www.vananaarbeter.nl".

The reference baseline for all our suggestions in this dialogue with the Dutch Authorities is Variant 5 of the report "Anders betalen voor Mobiliteit", which has broad political and public support.

**Chapter 1** is a management summary containing an overview of the entire report.

In **Chapter 2** we describe the basic system characteristics as well as the technical system components and the corresponding nomenclature in a brief fashion so that the reader is enabled to understand the later, more detailed chapters of this report.

Building on the technical overview, **Chapter 3** "High Level System Design" gives the basic process view as well as an organizational reference for the toll operator.

**Chapter 4** summarizes the results of our cost modeling, focusing on the major cost drivers. Naturally at this early stage of the project the estimates must be based on numerous assumptions, which have to be verified as requirements mature and become more stable

The **Chapter 5** describes the migration scenarios. Based on the key criteria risk reduction, quick mobility wins, user acceptance and cost minimization as well as the technical necessities based on lessons-learnt in the road charging project in Germany. T-Systems Satellic proposes a phased implementation approach based on segmentation of vehicles to be equipped with OBU´s in a sequential manner.

The **Chapter 6** Risk inventory and assessment gives an overview of the supreme risks to be encountered in the procurement and operation of the KMP system from an overall system perspective.

**Chapter 7** refers to comments offered by T-Systems Satellic in Market Consultation, Phase 1 concerning the "Draft Requirements Specifications" provided by the Principal.

The **Annexes** contain additional information, complementing the respective chapters.

**Liability Disclaimer**

The preparation of this report is based on information provided by the Ministerie van Verkeer en Waterstaat in the course of subjects 1 as defined in the work plan for the ABvM market consultation phase 2. This information is mainly given in the document "Cost Format phase2 v1.0.xls".

In preparing this report, T-Systems has endeavoured to offer current, correct and clearly expressed information. However, since the analysis is partly based on assumptions and estimates the information provided therein are neither exhaustive nor complete and do not constitute a comprehensive or complete statement of the issue discussed. No action should be taken or omitted to be taken in reliance upon information in this analysis. T-Systems shall not be responsible for any loss resulting from reliance on any information contained in this analysis. None of the above shall be taken to exclude liability for fraud or for negligence causing death or personal injury.

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# 1 Management Summary

The Netherlands have initiated a process to fundamentally change the way road users will be charged for mobility. As opposed to the conventional tax system, which is merely based on vehicle characteristics, a Kilometer Pricing (KMP) system will be introduced, which will calculate the charge based on the distance driven, time and place within The Netherlands. Road charging has become fairly common in Europe, however KMP is the first scheme to introduce distance, time and place-based pricing to all vehicle classes on all roads. Thus it could become a precedence and benchmark for other European countries, also planning innovative road charging schemes.

T-Systems Satellic has thoroughly studied The Netherlands requirements and conducted a fruitful exchange of views with numerous stakeholders in The Netherlands. We believe that the technology to implement the scheme envisioned, is available. Nevertheless, its introduction to the “mass consumer market” will hold significant challenges, which require careful planning of the scheme, its tariff structure and its implementation under continuous control and management of the risks involved. The cost monitor will be an important tool to support the realisation process.

The task to charge road use based on a diversified tariff structure covering all roads and, in its final stage, all vehicles, requires special organisational and technical solutions and migration concepts. For an automatic pricing system, which calculates the charge for each individual vehicle based on the distance driven, the time of the trip and the vehicles geographic position, only the GNSS/CN-based technology can do the job. Gantry systems require a prohibitively large number of DSRC beacons and can not be recommended.

The use of a GNSS/CN-based On-board Unit (OBU) in all vehicle classes though is not without challenges. The OBU must be connected to the vehicles power network, since their power consumption does not allow their operation on batteries over an extended period of time. For an OBU, which is easy to be installed, power connection can be accomplished via the electrical cigarette lighter.This might not be a satisfactory solution for all users. Therefore T-Systems Satellic proposes an OBU, which offers the possibility of a “plug-and-play” power connection as well as fixed installation for enduring operation use.

The utilisation of mobile communication technology in the vehicle requires further technical precautions: Because of its electro-magnetic emissions, the installation of the antenna in the vehicle’s cabin may not be possible, allowed or accepted by the driver. The OBU therefore will be designed to allow connection of an external antenna. This installation as well as the permanent power connection might have to be conducted by service personnel in a qualified garage. A network of qualified service partners (garages) will have to established also to provide necessary support in case of a malfunctioning OBU

Pricing of every km driven requires the OBU to be always functioning. A malfunctioning OBU must be replaced as rapidly as possible. A similar requirement exists for vehicles crossing the borders into The Netherlands and do not have an OBU. For both use cases a temporary OBU can be a solution. This concept is technically feasible but has inherent economical challenges: OBU´s must be provided on a just-in-time basis and rapidly installed in an operationally secure manner. To guarantee this will constitute a major effort in OBU logistics and be of significant impact on costs. These challenges can be overcome by complementing the automatic (OBU) system with a ticketing system, which allows KMP declarations for vehicles not equipped with an OBU or vehicles with an OBU temporarily out of order.

Our proposed enforcement concept is founded on stationary control points as well as mobile and portable enforcement units. The proposed ticketing system would also simplify the enforcement processes and reduce the transaction workload. In many cases users do not violate KMP obligations on purpose. For reducing the efforts for dealing with broken OBUs we propose to allow a grace period for ex-post declarations using the ticketing system before starting enforcement actions for registered OBU users. Exploitation of the grace period can be minimised by exclusion of repeating ex-post declarations and analysing the OBU status history.

The introduction of a KMP system to all vehicles on all roads in The Netherlands cannot be achieved in one “big bang” start of operation. User registration, production and distribution of the OBU´s in an economical way will require a time period of at least 2 years. Furthermore a KMP system as well as the operating structure of the complexity required in The Netherlands must be build in steps of increasing complexity to stabilise the system, increase capacities and adapt the business processes. We therefore propose a migration of the automatic system in an evolutionary approach in three phases of increasing OBU quantities. Our advice to segment OBU distribution by vehicle classes, starting with HGV and continuing with vans and passenger cars, is based on current European practice and compliant with EU recommendations. It can be implemented with acceptable organisational, technical and financial risk. If however the Principal will develop other segmentations, more appropriate from an organisational or political point of view, the proposed technical solution is flexible enough to accommodate such alternatives.

T-Systems Satellic does recognise the fact, that the controlling effects on traffic flows are limited to the vehicle classes equipped with OBU´s and thus the full benefit of KMP (gains in terms of mobility and environmental aspects) will not materialise before all vehicles are subject to distance-based pricing (time and place). To achieve early controlling effects on traffic flows on a broad vehicle basis, a vignette system can be introduced along with the first implementation phase of the automatic system. Users not yet supported by the automatic system would be obligated to buy a vignette. The price of such vignettes can be structured in a way to reduce congestions (e.g. peak and off-peak rates). The introduction of such a system would also contribute to better user acceptance of the initial phase. System introduction would be perceived as being fair, since all user groups would be affected. Vignettes can be sold via the ticketing system. Control of KMP-compliant payments can be made by licence plate number identification via the enforcement system.

T-Systems Satellic has conducted a thorough cost analysis for an overall KMP system based on the “Draft Requirements Specification” and the “Reference Architecture” given by the Principal. We have taken a macro-economic view, including all costs internal and external to a future KMP operator. Furthermore we have taken a conservative and prudent approach in interpreting the given requirements baseline. Our results indicate that the Principal’s initial cost target figures, might need to be reconsidered as requirements mature.

T-Systems Satellic stands ready to identify cost-driving requirements and discuss their effect on the overall costs with the Principal. We are also ready to analyse possible cost savings potentials and assist the Principal in the process of further developing the KMP requirements specifications.

## 2 Proposal of Basic System Characteristics

In this chapter the basic system characteristics as well as the technical system components and the corresponding nomenclature are introduced so that the reader is enabled to understand the later parts of this report.

### 2.1 System Overview

First we want to introduce the technical reference system layout as shown in Figure 2-1, which is divided in three major system segments (vertically) and roughly grouped in four process clusters (horizontally).

The subsystems are illustrated as white boxes. All interfaces between the subsystems are pictured as arrow lines. The highlighted red lines show the data flow of the charging data from the OBU up to the Billing and Invoicing. All user-interfaces are shown as dashed lines. The grey clouds illustrate the interfaces between the peripheral components and the subsystems of the central segment.

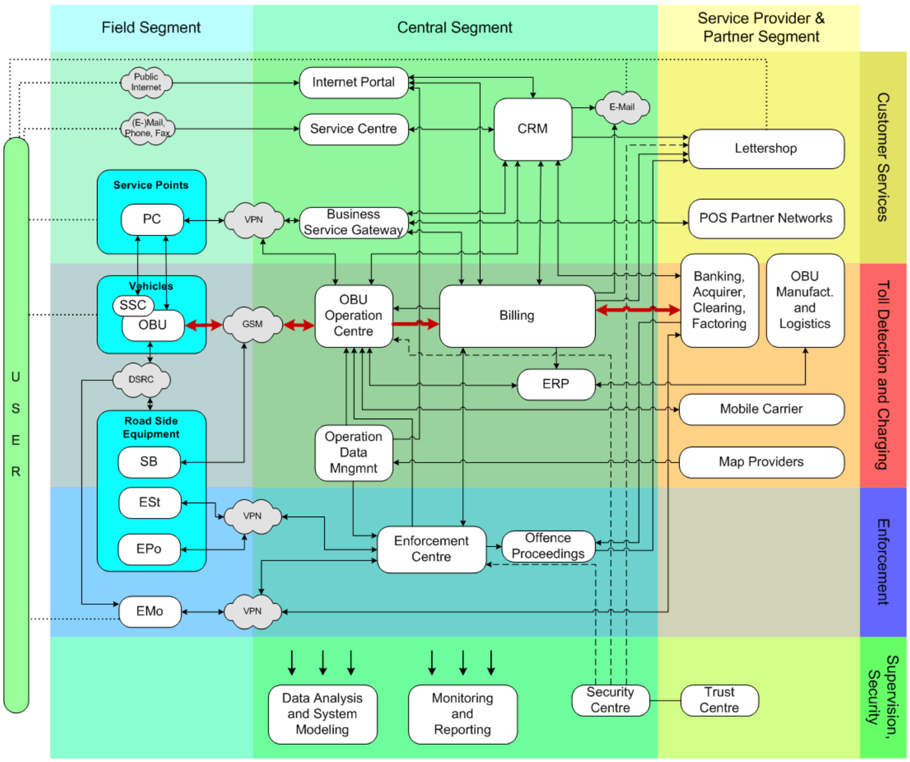


**Figure 2-1: Segment view of the toll system**

The three vertical segments are discussed in detail in the following chapters:

- Field Segment (see Chapter 2.1.1 and for enforcement 2.1.4)
- Central Segment (see Chapter 2.1.2 and for enforcement 2.1.4)
- Service Provider and Partner Segment (see Chapter 2.1.3)

Horizontal subsystems are associated with the following four process clusters. Please refer to Chapter 3 for a closer description of the processes.

- Customer Services
  These systems manage all customer related data and workflows.
- Toll Detection and Charging
  In this cluster all systems are grouped that fulfill the main system objective, i.e. determining and billing usage fees.
- Enforcement
  The Enforcement cluster comprises technical facilities, which enable the operator to check in real time whether a vehicle is compliant to the toll scheme. A closer description of the enforcement systems can be found in Chapter 2.1.4.
- Supervision and Security
  These systems are used to ensure and monitor the consistency and integrity of the whole tolling system and are also used to extract statistical data that is necessary for operational optimization.

In the following sections the subsystems are described in more detail.

### 2.1.1 Field Segment

Subsystems of the Field Segment are run outside a secure computing centre environment and therefore operate in a special routine. All field components are connected via secured and encrypted connections to the data centre. In particular the Field Segment comprises the On Board Unit (OBU) including the attached Trusted Element (TE) named Security and Storage Chip Card (SSC) plus the related service and support equipment used at service points, which will now be described briefly. For clarity the various enforcement facilities also located in the field segment will be described in Chapter 2.1.4, which is exclusively dedicated to the enforcement subsystem.

#### 2.1.1.1 Service Points

Service Points mainly serve as point of contact for road users that have to solve technical issues like support in installing OBUs or diagnosing malfunctioning OBUs. Service Partners have access to a web-based Service Point Portal and run a special service application to diagnose SSCs and OBUs. The equipment needed, besides a simply standard PC with Internet access, is two chip card readers, an interface cable to connect an OBU and a DSRC tester. Service Points are authorised to connect to the central services by receiving special service chip cards carrying a cryptographic key.

#### 2.1.1.2 Storage and Security Chip Card

The SSC is the Trusted Element (TE) of the OBU and contains secure and tamper-proof storage areas in which the security keys as well as the user and usage related data are retained; it is the only strictly personalised entity in the user segment. The SSC is mounted within the OBU but not changed on a trip by trip basis (comparable to mounting a SIM card within a mobile phone). The SSC can be transferred from one OBU to another (e.g. in case an OBU breaks or the user decides to use a different OBU form factor) without further actions (as well as an OBU might be reused by exchanging the SSC).

The content of an SSC (master data as well as not yet transmitted usage data, etc) can be read and transferred to the Operation Centre via Service Points without using an OBU to allow the clearance of accounts in case a vehicle vanishes and an OBU is not available. Alternatively the SSC can be sent to the KMP operator to be read out (a deposit on the SSC that is only paid back for SSCs that are returned to the operator for deregistered vehicles can smoothen this process).

#### 2.1.1.3 On Board Unit (OBU)

The OBU is the front end device of the toll system that captures the raw data indicating the road usage of the vehicle. The OBU is easily mounted inside the vehicle. The main functions of the OBU are to

- automatically detect and charge tolling events,
- securely store toll transaction data on the SSC,
- securely communicate the collected data to the OBU Operation Centre (OOC),
- enable the user to declare variable tariff parameters,
- monitor its integrity and operability and inform the user about it,
- enable the user to get detailed information about toll relevant data,
- enable the user to recharge credits directly at the OBU in the prepayment scheme,
- communicate with the enforcement units.

The OBU consists of the following hardware subcomponents:

- **GNSS receiver** for positioning, distance measurement and time stamps, possibly augmented by a gyro and/or accelerometers (also to be used as moving sensors).
- **GSM module** for communication with the OBU operation centre to transmit usage data and receive operation data
- **DSRC module** for communication with enforcement equipment and possibly support beacons
- **Trusted Element (TE/SSC)** for cryptographic personalization and storage of usage data
- **Human Machine Interface (HMI)** for displaying the OBU status (including audible alarms) and receiving user inputs
- **CPU** and **Memory** (RAM, FlashRAM)

- **Power Supply and Management** (power caps are preferred over rechargeable batteries)
- **Real Time Clock** to trigger time-controlled operations
- **Interfaces** for Service and possibly download usage data to external storage devices (USB, memory card).

The OBU is easily mountable at the windshield even by an inexperienced user. For a description of the user and vehicle registration processes as well as for the logistic and installation procedures for the OBU and the SSC please refer to Chapter 3.1.2.

The OBU-Software is implemented in modules organised in two major layers. The bottom layer is the specific hardware adaptation layer and is implemented by the hardware suppliers. On top of this the actual OBU application layer is run. The software modules can be updated by receiving new module releases from the OBU Operation Centre (OOC). The OBU checks the validity of its software configuration by using cryptographic methods. For a description of the toll detection algorithm, please refer to Chapter 3.1.1.1

#### 2.1.1.4 Support Beacons

Support Beacons (SBs) are portable or stationary installed facilities, which enable the OBU to determine the appropriate toll in situations, where the GNSS position is ambiguous or the tariff scheme needs to be altered temporarily.

Support Beacons can be used to support temporal changes (like lane diversion on construction sites, detours through closed roads, etc.) to the map data that one is not able to anticipate long enough or that are to transient to be published by the Operation Data Management (ODM, see Chapter 2.1.2.6).

Although the Automatic Toll Detection does generally not need Support Beacons, there might very rarely be special situations (like staggered roads) where fixed Support Beacons are necessary to assist. The number of necessary SBs mainly depends on the complexity of the tariff scheme.

Support beacons are controlled and operated by the OBU Operation Centre.

### 2.1.2 Central Segment

Subsystems belonging to the Central Segment are used to manage all data, which have to be handled in a secure computing environment (computing centre). In the following the central components of customer service, toll detection and charging and supervision and security cluster are discussed. For clarity the central parts of enforcement will be described in Chapter 2.1.4.

#### 2.1.2.1 Customer Relationship Management (CRM)

With the Customer Relationship Management solution (CRM) all user-oriented business processes are implemented as workflows in a flexible and maintainable way (please refer to Chapter 3.1 for a closer description of the processes). The CRM stores and provides all user and vehicle master data and might include subcomponents as e.g. a revision-proof Document Management System (DMS) to store all contracts and in- and outgoing documents in digital form.

The CRM might also exchange master data with other operators to provide interoperability, as soon as exchange standards are available.

#### 2.1.2.2 Internet Portal

The Internet Portal is used for anonymous information services (tariffs, toll calculators, etc), user information and download (subscriptions, forms), online user self services (invoices, online forms) as well as for reporting broken OBUs and booking tickets for occasional users or supporting the proposed phase-in scenarios (see Chapter 5.1).

The portal uses standard WEB technologies. Sensitive data is protected by cryptographic measures (SSL).

#### 2.1.2.3 Service Centre

The Service Centre processes all user related inputs that are not received via Internet self service (i.e. E-Mail, postal mail, Faxes or phone calls).

Technically the Service Centre consists of workplaces with CRM access for call centre and back office agents, a post office for scanning received paper documents and call centre phone equipment (IVR, ACD/CTI).

The workflows of the Service Centre are supported or entirely implemented by the CRM.

#### 2.1.2.4 Business Service Gateway

The Business Service Gateway is used to interface external business applications (like online POS partners) and service points (including the service point portal) to the central systems of the tolling system. It implements security features as well as flexible interface and protocol designs using standard methods (e.g. web services) in order to minimise efforts and gain maximum flexibility in interfacing business partners.

#### 2.1.2.5 OBU Operation Centre (OOC)

The OBU Operation Centre (OOC) is the direct communication counter part of the OBUs and hence implements a secure and transaction-safe communication concentrator.

Furthermore the OOC implements various functions allowing a safe operation of the large field of clients, as there are a status database indicating the last known status of each OBU as well as remote diagnosis and monitoring functions.

The OOC stores all necessary operational data (map tiles, parameter settings, software modules) and provides them on request to the clients.

The life cycle of SIM cards as well as the assignments of phone numbers (MSISDNs) to SIMs and the identification with an OBU is also managed by the OBU Operation Centre that therefore exchanges SIM card management information with the mobile carrier.

#### 2.1.2.6 Operation Data Management (ODM)

The Operation Data Management (ODM) is responsible for the acquisition, maintenance, administration, archiving and provision of the mapping and tariff data as well as the toll event catalogue. The operational data is modelled on top of standard maps provided by map providers as well as on map material to be provided in standard GIS formats by the infrastructure operators.

The operation data centre might also exchange data with other road charging operators to provide interoperability as soon as appropriate standards are available.

#### 2.1.2.7 Billing

The Billing system deals with processes based on interactions with customers that are relevant for the central accounting. It receives master data (for customers and vehicles) from the Customer Relationship Management and processes and stores charging data that was automatically generated by OBUs as well as by using prepayment vouchers (see Chapter 2.2.5) and ticketing data (see Chapter 2.2.3).

Transaction data for invoicing are received from the OBU Operation Centre, the Internet and Business Portal and the CRM and subsequently debt items are booked on customer accounts. Incoming payments paid in cash or via cards, by bank collection or bank transfer are also booked on these customer accounts. Invoices are created periodically by an automated job as well as by request from the CRM. In case a detailed trip listing is requested by the user this information is included. A frequent check of user credit limits is based upon both the user account information and master data and is sent to the OBU Operation Centre as part of the operators risk management. Part of the Billing is also the voucher management.

With all this information the Billing system is the main database for the transfer of revenue to the government (reimbursement).

As soon as exchange standards are available the Billing system can also route and receive usage data with other road charge operators for interoperability.

#### 2.1.2.8 Enterprise Resource Planning (ERP)

The Enterprise Resource Planning (ERP) system provides support functionality for various standard business processes that are to be performed by the toll operator (e.g. Financial Accounting, Asset Accounting, Financial Controlling, Materials Management, Maintenance Planning, Payroll Management, etc.).

In particular the Materials Management in our case comprises the measurement of personalisation numbers of new OBUs (i.e. the prediction of OBU demands) as an indicator to support for the OBU logistic partner.

#### 2.1.2.9 Security Centre

The Security Centre implements a Private Key Infrastructure (PKI) and issues and manages all cryptographic keys used by the system (especially to protect user related data stored on the OBU and while traversing insecure communication channels).

Potentially all keys might be certified by an external Trust Centre to allow for secure interoperability.

#### 2.1.2.10 Monitoring and Reporting

The Monitoring and Reporting System receives reporting data from various central subsystems and is used to measure and testify the overall system performance and to calculate Key Performance Indicators (KPIs).

#### 2.1.2.11 Data Analysis and System Modelling

The Data Analysis and System Modelling tool is used to simulate some essential parts of the road charging system for operational optimisation to extract direct observables of general interest (e.g. traffic frequencies and time profiles for individual streets) as well as to extract more complex underlying traffic parameters by Monte Carlo methods.

### 2.1.3 Service Provider and Partner Segment

As a matter of fact projects this size cannot be handled without reliable partners. From an economical point of view and for cost-reduction reasons it is reasonable to outsource specific services to specialised partners. In Figure 2-1 the main service provider and partner organisations that have technical interfaces to the operator are shown in the rightmost segment. Typically those interfaces are secured by technical and operative measures.

#### 2.1.3.1 Letter Shop

The Letter Shop prints and mails all outgoing paper documents (mostly from CRM and Billing), including sealed PIN-letters (e.g. for unlocking a new SSC and identification at the internet portal). Also the Security and Storage Chip Cards (SSCs) are personalised and mailed here.

#### 2.1.3.2 POS Partner Networks

These are already existing Point of Sales (POS) networks of partners that sell tickets for occasional users or prepayment vouchers for registered users. The use of existing POS networks minimises transaction costs. The partner systems are interfaced by the Business Service Gateway using standard technologies.

#### 2.1.3.3 Banking, Acquirer, Clearing, Factoring

One of the most important service providers is the banking and factoring partner, also taking care for acquiring and clearing credit-, banking-, fuel- and fleet card transactions as well as possibly cash management.

Banking includes account keeping, money transfers, bank collections and other common services.

Factoring includes the whole risk management for registered users including credit rating and dunning, i.e. the operator itself is not assumed to manage any payment risks.

#### 2.1.3.4 OBU Manufacturer and Logistics

The logistics provider is mainly responsible for distributing the OBU via retail channels and also to manage the reverse logistics for hardware for compliance with the EU Directive WEEE (Waste of Electrical and Electronic Equipment).

#### 2.1.3.5 Mobile Carrier

The Mobil Carriers (communication providers) are responsible for the GSM communication between central systems and the field equipment (mainly the OBUs) as indicated by the grey clouds in Figure 2-1.

#### 2.1.3.6 Map Providers

The Map Providers supply road infrastructure maps that are used to model the operation data in the ODM. Although such maps do not carry road charging information that is usable for the operator, the accuracy and precision of the available maps might influence the accuracy and performance of the automatic toll detection. Ideally maps have to be provided (by law) by the infrastructure operator(s).

### 2.1.4 Enforcement

The enforcement subsystems consist of roadside infrastructure (i.e. stationary, portable and mobile enforcement units) which carries out vehicle inspections on the road and central systems that collect and verify the evidence records created by the roadside infrastructure and conduct the penalty process. All data communication between the Road Side Infrastructure and the Central Enforcement Office is encoded with cryptographic keys.

#### 2.1.4.1 Stationary Enforcement (ESt)

Stationary Enforcement units are gantry mounted devices which are permanently installed at the road side and automatically carry out enforcement actions. For this purpose the gantries are equipped with sensors to detect and classify approaching vehicles and cameras to extract the vehicles license plate number by OCR and to provide images of non-compliant vehicles. Also a DSRC data exchange with the OBU is performed to verify the OBU operation status, the correct OBU-vehicle assignment as well as possibly declarations of variable tariff parameters.

The licence plate numbers (LPN) of vehicles taking part in the occasional user scheme are checked against a White List that is distributed frequently by the central system. KMP-exempt vehicles are also included in the White List.

#### 2.1.4.2 Portable Enforcement (EPo)

The Portable Enforcement is especially designed for easy usage in the secondary and lower level network, i.e. single lane streets. It is comparable to a speed trap; the device takes a picture of a passing vehicle, and receives a DSRC status message in case an OBU is on board. The licence plate number of the vehicle is extracted from the picture. In case the vehicle is found on the White List or the DSRC data matches the licence plate number and shows no distinctive feature, the picture is erased. In other cases the evidence record is stored for real-time or deferred transmission to the Enforcement Centre. In contrast to the Stationary Enforcement no reliable vehicle classification is possible. A mode for spot cashing might be available.

#### 2.1.4.3 Mobile Enforcement (EMo)

The Mobile Enforcement units are vehicles driving along the motorways traffic furnished with the necessary equipment to carry out enforcement actions while driving. This allows random checks of vehicles without the need to stop them or slow them down. In case the OBU has a permanent power connection mobile enforcement units can also be deployed at parking places or petrol stations to check vehicles stopping at the premises.

In contrast to the Stationary or Portable Enforcement, the Mobile Enforcement is conducted mostly manually, e.g. by entering the vehicles licence plate number and inquiring the related data from the Enforcement Centre. The OBU status and data is read and checked via a DSRC module.

If there is a reason to suspect a toll violation, the enforcement staff stop the vehicle and take the appropriate measures (e.g. impose a penalty). Evidence records are transmitted to the Enforcement Centre via GSM. The enforcement staff is able to accept and register payments by various means (cash, banking- and credit cards, possibly fuel- and fleet cards).

#### 2.1.4.4 Enforcement Centre

The main tasks of the Enforcement Centre are to handle the communications with the roadside enforcement infrastructure (i.e. the stationary, portable and mobile enforcement units) and to manage the evidence records including manual inspection (see below). It also manages the activation and scheduling of stationary and mobile enforcement as well as the white list of users taking part in the occasional user scheme and exempt vehicles.

The Enforcement Centre provides applications to manually verify the evidence records created by the automated enforcement units. This is necessary to protect compliant vehicles against unjustified prosecution.

Validated evidence records are transferred to the Enforcement Offence Proceedings (EOP) for execution.

#### 2.1.4.5 Enforcement Offence Proceedings

When non-compliance is established for a vehicle an appropriate penalty has to be imposed. For this purpose the evidence record is transmitted from the Enforcement Centre to the Enforcement Offence Proceedings (EOP).

The Enforcement Offence Proceedings system provides support to display evidence records and attached documents, optionally issue of a reprimand, a penalty or a subsequent invoice, handle appeals, complete and close cases on received payments, issue reminders, etc.

In case the KMP operator implements the EOP, this will be realised by using some customised standard software as used by local authorities to track administrative offences. Alternatively existing authorities can be contracted for executing the EOP.

## 2.2 Focus Areas

In this chapter the assumptions, underlying this report, are presented in more detail with respect to the focus areas as indicated in the “Bijl1 Statement of Work Subject 1, 19 mei 06”.

### 2.2.1 Distribution of Raw Data Processing

T-Systems Satellic understands the advantages and disadvantages of client and central centric data processing and will propose the most suitable solution to The Netherlands requirements in due time. At this point in time we assume a client centric processing of the raw data due to the following reasons:

- Data Privacy: Only by aggregating the data within the vehicle it is possible to avoid the transmission of user trajectories to a data centre. Note that nevertheless the user might opt-in the transmission of such data as a prerequisite for added value services as receiving detailed trip statements or accessing a logbook via the Internet Portal. Even if the user does not agree on the transmission of localization data, system transparency is given by being able to access detailed information via the OBU HMI or possibly by being able to download such date to a memory card or USB stick.

- System Scaling: The client centric processing systems scale much more efficient than central processing systems since the computing power needed to perform the automatic toll detection is added with each OBU.
- User Information and financial Risks: A client centric system generally needs much lower availabilities and response times of the connection to the central systems than a central approach to perform certain time and precision critical functions as informing the user about upcoming and ongoing tolling events, accumulated tolling charges or available deposits. Also the financial risk of the operator is reduced since the liabilities of the user are checked onboard against the limits not allowing tampering by intentionally disrupting GSM communication. It is also guaranteed that the information displayed by the OBU is exactly found on the billing statement, minimizing the attempts of users to use any differences as legal reasoning for claims.
- Optimal Usage of Positioning Information: The client centric data processing does not need to reduce the bandwidth of information between the localization and the map matching systems at all and hence can use all the available information with maximum efficiency.
- Over the Air Traffic: The amount of downstream traffic is depending on the frequency of software module updates, the software module sizes, the activity radius of a vehicle and the mean (weighted by their demand rate) frequency of data changes in individual map tiles. Rough preliminary estimations show a difference in the total amount of up- and downstream traffic of factors 2-10 in favor for a client centric approach, which can even be increased by applying broadcasting technologies (see Chapter 2.2.4) at later stages.
- Enforcement Scheme: Enforcement schemes for central and client centric raw data processing differ by their (technical and legal) coverage. While in the central case the enforcement can only check the correct SSC ID (related to the LPN), variable tariff parameter setting and the availability of the positioning module and communication interfaces, in the client centric case the enforcement equipment is able to validate actual toll events, which covers a larger span of the data processing chain.

### 2.2.2 Provisions and Organisation for Installation and Registration of OBUs

For cost reason two separated logistic domains are foreseen for the OBU (not being personalised in the common meaning) and the SSC (carrying all user and usage related information that can not be reproduced).

On registering a vehicle, the user receives a SSC personalised to him and the particular vehicle. The OBU is available from multiple suppliers (possibly in different form factors as windshield-, dashboard- or DIN-slot-mounting) and can be obtained via retail channels just like other consumer electronics as it does not carry security-relevant information prior to being connected to the SSC and booted the first time.

The OBU can be powered either by a fixed connection or by plugging into the cigarette lighter. If the user requests a fixed installation the OBU is installed by a service partner with fixed power (and possibly ignition) connection and a mounting bracket glued to the window. Both the power connection as well as the mounting bracket can be fixed prior to OBU delivery and SSC destribution. In case the user wants external antennas these are also distributed via standard retail channels and preferably installed by a service partner.

It is assumed that no odometer connection is necessary due to legal reasons, i.e. that the distance measurements by pure GNSS means is permitted to establish and invoice KMP charges.

The installation and functionality of the OBU might be checked at APK inspections; at this point also the mileage of the vehicles odometer might be compared with the mileage recorded by the OBU (allowing some tolerance) for fraud detection.

### 2.2.3 Occasional User Scheme

For the occasional user scheme we see two possible solutions:

- **Mandatory OBU**, which would be necessary to comply with the KMP requirements as stated in variant 5 of the report: "Nationaal Platform Anders Betalen voor Mobiliteit, May 2005".
- **Ticketing system**, which is much more cost effective and will also allow a more effective system roll-out.

A mandatory OBU would generally look like the OBU described in Chapter 2.1.1.3 but would not have a GSM module (due to the fact that GSM operation may be not allowed inside all vehicles and external antennas are not easy and fast mountable).

This occasional OBU would be available at POS locations and possibly via Internet orders. The OBU would be personalised with the vehicles licence plate number and tariff class and would carry the whole set of operational data (to be updated before or during personalisation), i.e. the maximum usage period is limited by the shortest validity period of operational data items. A user receiving an occasional OBU would have to pay a deposit in the order of the material value of the hardware as well as some toll prepayment. The enforcement scheme is nearly identical with the standard OBU. At the end of usage the occasional OBU would have to be returned to the KMP operator by mail or at a POS location, and the user would receive the deposit, the remaining prepayment as well as a receipt at that point.

To support this solution it is necessary to set up:

- Special OBU logistics (including return, loss and refurbishment) and personalization processes (esp. at borders).

- Special training for POS personnel is necessary (the high fluctuation and low skill standards at POS personnel would result in a high error rate in OBU personalization and subsequently higher efforts in enforcement).
- A mandatory OBU would require user and vehicle registrations, OBU retrieval and personalization, pre- or post-payment including risk management and refunding, OBU return and user and vehicle deregistration.
- The SLAs for registration systems (CRM, Billing) needs are therefore considerably higher than with pure batch processing.
- A rough estimation of transaction rates yields the need for several hundred POS locations in parallel operation (and the same number of staff) in the peak hour of a peak day. On the other hand the average KMP charge would differ from the costs imposed by the necessary infrastructure by a large factor.

We are convinced that such a system is not feasible and instead recommend a ticketing system for occasional users.

- A ticketing approach is not discriminative since every occasional user is free to register and use the automated system.
- A ticketing system can be used as back-up system for broken OBUs (post declaration)
- A ticketing system can be used for distributing vignettes during the phase-in of the tolling scheme
- The business processes are much easier. No user registration and accounting is necessary, the only interaction points are tickets sale and possibly refund (only before start of validity).
- Tickets are preferably sold via Internet, which requires no logistics at all. A ticket system allows easy access especially for foreign users (e.g. tourists).

The charge an occasional user has to pay using a ticketing system is also proportional to the road infrastructure usage; however on a different scale (time and not distance) and with a coarser granularity. The difference between the two system accesses hence depend on the exact tariff scheme, which also has to make sure (or tolerate) that it is not attractive for registered heavy duty users to "escape" into the ticketing scheme by switching the OBU off.

The occasional user scheme is implemented by selling tickets for fixed validity periods that are bound to the license plate number of a vehicle. Sales channels are mainly the Internet and (for users not taking part in e-commerce) a POS network.

For obtaining a ticket only the tariff class of the vehicle, the validity period, the license plate number and possibly available tariff options have to be declared. In particular no declaration of an anticipated route is envisioned which has two advantages: First this approach avoids extensive re-declarations in case the user wants to change the originally planned route and lowers the impact on the enforcement in case such re-declarations would not be done properly. Secondly the sales process of tickets does not need complex applications (as would be the case if routing would be required), i.e. tickets can be sold via the existing POS networks of partners that allow the input of the data mentioned above.

The pricing of the tickets needs to be structured in a way that it is not attractive for heavy duty users to migrate from OBU usage to tickets (not even for one particular day). Compliance with the EU Directive 1999/62/EG is still given by this scheme since users are at any time free to take part in the automatic scheme in case they want to.

Ticket tariffs can depend on the validity period, the vehicle class (including emission class, commercial/non-commercial usage, etc.) as well as on additional user selectable options (e.g. the vehicle is allowed to travel congestion roads or areas at all times or only at restricted times).

The enforcement of vehicles taking part in the occasional user scheme is done by categorizing the vehicle, OCR of the license-plate number and comparing these findings to the White List entries. The enforcement is complemented by occasional checks (by mobile enforcement or even standard police staff) to validate the non-measurable tariff parameters.

### 2.2.4 Communication with OBU

The communication between the OBU and the central segment is conducted by standard GSM technologies (SMS, BS26, GPRS) making sure, that multiple carriers can be contracted in a competitive scheme to achieve fair market costs. For security reasons the communication is generally OBU initiated, however the OOC as well as service equipment can trigger an OBU to build up a connection.

While the upstream data is generally specific for an individual OBU the downstream traffic can be grouped in an individual and an anonymous part. In principle the anonymous part can be distributed by broadcasting scenarios (UHF/FM, cell broadcast, etc.), however for the near future it is not given that these methods are more reliable or cost efficient than handling this data part also in a point to point fashion.

Furthermore the OBU communicates with the outer world over a DSRC and a service interface. Optionally a memory card or USB interface can be implemented to allow the user to download detailed trip data.

Generally those interfaces can be used to load large amounts of data onto the OBU in relatively short times. Also a newly issued SSC can carry the latest software version and operation data for a fast and cost effective first start up of the OBU.

### 2.2.5 Payment and Invoicing

Payment for registered users using an OBU is done by a factoring partner. Registered users might pay by bank collection (preferred), fuel, fleet and credit cards, or taking part in a prepayment scheme. Due to very different transaction (and risk mitigation) costs of different payment methods it might be necessary to restrict certain payment methods (fuel and fleet cards, credit cards) for certain customers (e.g. high revenue or commercial segment).

Registered users with low or no credit rating might be required to take part in the prepayment scheme, where they either charge their account by paying in or transferring to a public bank account (standard access with medium processing speed) or by obtaining vouchers that can be used directly on the OBU (as long as the OBU is online to check the voucher validity) and possibly via Internet or via GSM (SMS). Vouchers are sold by POS partners and are cleared the same way as revenues from tickets (see below). Via the POS channel vouchers might either be distributed as scratch cards (expensive logistics) or directly printed by the POS equipment upon a transaction with the Business Server Gateway (most secure and efficient solution). In either case the voucher distribution is much more expensive than the bank transfers, so it might be necessary to charge a premium rate for this express service.

All registered users are receiving invoices and, if opted in, detailed trip statements. Invoices and trip statements can be mailed in printed form, e-mailed or downloaded via the Internet portal in digital format. For cost saving reasons it is advisable to incentive users that do not wish to receive printed invoices. Invoicing is conducted bi-monthly whereas for special (e.g. commercial) users the billing period might differ from the invoicing date for settlement reasons. But in general it is not foreseen to grant users a definite invoicing date for liabilities to allow a constant workload of the billing system. Note that the term of payment towards the Authority (i.e. the period between the actual trip and the reimbursement) is a cost sensitive parameter and should be in the order of two billing cycles. Intermediate billing might be done in case the liabilities of a user are no longer covered by the credit rating or if the credit rating changes, if the user is migrated to the prepayment scheme or if the user is deregistered.

Users taking part in the occasional user scheme directly pay the tickets at the cash point of the POS partners by the payment methods accepted there (typically cash or a selection of cards). The revenue generated by each POS partner is directly cleared between the partner and the operator. Alternatively tickets can be obtained via the Internet Portal, in this case only credit cards are accepted.

### 2.2.6 Enforcement Concept

The main purpose of the enforcement system is to ensure the correct usage of the tolling system by identifying and deterring charge violators. Therefore it is needed to perform roadside inspections, gather evidence records of violators and conduct the penalty process in the central system.

In this simple model, based on the available statistic data, given in “Cost Format, Phase 2, Version V1.0” we distinguish between two major user clusters; namely foreign (occasional) and national (regular) users, travelling on two different road classes; i.e. the main road network (HWN, Hoofdewegennet) and the secondary and other road network (OWN, Onderliggend/Overig wegennet). Foreign users mainly use the HWN. The national user travels on the HWN and the OWN with the same probability.

We suppose that the Stationary and Mobile Enforcement as described in Chapter 2.1.4.1 and Chapter 2.1.4.3 (mainly located at the HWN) is dimensioned in a way that foreign users are enforced once per trip (on average) while the Portable Enforcement, as described in Chapter 2.1.4.2 (mainly used to enforce the OWN) is dimensioned in a way that the resident user is enforced once in a certain time span (on average). For detailed volumetric please refer to Annex A.

3 High Level System Design Description

In this chapter the basic process view as well as an organizational reference for the toll operator is given supplementing the technical system presented in Chapter 2.

## 3.1 Process View

Figure 3-1 shows a top-level view of an overall process architecture, which is subdivided into “Business Processes” and “Support Processes”. The process cluster “Toll Detection and Charging”, as described in Chapter 2.1, has been subdivided into the business processes “OBU/SSC Distribution and Logistics”, “Toll Determination” and “Billing”. In the following chapters the processes – as identified and structured by the Principal - are described in more detail.

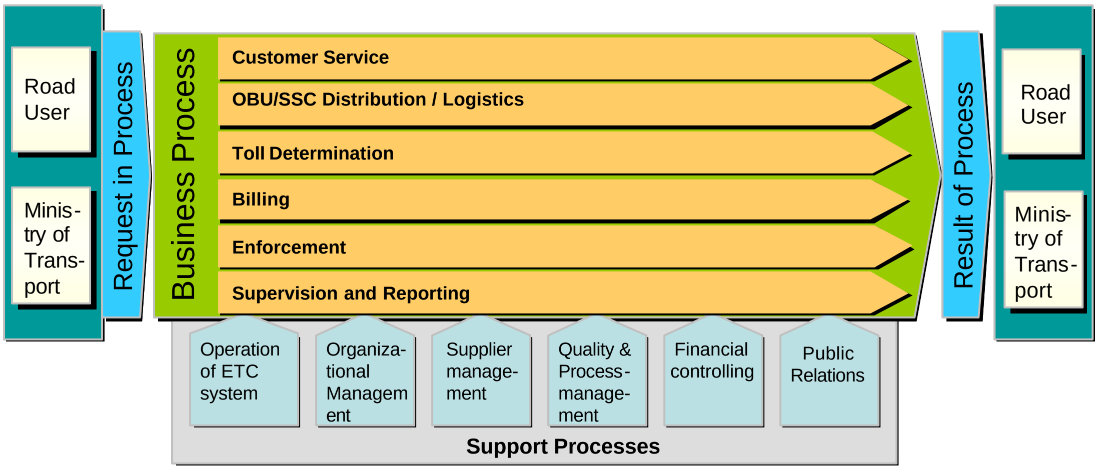


**Figure 3-1: Overall Process Architecture**

### 3.1.1 Primary Processes

#### 3.1.1.1 Automatic toll determination with OBU

##### 3.1.1.1.1 Measurement and Recording of Road Usage

The system discussed in this paper assumes the usage of GNSS (and Galileo later on) for both the measurement of driven distances and the location of the vehicle.

#### 3.1.1.1.2 Positioning

While the measurement of distances with GNSS (currently GPS, later Galileo) is accurate enough, in vicinities where a high accuracy is necessary the raw position from GNSS has to be enhanced using standard map matching technologies. Also in some cases the positioning can be augmented by the use of portable or stationary support beacons to allow temporary alternation of the tolling scheme as well as quick positioning in ambiguous or difficult road situations.

It is very important to note that mapping is only necessary in the vicinity of special tolling objects (see below) and not in general.

Map data is transferred to the OBU in small fractions called map tiles. A special process in the OBU assures that map tiles needed are available in a valid version. If necessary, map tiles are loaded or reloaded form the central side.

#### 3.1.1.1.3 Toll Objects

Knowing where a vehicle is located (either by raw GNSS position or by geographical objects detected by the map matcher) the OBU application identifies so called toll objects, which could be special street segments or areas. There is at least one toll object: the area where the standard kilometer fee is charged. Each toll object can be assigned to an individual tariff, to an individual infrastructure operator or a region and might mask other toll objects.

#### 3.1.1.1.4 Determination of Costs

Once a toll object is detected the costs for this object are calculated according to the tariff parameters that are given by the fixed master data of the vehicle, possibly variable parameters to be declared (no of axles, commercial/non-commercial trip, etc.) and the tariff class of the toll object. The tariff function might be proportional to mileage, proportional to time, a step function of time, or anything else.

The currently active toll object as well as the tariff rate and the collected charge are displayed to the user for transparency reasons.

A toll object is closed as soon as it is left, a tariff parameter changes or a given limit is reached (change of day, credit limits of OBU, etc.).

A closed toll object is a toll event to be charged. If no detailed trip statement is requested, all toll events with the same tariff parameters are aggregated for each day allowing billing a user without detailed travel data.

#### 3.1.1.1.5 Operation Data Management

Both the map data including the definition of toll objects as well as the tariff function are supplied to the OBU from the central segment. The management and maintenance of this data is one of the main processes of the operation of an automated toll detection system and one of the major cost drivers. It includes the definition of toll objects and their features as overlays to standard map data using a GIS, the versioning and revision-save archiving of versions, the quality assurance and publishing of maps, the (automatic) filtering of necessary map data and generation of map tiles and the monitoring of detection rates for toll objects and optimization of toll object modeling as well as of the underlying map data. The object modeling also includes the identification of necessary support beacons.

#### 3.1.1.2 Toll Determination with Tickets

Occasional Users without an OBU buy a ticket at POS or over the Internet Portal. Tickets are time-related and allow the user to use the street network for a validity period to be selected by the user. The price of a ticket must be higher than the toll an OBU user normally pays. To buy a ticket, the user has to key in his license plate number, his vehicle class and the beginning and the period of validity. Different tariffs for using the network in peak and off-peak times are possible. Using ticket machines the user can pay the ticket with credit cards or cash, via the Internet Portal with credit cards only.

To avoid extreme cancellation of tickets, we recommend not allowing cancellation of tickets with a period of validity of a day or week. Cancellation of monthly tickets is allowed if the remaining period of validity is at least on week. Cancellation can be conducted on the ticket machines or over the Internet portal. Credit is paid back the same way the original payment was done.

A ticketing function is also necessary for users with an OBU, which is out of order for whatever reason. These users can make a post-declaration in a reasonable time frame of their road usage on a time-related daily basis to avoid penalty processing.

Data of valid tickets and cancellation of tickets are stored on the central system and are made available for the enforcement process.

#### 3.1.1.3 Billing, Payment and Reimbursement

##### 3.1.1.3.1 Billing

The Billing system deals with processes based on interactions with customers that are relevant for the central accounting. The billing process uses master data from the Customer Relationship Management.

Transaction data for invoicing received from the OBU is checked with a Pre-Billing system and booked as debt items on customer accounts. A daily check of user credit limits is based upon both the user account information and master data and is sent to the Pre-Billing and OBU Operation Centre to minimize credit risks. Invoices are created periodically by an automated job as well as by request from the CRM. The invoicing data, after being verified through quality management measures and released, are handed over to the fulfillment service provider in the form of files. In case a detailed trip listing is requested by the user this information is included. The invoices for the users are printed there, put into envelopes and mailed to the road user.

Accounting data from the POS and the ticket function is booked as debt item on special POS accounts.

All debt is transmitted to the factoring partner.

##### 3.1.1.3.2 Payment

For payment a factoring partner is used. Incoming user or POS related payments are booked on the customer or POS accounts.

All toll-relevant monetary flows are monitored through the receivables management process. It includes the receipts of money at the user accounts, receipts of money from the card issuers and from the POS.

##### 3.1.1.3.3 Reimbursement (Pay-Out of Toll Revenues)

All revenues are reposted to the summary account of toll revenues designed for this purpose. Individual sums and the total amount can be reported in detail.

##### 3.1.1.3.4 Management of Vouchers for Express Recharge

A voucher can be bought at the POS or via the Internet Portal. The customer receives the voucher, carrying an individual security number. By keying in this voucher number into the OBU or via Internet the deposit will be immediately booked on the user account and the voucher account will be marked as voided.

### 3.1.2 Secondary Processes

#### 3.1.2.1 Registration and Installation of the OBU

The user registration and vehicle registration process are part of the customer services and therefore described in Chapter 3.1.2.2 “customer service”.

The user can buy the OBU using the established sales channels for the electronic consumer equipment. It is the task of the OBU-manufacturer to realize the necessary logistic and distribution.

Before installation of the OBU the SIM-card has to be activated via internet or with a call to the service center using the OBU number. The Storage chip card (SSC), provided to the user after his vehicle registration has to be inserted. Then the OBU can be installed.

#### 3.1.2.2 Customer Service

The Customer Service processes includes the supply process for general information of the KMP system through the Service Center or via the Internet, the user registration, the vehicle registration including possible declaration as toll exempt and the deregistration processes. Users can also change their master data (addresses and account data) and the vehicle's master data (vehicle characteristics, weight, number of axles, emissions classification).

After registration of a user and his vehicle(s), a SSC for each vehicle is sent to him together with a User ID and a PIN for Internet access.

This process also offers users the possibility to indicate their problems or to report the loss of the OBU, e.g. due to theft or destruction.

The customer service organization unit is responsible for the customer service process.

An Internet Portal is also offered, where the user can obtain general information and detailed data about his toll invoice. For special questions an FAQ will be available.

The invoice complaints process covers written complaints concerning KMP fee statements, which are received from the users on a special form. After a formal check of each complaint, the complaint is forwarded to the appropriate department for verification of the claim. For instance, if the complaint concerns a certain KMP statement, the justification of the claim is verified by the KMP determination process. In case the claim proves to be justified, an invoice credit note is initiated from the Customer Service process. The user is informed in writing in case of a favorable decision on his complaint as well as in case of rejection of his complaint.

#### 3.1.2.3 Enforcement

The aim of the enforcement performance process is to determine KMP evaders ("free riders") or false declarations thus leading to additional billing of unsettled KMP fees, and to impose penalty fines in order to ensure high degree of KMP duty compliance.

The enforcement processes are divided into automatic (stationary and portable) and mobile enforcement as well as post-processing of inspection cases through identification and determination of the facts, penalty levy and initiation of the offence proceedings.

##### 3.1.2.3.1 Automatic Enforcement

Automatic enforcement is to be understood as operation of stationary control gantries and as portable checkpoints. Data concerning entities, which are not subject to KMP duty or which have paid their charge correctly, are discarded. Data concerning KMP evaders or incorrectly declaring users are saved and transferred as evidence material to the Enforcement Center.

In the Enforcement Center a check of the evidence material and the vehicle data is carried out. It is necessary to determine whether the data are correct and whether the classification of bad payer or incorrectly declaring user, as the case may be, applies. This check is performed on the basis of the evidence material pictures and the automatically determined data. Records, for which the respective KMP charge was paid, are discarded.

Before starting the penalty levy process a grace period is used to enable any post declarations. If this declaration is made correctly, the process is terminated and no penalty is enforced.

The penalty levy process covers the post-payment of non-paid KMP fees as well as initiation of offence proceedings.

#### 3.1.2.3.2 Mobile Enforcement

Mobile enforcement is performed from a checking vehicle while passing a vehicle subject to KMP.

The following basic activities are performed: classification of the vehicle by humans, a check of the OBU via DSRC communication and a check against booking data and white lists with the license plate number.

In the event that a KMP evader or an incorrectly declaring user is identified, the vehicle will be stopped and the determination of the facts and penalty levy is immediately conducted by the enforcement personal.

## 3.1.3 Tertiary Processes

### 3.1.3.1 System Management and Maintenance

The KMP collecting system operation process can be broken down into central components operation and the operation of decentralized components. The aim of the process is to ensure efficient operation of all hard- and software components.

The operation of the central components is closely aligned with the standard ITIL procedures (IT Infrastructure Library). ITIL procedures are divided into support processes (Incident, problem, configuration, change and release) and delivery management processes (service, availability, IT service continuity and capacity).

The operation of the de-central components operations includes monitoring, maintenance, preventive servicing, damage-related servicing and construction management of all de-central components of the KMP system.

### 3.1.3.2 System Supervision

A monitoring and reporting process will ensure that all systems can be monitored from a central point. It is divided into physical and logical monitoring. In addition, all financial flows of the toll collection system are observed within this process.

The tasks of the physical monitoring are carried out in a monitoring system, which generates messages in case of hardware-, system- and application alarms as well as in case of a critical (hardware) process status.

The logical monitoring of the toll collection system helps to check the system processes. Therefore logical monitoring performs checks on consistency and monitors interrelated dimensions through correlation processes. In addition, it provides opportunities to assess the data.

In parallel to this, data from the central ERP (Enterprise Resource Planning) system is monitored by observing the various sequence numbers, status flags and table entries in the dataflow, complete processing of all components up to provision to the ERP for invoicing. Furthermore, statistical evaluations of the levies are carried out in order to control other charge determination influencing factors.

## 3.2 Organizational View

This following picture and tables sketches out a possible toll collection operator's company organizational structure as required to run the processes partially described above and gives a compact overview of the business processes including the designation of the organizational units involved.

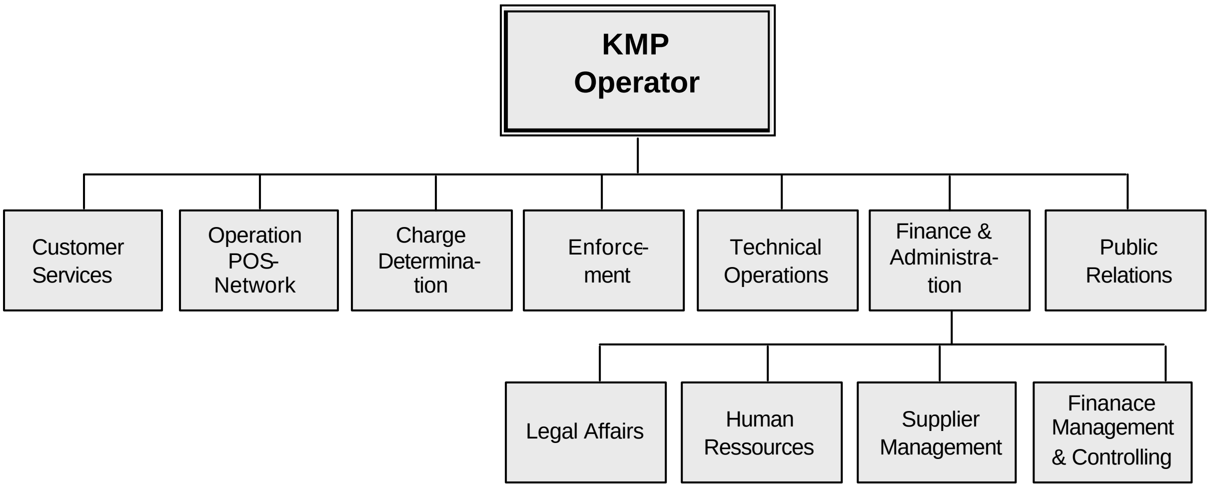


**Figure 3-2: Organizational Overview**

| Business Processes | Short Description | Unit Responsible |
|---|---|---|
| Customer Service | Information about toll user, registration or deregistration for users, vehicles and toll exemption as well as processing of payments claims. | Customer Service organization unit |
| OBU/SSC Distribution / Logistics | Advice and information for road users, OBU manufactures and the service network, quality management of the different OBU manufactures and the service network, forecasts of needed OBUs and attachments | Operations Contact and Distribution Point organization unit |
| Charge Determination | Operational data modeling, supervision of incoming KMP data, optimization and justification of toll claims | Charge Determination organization unit |
| Billing | Management of user accounts and processing of all toll-related payments, including billing and issuing invoices to users, payment and reimbursement | Billing organization unit |
| Enforcement | Identification of non-payers and false declarations, subsequent billing and fines | Enforcement organization unit |
| Monitoring & Reporting | Physical and logical monitoring of system as well as recording of financial flows within toll system | Technical operation and financial management & controlling organization unit |
| Operation of Technical System | System operation and maintenance for central and decentralized components | Technical operation organization unit |

**Table 3-1: Overview Business Processes**

| Support Processes | Short Description | Unit Responsible |
|---|---|---|
| Organizational Management | Ensuring of personnel resources, organization and organizational rules for the toll operator | Organization management organization unit |
| Supplier Management | Selection and management of suppliers, certification of OBU | Supplier management organization unit |
| Quality & Process Management | Maintenance and ensuring of quality and processes | Quality, process management & security organization unit |
| Financial Management & Controlling | Controlling of all financial flows through all processes | Financial management & controlling organization unit |
| Public Relations | Maintenance of communication both internally and with outside | Public relations organization unit |

**Table 3-2: Overview Support Processes**

## 3.3 Relations to other Concepts

### 3.3.1 Tariff Schemes

The basic technologies used to implement a tariff scheme are discussed in Chapter 2 and in Chapter 3.1.1, and are very flexible by mapping detected geo objects to toll charges by using a universal tariff function. The tariff function depends on tariff parameters, that are given by the toll object, the time, the (fixed) master data of the vehicle and by variable declarative parameters (e.g. number of axles, with/without trailer, commercial/non-commercial trip, etc.). The set of tariff parameters is also called tariff identifier and is used on the billing statement.

In the following the cost drivers in applying the described approach as well as a short discussion of the tariff differentiation scenarios as provided in [Tariff Scenario Memo] are given.

#### 3.3.1.1 Cost Driving Parameters

Although general technology allows covering almost all tariff scenarios, there are some important points to be considered in order to keep the efforts and costs at a reasonable level.

- Number of Toll Objects: The number of managed toll objects is a major source of efforts in modeling and maintaining these entities. A huge number of toll objects (and especially the underlying geo objects) can be considered highly volatile, which means that a released model would outdate very fast and probably would never describe reality on an accurate level. Also a large number of objects challenges the quality assurance scheme.

- **(Border) Length of Toll Objects:** The complexity of a single toll object is determined by its length or the length of its border (in case the toll object is an area), because these dimension relate to the number of geo objects that are necessary to be maintained in order to detect a toll objects with high accuracy.
- **Update Frequency of Toll Objects:** Each update of one or more toll objects requires the modeling or model update of the affected geo or toll objects and a subsequent quality assurance process including a test of the performance of the new model using a test fleet. In addition to these efforts the new data has to be distributed to the vehicle fleet, which is optimized by only transmitting the changed map tiles.
  Note that the update frequency is limited by the validity period each tile is assigned: a short period allows higher update frequencies but also induced a larger rate of requests for validity extensions.
  It also should be noted that the efforts of change merely the tariff function are smaller than also changing geo and/or toll objects, i.e. the update of the prices is easily possible at all times.
- **User Information:** All changes in the tariff scheme as well as all differentiated toll objects need to be addressed to the user. This implies first of all communication efforts or efforts for maintaining street signs but also implies a loss of acceptance in case the user is not willing or able to understand and/or to follow the changes of the tariff scheme.

#### 3.3.1.2 Application to Tariff Differentiation Scenarios

From the discussions in the previous chapter as well as from the technical introduction it becomes clear that not all tariff scenarios that are technically possible can be implemented at reasonable costs for the operator. The following examples might illustrate this point:

- **Exempting private Roads/Ground:** This would imply the necessity to distinguish clearly between public and private roads or ground on the very fine granularity of small street segments, which would directly lead to a number of geo and toll objects that cannot be managed by an operator.
- **Kilometer Charging based on Road Identification:** For the same reason it is most likely economically not possible to charge low order streets by identifying them individually. It is necessary to reduce the number of toll and geo objects drastically by introducing a mileage counter and (if necessary) toll areas.
- **Definition of Vehicle Classes:** As discussed in Chapter 2.2.6 the exact definition of vehicle classes is not so much a complexity parameter of the toll detection and billing scheme but much more for the enforcement scheme. It is recommendable that the basic vehicle class can be determined by automatic toll detection schemes with high certainty to avoid manual efforts in processing evidence records. The lookup of the vehicle class by using the OCR identified license plate number as index to the national vehicle register (at RDW) will not work for vehicles registered in foreign countries and

also implies efforts in message travel times in case the master data of a vehicle is changed.

With the mentioned background all of the scenarios (I, IA, II, III, IIIA, IIIB and IV) from “Tariff Scenarios for Phase 2 Assignments, V1.0” can be implemented, whereof scenario IIIB is preferred and recommended. The modeling of 19 regions (in particular their borders) as well as of 50 or more charged street segments including the disbursement of revenues to infrastructure holders should be manageable by the Operating Data Management as discussed in Chapters 2.1.2.6 and 3.1.1.1.5, in case private roads/ground are also tolled the same way as low order streets (i.e. by mileage measurement and not by identification).

It is not considered to be economically beneficial to cut down the requirements of the tariff differentiation since the organizational and operative reduction of costs would be under proportional compared to the loss of traffic influences. I.e. the systems and organizational units for ODM are necessary in any case can be operated with the given metrics close to their optimal working point.

### 3.3.2 Data Privacy

The main aspect of data privacy concerns the necessity for the transmission of vehicle / user trajectories, which is technically not necessary in case the aggregation is done within an application located on the OBU. Nevertheless the road pricing is fully transparent to the user by the instantaneous announcement of toll events and the possibility to access the detailed data directly on the OBU (via HMI or even download to an external storage media).

The data that is transmitted between any field equipment and the central segment (as well as between the central segment and partners) are secured by state of the art methods (i.e. VPNs or cryptography on application layer).

### 3.3.3 Interoperability and Standardization

The interoperability of future electronic toll services in Europe is of great importance to the European Commission. The Directive 2004/52/EC constitutes the requirement for a future European Electronic Toll Service (EETS). The OBU introduced and operated in the German road charging system already contains the technical components (GPS, GSM and microwave DSRC), recommended in this Directive.

To enable such an EETS, the Commission has initiated important standardization work and projects: The CESARE project will define the commercial arrangements for the interoperable EETS services. The Road Charging Interoperability Project (RCI) will develop an open, integrated framework enabling road charging interoperability at the technical and related procedural level based on the key existing and planned road charging deployments in Europe (Autopass, Europpass, LSVA, TIS, Toll Collect, VIA-T and VIA Verde). It will implement and test this framework in field trials at six sites, namely Austria, France, Germany, Italy Spain and Switzerland.

T-Systems Enterprise Services is a leading cooperation partner in the RCI project and cooperates in several EU road charging working groups. This expert know-how enables us to secure an implementation of the KMP system in The Netherlands which will be compliant to the emerging EETS.

### 3.3.4 Level Playing Field

To develop and operate a KMP system for The Netherlands, many deliveries (equipment and services) will be required. To procure such deliveries in a most economical way, competition must be enabled. It must be an important objective to establish a broad industrial supplier base to bid for required deliveries. To create a level playing field and enable competition, the technical system, as well as the services needed must be structured in a modular way. Components of the system structure and interfaces between them will - to the extent possible - be based on available standards. Procurement will be conducted in a most open and transparent way.

Major areas for broad industry participation will be the procurement of the OBU, necessary enforcement equipment and the standard hardware- and software components of the data centre. A level playing field can be created by clearly specifying required functions, characteristics, testing and delivery requirements for such components, and by building such specifications as far as possible on available standards. This will allow wide participation in competitive procurements. The OBU -because of its significant share of the overall investment costs- will need the broadest possible supplier base. Considering the quantities needed we believe that multiple sourcing from at least three suppliers will be appropriate.

A level playing field will also have to be established for the procurement of different services needed: mobile communication services will be purchased as “commodity“ services from established GSM network operators. Distribution services for the OBU can be provided by established supply chain operators. Ticketing services for Occasional Users will be procured from operators of existing PoS networks. Established payment system operators will provide required payment services.

Finally a level playing field will require the equal access to possible value-added services (VAS) as well as the possibility of running multiple tolling operations in parallel. For details concerning VAS please refer to Chapter 3.3.6, the interfacing between multiple operators require interoperability functions as described in Chapter 3.3.3.

### 3.3.5 Future-Proofness

First of all a toll systems needs to be clearly structured and unitized to allow the evolution and maintenance of individual system components without large impact on the vicinity.

Technically this means that the data structures (ER model) as well as the inter-module interfaces need to be as atomic and orthogonal as possible, using flexible and durable technologies and standards wherever it makes sense. Standard software and methods should be used wherever possible.

Also the overall business architecture should arrange as good as possible for business interfaces that are only realized at a later stage (e.g. value-added services, interoperability, etc.)

The system architecture as discussed in Chapter 2 fulfils both requirements – technical and business aspects of future-proofness without imposing any additional complexity at the beginning.

### 3.3.6 Value Added Services

Since the Telematic market is still in a rather early phase (in terms of penetration) it is not very likely that the stakeholders of the upcoming commercial applications are willing and able to integrate their services in a common platform at the first phase (next 5-10 years). They rather prefer to maintain the full control on both their business concepts and technical solutions and will not share intellectual property and operational know-how with potential competitors.

While commercial services are unlikely to be integrated at the beginning, there are services that are driven by legal and/or public reasons, which might very well benefit from the KMP infrastructure and even be integrated from the very beginning. Such services may include E-Calls (emergency calls), the tracking of dangerous goods (Hazmat) as well as inner city parking space management.

Of course a fully equipped vehicle fleet lowers the entry levels for services that would not be feasible as stand alone venture and hence there is the possibility for a new industry developing in the vicinity of the KMP operator that offers value added services to KMP users without distributing and operating own field equipment. Of course the access to the KMP resources needs to be open and regulated by using standard interfaces and business processes/conditions (technically to be implemented by a "telematics gateway").

The KMP operator itself or commercial partners may offer the following value-added services to the customers with relatively little efforts:

- Detailed trip statements (on paper/digital access)
- Logbook
- Online tracking (interfaces to fleet management)
- Usage of (full) maps for routing and navigation with special OBUs
- Usage-based vehicle insurance

# 4 Cost Estimate

## 4.1 Cost Evaluation Model

The target of phase 2 of the ABvM market consultation is to have more reliable cost estimates, further insight into the cost structure and more transparency concerning the benefits of different design choices.

The KMP cost summary shall describe the costs of Variant 5 on the macro economic level. The cost evaluation follows the model pointed out below

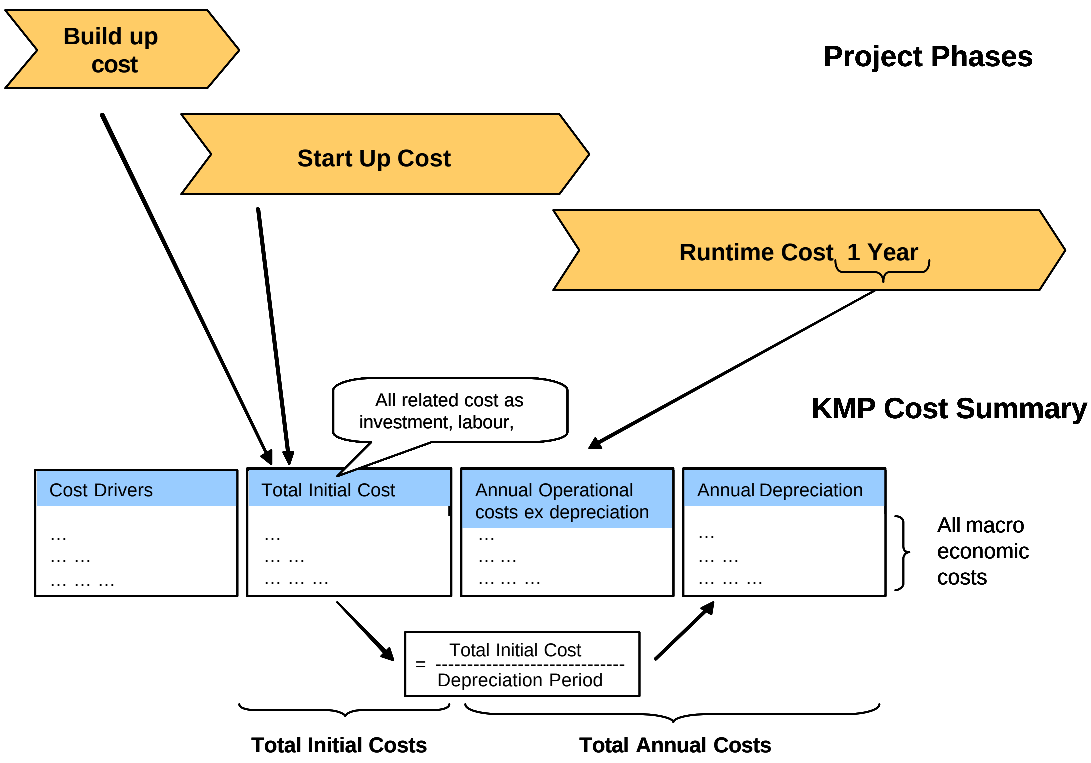


**Figure 4-1: Cost Evaluation Model**

For each predefined block the cost drivers are detailed according to following scheme:

| cost driver | calculation details | initial cost | operations cost | depr.period | annual depr. |
|---|---|---|---|---|---|
| ***group …*** | | *sum of* | | *sum of* | *sum of* |
| detail … | | | | | |
| detail …. | | | | | |
| ***group …*** | | *sum of* | | *sum of* | *sum of* |
| detail … | | | | | |
| detail …. | | | | | |

**Figure 4-2: Cost Drivers Scheme**

These cost details are aggregated to the predefined KMP Cost Summary form:

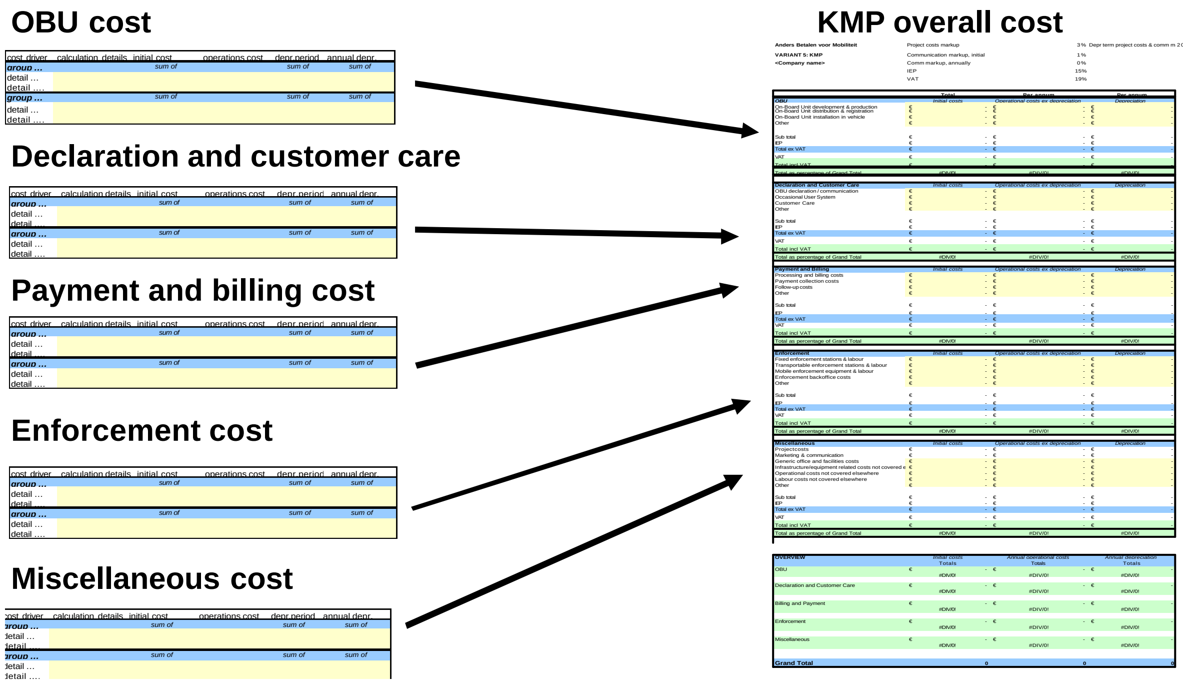


**Figure 4-3: KMP Cost Summary form**

T-Systems Satellic has used following premises for its cost evaluation:

- The costs for components and services are explicitly used as they would have occurred in 2005. This is to achieve the comparability of the 4 parties cost estimates. Only for the On Board Unit price indications have been estimated based on year 2010 assumptions.
- Unit cost and parameters provided by the Principal as “optional” are used when appropriate. Upon availability of more precise information, mainly derived from the German road charging system and other road charging projects, this information is used.

- In general parameters and unit costs which are provided as facts are used as facts. Common parameters for all 4 parties are not changed.
- Only significant costs are identified and estimated. Other costs are covered by the incidental expenditure markup.
- A continuous operation after build-up and start-up is assumed. Therefore no run-down cost or residual book values will be considered.

## 4.2 Cost Evaluation

### 4.2.1 OBU Costs

| Cost Driver | Calculation Details |
|---|---|
| ***On-Board Unit development & production*** | |
| OBU hardware & firmware development | covered by OBU production costs |
| OBU sw customization/ localization | on top of available charging core sw licenses |
| OBU sw licenses | OBU road charging core sw licenses at 5,000,000€ |
| OBU qualification & certification | certification of 3 suppliers assumed |
| OBU production; year 2010 price for requested quantity; install kit taken care by user | 8.49 mio. OBU at 95 € each; installation kit goesseparetely at user expenses |
| OBU antenna kit | not needed, as it is assumed that operational license for vehicles allow use of OBU inside of vehicle |
| OBU replacement | 4% of initial quantity p.a. due to final vehicle change |
| OBU lifecycle management | sw maintenance and OBU post-certification as 10% of initial cost p.a. |
| **Cost Driver** | **Calculation Details** |
| ***On-Board Unit distribution & registration*** | |
| Distribution channel & registration channel setup | Security and Storage Smart Card (SSC) development, adaptation of services for SSC lettershop, OBU logistics and OBU sales |
| OBU distribution | distribution (logistics/retail costs 25%, retail margin 3%) as 28% of OBU production cost |
| Security and Storage Smart Card (SSC) production | 8.49 mio. SSC at 8 € per card and 7 € per loading , personalisation and lettershop |
| **Cost Driver** | **Calculation Details** |
| ***On-Board Unit installation in vehicle*** | |
| Service points installation & inspection point equipment | 10,000 Service Points at 1000€ special equipment; platform assumed as available |
| Service points operations | 20% of initial cost p.a. |
| Initial OBU installation | no need for preinstallation assumed |
| OBU inspection | 8.49 mio. OBU at 5 min p.a. at 45 € per hour; part of APK |
| OBU maintenance | 0.5 hour at 45€ for 5% of vehicles |
| cost driver | calculation details |
| ***Other*** | |
| | |

legend: depr.=depreciation; p.a. per annum; maint.= maintenance; comm= communication

## 4.2.2 Declaration and Customer Care Costs

| Cost Driver | Calculation Details |
|---|---|
| **OBU declaration / communication** | |
| OOC/ODM sw royalty and license fees | digitized road map one time cost at 3,000,000 € and annual 10% maintenance cost assumed as no proposal accessable; road charging core sw licenses at 4,000,000€ |
| OBU mobile communication | 8.49 mio. OBU at 2 € flatrate per month and OBU assumed; cost rangeon market 2€ to 4€; roaming cost are neglectible due to clientcentric approach; 2 month comm cost prior to operation |
| Portable positioning support beacons | 30 portable support beacons at 100,000€ production cost and 5,000€ maint./ comm cost p.a. |
| Fixed positioning support beacons | 60 fixed support beacons at 81,000€ production cost and 5,000 maint./comm cost p.a. |
| Operation Data Management (ODM) labour | 30 FTE at 40,000€ |
| Staff overhead | 22,5% of 30 FTE at 50,000€ |
| Staff workplaces | for 37 persons at 4400€ p.a. |
| ODM measurement vehicles | 20 vehicles at 30,000€ vehicle cost and 10,000€ equipment cost; operations 20% of initial costs p.a. |
| OOC/ODM data centre / WAN services | sized for clientcentric approach; hw, sw, wan and security installations, infrastructure, transfer to operation, operations |
| OOC/ODM lifecycle management | sw-maintenance;staging for new releases |
| **Cost Driver** | **Calculation Details** |
| **Occasional User System** | |
| Indoor ticket booking terminals | 350 terminals at 1000€ each; 2 mio. bookings p.a. at 0,24€ |
| Outdoor ticket booking terminals | 50 terminals at 50,000€ each; 0,625 mio. bookings p.a. at 0,24€ |
| Other multiuse ticket booking terminals | Adaptation cost 2,000,000€; 0,625 mio bookings at 0,24€ |
| Outdoor Terminal Management labour | 2 FTE in 3 shifts at 30,000€ |
| Staff workplaces | for 2 persons at 4,400€ p.a. |
| **Cost Driver** | **Calculation Details** |
| **Customer Care** | |
| CRM / Business Service Gateway / Internet Portal sw customization | on top of available road charging core sw license |
| CRM sw royalty and license fees | road charging core sw licenses at 1,000,000; CRM sw at 6,000,000 € assumed as no proposal accessable |
| Service centre call centre labor | 500,000 generic 450,000 prepaid related 3,000,000 bill related 300,000 follow up, 700,000 penalty related calls at avg. 4 min. => 64 FTE at 30,000€; operative 3 month at double headcount prior to start up |
| Service centre back office labor | 8,000,000 actions at avg. 10min. => 254 FTE at 30,000€; operative 3 month at 12 times headcount prior to start up |
| CRM / Business Service centre / Internet Portal content labor | 5 FTE at 40,000€ |
| Staff overhead | 22,5% of 323 FTE at 50,000€; 12 times the first year |
| Additional staff workplaces | 150 for persons at 4,400€ |
| Interactive voice response facilities | 40 IVR systems at 3,500 € plus 40 officespace at 2,000€ plus backend system/WAN/LAN at300,000€ ; maint. 20% |
| CRM / Business Service Gateway / Internet Portal data centre / WAN services | sized for clientcentric approach; hw, sw, wan and security installations, infrastructuretransfer to operation, operations |
| CRM lifecycle management | sw-maintenance;staging for new releases |
| **Cost Driver** | **Calculation Details** |
| **Other** | |
| | |

legend: depr.=depreciation; p.a. per annum; maint.= maintenance; comm= communication

### 4.2.3 Payment and Billing Costs

| Cost Driver | Calculation Details |
|---|---|
| **Processing and billing costs** | |
| Credit check services | annual credit assessment, address check, bank account check at 0,60€ for 14,500 accounts |
| Paper invoice services | 0,88€ for 30% of 102 mio bills ; 30% changes within one year;1 bill per 2 month |
| Internet invoice download services | 0,30€ for 70% of 102 mio bills; 30% changes witnin one year ;1 bill per 2 month |
| **Cost Driver** | **Calculation Details** |
| **Payment collection costs** | |
| Sales partner voucher sales | 16 mio voucher p.a. at avg. value 25 € and retail margin 10 % assumed; 10c cost per voucher card |
| Outdoor terminals cash management | 50 terminals at 400€ once a week |
| Payment provisions | direct debit assumed at 0,08 € per invoice |
| **Cost Driver** | **Calculation Details** |
| **Follow-up costs** | |
| Payment processing services | processing costs for 102 mio. bills at avg. 0,15€ per bill |
| Debts collection services | debts are assumed as 0,4 % of potential KMP revenue of 7 bio. € p.a.; collection services cost at 5 % of debts |
| **Cost Driver** | **Calculation Details** |
| **Other** | |
| Billing/ERP sw customization/localizing | on top of available road charging core sw licenses |
| Billing/ERP sw royalty and license fees | Billing/ERP SW at 4,000,000 € cost assumed as no proposal accessable; road charging core sw licenses at 2,500,000 € |
| Fulfillment service provider setup fee | adaptation of contents, interfaces, organization |
| Accounting, transaction management, asset managment labour | 21 FTE in 1 shift at 40,000€ |
| Staff overhead | 22,5% of 21 FTE at 50,000€ |
| Staff workplaces | for 26 persons at 4400€ |
| Billing/ ERP data centre/ WAN services | sized for clientcentric approach; hw, sw, wan and security installations, infrastructure,transfer to operation, operations |
| Billing/ERP lifecycle management | sw-maintenance;staging for new releases |

legend: depr.=depreciation; p.a. per annum; maint.= maintenance; comm= communication

### 4.2.4 Enforcement Costs

| Cost Driver | Calculation Details |
|---|---|
| **Fixed enforcement stations & labour** | |
| Gantries (two-lanes + HS) mechanics and installation | 40 gantries(steelwork, power and comm lines at 1000 m avg.) at 175,000€; 20 % spare gantries |
| Gantries (three-lanes +HS) mechanics and installation | 4 gantries (steelwork, power and comm lines 1000 m avg) at 185,000€; 20% spare gantries |
| Gantries maintenance | 3 % of gantries initial cost p.a. |
| Fixed enforcement system (two-lanes +HS) incl dsrc,det,video,classification | 40 systems at 230,000€ ;20% spare systems |

| | |
|---|---|
| Fixed enforcement system (three-lanes +HS) incl dsrc,det,video,classification | 4 systems at 310,000€; 20% spare systems |
| Fixed enforcement system maintenance | 15% of initial cost |
| Fixed enforcement system operations | 44 systems at 7,000€ comm & energy for 92 lanes at 7000 € ;20% spare |

| Cost Driver | Calculation Details |
|---|---|
| **Transportable enforcement stations & labour** | |
| Transportable vehicle based enforcement systems dsrc,det,video | 244 units of enforcement equipment at 40,000€ cost & vehicles at 35,000€ cost |
| Transportable vehicle based enforcement systems maintenance | 15% of system cost p.a. |
| Transportable vehicle based enforcement systems operations | 244 systems at comm cost at 5,000€ & energy cost at 7000 € |
| Transportabel enforcement operations labour? | 275 FTE in 1,5 shifts at 30,000€ |

| Cost Driver | Calculation Details |
|---|---|
| **Mobile enforcement equipment & labour** | |
| Mobile enforcement vehicles and equipment | 44 vehicles at 60,000€ vehicle plus 65,000 enf. equip plus 20,000€ install |
| Mobile enforcement vehicles maintenance | 25% of initial cost |
| Mobile enforcement vehicles operations | 44 vehicle at comm 10,000€ & energy 14,000 € |
| Mobile enforcement | 132 FTE in 1,5 shifts at 30,000€ |

| Cost Driver | Calculation Details |
|---|---|
| **Enforcement backoffice costs** | |
| Enforcement system sw customization | on top of available core sw licenses |
| Enforcement system sw royalty and license fees | enforcement centre at 1,000,000; offence proceeding sw at 500,000 € assumed as no proposal accessable; |
| Penalty charge notices and vehicle registry queries RDW | 1,77€ for 5,36 mio offences p.a. |
| Enforcement case clarification labour | 120 FTE in 2 shifts at 30,000€ |
| Offence processing labour | 40 FTE at 40,000€ |
| Staff overhead | 22,5% of 160 FTE at 50,000€ |
| Staff workplaces | for 196 persons at 4400€ p.a. |
| Enforcement data centre/ WAN services | sized for above field equipment; hw, sw, wan and security installations, infrastructure transfer to operation, operations |
| Enforcement lifecycle management | sw-maintenance;staging for new releases |

legend: depr.=depreciation; p.a. per annum; maint.= maintenance; comm= communication

### 4.2.5 Miscellaneous Costs

| Cost Driver | Calculation Details |
|---|---|
| **Generic office and facilities costs** | |
| KMP operators generic office facilities | |

| Cost Driver | Calculation Details |
|---|---|
| **Infrastructure/equipment related costs not covered elsewhere** | |
| KMP operator generic ITC /Monitoring/Reporting services | sized generic platform for above services; hw, sw, wan and security installations, infrastructure, transfer to operation ,operations |

| | |
|---|---|
| Generic sw royalty & license fees | road charging core sw licenses and other generic licenses of 4,000,000€ assumed as no proposal accessable |
| General ITC Services lifecycle management | sw-maintenance;staging for new releases |
| **Cost Driver** | **Calculation Details** |
| **Operational costs not covered elsewhere** | |
| Legal Support | |
| Insurances | |
| Training | |
| Assessments | |
| **Cost Driver** | **Calculation Details** |
| **Labour costs not covered elsewhere** | |
| KMP System global system integration | |
| KMPl system internal help desk | 20 FTE in 3 shifts at 30,000€ |
| KMP system monitoring and reporting | 20 FTE at 40,000€ |
| KMP operator administration (Marketing,QM,HR, Controlling,Supplier Mgmnt, Finance; Org Mgmnt;Legal) | 100 FTE at 40,000€ |
| Staff overhead | 22,5% of 140 FTE at 55,000€; including chief offices |
| Staff workplaces | for 160 persons at 4,400€ p.a. |
| **Cost Driver** | **Calculation Details** |
| **Other** | |
| | |

legend: depr.=depreciation; p.a. per annum; maint.= maintenance; comm= communication

## 4.3 KMP overall Costs

This cost evaluation is based on the information available to T-Systems Satellic at this time. The costs are as if the system would have gone into operation in 2005. Since we describe a solution for the KMP pricing which is not available on the market yet, T-Systems Satellic can not guarantee that all estimations and calculations in this report will be valid upon implementation of the system. Nevertheless the overall view shall be close to reality, if major requirements or conditions of this project will not be changed.

| | | **Total** | | **Per annum** | | **Per annum** |
|---|---|---|---|---|---|---|
| **OBU** | | *Initial costs* | | *Operational costs ex depreciation* | | *Depreciation* |
| On-Board Unit development & production | € | 842.550.000 | € | 35.862.000 | € | 117.021.429 |
| On-Board Unit distribution & registration | € | 328.714.000 | € | 9.033.360 | € | 66.222.000 |
| On-Board Unit installation in vehicle | € | 10.000.000 | € | 43.388.750 | € | 2.500.000 |
| Other | € | - | € | - | € | - |
| Sub total | € | 1.181.264.000 | € | 88.284.110 | € | 185.743.429 |

| | | | | | | |
|---|---|---|---|---|---|---|
| IEP | € | 177.189.600 | € | 13.242.617 | € | 27.861.514 |
| Total ex VAT | € | 1.358.453.600 | € | 101.526.727 | € | 213.604.943 |
| VAT | € | 258.106.184 | € | 19.290.078 | € | 40.584.939 |
| Total incl VAT | € | 1.616.559.784 | € | 120.816.805 | € | 254.189.882 |
| Total as percentage of Grand Total | | 75,8% | | 13,0% | | 81,2% |

| **Declaration and Customer Care** | | *Initial costs* | | *Operational costs ex depreciation* | | *Depreciation* |
|---|---|---|---|---|---|---|
| OBU declaration / communication | € | 42.924.375 | € | 243.014.812 | € | 6.081.756 |
| Occasional User System | € | 27.367.200 | € | 848.800 | € | 8.550.860 |
| Customer Care | € | 52.306.563 | € | 48.300.250 | € | 3.919.328 |
| Other | € | 28.797.663 | € | 62.915.650 | € | 3.689.883 |
| Sub total | € | 151.395.800 | € | 355.079.512 | € | 22.241.827 |
| IEP | € | 22.709.370 | € | 53.261.927 | € | 3.336.274 |
| Total ex VAT | € | 174.105.170 | € | 408.341.439 | € | 25.578.101 |
| VAT | € | 33.079.982 | € | 77.584.873 | € | 4.859.839 |
| Total incl VAT | € | 207.185.152 | € | 485.926.312 | € | 30.437.941 |
| Total as percentage of Grand Total | | 9,7% | | 52,4% | | 9,7% |

| **Payment and Billing** | | *Initial costs* | | *Operational costs ex depreciation* | | *Depreciation* |
|---|---|---|---|---|---|---|
| Processing and billing costs | € | - | € | 30.476.700 | € | - |
| Payment collection costs | € | - | € | 50.800.000 | € | - |
| Follow-up costs | € | | € | 16.700.000 | € | - |
| Other | € | 28.797.663 | € | 62.915.650 | € | 3.689.883 |
| Sub total | € | 28.797.663 | € | 160.892.350 | € | 3.689.883 |
| IEP | € | 4.319.649 | € | 24.133.853 | € | 553.482 |
| Total ex VAT | € | 33.117.312 | € | 185.026.203 | € | 4.243.366 |
| VAT | € | 6.292.289 | € | 35.154.978 | € | 806.239 |
| Total incl VAT | € | 39.409.601 | € | 220.181.181 | € | 5.049.605 |
| Total as percentage of Grand Total | | 1,8% | | 23,8% | | 1,6% |

| **Enforcement** | | *Initial costs* | | *Operational costs ex depreciation* | | *Depreciation* |
|---|---|---|---|---|---|---|
| Fixed enforcement stations & labour | € | 21.915.000 | € | 3.316.250 | € | 2.191.500 |
| Transportable enforcement stations & labour | € | 18.300.000 | € | 13.923.000 | € | 4.575.000 |
| Mobile enforcement equipment & labour | € | 6.380.000 | € | 6.611.000 | € | 2.126.667 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Enforcement backoffice costs | € | 10.000.000 | € | 32.324.600 | € | 1.025.000 |
| Other | € | - | € | - | € | - |
| Sub total | € | 56.595.000 | € | 56.174.850 | € | 9.918.167 |
| IEP | € | 8.489.250 | € | 8.426.228 | € | 1.487.725 |
| Total ex VAT | € | 65.084.250 | € | 64.601.078 | € | 11.405.892 |
| VAT | € | 12.366.008 | € | 12.274.205 | € | 2.167.119 |
| Total incl VAT | € | 77.450.258 | € | 76.875.282 | € | 13.573.011 |
| Total as percentage of Grand Total | | 3,6% | | 8,3% | | 4,3% |

| **Miscellaneous** | | *Initial costs* | | *Operational costs ex depreciation* | | *Depreciation* |
|---|---|---|---|---|---|---|
| Project costs | € | 60.018.144 | € | - | € | 3.000.907 |
| Marketing & communication | € | 20.006.048 | € | 919.636 | € | 1.000.302 |
| Generic office and facilities costs | € | 2.000.000 | € | 2.000.000 | € | 200.000 |
| Infrastructure/equipment related costs not covered elsewhere | € | 2.000.000 | € | 2.000.000 | € | 200.000 |
| Operational costs not covered elsewhere | € | 36.000.000 | € | 4.000.000 | € | 1.800.000 |
| Labour costs not covered elsewhere | € | 20.000.000 | € | 7.836.500 | € | 1.000.000 |
| Other | € | - | € | - | € | - |
| Sub total | € | 140.024.192 | € | 16.756.136 | € | 7.201.210 |
| IEP | € | 21.003.629 | € | 2.513.420 | € | 1.080.181 |
| Total ex VAT | € | 161.027.821 | € | 19.269.556 | € | 8.281.391 |
| VAT | € | 30.595.286 | € | 3.661.216 | € | 1.573.464 |
| Total incl VAT | € | 191.623.106 | € | 22.930.772 | € | 9.854.855 |
| Total as percentage of Grand Total | | 9,0% | | 2,5% | | 3,1% |

| **OVERVIEW** | | **Initial costs** | | **Annual operational costs** | | **Annual depreciation** |
|---|---|---|---|---|---|---|
| | | **Totals** | | **Totals** | | **Totals** |
| OBU | € | 1.616.559.784 | € | 120.816.805 | € | 254.189.882 |
| | | 75,8% | | 13,0% | | 81,2% |
| Declaration and Customer Care | € | 207.185.152 | € | 485.926.312 | € | 30.437.941 |
| | | 9,7% | | 52,4% | | 9,7% |
| Billing and Payment | € | 39.409.601 | € | 220.181.181 | € | 5.049.605 |
| | | 1,8% | | 23,8% | | 1,6% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Enforcement | € | 77.450.258 | € | 76.875.282 | € | 13.573.011 |
| | | 3,6% | | 8,3% | | 4,3% |
| | | | | | | |
| Miscellaneous | € | 191.623.106 | € | 22.930.772 | € | 9.854.855 |
| | | 9,0% | | 2,5% | | 3,1% |
| | | | | | | |
| **Grand Total** | | **2.132.227.901** | | **926.730.352** | | **313.105.294** |

## 4.4 Conclusion

T-Systems Satellic cost evaluation provides a complete macro-economic picture, based upon the experience gained in the German road charging system and our engagements in various other road charging projects.

The estimate covers all life-cycle phases and cost categories, e.g. plannig, financing, build-out, start-up and operation of the complete system, beginning with the top-level business processes down to the detailed technical processes. The system which we evaluated is compliant with all known targets of the KMP variant 5 for all users (except 10% Occasional Users). It is fully compliant to national- and EU regulations. Significant provisions (user support) for the large number of users to deal with contracts, OBUs, different payment and billing methods are taken into account, to ensure customer acceptance.

All these requirements lead to macro-economic costs for the KMP Variant 5 which are exceeding the Principal's target cost figures.

Based on the KMP Variant 5 requirements, T-Systems Satellic identified the following major cost drivers:

- OBU equipment costs
  The cost are immanent to the principles of KMP Variant 5 and the required quantity of OBUs.
- OBU distribution and registration
  The logistics to provide 8,5 Mio. OBUs during start up without redundant units is a challenge. The costs of a sales channel which covers storage, invoicing and warranty costs are taken into account. The acceptance of other payment methods than prepayment require personalized user registration.
- Mobile communication
  Mobile communication costs are immanent to the principles of KMP Variant 5. The communications traffic today is the benchmark for the communication costs. Future costs are dependant on agreed prices with mobile communication providers.
- Life-cycle management of the system
  The life-cycle costs of the system are included. The costs are derived from operative system concerning telecommunication and road charging.

- Payment provisions and fees
  The costs include the fees for direct debit for 90% of the users. The rest may pay with credit cards or in cash.

In summary it is to be noted:

- The requested tariff flexibility of KMP Variant 5 can only achieved with a GNSS system.
- The individual costs of equipment per user and its operation with the requested performance are significant. Since the average user does not drive very long distances and the charge per km for passenger cars is quite low, there is an unfavorable revenue to costs ratio.

A significant cost reduction can be achieved if some principles of the KMP Variant 5 can be changed. This might reduce the OBU manufacturing, distribution and communication costs. An option for cost reduction is to change the payment scheme to pre-payment only and require the user to pay a surcharge for more convenient payment methods. As a consequence additional savings in the OBU registration are possible. Another option is to request the user to pay for the. These options have to be analyzed in more detail and as a consequence the requirements might have to be aligned.

Furthermore to give a realistic overall view the total macro-economic benefits as an effect of improved mobility should be quantified and taken into account to develop a complete picture of costs and benefits.

In addition the introduction of value added services like emergency calling, dangerous good tracking or usage based vehicle insurance (see Chapter 3.3.6) may also use the same in-vehicle infrastructure and create an additional source of revenues, which can improve the revenue to cost ratio significantly.

This is also valid for the revenues generated by the penalties of the enforcement system and the revenues of a debt collecting service. Penalty levels should be structured in a way to at least cover the costs incurred for the operation of such services.

# 5 Migration Scenarios

As rightly pointed out in the Statement of Work, careful consideration must be given to the implementation plan for the KMP system. A “big bang” introduction of a highly automatic system covering 8 million vehicles on all roads on nation-wide basis would constitute a risk, which cannot be controlled and sufficiently managed. Such a system rather needs to be introduced in an evolutionary (step-wise) manner, taking into account all important political, organizational, technical and financial aspects.

T-Systems Satellic has considered and assessed basic migration scenarios. The assessment was conducted based on a set of high-level evaluation and led to a proposal for a phased approach, viewed as most appropriate to the Dutch requirements. The proposed approach is based on an extensive hands-on experience, gained in the implementation and operation of the worlds first satellite-based road charging system, successfully in operation in Germany since January 1, 2005. It should be noted however, that T-Systems Satellics architectural design (see Chapter 2 and 3) is very flexible and also allows other implementation scenarios, if the Principal may deem them more appropriate.

## 5.1 Implementation Framework

The following framework for system implementation, as set by the Dutch Principal, is underlying the scenario analysis:

- The charging scheme must be in operation nation-wide by 2012
- It must cover all vehicles on all roads (any km driven in NL)
- The KMP charge is distance driven, Tariffs will be differentiated by vehicle classes, environmental factors, location and time of day

Acceleration projects (toll roads, regional or local projects) that might be in operation or emerging have to be integrated into the national scheme.

The objective of the proposed migration approach is to maximise positive effects on mobility and the environment at an early stage of system introduction. It should also minimise the inherent risks and costs as well as the burden on the users and thus meet the highest possible degree of political support and user acceptance.

## 5.2 Proposed Migration Solution

In consideration of the top-level criteria derived from the “Statement of work subject 1” provided by the Principle (see Annex B), the technical necessities and the lessons learnt in the German road charging project, T-Systems Satellic proposes a phased implementation approach that will, from the very beginning of operation, already cover all vehicles on all roads nation-wide. To achieve this, the technical system will consist of two major components:

- An **automatic system** with a GNSS-based OBU installed in vehicles will be implemented in logical steps based targeting segments of vehicles
- A **ticketing system,** allowing a variety of tariff levels**,** that will be installed as “blanket” system, to service all vehicles not (yet) supported by the automatic system. When the automatic system is fully deployed, the ticketing system will serve as Occasional User System.

### 5.2.1 Segmentation of Vehicles

The large quantity of vehicles to be subject to KMP and to be equipped with an OBU requires a segmentation and introduction in logical phases. In the following some criteria are listed that need to be considered in defining such segments:

- Sizing of classes of vehicles should be in manageable quantities of increasing numbers. Lessons learnt in one phase of introduction must be applied in the subsequent phases.
- Vehicle classes selected for the implementation should have physical characteristics that allow differentiation by technical means (automatic enforcement).
- To achieve economical OBU prices, production capacities must be carefully planned. Production lines to be established by the suppliers must be employed as efficiently as possible.
- The OBU distribution network should be build-up and operated in a linear fashion to reach an even distribution- and installation work load.

### 5.2.2 Proposed Migration Approach

T-Systems Satellic proposes a **3-phase evolutionary approach** to introduce the entire system within a shortest possible time frame. These phases are characterized by increasing numbers of users switched to the automatic system (see the diagram 5.1):

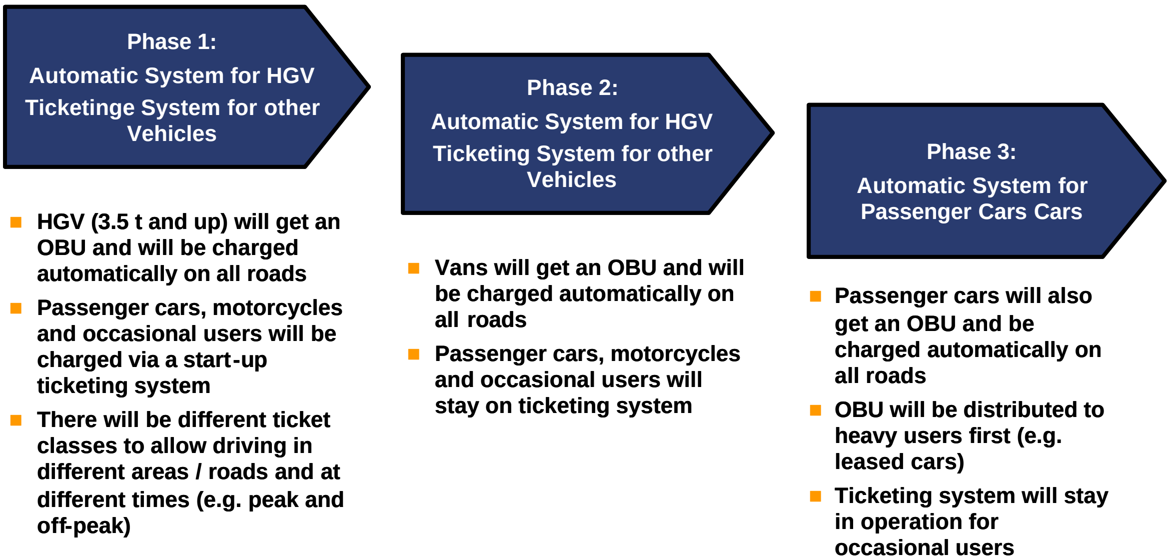


**Figure 5-1: Proposed 3-phase evolutionary approach**

- **Phase 1:** Simultaneous start of the automatic system and the ticketing system. The automatic system will support approx. 200,000 Heavy Goods Vehicles (HGV: trucks 3.5 t and up). The Ticketing system will be in service for vans, passenger cars, occasional users (e.g. foreign trucks not equipped with an OBU) and possibly motor cycles.
- **Phase 2:** Vans (approx 870.000) will be equipped with an OBU and switched to the automatic system. Passenger cars, occasional users and motorcycles will continue to be serviced by the ticketing system.
- **Phase 3:** All passenger cars and motorcycles will be equipped with an OBU and switched to the automatic system. The ticketing system will stay in service for occasional users and as interim fall-back for OBU replacements in case of failure. A further segmentation of the big passenger car class is possible. Priority in OBU distribution should be given given to cars heavily used (e.g. leased cars).

The following diagram qualitatively depicts the increasing proportions of users serviced by the automatic system and the ticketing.

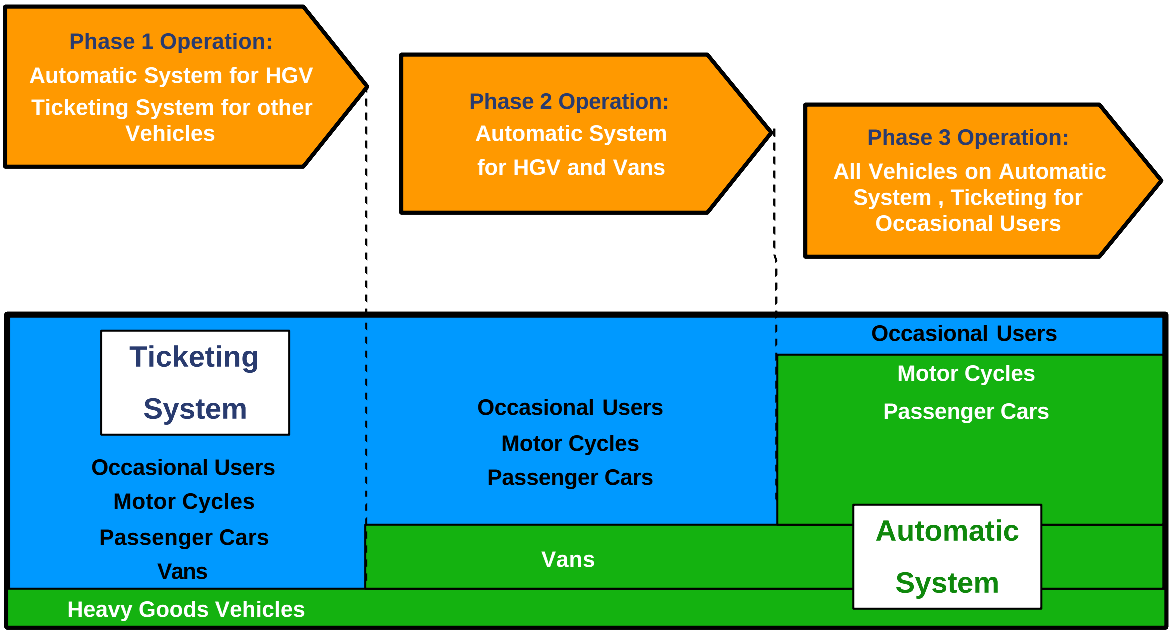


**Figure 5-2: Stepwise introduction of the automatic system**

To achieve an equal burden on the OBU distribution net, the distribution of OBU´s should be continuous and linear. The distributed OBU´s can be initiated for automatic charge collection in one big initiation step at the end of the respective phase (as shown in above diagram), or continuously as they are installed in the vehicle. The organizational and technical impact /merits of these options need to be investigated in more detail to arrive at a well-founded decision in due time.

## 5.3 System Implementation Schedule

The overall implementation schedule consists of the development phase and the step-wise roll-out and start of operation of the OBU as described above. The following chapters summarize the major work streams and their duration.

### 5.3.1 Development Phase

The development phase is mostly driven by the effort

- to specify, develop, test and certify the new OBU hardware and software
- to integrate components and system segments: charging, central services- and en-forcement system,
- to run necessary tests : from component tests to pilot test for system qualification and certification
- to register all vehicles in the KMP system

- to build-out the OBU logistics/distribution net and roll-out the OBU.

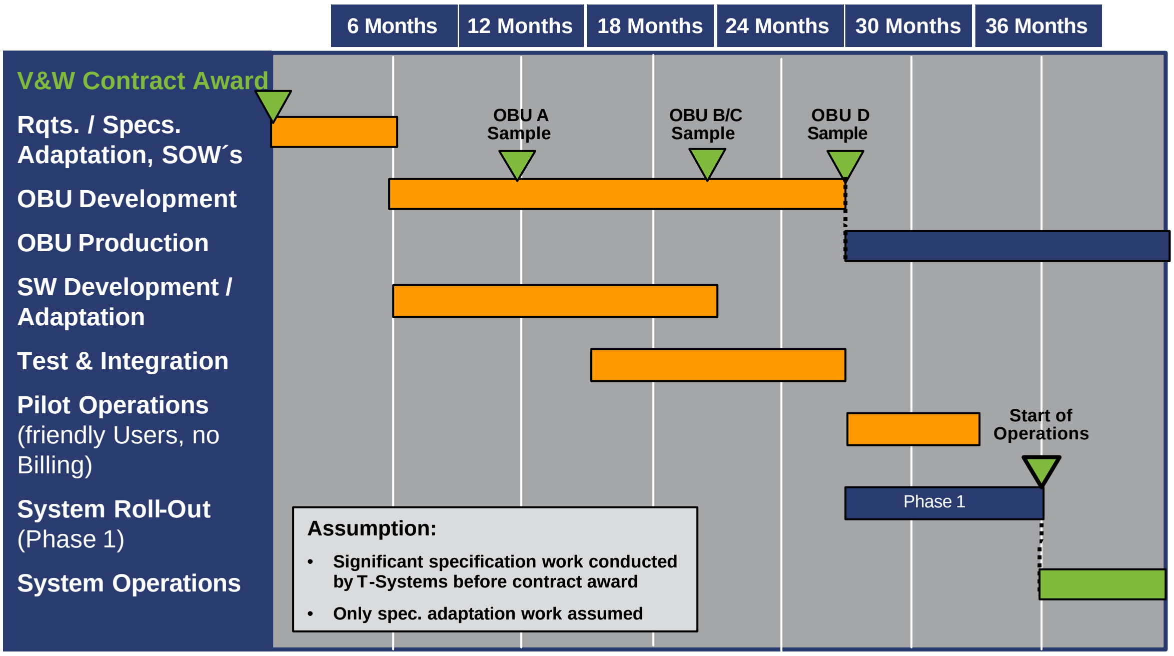


**Figure 5-3: Development Schedule**

Figure 5-3 gives an overview of the major development steps, and the respective time-frame. The estimates are based on T-Systems´ experience gained in the implementation of the road charging system in Germany, which can serve as a concrete precedence. The development of the OBU and build-up of the production lines is characteristic for the realization of automotive electronic equipment, which typically reaches the production-ready status in 4 model steps (A-, B-, C,- and D-Model) of increasing device maturities. This approach is on the critical path and determines the overall duration of the development phase.

Development starts with the award of the contract by V&W (marked as "X"). The overall time to implement Phase 1 adds up to 36 months. Underlying this estimate is the assumption that significant specification work for a next generation OBU, that T-Systems is conducting already, will be re-usable in a way that only adaptations to these specifications, based on NL requirements, need to be done.

## 5.3.2 Overall Schedule for System Implementation

As described in 5.1.2 T-Systems Satellic proposes a 3-phased process for the overall for system implementation. Figure 5-4 maps this overall implementation process on a time-line.

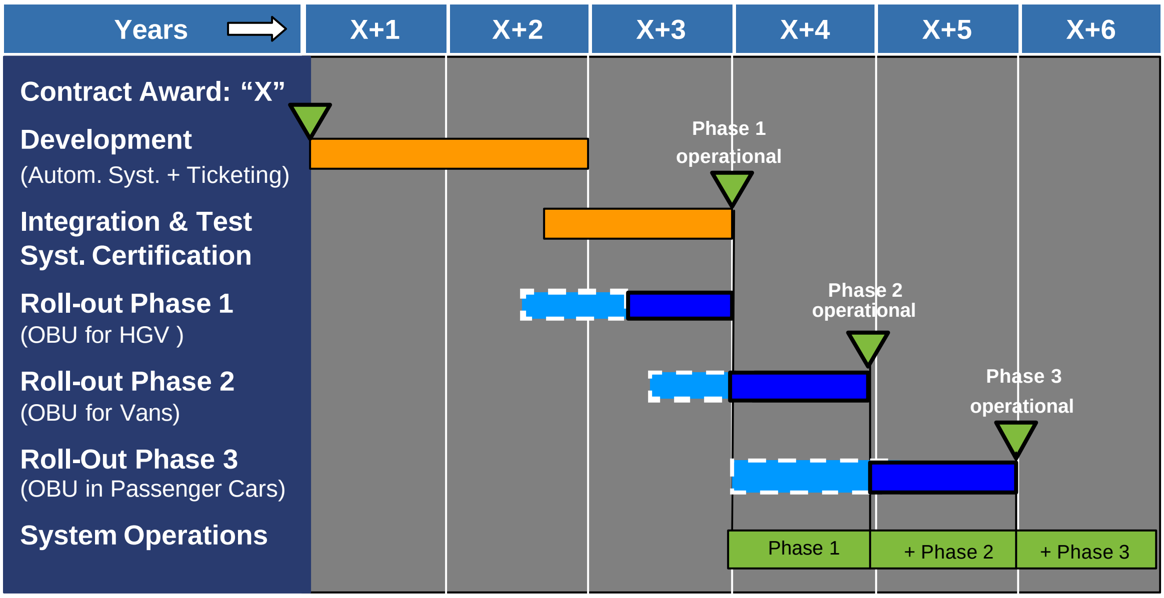


**Figure 5-4: Overall Schedule for System Implementation**

Major time blocks in the overall KMP system implementation will be:

- The development of system components, their integration and testing as described in chapter 5.3.1
- The establishment and build-out of the OBU distribution net: It is planned to establish a basic distribution infrastructure to support HGVs which then will be extended continually to accommodate vans and passenger cars. Similarly the capacity of the data centre, enforcement system and all organisations supporting system operations will be increased in a step-wise manner.
- The roll-out of the system: OBU distribution and testing, including pilot tests and certification for operation are planned to be conducted in phases of 12 months each.

If V&W will adhere to the current KMP acquisition plan, which foresees a contract award end of 2009, the first phase of system implementation can start operation in 2012. The system will reach full operational capability (all vehicles equipped with an OBU and subject to KMP) in 2014, 2 years after initial operation.

## 5.4 Rational for proposed Solution

The proposed migration solution combines two major objectives:

- It introduces the scheme on all roads and for all vehicles and will so provide the means to better control traffic on a national scale and will be fair to all user groups.
- It introduces the automatic system in logical steps and thus reduces the overall technical and financial risks down to a level that can be controlled and carefully managed.

Based on the top-level assessment criteria, derived from the Statement of Work, the following rational is underlying the migration solution proposed by T-Systems Satellic:

- **Risk Mitigation**: The introduction of the OBU to approx. 8 million vehicles is a challenging undertaking. By segmenting the vehicles into three classes, which will be equipped with OBUs in three sequential phases of increasing quantities, the complexity of the implementation can be significantly reduced. There are opportunities to further segment the large class of passenger vehicles by prioritizing heavily used vehicles (e.g. leased cars). By implementing the automatic system in the HGV first, the transport industry will not be subject to the more manual ticketing process. The transport sector - to a large extend - is familiar with tolling in other EU countries, which will make system introduction easier. The ticketing system will also be a straightforward solution, easy to handle. It will not just be the entry system for a broad range of users but also a fall-back in case of OBU malfunctions. Finally it will support the Occasional Users.
- **Quick Wins**: From its start of operation, the system will provide means of traffic control for all vehicle classes on all roads and thus cause early mobility gains and relief of the burden on the environment. The HGVs will have full KMP functionality already in phase 1. The ticketing tariffs can be structured in a way to achieve maximum traffic control, e.g. peak-hours or areas of heavy traffic will see less traffic congestion at the earliest point in time.
- **User Acceptance**: The implementation approach is straightforward and easy to communicate and understand by the users. The ticketing process will be made simple and not mean a heavy workload on the users. System introduction is fair, since all user groups are affected equally. There is no discrimination of foreign drivers. Early mobility gains will be visible and will contribute to user acceptance.
- **Minimum Costs**: The system will – to the extent possible - rely on proven technologies, business processes and organizational structures. We will fully capitalize on technical progress and competition, e.g. in the development and production of the "mass market" OBU. The implementation steps will be carefully planned and coordinated so that investments made in previous phases can be re-used in subsequent phases (no obsolete "throw-away" solutions).
- **Toll Road Integration**: Existing or emerging toll systems (toll objects) can be integrated into the national scheme for vehicles using the automatic system. For HGV toll roads can be integrated in the initial phase of system operation. The tariff structure of the ticketing system can also be designed to cover existing toll roads for vehicles not (yet) equipped with an OBU.
- **EU Compliance**: The implementation approach is compliant with EU recommendations and allows following EU standardization efforts. T-Systems Satellic supports the EU Road Charging Interoperability Project and will be best qualified to implement emerging interoperability standards.

# 6 Risk Analysis

In any major system development there are considerable risks involved that can endanger a successful system implementation and operation. Careful management of such risks is an absolute essential task of project management. Risks must be identified early in the project life cycle and continuously monitored and assessed during the planning, implementation and operations phase. Risk mitigation measures must be planned and implemented in the system design as well as all business and project management processes.

## 6.1 Risk Overview

Risks can be of political, organisational, technical or financial nature. They can cause significant delays and cost overruns or even be fatal for the project. The following diagram gives an overview of the most important risks allocated to the three project phases: **"Plan, Build and Run"**. The risk identification and assessment is based on T-Systems Satellic's experience, resulting from the implementation and operation of Europe's largest road charging system for trucks as well as the participation in major road charging tender processes in Europe.

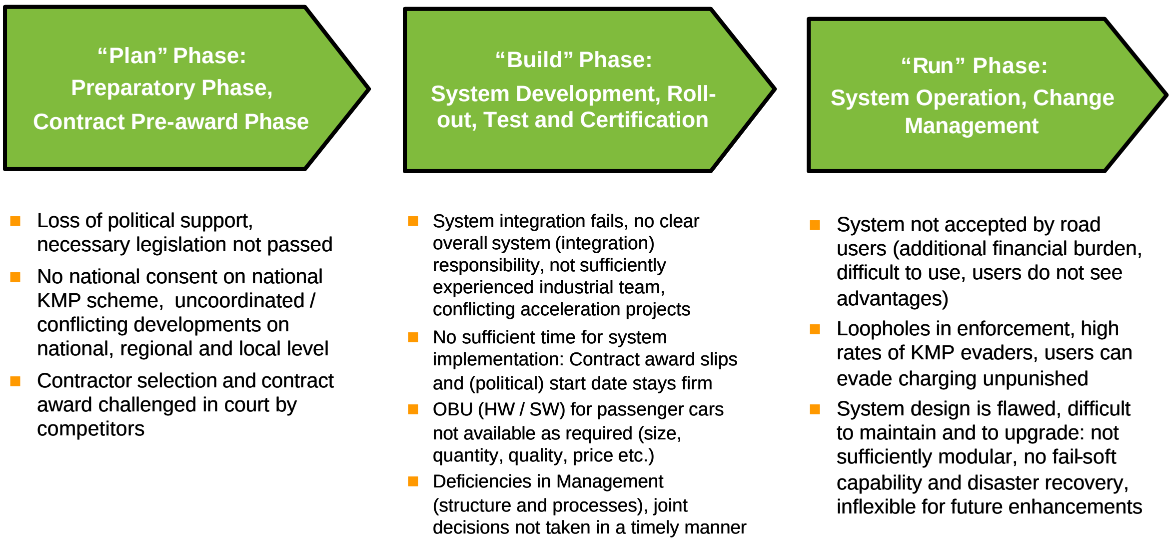


**Figure 6-1: Risks allocated to the project phases**

During the **"Plan Phase"**, which lays the foundation for a successful system implementation, a stable legislative basis for the KMP scheme must be established, a national framework KMP scheme must be coordinated and frozen and a migration and procurement master plan must be put in effect. The responsibility in this phase rests with the Principal.

A successful **“Build Phase”** strongly depends on: the assignment of clear industrial leadership and overall integration responsibility to an experienced and financially strong company, the allotment of sufficient time for system development testing and certification as well as the preparation of system operation, the timely availability of a highly integrated and economical OBU in large quantities and the establishment of efficient management structures and processes to guarantee rapid joint (industry/Principal) decisions.

Essential for a successful **“Run Phase”** is a high degree of user acceptance. Road users must understand the purpose of the system and must not be overwhelmed by a complicated usage burden. The system must be fair and just to all users. KMP evasion must be detected and punished appropriately. To guarantee reliable system operation and enable further evolution, the system must be designed for maintainability and efficient implementation of future changes and enhancements.

## 6.2 Risk Inventory and Assessment

The risk inventory (see Annex C) gives an overview of the supreme risks to be encountered in the procurement and operation of the KMP system from an overall system perspective.

We are using the description scheme as provided by the Principle. Because of the early stage of the project and system-level character of the described risks however we believe that a quantified estimation of the risk consequences and calculation of a risk severity index at this point in time would be premature. We rather suggest a qualitative (tendency) approach with the following levels: **Probability** (low, medium and high) and **Consequence** (minor, significant and severe).

T-Systems Satellic emphasizes the fact that the planning or preparatory phase (pre-contract award) is of vital importance to the overall success of the project: broad and enduring political support must be established, a clear and coordinated vision of the national scheme must be defined and a procurement approach with clear responsibilities must be implemented and strictly pursued. This responsibility rests with the Principal. In the later phases the responsibilities - to a large extent - will shift to the private sector. It is therefore important, that a strong industrial team will be selected, with clear leadership and integration responsibility of a company that is financially strong, technically capable and has a broad background in road charging.

Risk management must be established as a management discipline with highest visibility. It must be continuously pursued over the lifespan of the project and must include all stakeholders of the KMP system.

# 7 Comments on Requirement Specifications

T-Systems Satellic has commented on the KMP Requirements Specifications in the working paper: "KMP MC Working Paper V1.0 100506 Final", submitted to V&W on 10 May, 2006. For the time being we do not have any further comments.

# List of Abbreviations

| | |
|---|---|
| **ACD** | Automatic Call Distribution |
| **CTI** | Computer telephony integration |
| **CRM** | Customer Relationship Management |
| **DSRC** | Dedicated Short Range Communications |
| **DMS** | Document Management System |
| **EMo** | Mobile enforcement units |
| **EOP** | Enforcement Offence Proceedings |
| **ERP** | Enterprise Resource Planning |
| **ESt** | Stationary enforcement units |
| **GIS** | Geographic Information System |
| **HMI** | Human Machine Interface |
| **HWN** | Hoofdwegennet |
| **IVR** | Interactive Voice Response |
| **KPI** | Key Performance Indicators |
| **LPN** | Licence plaid number |
| **OOC** | OBU Operation Centre |
| **OCR** | Optical Character Recognition |
| **OBU** | On Board Unit |
| **ODM** | Operation Data Management |
| **OUS** | Occasional User Sceme |
| **OWN** | Onderliggend/Overig wegennet |
| **PIN** | Personal Identification Number |
| **POS** | Point of Sales |
| **PRB** | Pre-Billing |
| **PKI** | Private Key Infrastructure |
| **SAM** | Secure Application Module |
| **SB** | Support Beacon |
| **SSC** | Storage and Security Chip Card |

| | |
|---|---|
| **SSL** | Secure Sockets Layer |
| **TE** | Trusted Element |
| **WEEE** | Waste of Electrical and Electronic Equipment |

# References

The following documents were used as baseline in our study:

'Het Kan !', ('It is possible'), 'Eindrapportage Techniek, Organisatie, Handhaving en Kosten van Anders Betalen voor Mobiliteit' en 'Bijlagenrapport Het Kan !'; LogicaCMG, Cap-Gemini, Get ID; 14 juni 2005.

'Requirements Specification "Anders Betalen voor Mobiliteit" '; version 0.2 (draft); 27 maart 2006.

'Guidelines and standard format for KMP cost estimates phase 2'; version 1.0; under construction.

'Clarifications on Price per Kilometer Cost Estimates 2005'; Ministerie van Verkeer en Waterstaat; version 12042006.

'Guidelines for risk assessment'; version 1.0; under construction.

'Tariff scheme scenarios'; version 1.0; under construction.

“Bijl1 Statement of Work Subject 1, 19 mei 06”

# Annex A Enforcement Concept

The main purpose of the enforcement system is to ensure the correct usage of the tolling system. Therefore it is needed to perform roadside inspections, gather evidence records of violators and conduct the penalty process in the central system.

To determine the necessary quantity of the enforcement units a simple model is used depending on the statistical data provided by the government. In general one has to distinguish between foreign and national users of the tolling system. The foreigners will use the road net just for the journey whereas the local user will use the net all around the year. Therefore the foreigners have to be inspected during their journey, which will be mainly (85%) on the main road network (HWN, Hoofdwegennet). With an average travelled distance of 150 km per journey on HWN the total number of stationary enforcement units needed as described in chapter 2.1.4.1 is calculated by the length of the HWN for both directions (2*3268 km), divided by the average distance of 150 km. This results in a quantity of 44 enforcement units. As described in chapter 2.1.4.3 additional mobile enforcement units are planned to add some unpredictable enforcement means. With an estimated coverage of 400 km per mobile enforcement unit on HWN one will need additional 16 units for the inspections mainly on HWN.

For the local user the main parameter isn't the number of journeys but a requirement like the average time span between two inspections per. This enforcement pattern holds as long as the value of the penalty is at least as high as the average toll charged in that period or there is an increase in the penalty for frequently violators. On the HWN these vehicles are enforced as described above. Additionally portable enforcement units as described in chapter 2.1.4.2 will be used to inspect these vehicles on the secondary and other road network (OWN, Onderliggend/Overig wegennet). These units cover approx. 100 vehicles/hour. Therefore the number of units calculates as follows (the average time span between two inspections is assumed to be 30 days)

$$\frac{Numberoflocalvehicles}{ControlRatio * ControlHours * ControlDays} = \frac{8786000}{100 * 12 * 30} \approx 244 Units.$$

These units could be operated by local Authorities, which could cover the costs by an administrative fee in analogy to speeding tickets.

The data collected for occasional users, which may use the ticketing system on the HWN, contains the licence plate number and the visible classification parameters for matching with the data provided by the ticketing system. For vehicles with an OBU, the main parameters can be retrieved via the DSRC connection and therefore just the parameters that can be changed (e.g. trip with/without additional trailer) have to be checked by the enforcement units. These additional parameters do not have to be checked on the OWN because vehicles with additional trailers will mainly use the HWM and therefore be inspected by the enforcement units on the HWN. Therefore the work for manual inspection of the evidence records in the Enforcement Central gained on OWN and HWN differ. For HWN records an additional inspection of the classification of the vehicle has to be conducted, whereas for the OWN data only the usability of the evidence records has to be checked.

# Annex B Basic Migration Scenarios

## B.1 Introduction

This Annex summarizes some information concerning the analysis of different migration scenarios, which was conducted to derive a migration approach viewed as most suitable to the Dutch requirements and frame work conditions.

To assess different scenarios, T-Systems Satellic has defined some top-level evaluation criteria, which are described in Chapter B.2. These criteria have been derived from the statement of work given by the Principal. In Chapter B.3 an overview of the basic scenarios considered is given. Chapter B.4 summarizes the pro´s and con´s of the assessed scenarios.

## B.2 Evaluation Criteria

To assess the suitability of considered migration scenarios in a comparative way, aligned with the stated criteria in the Statement of Work, the following set of top-level criteria was used for the scenario evaluation:

| Criteria | Description |
| --- | --- |
| **Risk Reduction** | Potential to mitigate technical and financial risks by:<br>• Reduction of complexity, e.g. by limiting the number of vehicles (OBUs) to be covered per implementation step<br>• Application of proven technologies, organizational structures and processes<br>• Enable learning curve: Capitalize on operational experience (lessons learnt) to improve following steps etc.<br>• Take advantage of advancements of technology (e.g. OBU integration) to provide cost-effective, future-proof solutions |
| **Quick Wins** | Create and make visible quick success to users and politicians e.g.:<br>• Reduction of congestions (mobility gains)<br>• Reduction of burden on environment<br>• Revenues to improve road infrastructure or public transportation |

| Criteria | Description |
|---|---|
| **User Acceptance** | • Simplicity and efficiency of the scheme<br>• Minimization of burden (complexity) for the user (degree of automation)<br>• Fairness to different user groups (balance of burden)<br>• Minimization of loopholes for charge evasion<br>• Transparent implementation approach, easy to communicate and understand |
| **Minimum Costs** | Potential to minimize development-, investment- and operational costs by:<br>• Use of available technology to the extent possible<br>• Avoidance of throw-away solutions (re-use of investments of previous implementation steps in subsequent steps)<br>• Procurement, especially of large-quantity items (e.g. passenger car OBU), as economical as possible<br>• Design of the system for maintainability and future extentability (scheme changes, new services, new technologies) |
| **Integration of other Systems** | Design system to allow integration of existing or emerging local or regional charging systems<br>• Technical system architecture<br>• Business processes<br>• Operational organisation |
| **EU Compliance** | Adherence to EU Directives (eg 2004/52/EC) and Recommenda-tions concerning<br>• Introduction of road charging for different vehicle types<br>• Basis for Electronic Fee Collection Service (EFC) |

**Table B-7-1: Evaluation Criteria**

## B.2.1 Generic Scenarios

### B.2.1.1 Overview

In designing a migration approach, three different generic implementation scenarios have been considered (see the following diagram):

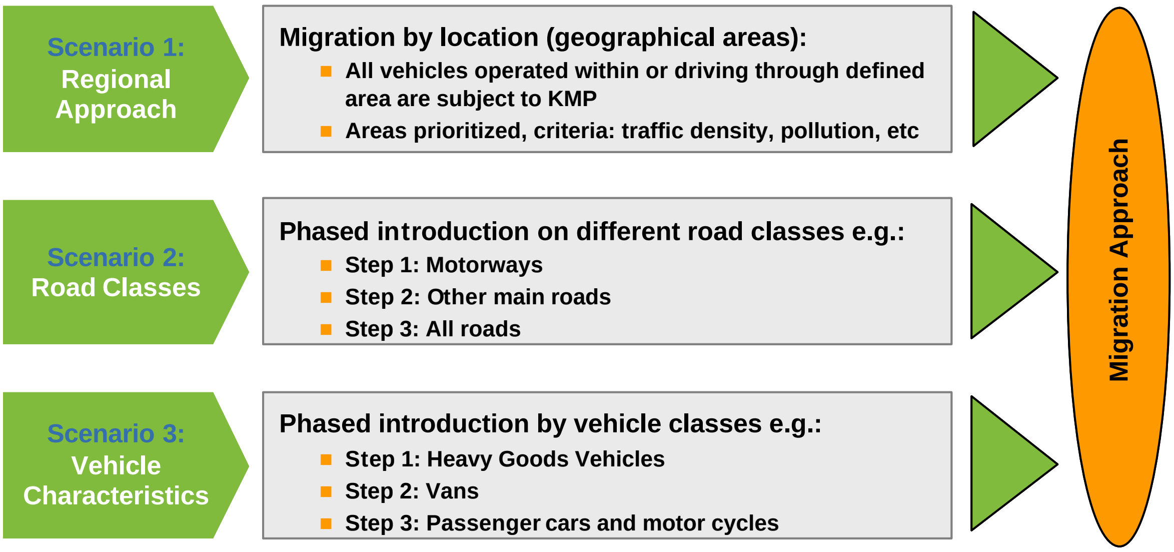


**Figure B-1: Generic implementation scenarios**

- **Regional Approach:** Selected regions (e.g. inner cities, bridges, tunnels or segments of roads) with high traffic densities are designated as charging area. All vehicles operated inside or transiting such areas are subject to charging (rates mostly not distance-based).
- **Introduction by Road Classes:** Charging will be introduced to distinct road classes (e.g. motorways / main roads, secondary roads and all other other roads) on a national basis in a step-wise manner. The charge will be distance-based.
- **Introduction by Vehicle Classes:** Different vehicles – according to their characteristics - are grouped in vehicle classes (e.g. HGV, vans, passenger cars, motorcycles), which will sequentially become subject to charging on all roads on a nation-wide basis. The charge is distance-based.

The approach to be taken can be a combination of these generic scenarios, e.g. vehicle classes on different road classes or in different charged regions.

## B.2.2 Summary Pro´s and Con´s of generic Scenarios

Each of these generic scenarios has its advantages and disadvantages. The following table will briefly summarise the pro´s and con´s of above generic scenarios.

| Scenario | Pro´s | Con´s |
|---|---|---|
| **Regional Approach** | • Risk reduction by reduction of complexity per region<br>• Focus on congestion areas, quick wins possible in these areas<br>• Deployment only in region, costs per region are limited | • Multitude of “insular” projects difficult to manage<br>• Integration into national system difficult<br>• No significant reduction of initial OBU quantities<br>• Possible loss of investments (lack of re-usability in national system)<br>• No nation-wide traffic control initially<br>• Lack of fairness: resident users are affected the hardest |
| **Introduction by Road Classes** | • Investment can be targeted to road class charged (e.g. enforcement)<br>• Possible quick mobility progress on selected roads<br>• All users groups affected (fairness)<br>• No “throw-away” investments if planned carefully | • No significant reduction of initial complexity (OBU distribution)<br>• Increase of traffic on uncharged roads<br>• Initially no traffic control for all roads nation-wide |
| **Introduction by Vehicle Classes** | • Reduces initial complexity (OBU distribution) significantly (risk reduction)<br>• Allows defined logical introduction steps with increasing vehicle numbers<br>• Avoids discontinuities and loss of investments<br>• Allows early start of the scheme<br>• Allows nation-wide traffic control for vehicle classes subject to the scheme | • Quick wins limited to vehicle classes subject to the scheme<br>• Lack of fairness: Possible resistance of user groups affected first<br>• Phased introduction causes long implementation time for national system<br>• For enforcement purposes, selection of vehicle classes must allow differentiation with technical means |

**Table B-2: Pro’s and Con’s of generic Scenarios**

# Annex C Risk Inventory and Assessment

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| 1. | Necessary legislation not passed | • Loss of public support for KMP<br>• Loss of political support<br>• Other priorities of new Government<br>• Change of responsibilities in the administration | • Fatal for KMP or<br>• Major delay (back to the drawing board)<br>• Waste of Government and industry resources | Probability: low<br>Consequence: severe | Pre-tender Phase | • Communicate advantages of KMP (mobility, accessibility of cities, environment)<br>• Gain support across the political parties<br>• Involve provinces, regions and communities as well as the private sector | Public |
| 2. | No national consent on KMP scheme | • Unstable political objectives (e.g. traffic control or source of revenue, allocation of revenues etc.)<br>• Conflicting interests of stakeholders (national, regional, local, user associations etc.) | • Instable requirements basis,<br>• Uncoordinated projects on national, regional and local level<br>• Delays and cost overruns | Probability: medium<br>Consequence: severe | Pre-tender Phase | • Approval / freeze of a national framework KMP scheme<br>• Cooperation and coordination between national, regional and local Authorities as well as the private sector<br>• Coordinated plan for change management | Public |

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| 3. | Tender selection appealed in court | • Loosing bidders see chances to change result of tender or<br>• Want to delay contract award to winning bidder | • Severe delay of contract award to be expected (up to 1 year)<br>• Political intervention possible<br>• KMP Scheme subject to reconsideration | Probability: high<br>Consequence: significant | Tender Phase | • Strict compliance with national and EU procurement regulations<br>• Adherence to approved procurement plan<br>• Transparent bid evaluation procedures and criteria | Public |
| 4. | Selected industrial team not up to the job | • No clear leadership and overall system integration authority<br>• Leading contractor and subcontractors not sufficiently qualified: resources, experience, financial strength<br>• No track record in working with public sector<br>• No integration role for implementation and operation of acceleration systems | • Conflicts and discontinuities in industrial team,<br>• Severe delays<br>• Cost overruns<br>• Possibly bankrupts and re-structuring of contract and industry team | Probability: medium<br>Consequence: severe | All Phases, mainly Development Phase | • Selection of capable, experienced and financially strong industrial team with clear leadership and integration responsibility for overall system<br>• Leading contractor awards and controls contracts with subcontractors<br>• Adequate contract (Principle / consortium)<br>• Approved system implementation master plan for national, regional and local systems. | Public: Contractor selection and structure of contract<br>Private: System design, selection and control of subcontractors |

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| | | | | | | • Joint organization and processes to coordinate national, regional and local developments<br>• Regular and comprehensive reporting: Industry – Principal - Parliament | |

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| 5. | No sufficient time allowed for system implementation | • Contract award delayed, but start of operation stays fixed (political date)<br>• Changing requirements during system implementation<br>• Premature OBU distribution, possibly call-backs<br>• Effort for system integration, roll-out, test & certification underestimated<br>• Political pressure to start system operations prematurely | • Delays,<br>• Cost overruns<br>• Loss of KMP revenues<br>• Damage to reputation of Principle and industry<br>• Possible loss of political support | Probability: low<br>Consequence: severe | Contracting Phase and Development Phase, TTO | • Allow sufficient time for system development, integration, test and certification<br>• Date for start of operations should not become "political"<br>• Select strong and experienced industrial team<br>• Implement and strictly apply change management system<br>• TTO only after thorough testing and pilot operation | Public: Contract<br>Private: Planning and system implementation |
| 6. | OBU not available in time, required quality or quantity and at forecasted costs | • No sufficient supplier effort<br>• Technical progress (chip sets, integration etc) does not materialize as planned<br>• OBU applications and HW / SW integration flawed | • Delays<br>• Cost overruns | Probability: low<br>Consequence: severe | Development and Roll-out Phase | • Build on existing OBU experience<br>• Initiate development early<br>• Cooperate with experienced suppliers<br>• Procure OBU in competition<br>• Multiple sourcing | Private |

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| 7. | Joint (Principal / industry) management decisions not taken in a timely manner | • Inefficient cooperative management structures and processes<br>• Lack of cooperation and mutual trust<br>• Lack of understanding of responsibilities and roles<br>• Services to be furnished by Principle not delivered as necessary | • Delays and cost overruns | Probability: low<br>Consequence: severe | Development and Roll-out Phase | • Thorough planning<br>• Clear definition of cooperative roles<br>• Agreement on joint management structures and procedures<br>• Agreement on services, infrastructure, equipment to be furnished by the Principal | Private: Plans, management structures and procedures<br>Joint: Cooperation<br>Public: furnish necessary services and equipment |
| 8. | Start of system operation fails | • System not fully integrated and not tested thoroughly enough<br>• Transition to operation (TTO) not sufficiently prepared, system start premature<br>• System too difficult to handle, lack of user acceptance<br>• Road user groups not sufficiently informed, do not co- | • User protests (possibly boycott)<br>• Loss of KMP revenues<br>• Damage to image (industry and public)<br>• Loss of public and political support<br>• Possibly cancellation of project | Probability: low<br>Consequence: severe | Transition to Operation and Operations Phase | • Thorough testing, pilot operation and certification<br>• Implementation of user-friendly technologies (high degree of automation)<br>• Careful planning and preparation of TTO<br>• Professional PR/ communications campaigns to all target groups | Private: Planning, technical system and business process, testing<br>Joint: Communication, PR campaign<br>Public: Coop- |

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| | | operate<br>• Acceleration projects not fully integrated | | | | | eration during testing, certification and TTO |

| # | Risk Event | Risk Source | Consequence | Severity Index | Phase | Mitigation Measure | Risk Owner ( |
|---|---|---|---|---|---|---|---|
| 9. | High percentage of KMP evasion | • Loopholes in enforcement technology<br>• Insufficient deterrent to road users<br>• Violations are not reliably fined or prosecuted<br>• Enforcement means not visible enough | • Loss of KMP revenues<br>• Lack of credibility with users | Probability: Medium<br>Consequence: significant | Operations Phase | • Comprehensive enforcement concept<br>• High degree of enforcement automation<br>• Enforcement means and units visible on the roads<br>• Fines and punishment will constitute significant deterrent<br>• Strict collection of fines and prosecution | Private: technical enforcement means<br>Public: sovereign task (prosecution) |
| 10. | System modifications or upgrades cannot be implemented | • System not designed for growth or changes | • System maintenance is very costly<br>• Changes to the scheme or additional functions will require redesign<br>• EU interoperability difficult | Probability: medium<br>Consequence: significant | Operations Phase | • Modular system design<br>• Defined/standardized interfaces<br>• Use of off-the-shelf products<br>• Close monitoring and support of the development of EU interoperability standards | Private |

**Table C-1: Risk Inventory and Assessment**

# Annex D Dialogue

T-Systems Satellic would very much welcome the opportunity and appreciate to continue an open and frank dialogue with the Dutch authorities and thus contribute to a most reliable and cost-effective KM pricing solution for The Netherlands.

For any request or comments please use your T-Systems contact in


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# Annex E T-Systems

T-Systems is one of the three business divisions of Deutsche Telekom AG, Europe's largest telecommunication and information technology services group. The other divisions are T-Com (fixed network communications, internet/online and mass-market access) and T-Mobile International (mobile communications).

The following picture provides some key facts and figures about Deutsche Telekom AG.

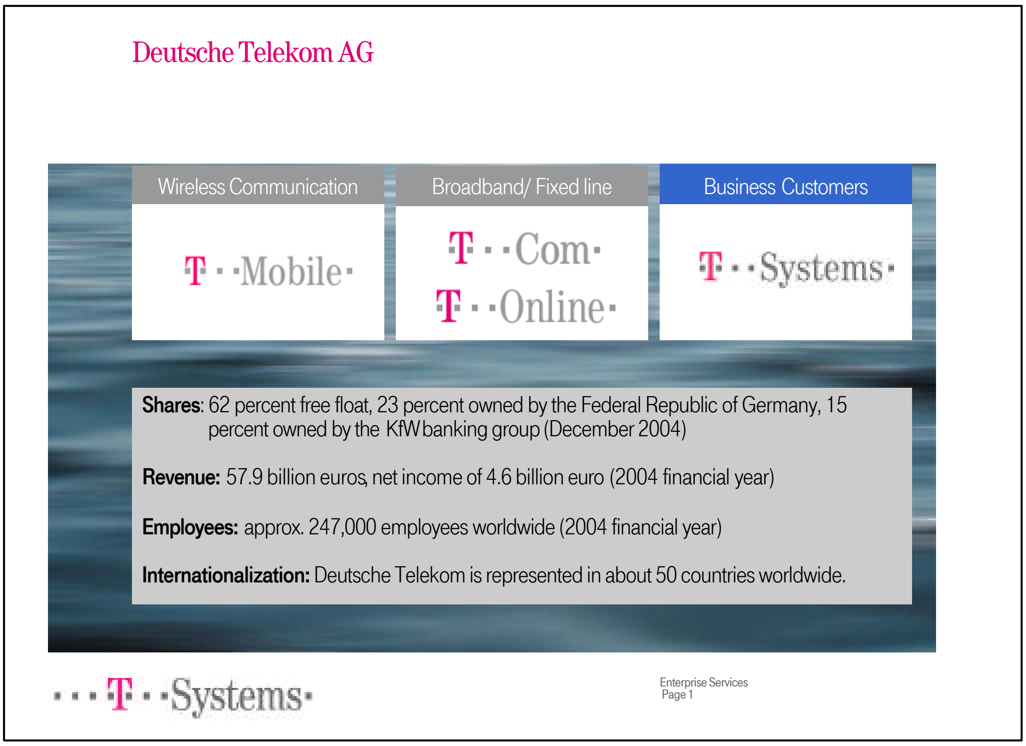


**Figure E-1: Facts and figures about Deutsche Telekom AG**

T-Systems is a leading European information and communications technology company with annual revenues of some 12.9 Bn EUR. T-Systems currently has a workforce of some 52,000 employees in 20 countries, including highly-skilled personnel with comprehensive hands-on experience of large-scale projects.

T-Systems subsidiary in The Netherlands is T-Systems NL, which is headquartered in Vianen.

T-Systems has a proven track record of integrating challenging IT systems and achieving high service levels in very large and highly complex environments. It has engineered its processes utilizing the industry standard IT Infrastructure Library (ITIL). Gartner Group say T-Systems “can capably provide for the entire value chain”.

As a major contractor in the implementation and operation of the German satellite-based road charging scheme T-Systems

- successfully integrated the overall system,
- developed the central services application software,
- implemented and is operating the data centre and
- provides mobile and fixed network telecommunication services.

The learning experience of the German road charging project has provided T-Systems with a unique and invaluable insight into the realities (both technical and operational) of rolling out a nationwide road user charging system. T-Systems has demonstrated technology flexibility and will further develop these system capabilities for other km-pricing systems.

T-System closely follows the road charging standardizations efforts of the European Commission and is a leading partner in the EU RCI project, an initiative to lay the groundwork for future European Road Charging Interoperability.

To get a most comprehensive picture of future road charging requirements, T-Systems closely co-operates with Toll Collect and is in close contact with responsible Authorities in other countries. In working with important technology suppliers, T-Systems also stay abreast with all technology developments relevant to KM Pricing.

**Satellic Traffic Management GmbH**

Satellic Traffic Management GmbH (Satellic), a member of T-Systems, is a global technology leader and service provider for the development and operation of electronic road charging systems based on satellite technology (GPS, Galileo). The company is forging ahead with the technological development of the pioneering system introduced by Toll Collect in Germany. Satellic is driving the international expansion of the new road charging technology.

Working in close cooperation with national traffic policymakers, Satellic goes beyond simply delivering the required technology, and as such is able to structure the complete process of system introduction and subsequent road charge collection. The company combines its technological expertise with comprehensive experience gained from the introduction and operation of the world’s first satellite-based road charging scheme, which was successfully launched in Germany on 1 January 2005. This successful model is currently operated by Toll Collect on behalf of the Germany Transport Ministry and is applicable to trucks weighing 12 tones or more operating on German motorways. T-Systems is one of Toll Collect’s key partner companies and system suppliers.

Founded in Berlin in 2006, Satellic is establishing itself as a technological leader in the field of info mobility. This involves modern information and communication technologies for sustainable mobility in passenger and goods transport. In partnership with key transport policy makers and authorities, Satellic deploys satellite-based road charging systems to facilitate the efficient utilization of existing transport infrastructures, thereby enhancing the free-flow of traffic that is both safer and more environmentally responsible.